JAPAN INTERNATIONAL COOPERATION AGENCY
MINISTRY OF WORKS AND TRANSPORT
KINGDOM OF NEPAL

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CONSTRUCTION OF NEW BAGMATI BRIDGE
AT THAPATHALI
IN
KATHMANDU
KINGDOM OF NEPAL

NOVEMBER 1993

NIPPON KOEI CO., LTD.
JAPAN ENGINEERING CONSULTANTS CO., LTD

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PREFACE

In response to the request of His Majesty's Government of Nepal, the Government of Japan has decided to conduct a basic design study on the Project for Construction of New Bagmati Bridge at Thapathali in Kathmandu and entrusted the study to the Japan International Cooperation Agency (JICA). JICA conducted the study in Japan since the beginning of September, 1993 reviewing the result of feasibility study on "Kathmandu Valley Urban Road Development" prepared by JICA in March 1993 from the view point of Japan's grant aid, and the result of study was compiled in the draft report.

JICA sent to Nepal a basic design study team, headed by Mr. Katsutoshi OHTA, Professor of Tokyo University and constituted by member of Nippon Koei Co., Ltd., from October 3 to October 10, 1993, in order to discuss the draft report, and as the result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Kingdom of Nepal for their close cooperation extended to the team.

November, 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

November, 1993

Letter of Transmittal

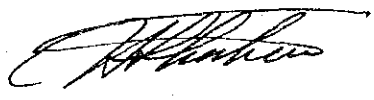
We are pleased to submit to you the Basic Design Study Report on the Project for Construction of New Bagmati Bridge at Thapathali in Kathmandu.

This Study was conducted by a joint venture of Nippon Koei Co., Ltd. and Japan Engineering Consultants Co., Ltd., under a contract to JICA from September 1, 1993 to November 30, 1993. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Nepal and formulated the most appropriate basic design for the project under the Japan's grant aid scheme.

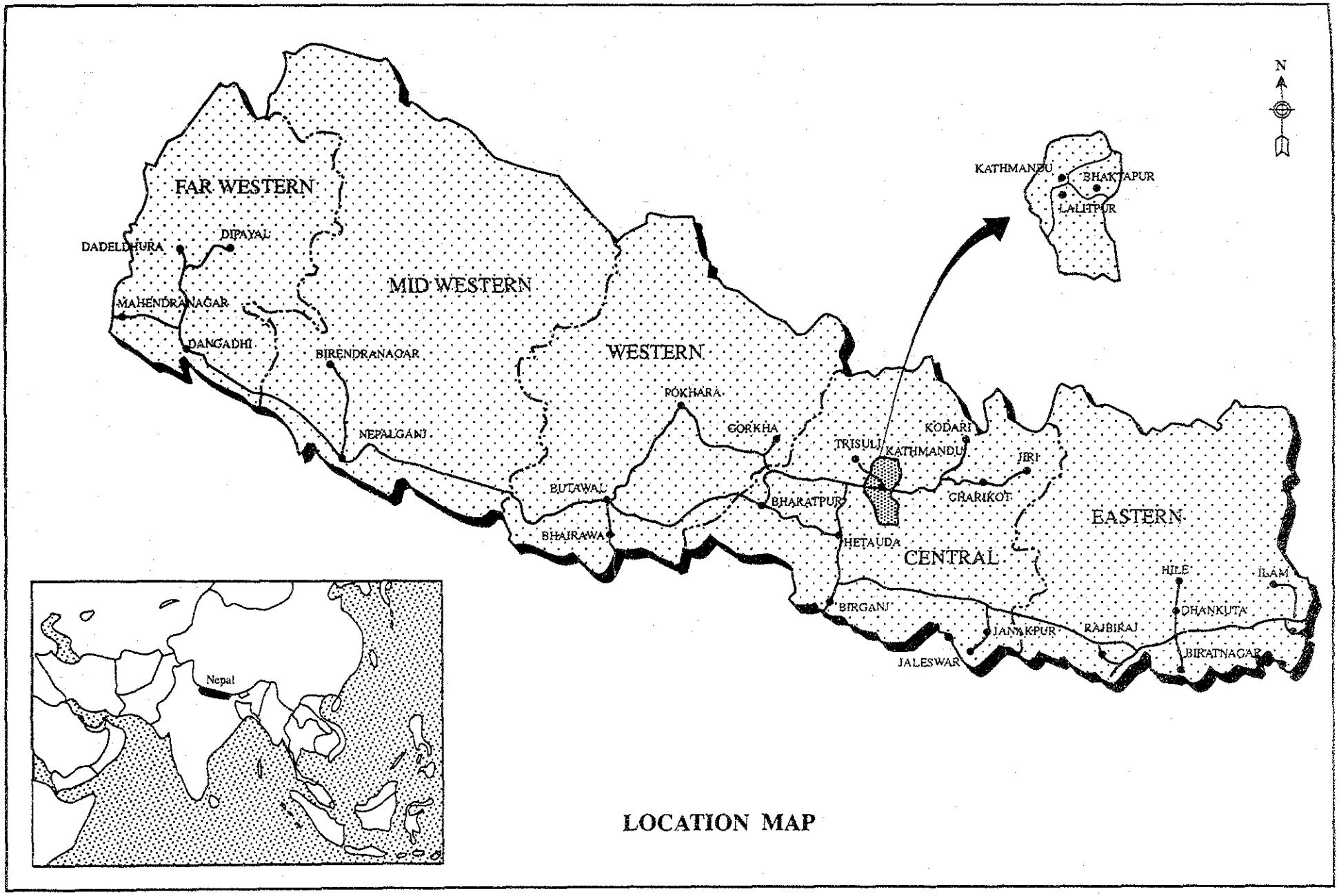
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, the Ministry of Construction, and the Ministry of Education, Science and Culture. We would also like to express our gratitude to the officials concerned of the Department of Roads in Nepal, the JICA Nepal Office and the Embassy of Japan in Nepal for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

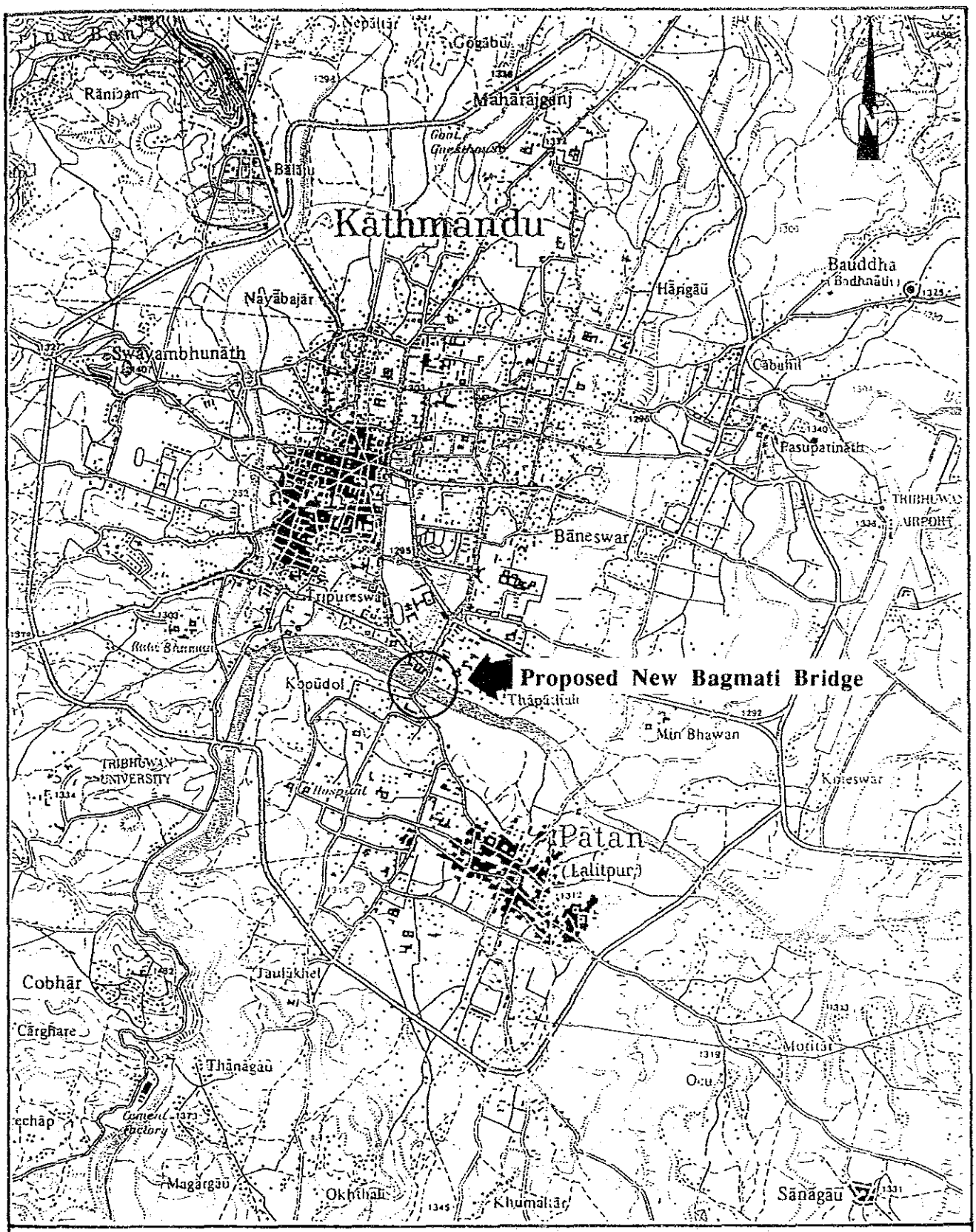
Very truly yours,



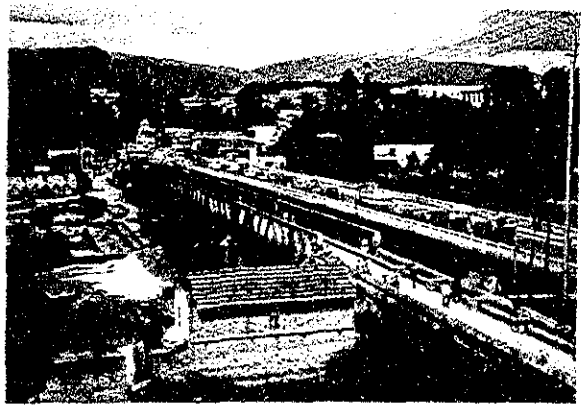
Hiroki Shinkai
Project Manager
Basic Design Study Team on the Project for
Construction of New Bagmati Bridge at Thapathali
in Kathmandu
Joint Venture of Nippon Koei Co., Ltd. and
Japan Engineering Consultants Co., Ltd.



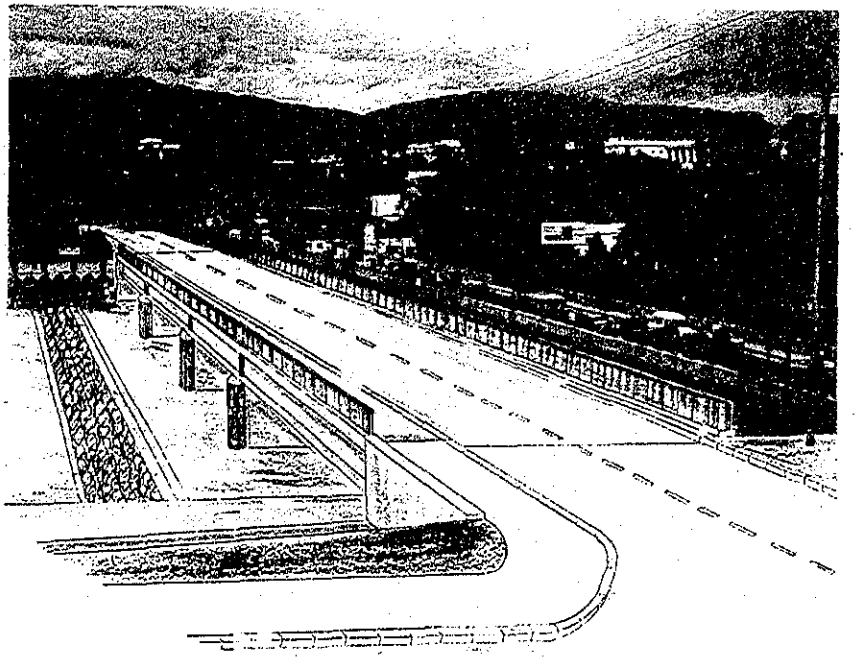
LOCATION MAP



LOCATION MAP Scale : 1/50,000



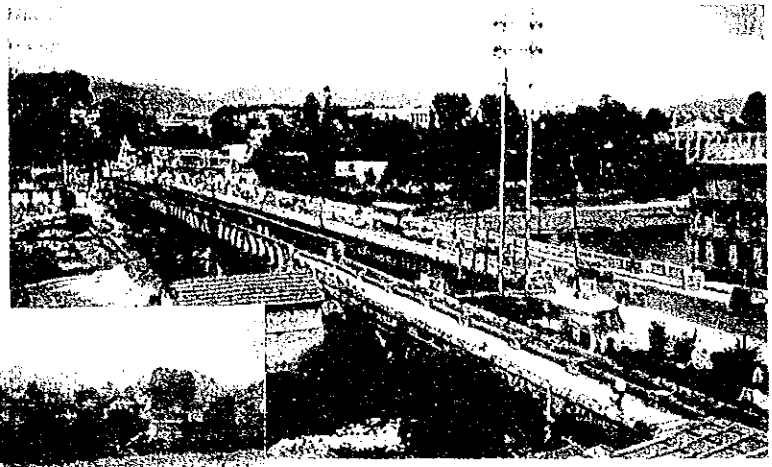
Existing Bagmati Bridge at Thapathali

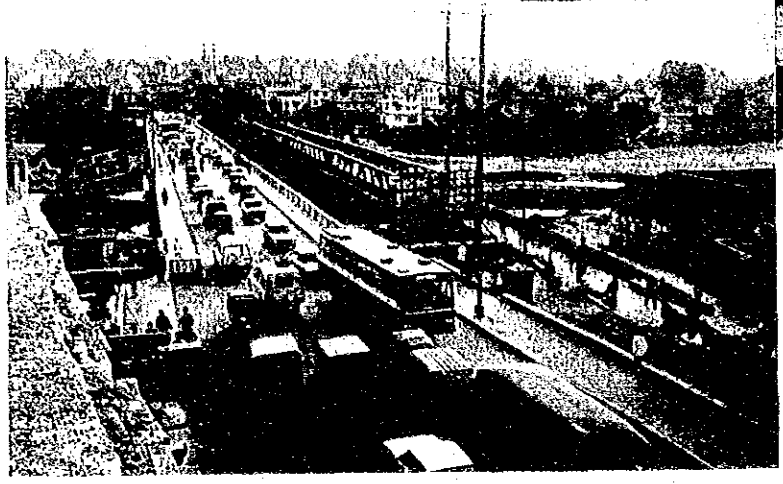


Tentative Bird's-Eyes view of New Bagmati Bridge at Thapathali

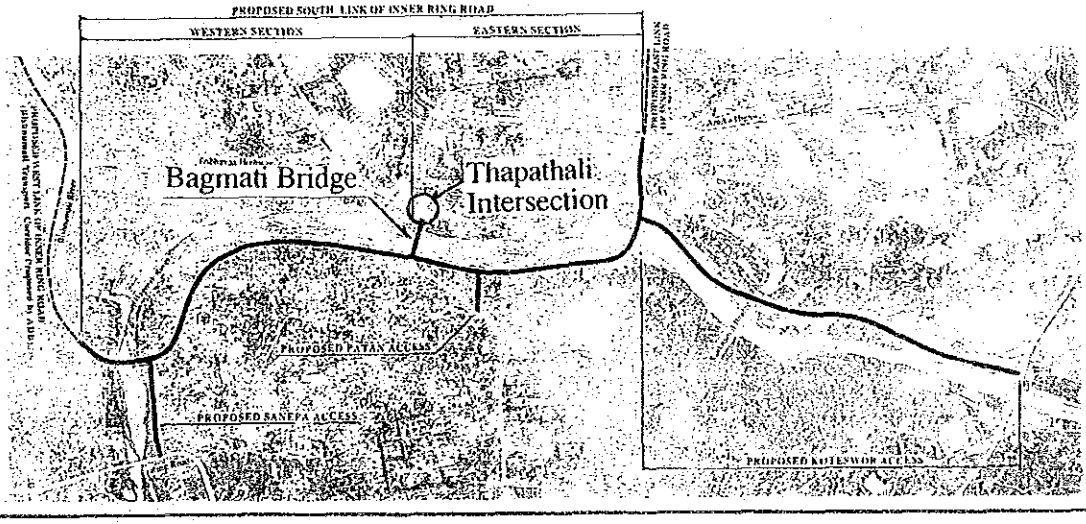
BAGMATI BRIDGE(1)

Heavy traffic congestion on the existing **Bagmati Bridge** at Thapathali. The traffic capacity across the Bagmati river is extremely insufficient.



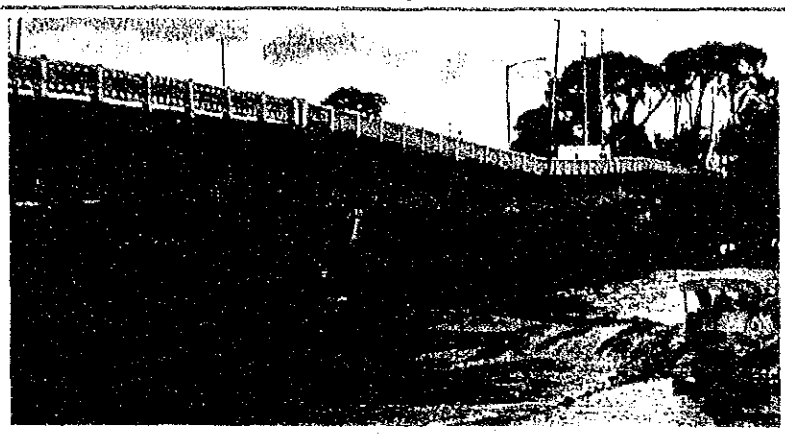


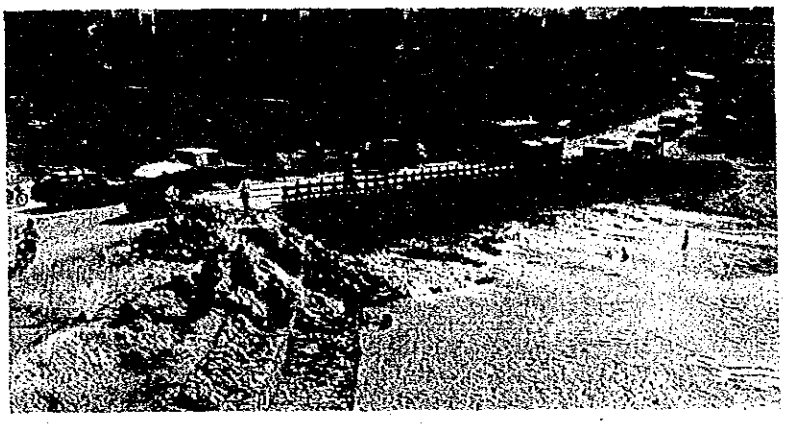
Present condition of **Thapathali intersection** near Bagmati Bridge. The intersection should be upgraded to have a sufficient traffic capacity. New signal control system and pedestrian over-bridge might be necessary so as to operate traffic flow smoothly and large numbers of pedestrian.



BAGMATI BRIDGE(2)

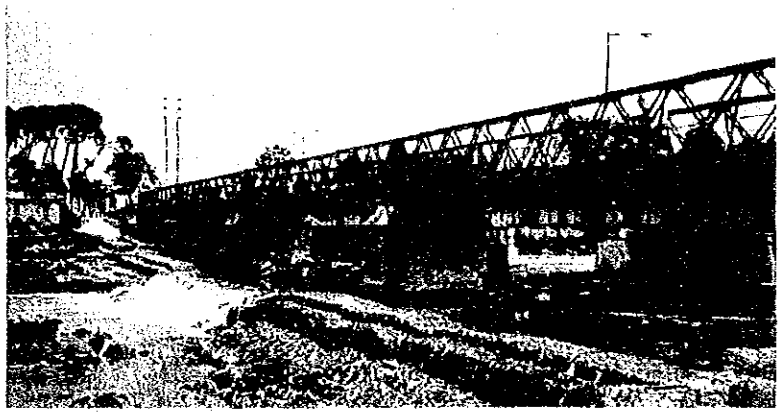
Bagmati Bridge collapsed in August 1991 due to settlement of one of its pier caused by scouring of bridge foundation.

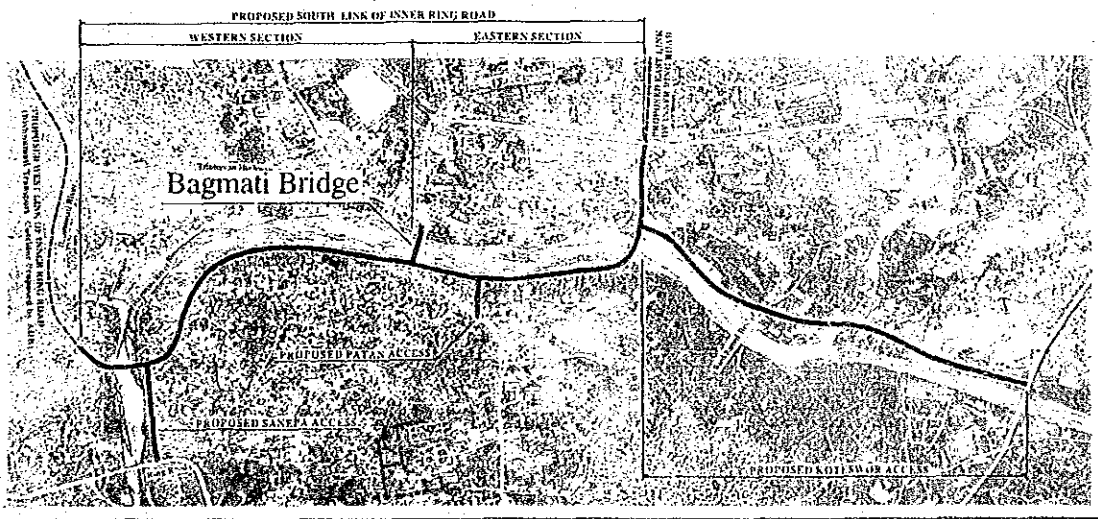




Temporary bridge built a little further upstream the existing bridge.

Temporary check-dam constructed by the government to prevent scouring of bridge foundation from further lowering of river bed. This countermeasure however is not sustainable against flood in next season.





SUMMARY

(1) Present Situation of Kathmandu

Due to rapid increase of population in the Valley, the population of Kathmandu Valley reached 1.0 million approx. in 1990, which has raised a variety of urban problems including sprawling of urban area, slumming inside the city, traffic congestion on the city roads and poor facilities of public transport, mainly caused by inadequate provision of urban infrastructure.

(2) Kathmandu Valley Urban Road Development

To cope up with the above issues, the Japan International Cooperation Agency (JICA), official agency responsible for the implementation of the technical cooperation program of the Government of Japan, conducted the master plan study on "Kathmandu Valley Urban Road Development" during November, 1991 and March 1993, and established urban road development master plan in the Valley in the long-term and short-term with the target year of 2015 and 1997 respectively. The master plan study consisted of the road network plan, public transport plan and traffic management plan.

The feasibility study was also conducted on the following high priority projects and recommended their early implementation:

(i) Improvement of Bagmati Transport Corridor which consists of;

- Construction of New Bagmati Bridge
- Construction of South Inner Ring Road along the Bagmati River including three access to the Ring Road

(ii) Construction of access to the New Bus Terminal.

(3) Request made by the Government of Nepal

On the basis of the recommendation of master plan study, the Government of Nepal decided to place the highest priority on the New Bagmati Bridge Project among the above projects as well as its early implementation and make a request to the Government of Japan to study the possibility of implementation of the Project under the provision of Japan's grant aid for these high priority projects.

(4) Objectives of the Project

The objectives of project is to improve the river crossing capacity across Bagmati River at Thapathali by constructing a new 2-lane Bagmati Bridge in order to remove the traffic bottleneck in the city and to provide a reliable transport facilities connecting Kathmandu and Lalitpur cities.

(5) Component of The Project

The Project consists of the following four(4) major works:

(i) Construction of New Bagmati Bridge (2 lanes, 140 m approx.)

(ii) Improvement of Thapathali Intersection

(iii) Emergency protection of the existing Bagmati Bridge

(iv) Protection against lowering the river-bed and bank slope

(6) Project Feature

(i) New Bagmati Bridge

Type of the Bridge	: Composite Steel Plate Girder Bridge
Bridge Length	: 137.9 m
Span Arrangement	: 15.9m + 4 @ 30.5 m
Bridge Width	: 10 m (2 lanes x 3.75 m + Slow vehicle lane 3.0 m)
Sidewalk	: 3.0 m
Type of pier	: Wall type
Foundation	: Friction pile foundation with steel pipe (800 mm)
Approach roads	: Lalitpur side 145 m
	Thapathali side 191 m

(ii) Improvement of Thapathali Intersection

Thapathali intersection will be improved by widening of traffic lanes with a provision of turning and storage lanes, provision of new traffic signal system with pedestrian signals and lane marking.

(iii) Protection of Existing Bagmati Bridge

Protection measure with the form of 1.0 m high concrete and gabion mat will be placed around the existing piers.

(iv) Protection of Lowering the River-bed and Bank Slope

A permanent checkdam in the form of 1.8 m high concrete and gabion mat apron are provided on down-stream of existing Bagmati Bridge in order to prevent the further erosion of river bed.

(7) Major Work Quantities

Steel Structure	262	ton
Concrete	7,000	m^3
Reinforcement bar	140	ton
Steel pile (800 mm in diameter)	323	ton
Asphalt Concrete	2,000	ton
Subbase Course	1,200	m^3
Base Course	750	m^3
Gabion	1,950	m^3

(8) Implementation Agency

Department of Roads (DOR) under the Ministry of Works and Transport (MOWT) will be responsible for the implementation of the Project and will act as the executing agency of the Project.

(9) Works to be done by the Government of Nepal

The Government of Nepal will be responsible for the land acquisition and house compensation prior to the commencement of construction by the contractor. Also responsible for relocation and protection of the existing public utilities, such as water main, electric pole and wire, telephone cable, etc. which might be affected by the construction of the Project.

(10) Implementation Schedule

The tentative implementation schedule is presented as shown in Fig. S.1 and planned to be implemented in three years as shown below:

(i) 1st Year : Detailed design (3 months)

(ii) 2nd and 3rd years : Construction (21 months)

(11) Project Benefit

(i) Direct Effects

- Provision of new 2-lane bridge will make a extension of the river crossing capacity which would dissolve the chronicle traffic congestion in the area of Thapathali and remove the traffic bottleneck in the city.

- Thapathali intersection is always congested due to small traffic capacity of the roundabout and poor maintenance of traffic signals. Improvement of intersection by widening of traffic lanes with a provision of turning and storage lanes will ensure a smooth traffic flow and reduce a traffic accidents inside the intersection.

- Existing Bagmati Bridge is still in danger of overturning due to lowering of the river-bed scouring. Protection of foundation will extend the life of existing Bagmati Bridge.

- Construction of new Bagamti Bridge will be functioned as a detour bridge connecting Kathmandu city and Lalitpur city, in case of the emergency of existing Bagmati Bridge.

(2) Indirect Effects

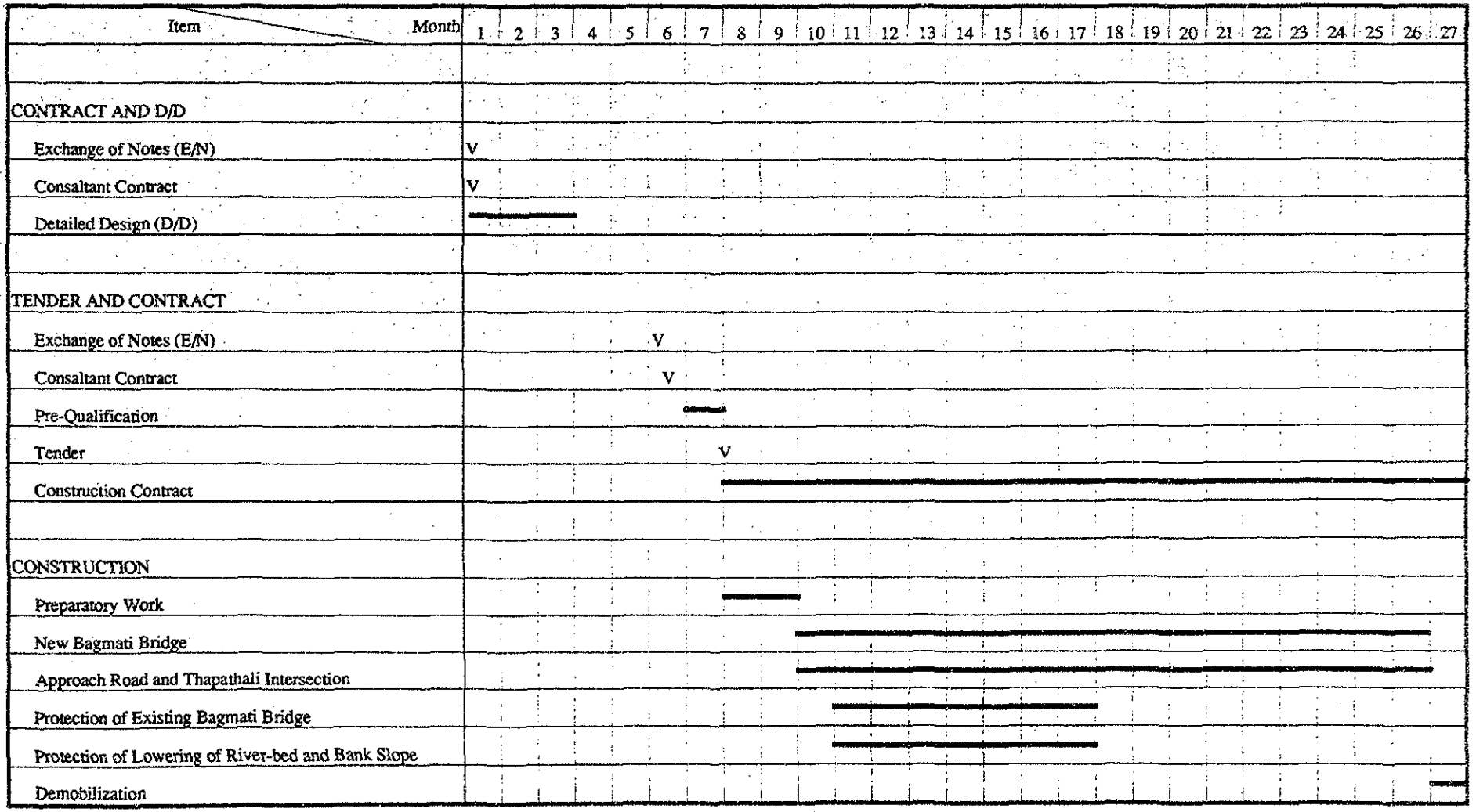
- Project will not only facilitate the anticipated traffic demand in between Kathmandu and Lalitpur but also release the traffic congestion and solve the bottleneck of the traffic movement in the area of Thapathali which will enhance the regional economy and accelerate land-use development in both cities.

- Project will exert an influence on a large majority of people and area in Kathmandu and Lalitpur cities. Total population that will benefit directly from the implementation of the Project is estimated to be 50% of the urban population (530,000 people) approx. Area that will benefit from the project would cover the whole urbanized areas of Kathmandu and Lalitpur cities

- Amount of saving costs in terms of vehicle operating and time cost are expected to be large, which will enhance the social and economic activities in Kathmandu.

- Improvement of traffic bottleneck will streamline the traffic flow in the city and driving condition of road to the level that reduce amount of exhaust gas from the vehicle, which would improve the air pollution in Kathmandu Valley.

Figure S-1 Implementation Schedule



Basic Design Study Report
on
The Project
for
Construction of New Bagmati Bridge
at Thapathali in Kathmandu

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ABBREVIATIONS

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
DOR	:	Department of Roads
GDP	:	Gross Domestic Product
E/N	:	Exchange of Note
HMG	:	His Majesty's Government of Nepal
IDA	:	International Development Association
JICA	:	Japan International Cooperation Agency
JIS	:	Japanese Standards
MHPP	:	Ministry of Housing and Physical Planning
MOF	:	Ministry of Finance
MOWT	:	Ministry of Works and Transport
NBCI	:	National Building Code of India
NRS	:	Nepal Road Standards
OD	:	Origin and Destination

Currency Equivalents

US$1.00 = 110.78Yen = NRs.49.72, or NRs.1.0 = ¥ 2.228 (As of September, 1993)

Chapter 1

Chapter 1 Introduction

Kathmandu Valley comprises of the city of Kathmandu, the capital of Nepal, the city of Lalitpur, the third largest city in Nepal, and the city of Bhaktapur. Due to rapid increase of population and immigration, the population in the Valley is estimated at about 1 million in 1991. This fact, along with inadequate provision of urban infrastructure, has given rise to a variety of urban problems including sprawling of urban area, slumming inside the city, traffic congestion on the city roads and poor facilities of public transport.

To cope with the above issues, in response to the request of His Majesty's Government of Nepal, the Government of Japan commissioned the Japan International Cooperation Agency (JICA), official agency responsible for the implementation of the technical cooperation program of the Government of Japan, to conduct the master plan study on "Kathmandu Valley Urban Road Development" during November, 1991 and March 1993. The master plan study established urban road development plan in the Valley in the long-term as well as the short-term, and identified the high priority projects to be followed by the feasibility study.

The feasibility study was conducted on the high priority projects identified in the master plan, namely (i) Improvement of Bagmati Transport Corridor consisting of construction of New Bagmati Bridge and South Inner Ring Road, and (ii) Construction of access to the New Bus Terminal. The feasibility study confirmed the viability of the project on technical, economical and social grounds and recommended their early implementation. Out of these projects, the implementation of New Bagmati Bridge Project was given the highest priority in order to remove the traffic bottleneck in the city.

Under such situation, the Government of Nepal decided to implement the said project to dissolve the traffic congestion by construction of New Bagmati Bridge at Thapathali and made a request to the Government of Japan to study the possibility of implementation under the Japan's grant aid program.

In response to the request of the Government of Nepal, the Government of Japan decided to conduct a basic design study (hereinafter referred to as the "Study") on the Project for Construction of New Bagmati Bridge (hereinafter referred to as the "Project") and entrusted the Study to JICA.

JICA organized a study team to confirm the viability of the said request from the view point of Japan's grant aid and conducted the study and review of the Project making reference to the feasibility study on "Kathmandu Valley Urban Road Development". All findings obtained through the study were compiled in the draft Final Report of Basic Design Study.

After finishing the works by a study team in Japan, JICA despatched a Final Report (Draft) Study Team, headed by Dr. Katsutoshi Ohta, Professor of Tokyo University, to explain the draft report to His Majesty's Government of Nepal for a period of 8 days from October 3 to October 10, 1993.

Minutes containing a basic agreement was signed and exchanged after the contents of this report was verified and agreed upon by the both parties. The present report was finalized incorporating the result of the said minutes. A list of study team members and survey itinerary (tentative) was included in the Appendix.

Chapter 2

Chapter 2 Background of the Project

2.1 General Situation of Nepal

2.1.1 National Land and Population

The Kingdom of Nepal is a long rectangular country, with an area of 147,181 km2, located between east longitude 80°04'- 88°12' and north latitude 26°22'~30°27'. It is bordered on the north by China and on east, west and south by India. Total population in 1989 was estimated to be 18 million with population density of 125 person/km2 and the average annual growth rate was estimated at 2.6%.

2.1.2 National Economy and National Development Plan

The economy of Nepal is largely influenced by agricultural production which is approximately 55% of the GDP. The GDP during the year of 1991 and 1992 was estimated at NRs. 121,062 million and the per capita GDP was NRs. 6,050 which was about US$130. Annual growth of GDP during the year of 1990 and 1991 was 5.5%, however, the GDP in 1991/1992 was grown at a rate of only 3.1%. The fall in the rate of growth is due mainly to the low growth in agricultural GDP which grew by only 0.5% as a unfavorable weather. However, it is estimated that the growth in non-agricultural GDP was 7.0%.

The first 5 year plan was implemented in 1956, and now the eighth 5 year plan (1991/92 - 1996/97) is under implementation. The objectives of the eighth 5 year plan are (1) Sustainable economic growth, (2) Alleviation of poverty and (3) Reduction of regional imbalance.

In order to achieve the above objectives, the GDP growth for the eighth year plan period is targeted at 5.1% and the growth in agricultural and non-agricultural sectors are respectively targeted at 3.7% and 6.1%.

2.1.3 General Situation of Transport Sector

Since Nepal is a land-locked country surrounded by mountains, the transportation system is mainly based on road transportation supported by air transportation. Ever since the first five year plan in 1956, the transportation sector was constantly given high priority in investment allocation. This is because the government is fully aware that in order to promote national economy through industrial, agricultural or resource development, transportation and other basic economic infrastructure are critical factors, especially

transportation, where most of investment is directed to upgrading roads and constructing trunk roads.

Railway system is operated in two lines near the Indian border, one running from Raxual to Amlekganj and the other from Jainigar to Janakpur. Ropeway system is operated between Kathmandu and Hetauda. Airway system plays an important role in the rural transportation.

As stated above, Nepal is landlocked country so that the international goods from other than India and China have been transported based on the road transportation from Calcutta port in India to the major cities in Nepal. The total length of the roads, which was only 624 km at the beginning of the first 5 year plan, was extended about 10 times totaling 6307 km in 1987 as shown in Fig. 2.1. Within the total extension, 2794k or 44% was paved roads.

2.1.4 Government Administration and Organization

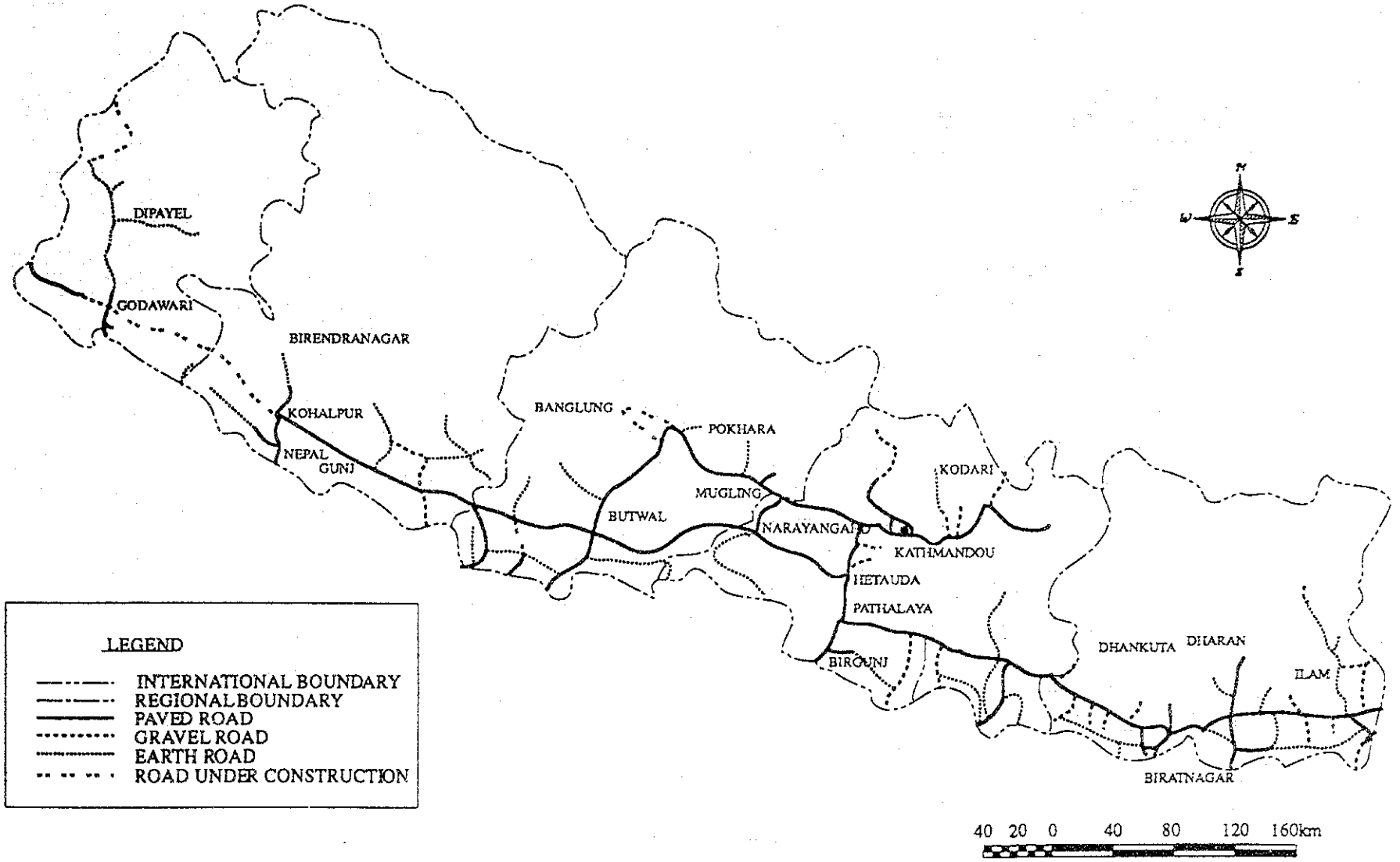
The organization of government administration of His Majesty's Government of Nepal consists of 23 ministries. The Ministry of Works and Transport is in charge of transport sector and Ministry of Housing and Physical Planning is responsible for making the urban planning and related urban road.

Organization chart of the Ministry of Works and Transport is shown in Fig. 2.2.

2.2 Related Projects and Program

The Government of Nepal has executed various transport sector projects being assisted by donor countries including India, China, Japan and international financing agency including Word Bank and ADB. The projects related to this project are presented in Fig. 2.3 and summarized as follows:

(1) Reconstruction of 6-bridges in Kathmandu (Phase 1) by Japan - completed
(2) Reconstruction of 4-bridges in Kathmandu by IDA -under construction
(3) Reconstruction of 4-bridges in Kathmandu (Phase 2) by Japan - under construction
(4) 2nd Road Rehabilitation Program by ADB - under construction
(5) Kathmandu Valley Urban Development and Program by ADB - completed
(6) Kathmandu Valley Urban Road Development by Japan - completed



ROAD SYSTEM 1987

Fig.2.1 Transportation System in Nepal

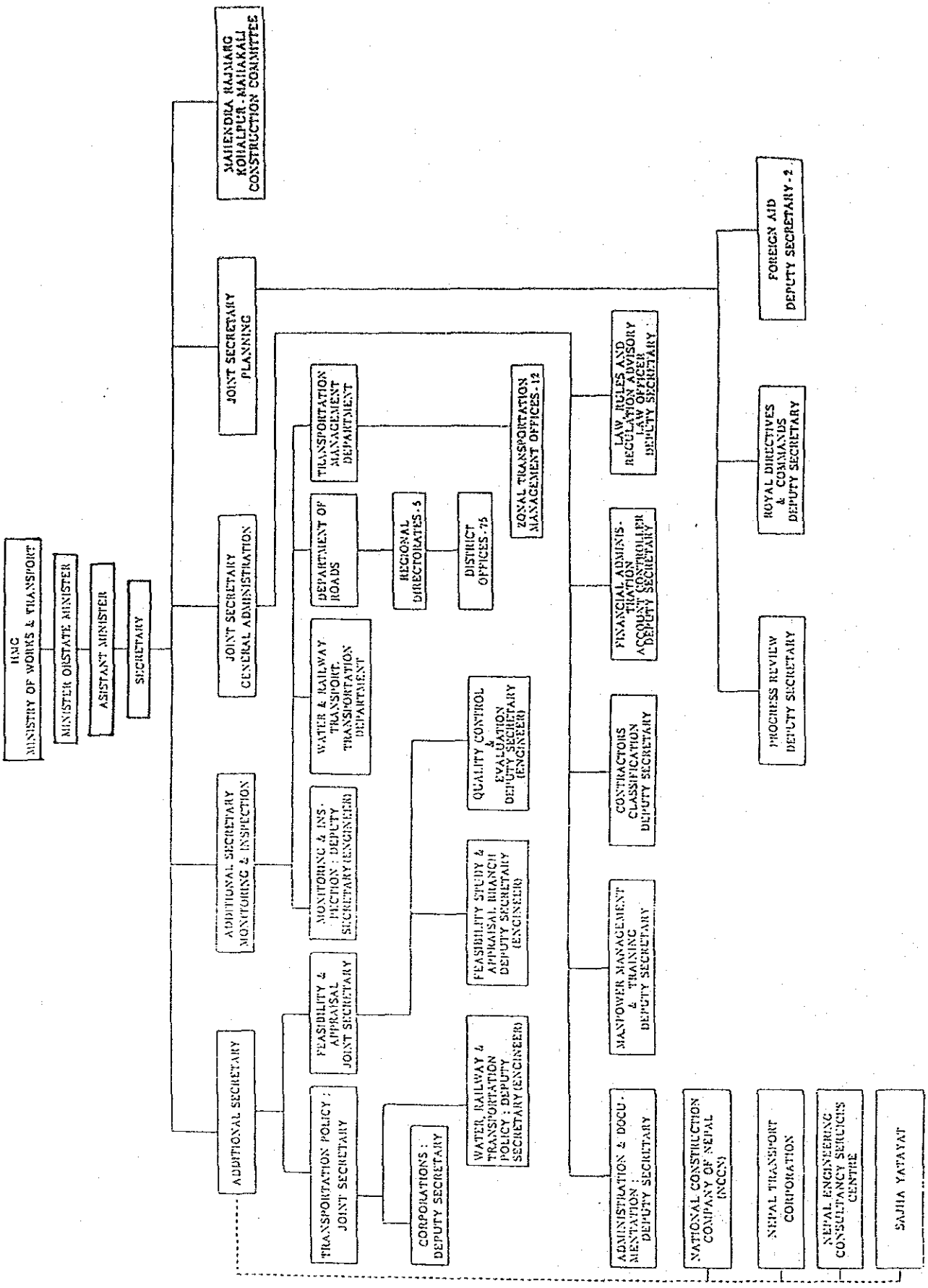


Fig. 2.2 Organization of Ministry of Works and Transport

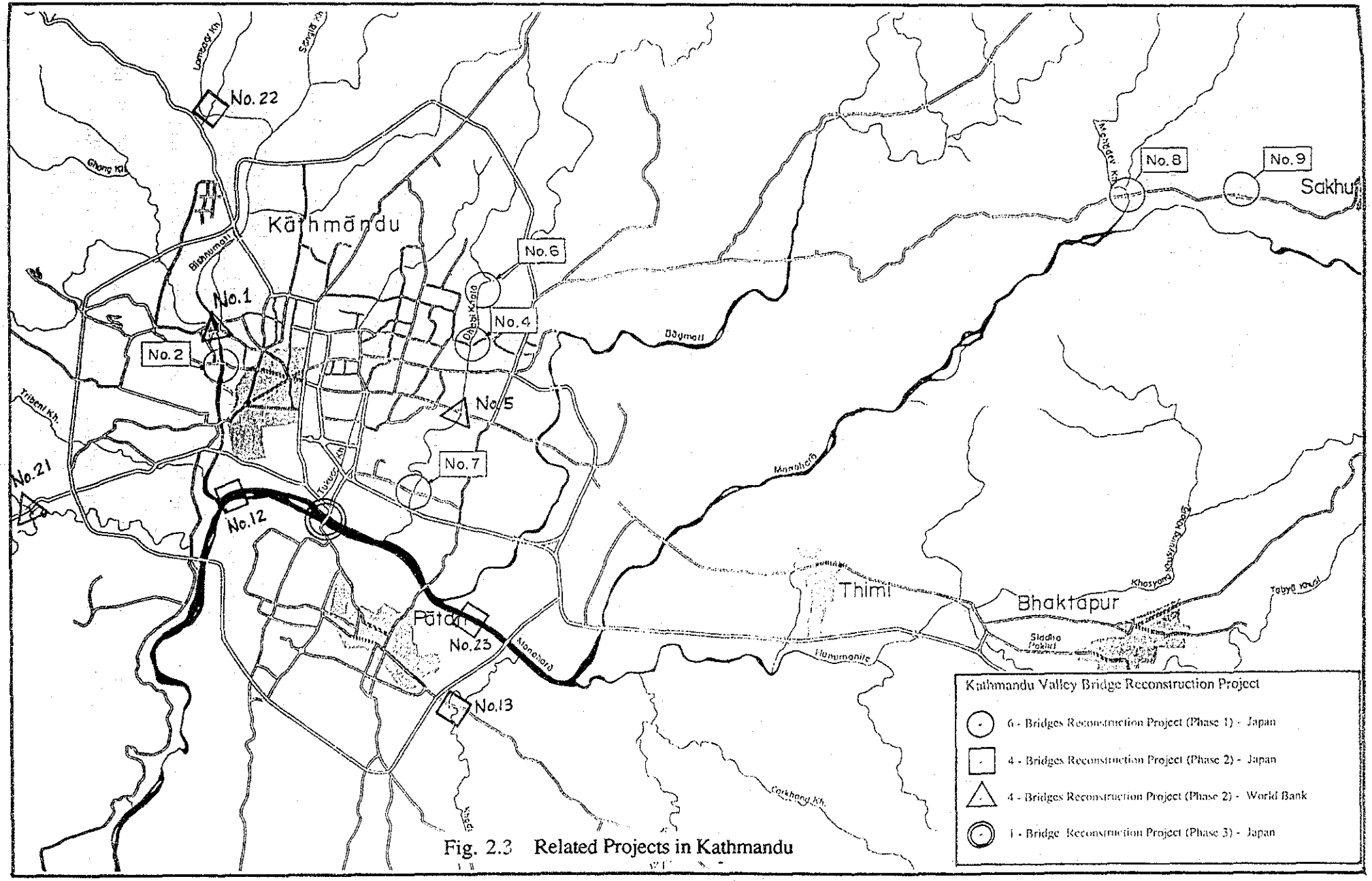


Fig. 2.3 Related Projects in Kathmandu

2.3 Outline of "Kathmandu Valley Urban Road Development"

A study of "Kathmandu Valley Urban Road Development" was conducted by JICA study team during the period from November, 1991 to March 1993 to cope up with the rapid increase of urban population, increase of traffic and expansion of urban area in the Kathmandu Valley. Objectives of the study was to prepare the road development master plan in the Kathmandu Valley in the long-term and short-term with the development concepts as shown below:

(1) Long-term Development (for the year 2015)

- Establishment of well-balanced road transportation system as a capital of nation
- Homogeneous development of the Valley

(2) Short-term Development (for the year 1997)

- Improvement of bottlenecks in urban roads
- Relief of transportation-poor areas

Long-term road development plan for the year of 2015 was prepared on the basis of the following five (5) development concepts and the result of road master plan is presented in Fig. 2.4.

(1) Road development as a capital of nation including;

- Construction of Arniko Bypass and Construction of 2nd Tribhuvan Highway

(2) Road development in the wave of outward shift of urban area including;

- Widening of 7 - radiating roads, Construction of ring roads, Thimi North-South Ladder Step Roads and Gothatar Service Road (East of Airport)

(3) Road development for the integration of three (3) existing city centers including;

- Widening of Koteswor - Thimi - Bhaktapur Feeder Road and Construction of Baneswor - Thimi Shortcut by provision of tunnel under Tribhuvan Airport

(4) Road development to streamline the traffic flow inside the Ring Road including;

- Construction of the Inner Ring Road, Linkage of the Inner Ring Road with the Ring Road, Widening of Kantipath and Widening of Bhaktapur Ring Road

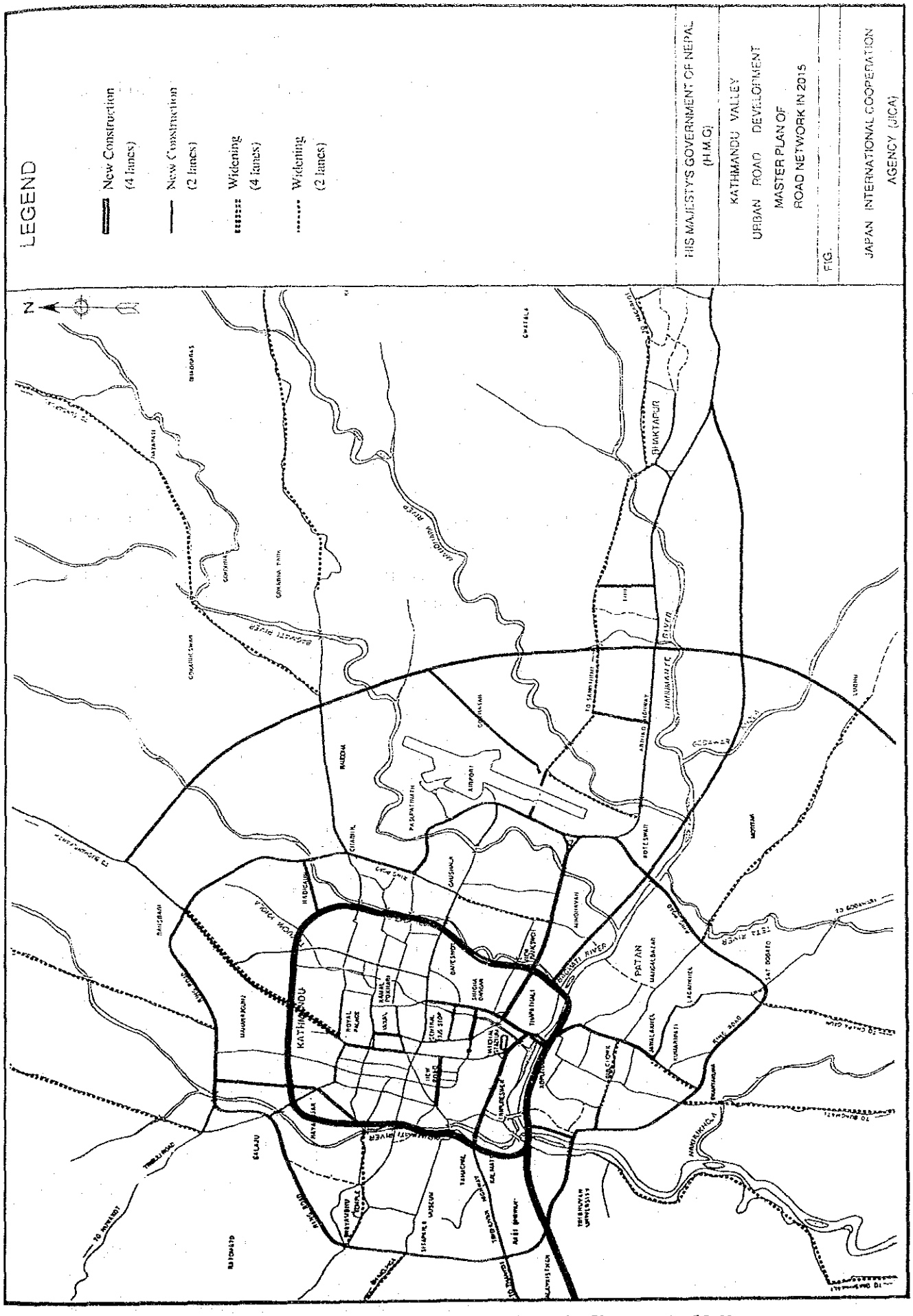


Fig. 2.4 Long-term Road Development Plan in Kathmndu Valley

Short-term road development plan was prepared as shown in Fig. 2.5 with the following recommended road network:

- Improvement of Bagmati Transport Corridor
- Improvement of Bishnumati Transport Corridor
- Access to the New Bus Terminal at Balaju
- Improvement of Lalitpur Access
- Improvement of radial roads connecting with the central area
- Widening of Baneswar road

High priority projects were selected among the above projects in the short-term plan taking into consideration the urgency and needs of the project and feasibility study was conducted to confirm the viability of these projects. The high priority projects selected are presented in Fig. 2.6 and summarized below:

(1) Improvement of Bagmati Transport Corridor, which consists of:

1) Construction of South Link of Inner Ring Road

2) New Bagmati Bridge

3) 3- Access including Koteswor, Sanepa and Patan Access

(2) Construction of Access to the New Central Bus Terminal at Balaju

(3) Improvement of 3- intersections at Maitighar, Tripureswar and Koteswor

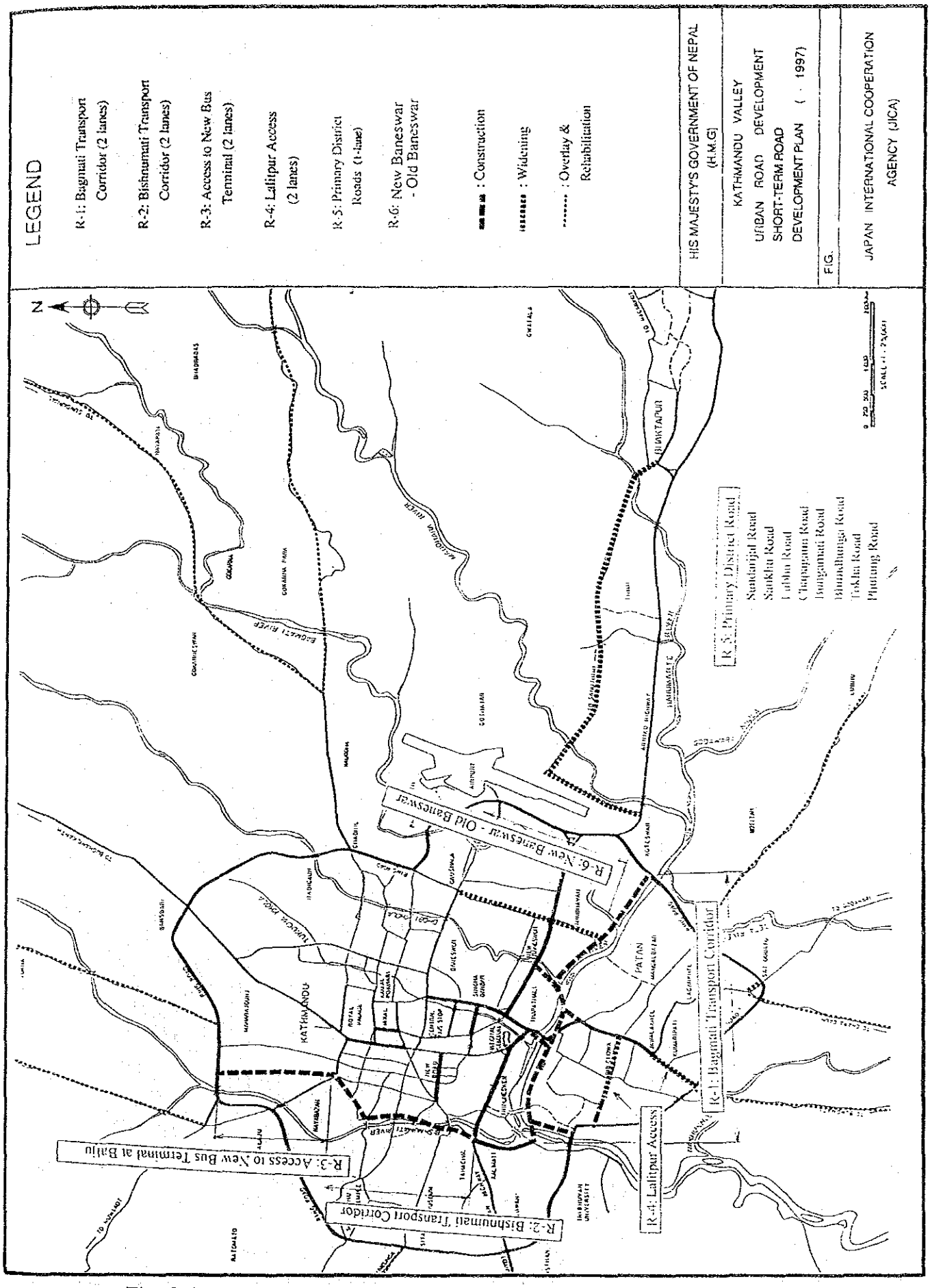


Fig. 2.5 Short-term Road Development Plan in Kathmandu Valley

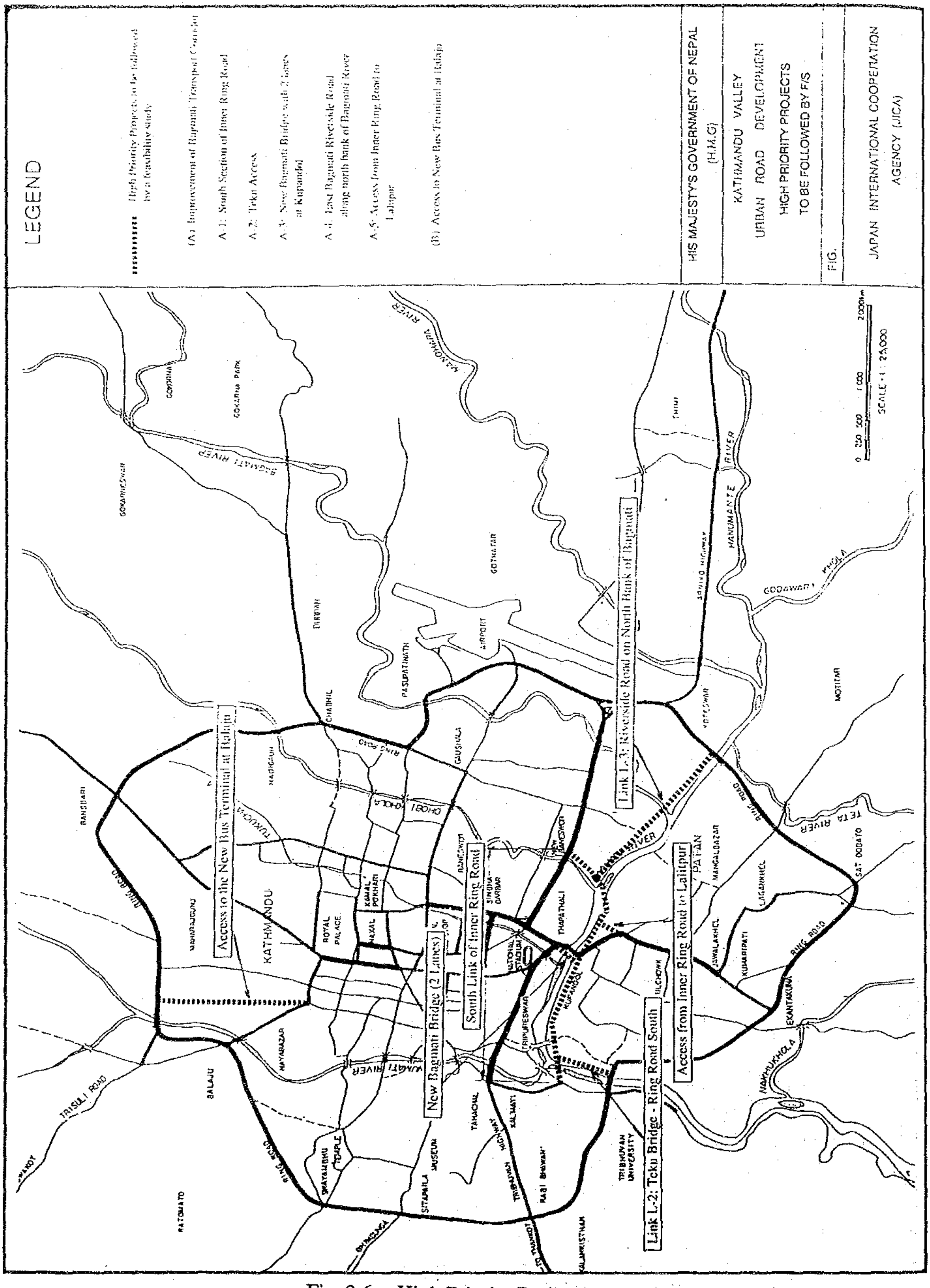


Fig. 2.6 High Priority Projects

2.4 Outline of the Request

2.4.1 Background of the Request

The feasibility study confirmed the project viability on technical, economical and social grounds and recommended to implement these high priority projects which consists of (1) Improvement of Bagmati Transport Corridor (2) Construction of Access to the new Bus Terminal and (3) Improvement of 3-intersections.

Based on the feasibility study, the government of Nepal decided to implement the construction of new Bagmati Bridge and improvement of 3-intersections taking into consideration urgency and needs of the project and make a request to the Government of Japan to study the possibility of implementation of the Project under the provision of Japan's grant aid for these high priority projects.

2.4.2 Contents of the Request

(1) Executing agency

The executing agency of the project is DOR under the jurisdiction of MOWT.

(2) Purpose of the Project

The project is to extend the river crossing capacity across Bagmati River by constructing a new 2-lane Bagmati Bridge to dissolve traffic congestion in the area and to provide a reliable transport route connecting Kathmandu and Lalitpur cities.

(3) Requested items

The Project requested by the Government of Nepal are summarized as follows:

i) Construction of New Bagmati Bridge (See Fig. 2.7) consisting of;

- Construction of New Bagmati Bridge (2 lanes, 140 m approx.)
- Improvement of Thapathali Intersection
- Emergency protection of the existing Bagmati Bridge
- Protection against lowering the river-bed and bank slope

ii) Improvement of 3-intersections (Fig. 2.8) consisting of

- Maithigar, Tripureswar and Koteswor

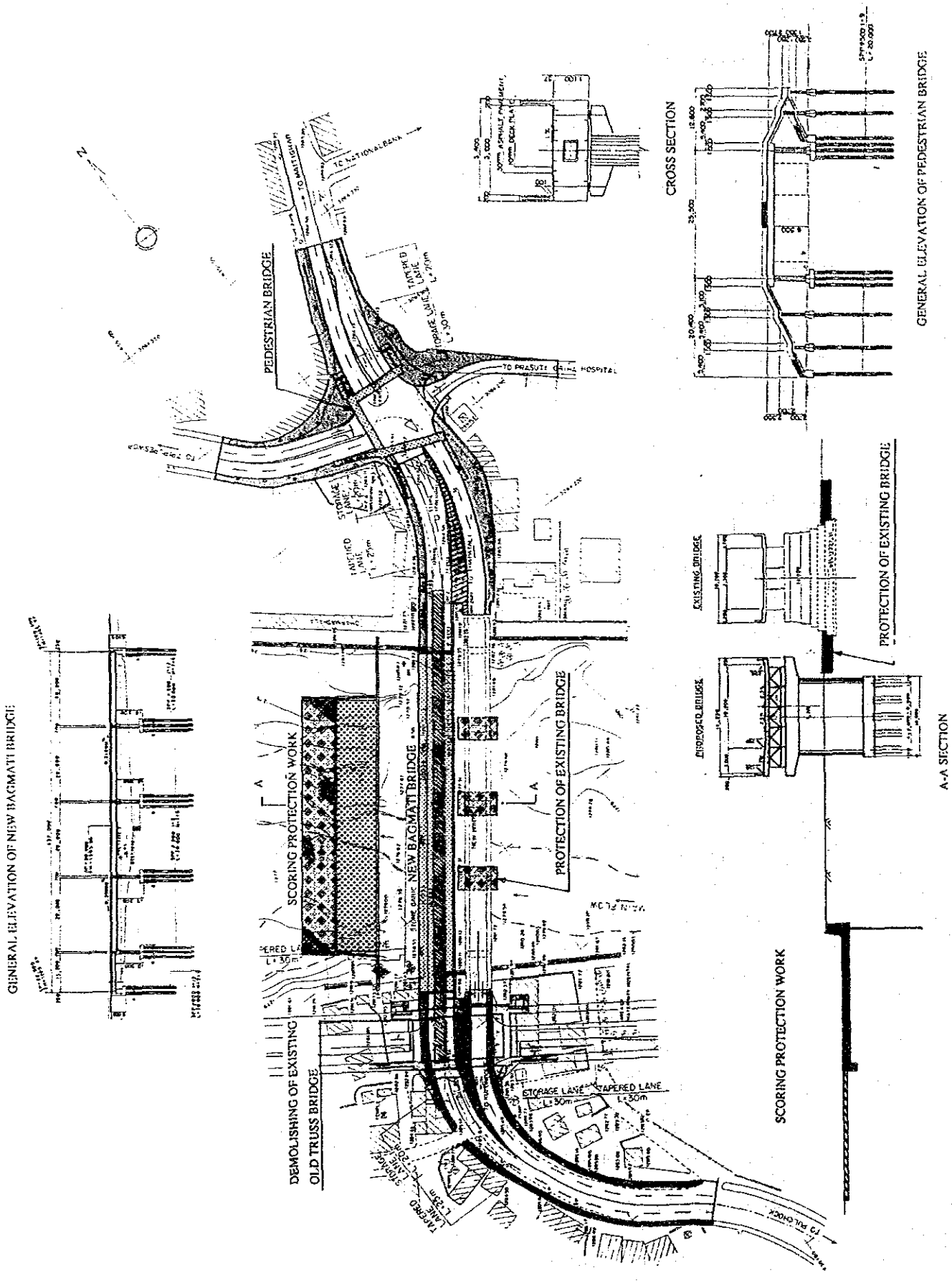


Fig. 2.7 New Bagmati Construction Project

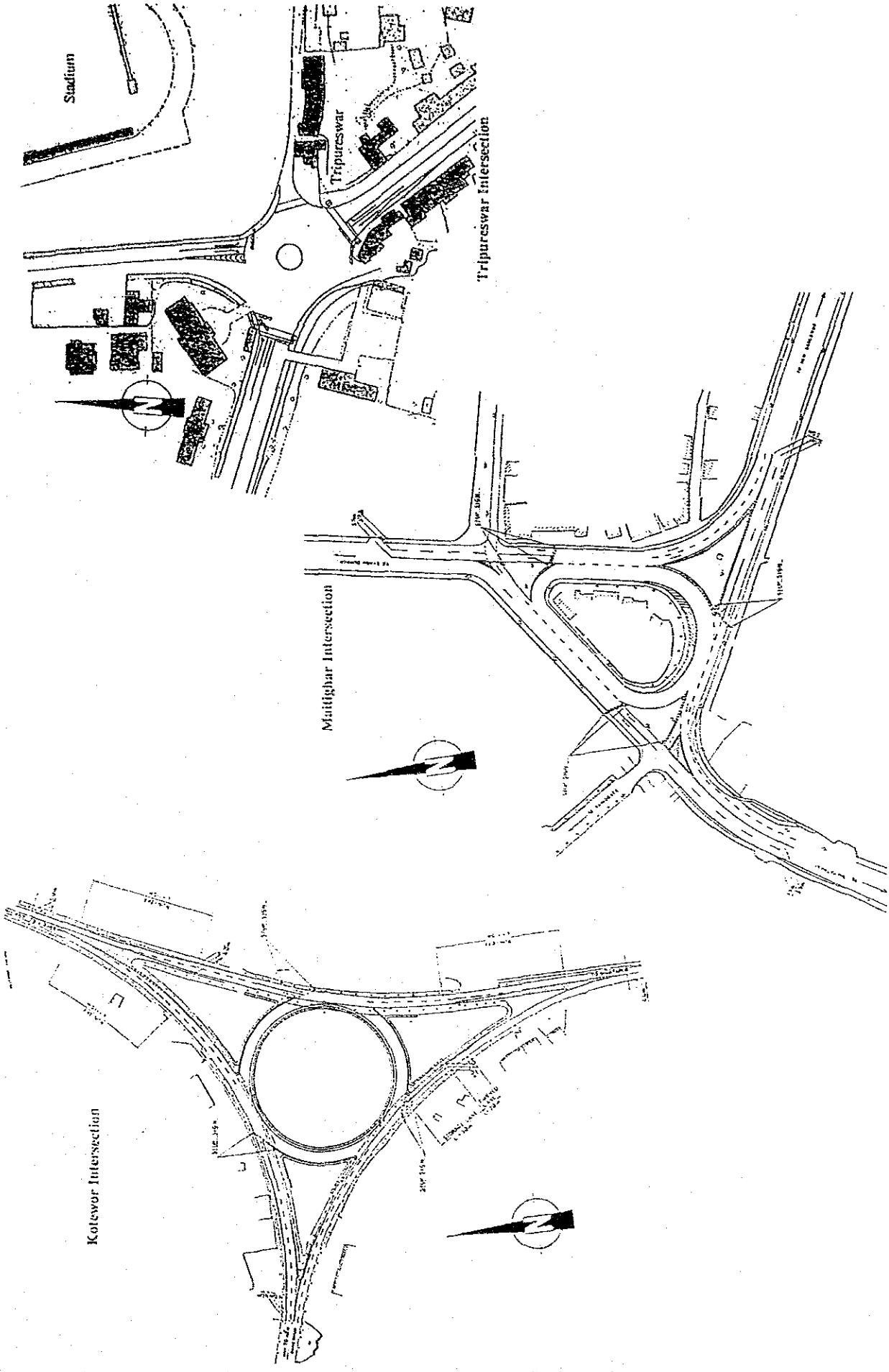


Fig. 2.8 Improvement of 3-Major Intersections

Chapter 3

Chapter 3 Outline of the Project Area

3.1 Characteristics of the Project Area

3.1.1 General Situation

Kathmandu, a capital of Nepal, is located in the central and east area of Kathmandu Valley with a elevation of 1,300 m approx. According to the Prompt Report of 1991 Census, the population in Kathmandu Valley is estimated at 1.0 million with an average annual growth of 4.9% in the period from 1981 to 1991, which was considerably higher than the average annual growth rate of 2.6% for the entire nation.

Kathmandu Urban area had a total population of 592,000 in 1991 and the population broken down for the three cities are 414,000 for Kathmandu (70 %), 117,000 for Lalitpur and 61,000 for Bhaktapur.

In Kathmandu valley, there are four main rivers, namely Bishnumati, Dhobi Khola, Bagmati and Manohara rivers. These river joint each other to Bagamati river and flow out from Kathmandu Valley at Chobar Gorge and confluent with Ganges River in India.

The climate of Kathmandu is subtropical zone with an average maximum and minimum temperature of 28°C and -4° respectively. It may be divided into the dry season (October - May) and the monsoon or wet season (June - September) with a rainfall of 15 to 45 mm and 100 to 400 mm respectively.

According to the record on earthquakes in Nepal, there is one earthquake per year with a magnitude greater than five in the past. Kathmandu city is specified in zone V, maximum hazard area, according to the national Building Code of India 1970, Part IV, Indian Standards.

3.1.2 Road Condition

Kathmandu Valley is served with the Ring Road and radial pattern of road network as shown in Fig. 3.1 with a total length of 740 km according to the DOR Statistics of 1990.

The road are classified into four (4) categories of the roads as given in Table 3.1.

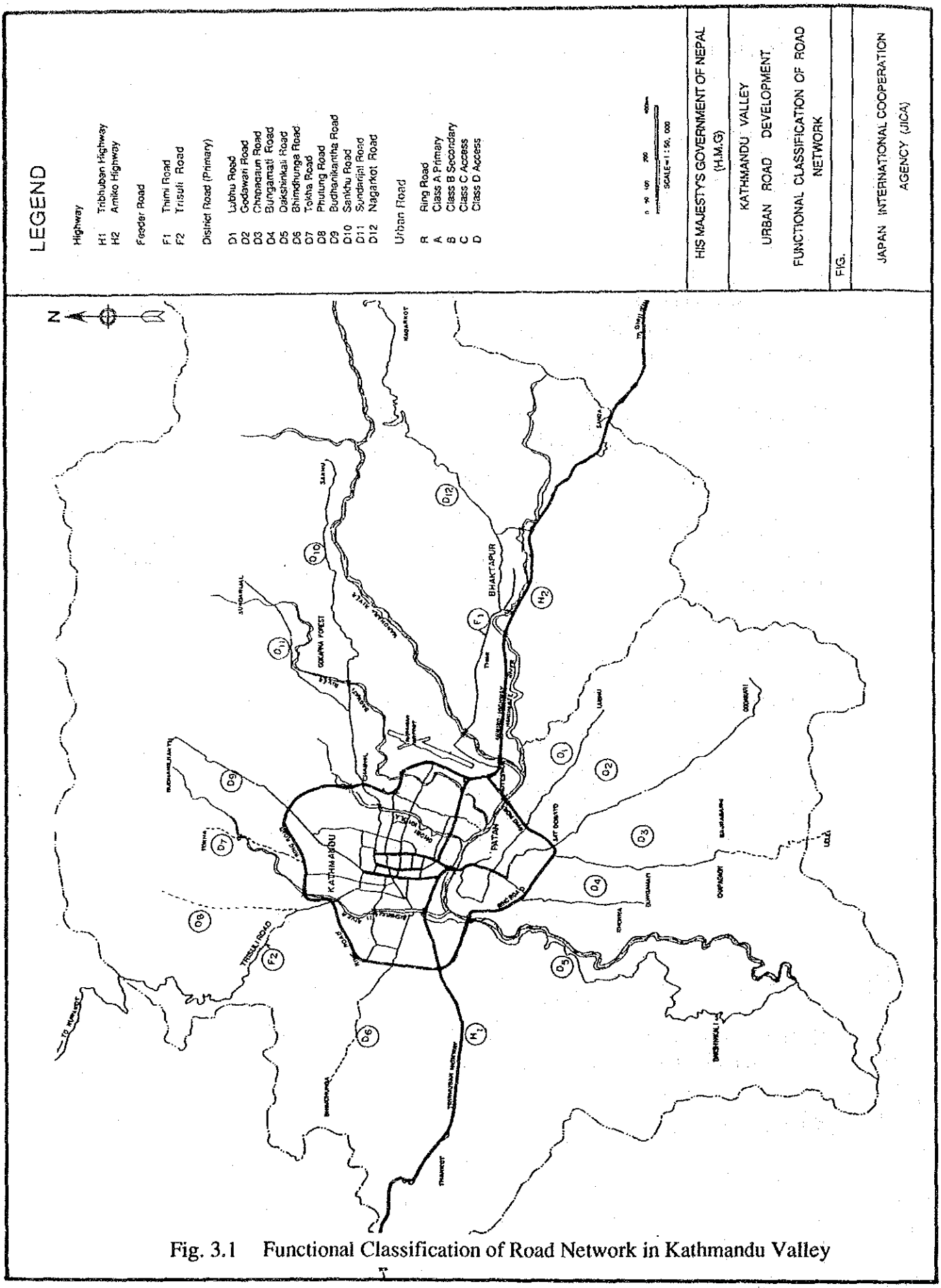


Fig. 3.1 Functional Classification of Road Network in Kathmandu Valley

Table 3.1 Classification of Roads in Kathmandu Valley

	Road Length (km)	Remarks
- Highway	34	Tribhuvan, Arniko
- Feeder Road	25	Thimi, Trisuli
- District Roads	342	Primary/Secondary Roads
- Urban Roads	339	Ring Road and City Roads
Total	740	

Urban roads in the Valley consists of the Ring Road and city roads with sub classification of four (4) grades from Class A to D as shown in Table 3.2.

The Ring Road as well as Class A and B roads are vital city roads constituting primary road network in the city and serve the greater portion of the vehicular traffic passing through the city, while Class C and D roads are providing access to abutting residential and business areas. Fig. 3.2 shows the road network by lane number in the Valley.

Table 3.2 Detailed Classification of Urban Road

	Kathmandu District	Lalitpur District	Bhaktapur District	Total (km)
Ring Road	21.0	7.0	0.0	28.0
Class A	24.3	5.0	0.0	29.3
Class B	71.9	13.5	7.8	93.2
Class C	39.0	13.5	8.2	60.7
Class D	86.8	41.0	0.0	127.8
Total	243.0	80.0	16.0	339.0

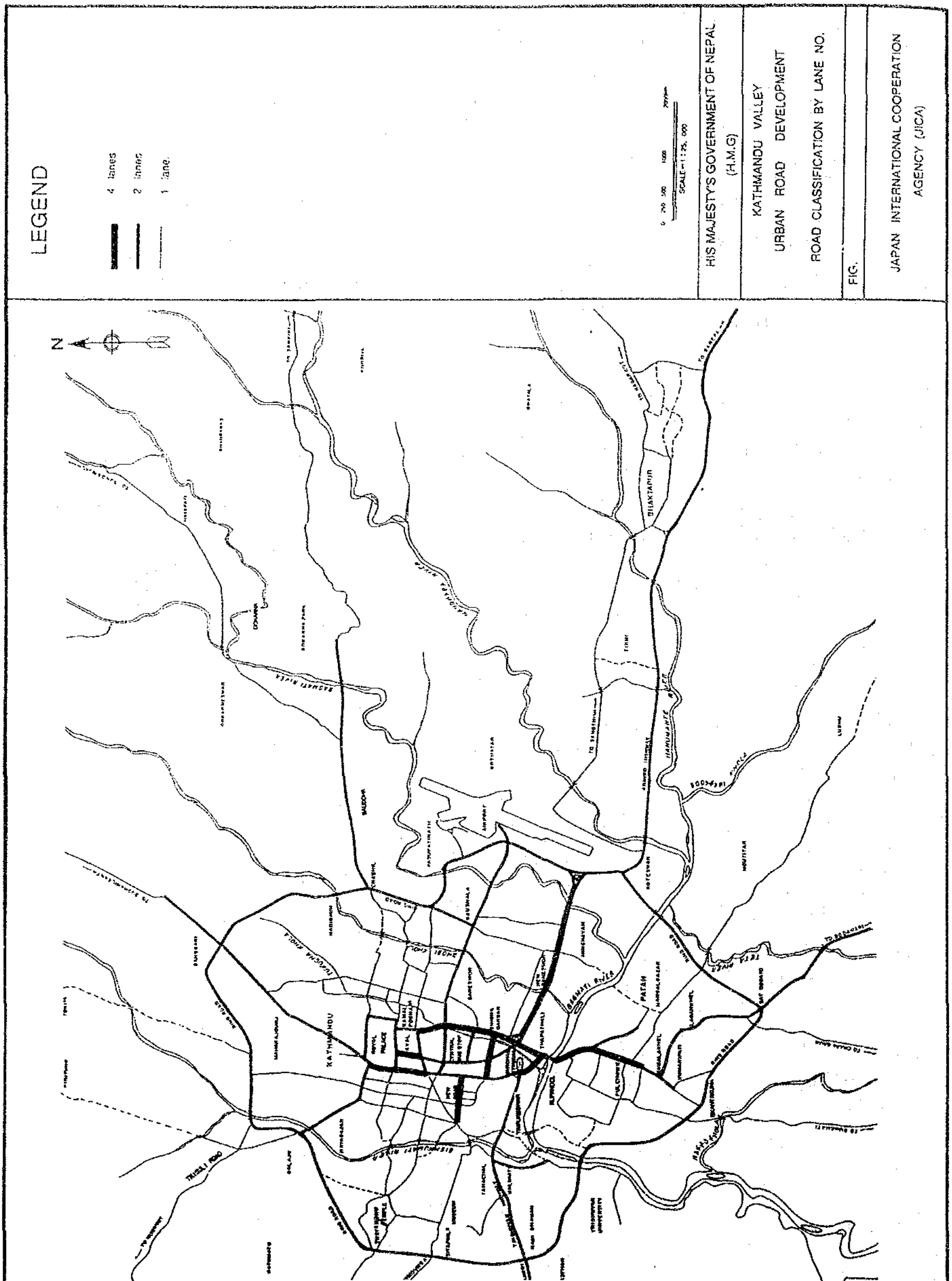


Fig. 3.2 Road Classification by Lane Number

3.1.3 Traffic Condition

The transportation in the Valley is mainly done by roads and there is no railway system in the Valley. The roads in the Valley have been upgraded and renovated into motorable roads and extended with the initiation of bus services by such companies as Sajha Yatayat in the beginning of 1960's.

At present, total number of registered vehicles in the Valley is estimated at about 54,000 in 1990 as shown in Table 3.3, however, actual figure might be larger than that of, if non-registered vehicles are included.

According to the data on person trip survey conducted in Kathmandu Valley Urban Road Development, JICA in 1993, the total number of trips by residents in the urban area of three (3) city is 1.02 million per day. Table 3.4 shows trip composition by mode in which walking trips account for more than one-half of total trips.

Fig. 3.3 shows the survey results on daily traffic volume on major roads in the Valley and Table 3.5 shows the traffic volume by vehicle type As seen in the table and figure, the daily traffic volume on the proposed site of Bagmati Bridge recorded at ADT 48,000 which the largest figure among the city road.

3.2 Characteristics of the Proposed Site

Proposed bridge site is located in the central part of Kathmanddu Valley along the east-west stretch of Bagmati River as shown in Fig. 3.4. Excepting the Koteswor area where the river is confined into a narrow channel, the river is significantly wide with braided channel.

Kathmandu is a synclinal tectonic basin with Paleozoic and Precambrian rocks at the periphery and cover with a thick fulviatile deposits in the northern part and dominantly lacustrine deposit in the south. The proposed bridge site is regarded as the transition zone between the predominantly fluvial deposits of soil and sand to the north and the predominant lacustrine deposits of organic clayey sit and clay to the south.

The clayey silt is generally highly porous, organic and compressible. This necessitates a understanding of the compressibility characteristics of the clay with potential settlement if it is loaded.

No significant problems of slope instability is foreseen for the project site, however, the liquefaction potential of bank erosion may be necessary.

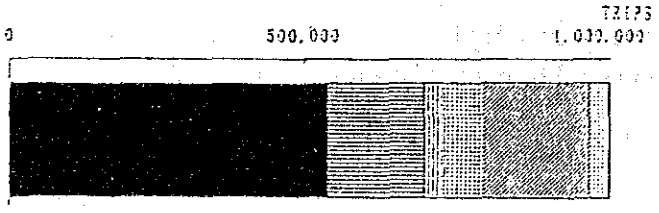
Table 3.3 Registered Numbers of Vehicles in Kathmandu Valley

SN.	VEHICLE	PUBLIC	PRIVATE	GOVERN-MENT	CORPORA-TION	TOTAL		
		90/91	90/91	90/91	90/91	73/74	80/81	90/91
1.	Bus, Minibus, Truck	3,217	2,378	1,134	340	1,952	3,658	7,069
2.	Car, Jeep	2,140	11,719	3,379	762	6,012	10,979	18,000
3.	Tempo, Autorickshaw	1,770	644	-	-	-	NA	2,414
4.	Power tiller, Tractor	1,026	703	-	-	NA	632	1,729
5.	Motorcycle, Scooter	-	21,219	2,193	799	NA	11,100	24,211
6.	Rickshaw	470				NA	464	470
7.	Hand Cart	NA				NA	600	NA
8.	CD/UN Vehicles					NA	NA	883
	Total					7,964	26,750	54,776

Remarks : 1. NA - Data not available for the corresponding year.
2. Vehicle number data was gathered from different available sources. Analysed and estimated by the Study Team.

Table 3.4 Composition of Traffic Means in Kathmandu Valley

PURPOSE	NUMBER OF TRIPS	PERCENTAGE
WALK	541,768	53.1
BICYCLE	67,233	6.6
MOTORCYCLE	94,711	9.3
TEMPO	36,875	3.6
TAXI	21,170	2.1
MINIBUS	39,744	3.9
BUS	179,692	17.6
CAR	35,677	3.5
TRUCK	2,300	0.2
OTHERS	1,310	0.1
TOTAL	1,020,480	100.0



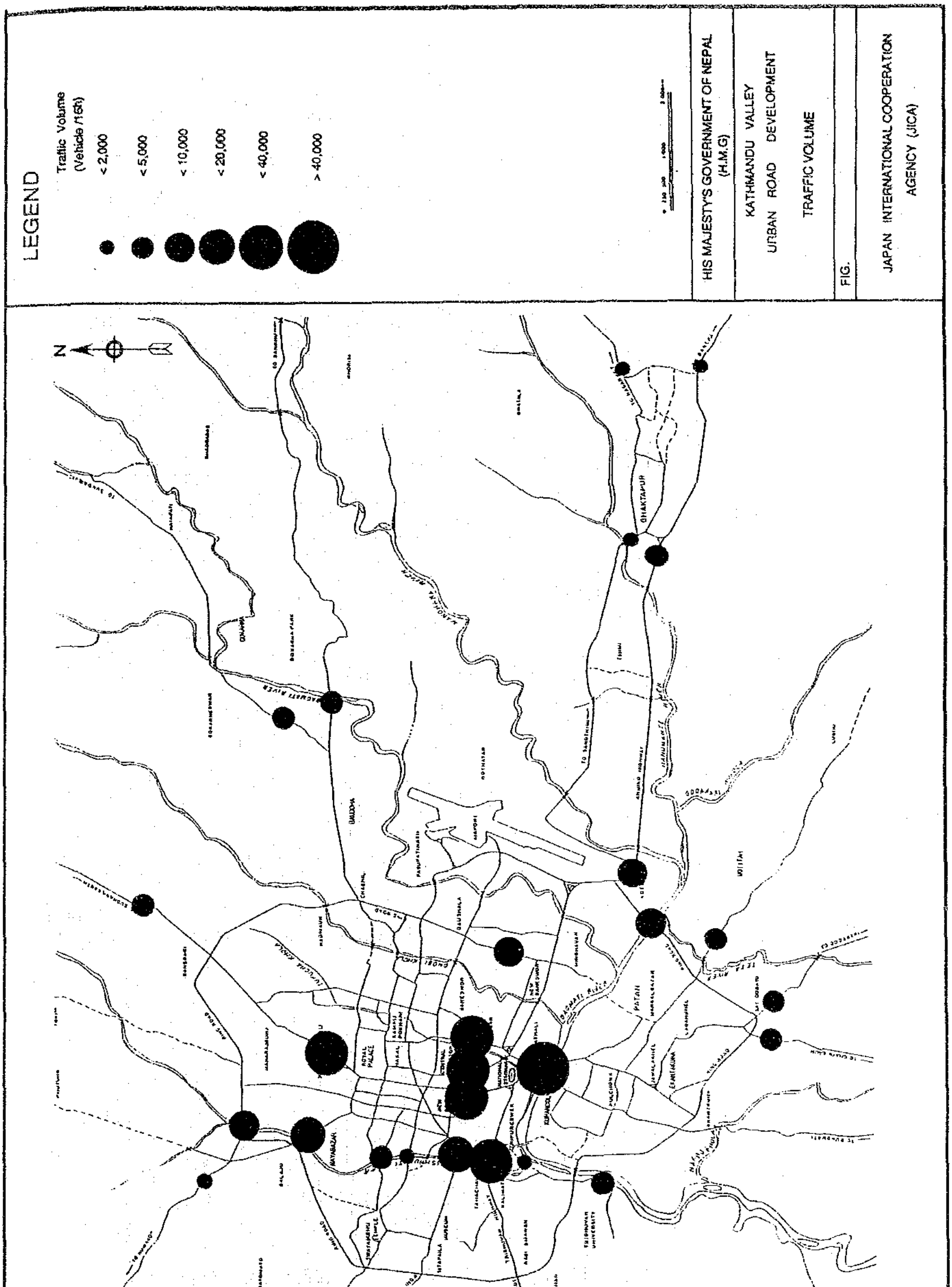


Fig. 3.3 Traffic Volume on Major Roads

Table 3.5 Traffic Volume by Vehicle on Major Roads

Vehicle/16h
(%)

Point	Bicycle	Motor-cycle	Tempo, Autori-ckshaw	Taxi	Mini Bus	Bus, Trolley Bus	Passen-ger Car	Light Truck	Heavy Truck	Others	Total
B1	955	425	620	196	124	46	327	71	49	125	2,938
	(32.5)	(14.5)	(21.1)	(6.7)	(4.2)	(1.6)	(11.1)	(2.4)	(1.7)	(4.3)	(100.0)
B2	1,441	496	324	99	160	52	264	93	126	143	3,198
	(45.1)	(15.5)	(10.1)	(3.1)	(5.0)	(1.6)	(8.3)	(2.9)	(3.9)	(4.5)	(100.0)
B3	1,411	2,312	518	594	1,067	482	841	304	746	524	8,799
	(16.0)	(26.3)	(5.9)	(6.8)	(12.1)	(5.5)	(9.6)	(3.5)	(8.5)	(6.0)	(100.0)
B4	2,197	492	149	107	60	19	90	70	220	126	3,530
	(62.2)	(13.9)	(4.2)	(3.0)	(1.7)	(0.5)	(2.5)	(2.0)	(6.2)	(3.6)	(100.0)
B5	1,937	799	236	179	155	42	444	78	346	93	4,309
	(45.0)	(18.5)	(5.5)	(4.2)	(3.6)	(1.0)	(10.3)	(1.8)	(8.0)	(2.2)	(100.0)
B6	1,683	556	95	383	47	28	139	29	127	162	3,249
	(51.8)	(17.1)	(2.9)	(11.8)	(1.4)	(0.9)	(4.3)	(0.9)	(3.9)	(5.0)	(100.0)
B7	1,064	955	209	257	326	120	461	127	323	168	4,010
	(26.5)	(23.8)	(5.2)	(6.4)	(8.1)	(3.0)	(11.5)	(3.2)	(8.1)	(4.2)	(100.0)
B8	575	619	875	237	286	375	385	153	1,041	212	4,758
	(12.1)	(13.0)	(18.4)	(5.0)	(6.0)	(7.9)	(8.1)	(3.2)	(21.9)	(4.5)	(100.0)
B9	1,353	333	55	98	69	17	125	56	30	129	2,265
	(59.7)	(14.7)	(2.4)	(4.3)	(3.0)	(0.8)	(5.5)	(2.5)	(1.3)	(5.7)	(100.0)
B10	240	64	17	35	47	24	55	8	41	37	568
	(42.3)	(11.3)	(3.0)	(6.2)	(8.3)	(4.2)	(9.7)	(1.4)	(7.2)	(6.5)	(100.0)
B11	520	1,194	168	279	658	484	520	174	327	262	4,586
	(11.3)	(26.0)	(3.7)	(6.1)	(14.3)	(10.6)	(11.3)	(3.8)	(7.1)	(5.7)	(100.0)
B12	467	182	24	43	203	20	51	11	51	102	1,154
	(40.5)	(15.8)	(2.1)	(3.7)	(17.6)	(1.7)	(4.4)	(1.0)	(4.4)	(8.8)	(100.0)
B13	1,161	118	19	31	40	9	73	15	7	79	1,552
	(74.8)	(7.6)	(1.2)	(2.0)	(2.6)	(0.6)	(4.7)	(1.0)	(0.5)	(5.1)	(100.0)
B14	285	343	30	85	247	137	193	45	146	103	1,614
	(17.7)	(21.3)	(1.9)	(5.3)	(15.3)	(8.5)	(12.0)	(2.8)	(9.0)	(6.4)	(100.0)
B15	77	152	97	71	220	360	165	96	847	136	2,219
	(3.5)	(6.8)	(4.4)	(3.2)	(9.9)	(16.2)	(7.3)	(4.3)	(38.2)	(6.1)	(100.0)
B16	1,341	1,546	347	390	737	276	903	236	816	193	6,790
	(19.7)	(22.8)	(5.1)	(5.7)	(10.9)	(4.1)	(13.4)	(3.5)	(12.0)	(2.8)	(100.0)
B17	16,986	10,092	8,231	4,351	254	179	7,581	131	15	645	48,265
	(35.2)	(20.9)	(17.1)	(9.0)	(0.5)	(0.4)	(15.3)	(0.3)	(0.0)	(1.3)	(100.0)
B18	1,269	564	0	0	0	0	0	0	0	21	1,854
	(68.4)	(30.4)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(1.1)	(100.0)
B19	6,072	5,118	5,338	2,648	1,004	450	4,084	398	330	562	26,004
	(23.4)	(19.7)	(20.5)	(10.2)	(3.9)	(1.7)	(15.7)	(1.5)	(1.3)	(2.2)	(100.0)
B20	5,380	2,331	661	389	19	0	555	48	3	303	10,374
	(57.2)	(23.2)	(6.4)	(3.8)	(0.2)	(0.0)	(5.7)	(0.5)	(0.1)	(2.9)	(100.0)
B21	1,449	462	0	0	0	0	0	0	0	0	1,911
	(75.8)	(24.2)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)
B22	1,209	712	294	564	10	0	242	30	10	129	3,200
	(37.8)	(22.3)	(9.2)	(17.6)	(0.3)	(0.0)	(7.6)	(0.9)	(0.3)	(4.0)	(100.0)
B23	4,364	2,043	1,981	849	346	120	1,232	175	207	513	11,830
	(36.9)	(17.3)	(16.7)	(7.2)	(2.9)	(1.0)	(10.4)	(1.5)	(1.7)	(4.3)	(100.0)
B24	1,719	819	630	354	188	59	778	227	391	266	5,431
	(31.7)	(15.1)	(11.6)	(6.5)	(3.5)	(1.1)	(14.3)	(4.2)	(7.2)	(4.9)	(100.0)
B25	6,159	4,266	5,329	1,956	292	122	4,416	101	57	380	23,078
	(26.7)	(18.5)	(23.1)	(8.5)	(1.3)	(0.5)	(19.1)	(0.4)	(0.2)	(1.6)	(100.0)
B26	7,859	9,215	8,156	4,357	1,169	699	6,797	274	56	408	38,990
	(20.2)	(23.6)	(20.9)	(11.2)	(3.0)	(1.8)	(17.4)	(0.7)	(0.1)	(1.0)	(100.0)
B27	7,521	8,102	6,796	4,964	2,110	759	6,364	571	182	302	37,671
	(20.0)	(21.5)	(18.0)	(13.2)	(5.6)	(2.0)	(16.9)	(1.5)	(0.5)	(0.8)	(100.0)
B28	7,862	6,525	4,192	2,505	670	229	4,706	222	157	313	27,331
	(28.7)	(23.8)	(15.3)	(9.1)	(2.4)	(0.8)	(17.2)	(0.8)	(0.6)	(1.1)	(100.0)
B29	3,130	2,152	1,078	678	51	8	1,203	63	54	212	8,629
	(36.3)	(24.9)	(12.5)	(7.9)	(0.6)	(0.1)	(13.9)	(0.7)	(0.6)	(2.5)	(100.0)

* Regarding the location of survey points, refer Fig. 4.2.

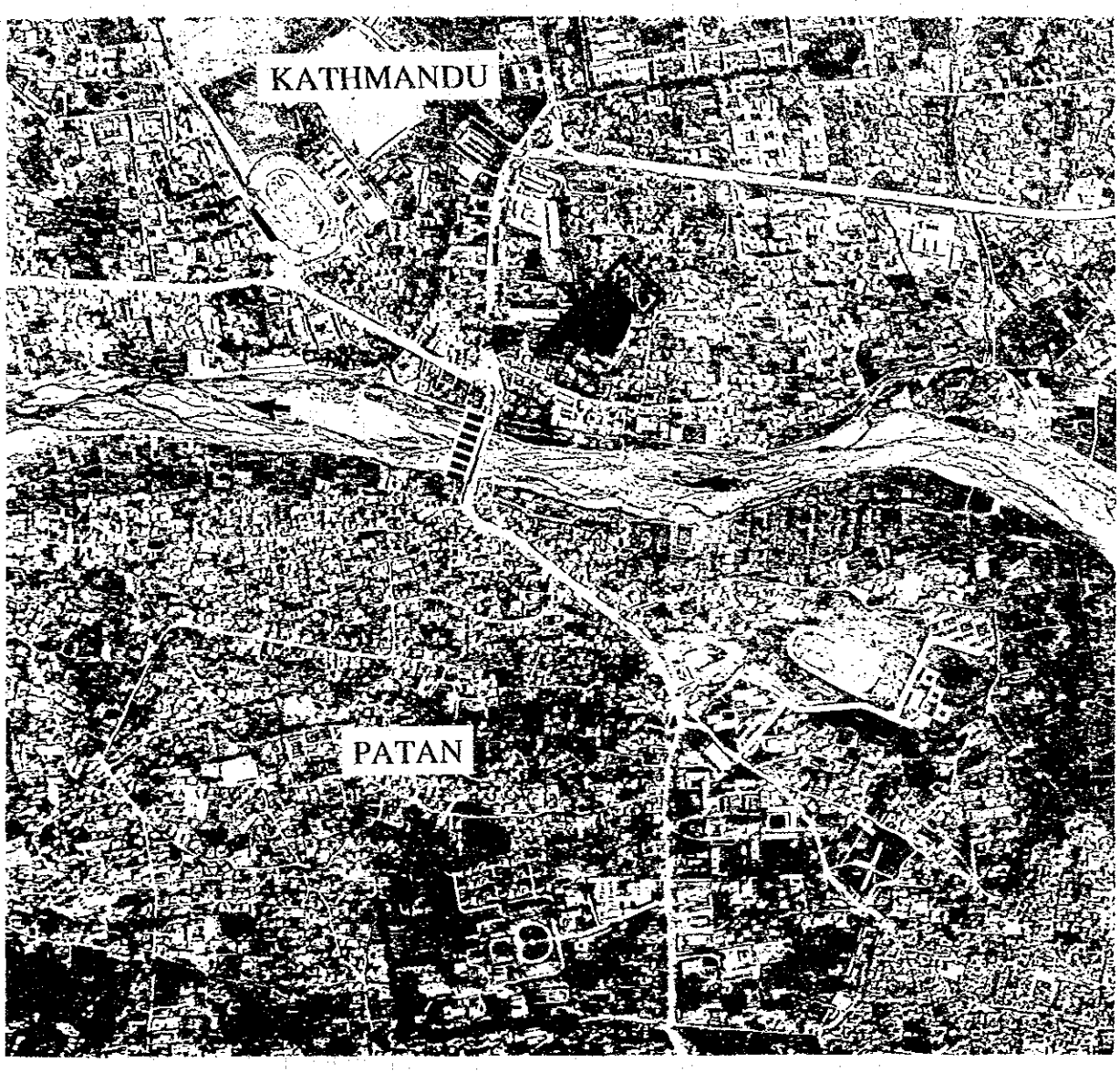


Fig. 3.4 Proposed Location of New Bagmati Bridge

One of the major problems is lowering of river-bed of Bagmati River which has caused the serious problem to the existing bridges. The main causes of lowering of river-bed are (1) Taking out excessive sand from the river bed, (2) Rocky river-bed at Chobhor Gorge going down and (3) Flow of river at river soil bed.

The sub-surface exploration including rotary machine drilling, insitu tests, sampling and laboratory test were conducted in the JICA study of "Kathmandu Valley Urban Road Development". The result of machine boring as well as the laboratory tests were presented in Appendix.

3.3 Present Condition of the Existing Bridges and Intersection

New Bagmati Bridge is planned to be constructed beside the existing 2-lane Bagmati Bridge at Thapathali. The present condition of the existing bridge and intersection to be improved under the Project is as shown below:

(1) Old Truss Bridge to be Removed

There is an old truss bridge where New Bagmati Bridge is to be constructed. This bridge, constructed sometime in 1950's, is utilized only for pedestrian at present because of its superannuation. The bridge is 135m long steel truss bridge with 4.0 wide carriageway. Appurtenant hung on the bridge are water main with 400 mm diameter, telephone cable and electric wire. These appurtenant shall be relocated to the existing Bagmati Bridge before demolishing this truss bridge.

(2) Existing Bagmati Bridge

The existing Bagmati Bridge is the 153.75 long composite steel girder bridge with 7.0 m carrigeway width and 1.75 m wide sidewalks on both side. The substructure is the wall type pier with spread footing foundation.

This bridge was collapsed by the settlement of one of its pier due to scouring of foundation bed in August, 1991. Traffic was suspended for almost 8 months until March, 1992. The urgent countermeasures was carried out by DOR, however, it is still in danger of overturning due to lowering of the river bed scouring.

(3) Existing Thapathali Intersection

Present Thapathali intersection is the at-grade intersection with a roundabout controlled by traffic signal. The intersection is always congested due to small traffic capacity of the roundabout as well as the poor maintenance of traffic signal.

Chapter 4

Chapter 4 Description of the Project

4.1 Objectives of the Project

The objectives of the project aim at improvement of river crossing facility of Bagmati River at Thapathali to remove the bottleneck of the transport sector and to stimulate and enhance the economic, social and administrative activities in Kathmandu and Lalitupur cities.

Works involved are;

1) to extend the river crossing capacity of Bagmati River by constructing a new 2-lane Bagmati Bridge to facilitate the increasing traffic demand and dissolve the traffic congestion of the bridge, and

2) to maintain effectively the function of bridge and to assure a reliable transport means between Kathmandu and Lalitpur.

4.2 Study and Examination of the Request

4.2.1 Necessity of the Project

The request made by the Government of Nepal consists of two (2) projects as shown below:

(1) Construction of New Bagmati Bridge

(2) Improvement of 3-Intersections

The above projects was reviewed making reference to the feasibility study report on "Kathmandu Valley Urban Road Development" prepared by JICA in March, 1993 as follows:

(1) Construction of New Bagmati Bridge Project

The project consists of four (4) construction items, namely (a) construction of New Bagmati Bridge, (b) Improvement of Thapathali intersection, (c) Emergency protection of existing Bagmati Bridge and (d) Protection against lowering the river-bed and protection of bank slope.

New Bagmati Bridge

The integration of Kathmandu and Lalitpur cities is progressing accompanied with the rapid urbanization of Lalitpur city as well as development areas outside the Ring Road. The present traffic volume across the existing Bagmati Bridge is about 48,000 ADT according the traffic survey result on "Kathmandu Valley Urban Road Development", which was the largest traffic volume among the city roads and exceeded far beyond the capacity of existing 2-lane bridge at Thapathali. It is estimated that the traffic demand at Thapathali will be 1.4 times in 1997 and 2.6 times in 2015.

Since the existing Bagmati Bridge is only the vehicular bridge connecting Kathmandu with Patan inside the Ring Road. New Bagmati Bridge is essential for facilitating the increased traffic demand between Kathmandu and Lalitpur cities.

Improvement of Thapathali Intersection

Thapathali intersection, which is close to the approach road to existing Bagmati Bridge, is the at-grade intersection with a roundabout controlled by signal traffic. However, the intersection is now a bottleneck of the traffic in the city due to insufficient traffic capacity mainly caused by the shape of roundabout as well as the slow vehicles mixed up with bicycle, motorcycle and tempo. The improvement of intersection by widening as well as provision of turning lane storage lanes is essential not only for maintain the function of intersection but also for reducing the traffic accidents inside the intersection.

The request made by the Government of Nepal in connection with the Thapathali Intersection included the provision of pedestrian bridge. However, a study team reviewed the necessity of the pedestrian bridge from the view point of construction cost, scenery and convenience of user (pedestrian). As the result, it is concluded that Thapathali intersection shall be improved, without pedestrian bridge, by provision of proper traffic lanes and traffic signal for pedestrian because of the following reasons:

- Pedestrian bridge would not harmonize with the surrounding area at Thapathali and spoil a beautiful scenery of Kathmandu city
- By provision of proper turning and storage lanes for the vehicles, traffic capacity of intersection would be increased and coped with the traffic demand in the short-term,
- Safety of pedestrian could be assured by provision of proper pedestrian crossing with traffic signal and islands.
- Construction cost of pedestrian bridge is large.

It is advised that the necessity of pedestrian bridge at Thapathali should be studied again in future when the traffic demand exceeds the traffic capacity of intersection. Underpass should be considered as an alternative if a situation of electric supply, DOR's maintenance capability as well as traffic morality of pedestrian are improved.

Protection of Existing Bagmati Bridge and Lowering of River-bed

The existing Bagmati bridge collapsed suddenly in August, 1991 by the settlement of one of its pier due to scouring of foundation bed and was suspended till March 1992. During that time, because of no alternative route in the area, all the traffic were diverted from the bridge to the Ring Road and traffic flow between Kathmandu and Lalitpur had been seriously disturbed.

The bridge was repaired by Department of Roads (DOR) with urgent countermeasures, however, it is still not in a reliable condition because of the progressing of lowering of Bagmati river-bed. Emergency protection work on the existing Bagmati Bridge against lowering of the river-bed is essential for maintaining the function of bridge and assuring the transport route between Kathmandu and Lalitupur cities.

(2) Improvement of 3-Intersections

Improvement of traffic management at major intersections are recommended in the study of "Kathmandu Valley Urban Road Development" and, out of the intersections identified in the study, three intersections (Maitighar, Tripureswar and Koteswor) are recommended to be implemented as soon as possible taking into consideration a importance of function of intersection, situation of traffic congestion and safety of traffic and pedestrian.

A study team reviewed the necessity of the improvement of these intersection from the view point of urgency as well as funds required for the implementation. As the result, though recognized its necessity and importance, it is concluded that these improvement measures should be excluded from the Project mainly from the view point of financial stand.

However, a study team recommends DOR to improve these intersection as soon as possible in order to relief the traffic congestion as well as to decrease the traffic accidents at the intersections.

4.2.2 Implementation Agency and Road/Bridge Maintenance

(1) Project Implementation Agency

Department of Roads (DOR) under the Ministry of Works and Transport (MOWT) will be responsible for the implementation of the Project and will act as the executing agency of the Project.

(2) Organization of DOR

DOR is responsible for the administration, planning, construction, machinery management, operation and maintenance of the roads in Kathmandu Valley. Organization chart of DOR is presented in Fig. 4.1.

DOR consists of 5 Regional Roads Directorate, 74 District Roads Office 6 Heavy Machine/Equipment Office and 13 Laboratories. These offices are operated and maintained by 2,400 employees in total.

(3) Budget Allocation and DOR Financial Situation

The budget allocation for the construction and maintenance of the road and bridge is annually made by the Ministry of Finance to DOR at the beginning of each year (June/July). Over the past five years, the allocated budge are tabulated in Table 4.1.

The budget divided into HMG and foreign sources, and break down into construction and maintenance are shown in Fig. 4.2 and 4.3 respectively.

(4) Maintenance for the Project

Central Regional Office under DOR will be responsible for maintenance of the Project. The Office is located near Koteswor along the Arniko Highway and executes daily and periodic maintenance for roads and bridges in Kathmandu Valley. They have a repair shop in the office, however, number of machine and equipment to be used for maintenance work is enough and service level of maintenance is not satisfactorily.

Present Organization of Central DOR

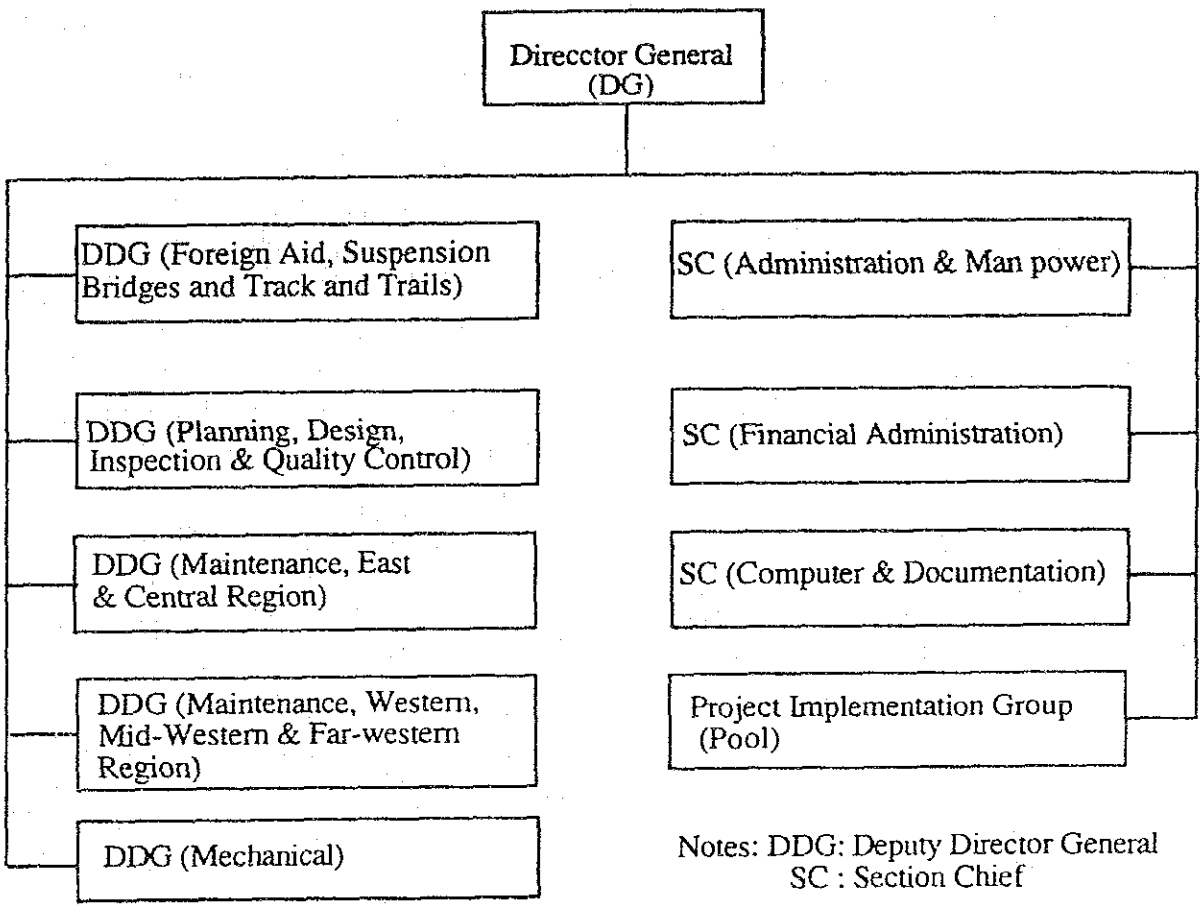


Fig. 4.1 Organization Chart of Department of Roads

Table 4.1 Budget Allocation to the road Sector in Nepal

(Unit in Million NRs)

Fiscal Year	Total Budget	HMG Source	Foreign Source
88/89	1,953.0	757.0 (38%)	1,196.0 (62%)
89/90	2,070.0	757.0 (36%)	1,313.0 (63%)
90/91	1,571.0	464.0 (30%)	1,107.0 (70%)
91/92	2,202.0	886.0 (40%)	1,316.0 (60%)
92/93	2,810.0	928.0 (33%)	1,882.0 (67%)

Fig. 4.2 Budget Allocation divided into HMG and Foreign Sources

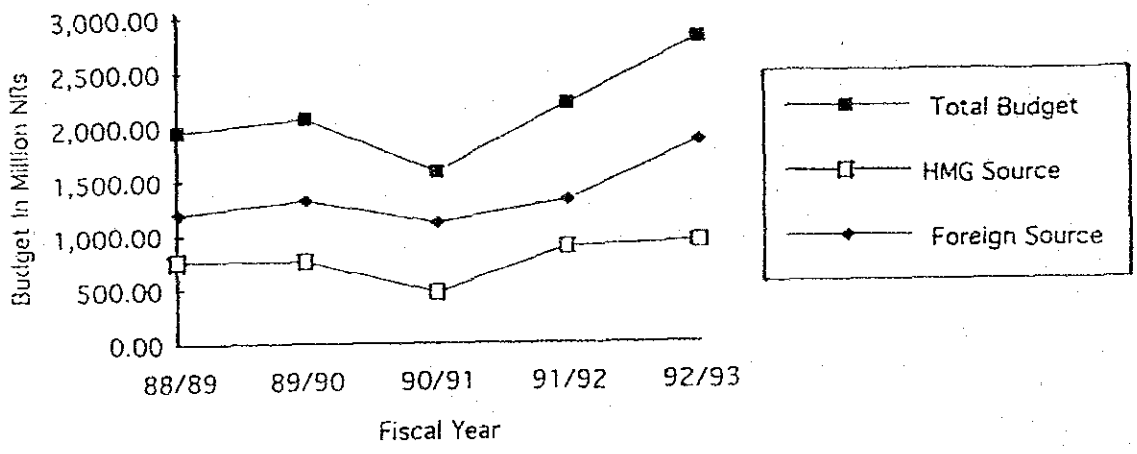
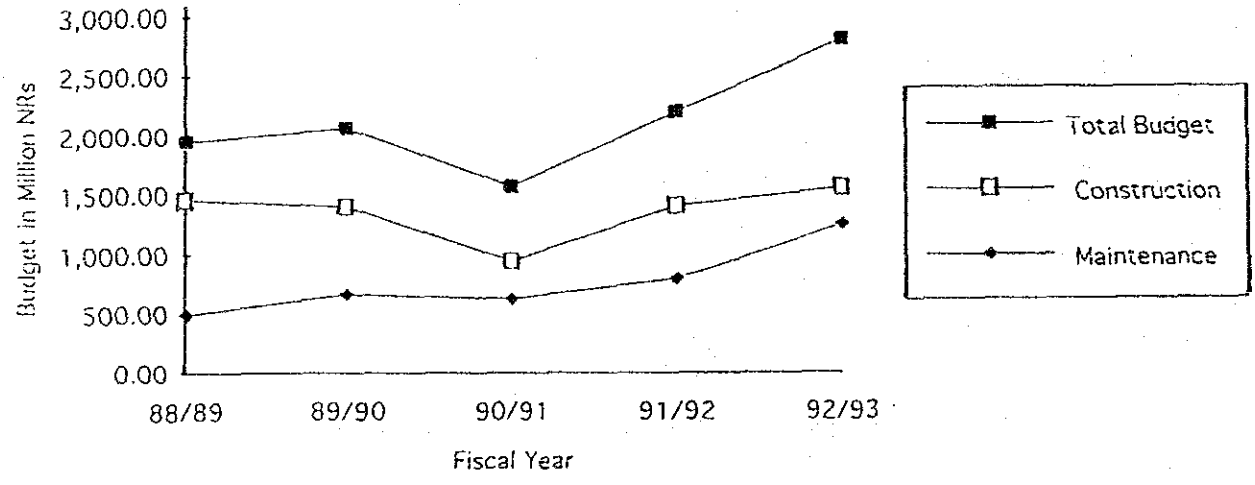


Fig. 4.3 Budget Allocation for Construction and Maintenance



4.3 Project Description

4.3.1 New Bagmati Bridge Construction Project

(1) Location of Proposed Bridge

New Bagmati Bridge was planned to be constructed 15m approx. downstream of the existing Bagmati Bridge taking into account the alignment of approach roads as well as an availability of land/house acquisition.

(2) Bridge Length and Elevation

Bridge length was determined taking into consideration the existing Bagmati Bridge, river width and surrounding condition including valuable and religious structures.

Left abutment was planned to locate behind the existing small road along the left bank of Bagmati River since this road is used by people as an access to the river.

Right abutment on Thapathali side was planned in front of stone steps of temple which is the actual right bank of Bagmati River. Right abutment of the existing bridge is set back about 20 m from the river bank, however, this set back might be not necessary taking into account the effective river section in the vicinity. It is proposed to construct a box culvert behind the abutment in order to provide the road space along the river which may be used as a river maintenance road or riverside walk.

Length of New Bagmati Bridge, therefore, was determined to be 137 m approx. which is 17 m shorter than that of existing bridge.

Elevation of bridge height was fixed to EL=1286.0 m, which is the same elevation of existing bridge, taking into consideration the vertical alignment of approach roads on both side. The flood water level at the Bagmati Bridge site is EL=1282.0 m according to the report of "Kathmandu Valley Urban Road Development". Since the height of steel girder is 1.5 m approx., vertical clearance below the girder would be 2.5 m in height which might be a sufficient freeboard against the flood.

(3) Bridge Width

The proposed bridge is connected with the major road with 4 lane on both side, so that the existing 2-lane bridge shall be utilized for descending lane exclusive use, while new 2-lane bridge for ascending lane exclusive use. The existing bridge is a 7. 0 m wide 2- lane road with 1.7 m sidewalks on both side.

New bridge is planned to be 2 lane bridge with a carriage way width of 7.0 m. In addition, one more 3.0 m wide lane will be provided for slow vehicle lane exclusive use taking into account the characteristic of traffic composition in the City. Sidewalk will be provided on one side. Total width of new bridge is determined to be 10 m.

(4) Approach Road

Approach road is planned to have 4 -lanes road with median slip. Road width is planned ranging from 6.0 m to 7.0 m and 2.0 m to 3.0 m wide sidewalk will be provided on both side.

Approach roads to be widened under the Project are as shown below:

- Thapathali side : 191 m including Thapathali intersection
- Lalitpur side : 145 m up to the end of transition

4.3.2 Thapathali Intersection Improvement Plan

The concept used for intersection capacity analysis is based on the "Japan Road Association", since much similarity is found in type and size of vehicles and in their operation in Nepal and Japan.

Designed hourly traffic volume at Thapathali intersection is calculated in accordance with the above concept of which result is presented in Fig. 4.4. As seen in figure, traffic volume of left turning is higher than that of right turning and straight direction so that an exclusive use lane for left turning traffic will be provided in order to obtain the smooth traffic flow in the intersection.

For the pedestrian across the roads, safety islands with a pedestrian signal shall be provided properly inside the intersection.

4.3.3 Emergency Protection of the Existing Bagmati Bridge

The settlement of No. 3 pier of existing Bagmati Bridge was occurred in August, 1991 due to scouring of the river-bed. Emergency measures was conducted by DOR, however, the bridge is still in danger due to the lowering of river bed.

Protection measure in the form of 1.0 m high concrete and gabion mat should be placed around the existing piers as shown in Fig. 4.5.

4.3.4 Protection of Lowering of Rover-bed and Bank Slope

Deepening of river bed is the most serious problem regarding safety of the bridge in Kathmandu Valley. On almost all the bridge sites, considerable deepening of the river bed has occurred since the time of construction. At some site the figure is as high as 3 m.

In order to stop further lowering of the river bed, a protection measure in the form of 3.5 m high concrete checkdam with gabion mat apron is proposed. In addition, Rip-rap or stone masonry slope protection is proposed on both side bank slope. The sketch of concrete checkdam is shown in Fig. 4.6.

4.3.5 Extent of the Project

(1) Construction of New Bagmati Bridge

- Construction of New Bagmati Bridge with approach roads on Thapathali side (L=191 m including Thapathali intersection) and Lalitpur side (L= 145 m up to the end of transition)

(2) Improvement of Thapathali Intersection

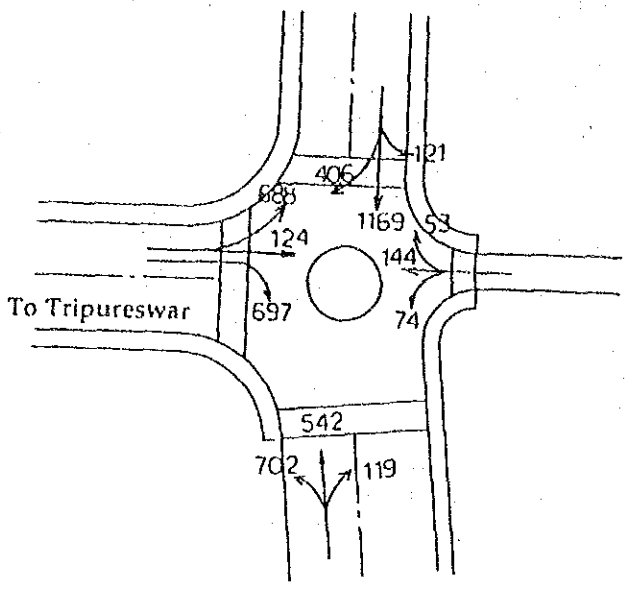
- Widening of intersection, provision of turning and storage lanes, provision of traffic signal for traffic and pedestrian

(3) Emergency Protection for Existing Bagmati Bridge

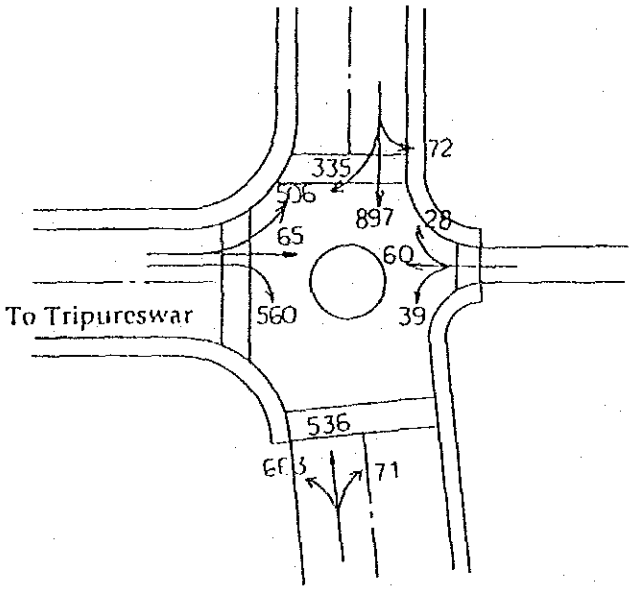
- Protection work with concrete and gabion mat around the piers and rip-rap slope protection in front of abutment

(4) Protection of Lowering of River-bed and Bank Slope

- Provision of Concrete Checkdam (3.5m) with gabion mat apron and protection of bank slope with rip-rap or gabion mat.



10:00 ~ 11:00



16:00 ~ 17:00

Fig. 4.4 Traffic Movement at Thapathali Interchange

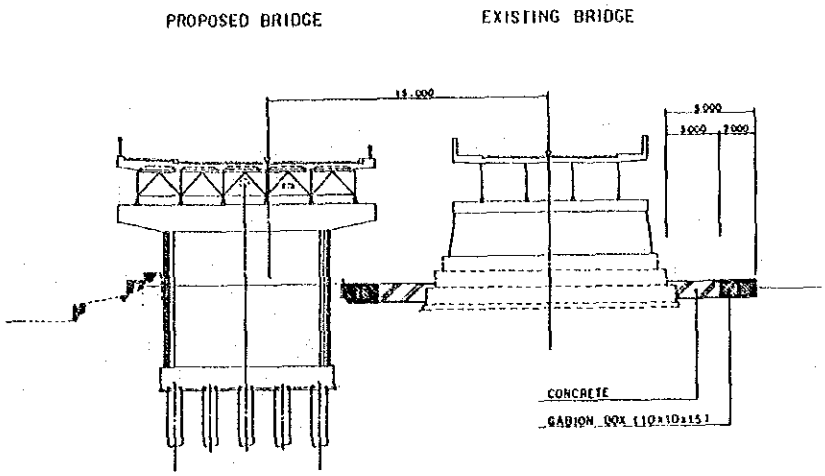
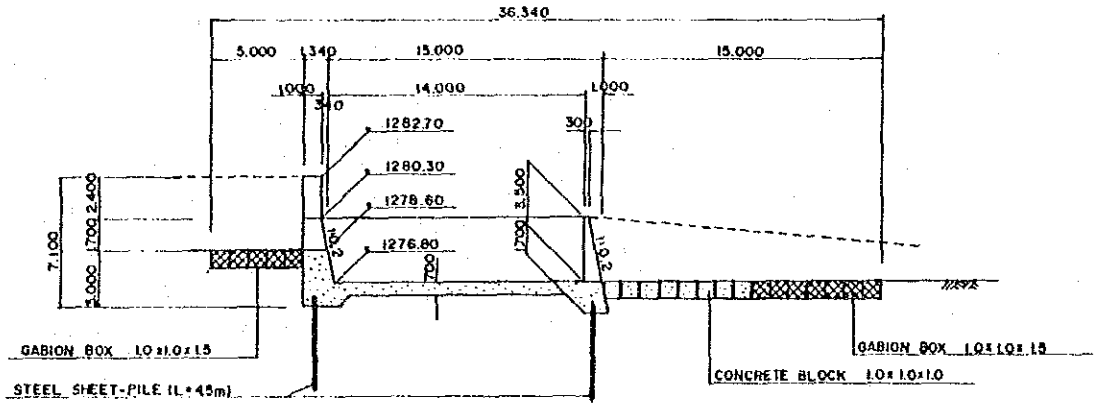


Fig. 4.5 Emergency Protection of Existing Bridge



5 - 5 SECTION

Fig. 4.6 Protection of Lowering of River Bed

Chapter 5

Chapter 5 Basic Design of the Project

5.1 Design Concept

Basic Design was carried out taking into account the natural conditions, traffic situation, socio-economic condition and environmental situation in and around surrounding area.

The following are the basic concept or conditions employing the basic design of the Project:

(1) Overall construction period shall be minimized.

(2) Natural conditions, especially lowering of the river-bed, soft ground condition and earthquake shall be fully considered in the design of super-structure and sub-structure including foundation.

(3) Characteristics of the traffic composition (mixed up with a slow vehicle).shall be considered in the design of width of bridge and road including intersection.

(4) Main construction materials shall be selected so as to minimize the maintenance cost after completion of the Project taking into consideration the financial situation of DOR.

(5) Acquisition of land and house shall be minimized and public utilities which might be affected by construction of the project shall be relocated and protected properly.

(6) Interference to the traffic and pedestrian shall be minimized during the construction of the project.

(7) New bridge shall be constructed so as not to interfere with the foundation of existing Bergamot Bridge.

(8) Affect on environment and scenery in the vicinity shall be minimized.

5.2 Design Conditions

The following design criteria and conditions are applied for the basic design of the Project: (No change was made in design criteria and conditions established in the feasibility study on Katmandu Valley Urban Road Development.)

5.2.1 Design Criteria

(1) Bridge and Road Width

- Nepal Road Standards 2027 (prepared by DOR, MOWT)
- Design Manual for Urban Roads (prepared by Department of Housing & Urban Development, MOWT)
- Japan Road Standards

(2) Design Load

- Japan Bridge Standards
- The American Association of State Highway and Transportation Officials (AASHTO)

(3) Earthquake Load

- National Building Code of India 1970
- Japan Bridge Standards

(4) River Structures and Others

- Japanese Standards of Specifications

5.2.2 Design Loads

Loads to be used in the bridge design are divided into three category of loads, namely, (i) principal load, (ii) subsidiary load and (iii) particular load and each load is further divided into the following sub-loads:

(i) Principal loads

- Dead load, Live load, Impact load, Effect of concrete creep, Effect of concrete shrinkage, Earth pressure, Hydraulic pressure, Buoyancy or Uplift,

(ii) Subsidiary loads

- Wind load, Thermal force and Earthquake force

(iii) Particular loads

- Effect of movement of ground, Effect of displacement of supports, Centrifugal force, Braking force, Temporary load and force during erection, Collision force, other force

Out of the above loads, detailed of dead load and live load are described below:

i) Dead loads

The following unit weights are applied in calculating the dead loads:

Table 5.1 Unit Weight of Construction Materials

Materials	Unit Weight (kg/m3)	Materials	Unit Weight (kg/m3)
Steel, Cast Steel	7,850	Concrete	2,350
Cast iron	7,250	Cement motar	2,150
Aluminum alloys	2,800	Asphalt pavement	2,300
Reinforced concrete	2,500	Concrete pavement	2,350
Prestressed concrete	2,500	Timber	800

ii) Live loads

Live loads is applied for TL-20 in accordance with the Japan Bridge Standards taking into account the traffic characteristics in the project roads.

5.2.3 Selection of Bridge Type

The proposed new bridge is planned to be located downstream of the existing Bergamot Bridge. The position of piers span arrangement should be the same as that of existing bridge to obtain smooth flow of river. Either St-Girder or PC-T bridge are considered for superstructure taking into account the span arrangement of existing bridge (approx. 30 m) as follows;

a) Pre stressed Concrete T-Girder (PC-T)

b) Composite Steel Plate Girder (St-Gr)

Pre-stressed concrete (PC) bridge is applicable. However, there seems to be technical problems in producing high strength concrete due to the quality of local cement. In case of longer span bridge, PC bridge is disadvantageous because of the bigger reactions to the foundations, if it is friction pile foundation.

Steel structure is of advantage to the bridge located on the soft ground, especially the bridge required for friction pile foundation. The material cost is relatively high because it must be imported from the outside, however, construction period is shorter than that of PC bridge.

Fig. 5.1 shows the alternative plan of new Bagmati Bridge and summarized below:

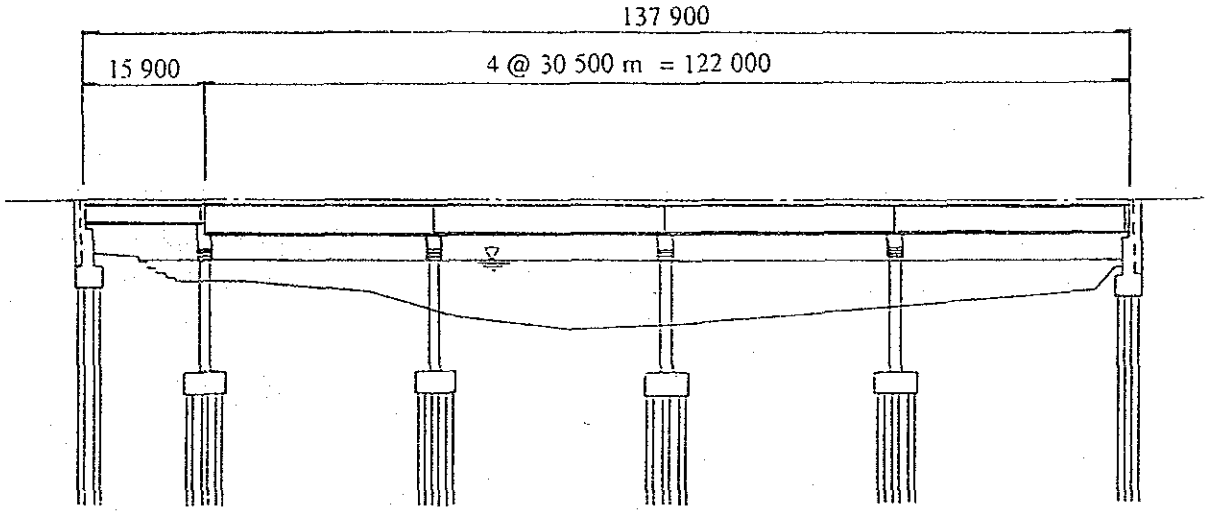
Bridge Name	Length (m)	Alternatives	Bridge Type	Approx. Span Arrangement
New Bagmati Bridge	140.0	a)	PC-T	16+4 x 31
	140.0	b)	St-Gr	16+4 x 31

The above alternative plans were evaluated taking into consideration, river conditions, soil conditions, seismicity, construction costs, construction period and maintenance cost.

Composite steel plate girder bridge (St-Gr) was selected for the reasons that (1) light weight superstructure, (2) shorter construction period, and (3) small maintenance cost.

BAGMATI BRIDGE SKETCH

NEW BRIDGE (2-lane) St-Gr



BAGMATI BRIDGE SKETCH

NEW BRIDGE (2-lane) PC-T

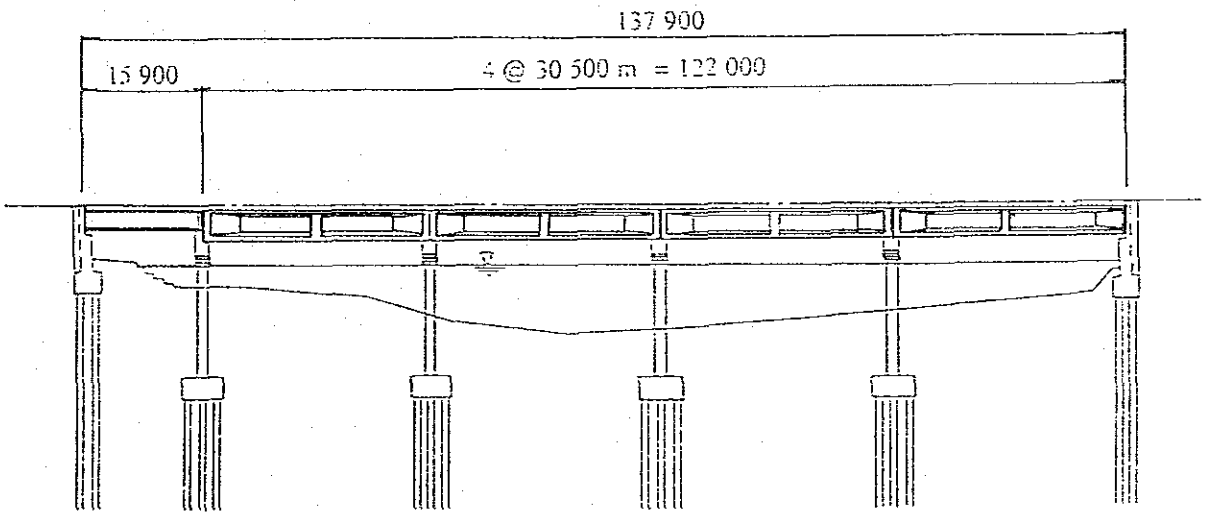


Fig. 5.1 Alternatives of Bridge Type

5.3 Basic Design

The proposed design of the Project was reviewed on the basis of examination of the Request made in paragraph 4. 2 of this report.

5.3.1 New Bagmati Bridge Construction Plan

(1) Design of Superstructure

Assuming the bridge span length of 30 m, 2 types of main girder, namely composite steel girder and non-composite steel girder were compared to paying attention to the economy of material as well as the ease of construction as shown below:

Type of Bridge	Height of Girder	Economy	Construction
(i) Non-composite steel girder	1,700 mm(1.00)	1.05	Good
(ii) Composite steel girder	1,500 mm(0.92)	1.00	Fair

It is concluded that the composite steel girder is selected taking into account the low height of girder as well as smaller construction cost, tough the construction might be a bit difficult comparing non composite girder bridge.

As for the material of girder, it is recommended to utilize the atmospheric corrosion resistant steel (ACRS) for the girder which is the materials of maintenance free. This material requires no maintenance of painting since oxided rust forms a dense and tight file on the surface of steel which protects the material from corrosion. Material cost of ACRS is a higher than that of ordinary steel, however, total cost would be cheaper, if maintenance included over the ten years.

Fig. 5.2 shows the typical cross section of New Bagmati Bridge.

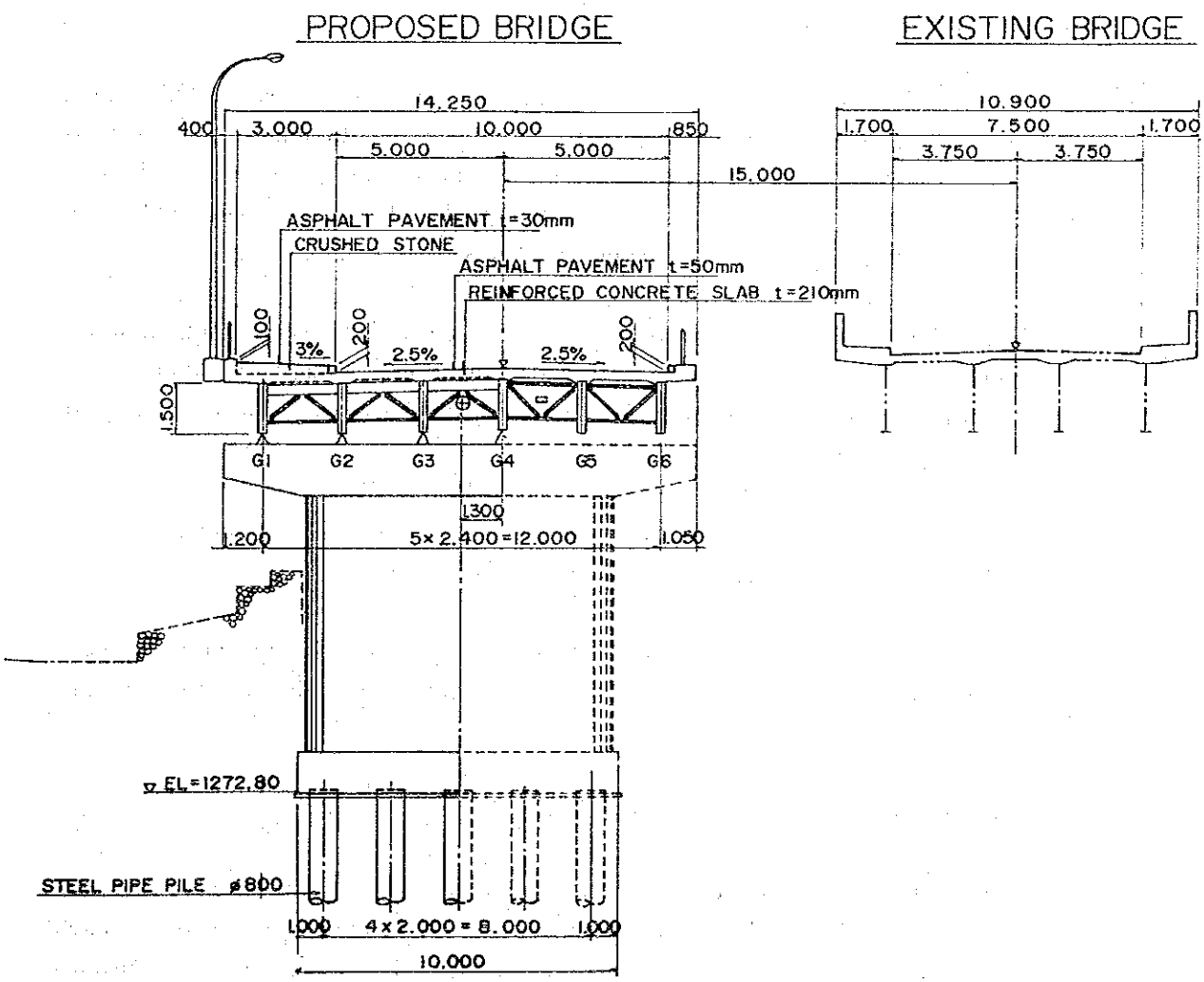


Fig. 5.2 Typical Section of New Bagmati Bridge

(2) Design of Substructure

Alternative study was conducted taking into account the reaction from the superstructure, river condition and earthquake resistance. 3 type of sub-structures were considered as an alternatives as shown in Table. 5.2, namely wall type, column type and rahmen type. The comparison was made and the wall type was selected as a result, taking into consideration harmony with surrounding area, river-flow direction, ease of construction and construction cost.

(3) Design of Foundation

The main geological constituent at the proposed bridge sites consists of alternative layers of clayey silt and sand of varying density.and thickness. Thickness of individual layers varies from 2 m to 12 m. N-value of these soil are 10 to 20 up to the depth of 30. This kind of soft lake sediment lies to a depth of 400 - 650 m. In this kind of soil, the friction pile foundation is the most suitable type.

Three (3) types of pile foundation are considered in the design of foundation as shown in Table. 5.3. Selection of bridge foundation is made taking into account ease of construction, availability of materials, affect on surrounding area during the construction and construction cost.

As a result of comparison, steel pile foundation was selected taking into account the short construction period s well as safety of construction.

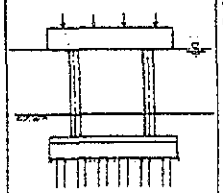
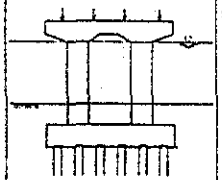
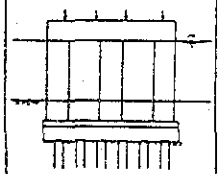
However, it is recommended to conduct the additional boring at the proposed site of center pier to confirm the depth of foundation stratum as well existence of natural gas.

(4) Distance from existing bridge to new bridge

It is observed that the existing Bagmati Bridge was constructed on soft ground without any pile foundation. The looseness of soil during excavation is calculated assuming that the distribution angle of bearing is 45°. As a result, the distance between center lines of the two bridges was determined to be 15.5 m.

(5) Demolishing of Old Truss Bridge

The old truss bridge located at the proposed new bridge should be demolished, before starting the construction of new bridge. This old bridge, however, hangs water main, telephone and electric line which must be relocated to the new Bagmati Bridge, before demolishing.

Type	Sketch	Structural Feature	Ease of Construction	River - Flow - Disturbance	Construction Cost	Remarks
Wall Type		Enough earthquake resistance ○	No need for scaffolding △	Suitable ○	1.00	Recommended
Rigid Frame Type		Relatively complex structure △	High quality control required △	Problems with driftage ×	1.00	—
Multi - Column Type		Influence of temperature stress ○	· Scaffolding required · High quality control required △	Problems with driftage ×	1.20	—

○ Good
△ Fair
× Bad

Table 5.2 Comparison of Substructures

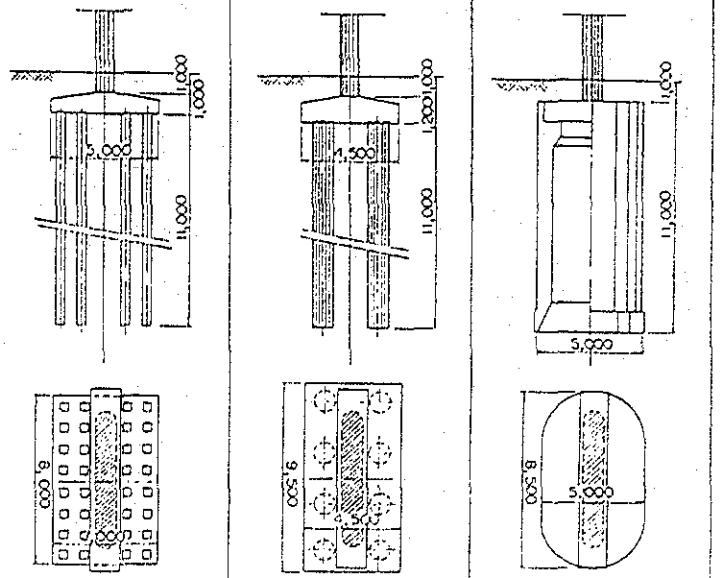
Type	Precast Concrete Pile	Cast - in Place Pile	Open Caisson
Sketch			
Structural features	Distributes the reaction from the superstructure ○	Thick and wise footing due to large diameter of pile △	Not enough bearing capacity due to soft soils ×
Ease of Construction	Shorter pile driving time ○	Water - contamination due to slime circulation △	Longer construction period △
Construction Cost	1.00 ○	1.10 △	1.50 ×
Remarks	Recommended	—	—

Table 5.3 Comparison of Foundations

5.3.2 Approach Road and Thapathali Intersection Improvement Plan

(1) Approach Road

Approach road to be connected with the new Bagmati Bridge shall be provided properly. Approach road at Patan side is 145 m long approx. up to the end of transition, while Thapathali side 191 m including intersection.

Typical cross section of approach road is presented in Fig. 5.3.

(2) Thapathali Intersection

The concept used for intersection capacity analysis is based on the "Japan Road Association" since much similarity is found in types and sizes of vehicles and in their operations in Nepal and Japan.

The traffic focusing on the Thapathali intersection is very large and is mixed up with fast and slow vehicles. Turning lanes and storage lanes should be provided properly and the intersection should be controlled by the modernized traffic signal system in order to maintain the traffic capacity of intersection.

Traffic signals shall be installed for traffic control, safety of drivers and smooth handling of traffic flow. Traffic signal, having standard lenses with red, armor and green colored, should be installed on overhanging tapered poles with arm at a height of 6 m.

Signal for pedestrian, which is a signal head covered with a symbol of a person and standard red and green colored, is also recommended to install at the top of a 3.5 m high pole in each direction at intersection.

Guardrail should be provided between traffic lane and sidewalk in the vicinity of intersection in order to eliminate the pedestrian from the intersection.

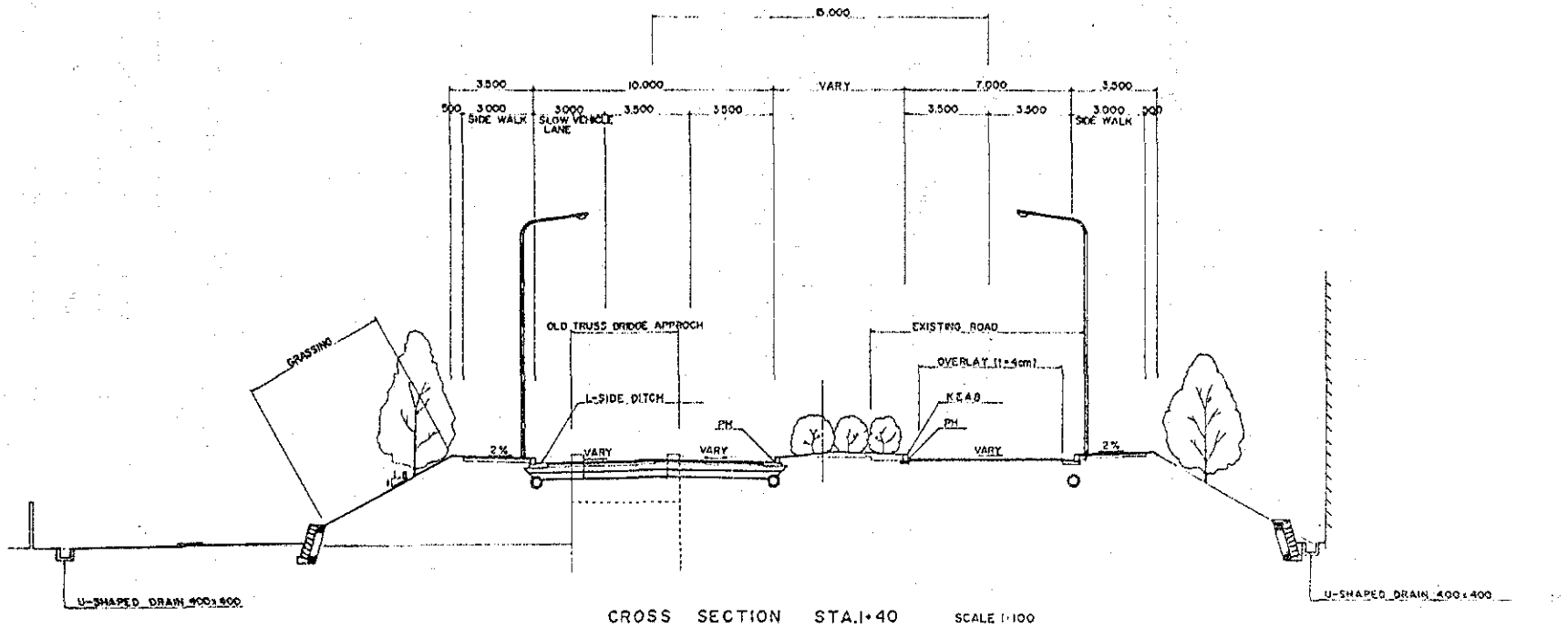


Fig. 5.3 Typical Cross Section of Approach Road

5.3.3 Existing Bagmati Bridge Improvement Plan

The existing bridge had been suspended by the settlement of one of its pier (No. Pier) due to scouring of foundation bed since August, 1991 till March 1992. The emergency countermeasure was conducted by DOR on No.3 Pier, however, no protection works on other piers have been conducted, though the gabion checkdam was constructed on downstream, so that the bridge is still in dangerous condition against the lowering of river-bed.

Protection measure was designed in accordance with the Japan Sabo and River Protection Standards. It was designed in the form of 1.0 m high concrete and gabion mat should be placed around the existing piers.

5.3.4 Protection Plan of Lowering of River-bed and Bank Slope

A permanent checkdam in the form of 1.8 m high concrete with gabion mat apron is provided on downstream in order to prevent the further erosion of river bed.

The elevation of the checkdam should be the same elevation (EL=1,278.6 m) as the top of pier footing of the existing Bagmati bridge in order to prevent further lowering of the river bed as well as to prevent flood in upstream side caused by back water from the checkdam..

5.3.5 Land Acquisition Plan

The right-of-way (ROW) limit lines for the proposed roads were indicated in the land acquisition plan attached in this report..

The estimated land and houses to be acquired for the construction of the Project is shown below:

Table 5.4 Estimated quantities of Land/House Compensation

	Unit	Patan side	Thapathali side
Land to be acquired	m^2	1,030	410
Houses to be removed	Nos.	7 ($283m^2$)	1 ($126m^2$)

5.3.6 Relocation Plan of Existing Public Utilities

Relocation of existing utilities is one of the most awkward aspects of the road construction in urban areas due to involvement of many authorities or agencies who have different policies, development time schedules and technical standards.

The existing data showing the location and dimension of utilities have not been updated, especially underground utilities, such as water main and distribution, the detailed investigation should be conducted in the detailed design stage prior to the commencement of construction.

Water main (400 mm in diameter), high and low voltage electric power cables and telephone cables are hung on the old truss bridge which is to be demolished for the construction of new bridge, These utilities must be relocated to the existing Bagmati Bridge during the construction of new bridge, of which work may be responsible for the Government of Nepal at their own cost.

The estimated quantities of utilities to be relocated are as shown below:

Table 5.5 Estimated Quantities of Utilities to be Relocated

Item	Unit	New Bagmati Bridge	Patan Side	Thapathali Side
Water main	m	200		
Water Distribution Line	m			100
Telephone Line	m	200		
Electric Line High Low	m	200	 150	 300
Electric Pole	No.		4	13
Traffic Signal	No.			1
Trolley Bus Electric Line	m			300

5.4 Basic Design Drawing

Basic design drawings are presented as follows:

Fig. 5.4	General Construction Plan of New Bagmati Bridge
Fig. 5.5	Improvement Plan of Approach Road and Thapathali Intersection
Fig. 5.6	Protection Plan of Existing Bagmati Bridge
Fig. 5.7	Protection Plan of Lowering of River-bed and Bank Slope
Fig. 5.8	Land and House Acquisition Map

5.5 Major Work Quantities

On the basis of the above drawings, work quantities were calculated and summary of major work items are presented below:

Table 5.6 Estimated Major Work Quantities

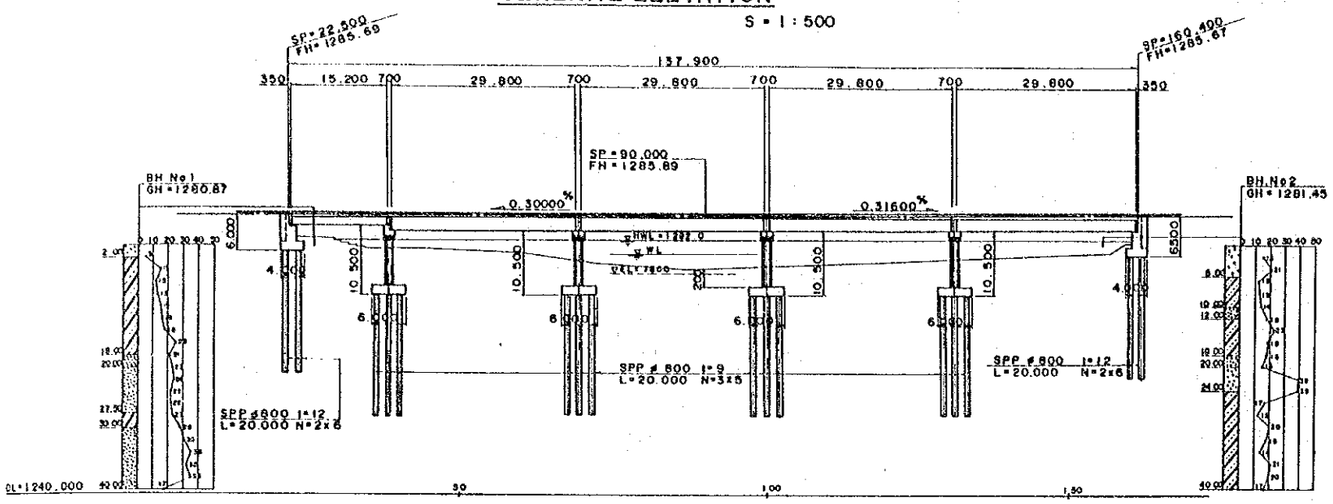
Bridge Area	1,793	m^2
Nos. of Abutment	2	nos.
Nos. of Pier	4	nos.
Steel Pile Foundation (800mm)	1,680	m
Length of Approach Road	336	m
Traffic Signal	1	set
Checkdam (length:140m)	1	set
Nos. of Protected Existing Bridge Pier	4	nos.
Box-culvert (3m x 3m)	20	m

Materials List

Steel Structure	262	ton
Concrete	7,000	m^3
Reinforcement bar	140	ton
Steel pile(800mm)	323	ton
Asphalt Concrete	2,000	ton
Subbase Course	1,200	m^3
Base Course	750	m^3
Gabion	1,950	m^3

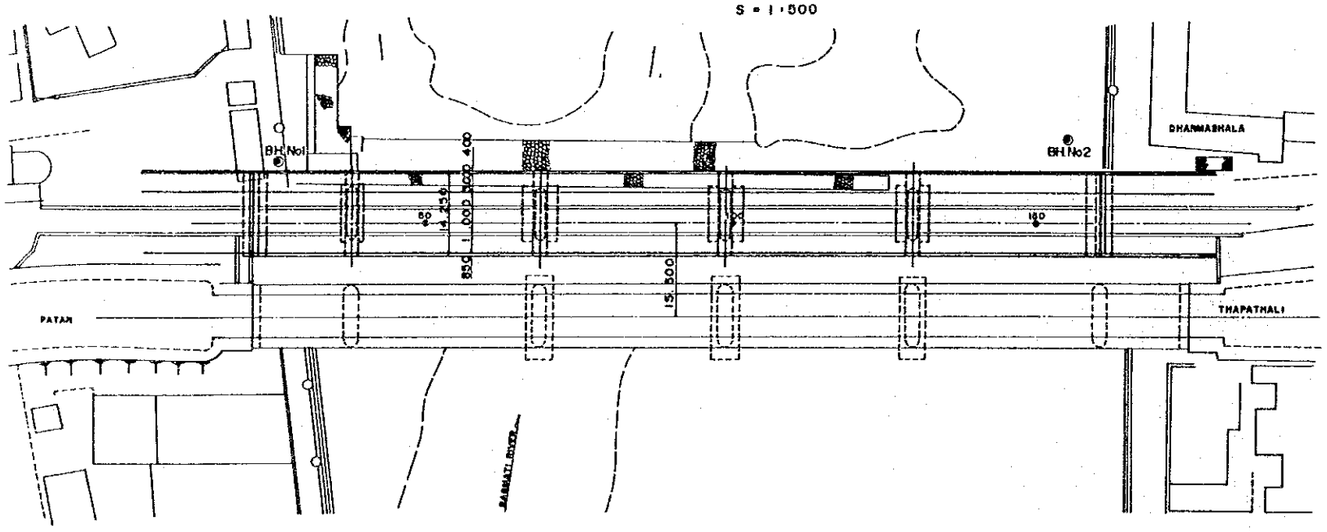
GENERAL ELEVATION

S = 1 : 500



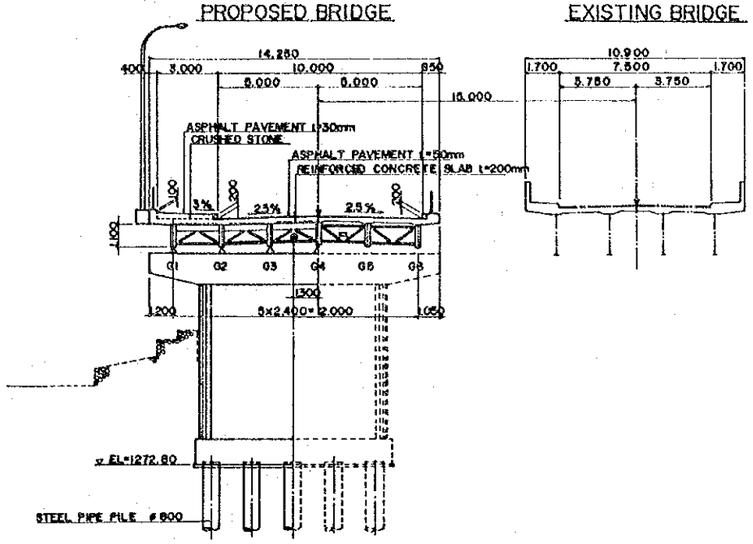
GENERAL PLAN

S = 1 : 500

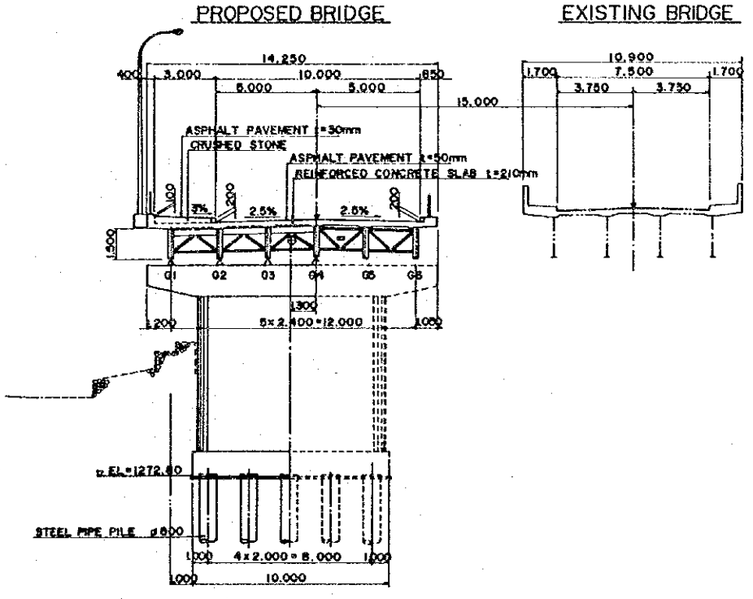


CROSS SECTION S = 1:150

SPAN LENGTH = 15.200m



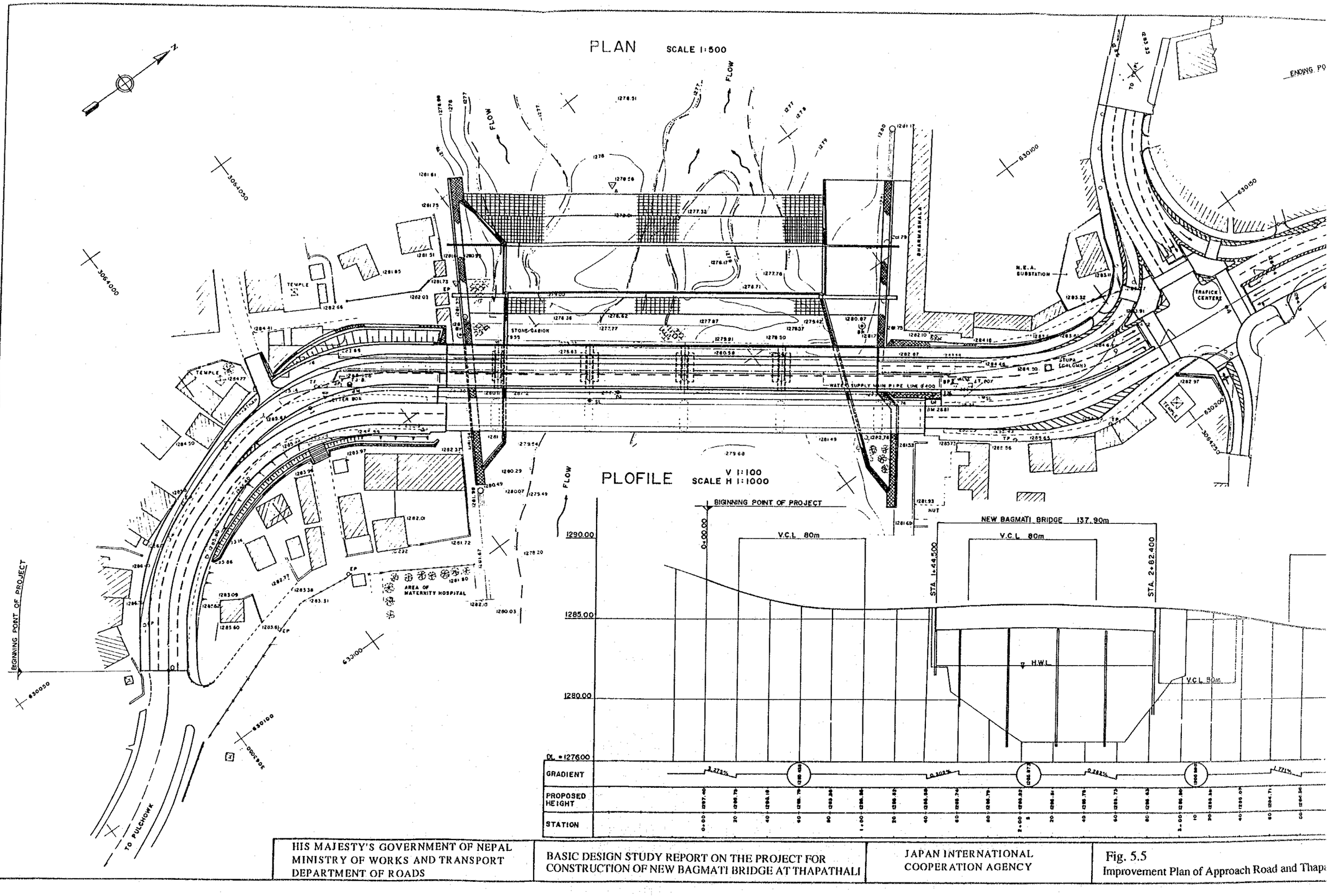
SPAN LENGTH = 29.800m



HIS MAJESTY'S GOVERNMENT OF NEPAL MINISTRY OF WORKS AND TRANSPORT DEPARTMENT OF ROADS	BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF NEW BAGMATI BRIDGE AT THAPATHALI	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.4 General Construction Plan of New Bagmati Bridge	DATE OCTOBER 1993	SHEET NO.

PLAN SCALE 1:500

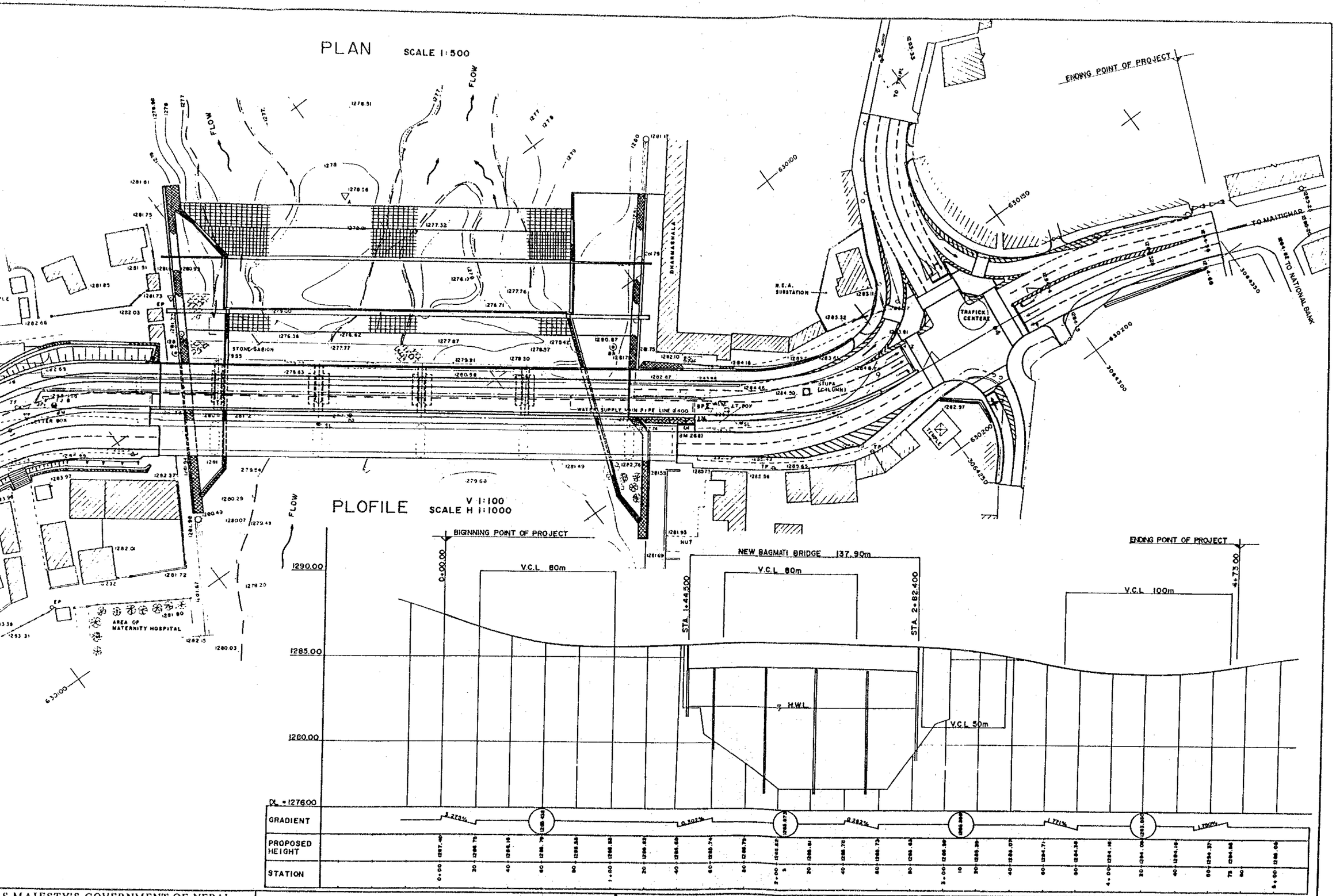
PLOFILE V 1:100 SCALE H 1:1000



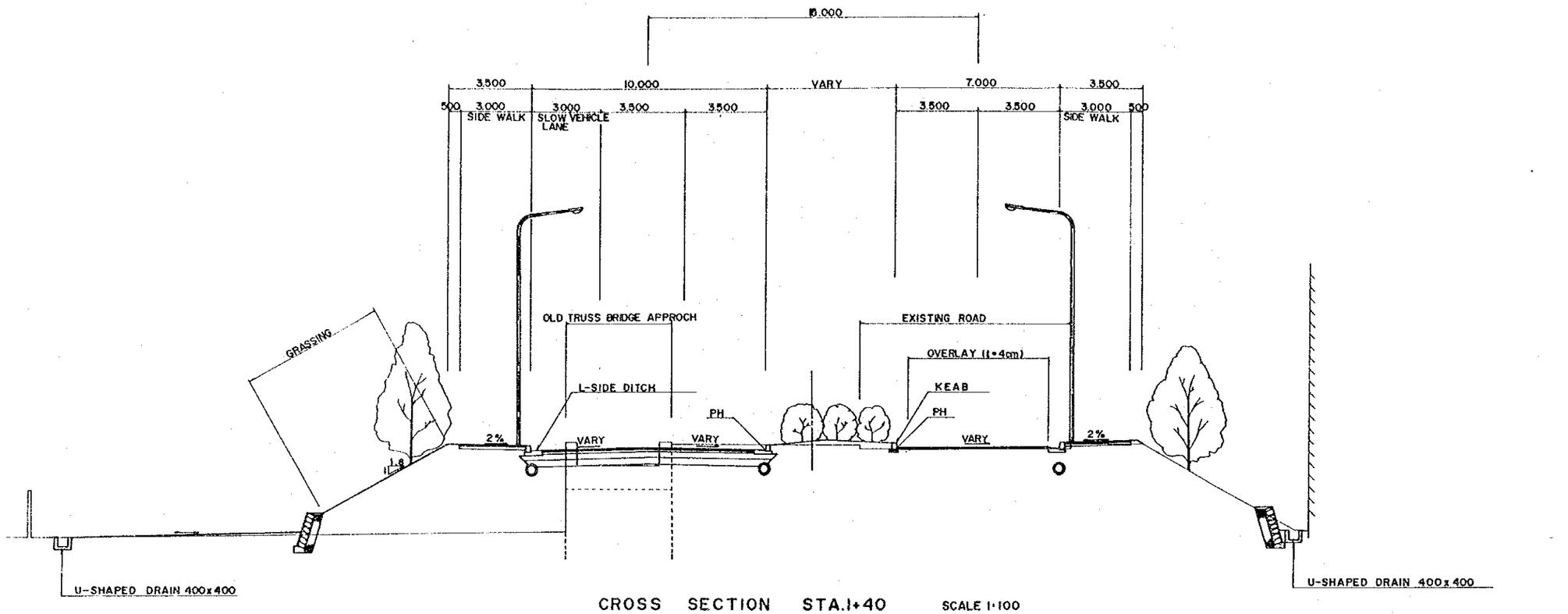
HIS MAJESTY'S GOVERNMENT OF NEPAL MINISTRY OF WORKS AND TRANSPORT DEPARTMENT OF ROADS	BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF NEW BAGMATI BRIDGE AT THAPATHALI	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.5 Improvement Plan of Approach Road and Thapa

PLAN SCALE 1:500

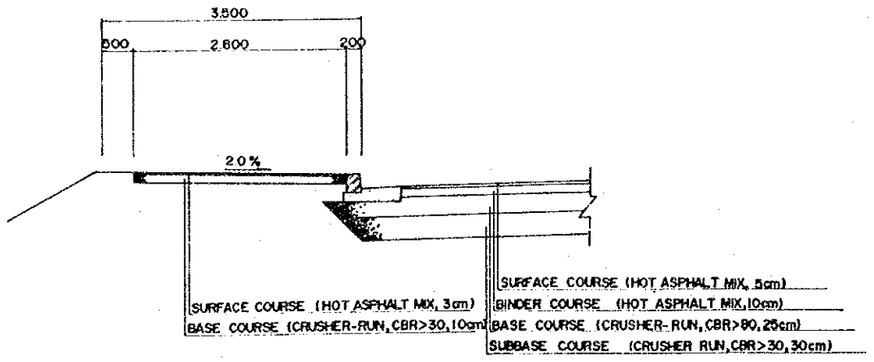
PLOFILE V 1:100 SCALE H 1:1000



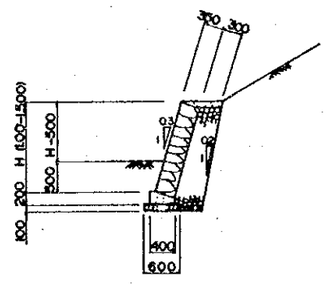
HIS MAJESTY'S GOVERNMENT OF NEPAL MINISTRY OF WORKS AND TRANSPORT DEPARTMENT OF ROADS	BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF NEW BAGMATI BRIDGE AT THAPATHALI	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.5 Improvement Plan of Approach Road and Thapathali Intersection	DATE: OCTOBER 1993 SHEET NO.



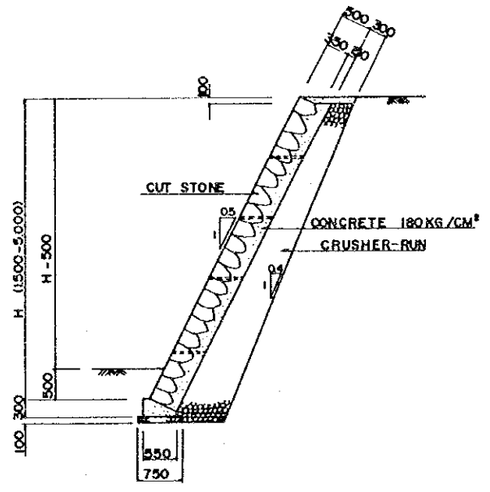
CROSS SECTION STA.1+40 SCALE 1:100



DETAIL OF PAVEMENT STRUCTURE SCALE 1:40



H=1.00m ~ 1.500m

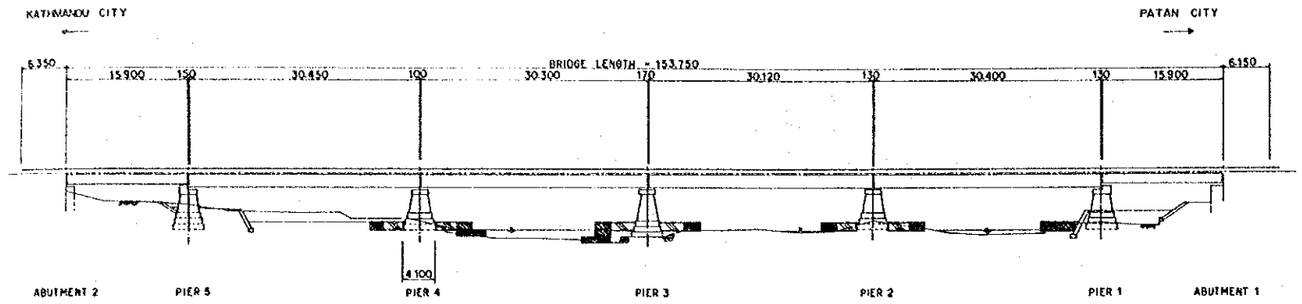


H =1.500m-5.000m

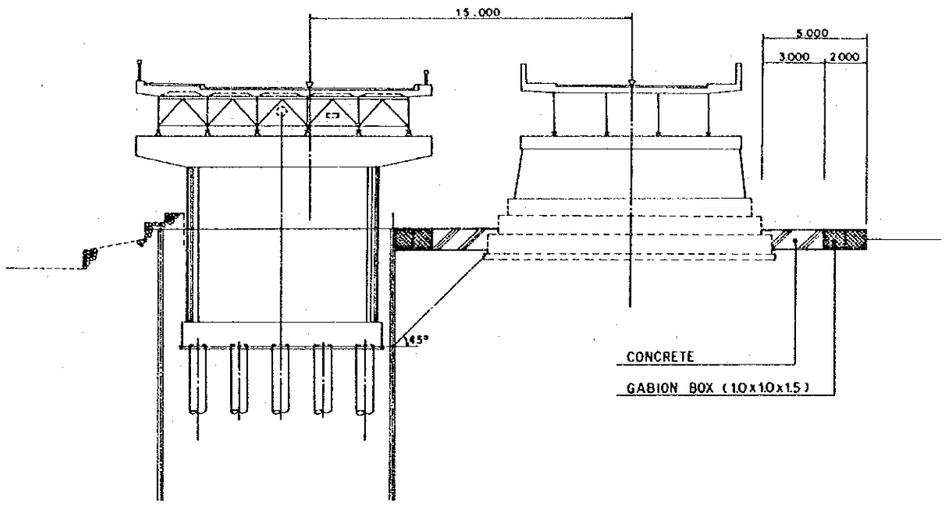
RETAINING WALL SCALE 1:50

HIS MAJESTY'S GOVERNMENT OF NEPAL MINISTRY OF WORKS AND TRANSPORT DEPARTMENT OF ROADS	BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF NEW BAGMATI BRIDGE AT THAPATHALI	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.5 (2) Cross Section of Approach Road	DATE OCTOBER 1993	SHEET NO.

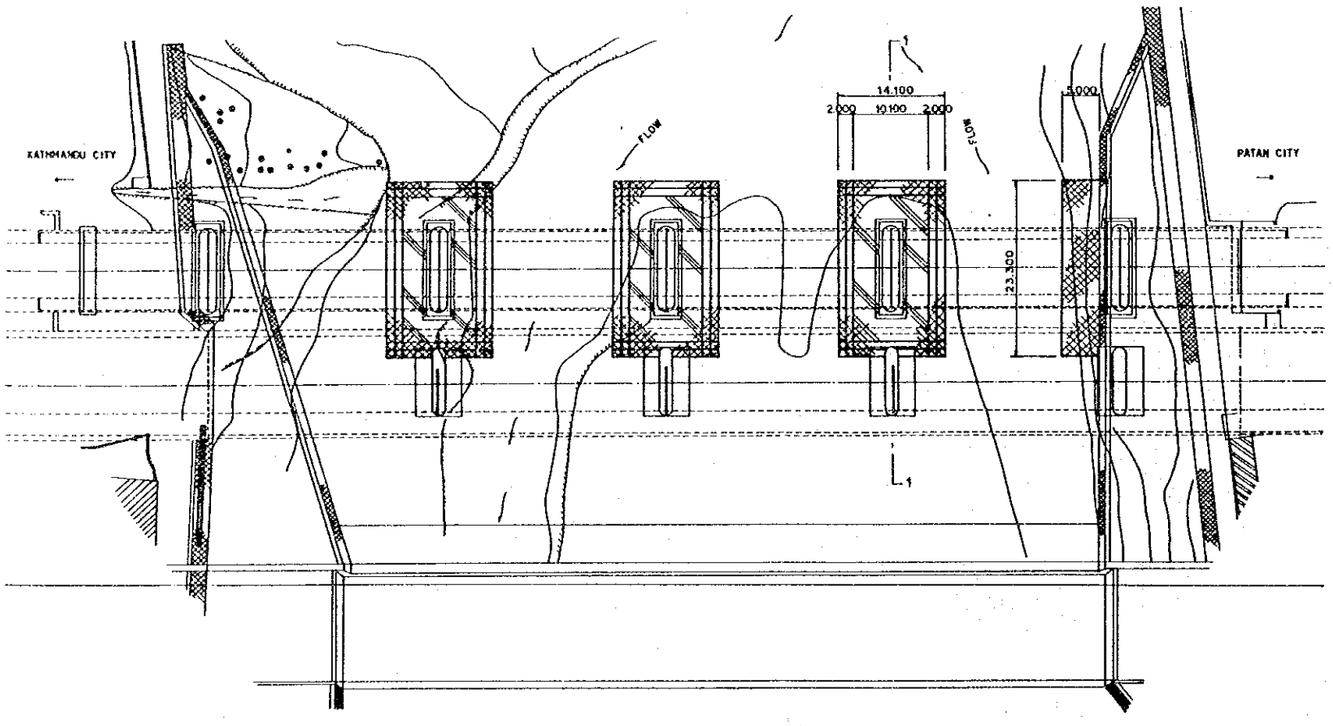
ELEVATION SCALE 1:400



1-1 SECTION SCALE 1:150



PLAN SCALE 1:400



HIS MAJESTY'S GOVERNMENT OF NEPAL MINISTRY OF WORKS AND TRANSPORT DEPARTMENT OF ROADS	BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF NEW BAGMATI BRIDGE AT THAPATHALI	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.6 Protection Plan of Existing Bagmati Bridge	DATE OCTOBER 1993	SHEET NO.