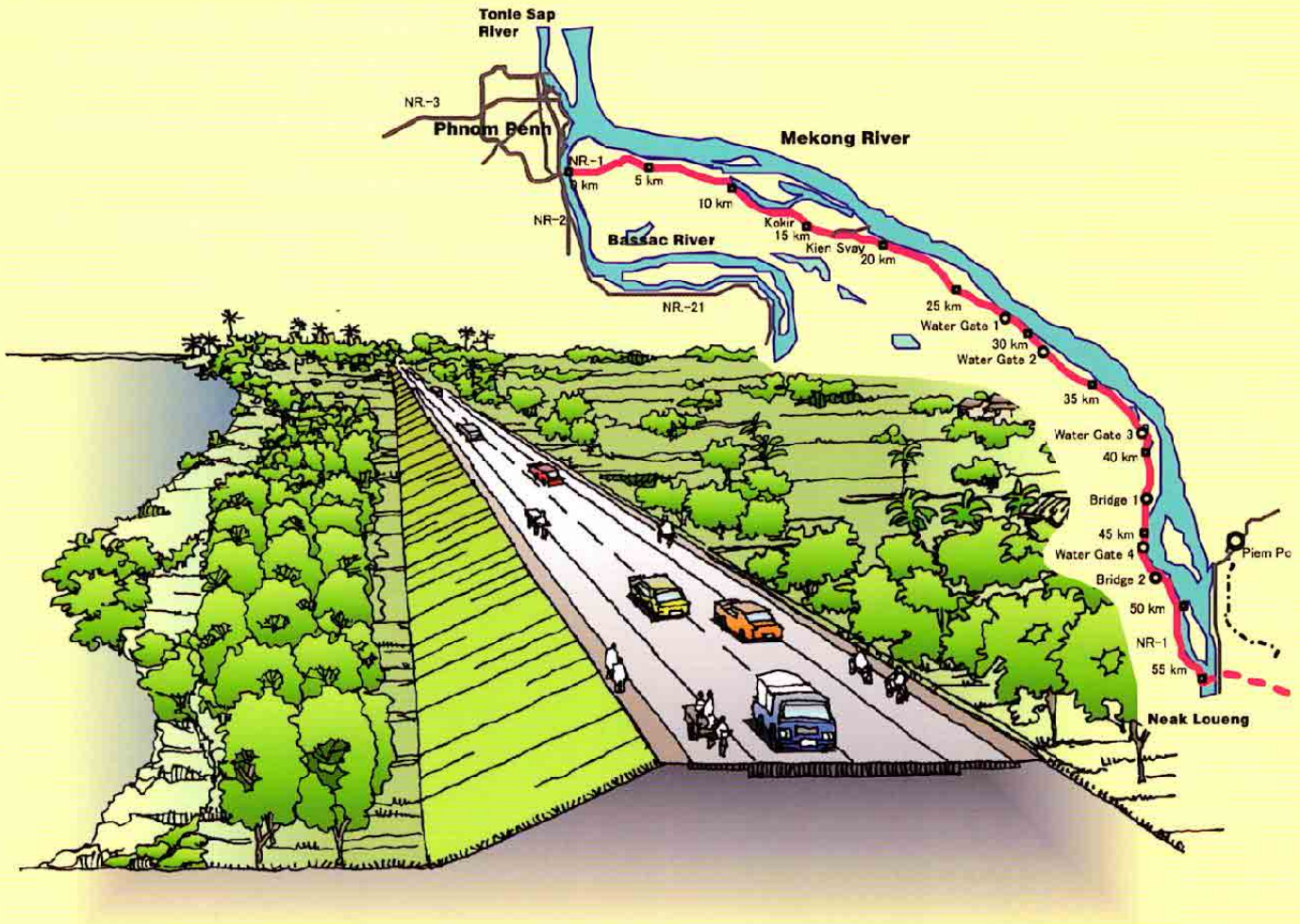
No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC WORKS AND TRANSPORT (MPWT)
THE ROYAL GOVERNMENT OF THE KINGDOM OF CAMBODIA

THE FEASIBILITY STUDY ON
THE IMPROVEMENT OF NATIONAL ROAD No.1
(PHNOM PENH - NEAK LOUENG SECTION)
IN THE KINGDOM OF CAMBODIA

FINAL REPORT



Vol.1 MAIN REPORT

March 2003

PACIFIC CONSULTANTS INTERNATIONAL
KATAHIRA & ENGINEERS INTERNATIONAL

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The following foreign exchange rate was applied in the study:

US$ 1.0 = JP¥ 120 = Reil 3,990 (as of October 2002)

PREFACE

In response to the request from the Royal Government of the Kingdom of Cambodia, the Government of Japan decided to conduct the feasibility study on Improvement of National Road No.1 (Phnom Penh ~ Neak Loueng Section) in the Kingdom of Cambodia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA dispatched a study team headed by Mr. Kenji Maruoka of Pacific Consultants International and consisting of Pacific Consultants International and Katahira & Engineers International to the Kingdom of Cambodia, three times between May 2002 and January 2003. In addition, JICA set up an Advisory Committee headed by Mr. Yukitoshi Fujishima of Japan Highway Public Corporation between May 2002 and January 2003, which examined the Study from specialist and technical point of view.

The team held discussions with the officials concerned of the Royal Government of the Kingdom of Cambodia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Royal Government of the Kingdom of Cambodia for their close cooperation extended to the team.

March 2003

Takao Kawakami
President
Japan International Cooperation Agency

March 2003

Mr. Takao Kawakami
President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit herewith the Final Report of "The Feasibility Study on Improvement of National Road No.1 (Phnom Penh ~ Neak Loueng Section) in the Kingdom of Cambodia".

The report contains the results of the study, which has been carried out by Pacific Consultants International in association with Katahira & Engineers International between April 2002 and March 2003. The report consists of four volumes, Summary, Main Report, Appendix, and Drawings.

The Summary briefly illustrates the findings in the study. The Main Report consists of 17 chapters and presents traffic demand forecast, engineering designs, road operation and maintenance plan, environmental conditions, project implementation plan, economic and financial analysis and conclusion and recommendations for the project implementation. It recommends that the institutional arrangements for project implementation should be organized as soon as possible.

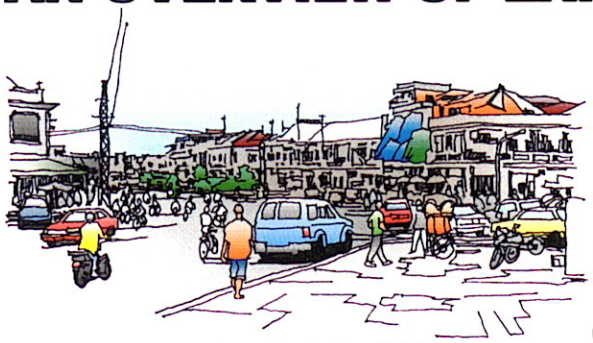
We wish to express our greatest appreciation to officials of the Ministry of Public Works and Transport and the Royal Government of the Kingdom of Cambodia for their assistance extended to the Study Team, and also to the personnel of your Agency, the JICA Advisory Committee, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and the Embassy of Japan in the Kingdom of Cambodia. The Study Team sincerely hopes that the results of the Study will contribute to the improvement of road in Cambodia.

Yours faithfully,

Kenji Maruoka
Team Leader
The Feasibility Study
on Improvement of National Road No.1
(Phnom Penh ~ Neak Loueng Section)
in the Kingdom of Cambodia

AN OVERVIEW OF EXISTING CONDITIONS ALONG NATIONAL ROAD No.1

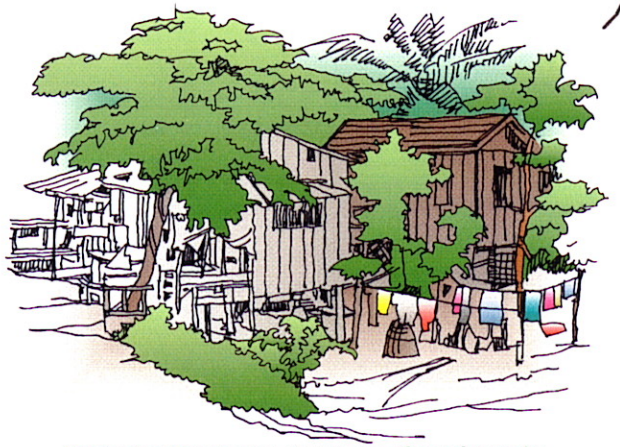
Urbanized and Settled Area



Congested section in the vicinity of Chbar Ampou market

Present land use at the intersection to Tiger beer factory

Roadside scenery in urban area with public facilities



Typical settled house structures along the route

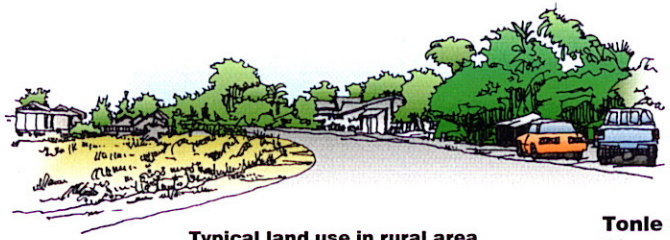
Roadside scenery with local daily life and activities

Ferry Terminal at West Neak Loueng

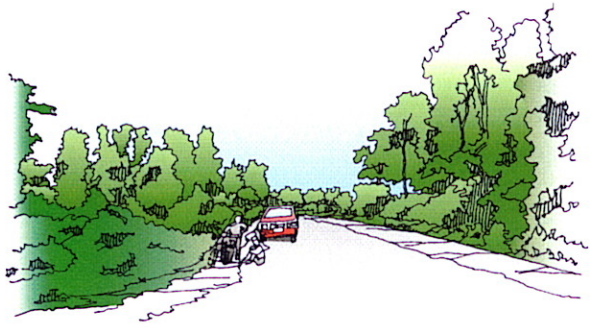
Motorcycles and moto-remorks are gathered for local activities at Kokir market.

AN OVERVIEW OF EXISTING CONDITIONS ALONG NATIONAL ROAD No.1

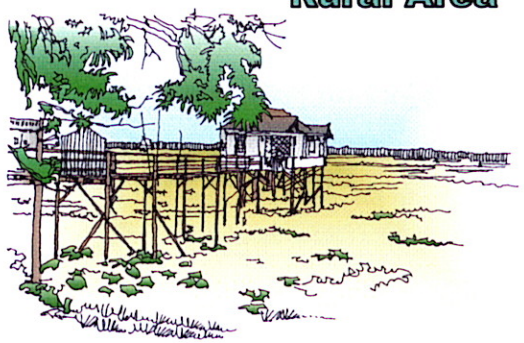
Rural Area



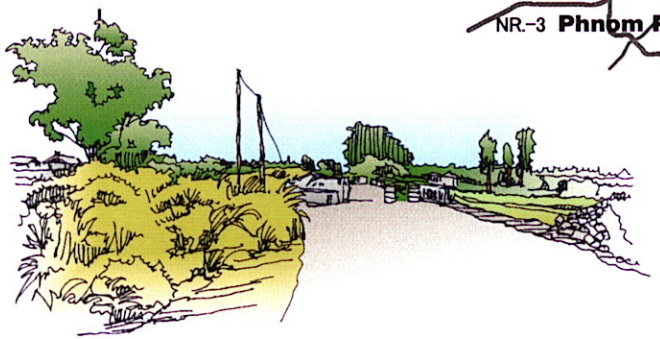
Typical land use in rural area



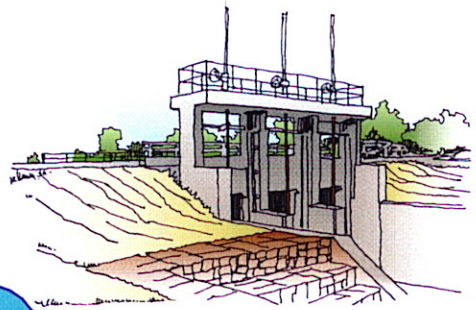
Foliaged bosquet performs rural roadside green scenery.



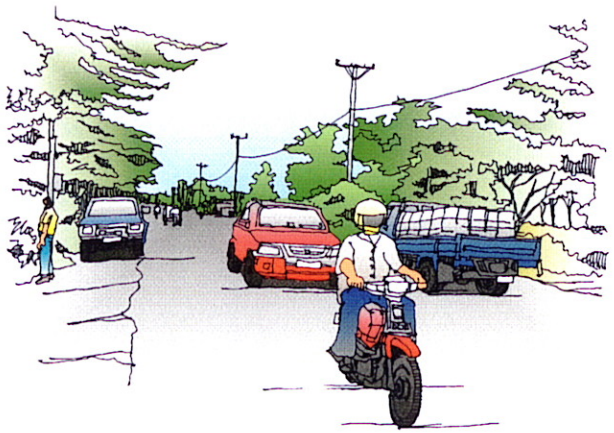
Extended wooden deck leads to local house in the low-lying and flood prone area.



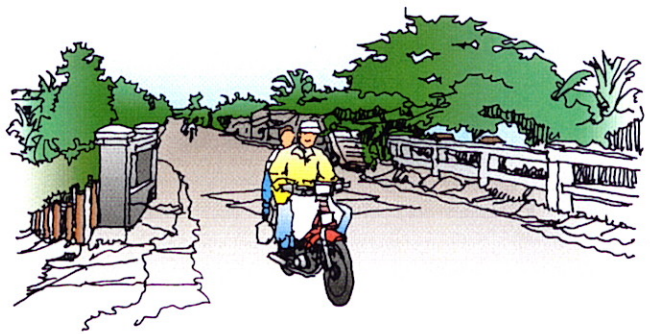
Temporary bridge with control of load limit at cut-off section



New colmatage water gate constructed by Japanese Grant Aid



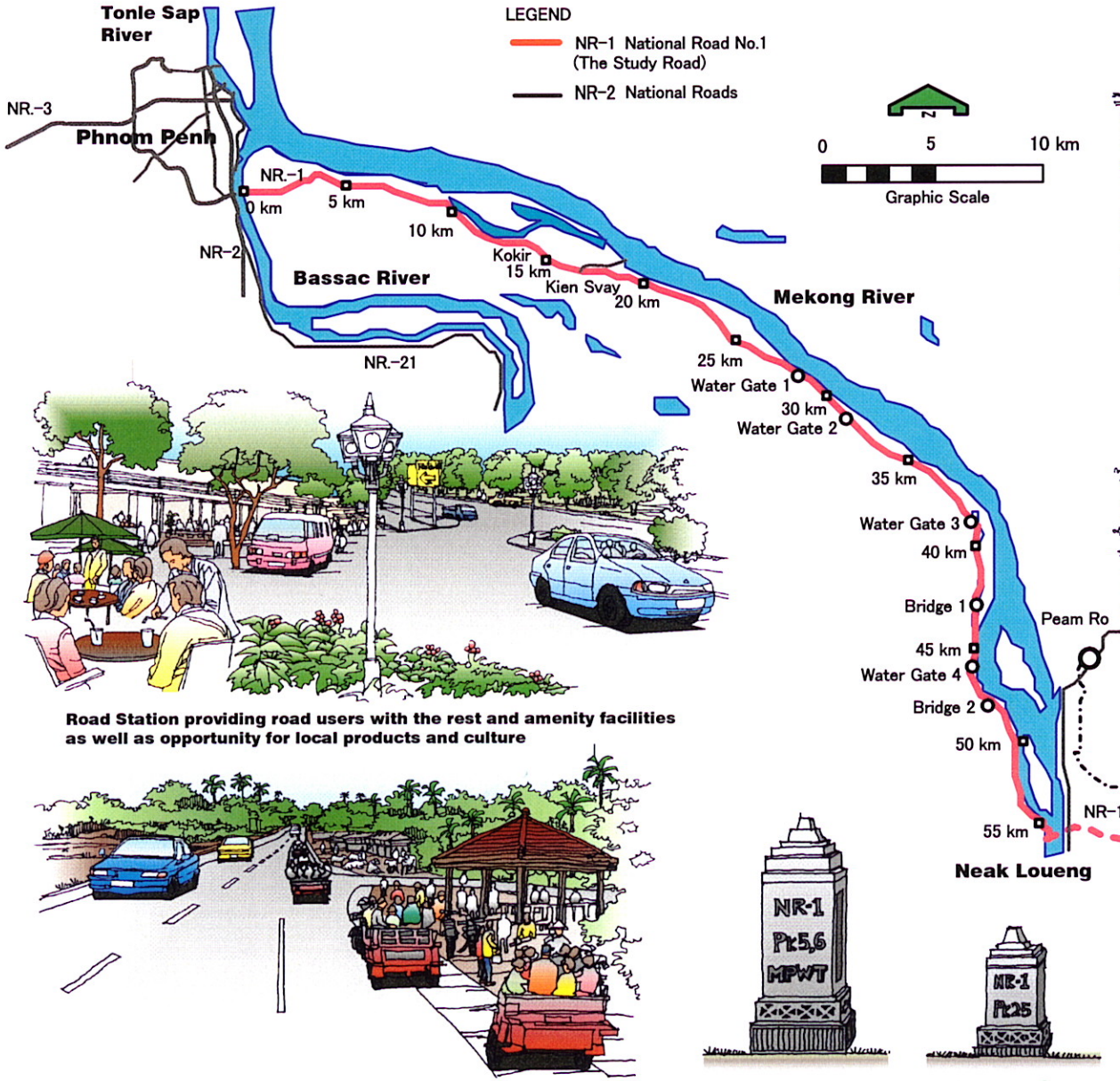
Existing condition of deteriorated pavement and mixed traffic

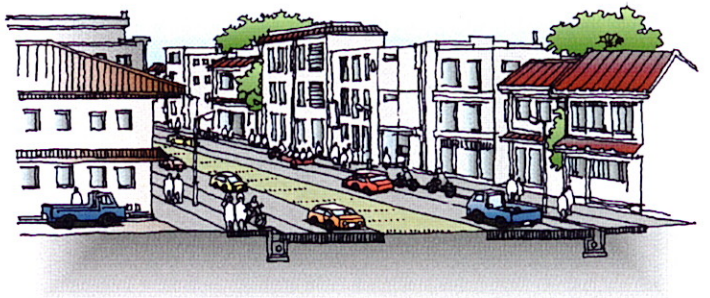


Old Colmatage water gate with damaged concrete slab

PROPOSED IMPROVEMENT PLAN OF NATIONAL ROAD No.1

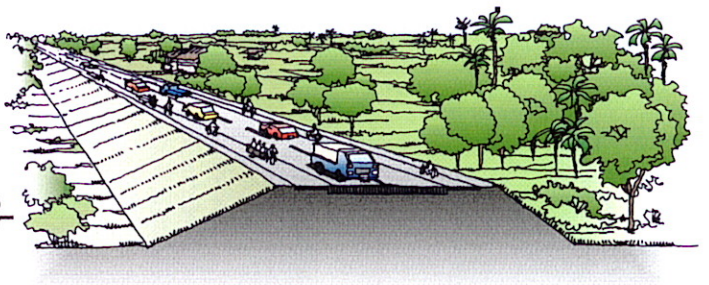
Road and Road Related Facilities





Road improvement in urban area considering traffic safety and future widening

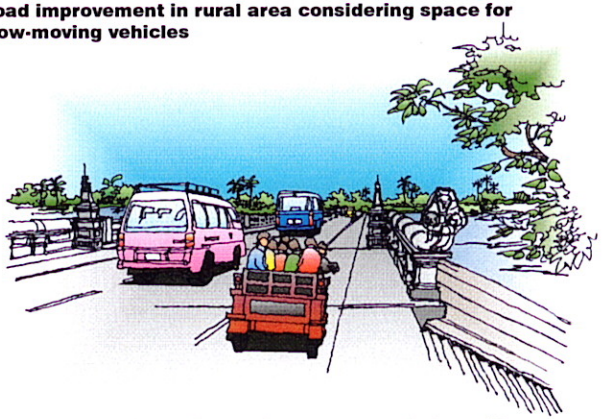
Road Station providing road users with the rest and amenity facilities as well as opportunity for local products and culture



Road improvement in rural area considering space for slow-moving vehicles

Multi-purpose space for moto-remork stop and livestock refuge during flood

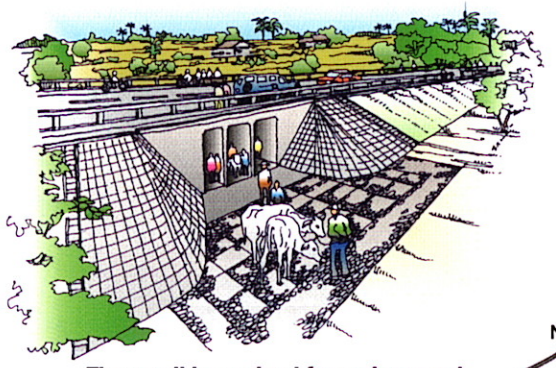
Kilometer Posts with particular design



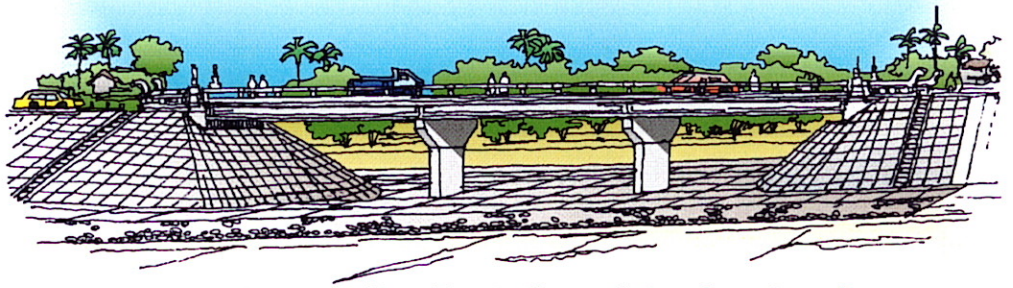
New bridge with designed parapet laden with Cambodian motif

PROPOSED IMPROVEMENT PLAN OF NATIONAL ROAD No.1

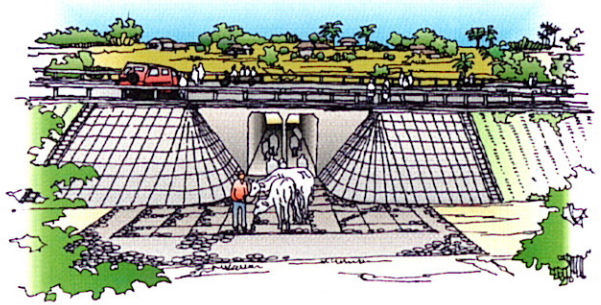
Bridges and Structures



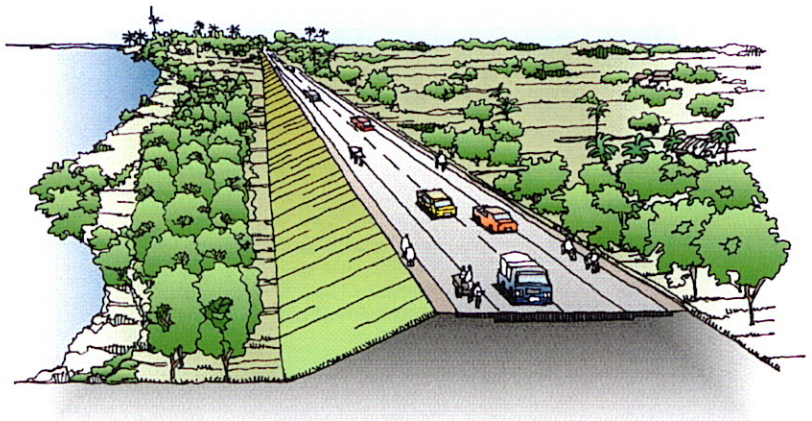
Three-cell box culvert for replacement of existing old water gate



Pre-stressed concrete bridge with protections against erosion and scouring



Two-cell box culvert with both functions of flood mitigation/water use and local communication



Slope protection against erosion by revetment or vegetation using green belt and sodding

Protection against local scouring using gabion mats

Map of Study Area

Photographs of Study Area (1/3)

Km 0+000: Origin point at Monivong Bridge South side

Bridge length: 270 meters, Width: Carriage-way 11 meters
Bridge type: Pre-stressed concrete box girder
Bridge is expected to be stabilized for heavy load.
Erosion at some locations of protection and approach road
Commercial Area at South side of bridge

Km 1+000: Commercial area at both side,
Traffic congestion due to lack of slow-vehicle lane
Pavement width 7 meters
Shoulder width: 2.0 to 3.5 meters with earth surface

Km 18+000: Road conditions of local area
Critical damage/destruction of road structure

Heavy Vehicles : Ratio of heavy vehicle (PCU) 13.9%,
(NR-1, C-1) over 25-ton truck 19.1%

Km 28+450: Newly constructed colmatage water gate
(Constructed by Japan Grant Aid, 2001)
Carriage-way: 13.5 meters on culvert

Photographs of Study Area (2/3)

Km 40+000: Road Conditions of local area
Critical damage: pothole/ broken road surface
Bumpy road condition
Pavement width 6 meters, shoulder width 2+2 meters

Km 42+850: Temporary steel bailey bridge

Cut off in year 2000 flood,
Bridge length 99 meters, width 4 meters,
limited live load 16 ton
ongoing improvement of piers and river-bed

Km 50+015: Old water gate,
constructed in Pol Pot Regime, 1976

Carriage-way width 5.8 meters
Defects and damages on concrete structure
Broken surface and concrete slab,
Steel plates are placed on road surface

Km 55+300: Terminal Plaza at Neak Loueng Ferry Port
and view on the Ferry

Photographs of Study Area (3/3)

Traffic accident of truck and motorbike
caused by not following traffic rules
(Km 18+000)

Traffic congestion with Moto-remork at commercial area
(Km 2+000)

National Road No.11 related Road to NR1
Critical erosion/ damage of existing paved road
Over flood on road in several past time

Colmatage water gate along the Bassac River
West to NR-1

ABBREVIATIONS

Authorities and Agencies

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asian Development Bank
ASEAN	:	Association of South East Asian Nations
CDC	:	Cambodia Development Council
DHI	:	Danish Hydraulic Institute
DPWT	:	Department of Public Works and Transport
ESCAP	:	Economic and Social Commission for Asia and the Pacific
FRMR	:	Fund for Repair and Maintaining of Road
GOJ	:	Government of Japan
GOK	:	Government of Korea
IRC	:	Inter-ministerial Resettlement Committee
JICA	:	Japan International Cooperation Agency
JRO	:	Japan Road Association
KOICA	:	Korea International Cooperation Agency
MAFF	:	Ministry of Agricultural and Forestry Regulation
MEF	:	Ministry of Economic and Finance
MIME	:	Ministry of Industry Policy
MLMUPC	:	Ministry of Land Management, Urban Planning and Construction
MOE	:	Ministry of Environment
MOH	:	Ministry of in Public Health
MOP	:	Ministry of Planning
MOT	:	Ministry of Tourism
MoWRAM	:	Ministry of Water Resources and Meteorology
MPWT	:	Ministry of Public Works and Transport
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
NASA	:	National Aeronautics and Space Administration
NIS	:	National Institute of Statistics
OPEC	:	Organization of Petroleum Exporting Countries
PIU	:	Project Impremention Unit
PMU	:	Project Management Unit
RCC	:	Road Construction Center
RGC	:	Royal Government of the Kingdom of Cambodia
RMMO	:	Road Maintenance Management Organization
RSOJ	:	Road Structure Ordinance of Japan
WB	:	World Bank (IBRD+IDA IBRD: the International Bank for Reconstruction and Development IDA: International Development Association)

Other Abbreviations

A	: Area	ALT	: Alternarive
AADT	: Annual Average Daily Traffic	AT	: Articulated Truck
AC	: Asphalt Concrete	Ave	: Average
ADCP	: Acoustic Doppler Current Profiler	B	: Bridge
AIDS	: Acquired Immune Deficiency Syndrome	BC	: Beginning of Curve
		BCD	: Boundary Condition of Downstream
AF	: Annualized Factor	BCU	: Boundary Condition of Upstream
ALEF	: Axel Load Equivalent Factors	BKK	: Bangkok

BOD : Biochemical Oxygen Demand
Br : Bridge
BST : Bituminous Surface Treatment
BTB : Battambang
B/C : Benefit Cost
CAD : Computer Aided Design
CBR : California Bearing Ratio
CDP : The Draft Cambodia Development Plan
Ch : Chainage
CHD : Chau Doc
CO : Carbon Monoxide
COD : Chemical Oxygen Demand
CSES : The Cambodia Socio-Economic Survey
CY : Pedal-cycles
C/R: : Crusher run
C/S: : Crushed stone
D : Depth
D : Gauge reading at water level gauging station
D : Inundation Depth
D or dia : Diameter
DBST : Double Bituminous Surface Treatment
DCP : Dynamic Cone Penetrometer
DCPT : Dynamic Cone Penetrometer Test
DEL : Design Embankment Level
dH : Freeboard
DHWL : Design High Water Level
DMS : Detail Management Survey
D/D : Detail Design
e : Exponent
EC : End of Curve
EDO : Environment Desk Officer
EEA : Environmental Examination Application
EIA : Environmental Impact Assessment
EIRR : Economic Internal Rate of Return
Elv or El : Elevation
EMAP : Environmental Management Action Plan
Env : Environment
ESAL : Equivalent Single Axle load
EP : Evaluation Point
F : Full access control
fc : Concrete Design Stress
FH : Formation Height
Fig : Figure
FMM : Flood Management and Mitigation
fp : Tensile strength of Tendon
FSM : Four-Stage Sequential Model
fsy : Yield Strength of Reinforcing Bar
GA : Generation and Attraction
GDP : Gross Domestic Products
GH : Ground Height
GL : Ground Level
GPS : Global Positioning System
GRDP : Gross Regional Domestic Product
H : Height
H : Water level
HCM : Ho Chi Minh City
HIV : Human Immunodeficiency Virus
HT : Heavy Truck
HV : Heavy Vehicles
HWL : Design High Water Level
I : Rainfall Intensity
IA : Investment Application
IC : Interchange
ICV : Induced Cargo Volume
i.e. : (Id est) that is
IEIA : Initial Environmental Impact Assessment
Int'l : International
IS : Intersection
ISIA : Initial Social Impact Assessment
Jct : Junction
KCH : Kampong Chhnang
KCM : Kampong Cham
KD : Kandal
Km : Station of Inventory Survey of the Existing Road
KPT : Kampot
KRT : Kratie
L : Length
Lat : Laterite
LCC : Life Cycle Cost
LEPNRM : Law on Environmental Protection and Natural Resource Management
Ln : Natural Logarithm
LRFD : Load and Resistance Factor Design
LS : Lump Sum
LV : Light Vehicles
Max : Maximum
MC : Motorcycles
McSt : Mechanically stbilized
Min : Minimum
M_R : Resilient modulus (psi) (subgrade).
MSL : Mean Sea Level
MT : Medium Truck
[HN1]M/M : Man Month
N : No access control
n : Roughness Coefficient
NLG : Neak Loueng
nos : Numbers

NO_2 : Nitrogen Dioxide
NPRD : The National Programme to Rehabilitate and Develop Cambodia
NPV : Net Present Value
NR : National Road
NR-1 : National Road No.1
N/A : Not Available
OD : Origin and Destination
ODA : Official Development Aid
ODG : Oudong
Org : Organization
ORR : Outer Ring Road
ORRSJ : Ordinance of River-Related Structures of Japan
P : Partial access control
PAP : Project Affected Person
Pave : Pavement
PC : Prestressed Concrete
PDF : Probability Density Function
PHN : Phnom Penh
PI : Intersection Point
PIP : Public Investment Program
Pk : Station of Existing National Road by MPWT
Plc : Places
PO : Project's Owner
PP : Phnom Penh
PP of PPP : Phnom Penh Port
psi : (Performance) Serviceability Index
p_0 : Initial Design Serviceability Index
p_t : Design Terminal Serviceability Index
PV : Prey Veng
Q : Rainfall Runoff
Q or Q_0 : Discharge Capacity
qu : Unconfined Compressive Strength
QV : Capacity (Q) and Velocity (V)
R : Radius
R : River
RA : Roundabout
RAP : Resettlement Action Plan
RC : Reinforced Concrete
Rd : Road
ROW : Right Of Way
R^2 : Correlation Coefficient
S : Slope
S : Water Surface Slope
SBST : Single-Layer Bituminous Surface Treatment
SEDP : Socio-Economic Development Plan
SES : Socio-Economic Survey
SHV : Sihanoukville
SV or SVP : Sihanoukville Port
SN : Pavement Structure Number
SO_2 : Sulfur Dioxide
SPT : Standard Penetration Test
SRP : Siam Reap
SS : Suspended Solids
St. or Sta. : Station
Stb : Stabilized
STTC : Saving in Travel Time Cost
SV or SVR : Svay Rieng
SVOC : Savings in Vehicle Operation Cost
S/W : Scope of Work
S_0 : Combined Standard Error of the Traffic Prediction and Performance Prediction,
T : Time
T : Transformable
TKV : Takeo
TMP -PPMA : Transport Master Plan of Phnom Penh Metropolitan Area
TTC : Time Value
US or USA : United States of America
UXO : Unexploded Object
U/S : Upper Side
V : Velocity
VAT : Value Added Tax
VCR : Volume Capacity Ratio
VB : Very Bad
Veh : Vehicle
VFC : Fixed Cost
VH : Vehicle Hours
VITRANSS : The Study on the National Transport Strategy in the Socialist, Republic of Vietnam
VK : Vehicle Traffic
VOC : Vehicle Operation Cost
W : Wheels
W : Width
W : with
WG : Water Gate
WL : Water Surface Elevation
WO : without
W/C : Weight-Capacity
W/F : Weight Factor
W_{18} : Predicted Number of 18-kip
Z_R : Standard Normal Deviate,
$\triangle$PSI : $p_0 - p_t$
ϕ : Diameter
σ : Stress
σ ck : Concrete Compressive Strength
σ py : Steel Yield strength

Units

cm	:	Centimeter	MPa	:	Mega Pascal
cm/s	:	Centimeter per Second	MPN	:	Most Provable Number
dB	:	Decibel	m/s	:	Meter per Second
deg	:	Degree	m^3/s	:	Cubic Meter per Second
ha	:	Hectare	NN/m^2	:	Newton per Square Millimeter
hr(s) of Hr	:	Hour(s)	Pa	:	Pascal
km	:	Kilometer	PCU	:	Passenger Car Unit
km^2	:	Square Kilometer	pcu-hr	:	Passenger Car Unit-hour
km/h	:	Kilometer per Hour	ppm	:	Parts per Million
kN	:	Kilo Newton	Riel	:	Cambodian Currency
kN/m	:	Kilo Newton per Meter	t	:	Ton
kN/m^3	:	Kilo Newton per Cubic Meter	t/yr	:	Ton per Year
kPa	:	Kilo Pascal	t/ha	:	Ton per Hectare
L or l	:	Litter	veh/day	:	Vehicles per Day
M or m	:	Meter	veh/Year	:	Vehicles per Year
m^2	:	Square Meter	VND	:	Vietnam Dong (Currency)
M or mil	:	Million	yr(s)	:	Year(s)
Mg/l	:	Milligram per liter	$	:	Dollar
min	:	Minute	%	:	Percent
mm	:	Millimeter	°	:	Degree
mo	:	Month	°C	:	Degree Celsius

PROJECT SUMMARY

1. COUNTRY	The Kingdom of Cambodia
2. NAME OF STUDY	The Feasibility Study on the Improvement of National Road No.1 (Phnom Penh–Neak Loueng Section) in the Kingdom of Cambodia
3. COUNTERPART AGENCY	Ministry of Public Works and Transport (MPWT)
4. OBJECTIVE OF STUDY	To carry out a feasibility study on the improvement of National Road No.1 (Phnom Penh–Neak Loueng Section) and transfer technology to Cambodian counterparts.

1. STUDY AREA Road section from Phnom Penh to Neak Loueng on National Road No.1, approximately 56km in length and inundation area

2. TARGET YEAR Year 2015

4. TRAFFIC DEMAND FORECAST 9,996～64,140 PCU/day

3. ECONOMIC FRAMEWORK

Population in Plain Region	Thousand	8,887
Per Capita GRDP	'000 Riels	1,440
Annual Growth Rate	%	6.0

5. OUTLINE OF FEASIBILITY STUDY AND PRELIMINARY DESIGN

(1) Flood Mitigation

- Hydraulic simulation was made to investigate flood condition of the study area. The design High Water Level (HWL) is set at the flood level of the maximum flood level of the year 2000. The free flow is set as 50cm for embankment and 100cm for bridges and box culverts.
- Inflow from main stream of the Mekong River to the inundation area on the right bank was studied to study the flood mitigation plan. The planned inflow was raised from 2,200m^3/s to 2,700m^3/s. This will lower the flood level of the Mekong River approximately 2～3.5cm more than present situation in the study area.
- The protection work for embankment slope is planned where the NR-1 faces to the Mekong River. It locates at 5 places and total length will be 3,800 meters. Revetment is planned for 900 meters in a place and green belt with 1:3-slope for 2,900 meters in four places.

(2) Road

- Proposed centerline is based on the existing centerline of NR-1. It satisfies geometrically design speed as 80km.
- As a result of alternative study, it is planned to provide space for future widening up to Kokir market and for slow-moving vehicles all along the study road. These spaces are to secure traffic safety and to correspond to the increase of the traffic demand in the future.

(3) Pavement

- NR-1 is planned to be improved with asphalt concrete. It is designed based on "AASHTO Guide for Design of Pavement Structures"
- Design CBR of 9 was used with improvement of subgrade by replacing the existing ground with a selected material.
- Five design sections were set based on the traffic demand forecast.

(4) Opening Structure

- PC (Pre-stressed Concrete) I-shaped simple girder is planned for superstructure of bridges after the alternative study. This type has advantage economically, in ease of construction, operation and maintenance.
- Gabion mat is planned for the protection of riverbed scouring and wet masonry for slope protection on each opening structure.

6. ROAD IMPROVEMENT PLAN

・Improvement of vertical alignment (higher than 2000 Flood level plus 50 cm) and pavement thickness
・New construction of asphalt concrete pavement whose structure consists of roadbed embankment including subgrade, sub-base course, base course and surface course
・Cross section of 7meter (3.5m/lane) through-traveled lanes with provision of space for slow-moving vehicles
・Provision of sidewalk and drainage together with street lighting up to the intersection to Tiger beer factory
・Provision of space for future widening up to Kokir Market
・Improvement of existing intersection to Tiger beer factory by channelization with traffic signal
・Existing two temporary bridges replaced by new pre-stressed concrete bridge with protection against erosion and local scouring and one new construction of bridge.
・Existing two pipe culverts replaced by new pipe culvert with protection against erosion
・Existing two water gates replaced by new box culvert with protection against erosion and new construction of nine box culverts.
・Protection of slope surface of road embankment: 900-meter long revetment and 2,900-meter long green belt
・Traffic safety measures by installing road markings, guard posts and rails, regulatory & warning signs, guide signs, kilometer posts and traffic signal at intersections
・Road related facilities such as moto-remork stops cum livestock refuge during flood, weighbridge station, and Road Station, etc.

7. Road Operation and Maintenance Plan

The road maintenance budget comes from "Fund for Repair and Maintaining of Road (FRMR)", and MPWT and provincial DPWT operate the maintenance and repair. The majority of the maintenance funds probably will be spent on emergencies by provincial level and leave very little for conventional maintenance activities.

It is indispensable to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement. It is suggested 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 in order to secure the annual funds required for road maintenance.

8. PROJECT IMPLEMENTATION PLAN AND EVALUATIONS

(1) Project Implementation Plan and Cost Estimate

Total construction period is planned as 36 months. Implementation plan starts in 2003 and the study road will be improved in second half of 2007. Estimated construction cost is 38.338 million US dollars and project cost is 43.408 million US dollars.

(2) Economic Evaluation

The base EIRR for the project is 13.3%, with various sensitivity scenarios giving results that range from 8.4% to 19.1%.

(3) Environmental Evaluation

The IEIA (Initial Environmental Impact Assessment) concluded that there are neither substantial nor irreversible adverse environmental and social impacts arising from the Project. No additional land acquisition for road right-of-way is required because the project only involves the improvement of existing roads. The project will require resettlement of project affected person. It is suggested that due procedure for the resettlement action should be taken into practice by implementation organization without delay.

(4) Overall Evaluation

High priority should be given to the implementation of the project because the project will promote economic and social development and there is expectation of a sufficient economic return. The project will also contribute to improve NR-1 to flood-free road to an all-weather standard, enhance traffic safety and environmental conservation by well-designed paved road, integrate producing and consuming centers in terms of regional context and increase job opportunities for the local poor especially in the development corridor between Phnom Penh and Neak Loueng.

9. CONCLUSION AND RECOMMENDATIONS

It is concluded that the Study reveals high feasibility for the project implementation. Namely, the project has high technical feasibility, there is no substantial or irreversible adverse environmental impacts arising form the project, and the project is economically viable based on the economic analysis. It is recommended that the institutional arrangement for project implementation should be taken without interruption.

OUTLINE OF THE PROJECT

The Feasibility Study on Improvement of National Road No.1 (Phnom Penh – Neak Loueng Section) in the Kingdom of Cambodia

・Study period: Apr. 2002 - Mar. 2003
・Counterpart Agency: Ministry of Public Works and Transport,
The Royal Government of the Kingdom of Cambodia

1. Background of the Study

National Road No.1 (NR-1) covers about 166 km in Cambodia from Phnom Penh to Bavet (on the border to Vietnam that is the main crossing point to the southern part of Vietnam and 72 km to Ho Chi Minh City). This route is designated as Asian Highway No. A-1 as well as ASEAN Highway No. 1, and almost of all road traffic between Phnom Penh and Ho Chi Minh passes on this route.

NR-1 is divided into two sections:

- The section C-1 from Phnom Penh to Neak Loueng
- The section C-2 from Neak Loueng to Bavet, on the border to Vietnam

The ongoing ADB funded "Ho Chi Minh City to Phnom Penh Highway Improvement Project" in Cambodia aims to directly improve an arterial road located in the Plain Region, which covers the five provinces of Kandal, Prey Veng, Svay Rieng, Kampong Cham and Takeo and one municipality of Phnom Penh. The Plain Region has a population of 6.8 million (2002) that is more than 50% of the national population. It produces 54% of GDP, but occupies only 14% of national land.

The C-2 section (105 km length) is being improved with ADB assistance and financing and is scheduled to be completed by the year 2003. A feasibility study is being carried out for the C-1 section (56 km length) by this study in cooperation with JICA.

The target year of the plan is the year 2015, which accords with that of relevant studies and projects implemented by the Royal Government of the Kingdom of Cambodia

The influenced area has high development potential in terms of domestic production/ consumption as well as international trade/ investment. This area produces crops such as paddy, maize and vegetables as well as fisheries and livestock & poultry products that are mainly transported to Phnom Penh, the biggest consumption center. Accordingly, once NR-1 is improved, it will stimulate the development potential within the influence area, and high vehicle traffic generation is anticipated.

The expected roles and functions of NR-1 are as follows:

- To ensure road transport throughout the year by upgrading to a flood-free road to an all-weather standard.
- To secure traffic safety and conserve environment by separating slow-moving vehicles such as motorcycles and motorcycle trailer ("moto-remorks").
- To stimulate economic and social development by connecting major productive centers to urban centers to provide better market accessibility, allow more competition and stable prices as well as to increase job opportunities for the poor.
- To strengthen linkages between producing and consuming centers and between exploited resources and trading gateways by the improvement of the arterial road to an international standard. This will encourage the ongoing transition to market economy that has opportunities for reducing poverty.

2. Outline of the Project

2.1 Flood Mitigation

(1) Flooding Condition and Flood Damage

Flooding area by 2000 Flood around Phnom Penh, NR-1 (C-1 and C-2) and NR-11 was very large with about 40 to 50 km width around Phnom Penh and about 20 km width around Neak Loueng. This large flooding area can be divided into three zones as follows: Zone 1: Mekong River Main Stream, Zone 2: Left Bank Side Flood Plain, and Zone 3: Right Bank Side Flood Plain (Colmatage Area). NR-1 C-1 is included in the Zone 3.

It was estimated that the maximum water level was almost same as the road top in 2/3 of the sections with three overflows occurring along NR-1 C-1. Two artificial Cut-offs were installed during 2000 flood to save urban area of Phnom Penh city. The flood survey clarified that the flood damage composed of damage to houses, agriculture and others by 2000 Flood was almost the same as other floods. This means that flood damage of 2000 Flood was not increased by the two artificial Cut-offs of NR-1 C-1 made during 2000 Flood.

In order to clarify the hydraulic effect by the two artificial Cut-offs along NR-1 C-1, unsteady hydraulic simulation model was developed. Effects of lowering the maximum water levels at Phnom Penh and Neak Loueng during 2000 Flood by the artificial Cut-offs were estimated at 9 cm and 14 cm respectively. This lowering of the flood water level at Phnom Penh and Neak Loueng was very important because these 2 towns seemed to be saved from flooding, but they would have been flooded if the water level was a little higher.

(2) Flood Mitigation Plan

As a principle for constructing roads in a flood plain, the road should not be an obstacle to the flow of a flood. Based on this principle and the purpose of this project (which is to formulate an improvement plan for NR-1 C-1 to be all-weather road even during floods), the height of road embankments and openings along the NR-1 C-1 were planned.

Since there is no clear historical trend of increasing flood water level along NR-1(C-1), it is sufficient to set the Design High Water Level (HWL) at the same elevation as the maximum water level of 2000 Flood. In order to maintain safety against wave height and possible floating debris, 0.5 meter of freeboard for embankment and 1.0 meter are considered above the HWL.

Plan for Openings is made based on the inflow into the Colmatage area. The plan indicates that inflow should be increased by installing new openings. Based on the hydraulic simulation, it was estimated that the plan could further lower the flood water level at Phnom Penh and Neak Loueng 2.0 to 3.5 cm. Bridge is installed near the existing temporary bridges and box culverts and pipe culverts are to be distributed along the road since flood flow is a kind of lateral flow. Followings are outline of the plan.

Opening	Length/Size	Place
Bridges	Total length: 232 m (Br.1: 66m, Br.2: 100m and Br.3: 66 m)	3 places
New Box Culverts with stop log slots	W 2.0 m x H 5 to 6 m x 2 cells	6 places
New Box Culverts without stop log slots	W 2.0 m x H 5 to 6 m x 2 cells	3 places
Improvement of Pipe Culverts	D 1.0 m x 1 no.	2 places
Improvement of Old Water Gates (by Box Culverts)	W 2.0 m x H5.6 m x 2 cell, W 2.0 m x H5.8 m x 3 cell	2 places
JICA Water Gates	No change	4 places
Total		20 places

Note: W: width, H: height and D: diameter, Stop log slots are to be attached to the 6 box culverts for water use for agriculture.

(3) Protection against Erosion and Scouring

Along NR-1 C-1, there are five places of total 3,800 meters where the road is facing the Mekong River and floodwater frequently attacks NR-1 C-1. In order to protect embankment slopes on the Mekong Side against erosion by waves or flow, revetment with wet masonry for the severest places between and Km 18+600 and 19+500 (900 meters) is planned. For other four places, gentle embankment slope (1:3) with green belt by swamp trees along the Mekong Side of the road for total 2,700 meters is planned

Protection for bridges and box culverts are necessary against erosion and local scouring by contraction flow with turbulence. The planned protection for bridge is composed of revetment with wet masonry around abutments and bed protection by gabion mats and boulders. Inlets and outlets of box culverts are also planned to be protected by revetment with wet masonry and gabion mats with boulders.

2.2 Road and Road Facilities

To design centerline horizontal alignment

i) to follow the centerline of the existing NR-1 C-1 section as much as possible
ii) to adjust irregular sections
iii) to adjust where the centerline does not satisfy the proposed criteria

As the study area is in very flat region, grades in general are less than 0.1%. Grades went up to about 1% for the approach section for the bridges and culverts.

Common features of cross section 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 has different component of cross section referring the results of traffic survey.

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	I	II	II	III	IV	V	V

- Detail 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.

To cope with the increased number and speed of vehicles after improvement and to secure safety, various safety measures are planned.

i) Installation of road markings
ii) Installation of guard posts on high embankment, guard rails on box culverts
iii) Installation of signals, regulatory & warning signs, guide signs, and kilometer posts
iv) Distribution of pamphlets to public to draw their attention for traffic safety

To enhance the function of the Study Road as well as to contribute to traffic safety, the following facilities were planned:

i) Installation of Moto-remork stops cum livestock refuge during flood
ii) Bus stop
iii) Pedestrian Bridge for traffic and pedestrian safety
iv) Weighing station to control over loaded vehicles for road maintenance.
v) Approach Slopes for Local Road to secure access for the local people
vi) Road Station for the amenity of road as well as to provide employment to the local people

2.3 Pavement Structure

"AASHTO Guide for Design of Pavement Structures" (AASHTO Standard) was used as the basic criteria for pavement design. Also, other criteria, such as "Asphalt Pavement Manual" by Japan Road Association (JRO) were referenced.

Design CBR of 9 was used assuming improvement of subgrade by placing a selected material of 30 cm thickness. Traffic demand forecast is used as traffic volume for the design. The study road is divided into five sections and each section is calculated to have required strength. The most economical structure of pavements (subrade, sub-base, base course and surface course) of pavement was selected. Table below show the structure of each section.

Section of Road	1	2	3	4	5
Station (St)	0.0 -3.5	3.5 - 7	7- 14	14 - 36	36 – end
Pk (MPWT)	5.6 – 9.1	9.1 – 12.6	12.6 – 19.6	19.6 – 41.6	41.6 - End
Total and Surface thickness	55cm, 10cm	52cm, 10cm	49cm, 10cm	59cm, 5cm	57cm, 5cm

2.4 Opening Structures

Opening structures are planned after flood mitigation plan. The plan has three bridges (superstructure: PC I-shaped splice girder, substructure: RC elliptic column, foundation: cast-in-situ RC), 11 box culvert (seven 2-cell with stop logs, one 3-cell with stop logs and three 2-cell without stop logs) and two pipe culverts (D: 1.0 meter). Type of bridge was selected concerning natural condition, construction cost, method and period, ease of maintenance. Box culverts has sufficient height and opening section for wild animals and live stocks to cross the study road safely through the culverts.

2.5 Road Operation and Maintenance System

The road maintenance budget comes from "Fund for Repair and Maintaining of Road (FRMR)". The fund will be used for routine and periodic maintenance and repair of the national, provincial and other roads under the management and responsibility of MPWT and other ministries. But the majority of the maintenance funds probably will be spent on emergencies by provincial level and leave very little for conventional maintenance activities. Both legal entities of Department of Public Works and Transport of province (DPWT) and Project Management Unit of MPWT (PMU) 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 skilled construction equipment operators, mechanics, and electricians
iv) Lack of repair facilities and tools
v) Lack of managerial capability and research ability

Therefore, in order to secure the annual funds 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. It is also necessary to ensure financing mechanism for road maintenance that are indispensable to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement:

3. Road Improvement Plan

The proposed road implementation is described as follows:

1) Improvement of vertical alignment (higher than 2000 Flood level plus 50 cm) and pavement thickness
2) New construction of asphalt concrete pavement whose structure consists of roadbed embankment including subgrade, 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 by installing road markings, guard posts and rails, regulatory & warning signs, guide signs, kilometer posts and traffic signal at intersections
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

4. Project Implementation Plan

Construction planning is made to formulate project implementation plan. Construction method is selected and quantity estimation is carried out for main construction works. Construction time schedule is prepared based on following conditions

- Earth works: six months from November to April
- Asphalt pavement works: throughout the year.
- Sub structure works under HWL: six months from November to April.

Implementation takes 36 months in total. Project implementation plan is shown in table below.

	2003										2004												2005		2006		2007	
	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1st	2nd	1st	2nd	1st	2nd
Basic Design																												
Detail Design/ Preparation of tender Documents																												
Pre-qualification of Contractors Tendering/Tender Evaluation/ Signing of Contract																												
Construction																												

5. Economic Evaluation

Project cost is calculated based on quantity volume and construction plan of main construction works. The followings are the basic condition of cost estimation.

i) The cost is estimated in US dollar base considering the risk of fluctuation of exchange rate.
ii) The unit cost of each cost component is determined based on the economic conditions prevailing in October 2002 (US$ 1.0 = ¥ 120 = 3,990 Riel).
iii) Temporary facility cost, field expenses and over head are assumed to be 4%, 17% and 10% of direct construction cost.
iv) Detail engineering service and construction supervision service are assumed to be 4% and 6% of direct construction cost.
v) Survey and demolition cost for UXO is not estimated because it has already been carried out in most of the area of the study area.
vi) Compensation cost, relocation cost for utilities and cost on environmental measurement are estimated separately.
vii) Equipment cost is based on the local market price as far as they are available. The cost analysis is made in case of special equipment that is not available in Cambodia.

The basic condition of economic evaluation is as follows:

i) Traffic volume is based on the result of traffic demand forecast.
ii) Base case of the economic growth rate is set as 6%/yr
iii) Project life is assumed to be 20 years.
iv) Two tangible benefits are taken into account, which are Saving in travel time cost (time saving) and Saving in vehicle operation cost (VOC saving).
v) Discount rate is set as 12%
vi) Sensitivity test is made in different economic growth rate, construction cost, benefit amount and time savings.

EIRR of base case in calculated as 13.3%. The result of sensitivity test shows that EIRR in most of the cases are more than 12%. Therefore, implementation of the project road is justified

6. Environmental Evaluation

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 additionally land acquisition for road right-of-way is required.

In the course of the Study, the activities designed to identify and predict the impact on the biogeographically environment and other matters was prepared based on the MOE's comments on IEIA. 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, the environmental justification for the project is confirmed officially.

7. Conclusion and Recommendations

(1) Conclusion

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. 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.

i) 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's sufficient economic return is anticipated due to the higher traffic volumes.

ii) 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 for NR-1(C-1) and Phnom Penh but also along NR-1(C-2) and NR-11 if 2000 Flood level should reoccur. By the inflow of floodwater to the Colmatage area through the planned openings, the water level inside the Colmatage area will slightly increase. However, no adverse impacts will affect agriculture in the Colmatage or the Bassac River.

iii) 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.

iv) The proposed plan will not require 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 as 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 outside the ROW.

(2) Recommendations

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

1) Appropriation of Funds for Project Implementation

It is recommended that the Government request a donor country to assist funding them, using bilateral ODA or a loan from a multi-lateral lending agency so as to alleviate the financial burden to the Government for the project implementation. The cost of compensation for resettlement and utility relocation, and the Government should appropriate the necessary funds for them in a timely manner.

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 locations before the construction works commence. These resettlement and relocation works require due and time-consuming procedures. Accordingly, it is recommended that such procedures should be taken in a timely manner to secure the necessary space for construction work.

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

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.

5) Control of Over-loaded Trucks

It is recommended that action against over-loaded trucks should be taken immediately so that a weighbridge station at Cut-off No.2 be built to control over-loaded trucks.

6) Ensuring Financing Mechanism for Road Maintenance

To ensure financing mechanism for road maintenance, it is indispensable to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement. It is necessary to continue the follow up Road Maintenance Catch-up Program officially requested to Japan to realize the concept "Fee-for-Service" to contribute to increasing the road maintenance funds.

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. In order to utilize their flood mitigation function, it is recommended to improve the existing outlet channels including bank protection against erosion.

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 become a really serious problem to NR-1(C-1).

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

It is necessary to deliberate a scheme for bridge crossings since considerable numbers of travelers are always exposed to risk and inconvenience. Therefore, it is recommended that a study on bridges 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 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.

THE FEASIBILITY STUDY
ON
THE IMPROVEMENT OF NATIONAL ROAD NO.1
(PHNOM PENH – NEAK LOUENG SECTION)
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT

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Vol. 1 MAIN REPORT

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Introduction

The National Road No.1 (NR-1) runs some 166 km in Cambodia from Phnom Penh to Bavet, the border to Vietnam that is the main cross-border to the southern part of Vietnam and the distance to Ho Chi Minh City remains 72 km. This route is designated as Asian Highway No. A-1 as well as ASEAN Highway No. 1, and almost of all road traffic between Phnom Penh and Ho Chi Minh pass on this route.

ADB undertook “The Greater Mekong Sub-region Project” in 1996-97, and it included confirming the feasibility of the improvement plan on NR-1 from Phnom Penh to Ho Chi Minh City as a part of Asian Highway. Upon the completion of the study, ADB has funded “Ho Chi Minh City to Phnom Penh Highway Improvement Project”.

The ongoing project in Cambodia directly improves an arterial road located in the Plain Region, which comprises five provinces of Kandal, Prey Veng, Svay Rieng, Kampong Cham and Takeo and one municipality of Phnom Penh. The Plain Region has a population of 6.8 million (2002) that accounts for more than 50 % of the national population and yields 54% of GDP, but it occupies only 14% of national land.

In response to the request of the Royal Government of the Kingdom of Cambodia (hereinafter referred to as "RGC"), the Government of Japan (hereinafter referred to as "GOJ") decided to conduct the Feasibility Study on the Improvement of National Road No.1 (Phnom Penh – Neak Loueng Section) in the Kingdom of Cambodia (hereinafter referred to as "the Study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of GOJ, dispatched a Scope of Work (S/W) mission to the Kingdom of Cambodia in December 2001. The mission headed by Mr. Satoshi UMENAGA had a series of meetings with related agencies of RGC, and both parties have agreed to the Scope of Work for the Study.

The JICA entrusted the study team headed by Mr. Kenji Maruoka in April 2002 to conduct the Study based on the agreed Scope of Work.

1.2 Background of the Project and its Justification

(1) General

The National Road No.1 (NR-1) runs some 166 km in Cambodia from Phnom Penh to Bavet, the border to Vietnam

The NR-1 is divided into two sections:

- The section C-1 from Phnom Penh to Neak Loueng
- The section C-2 from Neak Loueng to Bavet, the border to Vietnam

The C-2 section of 105 km in length is being improved by ADB financing and it is

scheduled to be completed by the year 2003.

As for the C-1 section of 56 km in length, the feasibility study is being carried out by this Study (JICA). However, ADB Emergency Flood Rehabilitation Project is underway from Km 19 to Km 56 to raise embankment level 20 cm above 2000 Flood Level at three over-flow sections, and the rehabilitated road condition will be the basis for the Study.

(2) Development Potential in the Plain Region

The area influenced directly by the project consists of three eastern provinces of Kandal, Prey Veng, Svay Rieng and the capital city of Phnom Penh including the Mekong River basin.

The influenced area has high development potential in terms of domestic production/ consumption as well as international trade/ investment. Industrial development is found along C-1 section of NR-1 such as timber factory, oil camp and food industry.

The Mekong River basin in Kandal province is productive for agricultural crops such as paddy, maize and vegetables and for fisheries and livestock & poultry, and they are mainly transported to Phnom Penh as the biggest consuming center.

Accordingly, once the NR-1 is improved and it stimulates the development potential within the influence area, high potential of vehicular generation is anticipated.

(3) National and Domestic Context

NR-1 exists in the Plain Region where half of national population concentrates in 14% of national land and agriculture as well as inland fishery is very productive. The improvement of the NR-1 is expected to bring enormous benefits to the region in several aspects. Major benefits are as follows:

1) Securing traffic safety and conserving environment by changing deteriorated and vulnerable road to a flood-free road to an all-weather standard;
2) Stimulating economic and social development by connecting productive area to consuming centers/major cities to provide better market accessibility for more competition and stable prices as well as to increase job opportunities for the poor;
3) Strengthening linkages between trading gateways and potential developing zones by the improvement of arterial road to an international standard. This will serve to encourage the development of the market economy; and
4) Connecting the major cities to Phnom Penh to expand a sphere of one-day activities, and accordingly enhance utilization of public facilities and disseminate information effectively.

The NR-1 connects major productive centers to urban centers. However, the Kandal province is the most productive province and Phnom Penh is the biggest urban center in Cambodia.

The eastern area of the Cambodia in the study area has broad resources of agricultural crops and inland fisheries. The major issue of obstruction for promoting the development and trade is high transport cost caused by insufficient internal transport infrastructures.

The development of agriculture in Cambodia is still underway and cash crops and fisheries are very favorable industry to be developed in future of Cambodia. Since some of cash crops and fisheries are exported to foreign countries such as Vietnam and Thailand, they are suitable for acquisition of foreign currency.

Accordingly, the project will stimulate the development of agricultural activities such as production of agricultural crops, inland fishery and livestock farming, and it is obvious that the movement of passengers and the transport of cargo volume will continue to increase as the socio-economic development is enhanced.

(4) International Context

The NR-1 improvement project addresses international contexts. The NR-1 is one of the major arterial roads in Cambodia and plays an important role in the socio-economic activity for Cambodia. Simultaneously, the NR-1 is designated as Asian Highway No. A-1 and ASEAN Highway No. 1 as well, and they aim to strengthen regional cooperation through development, formalization and promotion of road network in the aspects of classification/design standard, numbering/signage and cross-border administration. The NR-1 directly connects to the southern part of Vietnam and connects to the eastern part of Thailand through NR-5. The connecting road in the southern part of Vietnam is in good condition, but NR-5 that leads to Thailand still remains poor condition, especially in the northern part and damaged and deteriorated bridges.

(5) Provision of a Flood-free Road to an All-weather Standard

The NR-1 has been exposed to critical situation against flood. During 2000 Flood, in order to relieve Phnom Penh from danger of the flood, urgent artificial openings of embankment at two places along the NR-1 were made, which caused to disrupt traffic for several months and brought turmoil in Cambodia especially Phnom Penh and its surrounding areas. Inland water transport undertook passengers and cargoes in lieu of road transport, but it was inconvenient and very costly.

In the circumstances, the following countermeasures are to be taken into consideration to secure roles and functions of NR-1 by improving a flood-free road to an all-weather standard.

1) To make an elevation of road high enough to prevent adverse effects from flood
2) To protect road embankment by applying slope protection against erosion as well as to design pavement structure enough strong and durable to perform serviceability for a design life span

(6) Expected Roles and Functions of the Study Road

The major issues to impede exploiting development potential are pointed out in general as follows;

1) Poor infrastructure system and low efficiency of transport means/ facilities results in high transport costs due to the combined effect of river interruption and large fluctuation of water level.
2) Vulnerable transport means incurred by flood make road transport unreliable due to

heavy dependence on NR-1 as well as very coarse network of arterial roads.

Under such circumstances, the Royal Government of Cambodia has exerted great efforts in the improvement of the arterial road network and the rehabilitation of bridges to connect Phnom Penh with the rest of the country. These efforts can be seen in several strategic road improvement plans under multi-lateral lending agencies of ADB and WB as well as bilateral donor countries especially Japan.

These road improvement plans strategically target to strengthen radial national roads to connect with the capital city Phnom Penh, envisaging not only the improvement of road transport in Cambodia but also the enhancement of regional cooperation with Vietnam, Thailand and other surrounding countries.

The study road is identified as the priority section in the Second Socio-economic Development Plan (SEDP-2), and its expected roles and functions are as follows:

1) to ensure road transport through a year by improving a flood-free road to an all-weather standard;
2) to secure traffic safety and conserving environment by separating slow-moving vehicles such as motorcycles and moto-remorks;
3) to stimulate economic and social development by connecting major productive centers to urban centers to provide better market accessibility for more competition and stable prices as well as to increase job opportunities for the poor; and
4) to strengthen linkages between producing and consuming centers and between exploiting resources and trading gateways by the improvement of arterial road to an international standard. This will encourage undergoing transition to market economy that has common characteristics in terms of their needs and opportunities for reducing poverty.

1.3 Study Objectives

The objectives of the Study are as follows;

(1) To carry out the feasibility study on the improvement of National Road No.1 (Phnom Penh – Neak Loueng Section: C-1 Section); and
(2) To transfer technology to Cambodian counterparts.

1.4 Scope of the Study

1.4.1 Study Area

The study area covers National Road No.1 (NR-1) from the eastern edge of Monivong Bridge in Phnom Penh to the west of Neak Loueng ferry terminal (approximately 56 km in length) and the inundation areas surrounded by National Roads No.1, No.6, No.7 and No.11 as shown in Fig. 1-4-1.

The following conditions are taken into consideration as the precedence of the Study at both ends of the project road:

On the side of Phnom Penh, taking into consideration “the Transportation Master Plan of the Phnom Penh Metropolitan Area in the Kingdom of Cambodia” conducted by JICA.

On the side of Neak Loueng, taking into consideration the transportation improvement plan without considering the new bridge over the Mekong River, such as the improvement for ferry operation plan.

Fig. 1-4-1 Study Area

1.4.2 Target Year

The target year of the plan is the year 2015 which accords with that of relevant studies and projects implemented by RGC.

1.4.3 Concept of Work Flow

The Study is conducting in the following seven steps:

Step 1: Preparatory Work (Apr. 2002 in Japan)
Step 2: Setting of Alternative Plans (May through Jul. 2002 in Cambodia)
Step 3: Selection of Optimum Plan (Aug. through Sep. 2002 in Japan)
Step 4: Preparation of Road Improvement Plan (Oct. through Nov. 2002 in Cambodia)
Step 5: Preparation of Draft Final Report (Dec. 2002 in Japan)
Step 6: Presentation and discussion on Draft Final Report (Jan. 2003 in Cambodia)
Step 7: Preparation of Final Report (Feb. 2003 in Japan)

Fig. 1-4-2 shows the workflow concept for the Study and its progress.

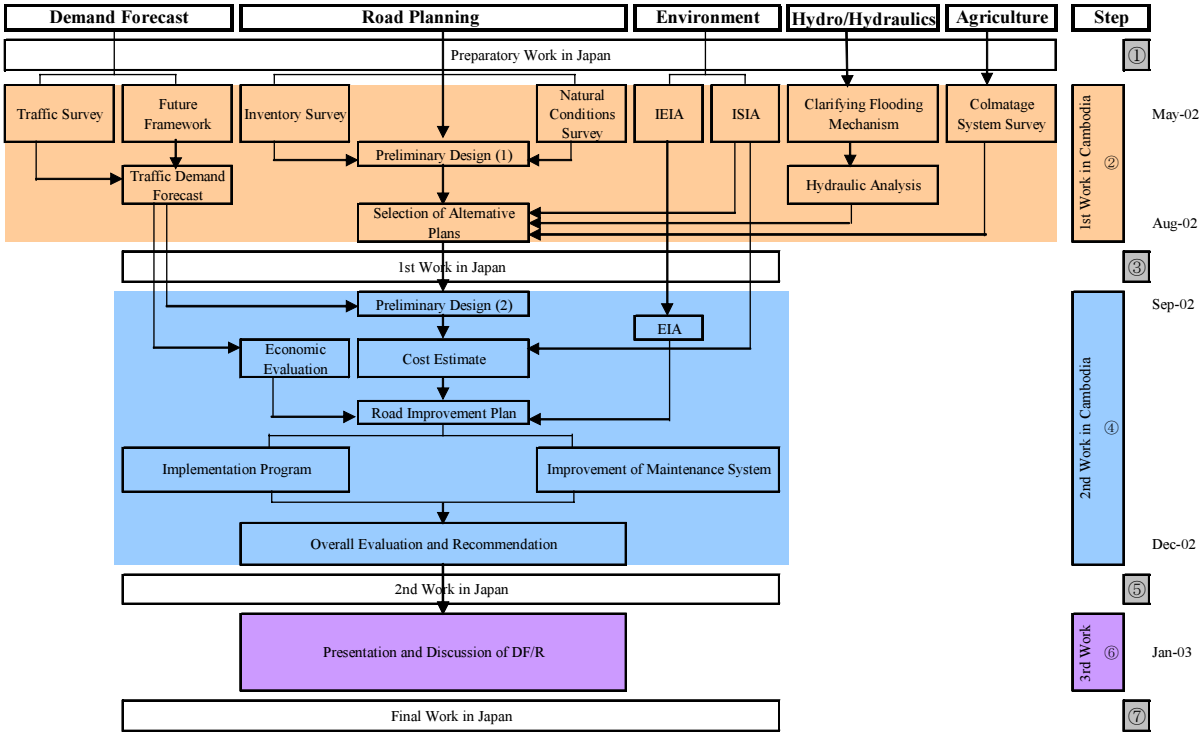

Fig. 1-4-2 Workflow Concept for the Study

1.5 Study Organization

The JICA Study Team closely collaborates with the Cambodian counterpart personel from various organizations of RGC. The following committees are set up for the entire duration of the Study:

- Steering Committee of the Cambodian side, and
- JICA Advisory Committee.

The Study Organization is shown in Fig. 1-5-1.

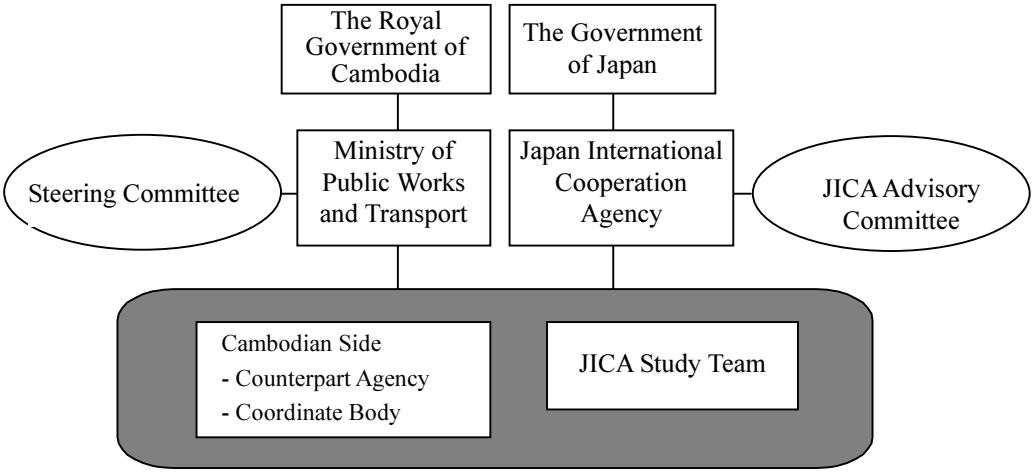

Fig. 1-5-1 Study Organization

The members of counterparts (Cambodian Counterparts) and JICA Study Team for execution of the Study are shown in Appendix-A.

1.6 Final Report

The Final Report sets out work completed in this study, taking into consideration results of engineering surveys, analysis and findings through series of discussions with MPWT, MoWRAM and other agencies concerned. It was completed after receiving the official comments of Draft Final Report that were made during the Steering Committee Meeting held in January 2003 in Phnom Penh, Cambodia.