Federal Democratic Republic of Nepal
Department of Roads (DOR)
Kathmandu Valley Development Authority (KVDA)

FEDERAL DEMOCRATIC REPUBLIC OF NEPAL
THE PROJECT ON URBAN TRANSPORT IMPROVEMENT FOR KATHMANDU VALLEY

FINAL REPORT

VOLUME II
MASTER PLAN
AND
PILOT PROJECT

MAY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.
NIPPON KOEI CO., LTD.
TAMANO CONSULTANTS CO., LTD.

EI
J R
17-068

Volume 2 MASTER PLAN AND PILOT PROJECT

Table of Contents
List of Figures
List of Tables
Abbreviations

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

AASHTO-LRFD	American Association of State Highway and Transportation Officials Load and Resistance Factor Design
ADB	Asian Development Bank
ADT	Average Daily Traffic
AGT	Automated Guideway Transit
B/C	Benefit/Cost Ratio
BMC	Bhaktapur Municipality
BRT	Bus Rapid Transit
CAAN	Civil Aviation Authority of Nepal
CBD	Central Business District
CBS	Central Bureau of Statistics
CCNN	Climate Change Network Nepal
CDRC	Central Disaster Relief Committee
CDRMP	Comprehensive Disaster Risk Management Program
CEN	Clean Energy Nepal
CO2	Carbon Dioxide
CWG	Collective Working Group
DDC	District Development Committee
DDG	Deputy Director General
DDMP	District Disaster Management Plan
DDRC	District Disaster Relief Committee
DFID	Department of International Development, UK
DG	Director General
DLRM	Department of Land Reform and Management
DMA	Disaster Management Act
DMA	Disaster Management Act.
DMG	Department of Mines and Geology, MOI
DOA	Department of Agriculture, MOAD
DOE	Department of Environment, MOSTE
DOF	Department of Forest, MOFSC
DOLIDAR	Department of Local Infrastructure Development & Agricultural Roads, MOFALD
DOR	Department of Roads, MOPIT
DORW	Department of Railways, MOPIT
DOTM	Department of Transport Management, MOPIT
DPR	Department of Plant Resource, MOFSC
DPR Plan	Disaster Preparedness and Response Plan
DTMP	District Transport Master Plan
DUDBC	Department of Urban Development and Building Construction, MOUD
DWSS	Department of Water Supply and Sewerage, MOUD
EIA	Environmental Impact Assessment

EIRR	Economic Internal Rate of Returno
ENPHO	Environment and Public Health Organization
EOJ	Embassy of Japan
ESCAP	Economic and Social Commission for Asia and Pacific
ETRN	Emergency Transport Network
F/S	Feasibility Study
FCB	Foreign Co-operation Branch, DOR
FIRR	Financial Rate of Return
FNNTE	Federation of Nepalese National Transport Entrepreneurs
FR	Feeder Road
FRN	Feeder Road Major
FRO	Feeder Road Minor
FS	Feasibility Study
FY	Fiscal Year
GDP	Gross Domestic Product
GESU	Geo-Environmental and Social Unit, DOR
GIS	Geographic Information System
GLD	Guided Land Development
GNDPRP	Guidance Note Disaster Preparedness and Response Planning
GOC	Government of China
GOJ	Government of Japan
GON	Government of Nepal
HCM	Highway Capacity Manual
HDM	Highway Development and Management Model
HGV	Heavy Goods Vehicle
ICD	Inland Clearance Depot
ICIMOD	International Center for Integrated Mountain Development
ICR	Inception Report
IDP	Internally Displaced Person
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IRC	Indian Road Congress
IRR	Inner Ring Road
JICA	Japan International Cooperation Agency
JST	JICA Study Team
KMC	Kathmandu Metropolitan City
KMRTC	Kathmandu Mass Rapid Transit Consortium
KSUTP	Kathmandu Sustainable Urban Transport Project
KUKL	Kathmandu Upatyaka Khanepani Limited
KUTMP	The Project on Urban Transport Improvement for Kathmandu Valley in Federal Democratic Republic of Nepal
KV	Kathmandu Valley
KVBB	Kathmandu Valley Building By-laws

KVDA	Kathmandu Valley Development Authority
KVRIP	Kathmandu Valley Road Improvement Project
KVTDC	Kathmandu Valley Town Development Committee
KVUDPP	Kathmandu Valley Urban Development Plan & Programs
KVWSMB	Kathmandu Valley Water Supply Management Board
LDRMPG	Local Disaster Risk Management Planning Guideline
LHS	Left Hand Side
LP	Land Pooling Program
LRN	Local Road Network
LRT	Light Rail Transit
LSGA	Local Self Governance Act.
LSMC	Lalitpur Sub-metropolitan City
M/P	Master Plan
MGV	Medium Goods Vehicle
MLIT	Ministry of Land, Infrastructure, Transport and Tourism (Japan)
MMI	Modified Mercalli Intensity Scale
MOAD	Ministry of Agricultural Development
MOCTCA	Ministry of Culture, Tourism and Civil Aviation
MOFALD	Ministry of Federal Affairs and Local Development
MOFSC	Ministry of Forest and Soil Conservation
MOHA	Ministry of Home Affairs
MOI	Ministry of Industry
MOLD	Ministry of Local Development (currently under MOFALD)
MOLE	Ministry of Labor and Employment
MOLRM	Ministry of Land Reform and Management
MOMG	Ministry of Mines and Geology (currently under MOI)
MOPE	Ministry of Population and Environment
MOPIT	Ministry of Physical Infrastructure and Transport
MOPPW	Ministry of Physical Planning and Works (currently under MOPIT)
MOSTE	Ministry of Science, Technology and Environment (currently under MOPE)
MOUD	Ministry of Urban Development
MRT	Mass Rapid Transit
MTPD	Metropolitan Traffic Police Department
MWSDB	Melamchi Water Supply Development Board
N.A.C.	Nepal Airline Corporation
N.P.	*Nagar Palica* (Municipality Office)
NAAQS	National Ambient Air Quality Standard
NDC	Nepal Disaster Council
NDRF	National Disaster Response Framework
NEA	Nepal Electricity Authority
NEA	Nepal Engineer's Association
NEFEJ	Nepal Forum of Environmental Journalists
NEOC	National Emergency Operation Center

NESC	Nepal Water Supply Corporation
NH	National Highway
NH	National Highway
NHRA	Nepal Hazard Risk Assessment
NIETTP	Nepal-India Electricity Transmission and Trade Project
NLUP	National Land Use Project
NMP	Non-motorized Transport
NOx	Nitrogen Oxide
NPC	National Planning Commission
NPCS	Nutrition Promotion and Consultancy Services
NPR	Nepal Rupee
NPV	Net Present Value
NRRC	Nepal Risk Reduction Consortium
NRS	Nepal Road Standards
NSC	National Seismological Centre
NSDRM	National Strategy for Disaster Risk Management
NSET	National Society for Earthquake Technology
O&M	Operation and Maintenence
OD	Origin and Destination
ORR	Outer Ring Road
pcu	Passenger Car Unit
PD	Planned Development
PHPDT	Peak Hour Peak Direction Traffic
PID	Project Implementation Directorate, MOUD
PIP	Priority Investment Plan
PIU	Project Implementation Unit
PM10	Particulate Matter 10μm
PRA	Public Road Act.
PT	Person Trip
Pre-FS	Pre-Feasibility Study
QV	Quantity - Velocity
R & D	Research and Development
RBA	Road Board Act.
RBN	Road Board Nepal
RC	Reinforced Concrete
RD	Record of Discussion
RHS	Right Hand Side
ROW	Right of Way
RR	Ring Road
RSA	Road Safety Audit
RSLUP	Risk Sensitive Land Use Planning
RTA	Road Traffic Accidentts
RUC	Road User Cost

RUPSON	Regional and Urban Planner's Society of Nepal
S/C	Steering Committee
SAARC	South Asian Association for Regional Cooperation
SCAEF	Society of Consulting Agricultural and Engineering Firms, Nepal
SCF	Standard Conversion Factor
SEA	Strategic Environment Assessment
SHM	Stakeholder Meeting
SONA	Society of Nepalese Architects
SRN	Strategic Road Network
SSRN	Statistics of Strategic Road Network
T-M Flyover	Tripreshwor Maitighar Flyover
TDA	Town Development Act.
TDC	Town Development Committee
TDF	Town Development Fund
TDPIC	Town Development Plan Implementation Comittee
TIA	Tribhuvan International Airport of Nepal
TOD	Transit Oriented Development
TP	Trend Pattern
TTC	Travel Time Cost
TYIP	Three Years Interim Plan
UNDP	United Nations Development Programme
UNRSC	UN Road Safety Collaboration
VDC	Village Development Committee
VOC	Vehicle Operating Cost
VT	Vehicle Trip
VTMA	Vehicle and Transportation Management Act.
VTMR	Vehicle and Transportation Management Regulations
W/G	Working Group
WB	World Bank

CHAPTER 6 URBAN STRUCTURE PLAN ALTERNATIVES

6.1 Framework

(1) Future Population in Nepal and Three Districts in Kathmandu Valley

In 2003, CBS published "Population Projection for Nepal 2002-2021" based on the result of Census 2001. The total population in Nepal is projected as three variant cases, namely high variant, medium variant and low variant in accordance with three different cases of population fertility decline. The three variant population projections are shown in Table 6.1.1 together with the result of Census 2011.

Table 6.1.1 Population Projection for Nepal based on 2001 Census

	2001	2011	2021
High variant		29,060,622	35,387,192
Medium variant		28,584,975	34,172,144
Low variant		28,177,454	32,030,767
Census result	23,151,423	26,494,504	

Source: Population Projection for Nepal 2002-2021, 2003, CBS

As a result of Census 2011, actual population in 2011 has turned out to be lower than even the low variant case. The decline of fertility in Nepal is faster than estimated. CBS reviewed future population based on the 2011 Census.

CBS re-estimated future population and issued "National Population and Housing Census 2011 (Population Projection 2011 – 2031)" in 2014. The document is the sole estimation of future population of Nepal; hence, future population in Kathmandu Valley is estimated based on the document. The future population of Nepal and three districts of Kathmandu Valley are shown below.

Table 6.1.2 Future Population Projection by CBS (Nepal and Districts of Kathmandu Valley)

	2011	2016	2021	2026	2031	Increase Rate			
						2011-16	2016-21	2021-26	2026-31
Nepal	26,494,504	28,431,494	30,378,055	32,144,921	33,597,032	1.421	1.333	1.137	0.888
Lalitpur	468,132	525,211	585,982	635,151	680,157	2.328	2.214	1.625	1.379
Bhaktapur	304,651	340,066	377,660	408,472	436,533	2.224	2.119	1.581	1.338
Kathmandu	1,744,240	2,011,978	2,300,890	2,522,103	2,729,056	2.897	2.720	1.853	1.590
3 districts total	2,517,023	2,877,255	3,264,532	3,565,726	3,845,746	2.711	2.558	1.781	1.523
Ratio in Nepal	9.50%	10.12%	10.75%	11.09%	11.45%				

Source: National Population and Housing Census 2011 (Population Projection 2011 – 2031), August, 2014, CBS

Since the year of population projection does not correspond to the target year of KUTMP, the short term as 2020, the mid-term as 2025, the long term as 2030 and the long-long as 2035, population in target year is estimated based on the increase rate in each period. Table 6.1.3 shows the adjusted population estimation in target years of KUTMP.

Table 6.1.3 Future Population Projection in Target Years of KUTMP

	2011	2020	2025	2030
Lalitpur	468,132	573,290	624,998	670,908
Bhaktapur	304,651	369,823	402,115	430,771
Kathmandu	1,744,240	2,239,966	2,476,221	2,686,350
3 districts total	2,517,023	3,183,078	3,503,334	3,788,028

Source: JICA Study Team (JST)

(2) Future Population in Kathmandu Valley

Five VDCs in Kathmandu District and 20 VDCs in Lalitpur District are located outside of Kathmandu Valley. Table 6.1.4 shows the population in those VDCs outside of Kathmandu Valley. From 2001 to 2011, variations in population are very few. Therefore, future population outside of Kathmandu Valley is estimated to be the same as present population.

Table 6.1.4 Districts Population outside of Kathmandu Valley

	3 District Total	Kathmandu Dist.	Bhaktapur Dist.	Lalitpur Dist.
2001	45,220	0	0	45,220
2011	43,505	0	0	43,505
Population increase	-1,715	0	0	-1,715
2001-11 Increase rate per year (%)	-0.39			-0.39

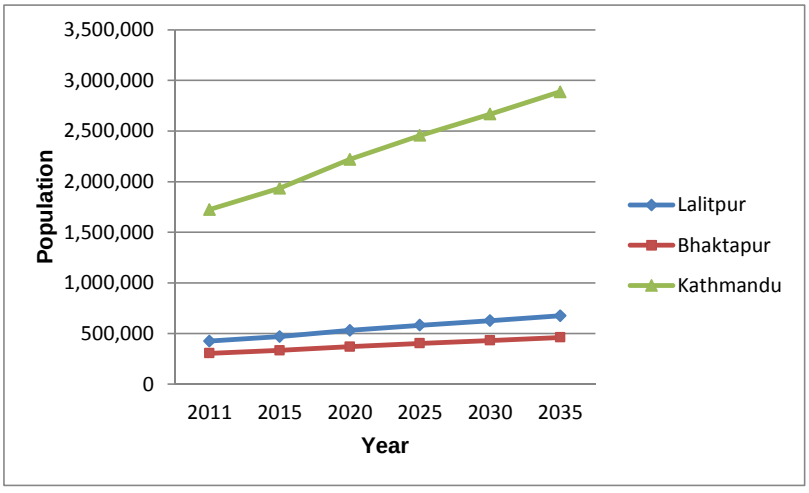
Source: National Population and Housing Census, CBS

Based on the above premise, future population of Kathmandu Valley is estimated as Table 6.1.5. The Population in Kathmandu Valley will reach more than four million in 2035.

Table 6.1.5 Future Population Framework of Kathmandu Valley by District

	2011	2020	2025	2030
Lalitpur	424,627	530,000	581,000	627,000
Bhaktapur	304,651	370,000	402,000	431,000
Kathmandu	1,744,240	2,240,000	2,476,000	2,686,000
Total	2,473,518	3,140,000	3,459,000	3,744,000

Source: JICA Study Team (JST)



Source: JICA Study Team

Figure 6.1.1 Future Population in Three Districts

(3) Economic Growth

1) GDP Growth in Nepal

Based on the growth of GDP in the past years and the envisaged long term vision "To upgrade Nepal from a least developed to a developing country by 2022", the thirteenth plan (from 2014/15 to 2016/17) set the target of GDP growth rate as 6% and growth rate of GDP per capita as 4.6%. However, the achievement of Three Year Plan (2010/11 – 2012/13) was lower than the target by 1.5 point as shown in Table 6.1.6.

Table 6.1.6 Quantitative Target Achievement of Three Year Plan

S. No.	Description	Status of FY 2009/10	Target of 3-Y Plan	Achievements of TYP period			
				2010/11	2011/12	2012/13	Average growth
1	Economic Growth Rate (%)	4.3	5.5	3.8	4.6	3.5	4.0
2	Agricultural Sector Growth Rate (%)	2	3.9	4.5	4.6	1.1	3.4
3	Non- Agricultural Sector Growth Rate (%)	5.4	6.4	3.6	4.5	4.6	4.2
4	Employment Growth Rate (%)	3	3.6	2.9	2.9	2.9	2.9

Source: An Approach Paper to the Thirteenth Plan, National Planning Commission, June 2014

Among the international donors, International Monetary Fund (IMF) projects that the economic growth in Nepal will be around 4.5% in the medium term, with gradual improvements in execution of the capital expenditure budget supporting activity as remittance growth moderates.[1]

Considering the achievement of previous national plan, actual economic growth will be lower than the target of national plan and become close to the projection by IMF. JST presume that GDP growth rate will be 5.0% in this project.

2) GDP Growth Rate per Capita in Kathmandu Valley

GDP growth rate per capita in Nepal is calculated as 3.67% in accordance with the economic growth rate of 5.0% and population projection by CBS.

6.2 Vision and Target

The objective of the master plan is to establish a sustainable and feasible urban transport integrated with land use plan. “Establishment of sustainable urban transport network with high mobility, safety and comfort” is instituted as the vision and six targets are emphasized under the vision.

Source: JICA Study Team

Figure 6.2.1 Vision and Target of Master Plan

In order to achieve the targets, the following approach will be taken:

[1] IMF Staff Report, June 17, 2014

(1) Strategic approach

Urban Transport Master Plan for the Kathmandu Valley should be implemented as a strategic Transport Oriented Development (TOD) approach both in the new town areas or suburbs and in the existing urban areas inside the Ring Road. The development and redevelopment should be promoted with appropriate transport infrastructure provisions associated with land use planning.

In addition, the master plan is implemented along a staging plan consisting of short, middle and long term plans. In particular, in the phased strategy the target of each stage should be clear and be attained by possible and practical measures.

(2) Sustainability

Sustainability is used as the key concept for every city in the world. In the Kathmandu Valley, particularly the following viewpoints should be emphasized.

- Social, economic and environmental sustainability is dependent greatly on the proper public transport system which everybody can use safely, conveniently, comfortably and environmentally-friendly.
- One of the key points in order to achieve a kind of sustainable transport system in the Kathmandu Valley, trip length should be shorter suitable for walking and bicycle. Therefore it is necessary to maintain compact urban form as much as possible and prevent urban sprawl and disorderly expansion in the suburbs.
- Another key point is the traffic management. It takes a long time to provide infrastructure and new towns. The traffic management can be applied within a short time. The traffic management tries to improve the traffic movement by utilizing as much as possible both possible supply-side and demand-side measures consisting of a variety of traffic flow regulations, traffic signal control, parking fare control, taxation for cars, car free areas for historical sites and so on. Although this master plan is focused on policy direction and long term plan, it is necessary to conduct the traffic management schemes continuously from the present to the future sustainable region.

(3) Impartiality, Universal Design

In general urban transport system should provide the opportunities for all the people including mobility impaired people such as disabled, children, older people, women, people without car or motorcycle ownership, low income people and the unemployed, to participate in the social, economic and cultural activities. In this regard, public transport has a great role to play in the provision of appropriate transport services with affordable different fares for people and priority seats. Furthermore feeder, urban and village roads should be linked well with the national road network for people living in remote places for access to bus routes, schools and hospitals

In addition, urban transport infrastructure for urban transport modes such as walking, bicycles, motorcycles, small-sized buses, large buses and aeroplanes, should be well integrated and well organized for better use by every person.

(4) Safety

Earthquake disasters and traffic accidents should be dealt with to reduce their severity. Emergency and evacuation road networks for earthquakes should be planned in combination with road network provision for improving congestion and reducing traffic accidents.

(5) Environment

Air pollution is the most related environmental issue with traffic condition. In the Kathmandu Valley, road congestion, exhaust gas from old vehicles and dust particles from unpaved roads are the main causes of air pollution from the transport sector. Air pollution leads to health complications and is a barrier to walking. If the transport management is improved, air pollution would be improved. If not

improved, the transport management would be called as failed one.

It is necessary to examine how air pollution can be improved in both the short term and the long term through urban transport planning.

(6) Culture

There are seven world cultural heritages in the Valley. Four heritages exist inside the Ring Road. In addition there are a number of historical and traditional places, events and community based activities. These assets should be preserved and well activated for not only residents but also tourists from all over the world through the appropriate services of mobility, accessibility and better surrounding environment. In particular, public transport and NMT should be combined for the assets and people in an environmentally friendly manner.

6.3 Basic Policy for Urban Structure

6.3.1 Land Use Trend

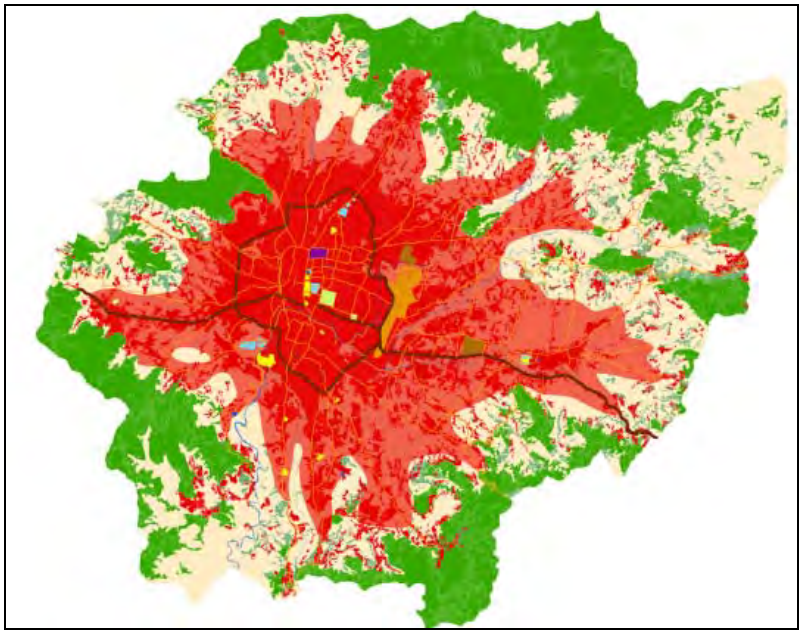
Average population density of urban expansion area is approximately 128 person/ha. This is because of low density development and scatted patches of undeveloped land.

Up to 2030, Kathmandu Valley will accommodate a population of about 1.33 million people. If this low density development trend is applied for land use change trend forecast, build-up areas in the Kathmandu Valley shall increase by 10,407 ha for the increased population. The calculation is shown in the table below. Percentage of built-up areas might reach more than 40% of the total area of KV.

Table 6.3.1 Land Use Change Trend up to 2030

Year	Population		Built-up area			Agricultural area		Expansion area popu density *1
	Census	Increase	Area	Ratio	Increase	Area	Ratio	
	x1,000	x1,000	ha	%	ha	ha	%	p/ha
1967	-	-	2,010	2.9	-	35,648	52.1	
1978	-	-	3,362	4.9	1,352	35,186	51.4	
1991	-	-	6,313	9.2	2,951	38,653	56.5	
2001	1,560	-	9,717	14.2	3,404	36,853	53.8	
2011	2,392	832	16,216	24.7	6,499	27,567	41.9	**128**
2020	3,140	728	21,904	**33.4**	5,688	21,879	33.3	128
2030	3,744	604	26,623	**40.6**	4,719	17,160	26.1	128

*1 Population density 2011 = increased population / expanded area (2001 to 2011) = 832,000 / 6,499 = 128 pp/ha



Source: JICA Study Team

Figure 6.3.1 Future Urban Expansion Image in 2030 without Control

Based on CDRMP result, only 34% of total KV land is constraint free land. Other areas are mainly suitable for agricultural and natural forest land use. If the existing urban spreading situation continues, more agricultural land and forest land might be consumed by urbanization.

High density planned urbanization mechanism shall be required for the future Kathmandu Valley.

6.3.2 Basic Policy for Urban Structure

Based on the existing issues on land use, the basic considerations for formulation of urban structure model are described as follows:

1) Coordination with 20-years Strategic Development Plan (2015-2035) for Kathmandu Valley

KVDA drafted "20 years Strategic Development Master Plan (2015-2035) for Kathmandu Valley" (Hereinafter referred to as 20 years Master Plan) described in Chapter 3, 3.1.1, (4). This Master Plan is coordinating with the 20 years Master Plan through discussion with the relevant personnel in charge of the 20 years Master Plan thus ownership for this Master Plan is engendered. Therefore, strategy for both master plans shall be held jointly.

2) Clear demarcation between urban land and agricultural land and protection of conservation area.

Cooperating with Land Use Zoning by National Land Use Project, protected agricultural land should be designated and protected from development. As shown in Figure 6.3.1, if the current trend of urban expansion proceeds, conservation areas, namely, forest, water recharge area and steep slope area, will not be protected. Protection of conservation areas is also essential.

3) Development of planned high density new urban areas and prevention of low density expansion

Development area should be designated with high density development due to the limited suitable areas for development plus high density development is efficient for development of urban infrastructure.

4) Decentralization of urban function in the Valley

To ease concentrated urban function in Kathmandu, certain urban functions, such as government offices or education facilities, shall be relocated to outside of Kathmandu municipality area.

Existing central commercial area in Kathmandu from Durbar Square via Indrachowk to Thamel is not only the commercial center of Kathmandu Valley, but the commercial center of neighboring districts. The bustle and vitality of the area are a great attraction of Kathmandu Valley together with the world heritage sites, so the townscape and commercial function shall be maintained. Commercial function of sub-centers is to cover the commercial demand of the new urban area.

5) Creation of sub-centers in new developed urban area

In the new developed urban area, sub-centers are required for the civic service to the residents. Sub-centers will be prepared for relocating functions from the city center, thus traffic volume to city center can be decreased.

6) Transit Oriented Development (TOD)

Together with the public transportation system development, new towns shall be developed to maximize access to public transport. TOD neighborhoods have a center with a transit station or terminal surrounded by highly dense population.

7) Strengthening Disaster Preventive Development

Based on the result of CDRMP, development area should be located away from high disaster risk areas. Possible urban areas are described in below.

8) Strengthening transportation network with public transport system

Weak transportation network is the main problem in KV. Installation of public mass transit system is the key for KV development.

9) Diversion of radial road network system to radial-circumferential road network system

Existing road network in KV is mainly radial road network system except for Ring Road. This system causes traffic concentration into city center. Therefore diversion of existing network system to radial-circumferential network is crucial. Especially connecting all the links of Inner Ring Road is highly beneficial.

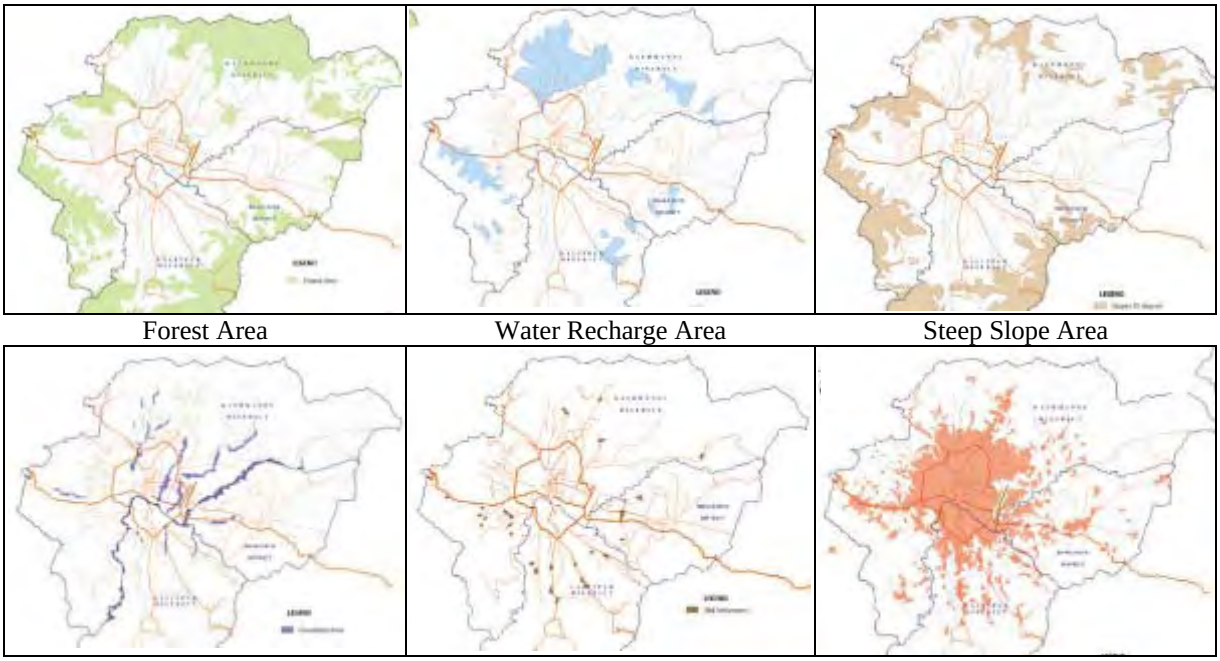
10) Development of arterial corridor connecting urban areas

To maintain the economic activity and livability of new urban areas, transport corridor connecting new urban areas and sub-centers to existing urban areas is needed.

6.4 Formulation of Urban Structure Alternative

6.4.1 Possible Urbanization Area

As a result of CDRMP, several land constraint areas are designated to avoid urban development. Land constraint maps are shown Figure 6.4.1 below.

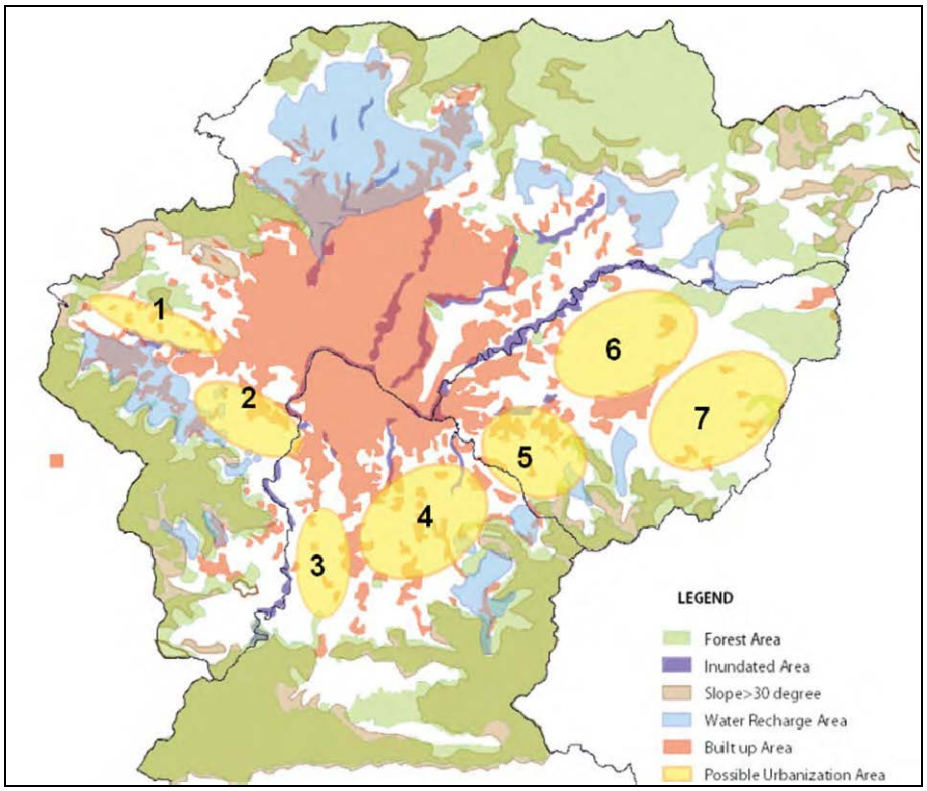


Forest Area | Water Recharge Area | Steep Slope Area

Inundated Area | Old Settlement | Built up Area

Source: CDRMP and JICA Study Team

Figure 6.4.1 Land Constraints Area



Source: JICA Study Team

Figure 6.4.2 Possible Urbanization Areas

6.4.2 Urban Structure Alternative

6.4.2.1 Conceptual Plan

As shown in Figure 6.4.2, possible urban area is limited to west, south and east of existing urban area. Prior to establishment of Structure plan, conceptual plan which indicates urbanization direction is analysed and four cases of conceptual plan are set up.

1) Case-0 (Base Case: Monocentric)

- Monocentric structure
- Trend pattern of expanding urban area in suburbs as typical sprawl
- Dispositioning sub-city centers on the Ring Road

2) Case-1 (Development along Outer Ring Road)

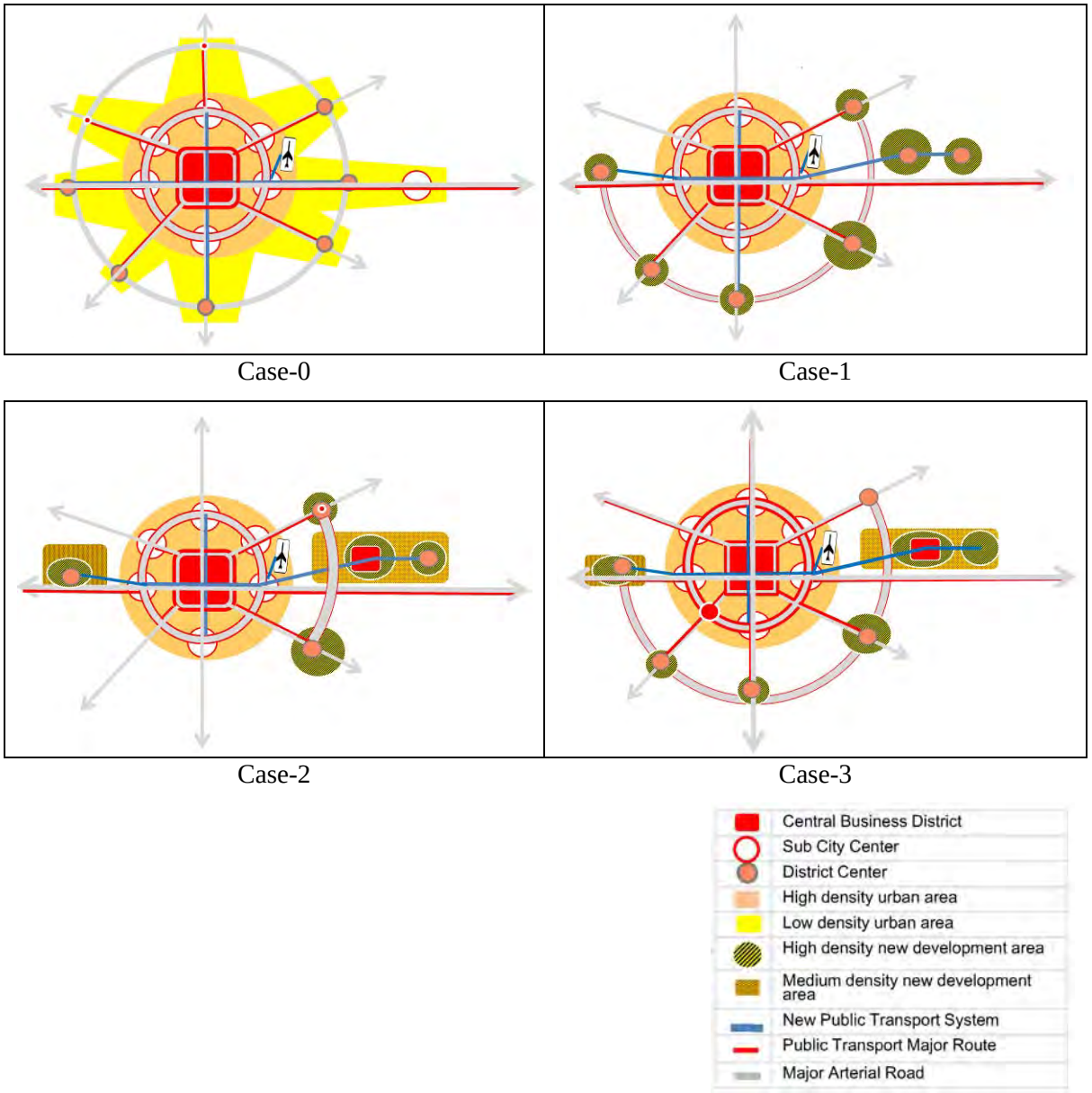
- Monocentric structure
- Development of new urban area at the crossing of Outer Ring Road and Radial Road

3) Case-2 (Development along east-west axis)

- Urban development along the east-west axis
- Typical TOD plan along with new transport system corridor.
- Creation of new CBD in the eastern development area.

4) Case-3 (Integration of Case-1 and Case-2)

- Development of new urban area at the crossing point of Outer Ring Road and radial road
- Eastern new urban area is smaller compared with Case-3.
- Population in eastern new urban area is dispersed to other development areas.
- Creation of new CBD in the eastern development area.
- Concept of TOD is also introduced in this Case.



Source: JICA Study Team

Figure 6.4.3 Conceptual Plan Alternative Case

6.4.2.2 Structure Plan Alternatives

(1) Case-0 (Base Case: Monocentric)

1) Land Use

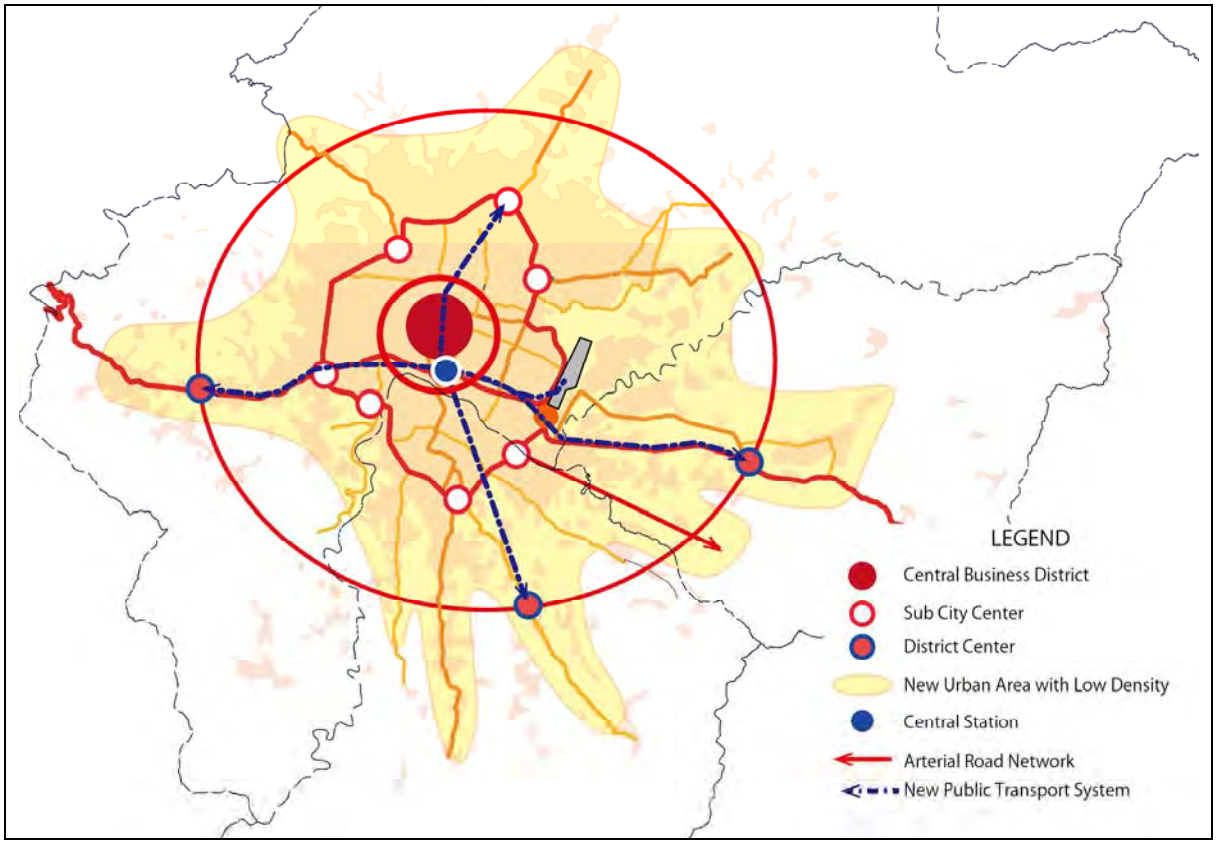
- Existing city center of KV continues as the sole Center of whole area.
- Urban area extends along the major radial road showing the shape of sprawl.
- Sub-city centers are distributed at the cross point on the Ring Road and radial road.

2) Road Network

- All the route of Outer Ring Road is developed.
- Inner Ring Road is developed and Ring Road is strengthened.
- Radial roads connecting sub-centres to existing city center are strengthened.

3) Public Transport Network

- New public transport system is introduced on north-south axis and east-west axis to the Outer Ring Road.
- Major bus routes are on the Inner Ring Road, Ring Road and major radial road.
- Existing central terminal functions as the major terminal of KV area.



Source: JICA Study Team

Figure 6.4.4 Structure Plan Case-0

(2) Case-1 (Development along Outer Ring Road)

1) Land Use

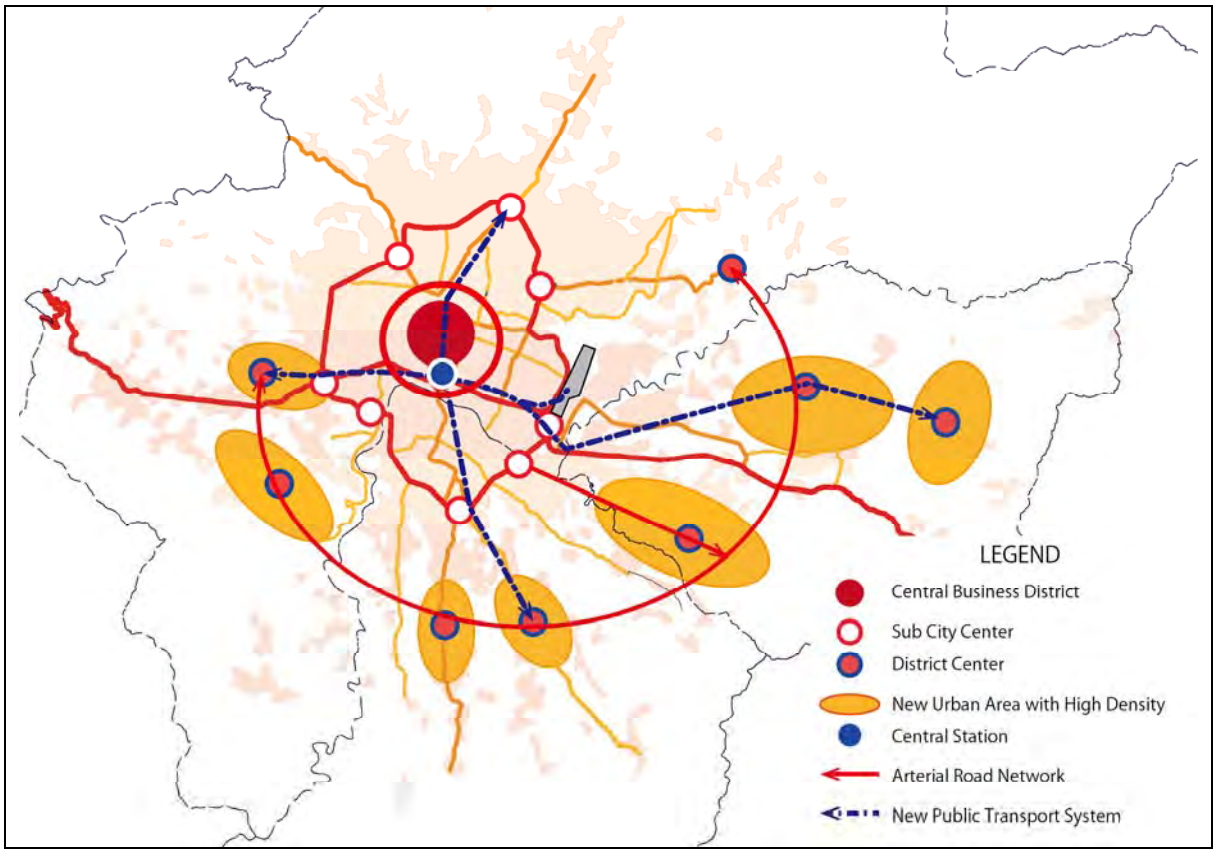
- Existing city center of KV continues as the sole Center of whole area.
- Improving Trend pattern by building new towns with high density along the Outer Ring Road in the suburbs.
- Sub-city centers are distributed to new urban areas at the cross point on the Ring Road and radial roads.

2) Road Network

- Northern part of Outer Ring Road is not developed to protect the conservation area.
- Inner Ring Road is developed and Ring Road is strengthened.
- Radial roads connecting new urban area are strengthened.

3) Public Transport Network

- New public transport system is introduced on north-south axis and east-west axis to the Outer Ring Road. East end of new public transport is extended to new urban area.
- Major bus routes are on the Inner Ring Road, Ring Road and major radial roads.
- Existing central terminal functions as the major terminal of KV area.
- New bus terminals are distributed to the sub-centers in new urban area.



Source: JICA Study Team

Figure 6.4.5 Structure Plan Case-1

(3) Case-2 (Development along east-west axis)

1) Land Use

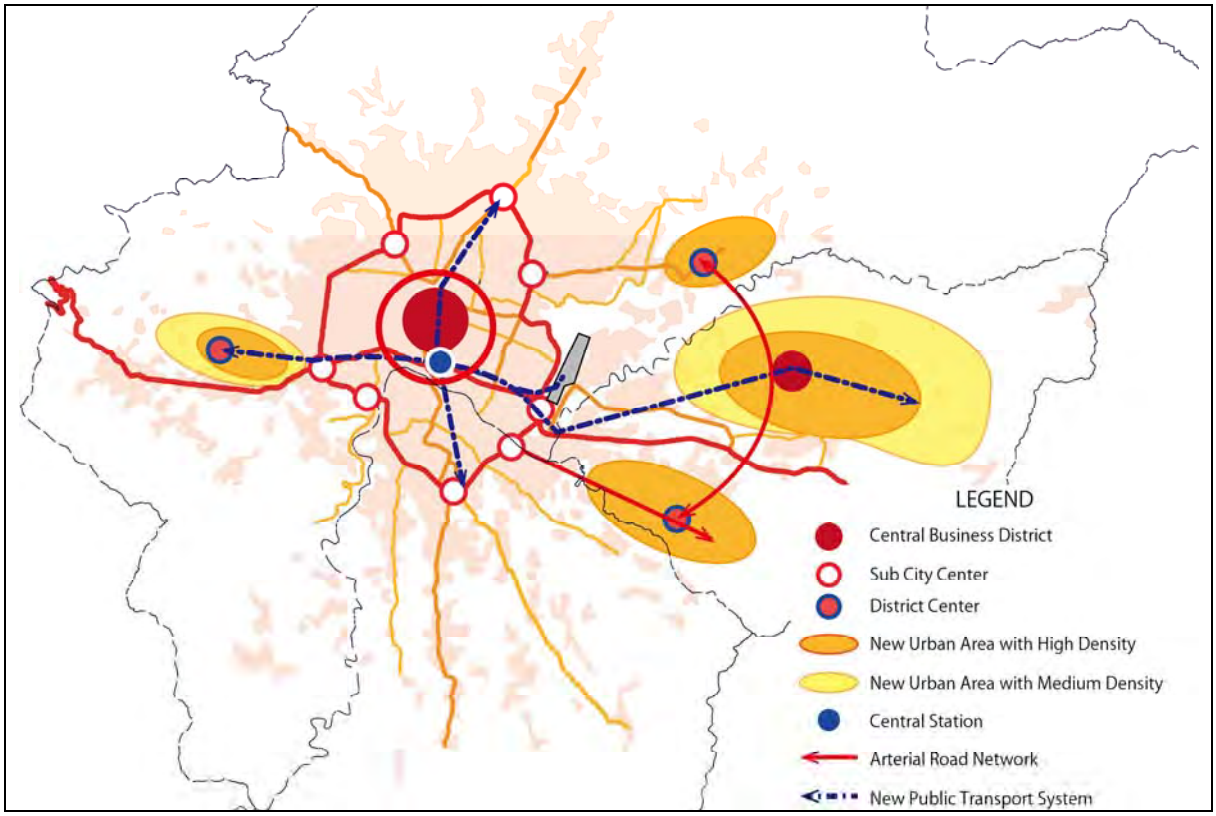
- New urban areas with high density are mainly distributed along the east-west corridor.
- New CBD is disposed in the eastern new urban area and compose twin center urban structure.
- Sub-city centers are distributed to new urban areas making the core of the new urban area.

2) Road Network

- A part of Outer Ring Road is developed in the eastern section.
- Inner Ring Road is developed and Ring Road is strengthened.
- Radial roads along the east-west axis are strengthened.

3) Public Transport Network

- New public transport system is introduced on north-south axis to the Ring Road.
- New public transport system is introduced along the east-west axis.
- Major bus routes are on the Inner Ring Road, Ring Road and major radial roads.
- New central terminal is developed in the eastern new CBD.
- New bus terminals are distributed to the sub-centers in new urban area.



Source: JICA Study Team

Figure 6.4.6 Structure Plan Case-2

(4) Case-3 (Integration of Case-1 and Case-2)

1) Land Use

- New urban areas with high density are distributed along the Outer Ring Road.

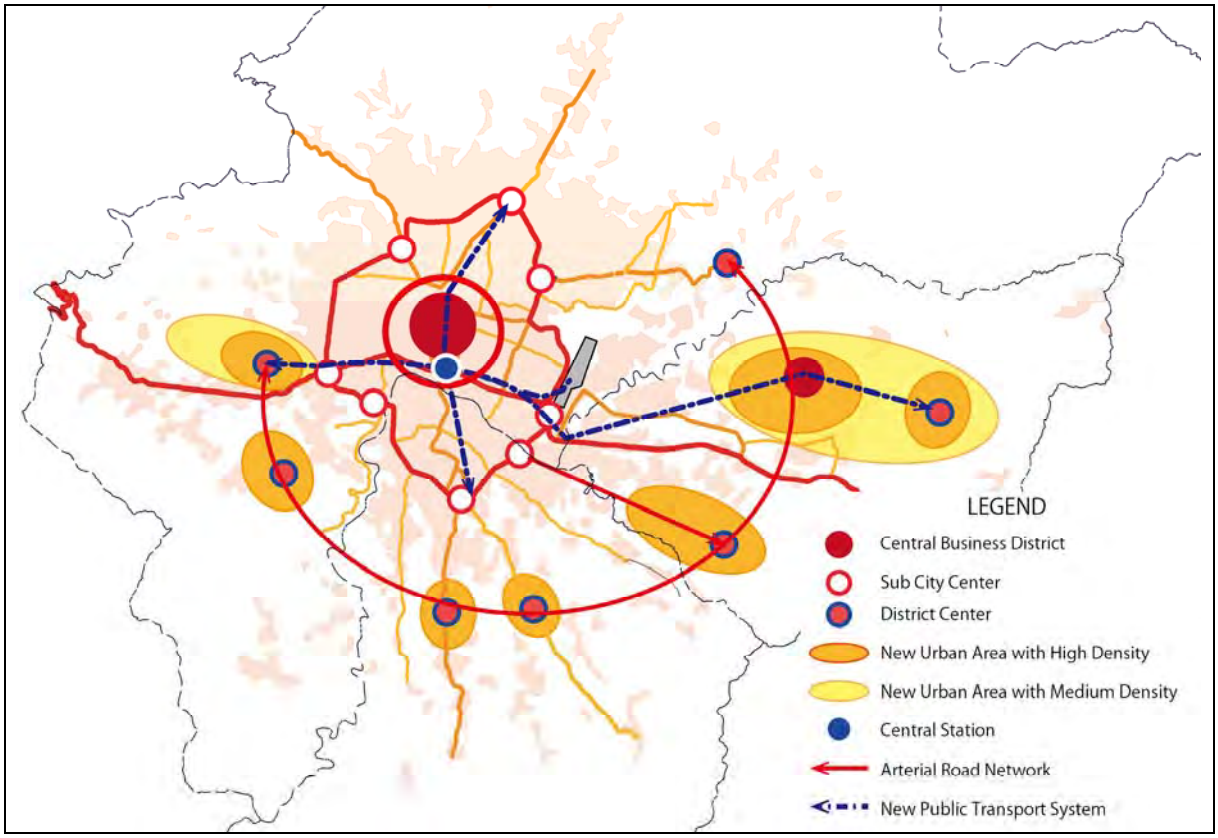
- Eastern new urban area is most strengthened among the new urban areas.
- New CBD is disposed in the eastern new urban area and comprised of twin center urban structure.
- Sub-city centers are distributed to new urban areas making the core of the new urban area.

2) Road Network

- Northern part of Outer Ring Road is not developed to protect the conservation area.
- Inner Ring Road is developed and Ring Road is strengthened.
- Radial roads connecting new urban area are strengthened.

3) Public Transport Network

- New public transport system is introduced on north-south axis to the Ring Road.
- New public transport system is introduced along the east-west axis.
- Major bus routes are on the Inner Ring Road, Ring Road and major radial roads.
- New central terminal is developed in the eastern new CBD.
- New bus terminals are distributed to the sub-centers in new urban area.



Source: JICA Study Team

Figure 6.4.7 Structure Plan Case-3

6.4.3 Evaluation of Urban Structure Alternative

Advantages and disadvantages are analyzed in each Structure Alternative. The result of the analysis is shown in Table 6.4.1.

Table 6.4.1 Advantages and Disadvantages of Structure Plan Cases

Structure Plan	Advantage	Disadvantage
Case 0 Base Case : Monocentric	Nothing	Heavy traffic congestion in city center, deteriorating environment in suburbs, huge investment for transport infrastructure and so on.
Case 1 Development along Outer Ring Road	Development areas are distributed to urban area and rural area. Creation of new municipality center is possible.	Traffic congestion in the city center will be difficult to improve without huge investment for public transport and radial arterial roads.
Case 2 Development along east-west axis	This is an innovative TOD solution for increasing future traffic demand if high capacity transport network is efficiently used along the east-west corridor. Brick kilns are utilized to create new function.	Vast agricultural land is demolished. Development and investment are concentrated in the East and West areas. Socio-economic inequality and disparities between the districts would occur.
Case 3 Integration of Case-2 and Case-3	This is set up by taking the advantages and overcoming the disadvantages of both Case-2 and Case-3. Therefore, this can be said to be a relatively better balanced urban structure than the above tree alternatives.	This would be the same as mono-centric urban structure like Case-2 if twin centers are not worked well. Therefore, building a CBD on East-west axis is the key to achieve the objective.

Source: JICA Study Team

As a definitive urban structure, based on the discussion of WGs, Case-3 is recommended.

In the next stage, the definitive urban structure, case-3, will be examined and compared in detail by comparison with Case-0 (Base Case) through future traffic demand forecast and strategic environmental analysis.

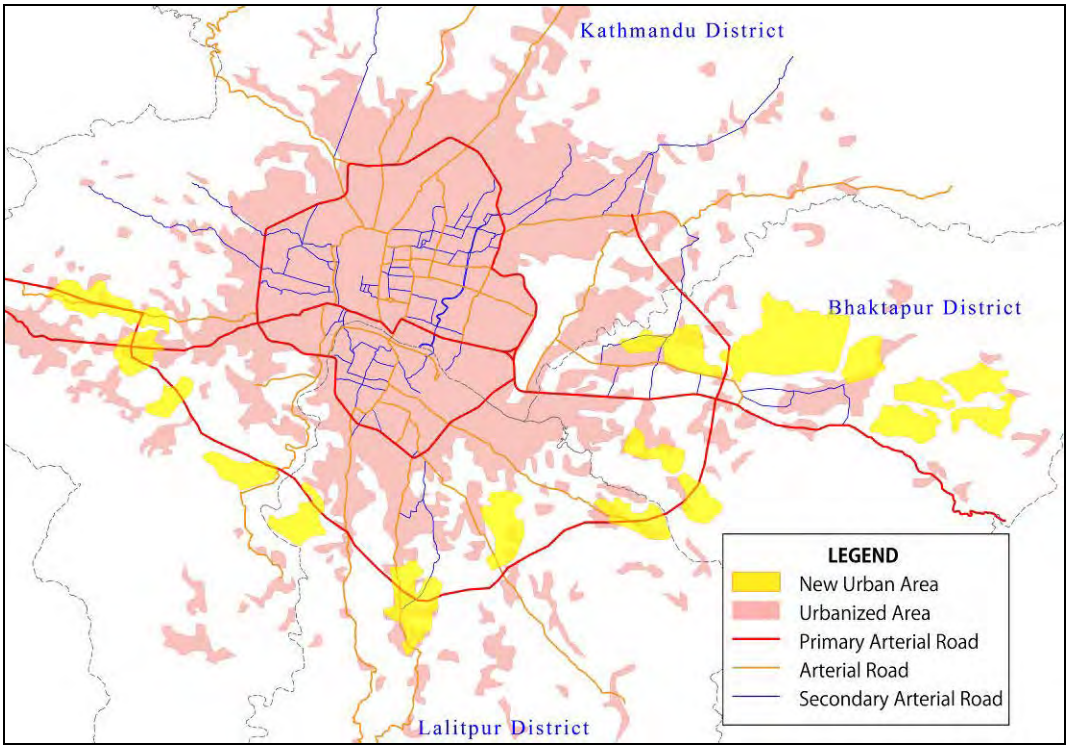


Figure 6.4.8 Actual Lay-out of New Urbanized Area (Case-3)

CHAPTER 7 STRATEGIC ENVIRONMENTAL ASSESSMENT

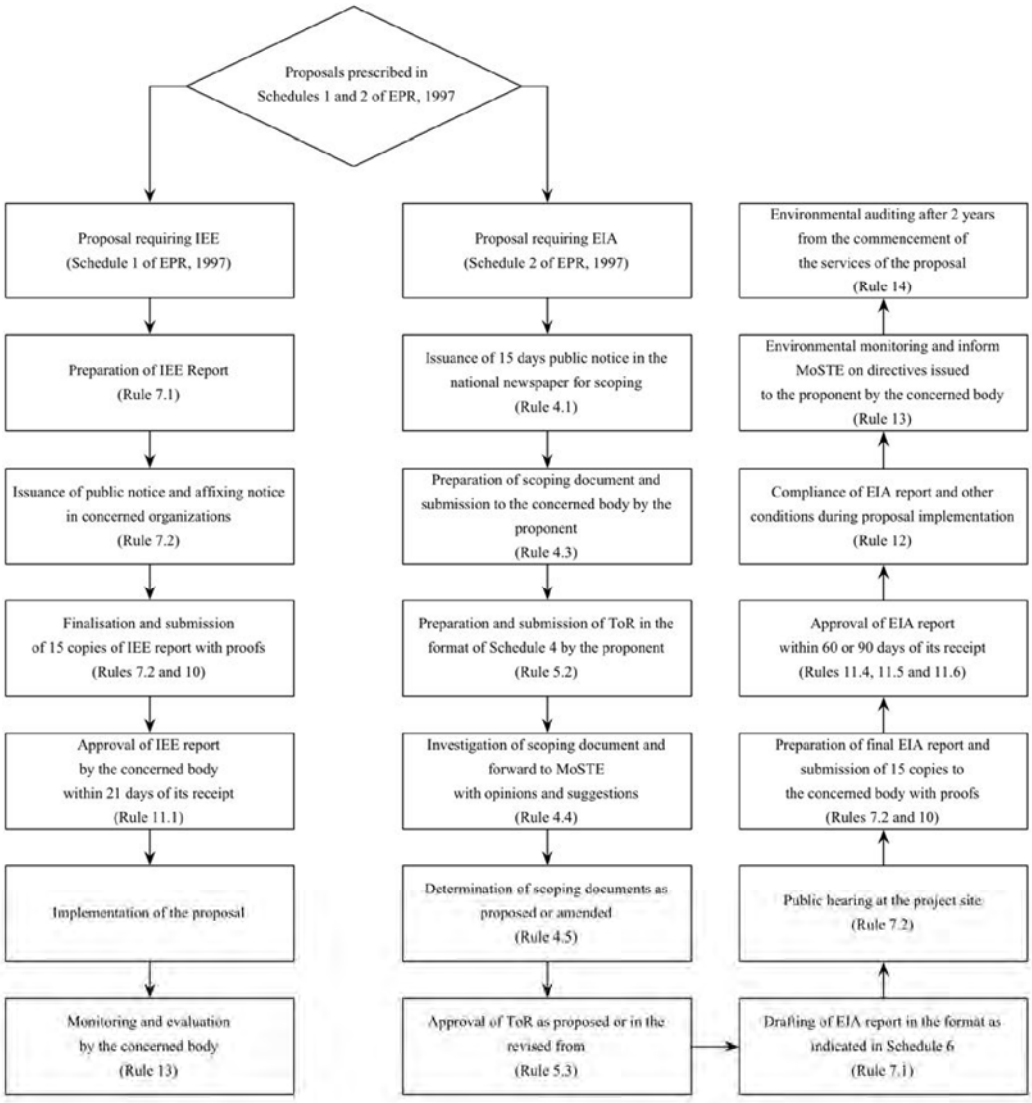
7.1 Outline of Environmental Assessment System in Nepal

Environmental impact assessment in Nepal has been defined by the Environment Protection Act and Environment Protection Rules. In addition, Environmental and Social Management Framework, 2007 DOR and Amendments/Update to ESMF relevant to the construction and maintenance of bridges, 2012, DOR are provided in relation to road projects.

Table 7.1.1 EIA / IEE about Road Development Project

<table>
<tr><th>Type of Road</th><th>Implementing Body</th><th>New Alignment</th><th>Upgrading, Rehabilitation, Reconstruction</th></tr>
<tr><td>National Highways</td><td>DOR</td><td rowspan="2">EIA
(MOSTE approves)</td><td rowspan="8">IEE
(MOPIT approves)</td></tr>
<tr><td>Main Feeder Roads</td><td>DOR</td></tr>
<tr><td>District Roads</td><td>District</td><td rowspan="6">IEE
(MOPIT approves)</td></tr>
<tr><td>Urban Roads</td><td>KVDA
Municipality</td></tr>
<tr><td>Rural Roads
(District Roads)</td><td>District</td></tr>
<tr><td>Small Feeder Roads</td><td>DOR</td></tr>
<tr><td>Major Bridges</td><td>DOR</td></tr>
<tr><td>Tunnels</td><td>DOR</td></tr>
</table>

Source: JICA Study Team



Source: GoN and MoEST (2006) [modified]

Figure 7.1.1 Procedure of Environmental Impact Assessment

7.2 Procedure of Strategic Environmental Assessment

Since SEA is not determined by the laws and regulations of Nepal, the procedure of SEA has been prescribed through consultation with the GON. The Stakeholder Meetings will be held three times and government agencies, environment-related NGOs/NPO, mass media etc. will be invited.

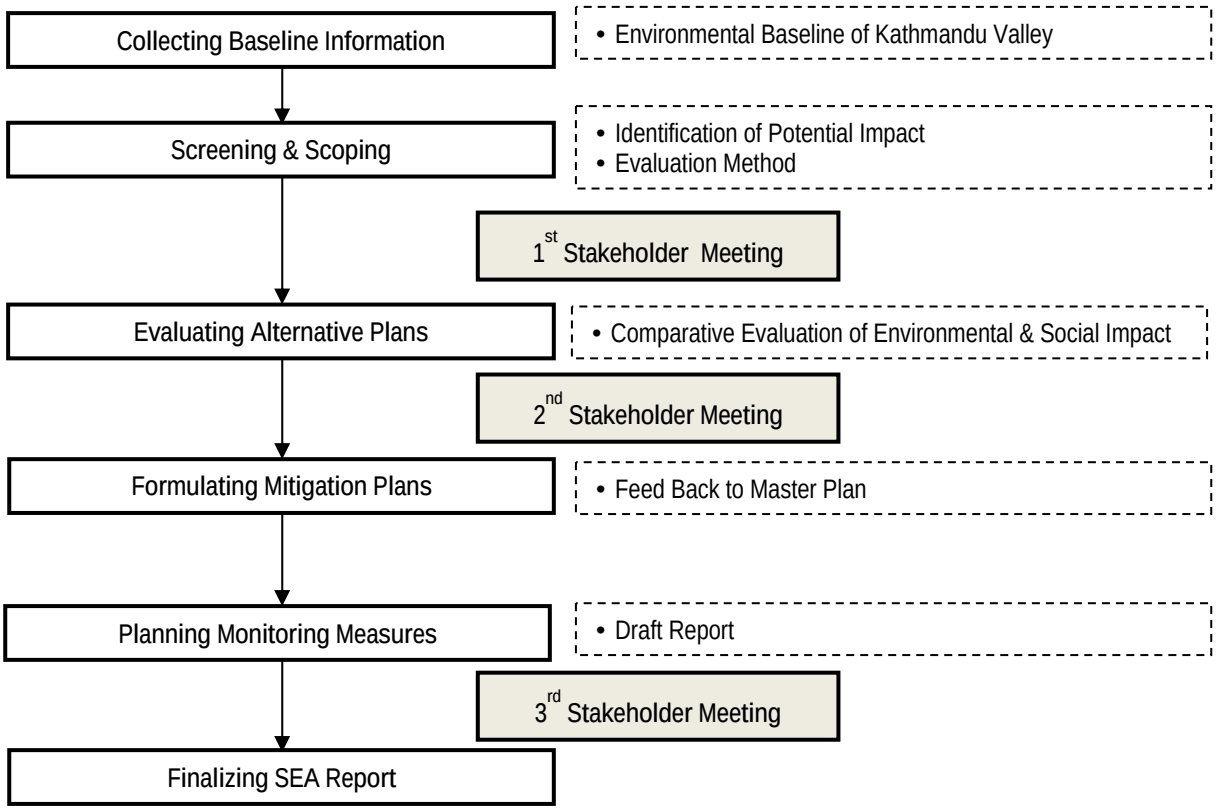


Figure 7.2.1 Procedure of SEA for the Master Plan

7.3 Evaluation of Urban Structure Alternative

7.3.1 Urban Structure Alternatives

There are 4 alternative plans, which are to be studied in relation to SEA. Table 7.3.1 shows the characteristics of each plan.

Case 0 is the plan to develop the whole outer ring road, and to arrange a central business district in the center, seven sub city centers along the ring road and three district centers along the outer ring road. The urban expansion will be continued at the current pace. Public transport will be installed both in the north-south direction and east-west direction. For the east-west direction, it will be located along the existing road.

Case 1 is the plan to develop the outer ring road except the northern part, and to arrange a central business district in the center, eight sub city centers along the ring road and eight district centers along the outer ring road. The concentration of industry and population to the center will be mitigated due to the numerous district centers and surrounding high-density urban areas. The public transport for north-south direction will be installed inside the ring road. For east-west direction, it will be extended to the district center which will be newly arranged in the east of Kathmandu Valley.

Case 2 is the plan to arrange a central business district in the east of Kathmandu Valley, two district centers in the east and a district center in the west. The outer ring road will be developed only as part of the east side. The public transport system will be the same as case 1.

Case 3 is the plan that integrates case 1 and case 2. The outer ring road will be developed except the northern part. A central business district and seven district centers along the outer ring road will be

arranged. The public transport system will be the same as case 1.

Details and figures of Structure Plan Alternatives are described in Chapter 6.

Table 7.3.1 Characteristics of Alternative Plans

	Urban Structure	Road Network	Public Transport
CASE 0	1 Central Business District 7 Sub City Centers 3 District Centers	Develop the whole outer ring road	Develop north-south and east-west direction
CASE 1	1 Central Business District 8 Sub City Centers 8 District Centers	Develop the outer ring road except the northern part	Develop north-south and east-west direction Extend to the east district center
CASE 2	2 Central Business District 8 Sub City Centers 3 District Centers	Develop the outer ring road only the eastern part	Develop north-south and east-west direction Extend to the east district center
CASE 3	2 Central Business District 8 Sub City Centers 7 District Centers	Develop the outer ring road except the northern part	Develop north-south and east-west direction Extend to the east district center

Source: JICA Study Team

7.3.2 Screening and Scoping

7.3.2.1 Environmental Impact Factor of the Master Plan

Environmental impact factors which affect physical environment, natural environment and social environment are determined in view of improvement of urban transport network and optimization of land use.

Improvement of urban transport network
- Construction of new roads and widening or improvement of the existing roads
- Optimization of urban transport by installation of public transportation
- Land acquisition for new roads or road expansion
- Variation in future traffic volume

Optimization of land use
- Conversion of land use
- Protection of national parks, reserved forests and water recharge areas

7.3.2.2 Scoping

The result of scoping is shown in Table 7.3.2, Table 7.3.3, Table 7.3.4 and Table 7.3.5 based on JICA Guidelines for Environmental and Social Considerations, 2010.

Table 7.3.2 Scoping Result of Physical Environment

Environment Impact Item	Scoping Result	Reason for Scoping
Air Quality	B+/-	Positive impact : The quantity of automobile emissions is expected to be decreased due to alleviation of traffic congestion coming from improved traffic network. Negative impact : The air quality might deteriorate along the road in which traffic volume increases due to improvement of traffic network.
Noise and Vibration	B+/-	Positive impact : Noise and vibration from vehicles is expected to be reduced due to alleviation of traffic congestion coming from improved traffic network. Negative impact : Noise and vibration might be increased due to increased traffic volume caused by improvement of traffic network.
Water Quality	C-	Negative impact : In case of new or widening roads at riverside, turbid water might flow into river during the construction period.
Waste	D	There is no influence.
Soil Contamination	D	
Land Subsidence	D	
Odor	D	
Sediment	D	

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
(A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

Table 7.3.3 Scoping Result of Natural Environment

Environment Impact Item	Scoping Result	Reason for Scoping
Protected Area	D	It is a policy of the Master Plan to protect conservation areas such as national parks and reserved forests.
Ecosystem	D	Since the project area is mainly in the urban area, there will be no influence to the ecosystem.
Hydrology/ Water Use	D	The Master Plan intends to protect the watershed area. Since the project area is mainly in the urban area, there will be no influence to hydrology/water use.
Underground Water	C-	Underground water might be affected if tunnel is planned in mountainous or hillside areas.
Topography and Geology	D	Since the important terrains will not be changed, there is no influence.
Soil Erosion	D	There is no influence.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
(A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

Table 7.3.4 Scoping Result of Social Environment

Environment Impact Item	Scoping Result	Reason for Scoping
Involuntary Resettlement	B-	The scale of involuntary resettlement depends on traffic network plan.
The Poor/ The Minority	B-	Due to road widening or road improvement, the resettlement of the poor people might occur.
Local economy (employment/a means of livelihood)	B+/-	Positive Impact: The local residents are expected to be employed during the construction work. Economic activity will be enhanced through the improved traffic efficiency. Negative Impact: When agricultural lands conversion to urban land use, local economy of agricultural livelihood will be changed
Public Health	D	There is no influence.
Work Environment (work safety)	D	There is no influence.
Disaster, Infection such as HIV/AIDS	C-	The risk of disasters such as a landslides exist if road construction takes place in mountainous and hillside areas.
Landscape	B+/-	Positive impact : The landscape of roadside is expected to be improved due to introduction of public transport, redevelopment of roadside along with main road improvement and adjustment of land use. Negative impact : The landscape might be changed in the mountainous and hillside areas due to road construction.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
(A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

Table 7.3.5 Scoping Result of Others

Environment Impact Item	Scoping Result	Reason for Scoping
Accident	B+/-	Positive impact: The number of car accidents on the existing road is expected to be reduced due to improvement of traffic network. Negative impact : There might be car accidents on the new road.
Global Warming	B+	Fuel consumption is expected to be reduced due to smoother traffic along with improved transport network.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
(A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

7.3.3 Evaluation Result of Alternative Plans

(1) Physical Environment

Table 7.3.6 Evaluation Result of Physical Environment

	Case 0		Case 1		Case 2		Case 3	
Air Quality	B-	The air pollution in urban areas may become more serious.	B+	The air pollution in urban areas may be alleviated.	B+	The air pollution in urban areas may be alleviated.	B+	The air pollution in urban areas may be alleviated.
			B-	Traffic congestion may occur around the new district centers, which causes air pollution.	B-	Traffic congestion may occur around the new district centers, which causes air pollution.	B-	Traffic congestion may occur around the new district centers, which causes air pollution.
Noise and Vibration	B-	The noise and vibration in urban areas may become more serious.	B+	The noise and vibration in urban areas may be alleviated.	B+	The noise and vibration in urban areas may be alleviated.	B+	The noise and vibration in urban areas may be alleviated.
			B-	Traffic congestion may occur around the new district centers, which causes noise and vibration.	B-	Traffic congestion may occur around the new district centers, which causes noise and vibration.	B-	Traffic congestion may occur around the new district center, which causes noise and vibration.
Water Quality	C-	On constructing the inner ring road, the river may get cloudy. On constructing the outer ring road at the upper stream of Bagmati river and Bishnumati river, the river may get cloudy.	C-	On constructing the inner ring road, the river may get cloudy.	C-	On constructing the inner ring road, the river may get cloudy.	C-	On constructing the inner ring road, the river may get cloudy.

Source: JICA Study Team

Table 7.3.7 Evaluation Result of Natural Environment

	Case 0		Case 1		Case 2		Case 3	
Protected Area	A-	Due to the outer ring road development, Shivapuri-Nagarjun National Park will be altered.	D	There is no alteration to Shivapuri-Nagarjun National Park.	D	There is no alteration to Shivapuri-Nagarjun National Park.	D	There is no alteration to Shivapuri-Nagarjun National Park.
Ecosystem	A-	The ecosystem may be affected since Shivapuri-Nagarjun National Park will be altered due to the outer ring road development.	D	The ecosystem will not be affected.	D	The ecosystem will not be affected.	D	The ecosystem will not be affected.
Under groundwater	C-	The function of watershed in north-west and west area may deteriorate due to sprawl of urban area. In case a tunnel is constructed at Shivapuri-Nagarjun National Park, ground water level and flow direction may be altered.	C-	The function of watershed may deteriorate in case district center is developed in the west area (statungal) where the rich watershed is located.	D	No development at rich watershed will be observed.	D	No development at rich watershed will be observed.

Source: JICA Study Team

Table 7.3.8 Evaluation Result of Social Environment

	Case 0		Case 1		Case 2		Case 3	
Involuntary Resettlement	B-	The scale of involuntary resettlement due to the development of the outer ring road will be relatively large. Involuntary resettlement will occur due to the development of arterial road network.	B-	Involuntary resettlement will occur due to the development of the outer ring road, arterial road network and new public transport system.	B-	The scale of involuntary resettlement due to the development of the outer ring road will be relatively small. Involuntary resettlement will occur due to the development of arterial road network and new public transport system.	B-	Involuntary resettlement will occur due to the development of the outer ring road, arterial road network and new public transport system.
The Poor/The Minority	B-	The riverside area will be developed along with the construction of the inner ring road, which may cause involuntary resettlement.	B-	The riverside area will be developed along with the construction of the inner ring road, which may cause involuntary resettlement.	B-	The riverside area will be developed along with the construction of the inner ring road, which may cause involuntary resettlement.	B-	The riverside area will be developed along with the construction of the inner ring road, which may cause involuntary resettlement.
Local Economy	B+	Development of district centers will have a positive impact on the local economy. Employment will be created in relation to the construction of the outer ring road and new public transport system.	B+	Development of district centers will have a positive impact on the local economy. Employment will be created in relation to the construction of the outer ring road and new public transport system.		Development of district centers will have a positive impact on the local economy. Employment will be created in relation to the construction of the outer ring road and new public transport system.		Development of district centers will have a positive impact on the local economy. Employment will be created in relation to the construction of the outer ring road and new public transport system.
	B-	Urbanization from farmland will be continued due to sprawl of the city and people who make a living by farming will be affected.	B-	Due to development of suburban farmland, people who make a living by farming will be affected.	B-	Due to development of suburban farmland, people who make a living by farming will be affected.	B-	Due to development of suburban farmland, people who make a living by farming will be affected.
Land Use/Local Resource	B-	Urban area and farmland will be intermingled due to sprawl of the city and land	B+	High-density urban area and farmland will be clearly divided, which is expected	B+	High-density urban area and farmland will be clearly divided, which is expected	B+	High-density urban area and farmland will be clearly divided, which is

Use		use may become inefficient.		to lead to efficient land use.		to lead to efficient land use.		expected to lead to efficient land use.
Social Capital / Social Organization	B-	Construction or expansion of roads such as the outer ring road may split the existing communities.	B-	Construction or expansion of roads such as the outer ring road may split the existing communities.	B-	Construction or expansion of roads such as the outer ring road may split the existing communities.	B-	Construction or expansion of roads such as the outer ring road may split the existing communities.
Existing Social Infrastructure/Social Service	C-	The accessibility to the existing social infrastructure in the center may be deteriorated due to the traffic congestion. Construction or expansion of roads may lead to split of communities, which can deteriorate the accessibility to the social infrastructure.	C-	Construction or expansion of roads may lead to split of communities, which can deteriorate the accessibility to the social infrastructure.	C-	Construction or expansion of roads may lead to split of communities, which can deteriorate the accessibility to the social infrastructure.	C-	Construction or expansion of roads may lead to split of communities, which can deteriorate the accessibility to the social infrastructure.
			C+	Social infrastructure will be developed in each district center, which improves the accessibility.	C+	Social infrastructure will be developed in each district center, which improves the accessibility.	C+	Social infrastructure will be developed in each district center, which improves the accessibility.
Misdistribution of Benefits and Damages	C-	While construction or expansion of roads such as the outer ring road causes involuntary resettlement, the land prices along the road will rise.	C-	While construction or expansion of roads such as the outer ring road causes involuntary resettlement, the land prices along the road will rise.	C-	While construction or expansion of roads such as the outer ring road causes involuntary resettlement, the land prices along the road will rise.	C-	While construction or expansion of roads such as the outer ring road causes involuntary resettlement, the land prices along the road will rise.
Water Use, Water Right, the Right of Common	C-	In case alteration to the community forest is necessary due to construction or expansion of roads such as the outer ring road, the right to use the community forest may be affected.	C-	In case alteration to the community forest is necessary due to construction or expansion of roads such as the outer ring road, the right to use the community forest may be affected.	C-	In case alteration to the community forest is necessary due to construction or expansion of roads such as the outer ring road, the right to use the community forest may be affected. However, the possibility is relatively less since the length of the outer	C-	In case alteration to the community forest is necessary due to construction or expansion of roads such as the outer ring road, the right to use the community forest may be affected.

						ring road is shorter than the other cases.		
Disaster, Infection Such as HIV/AIDS	C-	There is a risk of landslides in mountainous and hillside areas when constructing the outer ring road.	C-	There is a risk of landslides in mountainous and hillside areas when constructing the outer ring road.	D	The risk of landslides is low since the construction of outer ring road doesn't take place in mountainous and hillside areas.	C-	There is a risk of landslide in mountainous and hillside areas when constructing the outer ring road.
Landscape	B-	The landscape in the urban areas may become formless due to sprawl of the city. Natural landscape may be altered when the outer ring road is constructed through mountainous and hillside areas.	B+	The urban area will be formed properly and the landscape is expected to be tidy.	B+	The urban area will be formed properly and the landscape is expected to be tidy.	B+	The urban area will be formed properly and the landscape is expected to be tidy.

Source: JICA Study Team

Table 7.3.9 Evaluation Result of Others

	Case 0		Case 1		Case 2		Case 3	
Accident	B-	There will be heavy traffic congestion in the city center and the risk of accidents may increase.	B+	The traffic will be smoother in the center and the risk of accidents may decrease.	B+	The traffic will be smoother in the center and the risk of accidents may decrease.	B+	The traffic will be smoother in the center and the risk of accidents may decrease.
			B-	Traffic accidents may occur on the new roads.	B-	Traffic accidents may occur on the new roads.	B-	Traffic accidents may occur on the new roads.
Global Warming	B-	The emissions of greenhouse gas can increase for the following reasons: - The traffic will be concentrated in the center and this causes traffic congestion. - Suburban farmlands will be urbanized and the distance between the food production areas and the food consumption areas will be longer.	B+	The smoother traffic and introduction of public transport will contribute to reduction of greenhouse gas emissions.	B+	The smoother traffic and introduction of public transport will contribute to reduction of greenhouse gas emissions.	B+	The smoother traffic and introduction of public transport will contribute to reduction of greenhouse gas emissions.

Source: JICA Study Team

7.4 Stakeholder Meeting

7.4.1 Record of Stakeholder Meetings

During the Study period, three Stakeholder Meetings will be held. The first Stakeholder Meeting was held on December 8th, 2014.

Table 7.4.1 shows the outline of the first Stakeholder Meeting and Table 7.4.2 shows the comments from the participants.

Table 7.4.1 Outline of the First Stakeholder Meeting

Date	December 8th, 2014
Organizer	Department of Environment, Department of Road, and JICA Study Team
Venue	The Everest Hotel
Participants List	<Ministries and relevant organizations> Ministry of Agriculture Development Ministry of Forests and Soil Conservation Kathmandu Valley Development Authority Department of Environment Department of Plant Resource Department of Forests Department of Mines and Geology Department of Urban Development and Building Construction Department of Roads Department of Transport Management <NGOs> International Centre for Integrated Mountain Development Environment and Public Health Organization Nepal Forum of Environmental Journalists <Media> Rajdhani Daily Kantipur Daily <Donors> JICA
Agenda	Opening Remarks Outline of the Study Structure Plan Findings so far - Environmental Baseline of Kathmandu Valley - Scoping and Evaluation Method Discussion Conclusion / Way forward Closing Remarks

Table 7.4.2 Comments from the Participants of First Stakeholder Meeting

	Summary of Comment
Mr. Arnico K. Panday, ICIMOD	➢ It is essential to prepare, present and discuss future scenarios right from the start using a map showing real topography and land use. ➢ The three alternatives presented ignore the future highway connections to the south (fast track & tunnel highway to the Terai), as well as new connections to Tibet going northwest. Alternative 3, focusing on existing east and west linkages makes no sense on a 15 year time frame. ➢ Planning the Kathmandu Valley's transportation infrastructure is not only a matter of projecting future demand based on past trends, but it needs to connect to the broader national discourse on the direction of growth of Nepal as a nation. ➢ Although there was occasional mention of non-motorized transport or the possibility of rail-based mass transit, the focus of the presentation was primarily on road construction. Road construction is only a small part of visioning the Kathmandu Valleys' future transport network. ➢ Bicycling was only mentioned as a last-mile connector between public transport and home. The Kathmandu Valley has a climate that allows year-round bicycle use. 10 or 15 km commutes are easily possible by bicycle if suitable safe infrastructure exists. ➢ Sustainability was mentioned in terms of financial viability only, ignoring environmental sustainability concerns. The Kathmandu Valley's transport infrastructure should tie in with the National Planning Commission's push towards a zero carbon economy. ➢ The self-analysis gave the plans a B+ for global warming because of cuts in congestion, completely ignoring both the creating of longer trips, and the likelihood that vehicle fleet growth in a road-based system will overwhelm other improvement gains. ➢ Only parts of the valley were mapped as "water recharge area". Are those areas sufficient to recharge groundwater pumped out in other parts of the valley? ➢ Insufficient attention was paid to the valleys' fertile agriculture land. It was not even listed as something of value on the land use constraints map. Destroying the remaining agricultural land in the valley and trucking in all food will also add to pollution and congestion. ➢ It appears that population figures and projections taken from Central Bureau of Statistics ignored the large transient population of the valley.
Mr. Ramesh Basnet, Department of Plant Resources	➢ I wish Kathmandu could be a cycling city like Copenhagen, Denmark. For a symbolic urban development, bicycle should be promoted. ➢ Do you have any plans for parks or public recreation facilities when planning the road network? ➢ There are at least 14 plants that are planted in Kathmandu. I will send you the list of plants.
Mr. Shiva Prasad Nepal, Department of Road	➢ It is MOPIT that approves IEE, not DOR. ➢ After Transport WG and Traffic Management WG suggest and discuss the alternative plans, environmental and social considerations should be discussed.
Ms. Hisila Manandhar, KVDA	➢ SONA (Society of National Architects) is preparingVision2030.
Mr. Manoj Aryal, Department of Environment	➢ What is the source of the figure of land use?
Dr. Suman K. Shakya,	➢ We can provide some new data.

ENPHO	
JST	➢ We will present not only data but also how to promote NMT including pedestrians and cyclists at the next Stakeholder Meeting. ➢ In the scoping, we conducted preliminary evaluation of the relevancy between each environment impact item and MP. We will re-evaluate the impact on global warming quantitatively based on the future traffic volume. ➢ Transport and Traffic Management WG have just started last week. WG for land use and urban development has already been held three times since last month. The summary of discussion in Transport / Traffic WG will be discussed in the next Stakeholder Meeting in February. ➢ The map showing the real topography and land use has been now prepared. ➢ Although today's presentation appears to be focused on east-west linkage, we surely recognize the connections to south such as fast track. We will keep discussing on this. ➢ The population data used here is from Central Bureau of Statistics. Although the point is fair raised by Mr. Panday, ICIMOD regarding the population growth, it is beyond the scope of the Study. Therefore, the population inside Kathmandu Valley in 2030 is considered as given condition.

Source: JICA Study Team

The second stakeholder meeting was held on March 18th, 2015. Table 7.4.3 shows the outline and Table 7.4.4 shows the comments from the participants.

Table 7.4.3 Outline of the Second Stakeholder Meeting

Date	March 18th, 2015
Organizer	Ministry of Science, Technology and Education, JICA Study Team
Venue	The Everest Hotel
Invitees List	<Ministries and relevant organizations> National Planning Commission Ministry of Agriculture Development Ministry of Forests and Soil Conservation Ministry of Physical Infrastructure and Transport Ministry of Science, Technology and Education Office of Prime Minister Kathmandu Valley Development Authority Department of National Planning Department of Environment Department of Roads Department of Urban Development and Building Construction Department of Archaeology Department of Plant Resources Civil Aviation Authority of Nepal Kathmandu Valley Water Supply Management Board <NGOs> Environment and Public Health Organization Climate Change Network Nepal Yatayat Samachar <Educational Institutions/Universities> Kathmandu University <Media> Abhiyan Daily Kantipur Daily RSS Nepal Radio Nepal

Agenda	Opening Remarks Progress of the Study Urban Structure Alternatives Road Network and Public Transportation Plan Tentative Evaluation Results of Alternative Urban Structures Discussions Closing Remarks

Table 7.4.4 Comments from the Participants of Second Stakeholder Meeting

	Summary of Comment
Unknown	➢ There is 6 lane road at Bhaktapur (Koteshwor - Suryabinayak) and 8 lane road at Baneshwor (Tinkune - Maitighar) but still we are facing traffic congestion, so crossing should be at different levels (either underground or overhead). ➢ We can see the parking of vehicles at roadside randomly and this is also a major cause of traffic congestion. ➢ Focus has to be traffic management at intersections.
Clean Air Network Nepal	➢ Vision and Targets are good, however, there should be a holistic cycle road network plan as well. Cycle lanes should be developed not only on the Ring Road and arterial roads but also on the suburban roads. ➢ Green way should be constructed on the river corridor. ➢ Cyclist highway is also required on the route connecting the existing urban areas and eastern new urban areas.
Unknown	➢ Before construction work, we should make a study about the natural resources such as precious and rare plants so that we can protect and preserve them.
Department of Archaeology	➢ While widening and constructing roads we may come across important heritage sites like Jaya Bageswori Temple etc. for which an alternative route option has to be found. ➢ Air pollution and sound also have adverse impact on old temples and monuments hence due consideration has to be paid to them not only from road traffic but also from air traffic. ➢ Impact assessment should be done from the beginning (feasibility study) involving all the stakeholders including archaeology department.
Unknown	➢ Greenery should get priority on pedestrian lanes not at the middle of the road (Tinkune - Maitighar) as it is now. ➢ The driving style of public transport is the main cause of traffic congestion, so transport management system has to be improved and the lane awareness has to be enhanced. ➢ The vehicles from outside of the valley should be managed properly. Parks around the entrance to the city areas would be better than in business areas (like New Road).
Unknown	➢ The width of the ring road is ok but the system has to be there. The traffic management has to be strongly implemented.

Source: JST

The third stakeholder meeting was held on December 3rd, 2015. The outline and the comments from the participants are shown in Table 7.4.5 and Table 7.4.6 respectively.

Table 7.4.5 Outline of the Third Stakeholder Meeting

Date	December 3rd, 2015
Organizer	Department of Environment, JICA Study Team
Venue	The Malla Hotel
Invitees List	<Ministries and relevant organizations> Ministry of Agriculture Development Ministry of Forests and Soil Conservation Ministry of Science, Technology and Education Ministry of Land Reform and Management Office of Prime Minister Department of Roads Department of Environment Department of Urban Development and Building Construction Department of Archaeology Department of Plant Resources Department of Mines and Geology Civil Aviation Authority of Nepal Madhyapur Thimi Municipality Kirtipur Municipality <NGOs> Environment and Public Health Organization Clean Energy Nepal Nepal Forum of Environmental Journalists <Donors> World Health Organization
Agenda	Opening Remarks Outline of the Study Land Use Plan Road Network Plan Public Transport Plan Discussions Closing Remarks

Source: JST

Table 7.4.6 Comments from the Participants of Third Stakeholder Meeting

	Summary of Comment
Ministry of Forest and Soil Conservation	➢ Road along forests should avoid damage on forests. ➢ Need traffic island. ➢ Plant some trees along roadside. ➢ Land use plan and the master plan should be merged.
Department of Archaeology	➢ Heritage protection should be considered. ➢ Road expansion should avoid national and international heritage site. ➢ Promote vehicle free zone in world heritage site. ➢ Promote e-vehicle or cycle. ➢ The noise and vibration from vehicles also affect monuments thus road should keep some distance from them. ➢ We should consider the archaeological area, historical area, Lichhbi area (area such as Hadigaun, Bishalnagar, Lazimpat) during construction of underground and subway.
Department of Plant	➢ Separate cycle road should be constructed.

Resources	➢ Tree plantation on roadside have not included in the master plan. It must be added. ➢ There are lot of important plant species such as endangered, endemic and highly demand medicinal plants, so before construction road as per master plan botanist should be representative for identification of useful and valuable plants which helps conservation of plants for future as well as prevent erosion of natural growing plants.
DOR	➢ Presentation on prediction on environment impact is only compared between case 1 & 3 but what issues are more prevalent in case 3 is not clear. ➢ What sort of environment plan(especially site specific) has been prepared during EIA is missing in the presentation.
Kirtipur Municipality	➢ Land acquisition modality should be prescribed. ➢ Probable social problem should be identified. ➢ Sewerage system /Electricity system/ Telecommunication system as well as tree plantation should be prescribed.
Clean Energy Nepal	➢ Plan for cycle track network, plan for greenways on river corridor, and plan for pedestrian at core area are needed.
Department of Environment	➢ Cycle or pedestrian friendly networks should be established especially in the core area in order to avoid taking vehicles in. ➢ Considering the current fuel crisis, we should promote electric or solar vehicles. ➢ The presentation focused on urban transport & road network, however it is not clear whether the master plan focuses on the bus parks in Kathmandu that the buses enter either through Arniko Highway, Tribhuwan Highwayy or Dakshinkali or Nuwakot. Is there any provision of having separate bus parks or not. And do they enter the core area as in old bus park currently?
ENPHO	➢ My concern is on the environmental monitoring such as air pollution, sound/vibration, underground pollution, etc.
Department of Mines & Geology	➢ Increasing cycle users and making greenery along roads are not seen in the master plan. ➢ Suggest that low carbon development with local construction aggregate be promoted to reduce carbon emission.
MoLRM	➢ Should have a good vision of resettlement of squatters. ➢ This master plan should also consider the amended land use Act in order to have better land use zoning scheme which will be appropriate from disaster management perspective.
WHO	➢ Would be better if public health issues, eco-friendly vehicles etc. have been covered in the report.
DUDBC	➢ After recent earthquake disaster, Government of Nepal has revised land use plan and policy. It is better to incorporate them into the master plan. ➢ Mitigation measures to decrease traffic accident should be considered. ➢ There should be environmental management plan for improving road network and urban transport system.

Source: JST

7.4.2 Summary of Stakeholder Meetings

7.4.2.1 Comments and Response on Environmental and Social Considerations

(1) Policy on SEA/EIA

There are comments as follows:

- What sort of environment plan (especially site specific) has been prepared during EIA is missing in the presentation.
- After Transport WG and Traffic Management WG suggest and discuss the alternative plans, environmental and social considerations should be discussed.
- Land acquisition modality should be prescribed.
- Should have a good vision of resettlement of squatters.
- Probable social problem should be identified.

SEA is conducted to comparatively evaluate the environmental impact by the M/P. EIA for each project will be conducted when a concrete plan for each project is established and the project requires EIA.

(2) Environmental Management and Monitoring

There are comments as follows:

- My concern is on the environmental monitoring such as air pollution, sound/vibration, underground pollution, etc.
- There should be environmental management plan for improving road network and urban transport system.

Environmental management and monitoring should be conducted along the progress of the transport plan. When EIA is conducted for a project, environmental monitoring plan will be proposed. For instance, environmental monitoring plan for air pollution, noise and vibration shall be proposed for road development projects.

(3) Scoping Result

There is a comment as follows:

- The self-analysis gave the plans a B+ for global warming because of cuts in congestion, completely ignoring both the creating of longer trips, and the likelihood that vehicle fleet growth in a road-based system will overwhelm other improvement gains.

The M/P study is on the future traffic network in Kathmandu Valley including public transport development. The transport distance of the logistic vehicles will be longer due to road improvement, the negative impact is smaller than the positive impact gained from reduction of greenhouse gas emission owing to improvement of traffic condition in whole Kathmandu Valley.

(4) Natural Environment

There are comments as follows:

- Before construction work, we should make a study about the natural resources such as precious and rare plants so that we can protect and preserve them.
- There are lot of important plant species such as endangered, endemic and highly demand medicinal plants, so before construction road as per master plan botanist should be representative for identification of useful and valuable plants which helps conservation of plants for future as well as prevent erosion of natural growing plants.

The basic policy of land use plan is to avoid development in natural parks and forests. Hence, the impact on natural environment such as forests shall be minimized. EIA for each road and land development project based on the M/P will be conducted if the project requires EIA. Impacts on the natural environment and management plan shall be clearly identified and studied in EIA.

(5) Cultural Heritage

There are comments as follows:

- Impact assessment should be done from the beginning (feasibility study) involving all the stakeholders including archaeology department.
- While widening and constructing roads we may come across important heritage sites like Jaya Bageswori Temple etc. for which an alternative route option has to be found.
- Air pollution and sound also have adverse impact on old temples and monuments hence due consideration has to be paid to them not only from road traffic but also from air traffic.
- Heritage protection should be considered.
- Road expansion should avoid national and international heritage site.
- Promote vehicle free zone in world heritage site.
- The noise and vibration from vehicles also affect monuments thus road should keep some distance from them.
- We should consider the archaeological area, historical area, Lichhbi area (area such as Hadigaun, Bishalnagar, Lazimpat) during construction of underground and subway.

The basic policy of the land use plan is to avoid development in cultural heritage areas in order to preserve world heritages and temples. Hence, there will be little impact on cultural heritages.

7.4.2.2 Comments and Response on Structure Plan

(1) Background and Objective of Structure Plan

There are comments as follows:

- The three alternatives presented ignore the future highway connections to the south (fast track & tunnel highway to the Terai), as well as new connections to Tibet going northwest. Alternative 3, focusing on existing east and west linkages makes no sense on a 15 year time frame.
- Planning the Kathmandu Valley's transportation infrastructure is not only a matter of projecting future demand based on past trends, but it needs to connect to the broader national discourse on the direction of growth of Nepal as a nation.

The higher plans and the existing plans were taken into consideration when examining the structure plan. The target area of the M/P is within Kathmandu Valley.

(2) Land Use Plan

There are comments as follows:

- It is essential to prepare, present and discuss future scenarios right from the start using a map showing real topography and land use.
- Only parts of the valley were mapped as "water recharge area". Are those areas sufficient to recharge groundwater pumped out in other parts of the valley?
- Insufficient attention was paid to the valleys' fertile agriculture land. It was not even listed as something of value on the land use constraints map. Destroying the remaining agricultural land in the valley and trucking in all food will also add to pollution and congestion.
- This master plan should also consider the amended land use Act in order to have better land use zoning scheme which will be appropriate from disaster management perspective.
- Road along forests should avoid damage on forests.
- After recent earthquake disaster, Government of Nepal has revised land use plan and policy. It is better to incorporate them into the master plan.

The land use plan is examined integrally with transport plan on the basis that development in the existing high density area, agricultural land, water recharge area, world heritage area, forests area shall be avoided. Please refer to 8.1 Land Use Plan, Chapter 8 for more details.

7.4.2.3 Comments and Response on Sector Plan

(1) Road Plan

- Land use plan and the master plan should be merged.
- Do you have any plans for parks or public recreation facilities when planning the road network?
- Sewerage system /Electricity system/ Telecommunication system as well as tree plantation should be prescribed.
- There are at least 14 plants that are planted in Kathmandu. I will send you the list of plants.
- Plant some trees along roadside.
- Tree plantation on roadside have not included in the master plan. It must be added.
- Greenery should get priority on pedestrian lanes not at the middle of the road (Tinkune - Maitighar) as it is now.

The M/P includes the land use plan in the new urban area and arterial road plan which connects Kathmandu city center and new urban area. Please refer to 8.2 Road Plan, Chapter 8 for more details.
The M/P also proposes future arterial road network and cross section for each road classification. Roadside tree –planting shall be studied in each road development project.

(2) Public Transport Plan

There are comments as follows:

- The presentation focused on urban transport & road network, however it is not clear whether the master plan focuses on the bus parks in Kathmandu that the buses enter either through Arniko Highway, Tribhuwan Highwayy or Dakshinkali or Nuwakot. Is there any provision of having separate bus parks or not. And do they enter the core area as in old bus park currently?
- Although there was occasional mention of non-motorized transport or the possibility of rail-based mass transit, the focus of the presentation was primarily on road construction. Road construction is only a small part of visioning the Kathmandu Valleys' future transport network.

The public transport plan including new transport mode has been examined along with road network plan. Please refer to 8.3 Public Transport Plan, Chapter 8 for more details.

(3) Non-Motorized Transport Plan

There are comments as follows:

- Bicycling was only mentioned as a last-mile connector between public transport and home. The Kathmandu Valley has a climate that allows year-round bicycle use. 10 or 15 km commutes are easily possible by bicycle if suitable safe infrastructure exists.
- I wish Kathmandu could be a cycling city like Copenhagen, Denmark. For a symbolic urban development, bicycle should be promoted.
- Vision and Targets are good, however, there should be a holistic cycle road network plan as well. Cycle lanes should be developed not only on the Ring Road and arterial roads but also on the suburban roads.
- Green way should be constructed on the river corridor.
- Cyclist highway is also required on the route connecting the existing urban areas and eastern new urban areas.

- Plan for cycle track network, plan for greenways on river corridor, and plan for pedestrian at core area are needed.
- Cycle or pedestrian friendly networks should be established especially in the core area in order to avoid taking vehicles in.
- Increasing cycle users and making greenery along roads are not seen in the master plan.
- Need traffic island.
- Separate cycle road should be constructed.

Pedestrian sidewalk is proposed to be installed along the new arterial roads in the M/P. Please refer to 8.2 Road Plan and 8.7 Non-Motorized Transport Plan, Chapter 8 for more details.

(4) Traffic Demand Management

There are comments as follows:

- There is 6 lane road at Bhaktapur (Koteshwor - Suryabinayak) and 8 lane road at Baneshwor (Tinkune - Maitighar) but still we are facing traffic congestion, so crossing should be at different levels (either underground or overhead).
- We can see the parking of vehicles at roadside randomly and this is also a major cause of traffic congestion.
- Focus has to be traffic management at intersections
- The driving style of public transport is the main cause of traffic congestion, so transport management system has to be improved and the lane awareness has to be enhanced.
- The vehicles from outside of the valley should be managed properly. Parks around the entrance to the city areas would be better than in business areas (like New Road).
- The width of the ring road is ok but the system has to be there. The traffic management has to be strongly implemented.

JST proposes Kathmandu Valley Parking Development Project and Kathmandu Valley Traffic Safety Program as traffic demand management projects. Please refer to 8.4 Traffic Demand Management, Chapter 8 for more details.

(5) Traffic Safety Plan

There is a comment as follows:

- Mitigation measures to decrease traffic accident should be considered.

JST proposes traffic safety development strategies based on the examination on traffic safety. Please refer to 8.6 Traffic Safety Plan, Chapter 8 for more details.

(6) Low Carbon Emission

There are comments as follows:

- Suggest that low carbon development with local construction aggregate be promoted to reduce carbon emission.
- Considering the current fuel crisis, we should promote electric or solar vehicles.
- Would be better if public health issues, eco-friendly vehicles etc. have been covered in the report.
- Sustainability was mentioned in terms of financial viability only, ignoring environmental sustainability concerns. The Kathmandu Valley's transport infrastructure should tie in with the National Planning Commission's push towards a zero carbon economy.
- Promote e-vehicle or cycle.

JST proposes introduction of new public transport system and promotion of NMT based on land use plan and transport plan, which will contribute to realization of low carbon society. Discussion on eco-friendly vehicles is out of the scope of the study.

CHAPTER 8 COMPREHENSIVE URBAN TRANSPORT MASTER PLAN WITH SECTOR PROGRAM

8.1 Land Use Plan

The policy on disposition of land use and population density is described below.

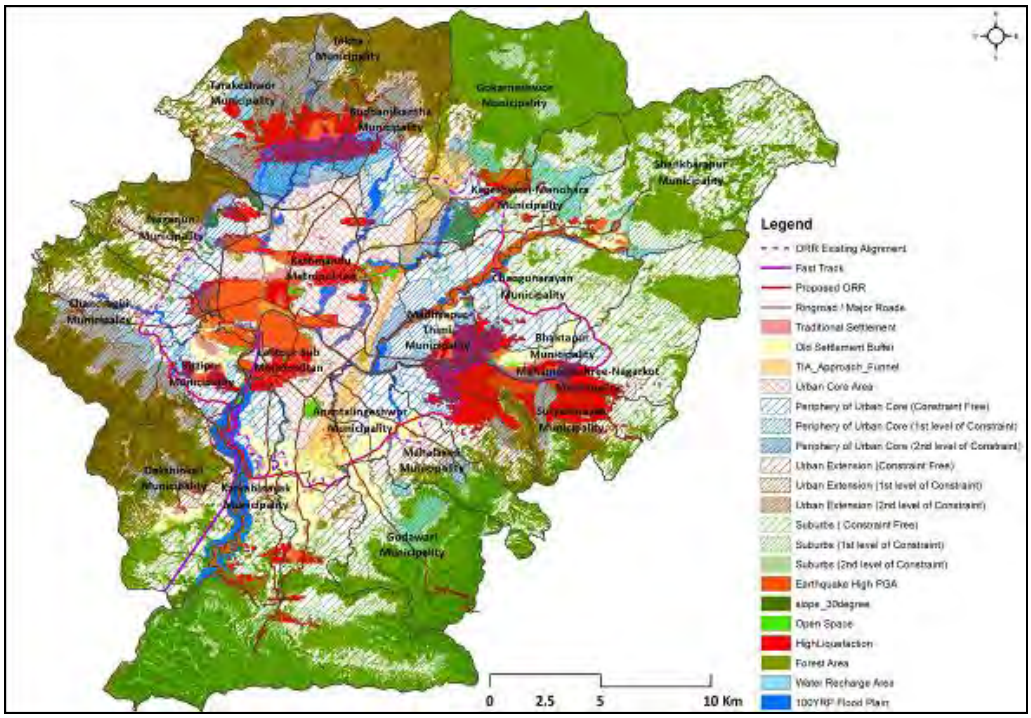
8.1.1 Urban Function Distribution Plan

8.1.1.1 Overall Policy on Land Use of Kathmandu Valley

The following are the basic stance on formulation of land use plan for Kathmandu Valley. After the study of Risk Assessment by JICA, it shall be reconsidered.

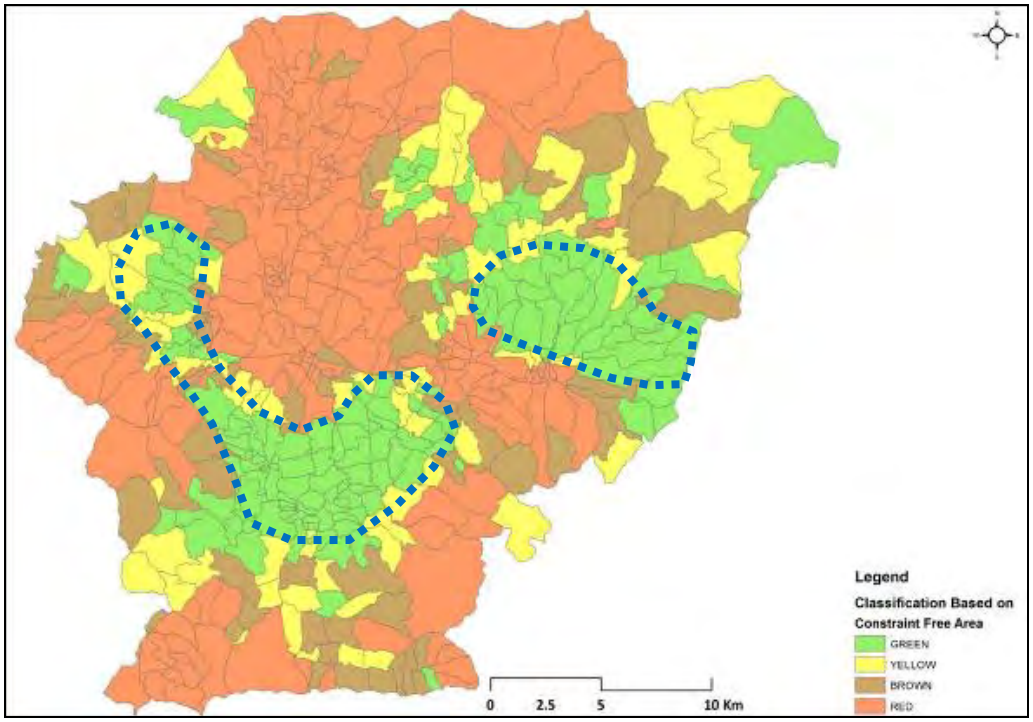
1) Follow CDRMP (Comprehensive Disaster Risk Management Programme)

Based on a series of discussion among Working Group-1 (Land use and urban development), land use zoning should adopt the result of CDRMP. CDRMP identifies risk constraint areas in KV to avoid urbanization in high risk areas, such as earthquake high PGA, high liquefaction, steep slopes, 100 year flood plains, and conservation areas such as forest, open space and water recharge areas.



Source: CDRMP

Figure 8.1.1 Risk Classification based on Constraint Free Mapping



Source: CDRMP

Figure 8.1.2 Risk Classification based on Constraint Free Mapping

Strict land use zoning and regulation, for example to preserve agricultural area by restriction of building construction, is not suitable for Nepal. It is because Nepal has a history of struggle for gaining land right for the peasant. Land use zoning plan and building control system shall appreciate its history, and have to apply soft control measures through the idea of "Risk Sensitive" or "Risk Prevention".

CDRMP classified constraint free areas based on their risk sensitive analysis. Figure 8.1.2 above shows constraint free areas in green colour. New urban centers shall be determined based on this zoning map.

2) TOD based development for planned population distribution and urban function

Introducing mass transit system to connect population concentrated areas is the key solution to ease traffic problem in the valley.

CDRMP does not consider population distribution and population density policy in detail for existing land use. To accommodate increasing population of about 1.4 million people in KV up to 2030, more than half of those population should be allocated in planned high density development area "New Urban Area".

Together with urban population distribution, urban functions such as government offices, education facilities shall be relocated to new urban areas to encourage development activities in new urban areas.

3) Disaster preventive development

To attain the build-up of disaster preventive urban environment of Kathmandu Valley, the following objectives shall be achieved;

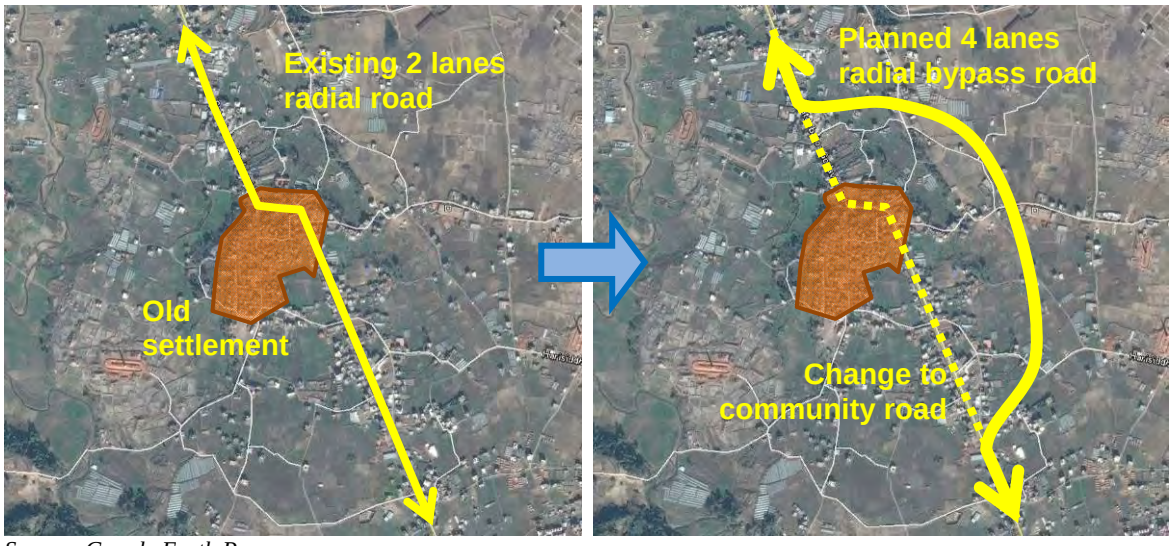
- Renewal of existing vulnerable buildings to earthquake-resistant structures including governmental buildings,

- Security of emergency road network by urban redevelopment and small scale land pooling project,
- Establishment of logistics centers including warehouse function for disaster relief activities, and
- Guarantee to certain open spaces to be used for evacuation after disaster.

4) Preserve heritage sites and old settlements

World Heritage sites are precious treasures for not only Nepalese but also tourists from all over the world. It is the only atmosphere in the world. Preservation of those cityscape and urban activities is valuable. Earthquake resistant preservation technology should also be studied and developed by utilization of modern techniques to protect heritage and old townscape from earthquakes.

Old settlements can be seen along radial roads in the Valley. Those settlements are also composing significant character of historic landscape in the Valley. Road widening projects are ongoing in the Valley including radial roads which pass through old settlements with narrow width. Bypass route shall be considered to avoid demolition of old buildings by road widening project. Figure 8.1.3 shows concept plan to preserve old settlements.



Source: Google Earth Pro

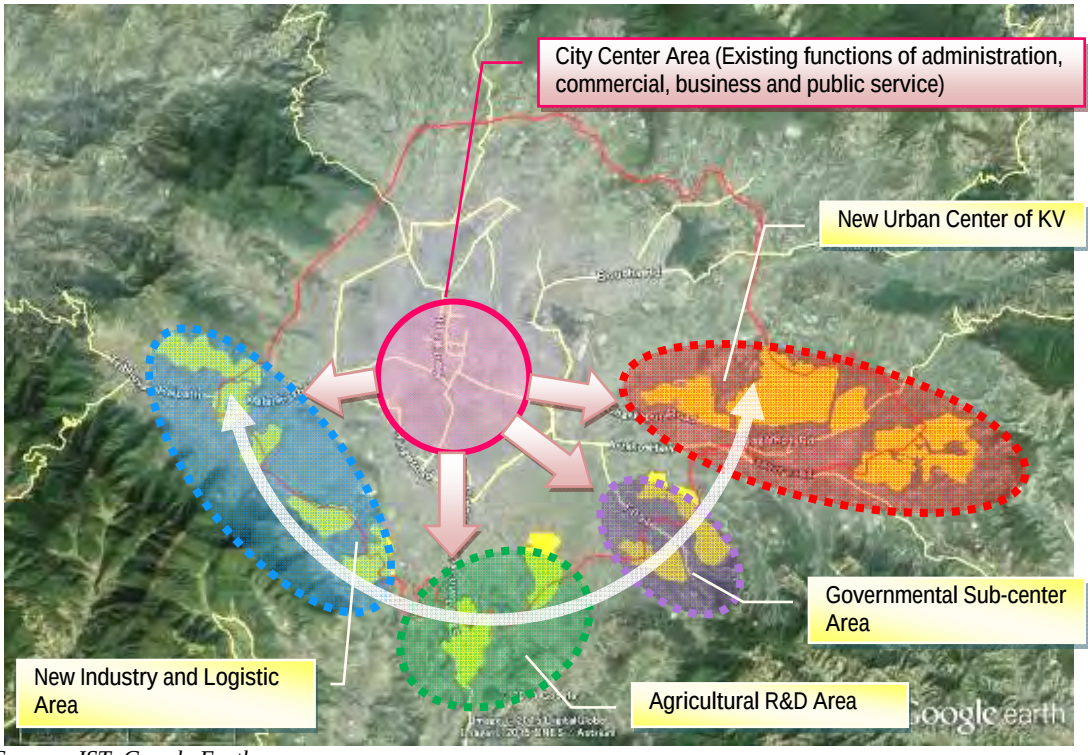
Figure 8.1.3 Preservation of Old Settlement

8.1.1.2 Proposed Distribution Plan of Urban Function

Figure 8.1.4 below shows the proposed distribution plan of urban functions in Kathmandu Valley.

The commercial and administrative functions in the existing city center shall be strengthened along with improvement of public transport system. The following section 8.1.2 explains land use policy in the existing city center.

New urban areas shall be developed in constraint free area along the Outer Ring Road to accommodate increasing population in the Valley. Besides, certain urban functions shall be relocated from the city center to new urban areas to ease congestion in the center. Section 8.1.3 explains land use policy in New Urban Areas.



Source: JST, Google Earth

Figure 8.1.4 Proposed Distribution Concept of Urban Functions

8.1.2 Policy on Land Use in City Center

1) Maintaining existing commercial activities

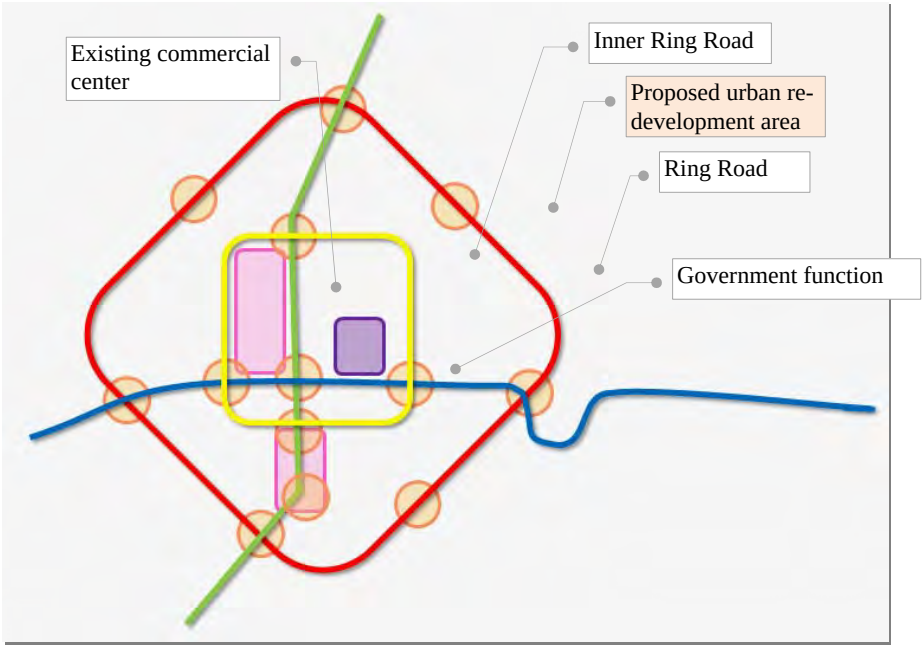
Existing commercial land use in the city center is one of the main attractions for foreign tourists especially in old commercial centers, and shall be maintained to keep the vitality of city center.

2) Promotion of urban re-development together with transport transit function

Except existing bus terminals, getting on and off activities on the roads near junctions cause traffic jam and complications in the city center. Development of mass public transport system is the key to solve the traffic problem in the center. Integrated urban development together with the new mass transit system should be promoted.

New PPP urban re-development scheme shall be introduced to encourage not only private investment for the commercial, business and housing sector, but also public commitment to ensure public transit function in the re-development project to vitalize the city center of Kathmandu.

The details of the urban re-development measures are described in Section 10.2.



Source: JST

Figure 8.1.5 Proposed location of Integrated Urban Re-development Areas

3) Relocation of government function

Certain government facilities, such as parliament house, zoo, government departments, shall be relocated to new town centers to divide up its function to avoid the risk from earthquake damage.

a) New parliament building

Parliament has been occupying Birendra International Conference Center at New Baneshwor. The New House of Parliament is planned to be constructed and shall be located in one of new towns as a symbol of reconstruction of Nepal.

b) New earthquake-resistant consolidated government office building

Some government buildings were damaged by the earthquake in 2015. A quake-proof consolidated government office building shall be developed in a new town which can work as a countermeasure headquarters after huge disasters. Especially damaged department buildings should be prioritized when relocating to the new government office.

c) New Central Zoo

There is an idea to relocate the Central Zoo to outside of the city center. The area of existing zoo can be characterized as education zone because of surrounding educational facilities. The site of the zoo can be utilized for development of an educational institution.

d) Redevelopment of the previous government facility sites

The sites are located at high potential areas for commercial and business activities in the city center. Redevelopment of the site together with transport function shall be a trigger of vitalization of the city.

4) Strengthening resilience against disaster

It is pointed out that many of existing building structures are not strong enough against future massive earthquakes. Road blockage caused by debris of collapsed buildings is one of the serious concerns which hinder emergency and rescue work in the Center during post disaster period.

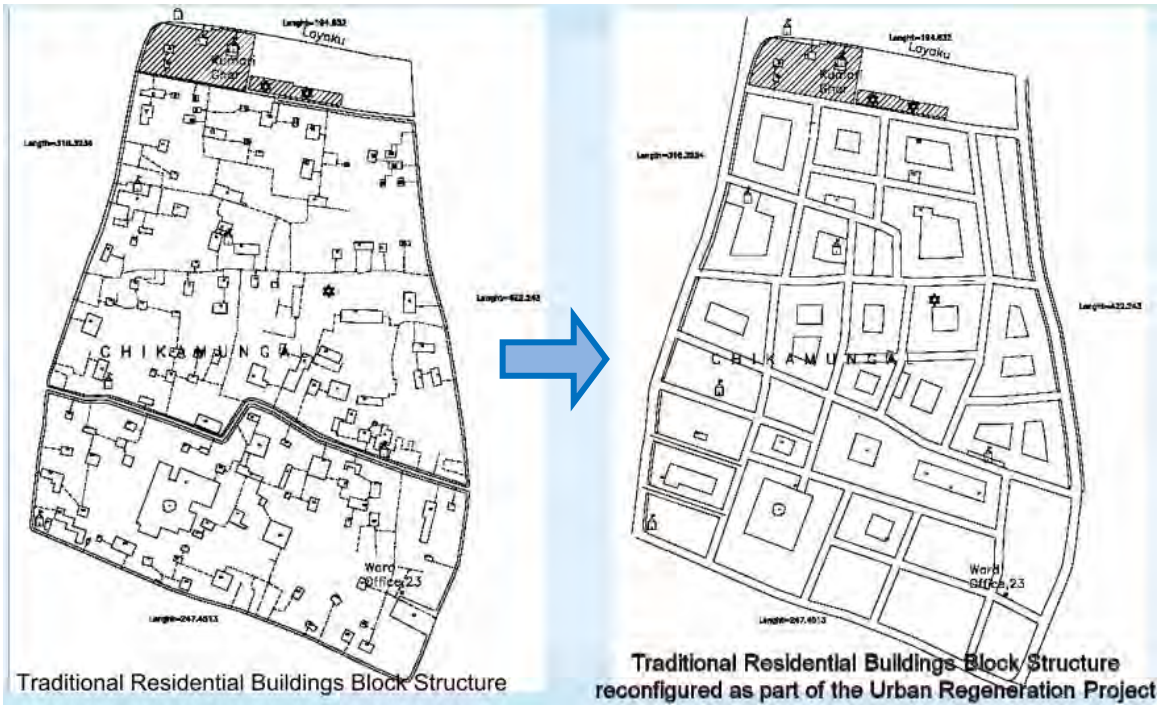
As a result of the Nepal earthquake of 2015, only weaker building structures were damaged and many other buildings remained safe. There may be a misunderstanding among the people in the Valley that buildings undamaged by the 2015 earthquake might be safe. However, expected seismic intensity in the valley is much bigger than 2015's. It is therefore important to renew our appreciation of earthquake-resistant planning and design.

5) Continuous urban regeneration with Traditional Building Block Structure Model

Except the historic heritage areas and old settlements, congested and densely urbanized areas present a high risk environment against earthquake and also make the historic townscape not look good. To strengthen earthquake-resistance and to enhance historic townscape, continuous urban regeneration with application of traditional building block structure.

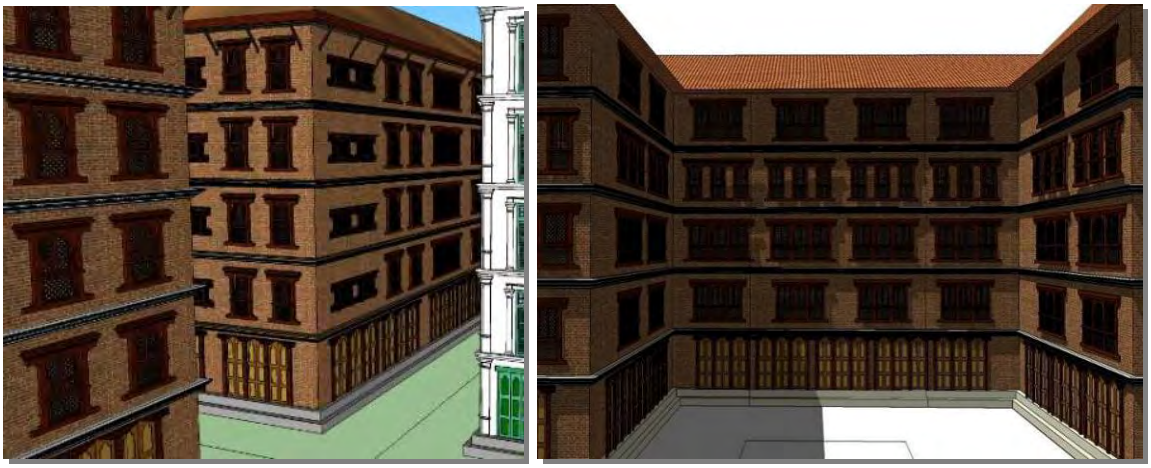
Planning points of traditional building block structure are listed below;

- Preservation of existing historic and religious heritage, buildings and statues,
- Conservation of courtyard and under passage network system in block layout (traditional layout) and maintenance by community,
- Establishment of *Dharmashala* (Open pavilion) for residents' community,
- Hierarchal road and pedestrian network (12m & 6m road network, under passages and courtyards),
- Transformation old vulnerable building stocks into earthquake-resistant building block,
- Underground common parking system in blocks,
- Overall urban environment improvement by redevelopment, and
- Ground floor shall be allocated for shops to keep street active and lively.



Source: Surya Bhakta Sangachhe "PPP for Urban Regeneration in Historic city core of Kathmandu"

Figure 8.1.6 Regeneration of Road Network with preservation



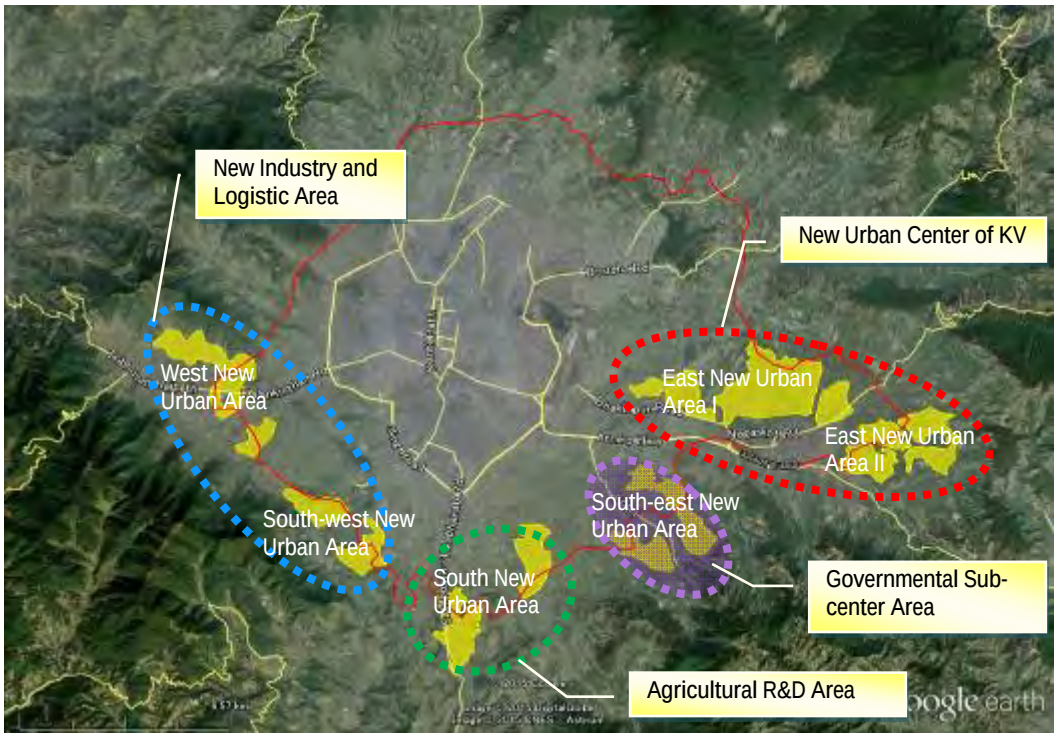
Source: Surya Bhakta Sangachhe "PPP for Urban Regeneration in Historic city core of Kathmandu"

Figure 8.1.7 Image of Traditional Regeneration of Urban Area

8.1.3 Land Use Plan of New Urban Areas

8.1.3.1 Proposed Location of New Urban Areas

Based on distribution plan of urban function and the overall policy, JST proposes four groups of new urban areas with six areas along the ORR.



Source: JST, Google Earth

Figure 8.1.8 Proposed Location of New Urban Areas

8.1.3.2 Policy on Land Use Plan of New Urban Areas

For land use planning of new urban areas, the following conditions shall be considered.

(1) Layout new municipality offices at each new urban area

To strengthen local administration of each municipality, new municipality offices with disaster-resistance structure shall be established in each new urban area.

(2) Conservation of water course and the buffer area

For the maintenance of irrigation network to surrounding agricultural activities, existing rivers flowing through the new urban area shall be conserved with buffer green area.

(3) Arrangement of large-scale green parks

For the creation of comfortable urban environment and safe evacuation space, large-scale green parks shall be laid out in the manner of covering the new urban area by a service range of 500m. In addition, pedestrian network will be laid out to connect between the green parks, center areas and the surrounding residential areas.

(4) Arrangement of commercial and business areas, and high-density residential areas along main road

Aiming at the high-traffic capacity of main roads and effective utilization of the development potential of the road side areas, commercial and business areas, and high-density residential areas shall be laid out along main roads such as arterial roads and sub-arterial roads.

(5) Adoption of TOD concept with AGT and BRT

Aiming at enhancement of development potential in the station surrounding areas of public transport, and increase in number of public transport users for urban development areas, integrated urban development with public transport system based on TOD concept shall be adopted for new urban areas. This adoption is expected for new urban centers of KV and governmental sub-center areas which have plans of new public transport system such as AGT and BRT.

8.1.3.3 Proposed Land Use Plan of New Urban Areas

(1) New Urban Center of KV

For the new urban center of KV, the concept, major functions and the land use plan are proposed as follows:

1) Concept

Concept of New Urban Center of KV is proposed as ‘Primary sub-center with new CBD and tourism site’. The concept aims that this area becomes a new urban core of KV and Nepal to strengthen its international competitiveness in terms of commercial, business and tourism. In addition, it also aims to create business opportunities, comfortable urban living spaces and amusement for citizens in KV.

2) Major Functions

According to the concept, the major urban functions are proposed as follows:

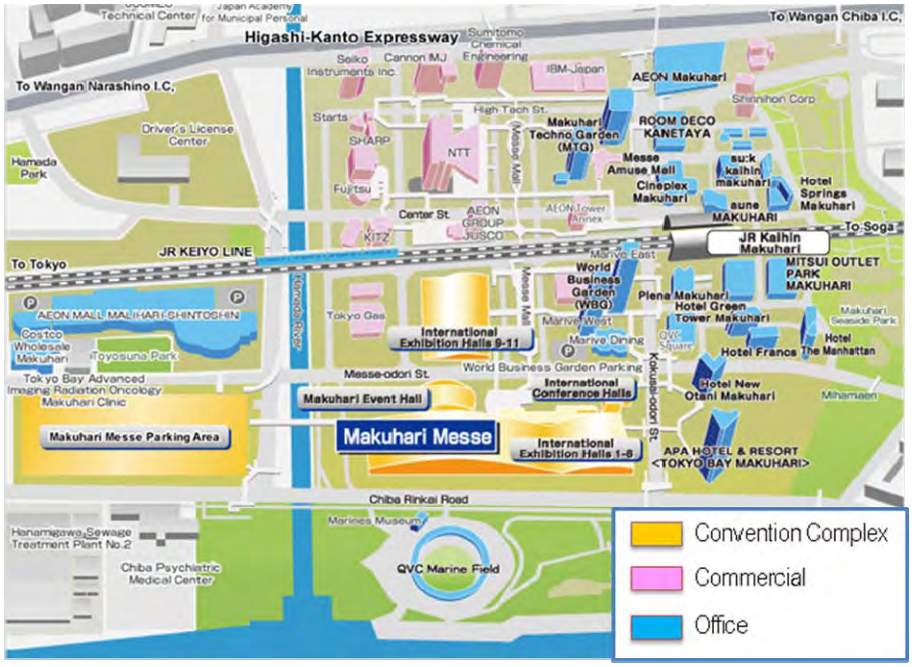
- National and local government offices
- Commercial and business complex
- National convention center
- National museum
- National stadium
- Accommodation for foreign visitors and tourists
- Amusement areas
- Large-scale green parks
- New residential areas
- New public transport (AGT) connecting with international airport and city center

- Intermodal facilities for AGT stations such as station plaza and parking

As an example, the major functions in Makuhari New Urban Center in Japan is shown as follows:

Makuhari New City is located in the Chiba city and is 35 km away from Tokyo. It has a total development area of 522 hectares, and balances the four vital functions of working, living, learning, and playing. It has become a city in which more than 26,000 people live, and where some 150,000 work. There are multiple functions such as international convention center, business & research zone, residential areas, academic zone, commercial area and stadium. Leading-edge systems will be provided to the area, including area cooling and heating, an aerial waste conveyance system, an underground electricity and urban railway system.

Makuhari Messe is a Japanese convention center which is the land mark for Makuhari New Urban Area and one of Japan's most spacious event venues. It was established in 1989 and has hosted many world-class technology events.



Source: Makuhari Messe

Figure 8.1.9 Examples of New Urban Center of KV (Makuhari New Urban Center, Japan)

3) Proposed Land Use Plan

New urban center of KV consists of two urban areas of East New Urban Area I and II. Based on the concept and the major urban functions, land use plans of two new urban areas are proposed as follows:

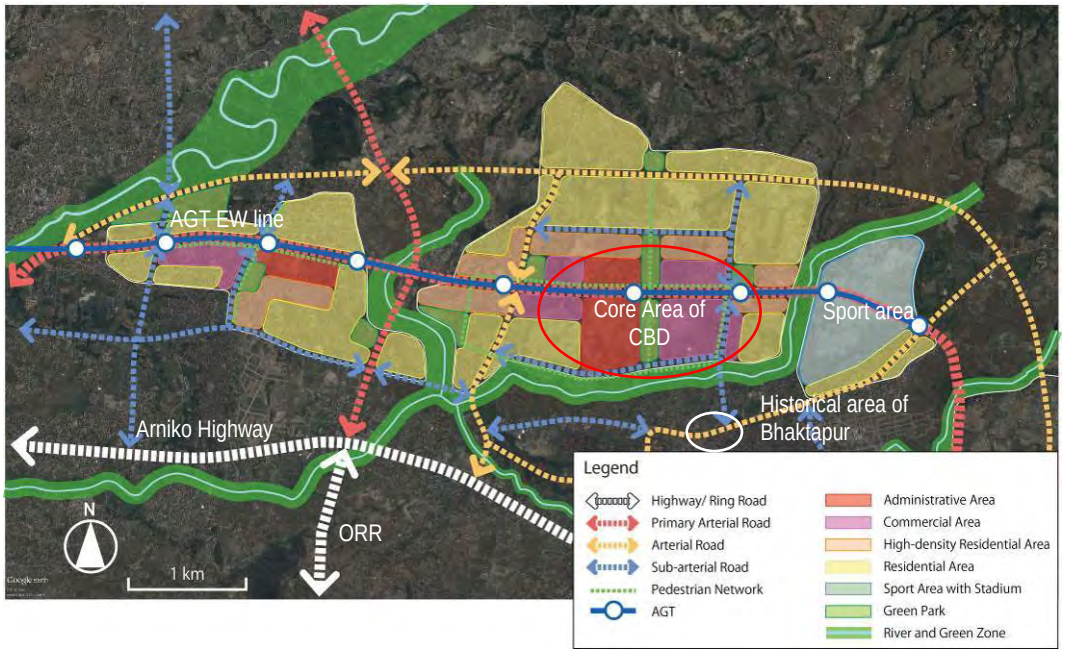
a) East New Urban Area I

East new urban area I has a total area of approximately 800 hectares and the planned living population of 180,000 people. AGT line connecting to existing city center of KV passes from east to west in the central portion of the new urban area.

The layout of two major functions of the core area of CBD and sports area follows the TOD concept. These two functions must be the main destination of AGT users. The core area of CBD is laid out at the mid-eastern area near to the historical area of Bhaktapur, and has multiple functions such as administration, commercial and business, national convention center, museum and accommodation. Sporting area including national stadium is laid out at the terminal station of AGT.

Regarding residential area, high-density residential areas with the gross density of 600 population per hectare are laid out at the high development potential area along AGT line and major roads. Other residential areas are planned as low-density areas with maximum five stories buildings.

For the conservation of the natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks are laid out to cover whole urban area by the service rage of 500m, and are connected to other major function by pedestrian networks.



Source: JST

Figure 8.1.10 Proposed Land Use Plan of East New Urban Area I

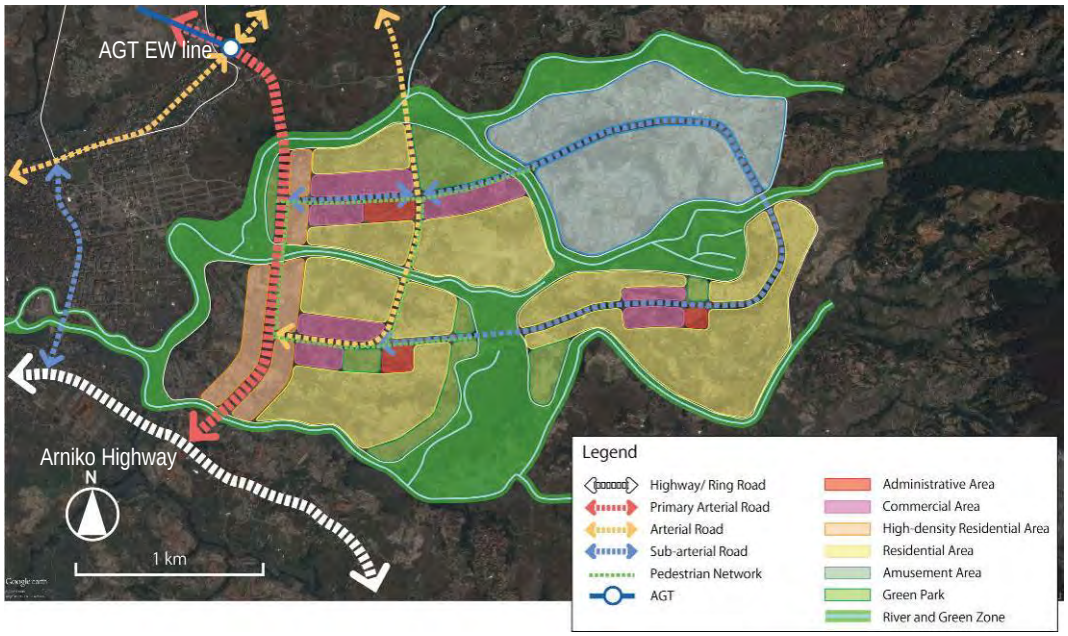
b) East New Urban Area II

East new urban area II has a total area of approximately 500 hectares and the planned living population of 100,000 people. This area is divided into four zones by the existing river.

As the main function, amusement area is laid out at the north-east zone. It has botanical garden, open-air theatre and entertainment facility to attract citizens and tourists. The other zones are planned as residential areas with municipality offices, commercial and business area.

Regarding residential area, high-density residential areas with the gross density of 600 population per hectare are laid out along primary arterial roads. Other residential areas are planned as low-density areas with maximum five stories buildings.

For the conservation of the natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks area laid out to cover whole urban area by the service rage of 500m, and are connected to other major functions by pedestrian networks.



Source: JST

Figure 8.1.11 Proposed Land Use Plan of East New Urban Area II

(2) Governmental Sub-center Area

For the governmental sub-center area, the concept, major functions and the land use plans are proposed as follows:

1) Concept

Concept of governmental sub-center area is proposed as 'New Administrative Area for Securing Administrative Functions in time of Disaster'. The concept aims to enhance the redundancy of administrative function, and relocate existing administrative function in city center of KV which relate to disaster counter measure, urban management and public services.

2) Major Functions

According to the concept, the major urban functions are proposed as follows:

- Government offices relating to disaster countermeasure (NRRC, NSC, etc.)
- Government offices relating to urban management (KVDA, DUDBC, etc.)
- Public service offices (Police office, fire department, information center etc.)
- Large-scale green parks
- New residential area
- New public transport (BRT) connecting to city center

- Intermodal facilities for BRT stations

  As an example, Putrajaya in Malaysia and Saitama New Urban Center in Japan are introduced as follows:

a) Putrajaya Sub Administrative Center in Malaysia

Putrajaya is a planned city located 25 km south of Kuala Lumpur, the capital of Malaysia. The area is approximately 4,900 hectares and its population is 68,000 people. This city was developed as the federal administrative center of Malaysia in 1999. Then the government functions were relocated from Kuala Lumpur to Putrajaya. As of 2012 most of Malaysia's governmental ministries had relocated to Putrajaya.

Source: Wikipedia, Google map

Figure 8.1.12 Example of Governmental Sub-center Area (Putrajaya in Malaysia)

b) Saitama New Urban Center in Japan

Saitama New Urban Center is a business district which is located in Saitama city in Japan. It is 35 km from Tokyo and the area measures 47 hectares and the planned population is 57,000. This new urban center was developed to decentralize Japanese government functions from city center of Tokyo. The major function consists of ministerial office complex, stadium, JR station, hotels, private companies' offices and commercial complex.

Source: Wikipedia, Google map

Figure 8.1.13 Example of Governmental Sub-center Area (Saitama New Urban Center)

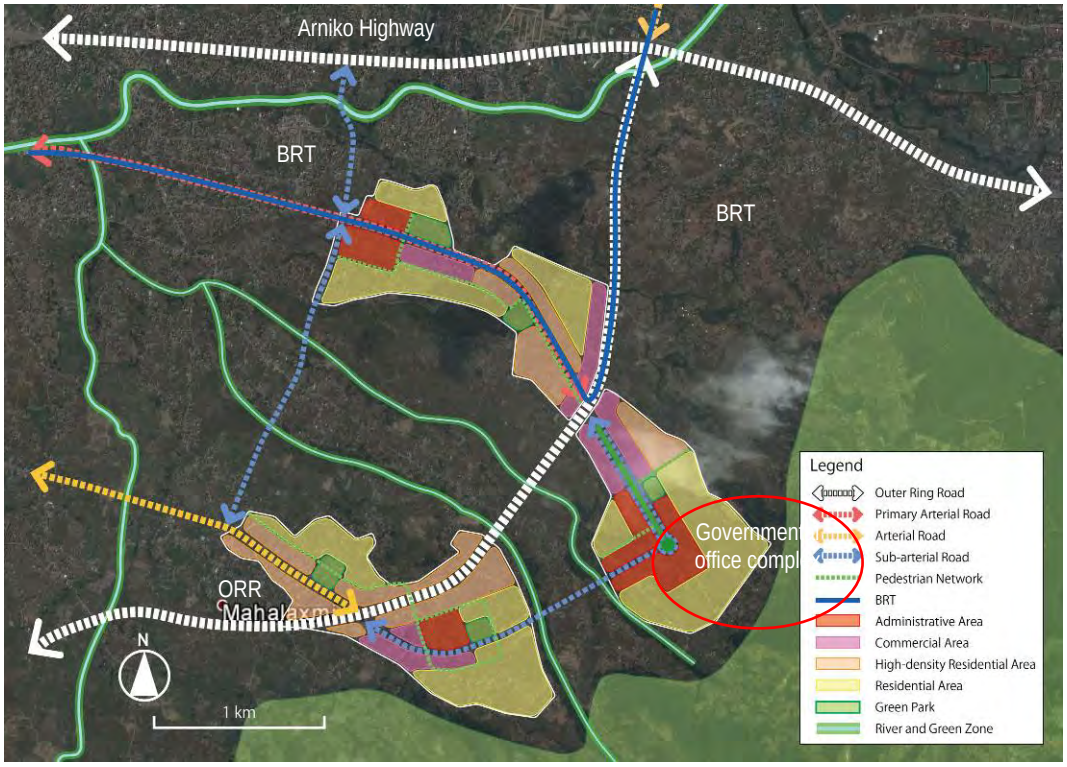
3) Proposed Land Use Plan

South-east new urban area has a total area of approximately 350 hectares and the planned living population of 60,000 people. BRT line connecting to existing city center of KV passes through the northern area of the new urban area.

As the main function, governmental office complex is laid out at the south-east zone. It has governmental offices relating to disaster management, urban management and public services aimed at enhancing the redundancy of administrative function of KV. In addition, a symbolic road with green space connect between the governmental office complex and BRT station on Outer Ring Road to create a city scape in the new governmental area.

Regarding residential areas, high-density residential areas with the gross density of 600 population per hectare are laid out at the high development potential areas along Outer Ring Road and major roads. Other residential areas are planned as low-density areas with maximum five stories buildings.

For the conservation of natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks area laid out to cover the whole urban area by the service rage of 500m, and are connected to other major functions by pedestrian networks.



Source: JST

Figure 8.1.14 Proposed Land Use Plan of South-east New Urban Area (Governmental Sub-center Area)

(3) Agricultural R&D Area

For the south new urban area as agricultural R&D area, the concept, major functions and the land use plan are proposed as follows:

1) Concept

Concept of south new urban area is proposed as 'R&D center for agricultural industry and nature-friendly living'. The concept aims to support agricultural industry of KV and Nepal to improve the capability and profitability. This improvement will motivate agricultural activity and effect preservation of existing agricultural lands in terms of land use control. In addition, it also aims to promote new living style and nature resort for citizens and foreigners.

2) Major Functions

According to the concept, the major urban functions are proposed as follows:

- Agricultural R&D Center:
- Agriculture laboratory to develop new valuable product (Medicine, health food, etc.)
- Agricultural mechanization promotion center
- Agriculture training center to improve breeding and market distribution
- Botanical garden
- New residential area for researchers and workers
- Nature-friendly residences with farm lands
- Nature resort for foreign tourists

Source: Wikipedia

Figure 8.1.15 Example of Major Function of Agricultural R&D Area

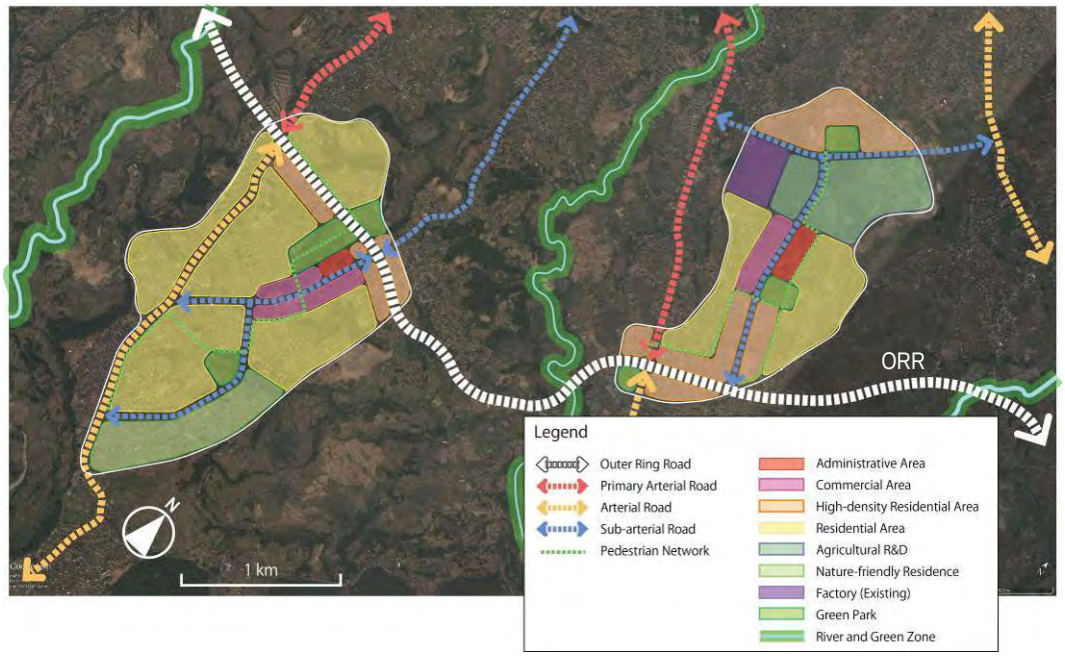
3) Proposed Land Use Plan

South new urban area has a total area of approximately 400 hectares and the planned living population of 80,000 people.

As the main function, an agricultural R&D area is laid out at the north-east. It has laboratories, promotion center and training center.

Regarding residential areas, high-density residential areas with the gross density of 600 population per hectare are laid out at the high development potential areas along Outer Ring Road and major roads. Other residential areas are planned as low-density areas with maximum five stories buildings. In addition, nature-friendly residential areas with detached houses and private farm lands laid out at the south area with hilly topography.

For the conservation of the natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks area laid out to cover whole urban area by the service rage of 500m, and are connected to other major function by pedestrian networks.



Source: JST

Figure 8.1.16 Proposed Land Use Plan of South New Urban Area (Agricultural R&D Area)

(4) New Industry and Logistic Area

New industry and logistic area consists of two urban areas of South-west New Urban Area and West New Urban Area. The concept, major functions and the land use plans are proposed as follows:

1) Concept

a) South-west New Urban Area

Concept of west new urban area is proposed as 'Industry-university Collaboration Zone'. The concept aims to develop and improve secondary-industry collaboration with public authority, university, and private companies.

b) West New Urban Area

Concept of south-west new urban area is proposed as 'Agro-industrial zone with logistic hub center'. The concept aims to improve agricultural industry of KV in terms of producing valuable agricultural food and the logistics of the materials and products. It will promote the sustainable economic growth of KV and Nepal and reduced dependency on food imports.

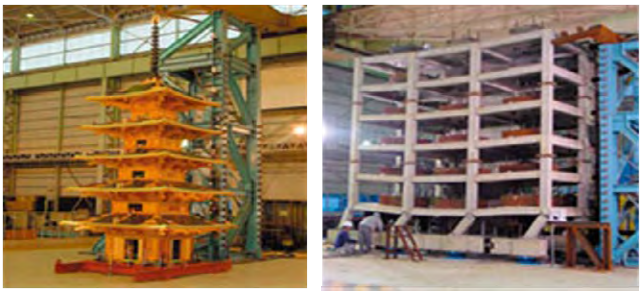
2) Major Functions

According to the concept, the major urban functions are proposed as follows:

a) South-west New Urban Area

- New Campus of Tribhuvan University
- R&D centers for collaboration:
- University – private company
- University – foreign university (disaster management, medicine, etc.)
- University - venture company
- Private factory
- New residential area for workers
- Dormitory for students

R&D Center (Laboratory for earthquake resistance test)



Source: Wikipedia

Figure 8.1.17 Example of Major Function of South-west New Urban Area

b) West New Urban Area

- Agro-industrial Factories
- Logistic center
- Warehouse
- Residential area for workers

Source: Wikipedia

Figure 8.1.18 Example of Major Function of West New Urban Area

3) Proposed Land Use Plan

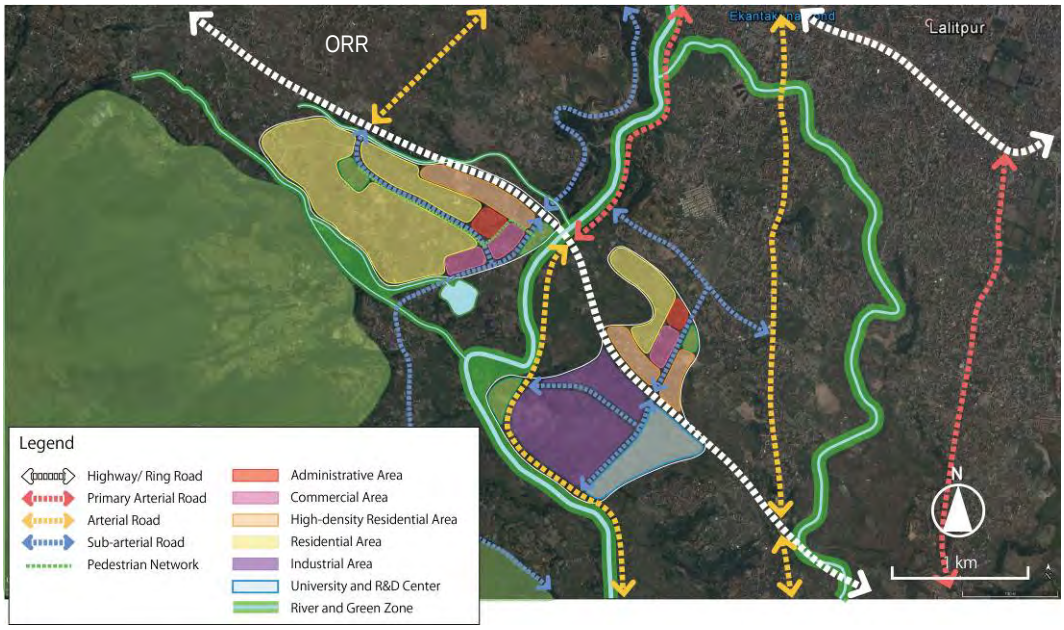
a) South-west New Urban Area

South-west new urban area has a total area of approximately 300 hectares and the planned living population of 50,000 people.

As the main function, a university and R&D center and agro-industrial area are laid out at the southern area in consideration of the separation with residential area.

Regarding residential area, high-density residential areas with the gross density of 600 population per hectare laid out at the high development potential area along Outer Ring Road and major roads. Other residential areas are planned as low-density areas with maximum five stories buildings. They include dormitories for workers and students.

For the conservation of the natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks area laid out to cover whole urban area by the service rage of 500m, and are connected to other major function by pedestrian networks.



Source: JST

Figure 8.1.19 Proposed Land Use Plan of South-west New Urban Area

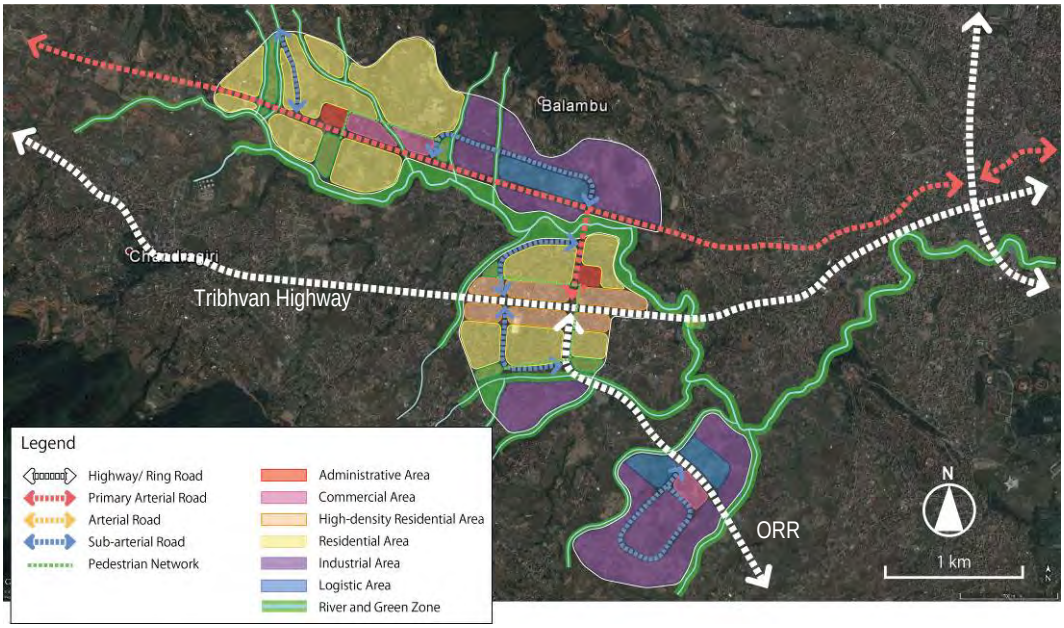
b) West New Urban Area

West new urban area has a total area of approximately 300 hectares and the planned living population of 50,000 people.

As the main function, industrial and logistic areas are laid out in consideration of the accessibility to Outer ring road and primary arterial road and the separation with residential areas.

Regarding residential area, high-density residential areas with the gross density of 600 population per hectare are laid out at the high development potential areas along Outer Ring Road and major roads. Other residential areas are planned as low-density areas with maximum five stories buildings.

For the conservation of the natural environment, existing river side is planned as green area. In addition, large-scale green parks with an area of 2 to 4 hectares are planned for urban amenity and evacuation space. These parks area laid out to cover whole urban area by the service rage of 500m, and are connected to other major functions by pedestrian networks.



Source: JST

Figure 8.1.20 Proposed Land Use Plan of West New Urban Area

8.2 Road Plan

8.2.1 Basic Policy for Road Plan

Based on the issues on traffic condition described in 5.5, basic policy for the road plan is formulated as follows:

(1) Coordination with Urban Land Use Plan

In order to compose a efficient transport network, distribution of network in conformity with land use structure is essential. The density of roads is closely related to land use and smooth connectivity of major trip generation area and trip attraction area is necessary for efficient network.

(2) Improvement of Network System

Present road network system is basically radial network except for the Ring Road. Conversion to radial-circumferential system from radial system is required to avoid traffic concentration into the city center. To this end, development of Inner Ring Road and is crucial. Detailed explanation is done in the next section.

(3) Strengthening of Road Capacity

The road capacity of almost all of the arterial roads in the existing road network is going to be saturated by 2030 as indicated in Chapter 5 and the road network must be strengthened based on the comprehensive transport master plan.

(4) Improvement of Bottle-neck

Current traffic congestion is caused by the existence of bottle-necks as well as lack of road capacity. Improvement of bottle-necks such as intersections, river crossings and narrow road section will contribute to the alleviation of traffic in short term.

(5) Road Network in Coordination with Public Transport

Since the improvement of road network alone cannot cope with the worsening traffic condition in Kathmandu Valley, development of public transport network is necessary. Formulation of road network system should take into account the coordination with the public transport system.

(6) Provision of Appropriate Road Facilities

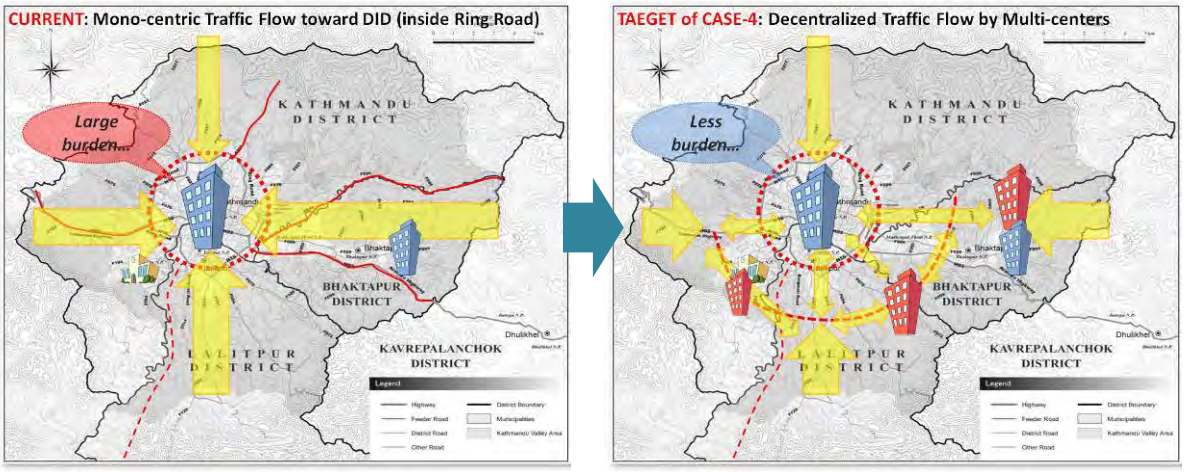
Road space is not only for the vehicles but also for pedestrians and bus passengers. Therefore facilities for the convenience and safety of road users should be furnished, namely pedestrian ways, pedestrian crossings, signals and bus bays.

8.2.2 Road Network System

The present traffic demand in the valley is concentrated in the city center inside the Ring Road. The concentration is caused by the current urban structure which contains all of the urban functions such as government, business and commerce, school, social security and medical facilities in the city center. This mono-centric and over-concentrated urban structure should be reformed for the future traffic demand by distributing the urban functions to the proposed sub-centers outside the Ring Road.

As mentioned in Chapter 5, the current traffic flow in the valley is mono-centric between the suburban area outside the Ring Road and the CBD area inside the Ring Road, and the traffic demand is over-concentrated to CBD area. Since further road development such as new construction inside the densely built-up CBD area will be quite difficult, the current traffic flow shall be changed to accommodate the future traffic demand in the valley.

The overall concept of the future traffic flow is shown in Figure 8.2.1 which is to change the current mono-centric traffic flow to the decentralized traffic flow by diverting the traffic demand to the newly proposed sub-centers.



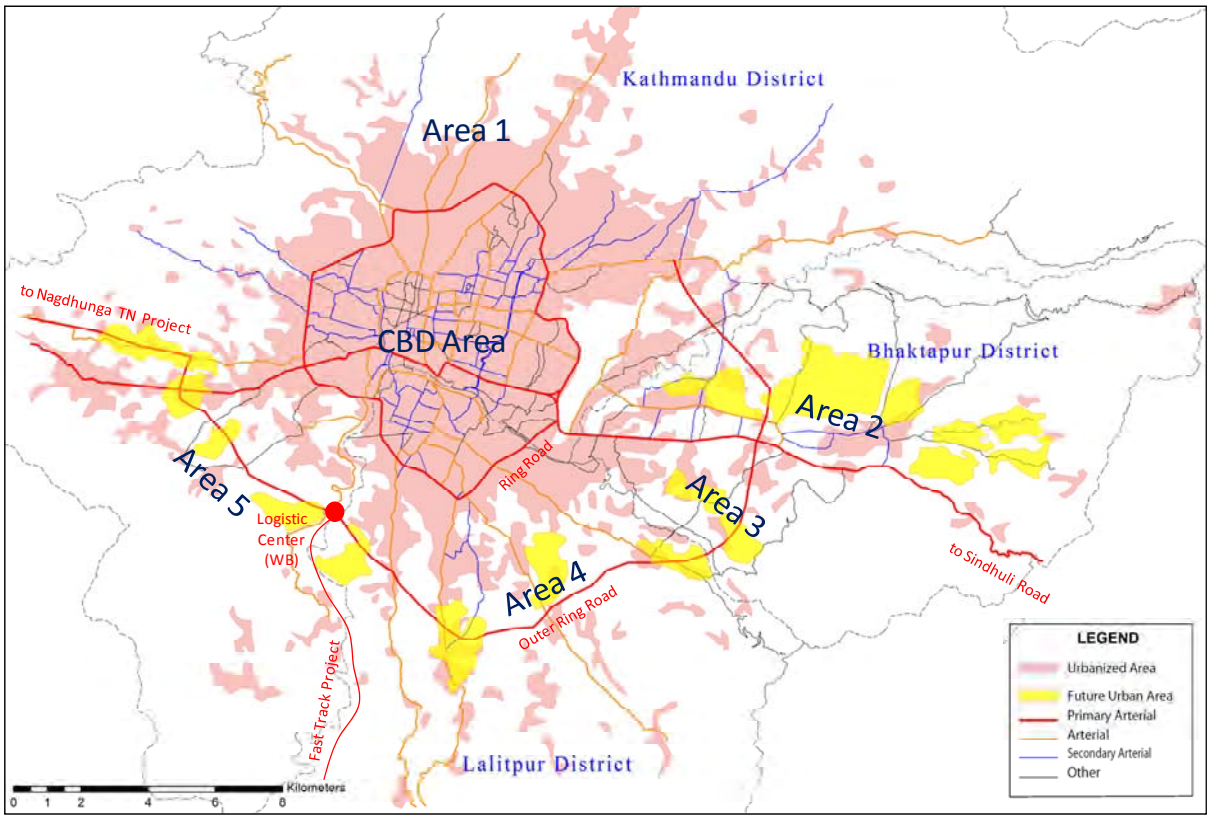
Source: JST

Figure 8.2.1 Concept of Traffic Pattern Modification

The location of the newly proposed sub-centers (future urban area) has been studied and determined as explained in 8.1, Chapter 8.

8.2.3 Road Layout Plan

Figure 8.2.2 presents the overall road development concept on the definitive urban structure agreed by Steering Committee of the MP.



Source: JST

Figure 8.2.2 Overall Road Development Concept on Definitive Urban Structure

1) CBD Area

Traffic congestion is currently observed along major existing arterial roads and most existing roads will be soon saturated if there is no change in the current mono-centric traffic flow towards CBD area. However new construction of roads will be quite difficult inside the densely built-up area and the following measures have been considered in the road network planning:

- Acceleration of modal shift to public transport
- Continuation of on-going road widening program within the legally available land in accordance with the GLD (Guided Land Development)
- Enhancement of road capacity of the existing roads by limited road improvements such as additional lane at intersections, etc.
- Development of strategic emergency roads even inside the densely built-up area for the present risk of disaster

2) Area 1 (Northern area of Outer Ring Road)

Urbanization in this area has been recently implemented mainly by private developers especially along Thoka Road and Bansbari Road and further road development (new road construction and widening of roads) will be difficult as well as that in CBD area. New road network such as Outer Ring Road in this area will induce further uncontrolled urbanization and accelerate the current mono-centric traffic flow toward CBD. The following limited measures have been considered in the road network planning:

- Acceleration of modal shift to public transport
- Maintain the current road network to restrict further urbanization
- Implementation of limited additional network such as emergency roads for the present risk of disaster

3) Area 2 (New sub-center in Bhaktapur District)

There still remains large space available for future urbanization and the road network shall be planned strategically according to the land use plan for the proposed new urban structure. The large-scale new urban area is expected to be developed in this area and the following measures have been considered to support the new sub-center (secondary CBD):

- Construction of strategic road network (grid pattern) to support people's activities and amenity of the new sub-center
- New road network to be functioned as emergency roads in case of disaster
- Synchronization with the proposed public transport system by TOD policy

4) Area 3 (New sub-center in Ananthalingeshwor District)

There still remains large space available to develop new road network. This area will be strategically located between the current urban area inside the Ring Road and the proposed new sub-center in Bhaktapur. JST recommends GON to relocate a part of government function to this area. The following measures have been considered in road network planning:

- Early implementation of new road network connecting the current urban area with the proposed sub-center to accelerate the relocation of government function as a "pilot model"
- Development of new wider radial road between the proposed sub-center in Ananthalingeshwor District and the current CBD area and restriction of transversal vehicle movement in the southern area in order to prevent ad-hoc urban sprawl
- Connection of each proposed sub-center only by Outer Ring Road

5) Area 4 (New sub-centers along Existing Radial Roads)

New sub-centers have been proposed at the node points between the existing radial roads and the proposed Outer Ring Road.

The following measures have been considered in the road network planning:

- Widening of the radial roads to prevent ad-hoc urban sprawl and accelerate the compact development only in the sub-centers
- Connection of each proposed sub-center by Outer Ring Road

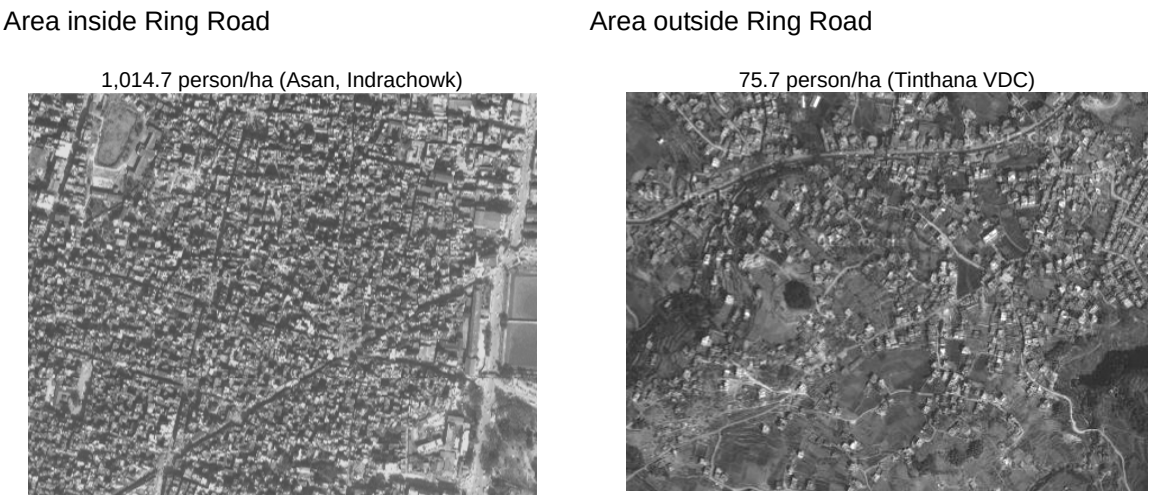
6) Area 5 (New sub-centers in Kirtipur)

New sub-centers will be located around the national logistic route such as Tribhuvan Highway and the proposed Fast Track.

The following measures have been considered in the road network planning:

- Limited road network to prevent ad-hoc urban sprawl and accelerate the compact development only in the proposed sub-centers
- Strengthening of logistic distribution route for the valley
- Connection of each proposed sub-center by Outer Ring Road

The urban development patterns in the valley are typically categorized into 2 patterns such as the densely built-up area inside the Ring Road and the area outside the Ring Road which is being developed.

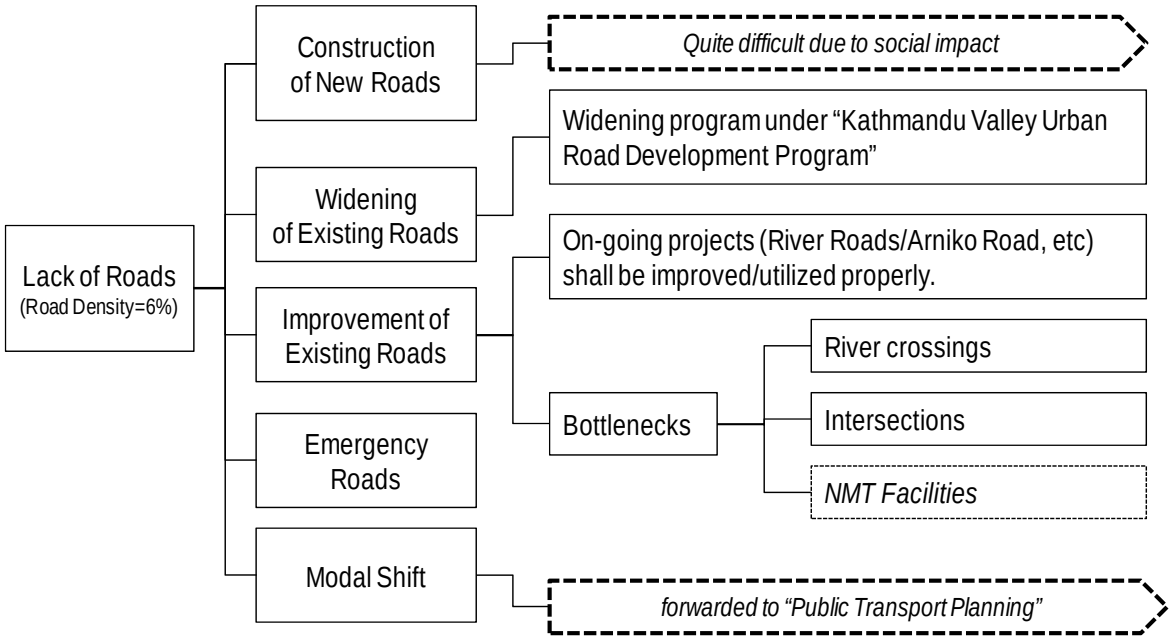


Source: KMC and Data Collection Survey (2012) by JICA

Figure 8.2.3 Typical Population Density in the Valley

8.2.3.1 Road Network inside Ring Road

The area inside the Ring Road has been densely built-up. The road density inside the Ring Road is only 6% (UNCRD/MOPIT) even after hard efforts of the recent road widening program by DOR/KVDA. The further road widening and/or construction of new roads will be practically difficult due to the issues related to land acquisition and resettlement and thus modal shift to public transportation must be incarnated. Figure 8.2.4 presents the concept of road network planning based on the discussions in the Working Group (WG-2 for Transport) officially organized during the Study.



Source: Working Group, GON and JST

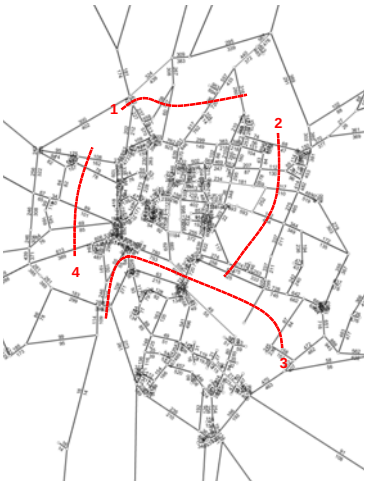
Figure 8.2.4 Planning Concept of Road Network inside Ring Road

(1) Widening of Existing Roads

The on-going road widening program, "Kathmandu Valley Urban Road Development Program, KVDA/DOR", shall be continued to strengthen the road network.

The target roads of the program will be determined corresponding to the demands and the Guided Land Development (GLD) Plan in 1989 stating the right of way for each road.

Figure 8.2.5 presents the required number of lanes by 2030 preliminarily estimated for a proposal of further road widening under the on-going program. It should be noted that some of on-going widening of roads are included in this list but the majorityof the roads are newly proposed to be widened to accommodate the future traffic demand. The road widening will need large-scale land acquisition and resettlement however the widening will be requisite for the future traffic demand and also for the emergency accessibility in case of disaster.



Cordon Line	Volume (2030) (pcu/day)	Lane Capacity (pcu/lane/day)	Required Number of Lanes (lanes)	Actual Number of Lanes (lanes)	Required Additional Number of Lanes (lanes)
	a	b (1100/9%)	c=a/b	d	c-d
1	339,600	12,222	28	19	9
2	299,800	12,222	25	20	5
3	356,300	12,222	30	24	6
4	177,200	12,222	15	12	3

Cordon Line 1: traffic movement to across the "North Axis" in the Ring Road

Cordon Line 2: traffic movement to across the "East Axis" in the Ring Road

Cordon Line 3: traffic movement to across the "South Axis (Bagmati River)" in the Ring Road

Cordon Line 4: traffic movement to across the "West Axis" in the Ring Road

Source: JST

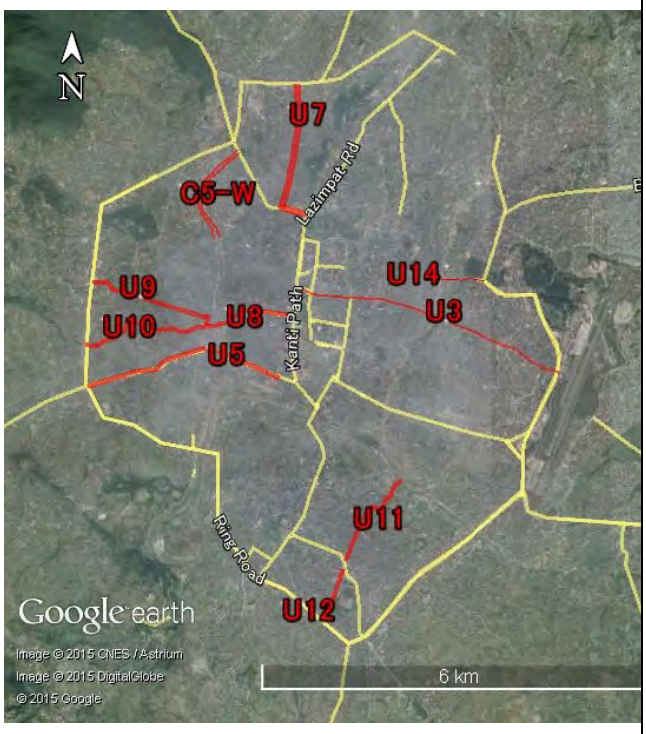
Figure 8.2.5 Preliminary Check of Required Number of Lanes at Designated Cordon Lines

The following road widening projects thus have been proposed for future road network in the traffic demand forecast process:

Table 8.2.1 Proposed Road Widening inside Ring Road

ID	Projects	Axis to be strengthen	Current Number of Lanes	Proposed Number of Lanes
U7	Widening of Samakhui Marg	North Axis	narrow 2-lane	4-lane
C5-W	Extension of Bishnumati River Road		-	4-lane
U14	Widening of Pashupati Road (Ratopul-Gaushala)	East Axis	4-lane	6-lane
U3	Widening of Dilli Bazaar Road (on-going)		narrow 2-lane	2-lane
U9	Widening of Museum Marg	West Axis	narrow 2-lane	4-lane
U8	Widening of Bhimsen-Ganga-New Road		narrow 2-lane	2-lane
U5	Widening of Tripureswor-Kalanki Road (on-going)		narrow 4-lane	4-lane
U10	Widening of Gyanodaya Marg-Tahachal Marg Road		narrow 2-lane	2-lane
U11	Widening of Shankhamulghat-Patan Road	South Axis	narrow 2-lane	4-lane
U12	Widening of Mahalaxmisthan Road		2-lane	4-lane
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads				

Source: JST



C5-W: Extension of Bishnumati River Road

U3: Widening of Dilli Bazaar Road (On-going)

U5: Widening of Tripureswor-Kalanki Road (On-going)

U7: Widening of Samakhui Marg

U8: Widening of Bhimsen-Ganga-New Road

U9: Widening of Museum Marg

U10: Widening of Gyanodaya Marg-Tahachal Marg Road

U11: Widening of Shankhamulghat-Patan Road

U12: Widening of Mahalaxmisthan Road

U14: Widening of Pashupati Road (Ratopul-Gaushala)

Source: JST

Figure 8.2.6 Location Map of Proposed Road Widening

(2) Improvement of Existing Roads

The road widening shall be strategically implemented according to the future traffic demand as mentioned above. Meanwhile, the capacity of each existing road shall be maximized to strengthen the overall road network.

Table 8.2.2 Issues and Improvement Measures on Existing Roads

Issues	Measures
Traffic accidents	1) Reduction of width of lanes to control the vehicle speed and create spaces for below measures
Congestion at intersections (conflict of traffic flow)	1) Provision of additional lane for "right-turn" 2) Prohibition of straight flow from service road (only allow "left-turn") 3) Installation of traffic signal 4) Construction of flyovers or underpasses
Congestion at bridges	1) Widening of bridges to eliminate the bottleneck 2) Construction of new bridges
Less traffic on service road	1) Reduction of width and number of lanes 2) Provision of openings at mounted dividers between service road and main line

Source: JST

1) Further Improvement for On-going Projects

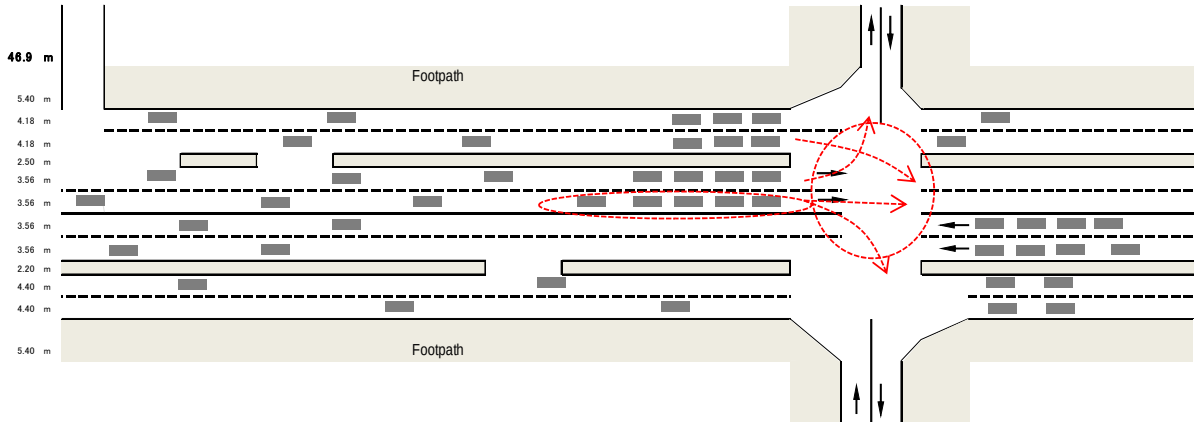
Several large-scale road projects such as improvement of Arniko Road and the construction of the riverside roads along Bishnumati River and Dhobi Kola are in progress while new construction of roads inside the Ring Road is quite difficult due to land constraint.

JST has proposed the following measures to make these on-going projects more efficient for future traffic demand in Working Group meetings.

- Arniko Road

There is room to improve the road capacity even within the current right of way (ROW) of Arniko Road. Arniko Road is the National Highway under the Strategic Road Network of DOR and the road widening has recently been implemented. The present lane configuration of Arniko Road is shown below based on the road inventory survey by JST. The traffic congestion at every major intersection is frequently observed mainly due to conflict of the traffic flow between the service road and the main lane as shown in the below figure (marked in red). The traffic volume of the service road is quite less than that of the main lane. The number of lanes (or width of carriageway) of the service road can be reduced according to properly estimated traffic volume.

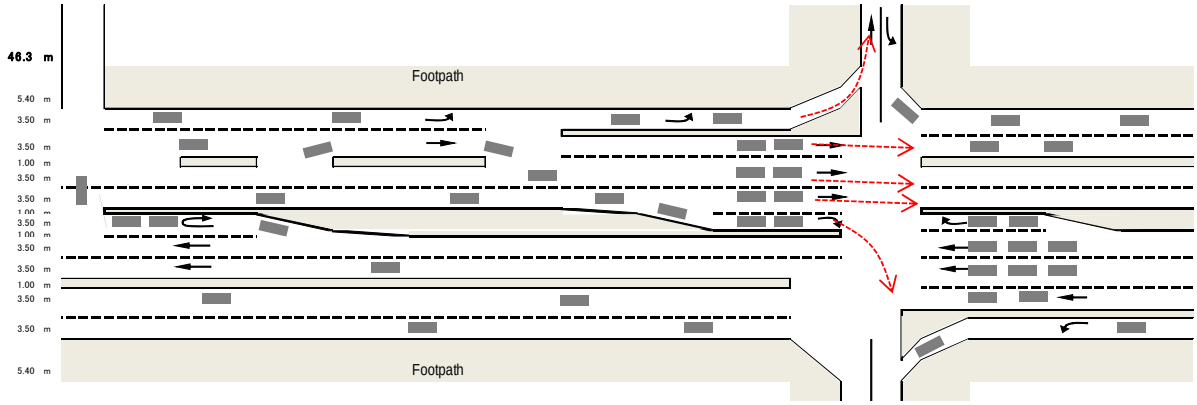
The above issues are also generally found on other major arterial roads in the valley and measures to be taken for Arniko Road could be applicable for other major arterial roads, too.



Source: JST

Figure 8.2.7 Present Lane Configuration of Arniko Road

The road capacity of Arniko Road and other arterial roads can be improved without additional land acquisition by implementing certain measures presented in Table 8.2.2 and Figure 8.2.8.



Source: JST

Figure 8.2.8 Proposed Lane Configuration of Arniko Road

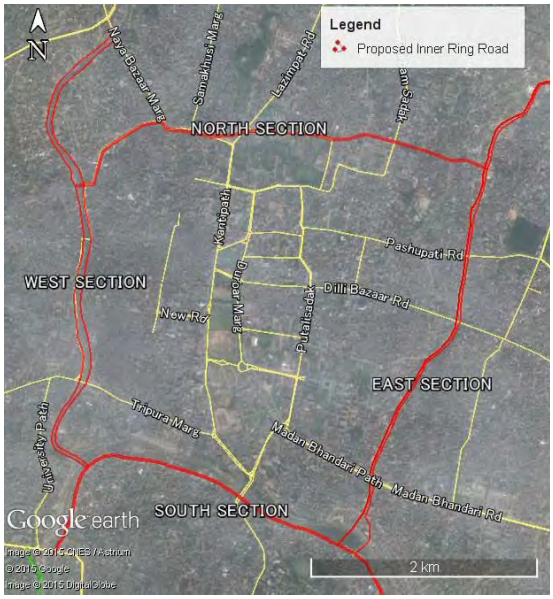
- Riverside Roads

Riverside road along Bishnumati River was widened by DOR under the support of ADB. DOR is also constructing the new roads along Dhobi Khola and Bagmati River. These riverside roads are part of the Inner Ring Road recommended in the previous transport master plans (JICA, 1993) which have a function as a core arterial road inside the existing Ring Road. It was planned to disperse the traffic in the central areas of the city to avoid excessive concentration as well as to reduce the traffic load on the existing arterial urban roads located inside the Ring Road. However there are missing links to complete the Inner Ring Road.

Due to recent excessive increase in traffic demand, the function of the Inner Ring Road became more vital than it was planned in 1993. The road network cannot bear the whole traffic demand especially inside the Ring Road and the traffic demand shall be shared with the public transport system such as BRT. The CBD area is surrounded by the alignment of the Inner Ring Road and walking access to the alignment is secured. Thus, introduction of the public transport system on the proposed Inner Ring Road will be valid.

The alignment of the Inner Ring Road basically traces along rivers except the north section. The north section is planned along the existing arterial roads which are proposed to be widened together with the construction of the Inner Ring Road. There is a missing connection of the arterial road at the connection point between the north section and the east section (Dhobi Khola).

In the technical working group for this MP, several alternative routes were discussed and the definitive alignment has been determined. It is recommended to conduct further study such as route design based on the topographic survey and hydraulic study of the rivers immediately after this MP. Figure 8.2.9 shows the proposed route of the Inner Ring Road.



(NORTH SECTION)
Length : 2.1km
Number of Lane : 4-lane
(+elevated 2-lane for public transport)

(EAST SECTION)
Length : 4.9km
Number of Lane : 2-lane

(SOUTH SECTION)
Length : 4.5km
Number of Lane : 4-lane

(WEST SECTION)
Length : 4.4km
Number of Lane : 4-lane

Source: JST

Figure 8.2.9 Proposed Inner Ring Road

The proposed improvement for the on-going projects is listed below.

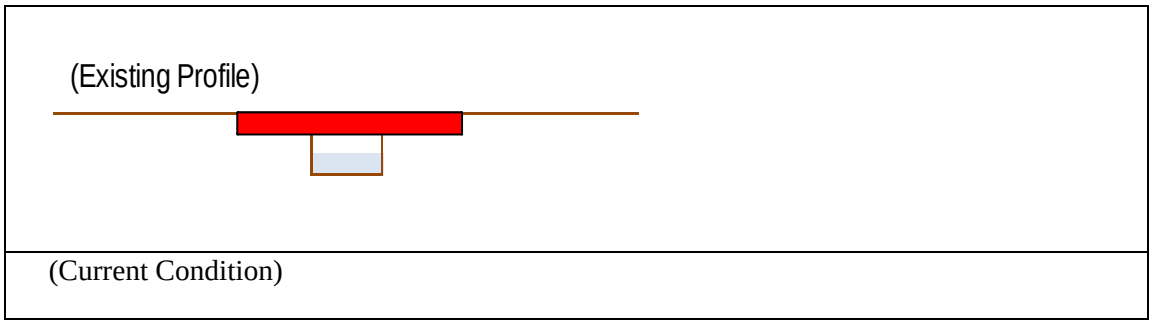
Table 8.2.3 Proposed Road Improvement of On-going Projects

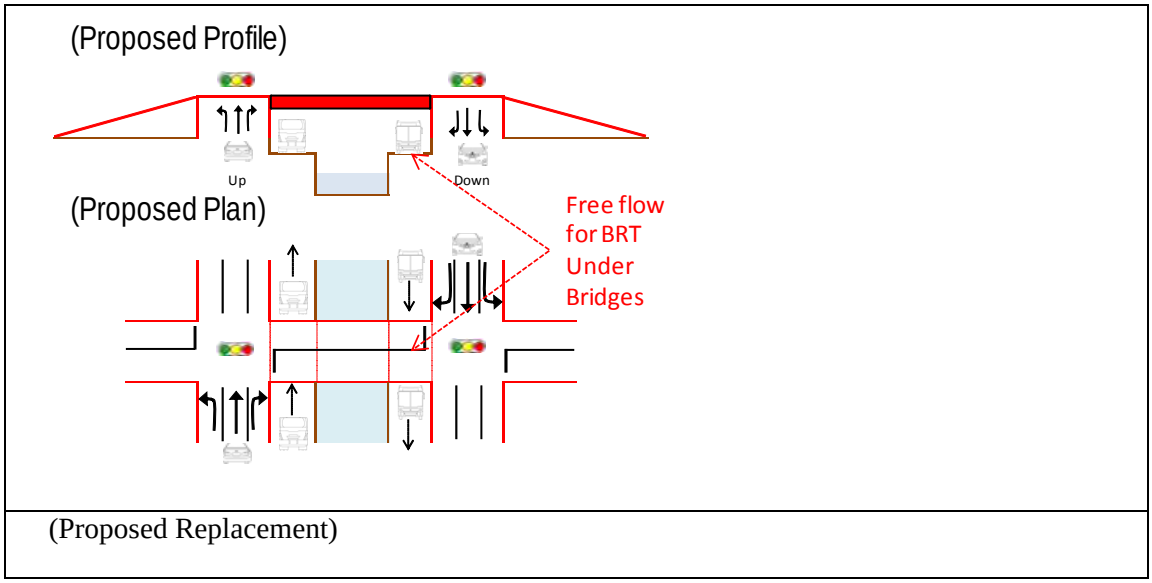
ID	Projects	Project Feature
U4	Upgrading of Arniko Road including New Baneswor Underpass Project	Lane re-configuration and construction of an underpass structure at New Baneswor Intersection
-	Road widening proposed in Table 8.2.2	Lane re-configuration
C5	Inner Ring Roads	Completion of the circular road without missing link
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads		

2) River Crossings

Traffic congestion is often found around bridges inside the Ring Road. The number of the required lanes on bridges has been examined through the cordon line analysis as presented in Figure 8.2.5 and the additional lanes/bridges are included in the proposed road improvement in Table 8.2.1, Figure 8.2.6 and Figure 8.2.9.

In addition to the above, the replacement of the existing bridges is proposed along the Inner Ring Road. The existing bridges along Bishnumati River and Dhobi Khola shall be renovated to allow free flow for the part of lanes of the riverside roads especially for the proposed public transport (bus network). The concept of the bridge replacement is presented below.





Source: JST

Figure 8.2.10 Proposed Replacement of Bridges along Inner Ring Road

Table 8.2.4 Proposed Bridges along Inner Ring Road

ID	Projects	Proposed Bridges
C5-W	Inner Ring Road (West Section)	Replacement of 3 bridges
C5-N	Inner Ring Road (North Section)	Construction of viaduct for BRT (L=around 2.1km)
C5-E	Inner Ring Road (East Section)	Replacement of 3 bridges New construction of 1 bridge
C5-S	Inner Ring Road (South Section)	New construction of 2 bridges
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads		

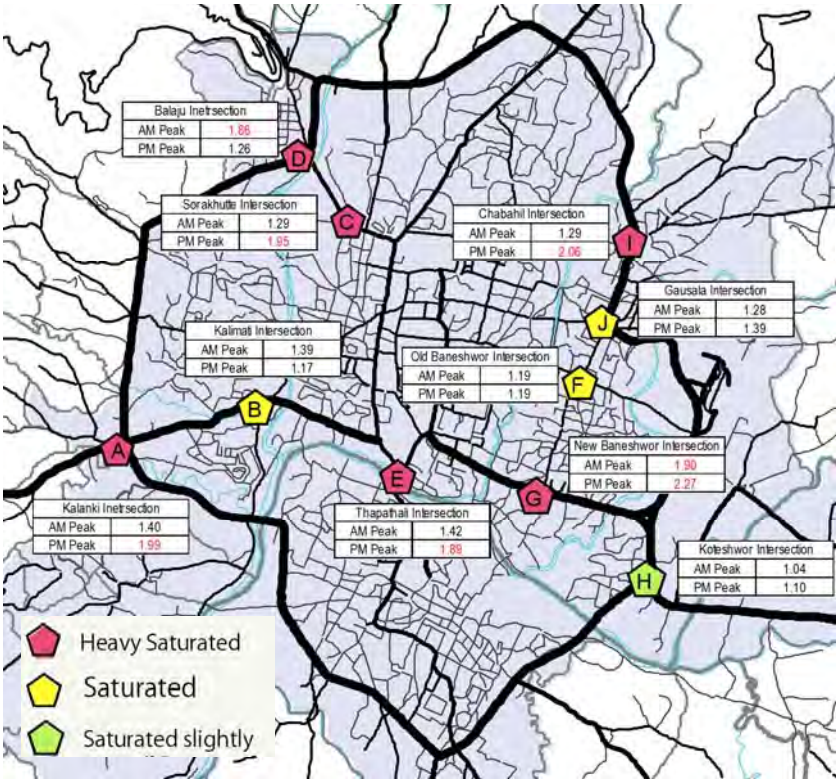
3) Intersections

ADB is conducting the Kathmandu Sustainable Urban Transport Project (KSUTP). The scope of works under KSUTP includes improvement of 27 congested intersections by re-configuration of the geometry of the intersections and installing traffic signal systems. These signals will be synchronized with each other by traffic control center installed by KSUTP. Figure 3.2.5 in Chapter 3 shows the location map of KSUTP. Immediate implementation of intersection improvement by KSUTP is expected to reduce the traffic congestion in the City as an urgent short-term program.

Regardless of improvement of the intersections by KSUTP, the capacity of some intersections will be saturated with future traffic demand.

Figure 8.2.11 shows the saturation ratio of the major intersections inside the Ring Road based on the traffic counting survey by JICA in 2012 and the traffic volume at all intersections are already beyond its capacity (>1.0) in peak hours.

Grade separated structures, such as flyovers and underpasses, will be required at these congested intersections as planned by DOR. (See Figure 3.2.1 in Chapter 3.)



Source: Data Collection Survey, JICA, 2012

Figure 8.2.11 Saturation Ratio of Intersections inside Ring Road

Among the above intersections, this MP proposes that the improvement of the intersections at Balaju, Chabahil and Gausala shall be implemented in parallel with the proposed construction of the northern half of the Ring Road as well as Kalanki underpass which is already included in the scope of the on-going construction works for the southern half of the Ring Road.

The improvement of Sorakhutte Intersection is proposed to be part of the proposed Inner Ring Road. A new flyover was once designed by DoR at Old Beneshwor but the project has not been implemented due to land constraint. Therefore, in this master plan too, the improvement of this intersection is proposed to be implemented after the long-term plan depending on the progress of the land acquisition. The below table summarizes the saturation ratio of the congested intersections in Figure 8.2.11 except the intersections along the Ring Road.

Table 8.2.5 Saturation Rate of Existing Bottleneck Intersections

Items		New Baneshwor	Thapathali	Sorakhutte	Old Baneshwor
Traffic Volume (vehicle/h)	AM Peak	7,902	6,984	4,791	2,850
	PM Peak	10,344	7,805	3,999	4,969
	Average	9,123	7,395	4,395	3,910
Saturation Rate	AM Peak	1.90	1.42	1.39	1.19
	PM Peak	2.27	1.89	1.17	1.19

Source: JST

The new public transportation system (AGT) proposed in this MP runs from the eastern suburb to the western suburb thorough the central area of the city. Some of the congested intersections in Figure 8.2.11 are located along the proposed route of AGT. The traffic volume on these intersections is expected to be largely shifted to the passenger volume of AGT. Therefore the saturation ratio of these intersections (at-graded) has been re-examined based on the estimated future traffic network including AGT. In this re-examination, the reconfiguration of the intersection such as additional lane(s) has been considered for the intersections which have space for road widening for additional lane(s). The saturation ratio of the intersections is shown in the below table.

Table 8.2.6 Saturation Rate of Improved At-graded Intersections

Items	Kalimati	Koteshwor
Peak Traffic Volume (pcu/h)	4,897	9,996
Saturation Rate at Peak Hour	0.84	0.97

Source: JST

Table 8.2.7 summarizes the proposed implementation schedule in this MP.

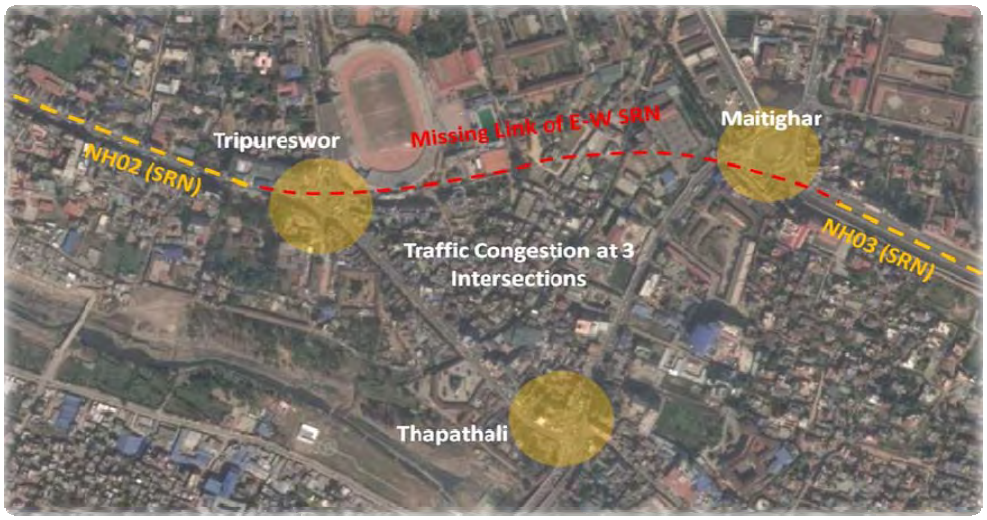
Table 8.2.7 Implementation of Grade-separated Structures

Terms of Implementation	Intersections	Saturation Rate	Remarks
Short -term	New Baneshwor	2.27	Serious traffic congestion is constantly observed and immediate measures will be required.
	Thapathali	1.89	
Mid to Long -term	Sorakhutte	1.39	Improvement works will be implemented under the scope of the Inner Ring Road.
after Long -term	Koteshwor	0.97	At-grade improvement could be proposed in parallel with the construction of new public transport system.
	Kalimati	0.84	
	Old Baneshwor	1.19	Large scale relocation will be required.
Others or On-going	Chabahil	2.06	Improvement of these intersections is proposed to be implemented under the Ring Road Construction Project.
	Kalanki (on-going)	1.99	
	Balaju	1.86	
	Gausala	1.39	

Source: JST

JST proposes to improve 2 intersections (New Baneshwor and Thapathali) as short-term program in this MP. The new public transportation system, AGT (with elevated structure), is proposed along Arniko Road across New Baneshwor Intersection. Therefore an underpass structure is proposed in this intersection. JST proposes an elevated structure to ease traffic congestion at Thapathali Intersection.

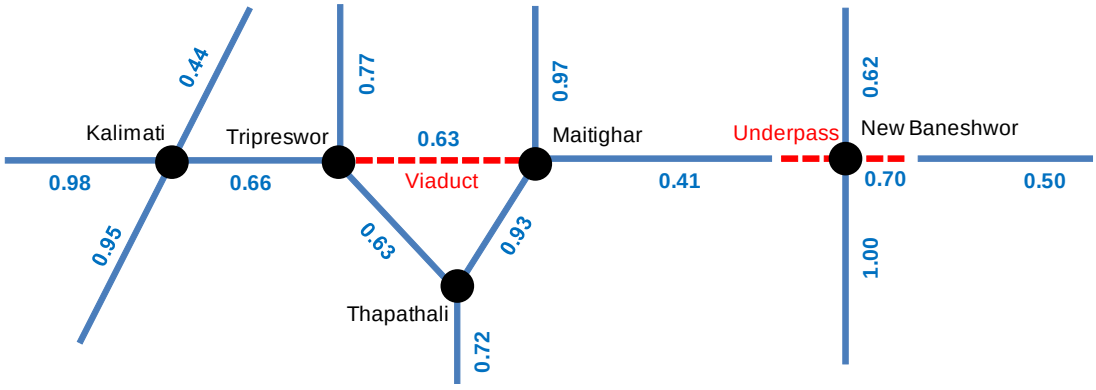
DOR proposed the elevated viaduct across Thapathali Intersection and Tripreswor Intersection as shown in Figure 3.2.1 in Chapter 3, however the proposed project has been suspended. It will be impractical to construct viaduct at Thapathali with very sharp curve and steep super elevation. JST proposes to construct the viaduct connecting Tripureswor and Maitighar. The alignment of the proposed viaduct is the current missing link of the east-west corridor of SRN (Strategic Road Network) through the city. The proposed viaduct is expected to ease traffic congestion at these intersections and Thapathali Intersection.



Source: JST

Figure 8.2.12 Road Network around Thapathali Intersection

Figure 8.2.13 shows the projected vehicle capacity ratio at major intersections in 2030. The ratio will be less than 1.0 after the construction of grade separated structures such as viaduct, underpass and also the improvement of public transport.



Source: JST

Figure 8.2.13 Projected Vehicle Capacity Ratio at Major Intersections in 2030

The list of the proposed grade separated structures is shown in Table 8.2.8.

Table 8.2.8 Proposed Grade Separated Structures

ID	Projects	Proposed Grade Separated Structures
C4	Ring Road (North Section)	Gausala Flyover, Chabahil Flyover, Maharajigunji Flyover, Baraju Flyover
U2	Tripureswor-Maitigar Viaduct	1.1 km long viaduct across 2 intersections easing the traffic congestion at Thapathali
U4	Upgrading of Arniko Road	900m long underpass at New Baneswor
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads		

8.2.3.2 Road Network outside Ring Road

The area outside the Ring Road has recently been developed mainly by private town developers without comprehensive road network planning by the central/regional government.

Photos below shows the urbanization and road development around Tinkne. Currently this area is already densely built-up with narrow road network and improvement of the road network such as new road construction and road widening is quite difficult. The area outside the Ring Road still has available land space to construct proper road network for the future traffic demand.

Satellite Photo in 1991 (SPIN, 1991)

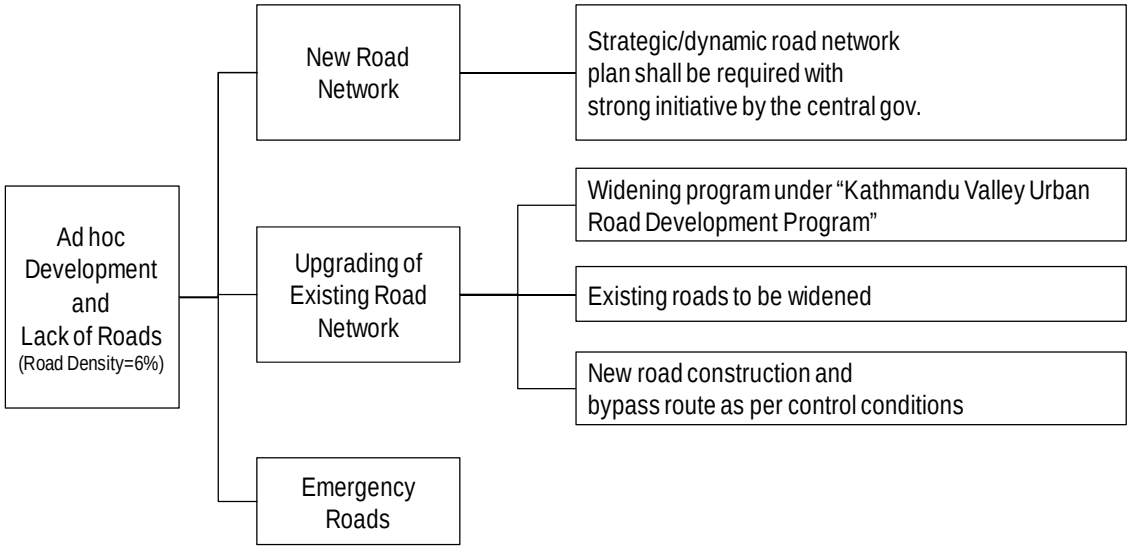
Satellite Image in 2000 (IKONOS, 2000)

Source: KVDA (SPIN, IKONOS)

Figure 8.2.14 Road Development around Tinkne (1991-2000)

The comprehensive road network shall be planned strategically based on the agreed urban structure and the traffic demand forecast.

Figure 8.2.15 presents the planning concept of the road network outside the Ring Road based on the discussions in the Working Group (WG-2 for Transport) officially organized during the Project.



Source: Working Group, GON and JST

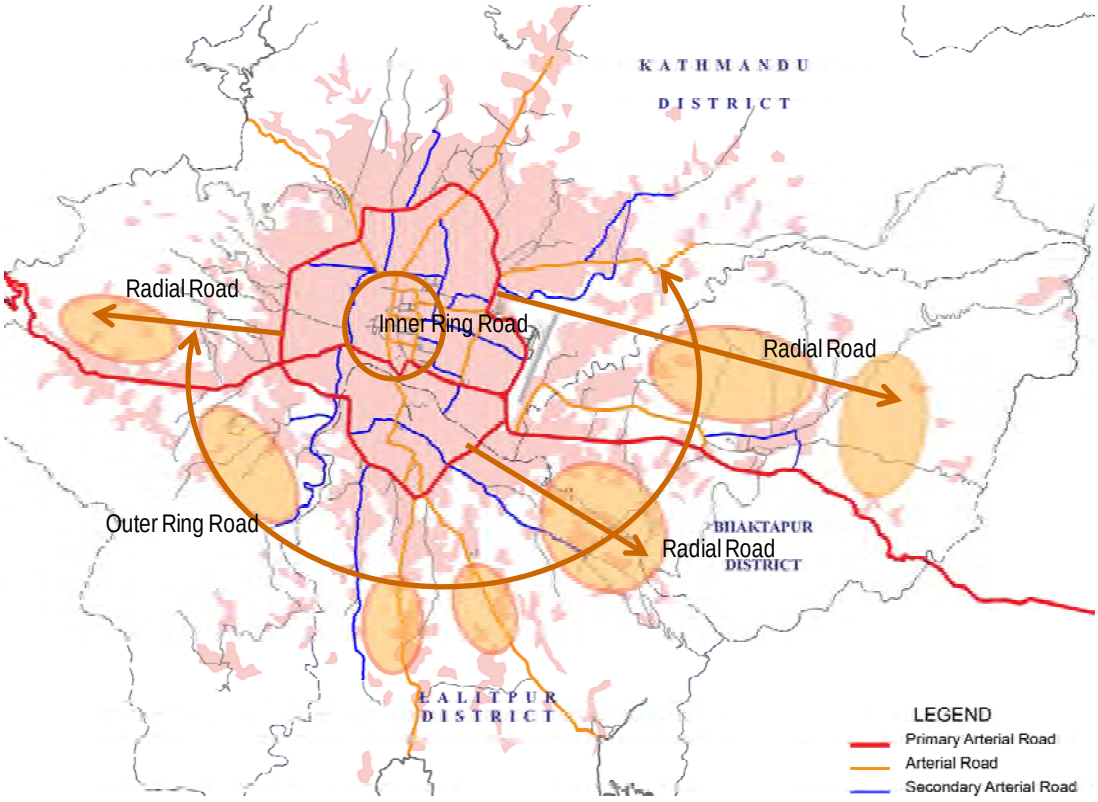
Figure 8.2.15 Planning Concept of Road Network outside Ring Road

(1) New Road Network

Based on the agreed future urban structure, overall development concept of the new road network has been prepared with the following concept:

- Development of transport network in coordination with land use

- Development of road connecting each proposed sub-center



Source: JST

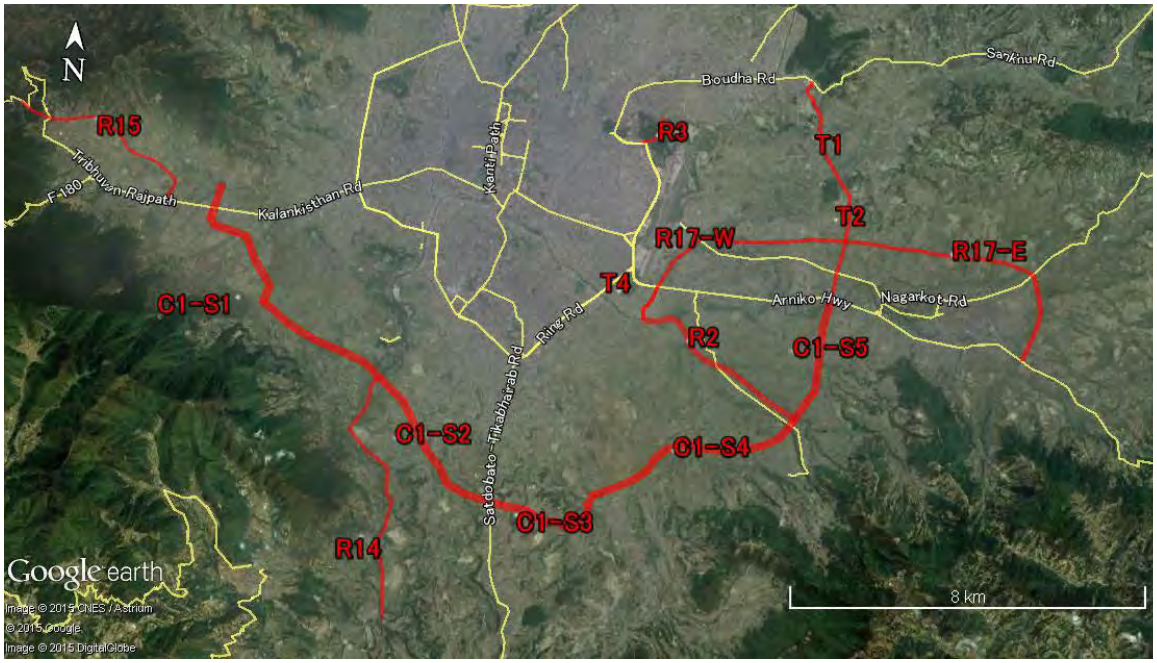
Figure 8.2.16 Overall Development Concept of Road Network

In order to realize the above development concept, the following new roads have been proposed.

Table 8.2.9 Proposed New Roads outside Ring Road

ID	Projects	Proposed Number of Lanes
C1-S1	Outer Ring Road (Section 1)	4-lane
C1-S2	Outer Ring Road (Section 2)	4-lane
C1-S3	Outer Ring Road (Section 3)	4-lane
C1-S4	Outer Ring Road (Section 4)	4-lane
C1-S5	Outer Ring Road (Section 5)	4-lane
C8-W	Bhaktapur Peripheral Road West Section	2-lane
R2	New Road for Anantalingeshwor Sub-center	4-lane
R3	Golf Course-Bagmati Link	4-lane
R14	Kathmandu-Hetauda Fast Track (on-going)	4-lane
R15	Nagdhunga Tunnel (on-going)	3-lane
R17-W	2nd Bhaktapur Road West Section	4-lane
R17-E	2nd Bhaktapur Road East Section	4-lane
T1	Thimi-Gokarna Road	4-lane
T2	Billigal-Thimi Road	2-lane
T4	Manohara-Imadol Road	4-lane

Source: JST

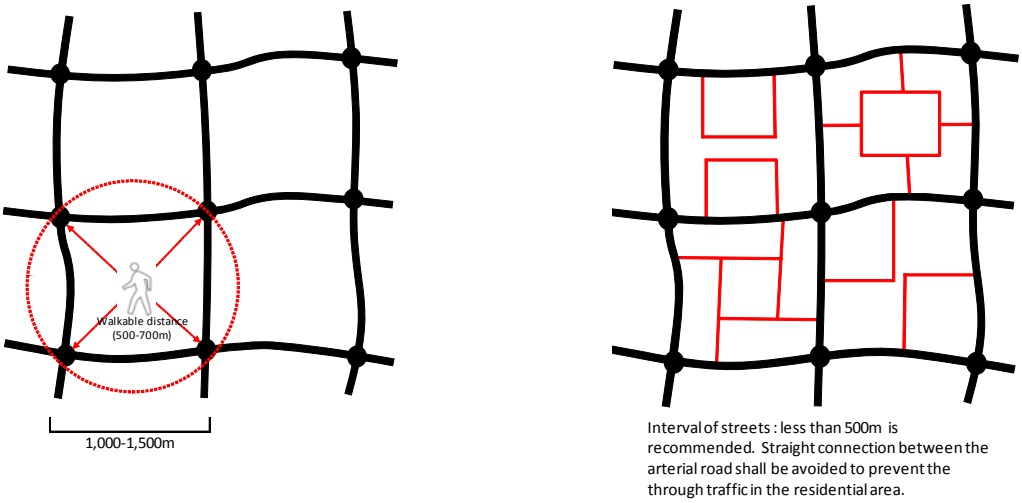


C1-S1 to C1-S5: Outer Ring Road (Section 1 to Section 5)
R2: New Road for Anantalingeshwor Sub-center
R3: Golf Course-Bagmati Link,
R14: Kathmandu-Hetauda Fast Track (on-going), R15: Nagdhunga Tunnel (on-going)
R17-W and R17-E: 2nd Bhaktapur Road (West Section and East Section)
T1: Thimi-Gokarna Road, T2: Billigal-Thimi Road, T4: Manohara-Imadol Road

Source: JST

Figure 8.2.17 Location Map of Proposed New Road outside Ring Road

In this MP, LRN network has not been proposed. DOLIDAR shall plan the supplemental road network inside the above proposed SRN network. However ad-hoc road network as indicated in Figure 8.2.14 shall be avoided and the new road network shall be properly designed in coordination with the urban development plan by KVDA. Figure 8.2.18 presents the suggested development concept of the LRN network.



(Concept of Arterial Roads (SRN/LRN) Network) (Concept of Collector Roads Network)

Source: JST

Figure 8.2.18 Layout Concept of New Road Network

(2) Upgrading of Existing Road Network

The on-going road widening program, "Kathmandu Valley Urban Road Development Program, KVDA/DOR", shall be continued to strengthen the road network outside the Ring Road corresponding to the demands and the Guided Land Development (GLD) Plan in 1989 stating the right of way for each road.

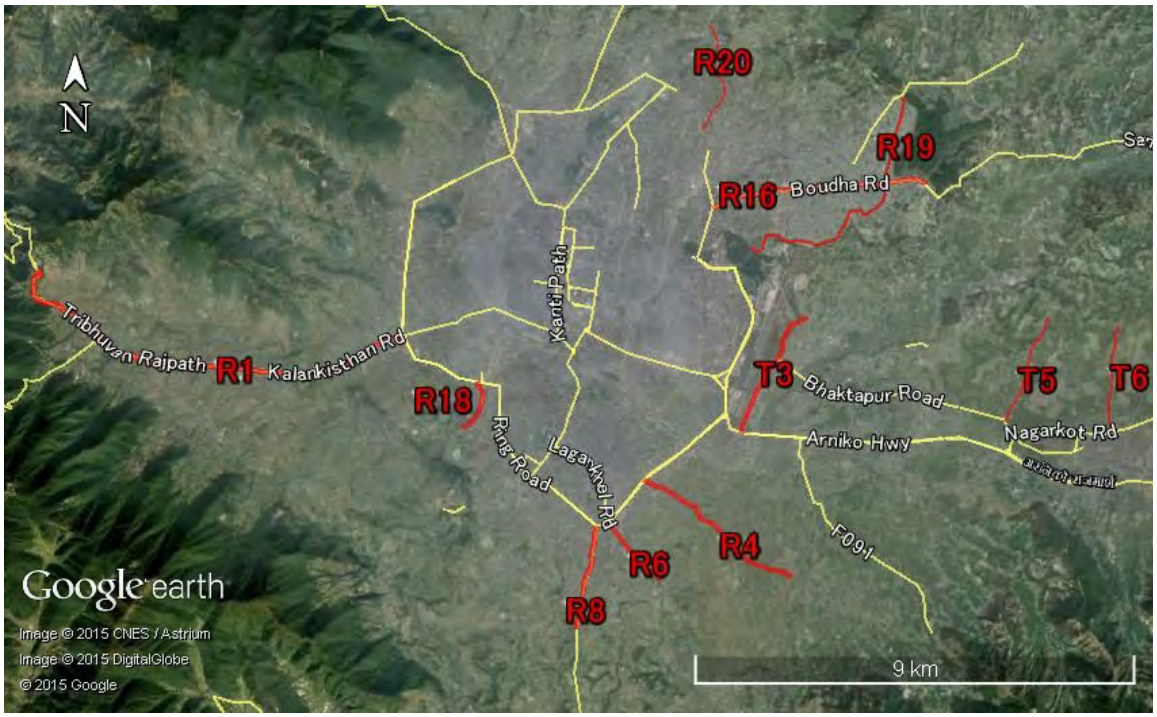
1) Widening of Existing Roads

Table 8.2.10 shows the road widening projects proposed in this MP including some of the on-going widening projects which are reflected in the traffic demand forecast model.

Table 8.2.10 Proposed Road Widening outside Ring Road

ID	Projects	Current Number of Lanes	Proposed Number of Lanes
R1	Widening of Kalanki-Nagdhunga Road (H02 : on-going)	2-lane	4-lane
R4	Widening of Lubhu Road (F072)	narrow 2-lane	2-lane
R6	Widening of Godawari Road (F024)	narrow 2-lane	2-lane
R8	Widening of Chapagaun Road (F023)	narrow 2-lane	2-lane
R16	Widening of Bodha Road (F026)	narrow 4-lane	4-lane
R18	Widening of Balkhu-TU Gate-Naya Bato Road	2-lane	4-lane
R19	Widening of Bagmati Rver Road Left Bank (on-going)	dart 2-lane	2-lane
R20	Widening of Dhumbarahi-Mandukhatar-Galfar Road (planed)	narrow 2-lane	2-lane
T3	Widening of Jadibuti-Pepsi-Manohara Road (on-going)	narrow 2-lane	2-lane
T5	Sallaghari-Duwakot Road	narrow 2-lane	2-lane
T6	Mandev Marg Road	narrow 2-lane	2-lane
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads			

Source: JST



R1: Widening of Kalanki-Nagdhunga Road (H02 : on-going), R4: Widening of Lubhu Road (F072), R6: Widening of Godawari Road (F024), R8: Widening of Chapagaun Road (F023), R16: Widening of Bodha Road (F026), R18: Widening of Balkhu-TU Gate-Naya Bato Road, R19: Widening of Bagmati Rver Road Left Bank (on-going), R20: Widening of Dhumbarahi-Mandukhatar-Galfar Road (planed), T3: Widening of Jadibuti-Pepsi-Manohara Road (on-going), T5: Sallaghari-Duwakot Road, T6: Mandev Marg Road

Source: JST

Figure 8.2.19 Location Map of Proposed Road Widening

2) Construction of New Roads for Upgrading of Existing Road Network

In parallel with the new SRN network and the road widening mentioned above, some of new roads are also proposed in this MP.

The radial road network such as Lubhu Road, Godawari Road and Chapagaun Road shall be widened to back up the proposed new sub-centers.

However there are historical villages along these radial roads. The current radial roads are passing through the villages (See photo in RHS.) with very narrow lanes (less than 2-lane) and the roads function as community roads too. Bypass roads are proposed to avoid such limitations. Solid waste management is one of the serious issues of the valley. Kathmandu Municipality and Lalitpur Municipality operate the waste disposal site in Okharpauwa area (Sisdol Phase I (since 2005), Sisdol Phase II (since 2011, See photo in LHS.), Aletar (since 2009)). Due to increasing solid waste from both municipalities, new final disposal site has been planned at Pancharedandda also in Okharpauwa Landfill Site. However the existing sole access road (Balaju Road) to Okharpauwa area does not have sufficient road capacity for the waste disposal vehicles and will need an alternative access.

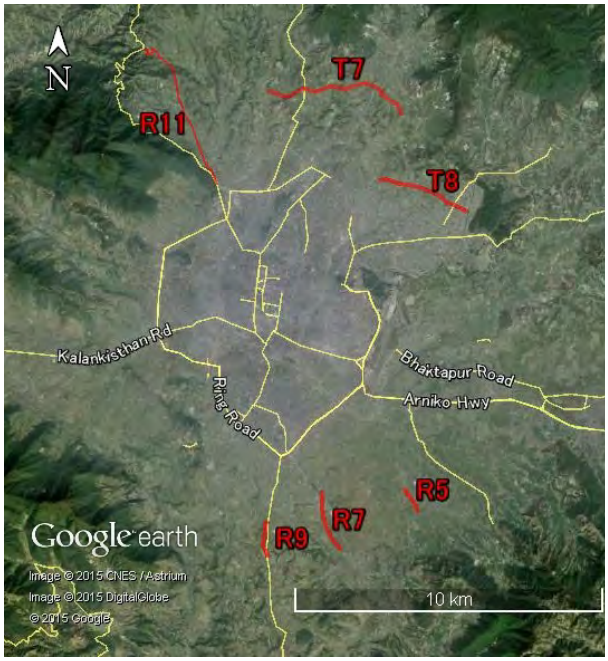
In the north area of the valley, transversal road network connecting each radial road is insufficient. The new roads have been proposed to strengthen the road network in the northern area. These roads will have to function as the community roads as well as emergency roads in case of disaster.

Table 8.2.11 presents the proposed new roads for upgrading of the existing road network.

Table 8.2.11 Proposed New Roads for Upgrading of Existing Road Network

ID	Projects	Proposed Number of Lanes
R5	Bypass Road for Lubhu Road	2-lane
R7	Bypass Road for Godawari Road	2-lane
R9	Bypass Road for Chapagaun Road	2-lane
R11	Balaju-Jitpur-Phedi Road (access for solid waste disposal)	2-lane
T7	Emergency Road 1 (Bishnumati-Dhobi)	2-lane
T8	Emergency Road 2 (Dhobi-Makaibari)	2-lane
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads		

Source: JST



R5: Bypass Road for Lubhu Road

R7: Bypass Road for Godawari Road

R9: Bypass Road for Chapagaun Road

R11: Balaju-Jitpur-Phedi Road (access for solid waste disposal)

T7: Community/Emergency Road 1 (Bishnumati-Dhobi)

T8: Community/Emergency Road 2 (Dhobi-Makaibari)

Source: JST

Figure 8.2.20 Location Map of Proposed New Roads

(3) Emergency Road Network

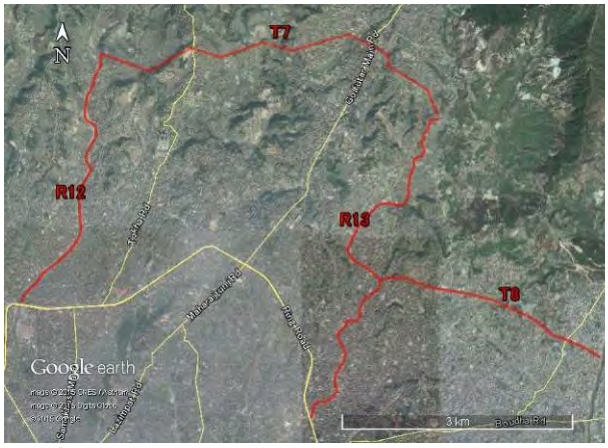
Kathmandu Valley suffered a large scale earthquake 80 years back. As shown in Figure 8.2.17, new road network is proposed in the area where the development land is available. On the other hand, the northern area of the valley has already been developed recently and has very limited space available for new road network development. In road network planning, minimum emergency roads are proposed for the northern area. Thoka Road and Bansbari Road alone are the main radial roads from the Ring Road (primary emergency road to connect TIA). The improvement of the riverside roads along Bishnumati River and Dhobi Khola is proposed as supplementary radial roads for emergency road. Also the transversal connection between radial roads are newly proposed.

Table 8.2.12 presents the proposed emergency roads. Further detailed planning of the emergency road network is explained under section 8.8 Disaster Management Plan, Chapter8.

Table 8.2.12 Proposed Emergency Roads

ID	Projects	Current Number of Lanes	Proposed Number of Lanes
R12	Bishnumati River Emergency Road	Dart narrow 2-lane	2-lane
R13	Dhobi Khola Emergency Road	Dart narrow 2-lane	2-lane
T7	Emergency Road 1 (Bishnumati-Dhobi)	-	2-lane
T8	Emergency Road 2 (Dhobi-Makaibari)	-	2-lane
(Numbering of ID) C: Circular Roads, R: Radial Roads, T: Transversal Roads, U: Urban Roads			

Source: JST



R12: Bishnumati River Emergency Road

R13: Dhobi Khola Emergency Road

T7: Community/Emergency Road 1 (Bishnumati-Dhobi)

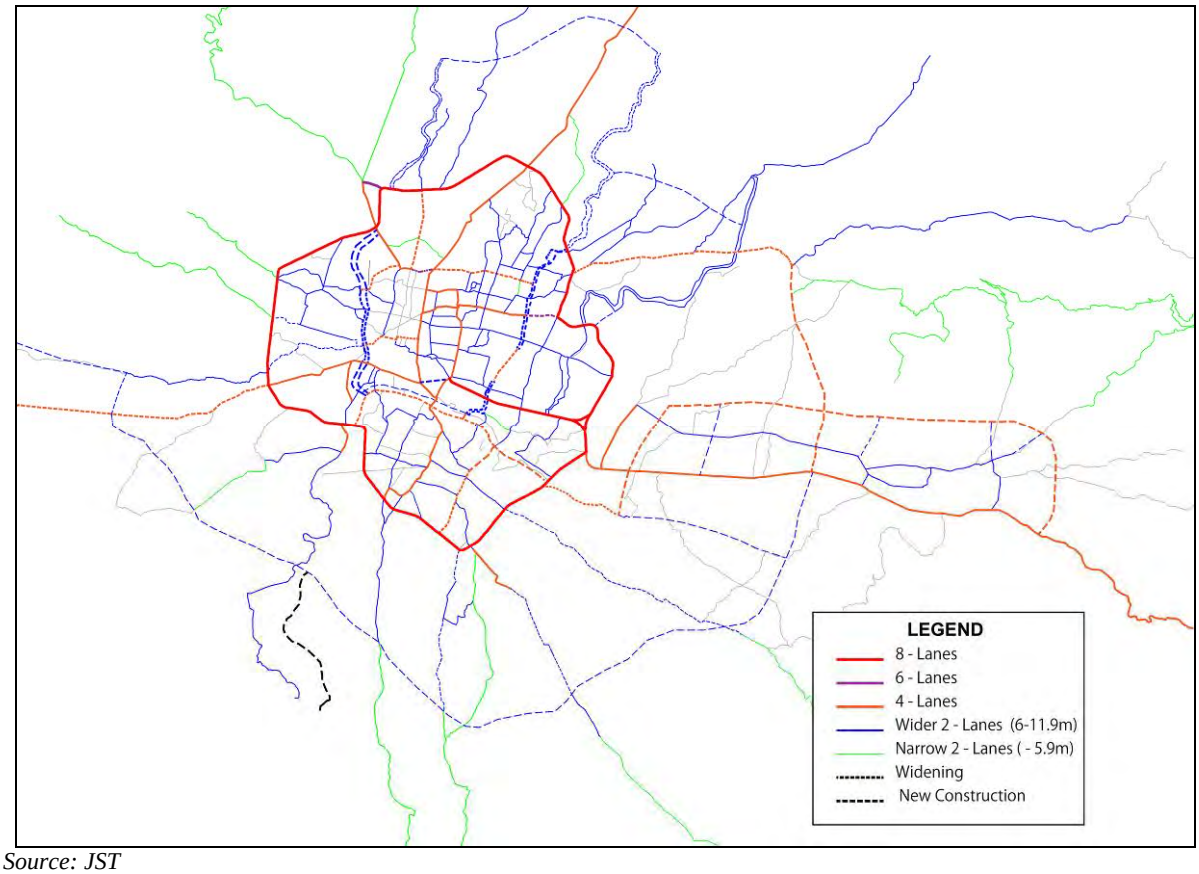
T8: Community/Emergency Road 2 (Dhobi-Makaibari)

Source: JST

Figure 8.2.21 Location Map of Proposed Road Widening

8.2.3.3 Proposed Road Network

The proposed road network explained above was examined by the traffic demand forecast model and the appropriate number of lanes has been determined as shown below.



Source: JST

Figure 8.2.22 Proposed Road Network

8.2.4 Road Classification and Design Criteria

Road classification is one of the fundamental issues for road planning and designing. Nepal Road Standard (NRS 2070) established in 2013 specifies the road classification and design criteria for each classification.

8.2.4.1 Road Classification

(1) Current Road Classification

In NRS 2070, the administrative classification is introduced and the roads are classified into 4 categories namely National Highways (NH), Feeder Roads (FR), District Roads (DR) and Urban Roads (UR) and the class of roads and the design speed are simply determined by the expected traffic volume (average daily traffic in 20 years).

Table 8.2.13 Road Classification and Classes by NRS 2070

Road Classification	Jurisdiction	ROW
National Highways	DOR	50
Feeder Roads		30
District Roads	DOLIDAR	20
Urban Roads		-

Class	ADT in 20yrs	Design Speed (plain)
Class-I	more than 20,000 pcu	120 km/h
Class-II	5,000-20,000 pcu	100 km/h
Class-III	2,000-5,000 pcu	80 km/h
Class-IV	less than 2,000 pcu	60 km/h

Source: NRS 2070, DOR

NRS 2070 also guides the combination between the road classification and the type as shown below. NRS is prepared for Strategic Road Network. The type of District Roads and Urban Roads is not clear and the individual decision by engineers of DOLIDAR or Municipalities is required.

Table 8.2.14 Road Classification and Classes by NRS 2070

Road Classification	Type by Terrain	
	Plain and Rolling	Mountainous and Steep
National Highways	Class-I, II	Class-II, III
Feeder Roads	Class-II, III	Class-III, IV

Source: NRS 2070, DoR

According to the above classification of NRS 2070, National Highways in the urban area (such as Arniko Road) is likely to be classified into "Class-I (more than 20,000 pcu)" and the design speed will be "120km/h". Driving at high speed in the urban area will not be accepted and it is necessary to prepare a specific design standard for Urban Roads.

GON recognizes the necessity of the design standard including the classification for the urban roads and is preparing "Nepal Urban Roads Standard 2071" with the support of UN-HABITAT. While this new standard is still in a draft version, JST has proposed the road classification and the design criteria for this MP as explained below and the proposal by JST has been shared by the team of UN-HABITAT during the Working Group.

(2) Proposed Road Classification

The concept of the proposed road classification and the proposed typical cross sections in this MP are presented in Figure 8.2.21. Regardless of the current classification of SRN 2070, the roads in the valley are categorized as the arterial roads (primary, secondary, tertiary).

Table 8.2.15 Proposed Urban Road Functional Classification

Classification	Facility Stratification	Application	Intent
Arterial Roads	Primary Arterial	Entire Region Link to trunk roads outside	- Form core metropolitan spines - Accommodate longer trips - Connect major trip generators (sub-centers, airport, etc) - Link to national trunk roads - Can accommodate BRT

	Secondary Arterial	Between wards Link to primary arterial	- Accommodate travel demands between wards in the region - Link to primary arterial roads - Network bus services provided - Transit priority (but not BRT) possible - Emergency Roads
	Tertiary Arterial (collector roads)	Between neighboring precincts Link to primary and secondary arterial roads	- Provide circulation within, as well as between, wards, sub-wards, and residential areas - Link to secondary arterial roads - Network bus services (small busses) possible
Community Roads	Access Roads (local collector roads)	Within community and residential area Link to tertiary arterial	- Local circulation and property access
Special Roads	BRT Exclusive Roads	Exclusive BRT road	- Enhanced BRT operation in support of primary arterial road network
	NMT Roads (Non Motorized Transport)	CBD, sub-centers, busy commercial area, tourism/leisure	- Provide exclusive pedestrian/cycling space

Source: JST

Table 8.2.16 Proposed Urban Road Functional Classification

Classification	Typical Cross Sections	Number of Lanes	Type of each class
Primary Arterial	Urban Road Class-A Urban Road Class-B Urban Road Class-C	6-lane 4-lane 2-lane	Type-1 (with service road) Type-2 (without service road) Type-3 (with minimum sidewalk) Type-4 (grade separated section) Type-5 (with BRT for Inner Ring Road) Type-6 (with BRT for others)
Secondary Arterial			
Tertiary Arterial (collector roads)			

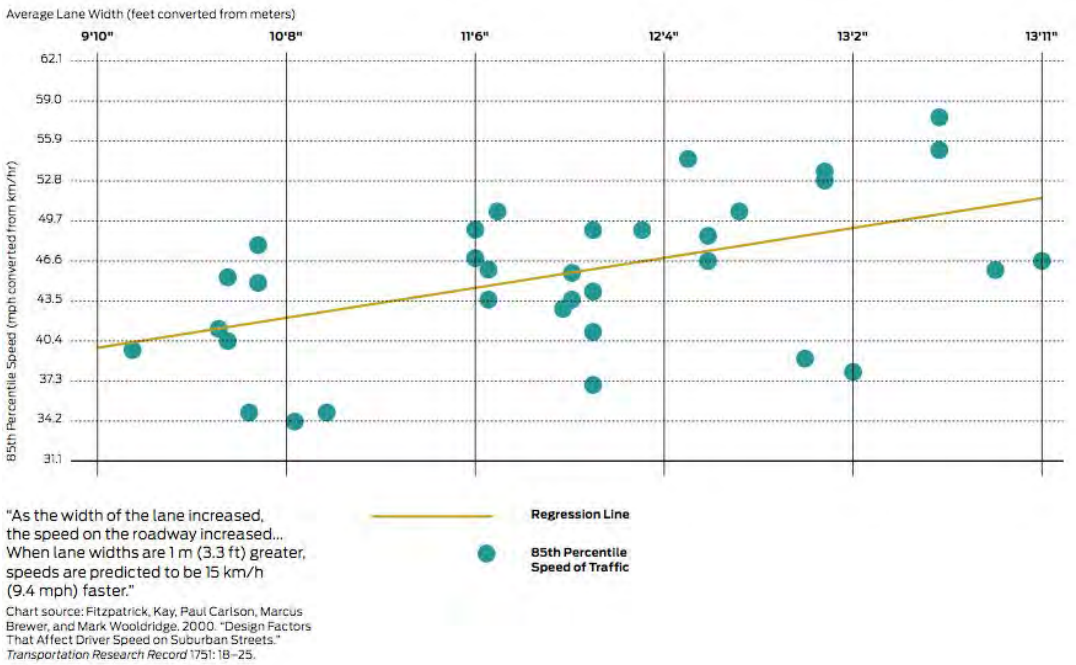
Source: JST

8.2.4.2 Proposed Design Criteria

The design criteria have been proposed for the typical cross sections in this MP. The detailed design criteria such as horizontal/vertical elements shall be determined in the on-going design standard program under UN-HABITAT.

(1) Carriageway

The width of carriageway in NRS 2070 is 3.5m. Wider carriageway generally encourages driving at high speed and triggers traffic accidents especially in urban areas. Figure 8.2.21 presents the correlations between carriageway width and vehicle speed. Wider carriageway width are correlated with higher vehicle speeds.



Source: National Association of City Transportation Officials (NACTO), USA

Figure 8.2.23 Correlation between Carriageway Width and Vehicle Speed

In developed countries, recommended carriageway width in urban area is less than 3.5m (3.25m in Japan, 9.5-10 feet=3.0-3.3m in the USA). JST proposes 3.25m in this MP.

(2) Median

The wider median will contribute to the following:

1) Function of Median (Traffic Point of View)

- To prevent serious accident (head-on crash) by splitting the traffic direction
- To prevent miss-entering to the opposite direction
- To regulate smooth traffic flow controlling U-turn movement
- To achieve smooth flow adding space for “right-turn lane”
- To enhance pedestrian safety
- To provide space for road side facilities such as sign board, lighting, etc.
- To secure future infrastructure space such as AGT, BRT, etc.

2) Function of Median (Urban Amenity Point of View)

- To support urban landscape
- To create space for emergency use in case of disaster

JST has proposed 3.0m of median width to accommodate the above functions.

(3) Shoulder

Road side shoulder tends to be underestimated especially in developing countries and the shoulder-free roads are often found in the valley.

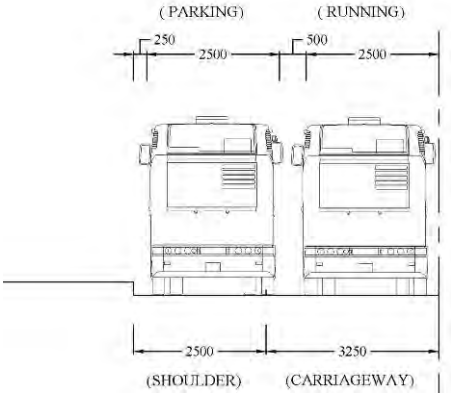
Usually in developed countries, minimum 0.5m and 0.25m of outer and inner shoulders are recommended to serve the following functions:

- To protect road structure
- To separate "stopping (disabled or parked) vehicle" and "running (idling) vehicle"
- To maintain traffic safety and driving comfort
- To create space for road maintenance and cleaning
- To collect surface water on the shoulder, etc.

JST has proposed 0.5m of absolute minimum of outer shoulder as well as NRS 2070.

0.25m of inner shoulder adjacent to mounted median or separator is also proposed though the inner median is not specified in NRS 2070.

2.0-2.5m of wider outer shoulder (5.75m in total as shown in the RHS figure) has been proposed for several roads to ensure smooth traffic flow even together with parked vehicles.



Source: JST

Figure 8.2.24 Wider Outer Shoulder

(4) Sidewalk

The design standard in Japan specifies the requirement to split bicycle traffic from motor traffic if the bicycle traffic volume exceeds more than 40 (bicycle/hour/direction) based on the below formula.

N=1,000*V/L

N: Bicycle Volume (bicycle/hour/dir)

V: Average Speed of Bicycle (km/h)=20km/h

L: Interval of Bicycle when always in sight of car driver=500m

[Concept: When bicycle always in sight of car drivers, the smooth traffic flow will be interfered with and the bicycle user will be also at risk.]

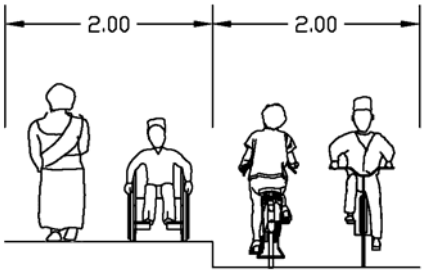
Table 8.2.17 Traffic Count Survey on Arniko Road

Date	Time	Pedestrian	Bicycle
March 31 (Tue), 2015	13:00-14:00	619	78
	16:00-17:00	689	80
April 1 (Wed), 2015	09:00-10:00	555	124
April 3 (Fri), 2015	09:00-10:00	457	123
	13:00-14:00	542	57
April 6 (Mon), 2015	16:00-17:00	660	94
April 9 (Thu), 2015	09:00-10:00	530	112
	13:00-14:00	464	59
	16:00-17:00	522	72

Source: JST

According to the survey by JST, the volume on Arniko Road is more than 80 (bicycle/hour/direction) and the current provision of the bicycle lane is appropriate though it is not used properly.

JST thus proposes provision of 4m sidewalk including bicycle lane along the newly proposed main arterial roads.



Utilization Pattern	Occupied Width
Wheel Chair	1.0m
Walking with a guide dog	1.5m
Walking with a baby buggy	0.75m
Walking with an umbrella	1.0m
Walking and chatting with a friend	1.5-2.5m
Window shopping	1.5-2.0m

Source: JST *Source: RAS-E, German and JRA, Japan*

Figure 8.2.25 Proposed Width of Sidewalk/Bicycle Lane

8.2.4.3 Proposed Cross Sections in the Master Plan

According to the above, the cross sectional design element has been determined and the typical cross sections have been prepared for the MP. The following table summarizes the comparison between NRS 2070 and the proposed design.

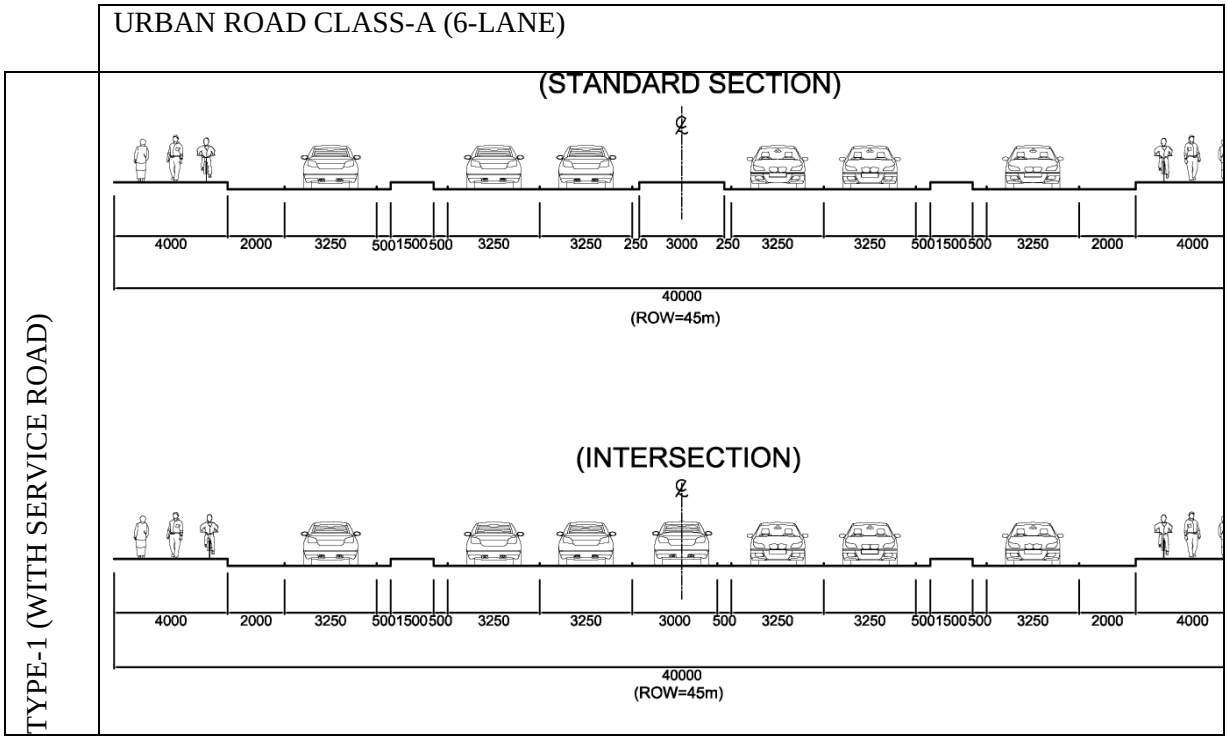
Table 8.2.18 Design Element of Typical Cross Sections

Cross Section Elements	NRS 2070	Proposed in this MP
Width of Carriageway (Lane)	3.50m	3.25m
Width of Median	3.00 – 5.00m	3.00m
Width of Inner Shoulder	na	0.25m
Width of Outer Shoulder (standard)	0.50 – 0.75m	0.50m
Width of Outer Shoulder (wider)	1.50 – 3.75m	2.50m
Width of Sidewalk	1.50 – 3.00m	4.00m with bicycle lane
Width of Bicycle Lane	1.20m	2.50m without bicycle lane
Width of BRT Lane	na	3.50m
Width of BRT Station	na	5.00m

Source: JST

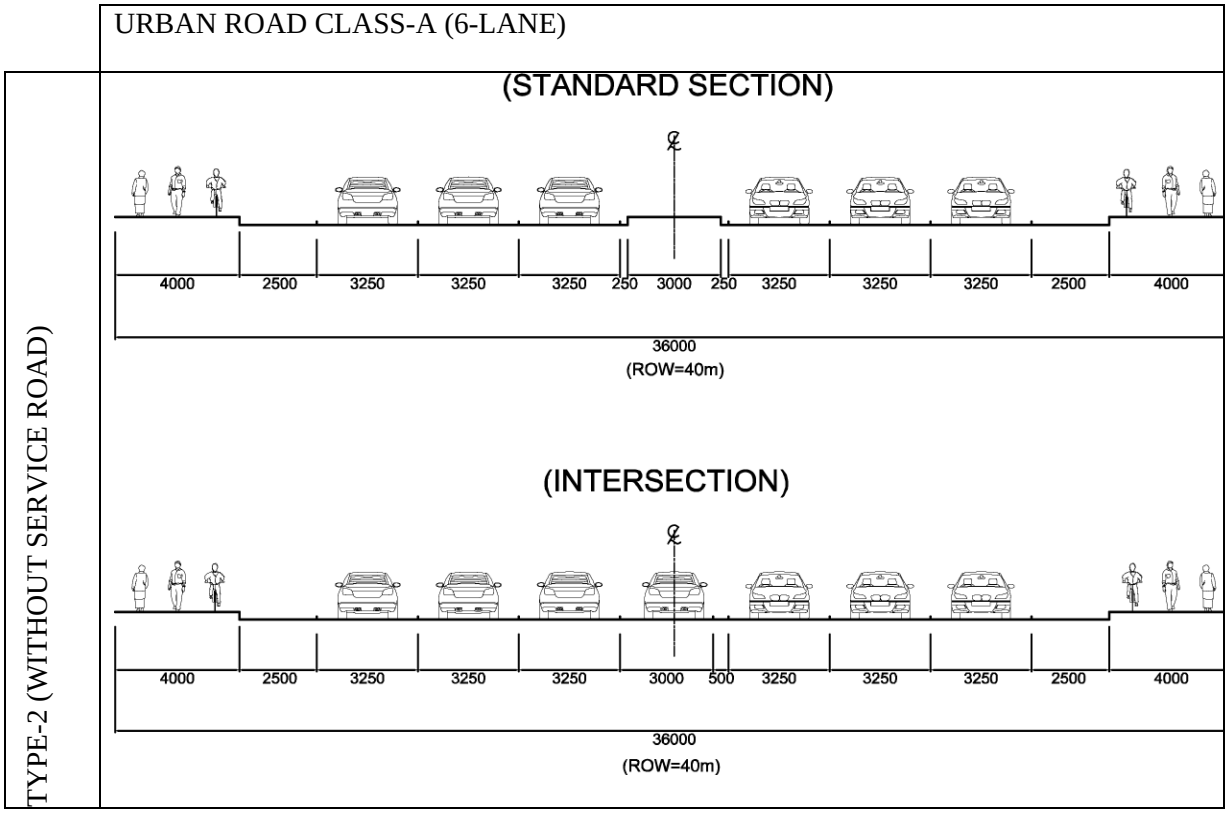
(1) Urban Road Class-A

Typical cross sections for Urban Road Class-A are shown below.



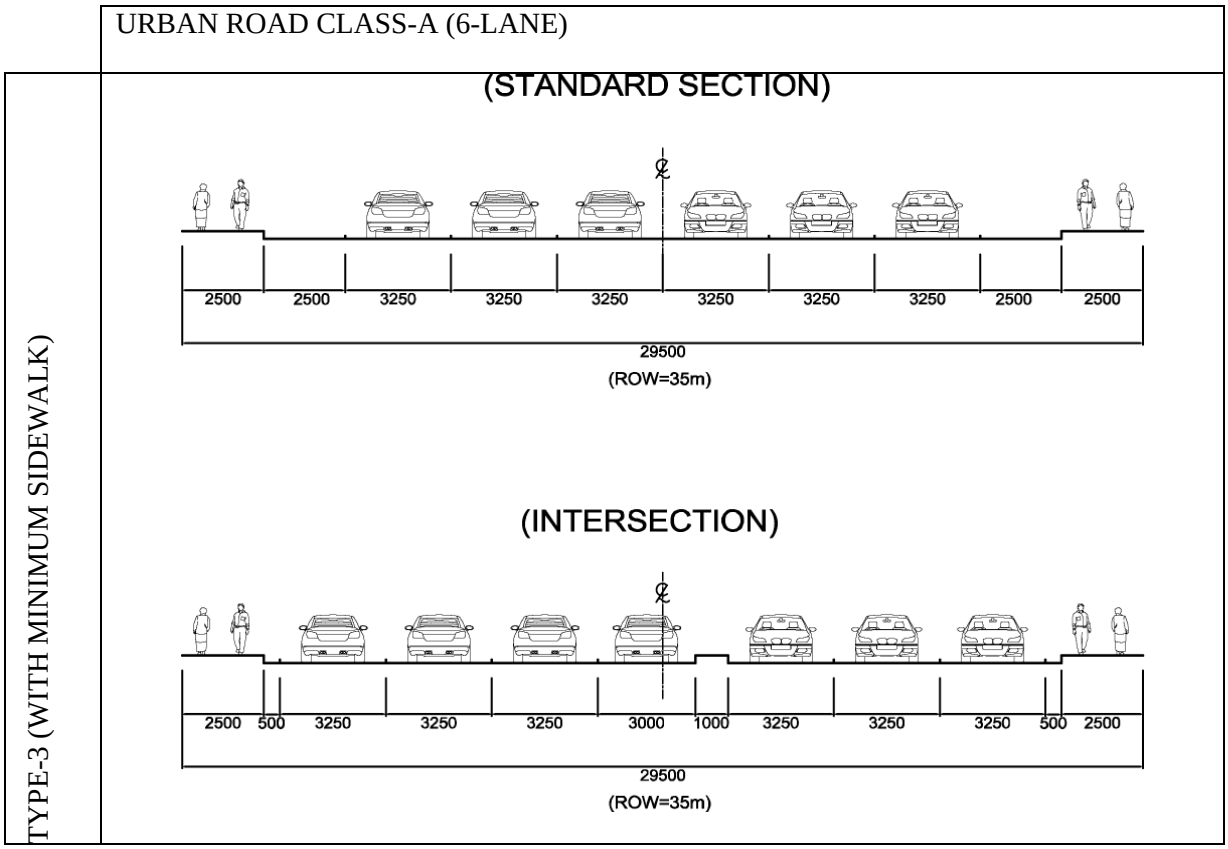
Source: JST

Figure 8.2.26 Typical Cross Section (Urban Road Class-A, Type-1)



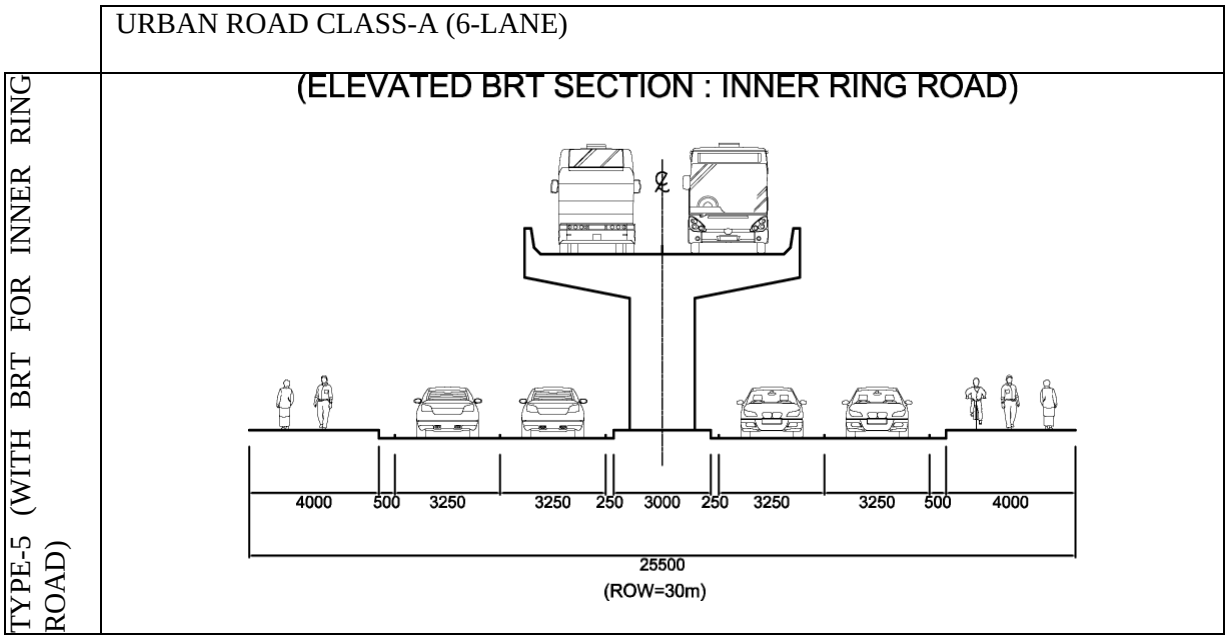
Source: JST

Figure 8.2.27 Typical Cross Section (Urban Road Class-A, Type-2)



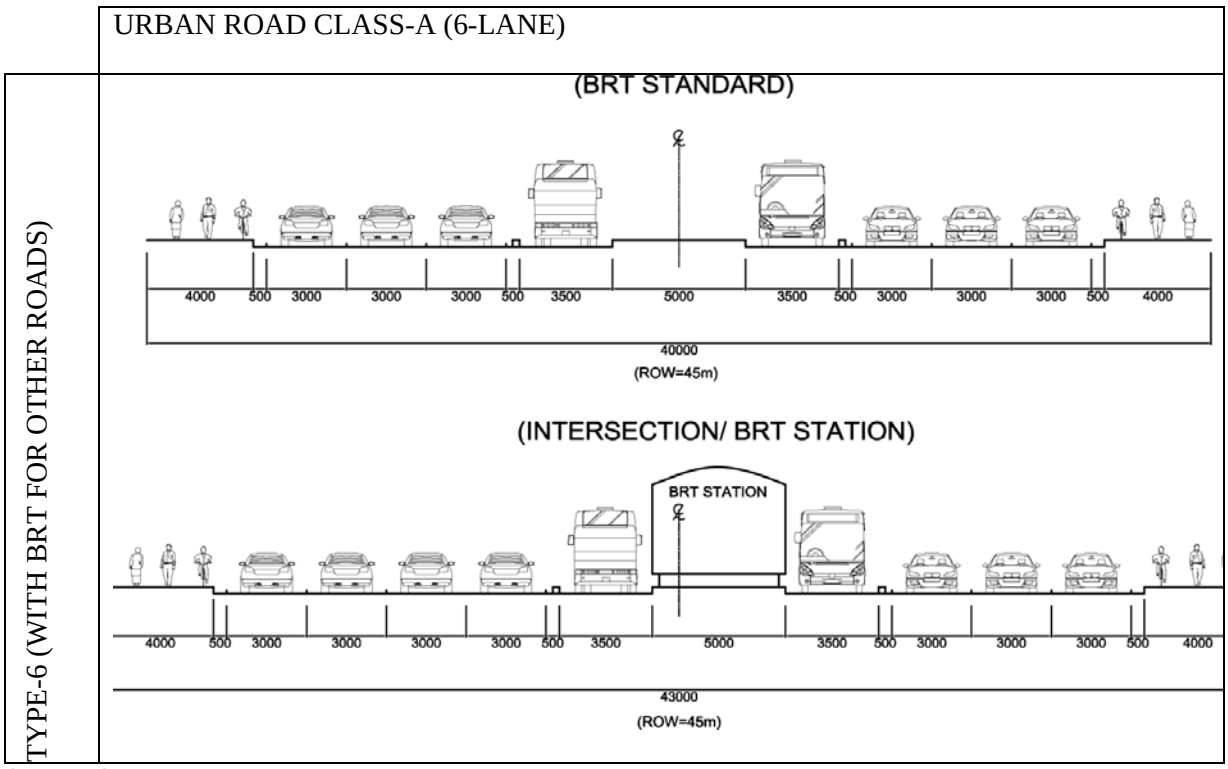
Source: JST

Figure 8.2.28 Typical Cross Section (Urban Road Class-A, Type-3)



Source: JST

Figure 8.2.29 Typical Cross Section (Urban Road Class-A, Type-5)

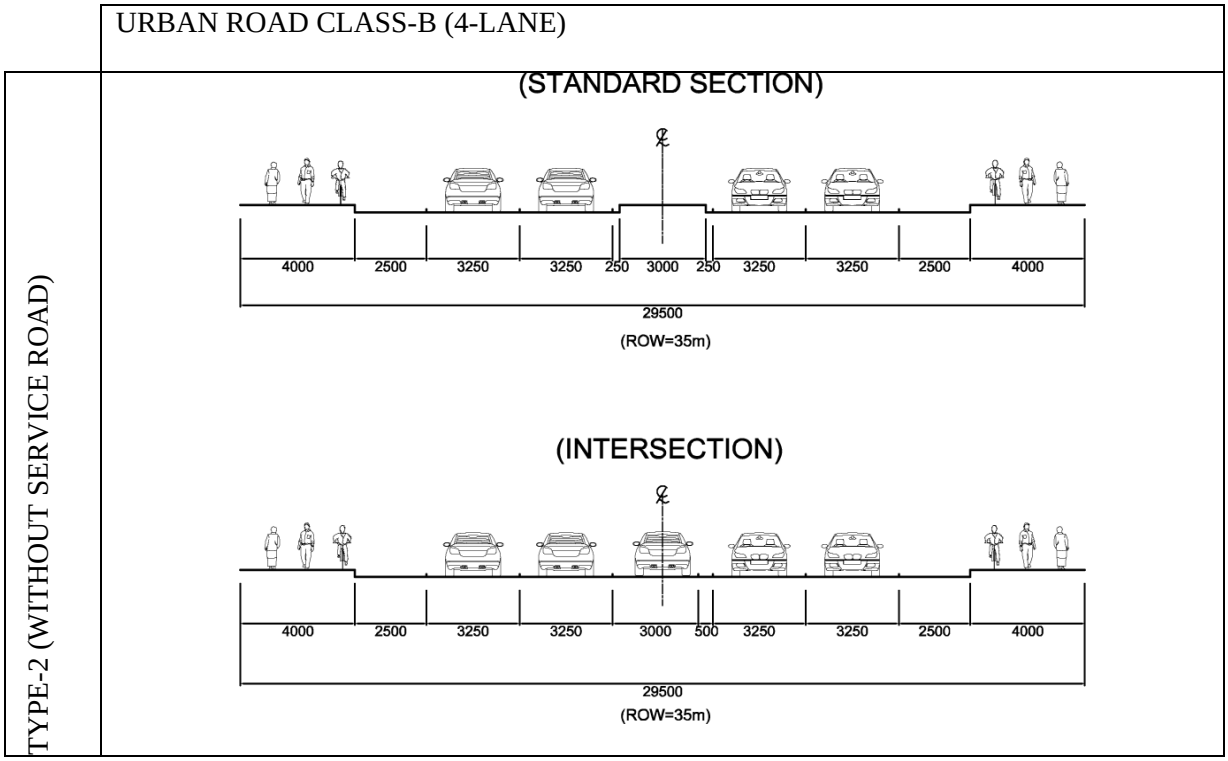


Source: JST

Figure 8.2.30 Typical Cross Section (Urban Road Class-A, Type-6)

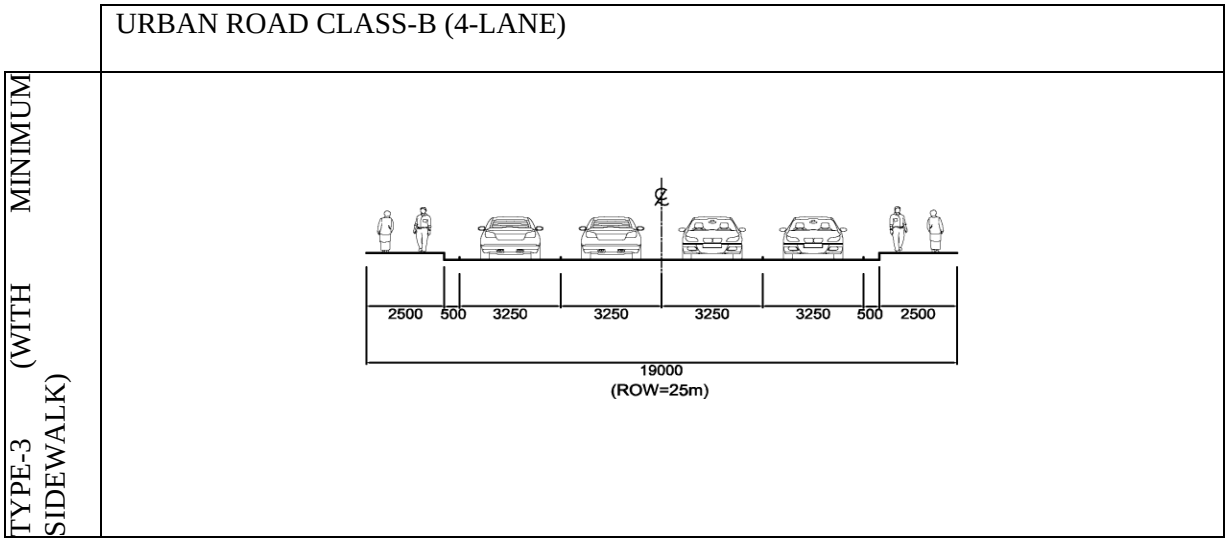
(2) Urban Road Class-B

Typical cross sections for Urban Road Class-B are shown below.



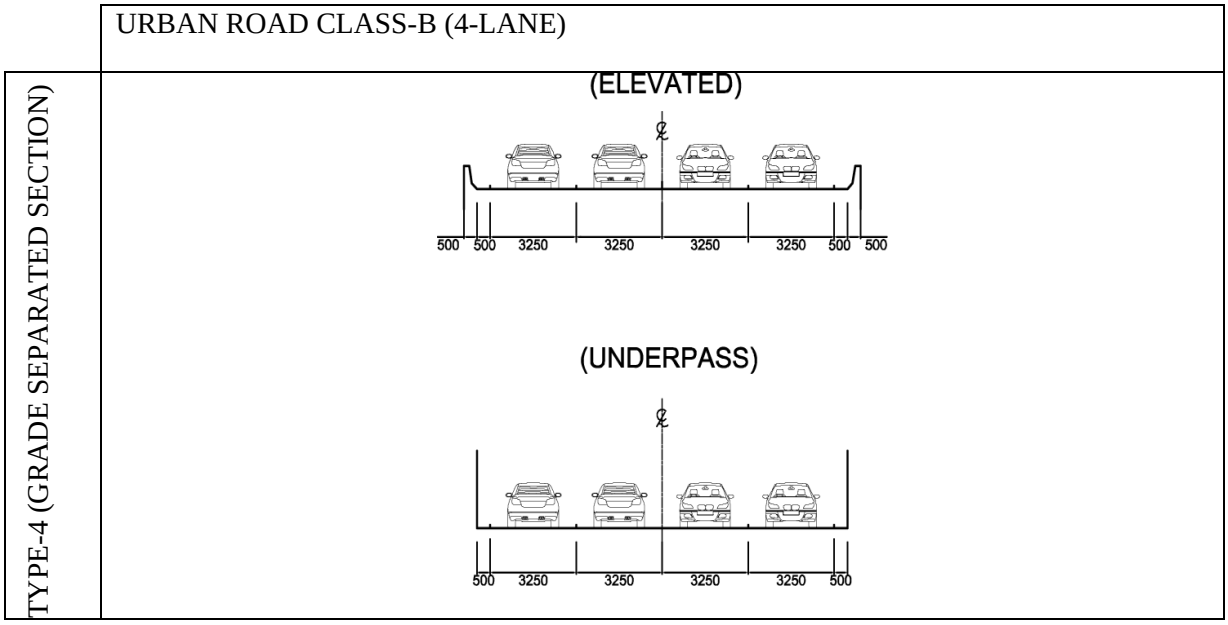
Source: JST

Figure 8.2.31 Typical Cross Section (Urban Road Class-B, Type-2)



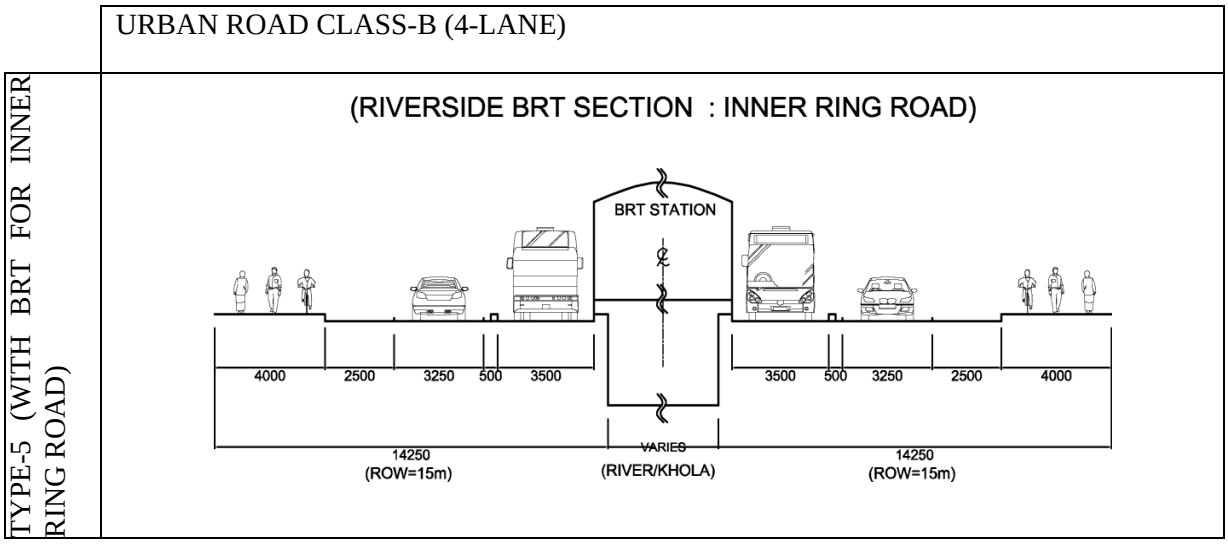
Source: JST

igure 8.2.32 Typical Cross Section (Urban Road Class-B, Type-3)



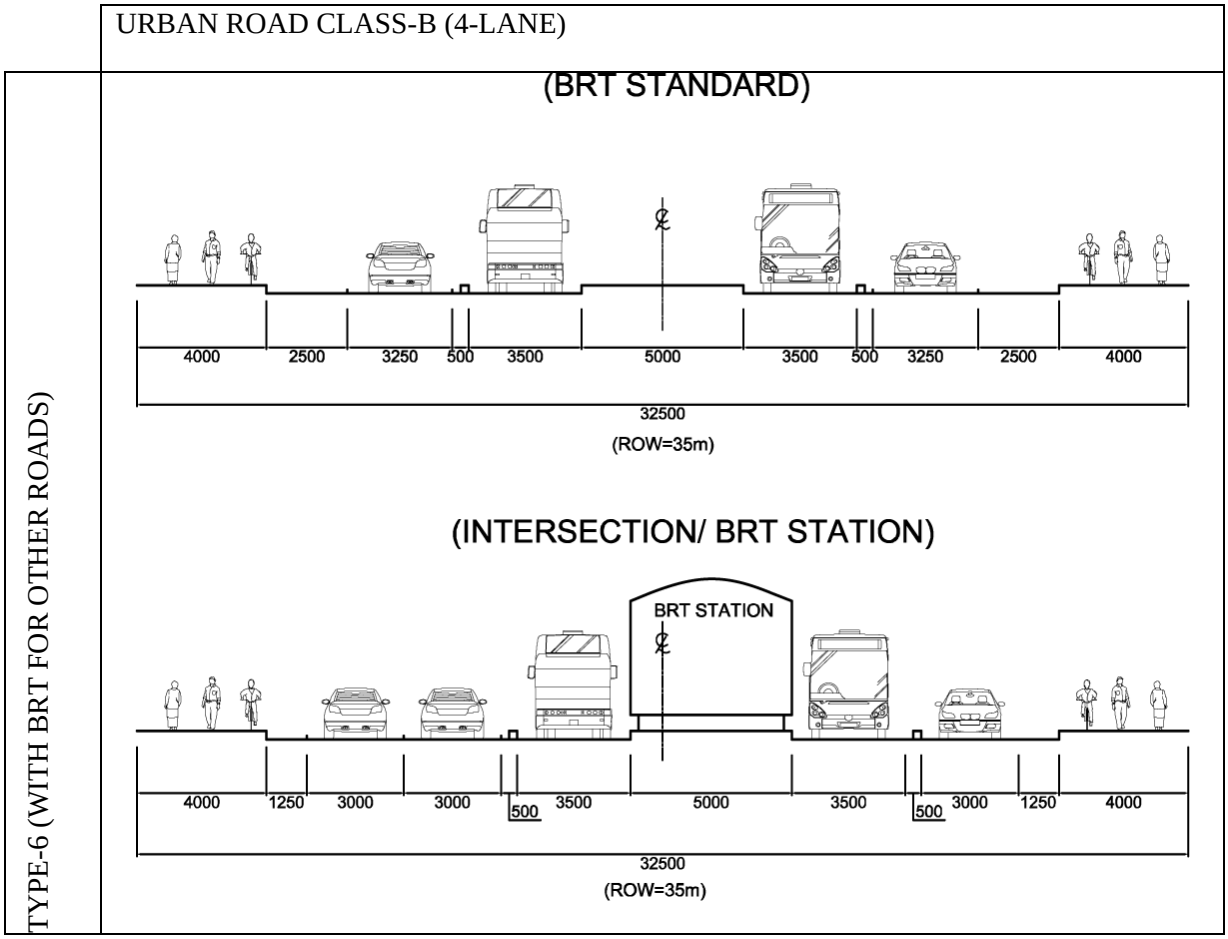
Source: JST

Figure 8.2.33 Typical Cross Section (Urban Road Class-B, Type-4)



Source: JST

Figure 8.2.34 Typical Cross Section (Urban Road Class-B, Type-5)

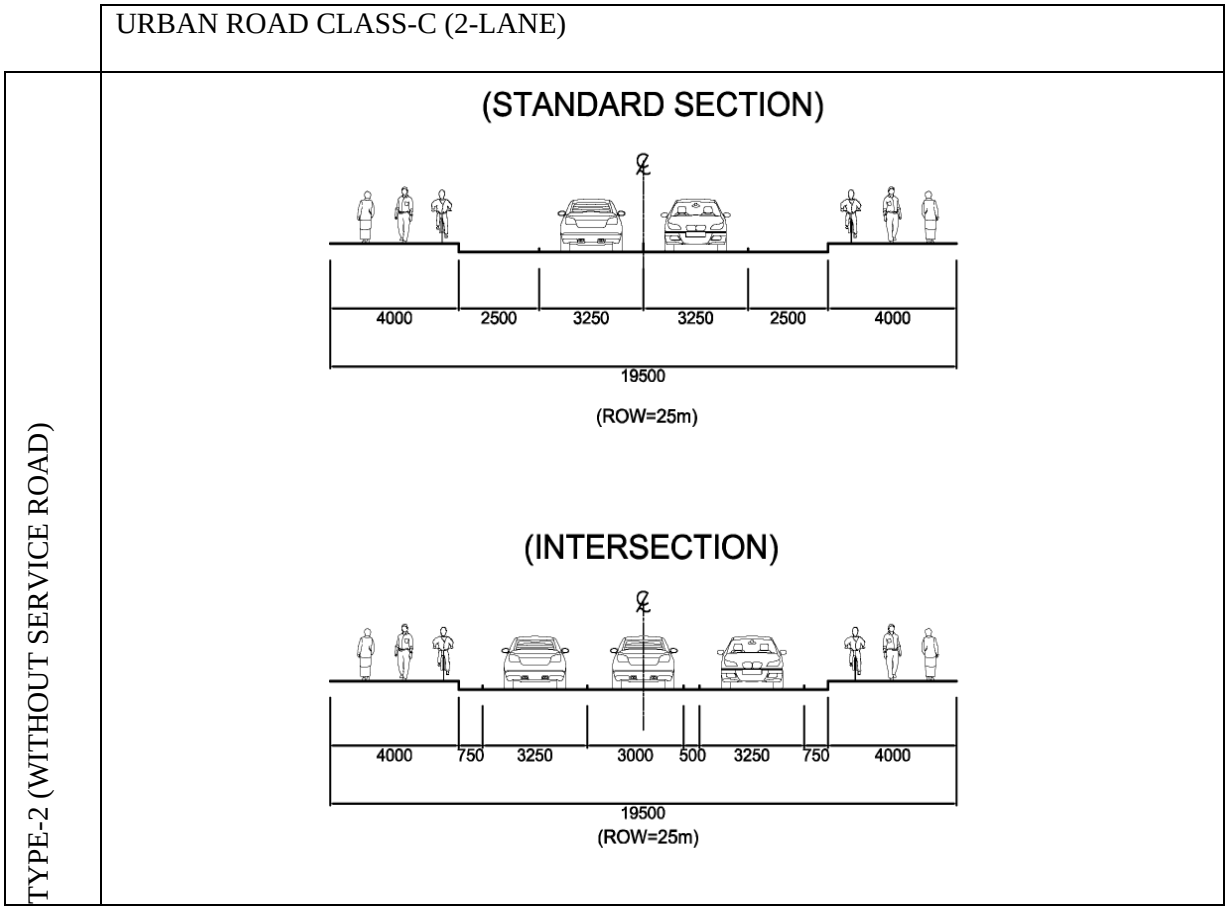


Source: JST

Figure 8.2.35 Typical Cross Section (Urban Road Class-B, Type-6)

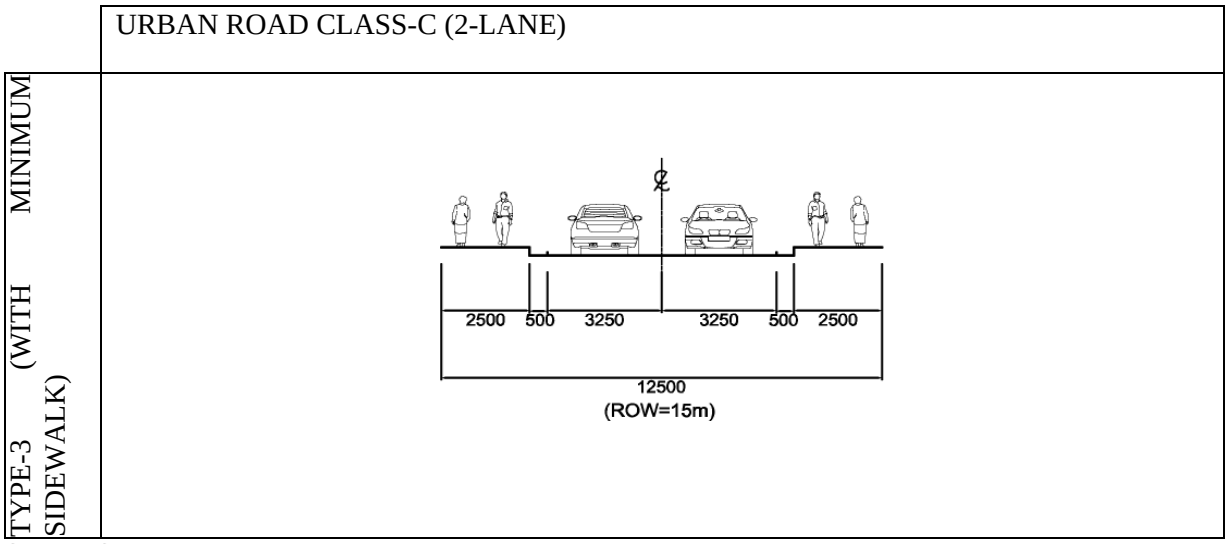
(3) Urban Road Class-C

Typical cross sections for Urban Road Class-C are shown below.



Source: JST

Figure 8.2.36 Typical Cross Section (Urban Road Class-C, Type-2)

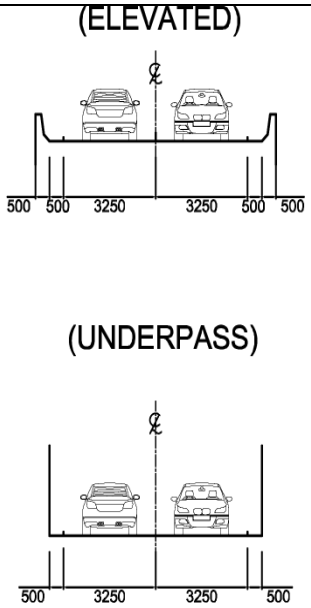


Source: JST

Figure 8.2.37 Typical Cross Section (Urban Road Class-C, Type-3)

URBAN ROAD CLASS-C (2-LANE)

TYPE-4 (GRADE SEPARATED SECTION)

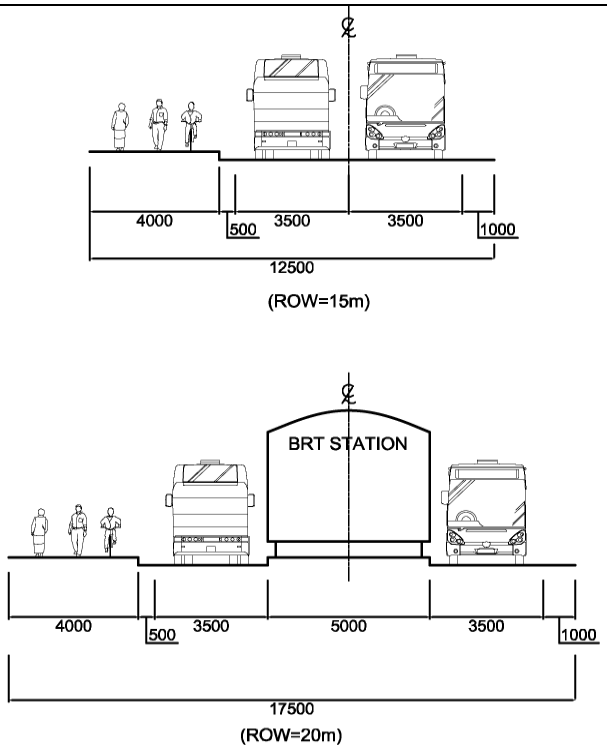


Source: JST

Figure 8.2.38 Typical Cross Section (Urban Road Class-C, Type-4)

URBAN ROAD CLASS-C (2-LANE)

TYPE-5 (WITH BRT FOR INNER RING ROAD)



Source: JST

Figure 8.2.39 Typical Cross Section (Urban Road Class-C, Type-5)

8.3 Public Transport Plan

8.3.1 Public Transport Strategy

(1) Problems, Causes and Strategy

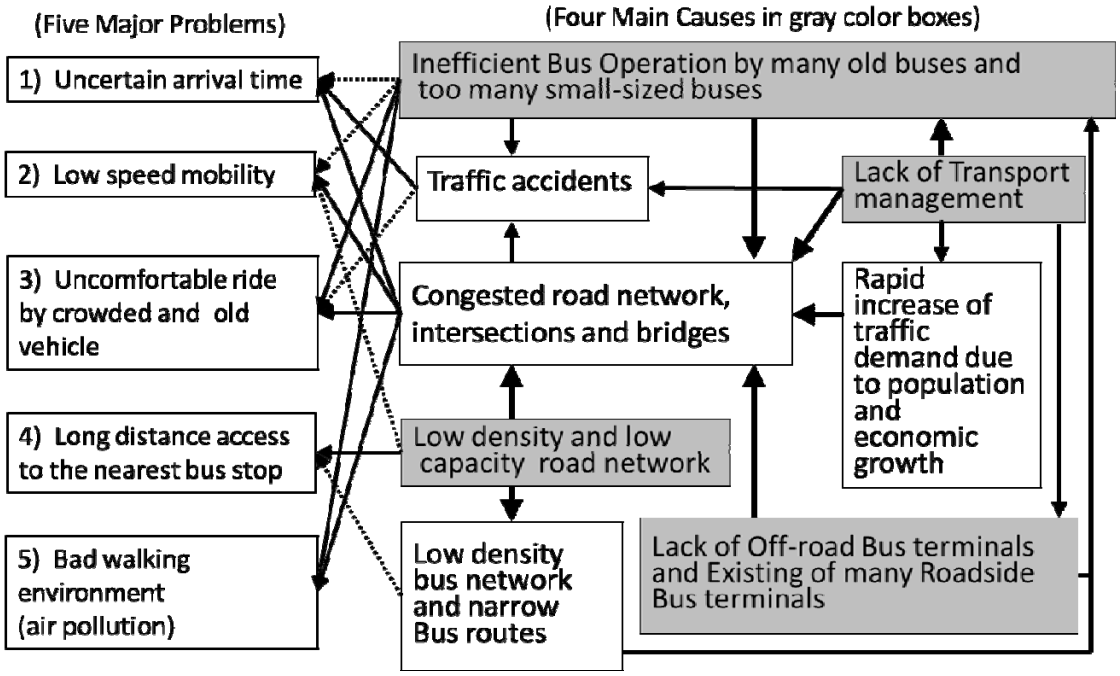
There are five major problems in the existing public transport system of KV as shown in Figure 8.3.1. The first one is uncertainty of operation. Due to frequent delays, it is very difficult for bus users to predict arrival time especially in peak hours. This is caused by traffic congestion, traffic accidents and inefficient bus operation with a number of old small-sized buses. In fact, micro/mini bus which is the dominant type of bus in KV is operated without a timetable.

The second one is low speed operation of bus. Buses are being operated at the speed of less than 10km/h inside the Ring Road in peak hours. For example, it takes more than an hour from Gongabu to Lagankhel Bus Park. This low mobility is caused by not only heavy traffic congestion, but also lack of traffic management. For example, there is no bus exclusive lane or bus priority lane in KV, therefore buses share the road space with motorcycles and cars, and are easily affected by traffic condition.

The third one is uncomfortable ride in crowded and old buses. Many buses are operated with passengers over the capacity. Passengers are squeezed in such a crowded bus with low speed and often for unexpectedly a long time.

The fourth one is low accessibility to the nearest bus stop for people living in the area with insufficient road density and capacity. Even in the area inside the Ring Road, approximately 15% of the area is blank zone with a distance of more than 500m to the nearest bus stop.

The last one is the undesirable walking environment. Air pollution is one of the disincentives for people to choose walking as a travel mode. It also induces people's reluctance to take a bus since taking a bus often requires walking a long distance to the bus stop.



Source: JST

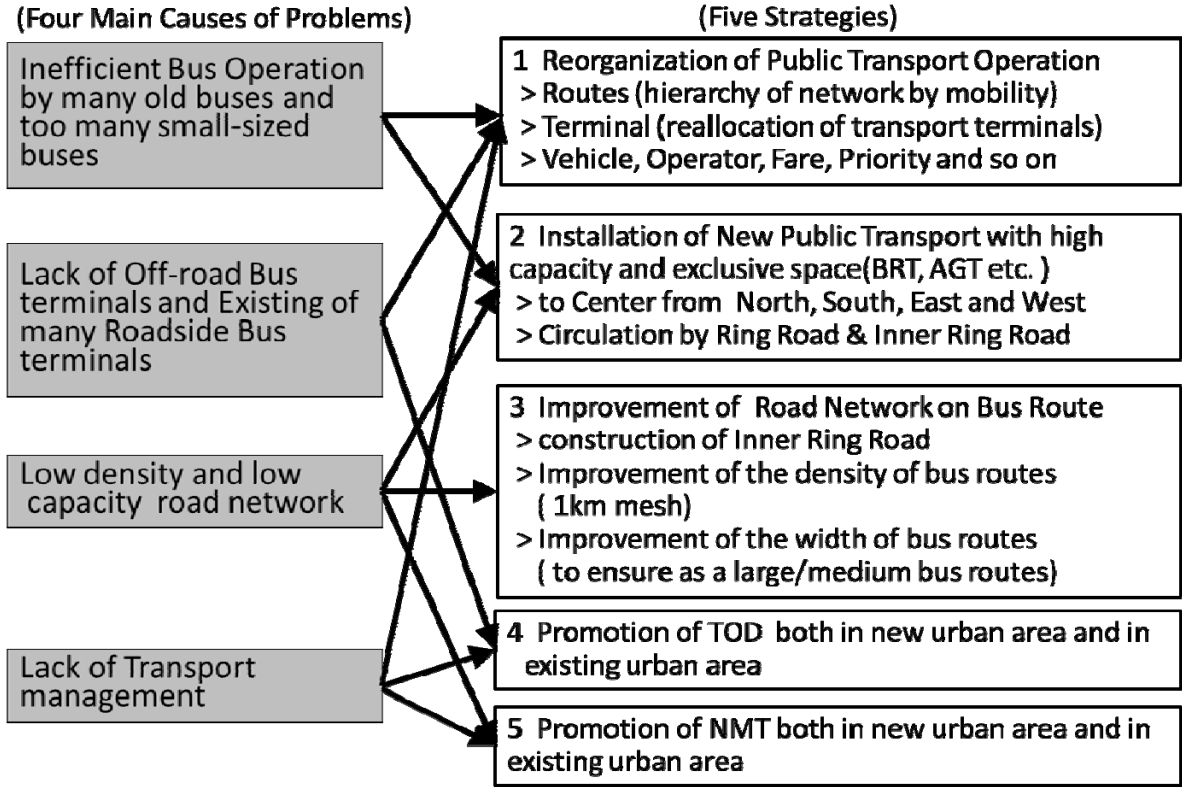
Figure 8.3.1 Problems and Main Causes of Public Transport System

Based on the analysis of the causal relationship on the above five problems, the following fore points are defined as main causes to the problems:

- Inefficient bus operation with a number of old and small-sized buses
- Lack of off-road terminals and too many roadside bus terminals
- Insufficient road density and capacity
- Lack of traffic management

JST proposes five countermeasures to the problems as public transport development strategy as shown in Figure 8.3.2.

1. To reorganize bus operation: bus routes, terminals, vehicle size, operators, etc to improve efficiency of bus operation.
2. To install new public transport with large capacity and exclusive space such as BRT and AGT to encourage people to use public transport.
3. To improve road network for bus routes by constructing the Inner Ring Road, developing 1km mesh bus network and widening roads for large or medium size bus operation.
4. To promote Transit Oriented Development (TOD) both in new urban area and existing urban area to realize promotion of public transport use and develop or redevelop town along public transport corridor at the same time.
5. To promote Non-Motorized Transport (NMT) such as walk and bicycle both in new urban area and existing urban area to promote eco-friendly travel mode.



Source: JST

Figure 8.3.2 Strategies of Public Transport Development

(2) Strategic Target

The strategic targets of the future public transport system are set up as shown in Table 8.3.1. The targets are divided into five items:

1) Mobility

Mobility can be indicated as speed, frequency or operation hours. Frequency and operation hours are excluded from the indicator in this study since the target for these should be determined for each route responding to demand. Speed is set up as an indicator because modal choice highly depends on how fast a transport mode can operate. The targets are 30km/h on Primary Routes and 15km/h on others. 30km/h as travel speed is faster than private vehicles driving inside the Ring Road during peak hours. The speed of 15km/h can be the same as cars.

2) Accessibility

Accessibility is represented as distance or time to the nearest public transport nodes such as bus stop or railway station. The main travel mode to the nearest bus stop is walking in Kathmandu Valley. Distance to the nearest stop is also an indicator for network density, which is closely related to road network density. In this Study, the target for accessibility inside the Ring Road is set up as less than 500m to the nearest stop.

3) Reliability

Reliability is attained by stable and accurate operation. If a bus runs at 30 km/h, it takes 10 minutes to travel 5 km which is the average trip length at present. On the other hand, it takes 25 minutes to travel 5 km at 12 km/h, rough estimation of current bus speed. The time difference is 15 minutes. Thus the target of delay time is within 15 minutes on primary route. If a bus is delayed by 15 minutes and the travel distance is 5 km, travel time including waiting time will be 25 minutes, which is the same as the current travel time. Reliability is a very important target for public transport operators.

4) Efficiency

Improvement of bus transport efficiency contributes to reduction of traffic on roads. Currently about 90% of buses are micro/mini bus. In order to operate public transport system efficiently, smaller buses should be replaced by larger ones. The target of the average number of passengers is 14.4 passengers for micro/mini bus and 30 passengers for medium sized bus.

5) Equity

Public transport services should be fairly provided to all in terms of fare, design and seat. Fare of public transport should be cheaper than the price of petrol for a motorcycle to cover 5km. For example, if a motorcycle runs 20 km/l, it consumes 0.25l of petrol to cover 5 km. If the price of petrol is 100NPR/l, it costs 25NPR for a 5 km run. Thus the target of fare is less than 25NPR for 5km. In addition, universal design for buses and terminals is also necessary in the future such as lower floor bus and terminals with slope or elevators. Priority seats for the disabled, aged, children and women should also be provided which are insufficient on the existing buses.

Table 8.3.1 Strategic Target of Future Public Transport System

Item	indicator	Strategic Target (current situation)
1) Mobility	Operation speed on Primary Routes -Routes to City Center from North, South, East and West -Routes of Circulation (Ring Road and Inner Ring Road)	Desirable Speed 30km/h in peak hours , at least 20km/h (9-13km/h in peak hours)
	Operation speed on the other routes	Speed 15km/h in peak hours (9-13km/h in peak hours)
2) Accessibility	Distance to Bus stop and other public transport stations	Within 500m inside the Ring Road (roughly 15% of area inside the Ring Road has a distance of more than 500m)
3) Reliability	Delay time	Within 15 minutes of delay time on primary routes for 5km movement(if speed of bus is 30km/h, it takes 10minutes for 5km although it takes 25minutes for 5km at the speed of 12km/h like the current situation)
4) Efficiency	Number of passengers per vehicle	30 passengers per vehicle equals approximately to two times of the current (14.4 passengers per vehicle)
5) Equity	Fare	Cheaper than the price of petrol by motorcycle for 5km. For example, if a motorcycle runs at the speed of 20km/l, it consumes 0.25l/5km. If the price of petrol is 100NPR/l, it costs 25NPR for 5km run.
	Comfortable ride, Universal Design	Lower floor Bus Vehicles, Slope or Elevator installation for transport terminal such as bus terminal (no elevated facility)
		Sufficient priority seats for disabled, the old, children, women (several seats for medium or large bus)

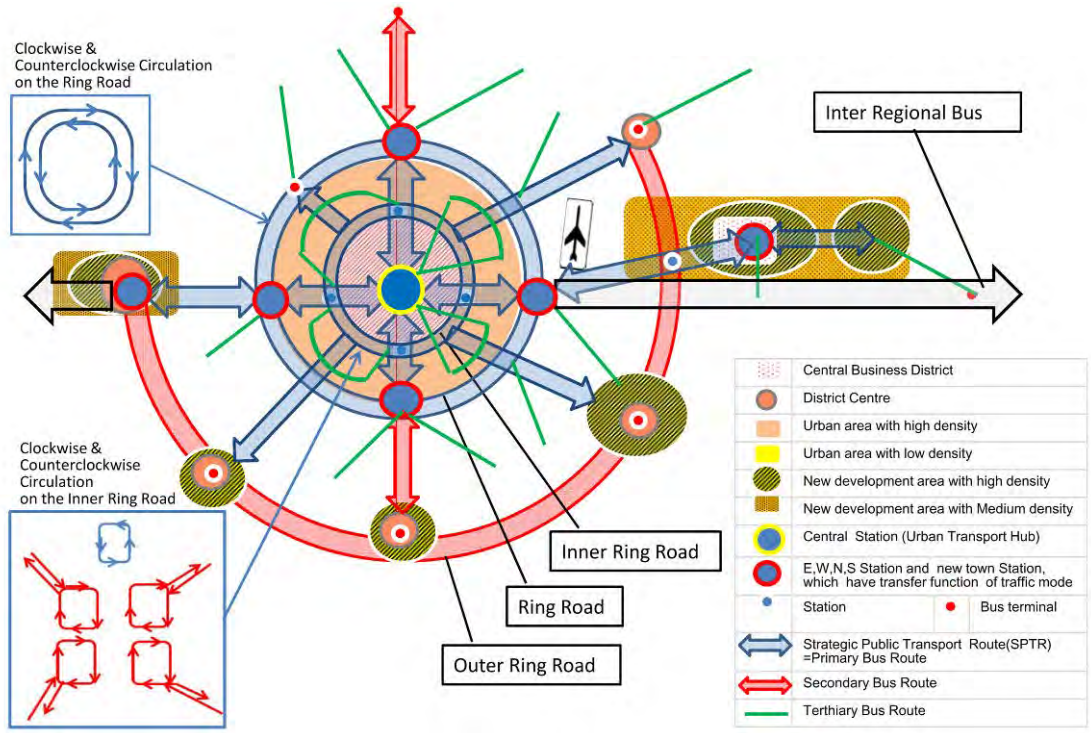
Notes: *1 Demand includes all modes excluding walking and bicycle
*2 Speed is a travel speed on route including passenger getting on and off time
Source: JST

8.3.2 Public Transport Network Plan

(1) Principals of Public Transport Network Hierarchy

Principals of public transport network are:

- Public transport network should be reorganized to a new hierarchy consisting of three kinds of public transport route namely primary, secondary and tertiary route. The hierarchy is based on the trunk and branch network pattern. The basic concept of this principal is the same as the one proposed by KSUTP, ADB, although the network itself is different.
- Primary route is defined as a high demand link on the axis of urban structure, linkage to the city center from North, South, East and West direction and circulation in high density area. Primary route should have exclusive space for public transport, which enables high speed, high frequency, high capacity and punctual operation. The primary routes are called the strategic routes that the master plan mainly deals with.
- Secondary route is defined as a medium demand link, next candidate route for the Primary route, complemental route to Primary route and convenient transfer route to Primary Route.
- Tertiary route is defined as a relatively low demand link, feeder link for inconvenient area access to bus stop, feeder link for first mile and last mile of Primary and Secondary Route.
- Inter-Regional Route is assumed for long distance link between KV and the regions outside KV.
- Classification, definition and image of the three kinds of public transport network are shown in Figure 8.3.3 and Table 8.3.2.



Source: JST

Figure 8.3.3 Image of Strategic Public Transport Routes

Table 8.3.2 Classification and Definition of Public Transport Network

Area	Classification & definition	Demand on link *1	Vehicle	Speed *2
Intra-Regional	**Primary Route** is for: -high demand link on the axis of urban structure -linkage to the city center from North, South, East West direction and so on -circulation in high density area -link with high speed, frequency and capacity -link with punctual operation with exclusive space	(passengers/day) -More than 100,000 (passengers/h/direction) -More than 5,000	-BRT -AGT -Monorail	-More than 30 km/h （BRT 20km/h）
	Secondary Route is for: -medium demand link -next candidate route for the Primary route -complemental route to Primary route -convenient transfer route to Primary Route	(passengers/day) -More than 50,000 and Less than 100,000 (passengers/h/direction) -More than 2,000 and Less than 5,000	-BRT -Large Bus -Medium Bus (Minibus for narrow route)	-More than 15 km/h
	Tertiary Route is for: -relatively low demand link -feeder link for inconvenient area access to bus stop -feeder link for first mile and last mile of Primary and Secondary Route	(passengers/day) -Less than 50,000 (passengers/h/direction) -Less than 2,000	-Minibus -Microbus -Tempo	-More than 15 km/h
Inter-Regional	**Inter-Regional Route** is set up for: -long distance link between KV and the regions outside KV	Not specific	-Large Bus	Not specific

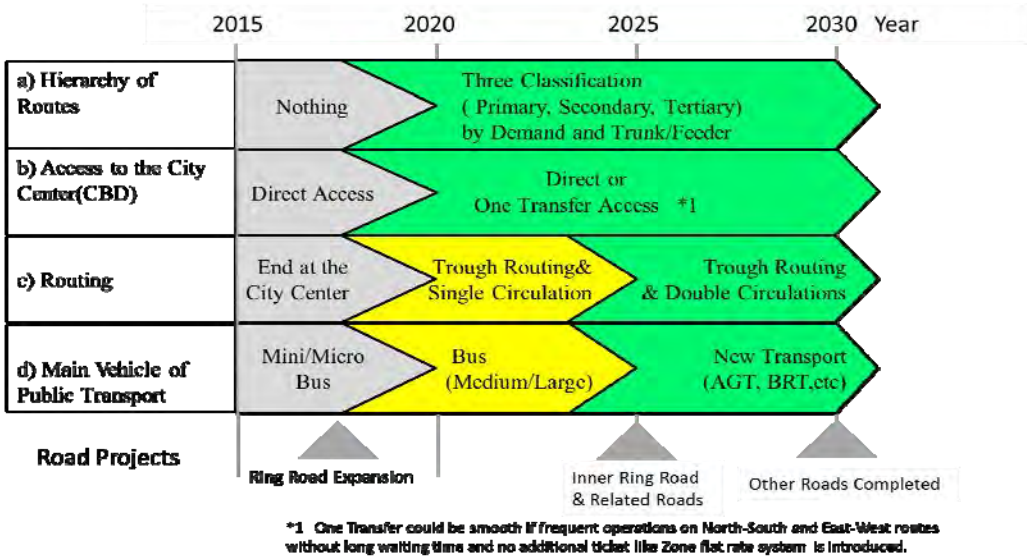
Notes: The above definition of primary, secondly and Tertiary routes are defined by JICA Study Team referring to the definition by KSUTP,ADB.
*1: Demand includes all motorized modes excluding walking and bicycle
*2: Speed is a travel speed on route including passenger getting on and off time

Source: JST

(2) Principals of Restructuring of Public Transport Network

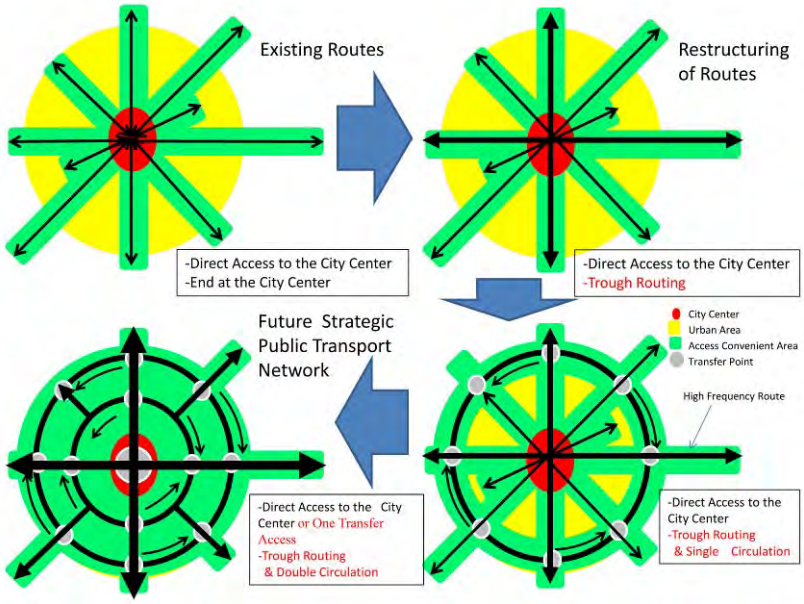
In addition to setting the hierarchy, restructuring of public transport network should be conducted as shown in Figure 8.3.4 and Figure 8.3.5.

- Shift the capacity of transport from micro/mini bus to large bus or new transport with larger capacity
- Shift the traffic flow from having the end at the city center to through-routing that flows across the city center and out the other side
- Inner Ring Road should be developed to formulate double circulation route. With the circulation routes, one transfer access to the city center will be possible in addition to direct access to the city center.
- Building higher density of public transport network which enables people living inside the Ring Road to reach the nearest transport nodes within 500m. This makes Walk & Bus principal inside the Ring Road possible.



Source: JST

Figure 8.3.4 Reorganization Plan 2015-2030



Source: JST

Figure 8.3.5 Reorganization Plan of Network Pattern

Nine are proposed as Primary Route as shown in Figure 8.3.6. These routes are North-South, East-West, Circulation on the Ring Road and the Inner Ring Road with clockwise and anticlockwise rotation, Northwest, Northeast, Southeast and Southwest with circulation on the Inner Ring Road.

Source: JST

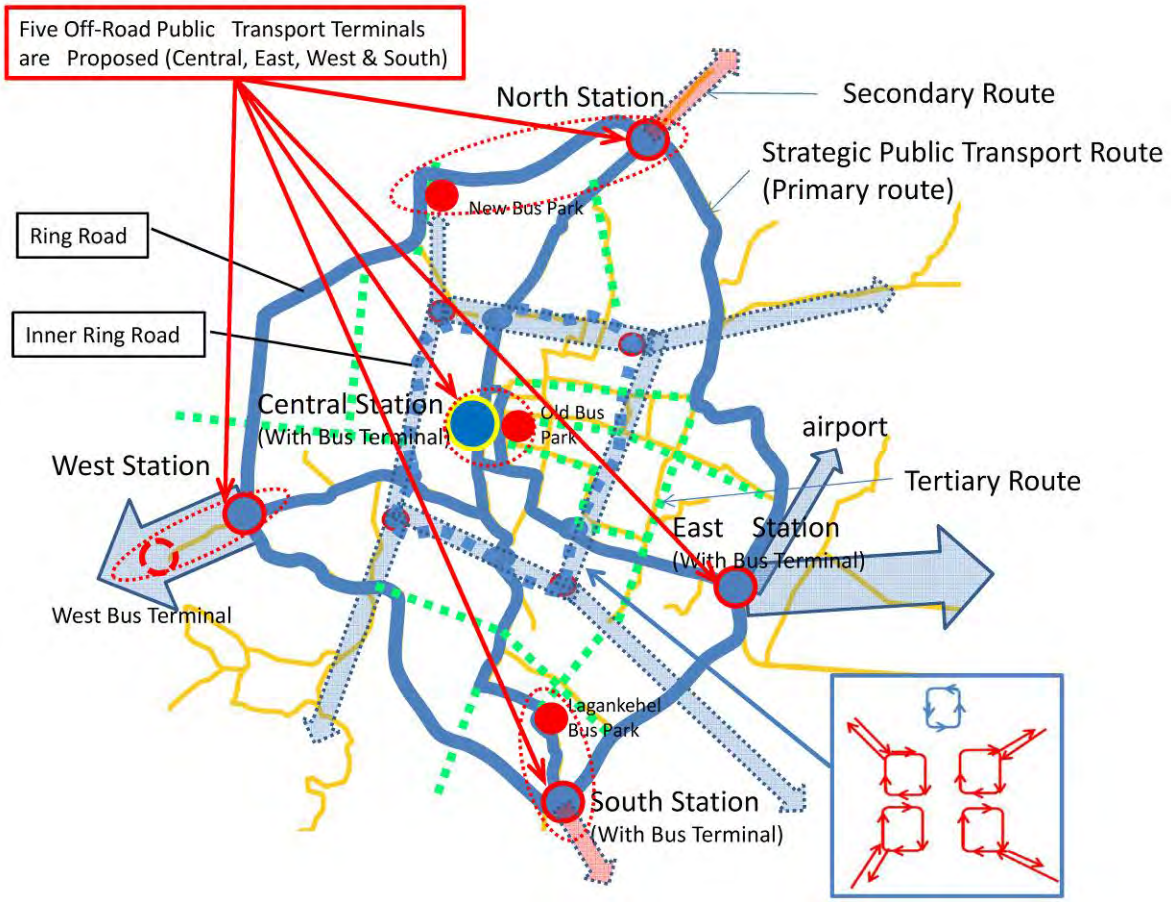
Figure 8.3.6 Proposed Primary Routes

(3) Principals of Public Transport Terminal

There is an increasing number of road side bus terminals such as Koteshwor and Kalanki. In the future, off-road bus terminals should be built instead of road side bus terminals which cause traffic congestion.

Focusing on the important public transport terminal where a great number of people transfer and change transport modes, five strategic public transport terminals are proposed as shown in Figure 8.3.7 and Table 8.3.3.

- The Central Station is the public transport hub instead of NAC road side bus terminal. It will work with Old Bus Park as a gate of Kathmandu.
- The East Station is a new public transport terminal replacing Koteshwor road side bus terminal. It also serves as Inter regional bus terminal.
- The West Station is a new public transport station replacing Kalanki road side bus terminal. It can be located within 1km from Kalanki intersection and can also serve as inter regional terminal
- The North Station is a new public transport station replacing Narayan Gopal Chowk road side bus terminal. It will work collaboratively with New Bus Park.
- The South Station is a new public transport station which will work in collaboration with Lagankehel Bus Park.



Source: JST

Figure 8.3.7 Proposed Transport Terminals

Table 8.3.3 Proposed Transport Terminals

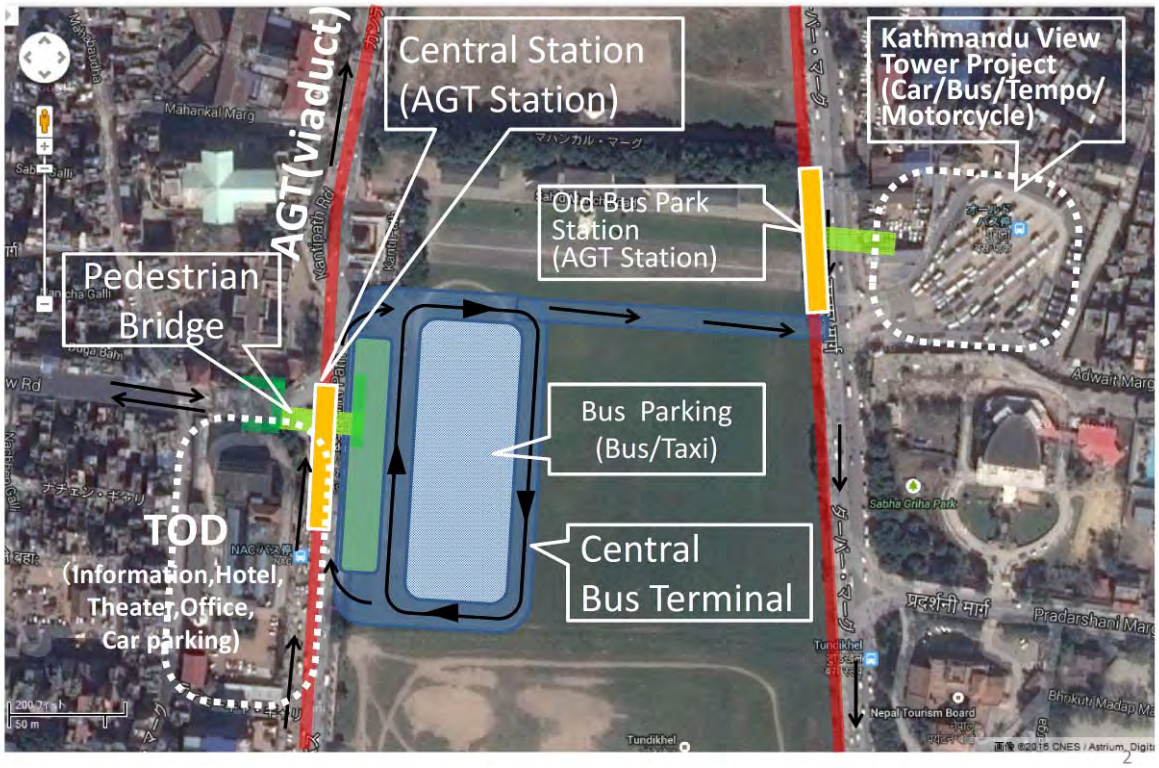
Name	Function	North – South Route	East – West Route	Ring Road Route	Transfer mode
Central Station	**-Public Transport Hub Terminal** instead of NAC road side bus terminal -Cooperation with Old Bus Park -Gate of Kathmandu	AGT/ BRT	AGT/ BRT		**Central Bus Terminal** (All modes : Bus, Mini/Micro Bus, Tempo, Taxi, Car, Bicycle)
East Station	**-New Public Transport Terminal** Instead of Koteshwor road side bus terminal -Inter regional terminal		AGT/ BRT	BRT/ Bus	**East Bus Terminal** (Long distance Bus, Mini/Micro Bus, Taxi, Bicycle)
West Station	**-New Public Transport Station** -Cooperation with West Bus Terminal -West Bus Terminal might be located within 1km from Karanki intersection as inter regional terminal		AGT/ BRT	BRT/ Bus	**West Bus Terminal** might be located a little away west (Long distance Bus, Mini/Micro Bus, Taxi, Bicycle)
North Station	**-New Public Transport Station** Instead of Narayan Gopal Chowk road side bus terminal -Cooperation with New Bus Park	AGT/ BRT		BRT/ Bus	New Bus Park is located a little away west (Long distance Bus, Mini/Micro Bus, Taxi, Bicycle)
South Station	**-New Public Transport Terminal** -Cooperation with Lagankehel Bus Park	AGT/ BRT		BRT/ Bus	**South Bus Terminal** (Bus, Mini/Micro Bus, Taxi, Bicycle)

Source: JST

Figure 8.3.8 shows the image of Central Station Plan as a new public transport hub terminal. The terminal will have a station plaza and bus parking, and will serve in collaboration with Old Bus Park. Furthermore, development of the Central Station designed for TOD will accelerate urban development by private sector.

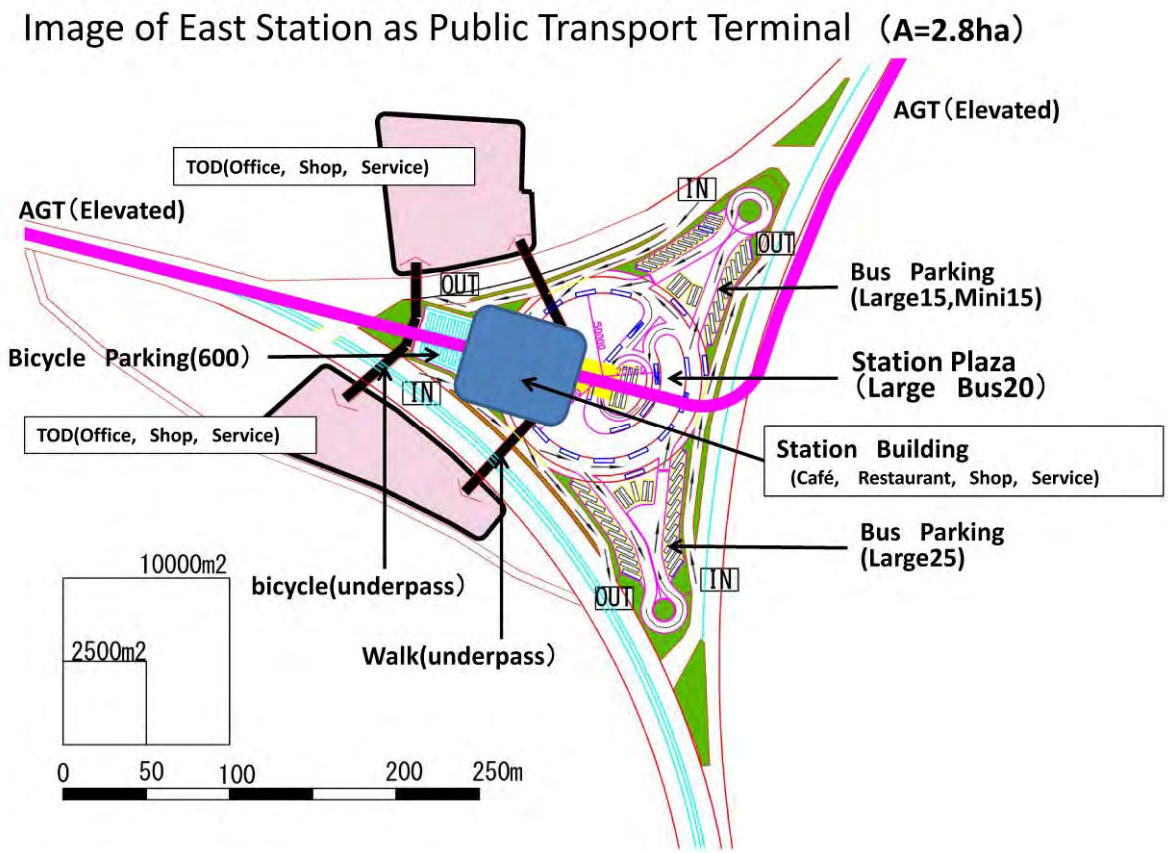
Figure 8.3.9 shows the image of East Station Plan as a new public transport terminal. The terminal will have a station plaza, bus parking and bicycle parking. The capacity will be larger than that of the existing road side bus terminal in Koteshwor.

The other transport stations such as West, North and South stations will be planned together with AGT route planning and work with bus terminals.



Source: JST

Figure 8.3.8 Image of Central Station Plan



Source: JST

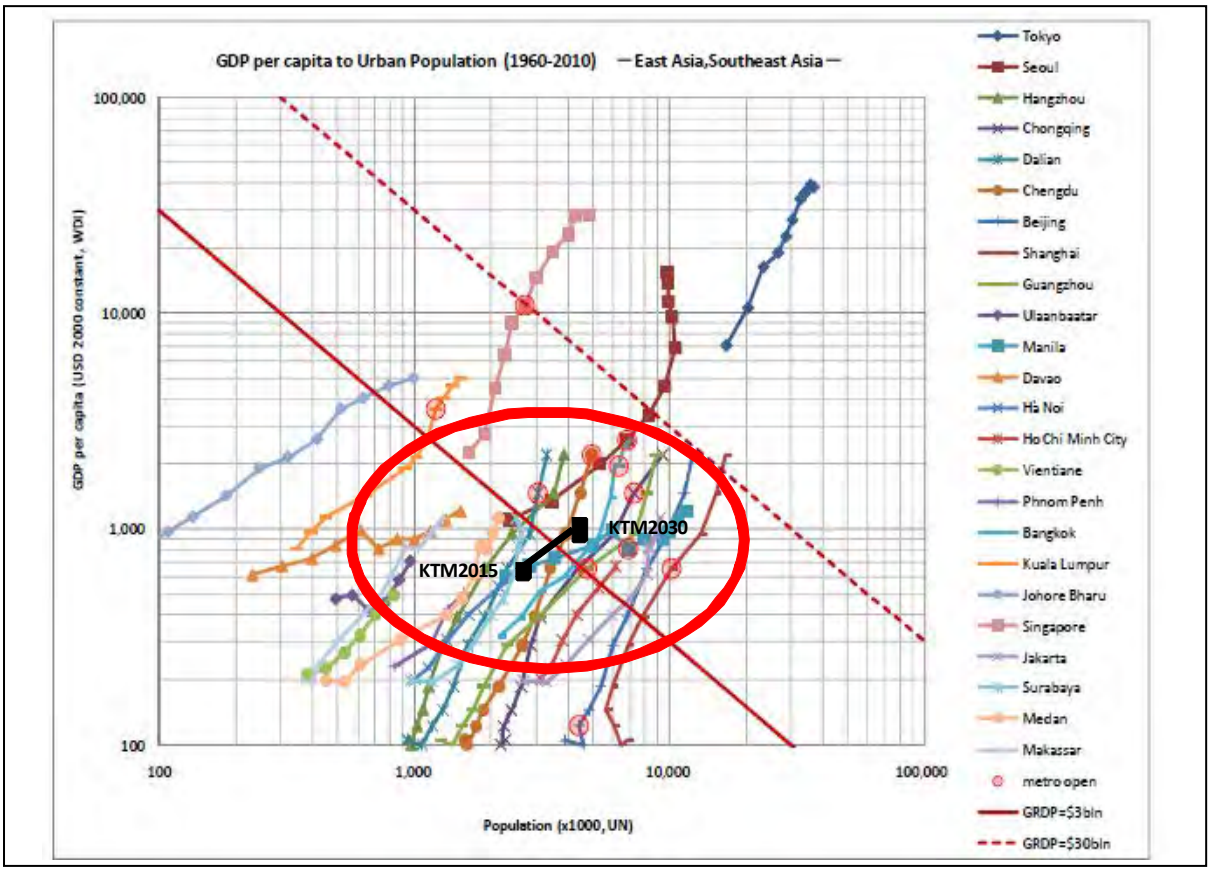
Figure 8.3.9 Image of East Station Plan

8.3.3 Introduction of New Public Transportation System

8.3.3.1 Appropriate Timing for commencement of Mass Transit System Operation

The timing for introduction of mass transit system in Asian mega cities is highly related to the gross income and population of the city. JICA's study on urban transportation planning in 2011 indicates that most of the Asian mega cities have commenced the 1st MRT operation when the gross product of the city became US$ 3 to 30 billion. The envelop curve in the following figure shows the trend of gross product of 24 Asian mega cities and the timing of the first MRT operation.

In the case of Kathmandu Valley, it is expected that the population in the valley would be 4 million and the GDP per capita would be over US$900 in 2030. Based on the experience in other Asian mega cities, it shall be appropriate to introduce the 1st MRT system in Kathmandu Valley between 2020 and 2030.

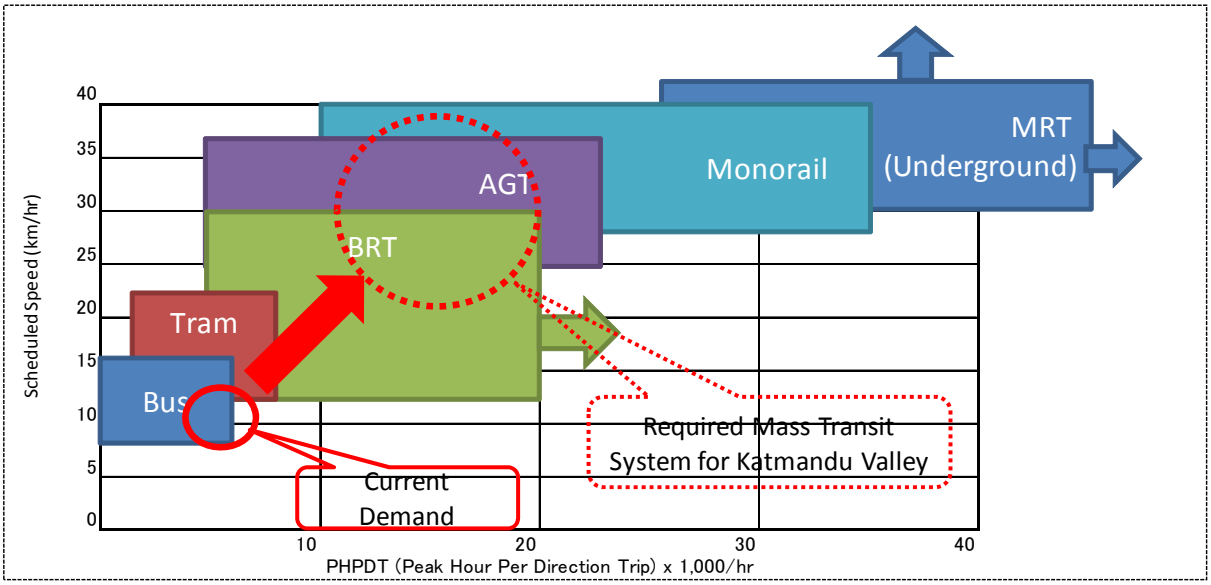


Source: JICA Research for Asian Country, 2011

Figure 8.3.10 Timing for the First MRT Operation in Asian Mega Cities

8.3.3.2 Selection of Mass Transit Mode of Kathmandu Valley

JST has estimated that the daily demand on public transportation system will be 100,000 persons/day for major corridors in Kathmandu Valley. The peak hour passenger per direction traffic (PHPDT) is estimated to be within the range of 10,000 to 15,000. Considering the expected speed of Mass Transit System is around 35 km/hr, the appropriate mode of public transportation system for Kathmandu Valley is BRT, AGT or Monorail System as shown in Figure 8.3.11.



Source: JICA Study Team made this figure referring to the document written by Japan Transportation Planning Association and other related documents.

Figure 8.3.11 Speed and Capacity of Mass Transit Mode

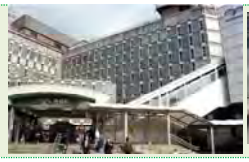
Figure 8.3.12 compares the characteristics of the different modes of mass transit system.
MRT system has the largest capacity with 25,000 to 85,000 PHPDT. Alignment of MRT is rather linear with large curve radius (minimum R = 200m) and horizontal gradient (maximum gradient = 35‰). MRT can be installed as elevated routes in sub urban area, but it is generally installed as underground routes in the center of urban area where high-rise buildings are densely built up.

Monorail system has comparatively larger capacity with 10,000 to 30,000 PHPDT. Monorail is generally installed as elevated structure system. Since its major structure is beams and no slab structure is required on the alignment, the system has advantages in less impact on the right to sunshine and landscape. Furthermore, high gradient up to 60‰ can be applied since the cars run by rubber tires on both sides of the beam. It is also flexible in horizontal alignment with minimum radius of 60 to 100m.

AGT system is defined as a new transit system, which is mainly used as a transport mode in major international airports of the world. Recently, it has widely spread to cities as a new and modern public transportation system. AGT system is generally driverless transit system. The cars run on the guided slab structure. Its flexible alignment can be 30-60m in minimum horizontal curve and 60‰ in maximum vertical gradient. Its capacity is estimated to be 5,000 to 23,000 PHPDT, which is almost the same or rather smaller than that of Monorail system.

BRT system is known as the most economical mass transit system, which is widely accepted in the world. The dedicated lanes on the roads will be prepared on the existing roads for both directions. No heavy structure is required. Its capacity is around 5,000 to 15,000 PHPDT, which highly depends on the condition of the dedicated lanes.

In Figure 8.3.11 and Figure 8.3.12, LRT or Tram is not referred as a candidate of mass transit system. LRT is usually operated on the road as same as BRT whereas AGT and Monorail are operated on the elevated structure or separated from the road horizontally. LRT has not enough capacity to carry more than 10 thousand PHPDT. In addition, LRT is not flexible and suitable for Kathmandu urban area where sharp slope and curve aliment is often required. Therefore LRT is excluded as a candidate of a new mass transit system for Kathmandu case.

Item	MRT	Monorail	AGT	BRT
Rolling Stock				
Station				
Capacity(PHPDT)	More than 25,000	10,000 - 35,000	5,000 - 23,000	5,000 - 15,000
Speed	More than 30 (km/h)	28 - 42 (km/h)	25 - 37 (km/h)	25 - 35 (km/h)
Construction and Operation Cost	Largest	Large-middle	Middle	Middle-small
Necessary Space	Small (Underground)	Large-middle (Viaduct)	Large-middle (Viaduct)	Large (Dedicated Lanes on Road)
Impact on Environment	Small / None/ None (Air / Noise / Aesthetic)	Small / Small / Small (Air / Noise / Aesthetic)	Small / Middle / Middle (Air / Noise / Aesthetic)	Middle/ Middle / Small (Air / Noise / Aesthetic)
Maximum Gradient	35‰	60‰	60‰	--
Minimum Curve	R= 170m – 200m	**R= 60m – 100m**	**R = 30m – 60m**	--
Note	• Mass Transit • High Speed • Huge Construction Cost • Less impact on environment (underground)	• Mass – middle transit • Road traffic is affected by the viaduct structure • Environmental friendly in **landscape , sunlight, and air circulation**	• Mass – middle transit • Road traffic is affected by the viaduct structure • Driverless Operation • **Flexible horizontal alignment**	• Mass – middle transit • Road traffic is severely affected by dedicated lanes • **Less Investment Cost**

Source: Prepared by JCIA Study Team based on various WEB sites information

Figure 8.3.12 Mode and Characteristics of Mass Transit System

Taking into account the geographic and topographic characteristics and further economic growth of Kathmandu Valley, public transportation system with medium capacity is the most appropriate mode, namely Monorail, AGT and BRT system. The estimated required capacity of public transportation is more or less 15,000 PHPDT as of 2035, and those transportation systems can cover the required capacity.

Where the road is wide enough to introduce BRT system, BRT is probably the best mass transit mode for Kathmandu Valley because of the cost advantage. Thus introduction of BRT system on the Ring Road is reasonable since the road is wide enough and expected to have high demand on public transportation. The other routes for BRT are on the Inner Ring Road and on the newly constructed road for Anantalingeshwor Sub Center. The new road for Anantalingeshwor is on the plan to connect the existing city center and new sub center by BRT.

On the corridors which are congested and narrow for BRT, AGT system is likely to be the best option for Kathmandu Valley. In particular, JST proposes developing AGT system on North-South Corridor along Narayan Gopal Chowk – Lazimpat – Kantipath – Patan – Satdobato, and on East-West Corridor along Arniko Highway. The reasons why AGT system is suitable for the congested corridors of Kathmandu Valley are as follows:

I. The topography of Kathmandu Valley is rather steep and not suitable to introduce ordinary MRT system. Only monorail or AGT system can meet the steep gradient of around 60‰.
II. Road width of Kathmandu Valley is rather narrow and building density along the main road is very high. Steep curves for horizontal alignment will be required to minimize affected buildings. AGT can be applied for steep curve with minimum radius of 30 to 60m.
III. AGT system has advantages in cost compared to Monorail System.

Table 8.3.4 summarizes the comparison of mass transit system, BRT, Monorail and AGT. Capacity and cost for Mass Transit System is shown in Table 8.3.4. The reason why range of capacity or cost is wide is that there are several types of BRT, Monorail and AGT in number of cars and lanes in practice. Therefore it is difficult to set narrow range of capacity and cost. It is better to understand the characteristics of mode if maximum capacity and cost is compared each other.

Furthermore, it is recommended that the final decision for mass transit system selection in Kathmandu urban area should be done based on the following viewpoints:

- There are several rivers crossing the area within the Ring Road. In particular Bagmati River crosses the area in the east and west direction. Location and structure of mass transit system for crossing river should be examined from the view of not only cost efficiency, but earthquake proof, environmental and cultural considerations.
- If elevated structure on the narrow road sections is introduced, location of piers should be selected to make use of the cross section of road appropriately and to manage the traffic flow smoothly during the construction work in order to avoid severe traffic congestion and accidents.
- Underground Metro in highly urbanised area is always an option as the highest capacity mode and ideal transport system not to disturb any activities and landscape although its cost is huge. It depends on cost-benefit balance financially and socio-economically whether the Metro is feasible or not. Currently the feasibility is seemed to be lower until 2030, but in the long run after 2030 it should be reconsidered.

Table 8.3.4 Comparison of Mass Transit System for KV

	Full Scale BRT	Monorail	AGT
Road Condition	• Should have 2 dedicated lanes (7m on route, 10m at Station) • Dedicated lane on Intersections for PHPDT > 5,000 •Passing through Lanes at Station for PHPDT > 10,000	• Required dedicated viaduct structure. • Required road width > 18m for 4 lanes, and 14 for 2 lanes. • Minimum curve radius = 100m ~ 60m	• Required dedicated viaduct structure. • Required road width >18m for 4 lanes, and 14m for 2 lanes • Minimum curve radius = 50m ~ 30m
Indicative Project Cost	Low (2 – 20 mil.US$/km)	High (50 – 100 mil.US$/km)	Middle(30 - 70 mil.US$/km)
Suitable Location	Ring Road Arniko Highway New Road Construction Site	Road width more than 20m	Road width more than 18m

Full Scale BRT is the best option in case enough road width is secured

→ Less Investment Cost

AGT shall be selected for Build-up Area with heavy traffic congestion

→ Advantages to Monorail in the view of alignment and cost

Source: Prepared by Study Team

8.3.3.3 Proposed New Public Transportation Network for Kathmandu Valley

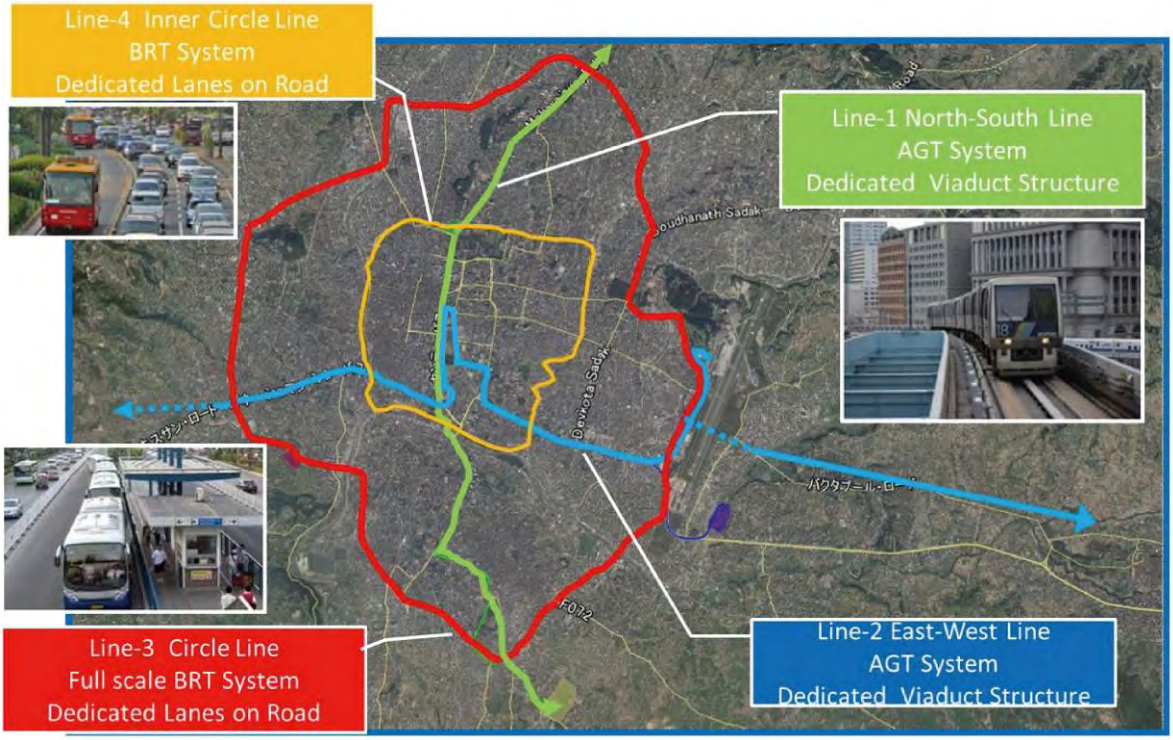
Figure 8.3.13 shows the proposed public transportation network for Kathmandu Valley, which is comprised of two AGT lines and two BRT lines. The network is planned in consideration of the urban development plan of Kathmandu Valley to provide as a reliable public transportation mode between the existing city center and new sub centers in Kathmandu Valley.

Total length of dedicated public transportation network is 80 km. 2 AGT lanes are planned as viaduct structure on the existing road. Kathmandu Central Station is proposed at Kantipath and New Road junction, which is a junction station of AGT Line-1 (North-South Corridor) and Line-2 (East- West Corridor).

Table 8.3.5 Proposed AGT and BRT Lines

Line No	Mode	Structure	Length(km)	Characteristics
1	AGT	Viaduct	10.9	North-South
2	AGT	Viaduct	25.1	East-West, Airport Link
3	BRT	At Grade	27.4	Ring Road
4	BRT	At Grade	17.4	Inner Ring Road
Total			80.8	

Source: JICA Study Team



Source: JST

Figure 8.3.13 Proposed New Public Transport Network

AGT Line-1 is proposed on North-South corridor. The total length is 11.9km between Narayan Gopal Chowk and Satdobato Depot Area. The route is planned on the existing road along Maharajganj Road, Lazimpat Road, Kantipath, Bagmati Bridge, Pulchowk (Patan), Jawarkhel Circle, Lagankhel Bus Terminal, Patan Industrial Estate and crossing over the Ring Road to Satdobato Depot. The road width is generally more than 18m, on which viaduct structure is technically possible to construct, except for Maharajganj – Panipokali on Lazimpat road, and Lagankhel – Satdobato on Lagankhel Road. The two narrow sections are required to be widened.

Table 8.3.6 Staations on AGT Line-1

Sta.No.	Station Name	Distance (m)	Accum. Distance (m)	Elevation (El.m)	Average Gradient	Road Width (m)
NS01	Narayan Gopal Chowk	0	0	1355		18m
NS02	Maharajgunj	1115	1115	1344	0.99%	14–17m
NS03	Panipholari	1130	2245	1324	1.77%	15–18m
NS04	Lainchaul	1052	3297	1318	0.57%	18m
NS05	Jamal	973	4270	1312	0.62%	20m
NS06	KTM Central (New Road)	642	4912	1311	0.16%	25m
NS07	Tripureshwar	937	5849	1297	1.49%	18m
NS08	Kupandole	1399	7248	1308	0.79%	20m
NS09	Jawalakhel	1299	8547	1335	2.08%	20m
NS10	Lagankhel	1308	9855	1331	0.31%	17m
NS11	Patan Industrial Estate	886	10741	1333	0.23%	14m
NS12	Satdbato Terminal (Depot)	1161	11902	1318	1.29%	

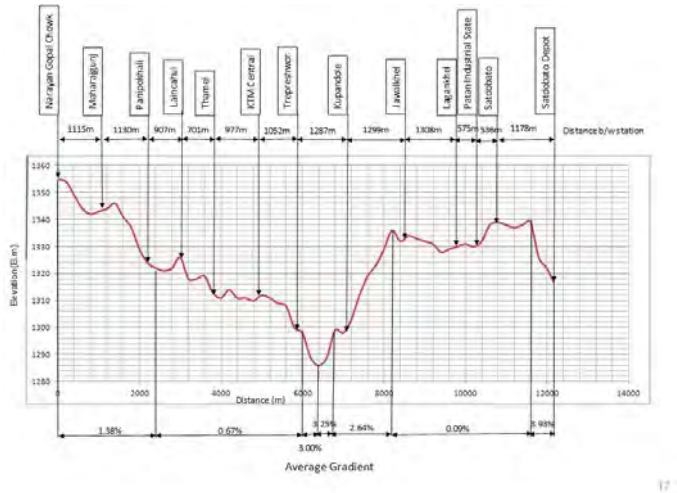
Source: JICA Study Team

Line-1 is a redevelopment axis connecting between Kathmandu and Patan in north- south direction via CBD, which can provide incentive to redevelop existing attractive sites.

Horizontal and vertical alignment of AGT Line 1 and Line 2 are shown below.

Source: JST

Figure 8.3.14 Horizontal Alignment of AGT Line-1



Source: JST

Figure 8.3.15 Longitudinal Profile of AGT Line-1

AGT Line-2 is proposed on East-West corridor. The total length is 13.8 km. Table 8.3.7 shows the list of proposed stations on AGT Line-2. The route is planned on Arniko Highway between Tinkune and Darbar Marg, passing through Kathmandu City Center on Kantipath, and on Ganesh Man Singh Road to Kalanki Junction. From Tinkune junction in the east, the route will take on Ring Road toward north and reach to Tribuvan International Airport. The route will take underpass crossing the airport and reach to the eastern side of the airport. Arniko Highway and Ring Road are wide enough even for BRT system, but JST proposes to introduce AGT system taking into account the future traffic demand on Arniko Highway, which will be a highly demanded route as the main corridor connecting Kathmandu and Baktapur. The number of traffic lanes should not be decreased due to AGT, thus dedicated viaduct structure on Arniko Highway is

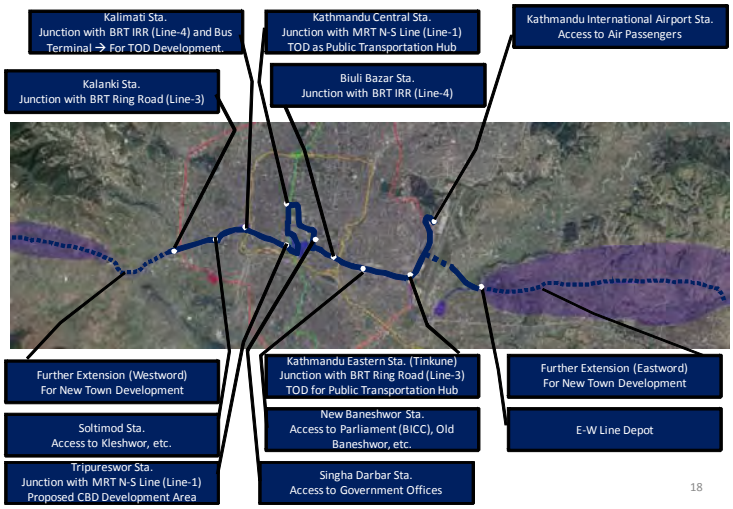
Table 8.3.7 Stations on AGT Line-2

Sta.No.	Station Name	Distance (m)	Accum. Distance (m)	Elevation (El.m)	Average Gradient	Road Width (m)
EW01	KTM West Terminal	0	0	1335		
EW02	Kalanki St.	1077	1077	1322	1.21%	20m
EW03	Soltimod St.	1345	2422	1296	1.93%	16m
EW04	Kalimati	841	3263	1297	0.12%	14-16m
EW05	Tripureshwor	1256	4519	1298	0.08%	18m
EW06	KTM Central (New Road)	1021	5540	1310	1.18%	20-40m
EW07	KTM Bus Terminal	442	5982			
EW08	Singha Darbar	1088	7070	1304	0.55%	20-40m
EW09	Biuli Bazar	1119	8189	1296	0.71%	40-50m
EW10	New Baneshwor	893	9082	1312	1.79%	40-50m
EW11	KTM East (Tinkune)	1098	10180	1301	1.00%	40-50m
	Junction Point	900	11080	1311	1.11%	20m
EW12	Puran Sinamangal	921	12001	1310	0.98%	12-14m
	E-W Line Depot	660	12661	1308	0.30%	12-14m
EW13	International Airport	1088	13749	1335	3.13%	20m

Source: JICA Study Team

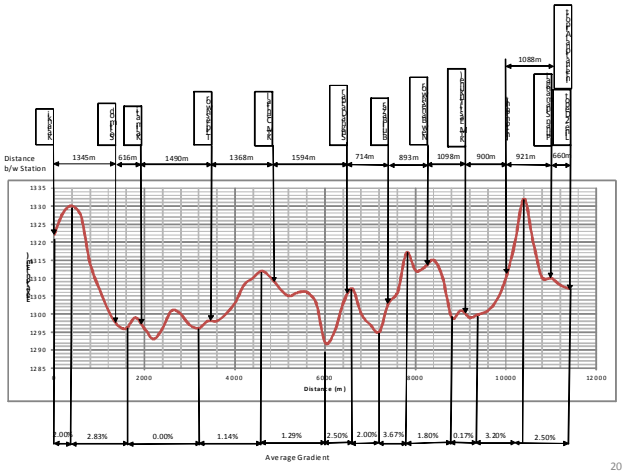
recommended. Likewise, since the road width from Trispreswor to the westward is not sufficient for introduction of AGT system, road widening will be required.

Line-2 is a new development axis or TOD corridor connecting the central station, CBD, Singha Durbar, airport, Bhaktapur and new towns on the route. It is very important to connect Line-2 with Line-1 at the Central station for not only residents but also tourists.



Source: JST

Figure 8.3.16 Horizontal Alignment of AGT Line-2



Source: JST

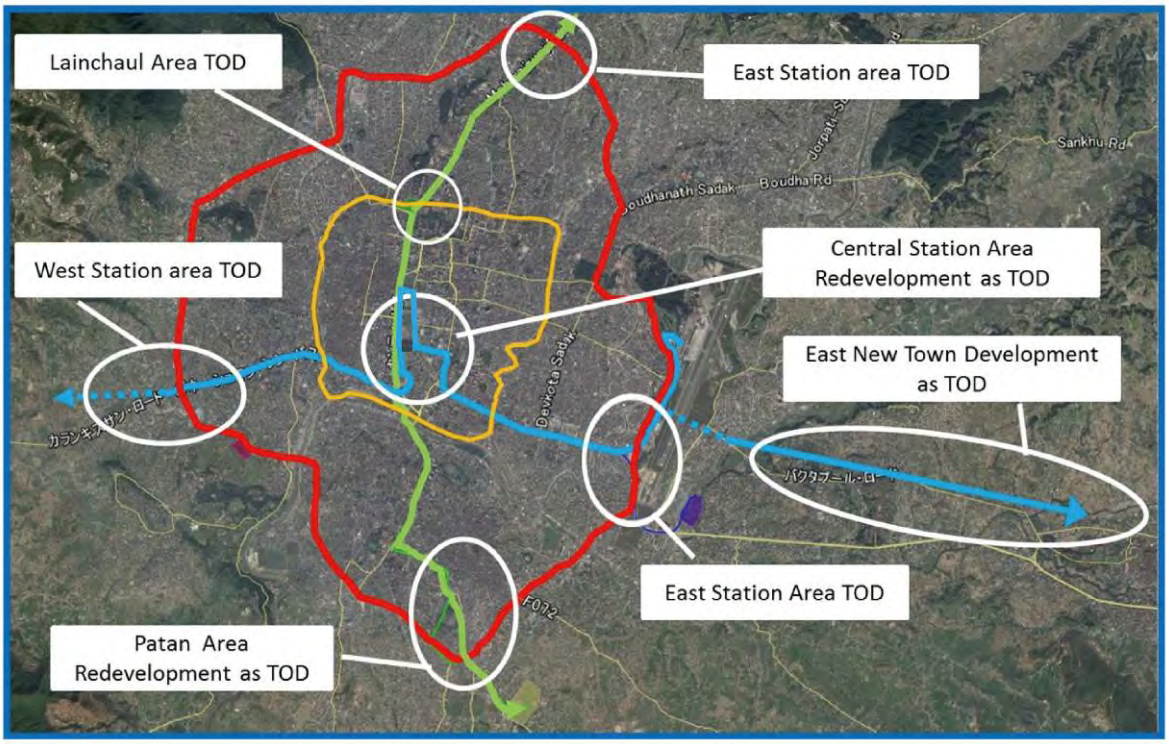
Figure 8.3.17 Longitudinal Profile of AGT Line-2

8.3.3.4 CBD / TOD Development at Junction Station

In general, terminals or junction stations of mass transit system are the most attractive sites for CBD (Central Business District) development. People gather at the stations for daily commutes to work or to school. Commercial opportunities targeting on the transit passengers can be highly expected, so that involvement of private investors in station development can also be expected. As a result, the land value in station surroundings can shoot up, which should be taken into account for the further urban planning. For the realization of TOD, redevelopment projects around the Central Station area and Patan Area should be implemented to attract tourists and investment.

Land pooling is necessary for station plaza development with participation of stakeholders such as railway operator and land owners. Formulation of a committee can allow a number of stakeholders to coordinate on land pooling as well as financial arrangement for station plaza development.

Kathmandu Valley Development Authority should take the lead as a coordinator of terminal/station development.



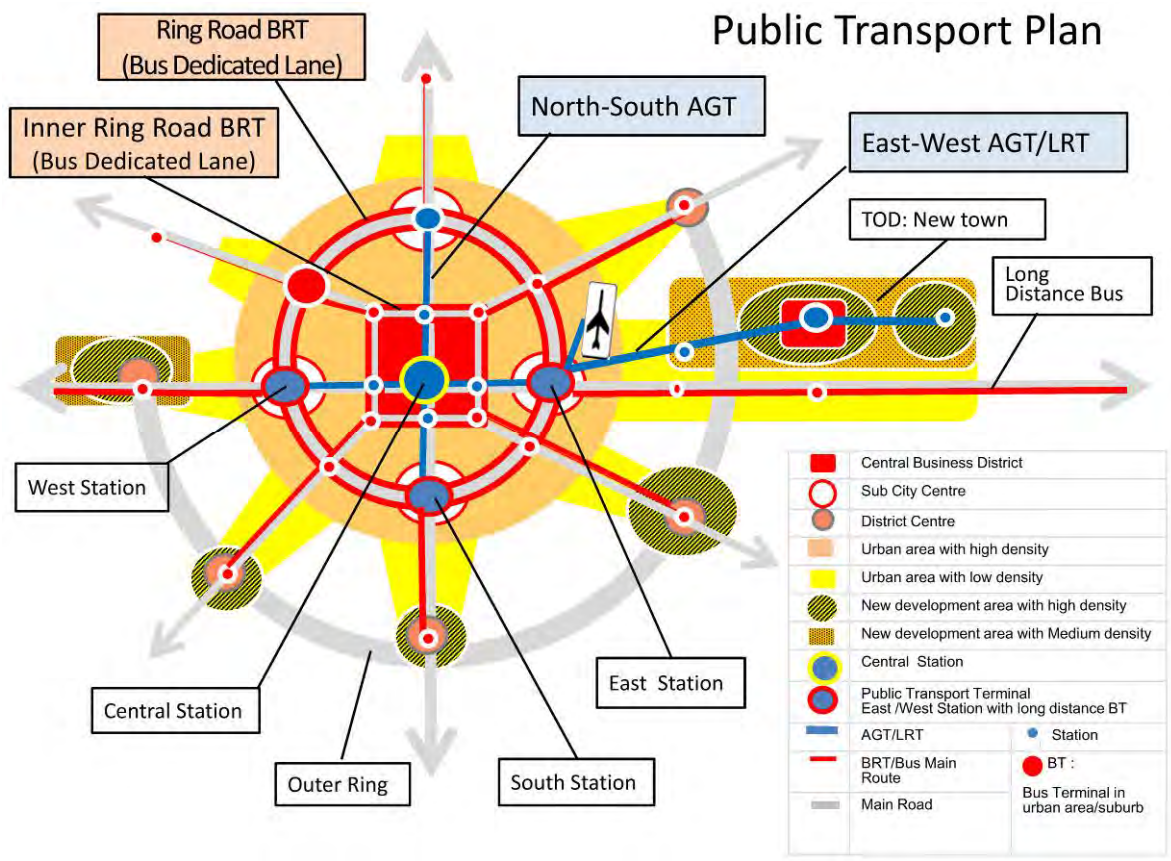
Source: JST

Figure 8.3.18 Potential Development Sites for TOD

8.3.4 Definitive Public Transport Network

(1) Public Transport Plan with New Transport System

JST proposes AGT and BRT as a new public transport. AGT is planned to be on North-South and East-West corridor and BRT is to be on the Inner Ring Road and the Ring Road. Figure 8.3.19 illustrates the conceptual plan of future public transport network.



Source: JICA Study Team

Figure 8.3.19 Future Public Transport Plan

8.3.5 Organization for operation & management of BRT and AGT

- Mass Rapid Transit System such as AGT/BRT should be installed on the primary routes as proposed in the Public Transport Plan because the demand of passengers per peak hour on the routes will be much larger than the ordinary bus capacity.
- An appropriate operator for AGT/BRT is required to manage the great number of vehicles, facilities, drivers, mechanics and other workers for frequent, punctual, and safe operation.
- KV is devoid of mass rapid transit operator and furthermore administrative organizations such as DOTM and DORW are deficient in enough capacity and experiences for managing and operating urban MRT system.
- Based on the above current situation, the following institutional and organizational alternatives are proposed.

Figure 8.3.20 Alternatives of Organization for AGT/BRT Operation and Management

	Current	After 2020 (BRT Operation)	After 2025 (AGT Operation)
Vehicle	Large/Medium bus Micro/Mini bus Tempo	Large Bus Capacity is more than 70 passengers.	AGT Train with six cars Capacity is more than 300 passengers.
Infrastructure	-Bus route -Bus stop -Bus terminal	-BRT route -BRT station -Bus terminal	AGT route AGT station Transport Terminal
Provider of infrastructure	DOR / local government	The alternatives are: 1) DOTM 2) KVDA *Provider should be decided by 2018.	The alternatives are: 1) DORW 2) KVDA *Provider should be decided by 2020.
Regulation: Route Planning, permission, fare, Vehicle license, etc.	DOTM	DOTM	DORW
Operation and Management	1) Semi governmental body (Sajha Yatayat Bus) 2) Private company	The alternatives are: 1) Semi governmental body under DOTM 2) Semi governmental body under KVDA 3) Private Company *Operator should be decided by 2018.	The alternatives are: 1) Special Agency under DORW 2) Special Agency under KVDA *Operator should be decided by 2020.
Comment by JICA Study Team	-lack of large sized operator	-Semi governmental body such as Sajha Yatayat Bus operator should operate BRT. -As far as primary investment for vehicles and facility is concerned, the government is required to help the management organization.	-Special agency for AGT operation and management should be established under the cooperation of international donors. -It will be possible for a new special agency under KVDA to operate and manage AGT operation because KVDA is a main player for TOD scheme along the AGT Routes and BRT routes.

Source: JICA Study Team

8.4 Traffic Demand Management

8.4.1 Traffic Management Development Strategy

As shown in Figure 5.2.12 in Chapter 5, walking and bus are dominant in travel mode, which account for 68.3% of all modes in 2011. The rate of "bus" has been almost the same from 27.2% in 1991 to 27.6% in 2011 but "walking" has reduced from 53.1% in 1991 to 40.7% in 2011. Instead of the decrease in "walking", "motorcycle" has been rapidly increasing from 9.3% in 1991 to 26% in 2011. The mode "cars" has been almost the same from 3.8% in 1991 to 4.2% in 2011. The average trip length of all travel modes is 5km as shown in Figure 5.2.7 in Chapter 5.

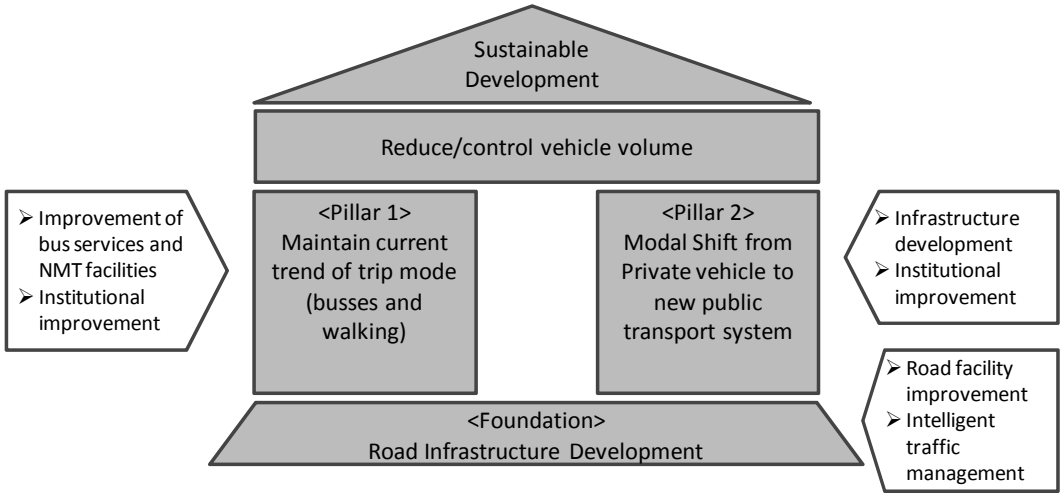
People's mobility in the valley is low. Walking serves as the prime mode of transport for their personal mobility, in particular, to and from home and school. Bus and motorcycle serve as the secondary mode of transport to and from place of work and business. Bus system is beleaguered with

perennial problems and services provided are often regarded as inadequate. This results in people preferring to live near their place of work, particularly in old and narrow houses around the CBD area.

Due to recent rapid sprawled urbanization and increasing people's income, vehicle ownership and use of the motor vehicles will expectedly expand and further excessive modal shifting from busses to motorcycles will be accelerated. Increase of motorcycle will induce a shift to use of private cars along with increasing economic activities and peoples' income.

Kathmandu Valley has common urban transport problems like other urban cities in Asia such as serious traffic congestion and accompanying air pollution, traffic accidents, among others. The shortage of available parking space in the urban center is also a serious problem. Although the respective city governments attempt to promote the use of public transportation by way of controlling or regulating the private mobility, these may not automatically result in a fast modal shift from the private to public modes due to the convenience of using private cars which provide "door-to-door" transfer of passengers. Consequently, roles of Traffic Demand Management (TDM), sometimes known as "mobility management", become more important as well as to be permanent and long term policy not limited to the short or temporary measures until sufficient road network be developed.

Principal TDM policy shall be to develop a comprehensive management policy in coordination with overall transport policies and urban development policy as well. The proposed comprehensive traffic management policy and TDM measures are presented below.



Source: JST

Figure 8.4.1 Image of Proposed Comprehensive Traffic Demand Management Policy

Table 8.4.1 Traffic Demand Management (TDM) Measures

Measures	Relation with Policy (Fig. 8.4.1)	Proposed Menus
Economic Measures	Pillar 1 & 2	● Taxation (fuel tax, ownership tax, cordon charging, etc) ● Parking charge ● Subsidizing public transport, etc.
Land Use		● Land use and transportation strategies such as car-free developments, and finding the right location for the new developments ● Park and ride (P&R) facilities, etc.
Information for Travelers		● Travel information before a trip is undertaken ● Car pooling, car sharing, etc. ● Tele-activities and interaction ● E-commerce, etc.

Administrative Measures	Foundation, Pillar 1 & 2	● Parking controls ● Area licenses scheme ● Pedestrian zones (on-going by ADB) ● Alternative working hours, flexible-working, home working, etc
Infrastructure Measures (except road/public transport network construction)		● Improved public transport facilities incl. P&R ● Demand responsive road traffic control ● Parking development ● Improved NMT facilities

Source: JST

8.4.2 Traffic Management Projects

Traffic demand management may not require huge amount of investment such as construction of infrastructures for road and new public transport system. The issue for the traffic management in this MP is how to provide appropriate measures responding to the changing social needs. In the short term, it is required to tackle with the existing traffic issues including traffic congestion and traffic accidents, while in the long term more radical countermeasures which will be able to change peoples' behaviours and habits and to meet global environmental requirements. How to restrain the motorization and how to make people stay on the public transport system will be radical issues in the traffic management sector.

In accordance with the above-mentioned circumstances and the development strategy mentioned in the section 10.1, JST has proposed the projects listed below aiming to mitigate existing traffic issues as well as to strengthen various administrative functions for traffic management.

1) Traffic Congestion Mitigation Project
2) Capacity Development Project on Traffic Planning and Management
3) Kathmandu Valley Parking Development Project
4) Kathmandu Valley Traffic Safety Program

8.4.2.1 Traffic Congestion Mitigation Project

Unlike most urban cities, Kathmandu Valley controls well the issues regarding road vendors/street markets occupying busy carriageway and sidewalk. However, the main issues in the Valley are on-road parking and insufficient traffic management especially at intersections. On-road parking is an obstacle to the traffic reducing the road capacity to less than the originally designed. Most of the on-road parking in the Valley is caused by over supplied public transport (bus, mini-bus, and private taxi), trucks and motorcycles. The following photos indicate general condition of the parking issue in the Valley.

(Well-controlled parking on Arniko Road)

(Off-road parking space behind buildings)

(On-road parking on arterial road)

(On-road parking by large/medium size busses)

(On-road parking by mini busses)

(On-road parking by motorcycles)

Source: JST

Figure 8.4.2 Parking Conditions in Kathmandu Valley

The following is the main issues of congestion mitigation in the valley.

1) Lack of institutional framework
2) Less road capacity due to “on-road parking”
3) Insufficient management of the public passenger bus operations
4) Insufficient traffic management and signal operations

5) People's road use behaviour

Table 8.4.2 Main Issues and Proposed Measures

Issues	Proposed Measures and Project Components	Implementation Period
Lack of institutional framework	"Institutional strengthening program" Provision of guidance and enforcement, review of illegal parking penalties, capacity development of traffic police, etc.	Short-term
Less road capacity by "on-road parking"	"Off-road parking development" Parking development plan shall be prepared as indicated in the section 8.4.2.3 below.	Short/Mid-term
Insufficient management of the public passenger bus operations	"Improvement of bus services" as proposed in the section 8.3 in order to maintain current trend of trip mode (busses and walking)	Short/Mid-term
Insufficient traffic management and signal operations	"On-going program under ADB (KSUTP)" Additional installation of the traffic signal shall be further studied after or during KSUTP.	Short/Mid-term
Lack of people's road use behaviour	"Seminar, workshops, community activities"	Mid/Long-term

Source: JST

8.4.2.2 Capacity Development Project on Traffic Planning and Management

Traffic management is one of the most significant urban transport policies to enhance the efficiency of road network system and to control traffic demand; nowadays the role of traffic management is increased to meet the requirements from global climate change as well as economic losses induced by the traditional automobile oriented development. TOD becomes a common target in major cities in the world. Traffic demand management is an indispensable component to build public transport oriented society. However, the current specialized organization responsible for the traffic management, DOTM does not have adequate capacity to control the traffic demand. This project is aiming to strengthen the capacity of DOTM and establish a new organization specialized in the management of the newly proposed public transportation system. Capacity development of DOTM is currently in progress under ADB. Outline of the project is as follows:

[Objective of the Project]

- Improve transport planning capability including traffic survey and analysis
- Enhancement of intersection traffic management skill
- Improve implementation capacity on Transport Demand Management Measures including parking policy

[Activities]

i. Training (lecture) on transport planning, intersection planning, TDM, parking measures and other traffic management issues

ii. Implementation of pilot projects (intersection improvement, parking management and propaganda activities, and some traffic safety measures)

iii. Counterpart training in Japan and third countries

iv. Seminars and workshops

v. Preparation of mid-term traffic congestion improvement plan based on KSUTP

This project shall be implemented in corroboration with the proposed traffic mitigation projects so that the proposed organization will have practical experience.

8.4.2.3 Kathmandu Valley Parking Development Project

On-road parking causes traffic congestion due to the decrease in road capacity by the parking vehicles. And on-road parking occupies public space without due charge, while public transport users have to bear passenger fare. From the viewpoint of benefit principle, the following policy is applied for the improvement of parking condition.

a. Car owners should prepare parking space at their residence.
b. Enterprises should prepare parking space for vehicles of business use.
c. Enterprises should prepare parking space for vehicles of employer/employee.
d. Facilities which attract many guests/customers should prepare parking space for guests/customers.
e. For the general parking demand, development of public parking is enhanced.

Based on the aforesaid policy, the following projects shall be conducted.

(1) Establishment of Parking Development Plan

The area which has serious traffic congestion due to street parking shall be identified first. Then parking survey is conducted in the identified area. Capacity of existing off-road parking lot and number of on-road and off-road parking vehicles are surveyed and parking demand is analyzed utilizing person trip data. Based on the survey and analysis, policy for parking development is established.

- Forecast of parking demand in future.
- Analysis on method for supply of parking
- Institutional plan
- Parking development plan

(2) Institutional Plan

1) Equipment duty car park

Facilities which attract many guests/customers will be obliged to install necessary parking lot (Equipment duty car park). Type of facility which is target of the equipment duty car park will be clarified and required capacity will be analyzed. Necessary procedure for institutional arrangement will be proposed.

2) Financial aid for parking development

The public parking lot outside the parking restricted area needs to be arranged strategically. 500 m is the rough standard distance between parking lot and people's destination such as public facilities and shopping centers. In the city center where parking demand concentrates, development of multi-story car park is expected for the efficiency of land use. However sometimes construction cost is not covered by the parking fee. Therefore financial aid such as subsidy and low-interest loan is recommended.

(3) Parking Development by the Government

The government itself should develop parking building utilizing unused and low used ground when the private investment to car park is not expected.

(4) Parking Charge Policy based on Beneficiary Charge

Parking lot business should be profitable. Parking lot inside the parking restricted area and at the fringe area should be charged. The department of the parking lot business aims to be profitable. In case of financial shortage, the parking lot should also be made under the management of the department as well collection of parking fines.

(5) Installation of Parking Lot Guidance System

Parking lot guidance system and related facilities should be introduced in the CBD to guide drivers to the appropriate use of parking lot. Since parking space will be limited in the CBD, drivers will probably have difficulties in finding parking space as opposed to the present situation where they park on the street except for some arterial roads. The drivers searching and waiting for parking space might cause traffic congestion in the CBD.

(6) Parking Management and Parking Violation System

Various institutions and systems should be developed to conduct parking management works effectively such as parking lot maintenance, collecting parking charge, crackdown on parking violation, and collection of parking penalty.

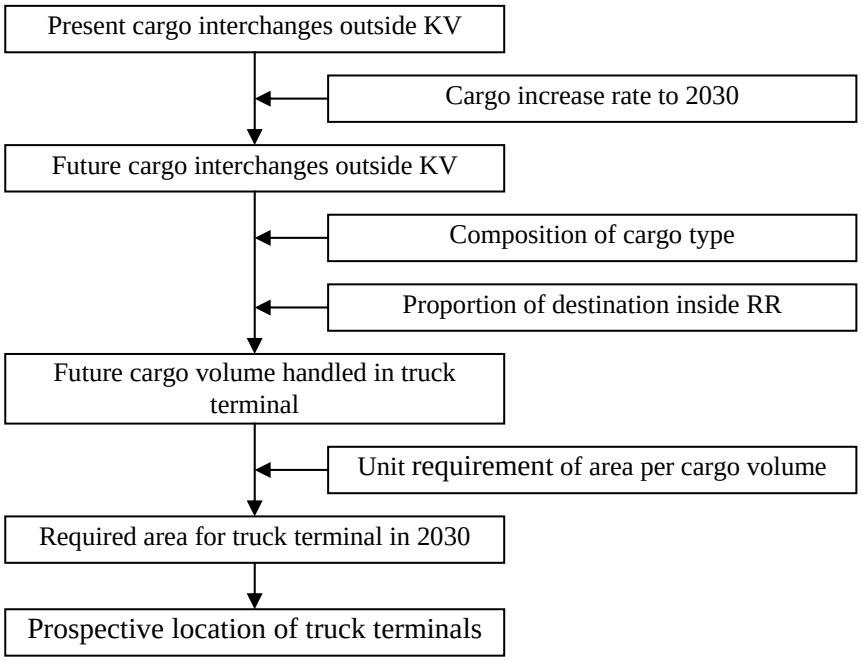
(7) Procurement of Financial Source and Repayment Planning

Procurement of financial source for public parking development and maintenance cost should be considered along with the repayment planning. The profitability of the project should be examined in the financial analysis.

8.5 Logistic Plan

8.5.1 Objective of Logistic Plan

Generally, as economic activities become active and informal activities increase, movement of small commodities become commonplace. In this condition, large trucks are not appropriate for flexible delivery and collection of commodities in urbanized area. Based on this concept, large trucks are prohibited to enter inside the Ring Road from 5:00 to 22:00 at present. Hence, in this section, necessary capacity of truck terminal for transshipment of cargoes between large trucks and light trucks are estimated and possible locations are analyzed. Method for analysis is shown in Figure 8.5.1



Source: JICA Study Team

Figure 8.5.1 Flowchart of Logistic Plan

8.5.2 Development of Truck Terminal

8.5.2.1 Future Freight Traffic Demand

(1) Present Freight Volume by Heavy Goods Vehicle (HGV)

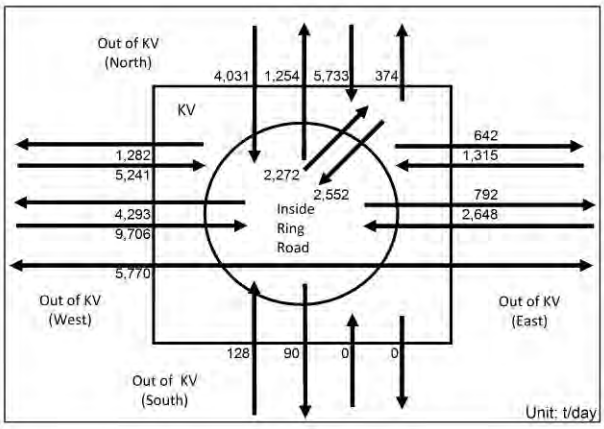
Cargoes carried by heavy goods vehicles (HGV) requires re-shipment. Freight movement by HGV captured by the roadside freight OD survey is shown in Table 8.5.1 and Figure 8.5.2.

Table 8.5.1 Freight Traffic Movement around Kathmandu Valley

Unit: t

	Inside RR	Kathmandu Valley	Lalitpur South	Eastern Outside	North Eastern Outside	North Western Outside	Western Outside	India	Outside KV Total	Total
Inside RR	920	2,272	90	792	257	997	3,873	420	6,429	9,619
Kathmandu Valley	2,552	739	0	642	123	251	1,216	66	2,298	5,589
Lalitpur South	128	0	0	0	0		118	0	118	246
Eastern Outside	2,648	1,315	5	349	17	0	377	18	766	4,729
North Eastern Outside	3,514	5,441	0	68	0	0	165	0	233	9,187
North Western Outside	517	292	0	0	0	0	10	0	10	819
Western Outside	8,809	4,989	42	3,329	393	0	85	0	3,849	17,647
India	897	252	0	794	0	0	0	0	794	1,943
Outside KV Total	16,513	12,289	47	4,540	410	0	755	18	5,770	34,571
Total	19,985	15,300	137	5,974	790	1,248	5,844	504	14,497	49,782

Source: JICA Study Team



Source: JICA Study Team

Figure 8.5.2 Freight Traffic Movement around Kathmandu Valley

With regard to the freight volume carried by HGV to/from Kathmandu Valley, total inbound and outbound freight volumes per day are 28,802t and 8,727t respectively.

(2) Future Freight Volume by HGV

Increase rate of freight volume to the target year are estimated in accordance with the increase rate of traffic volume of trucks between Kathmandu Valley and outside of the Valley as shown in Table 8.5.2.

Table 8.5.2 Increase Rate of Traffic Volume of Truck between KV and Outside of KV

Year	Increase rate
2014	1.000
2020	1.38795
2025	1.83196
2030	2.37552

Source: JICA Study Team

Based on the increase rate, future freight volume is given as shown in Table 8.5.3

Table 8.5.3 Future Freight Volume of HGV between KV and Outside Area

Year	Inbound	Outbound
2014	28,802	8,727
2030	68,400	20,700

Source: JICA Study Team

(3) Freight Volume to the Terminal

1) Type of Cargo

Composition of cargo type in volume inbound/outbound to/from Kathmandu Valley is shown below.

Table 8.5.4 Composition of Cargo Type inbound/outbound to/from Kathmandu Valley

Unit:%

	Inbound	Outbound
Timber	4.0	2.8
Agricultural	11.9	18.2
Oil	5.8	5.6
Mineral or Earth and sand	10.6	12.5
Machinery	2.2	4.0
Chemical	2.4	3.2
Construction Material	51.7	28.7
Miscellaneous	11.4	25.0
Total	100.0	100.0

Source: JICA Study Team

With respect to types of cargo handled in the truck terminal, agricultural, machinery and miscellaneous are major items. Other types of cargoes are carried to stockyards, warehouses or factories and processed to secondary products. Total percentage of type of cargoes handled in the truck terminal is 25.5% of inbound cargoes and 47.2% of outbound cargoes.

2) Delivery/Collection Area

Basic concept of logistic plan is to restrict the number of large trucks inside the Ring Road. Therefore proportion of traffic demand whose final destination is inside the Ring Road is required. Based on the assumption that the destination of trucks is the place of economic activity, person trip attraction of trip purpose “To work” represents the final destination of cargoes carried by large truck. Proportion of person trip attraction inside the Ring Road is shown in Table 8.5.5

Table 8.5.5 Proportion of Person Trip Attraction inside KV

	2011	2030
Total trip attraction of "To work" in KV	632,965	1,019,102
Total trip attraction of "To work" inside RR	405,960	478,998
Proportion	64.1%	47.0%

Source: JICA Study Team

3) Freight Volume to Truck Terminal

Taking into account the future freight volume between Kathmandu Valley and outside of the Valley, type of cargo and delivery/collection area, freight volume to be handled in the truck terminal is calculated as shown in Table 8.5.6.

Table 8.5.6 Freight Volume to be handled in Truck Terminal

Year		Freight volume (t/day)	Percentage of cargo type handled at truck terminal (%)	Percentage of cargo relating inside RR (%)	Freight volume handled at truck terminal (t/day)
2014	Inbound	28,802	25.5	64.1	4,700
	Outbound	8,727	47.2	64.1	2,600
2030	Inbound	68,400	25.5	47.0	8,200
	Outbound	20,700	47.2	47.0	4,600

Source: JICA Study Team

As a result of estimation, future freight volume in 2030 for the truck terminal is 8,200t/day for inbound and 4,600t/day for outbound.

8.5.2.2 Required Area for Truck Terminal in Future

The necessary area for truck terminal is estimated utilizing cases in Japan and Thailand (See reference table). Based on the example cases, unit requirement of area against freight volume is assumed to be 18m^2/t/day. Required area for the truck terminal is estimated as 23.1ha in 2030.

Table 8.5.7 Required Area for Truck Terminal in 2030

	Freight volume (t/day)	Area unit requirement (m^2/t/day)	Required truck terminal area (m^2)
Inbound	8,200	18	148,000
Outbound	4,600		83,000
Total			231,000

Source: JICA Study Team

WB is conducting the study for the improvement of logistics and issued “Nepal Trade Facilitation and Logistics Improvement Study”, January, 2014. In the study, Inland Clearance Depot (ICD) with 8 ha area in Chobar site is proposed. On the presumption that the ICD is constructed, additional truck terminal with 15 ha is required.

8.5.2.3 Location of Additional Truck Terminal

Seeing that almost all inbound trucks are coming from west and outbound trucks are going to east, there should be one truck terminal in west for inbound trucks and one in east for outbound trucks.

- West side truck terminal (7 ha): Expansion of planned ICD or new location along Outer Ring Road for inbound trucks.

- East side truck terminal (8ha): New location along Outer Ring Road for outbound trucks.

Reference) Example of Truck Terminal

Name of Terminal	Area (m^2)	Cargo volume handled (t/day)	Unit requirement of area (m^2/t)
Keihin, Japan *1	242,068	13,000	18.6
Itabashi, Japan *1	115,828	7,000	16.5
Adachi, Japan *1	113,328	6,500	17.4
Kasai, Japan *1	184,976	10,500	17.6
Greater bangkok *2	399,675	19,347	20.7

*Source: *1 Japan Motor Terminal Co., Ltd homepage, *2 The Study on greater Bangkok truck terminal in the Kingdom of Thailand. Final report, JICA, 1992,9.*

8.6 Traffic Safety Plan

8.6.1 Traffic Safety Development Strategic Plan and Program

8.6.1.1 Planning Goals and Target

The purpose of the strategic plan is to formulate long-term strategies which can reduce the number of road traffic accidents with consideration of future socio-economic situation. Moreover, the following two areas are needed to properly address the essential elements of road traffic safety.

- Develop a countermeasure which can mitigate road traffic accidents at present as well as in anticipation of the highly-motorized traffic society in the future
- Develop institutional fundamentals of sustainable development of traffic safety policy and measures

In order to show a strong policy for this strategic plan, a numerical target should be proposed to make it possible to estimate the socio-economic benefits of the measures.

Table 8.6.1 Target of the Traffic Safety Strategy and Responsible Institutions

Target	Reasons	Responsible Organization
Drives/Owners	Statistically it was found that most of the causes of traffic accident derive from drivers/owners driving behaviour. Lack of driving skills as well as manners give strong influence to traffic safety.	MOE/MOFALD/MOHA
Mechanical	For public transport such as bus and tempo, mechanical condition was the strongest cause related to traffic accident.	MOPIT/DOTM
Manual /Guideline	Most of the manual/guidelines including design standards were established in the 90's and have not yet been updated since then.	MOPIT
Institution /Statistic	Utilization and reflection of analyzed past accident records to the planning and strategy is not only effective but also essential.	MOPIT/MOE/MOFALD/ MOHA
City Structure	Complicated road alignment with narrow roads, concentrated traffic flow, and inadequate traffic safety facilities makes traffic accidents blackspots.	MOPIT

Source: JICA Study Team

8.6.2 Identification of Current Traffic Safety Issues

(1) Identification of traffic safety policy issues

Traffic safety issues being subjected to policy consideration and strategic planning will be identified based on the analysis of the present situation and shall be categorized into specific themes.

Road traffic safety institutional capacity building which includes human and financial resources development is essential besides the development of effective road traffic safety measures. The strategic plan thus requires focus on both traffic safety and institutional development.

(2) Summary of the Existing Traffic Safety Problems

Institutional and sectorial traffic safety problems were examined to identify policy and planning issues based on present traffic safety situation in Kathmandu Valley including analysis of traffic accidents, traffic safety measures and traffic safety institutions as mentioned above. From discussion and explanation made in 5.1.4 of this report, summary of the existing traffic safety problems and issues shall be given below.

Table 8.6.2 Summary of the Current Traffic Safety Issues and the Key Organization

Categories by UN / Targets & Responsible Organization	Pillar-1 (Manage-ment)	Pillar-2 (Road Conditions)	Pillar-3 (Vehicles)	Pillar-4 (Uses)	Pillar-5 (Post-Crash)
A: Drives/Owners (MOE/MOFALD/ MOHA)				A1: Inadequate awareness to follow traffic rules A2: Inadequate training driving skills, law, culture	
B: Mechanic (MOPIT/DOTM)			B1: No frequent maintenance /inspection system		
C: Manual /Guideline (MOPIT)	C1: No update on Manual/ Guideline since established				
D: Institutions /Statistics (MOPIT/MOE/ MOFALD/MOH A)	D1: No practical use of Accident Data. D2: No				

	specialized T/F Unit				
E: City Structure (MOPIT)		E1: Inadequate safety facilities E2: Inappropriate cross section, intersection, alignment E3: Blackspots			

Source: JICA Study Team

8.6.2.2 Basic Strategies for Traffic Safety Measures

Basic strategies will be discussed in two areas, which are basic planning policies and implementation strategies.

(1) Basic Planning Strategies

- For Basic Planning Strategies, five pillars which were defined by the UN shall be followed.
- Establishment of necessary institution including establishment of new laws and regulations and database shall be implemented within this strategic period.
- Sustainable human and financial resources are the most important challenges of the strategies.

(2) Implementation Strategies

- Appropriate mechanisms to promote comprehensive traffic safety measures shall be developed, which can be referred to as the 4Cs (Communication, Cooperation, Collaboration and Coordination) among traffic safety stakeholders.
- Priority shall be given to human resource development rather than investing on highly advanced technology system such as introduction of traffic control center and ITS (Intelligent Transport System).

8.6.3 Traffic Safety Development Strategies

The following strategies shall be given as a countermeasure to issues indicated in Table 8.6.2 above.

Table 8.6.3 Traffic Safety Development Programs

S/N	UN Pillar /Target	Name	Objective/Background	Issues	Contents
1	Pillar -1 Management C: Manual/Guideline	Road Safety Audit System Development Program	• Road Safety Audit Manual was introduced in 1997 on the purpose to save cost introducing road safety facility on opening roads as well as rehabilitation of sections of existing roads. • The manual requires intervening to audit the road design from the early stages of the project such as feasibility study since huge amount of investment must be required on development or improvement in future and not at early moments. Saving in the damaged section should also be introduced as an alternative allocating budget rather than just opening new alignments. • However, this manual has not been updated since it was established and does not cover recent technologies such as LED, GPS and others. • Furthermore, establishment of new traffic management organization is now underway, and the operation of this manual shall be reconsidered to harmonize with this policy.	• Review and revise the current manual. • Development of Guideline to guide the target, procedure and others how to utilize the manual. • Training and promotion of new manual & Guideline • Enhancement of legislation regarding obligation and responsibility of relevant authorizes. • Incorporation to the new organization system.	• New road safety audit system and manual & guidelines
2	Pillar-1 Management D: Institution/Statistics	License renewal system development Program	• License management is essential to maintain appropriate quality of drives. • In Kathmandu, current driving management system is not proper as it has no link with the accident & violation record to law to give accurate evaluation. • Development of database with linkage to other personal data shall be considered. •	• Promotion of computerized driving license and database system • Development of a computerized driving license management system.	• License renewals system • Development of license management system
3	Pillar-1 Management D: Institutions/Statistics	Traffic Safety Monitoring and Maintenance Program	• The success of traffic safety depends on the road management authority's capacity as well as stable financial resources. • However, under the limited human and financial resources, it might be difficult to plan and implement effective/efficient road safety mitigation.	• Capacity development on planning of implementation of traffic safety environment improvement • To ensure financial sources for traffic safety environment improvement in responsible government agency.	• Capacity Development on planning and implementation of traffic safety environment improvement

S/N	UN Pillar /Target	Name	Objective/Background	Issues	Contents
			• Therefore, introduction of capacity development for planning, implementation and monitoring is proposed. • Furthermore, this Program shall be in collaboration with establishment of traffic management agency which is currently underway by the Government.		
4	Pillar-1 Management D: Institutions/Statistics	Traffic Safety Research and Development (R&D) Program	• The present road authorities do not have any comprehensive department or unit which controls the data related to traffic accident such as interview/inspection record, vehicle inspection/registration record and driving license update/issuing records. • To have efficient and effective planning on traffic safety, analyzing the past record is a significant matter and needs an organization exclusively responsible for traffic safety mitigation.	• Enhancement of legislation regarding obligation and responsibility of relevant authorities, and education of Road Safety Audit (RSA). • Establishment of licensing /accrediting system and human resource development mechanism for the auditors. • Utilization of database supporting the auditing, development of the supporting tools and establishment. • Scientific traffic accident analysis	• Utilization of the black spot improvement database, development of supporting tools and establishment of the executing agency, • Follow-up the results of post monitoring of the black spot improvement. • Utilization of licensing/accrediting system and human resource development mechanism of the auditors. • Utilization of database supporting the auditing, development of the supporting tools and establishment of the responsible agency • Scientific traffic accident analysis, evaluation of effectiveness of RSA implementation and cost-effectiveness, and feedback mechanism for the results to be appropriately utilized. •
5	Pillar-2 Road condition E:City Structure	Black Spot Improvement Program	• Approx. 75% of the accident happens at 10 worst traffic accident locations which are called the Black Spots. • Targeting to improve the Black Spots would contribute to reduction in the number of traffic accidents in the Valley. • Prioritizing treatment of these locations would respectively provide the highest return in terms of number of accidents avoided. • Therefore, the black spot improvement has to be conducted immediately as it is expected to effectively reduce traffic accidents with effective utilization of experiences and feedbacks.	• Need to legislate to designate executing agencies with clear delineation of responsibility and to further promote understanding among stakeholders. • Development of the Black Spot improvement system, such as definition of the criteria, upgrading the Black Spot improvement system, develop cost-effective measures both in terms of time and resources in a sustainable manner to secure stable allocation of financial resources. • Training and technical upgrading system for the Black Spot improvement engineers.	• Legislation designating executing agencies with clear delineation of obligations and responsibilities and further promotion of understanding. • Development of the Black Spot improvement. • Training and technical upgrading system for black spot improvement engineers. • Utilization of the Black Spot improvement data base, development of supporting tools and establish executing agencies. • Institutionalization of school traffic safety education, development of

S/N	UN Pillar /Target	Name	Objective/Background	Issues	Contents
					curriculum and teaching materials • Sustainable coordinated safety awareness activity system development • Sustainable community traffic safety system development • Traffic safety consciousness publication by media
6	Pillar-2 Road Condition E: City Structure	Traffic Safety Facility Enhancement Program	• Instruction and guidelines on adoption of basic traffic safety facilities in Nepal are indicated in design standards basically. However, since many traffic accidents occur due to illegal & careless driving, the standard shall be updated based on assessment of the practical accident analysis of subject road. • In consideration of lessons learnt from the traffic accident report of the traffic police, it can be said that simple introduction of international standards from developed countries shall not be effective since such standards are generally preconditioned with effective enforcement, drivers training and safety education and promotion. Furthermore, traffic conditions and type of traffic on the roads are much different from Nepal. • Therefore, it is necessary to review and revise accordingly the design standards and guidelines on more road-safe consciousness as well as the road safety facilities based on the accident analysis and assessment of the relationship between the accident and road facilities.	• Road network development with appropriate road function sharing • Enhancement of traffic control to respond to present situation and the road function. • Needs to accord with international standards. • Promotion of smooth road traffic and road accident prevention measures on general roads. • Review of design standards • Promotion of design standards • Development and promotion of Instruction Guideline	• Systematic road network development with appropriate function sharing. • Enhancement of traffic control in accordance with local characteristic and road function. • Promotion of smooth and comfortable road traffic and road accident prevention • Review and update related manual /guidelines, and develop instruction guideline. • Promotion of updated Standard/guidelines.
7	Pillar-3 Vehicles B: Mechanic	Vehicle Inspection Program	• Huge number of second hand vehicles are used in Kathmandu, and most of them don't have proper maintenance record. • Inspecting these vehicles frequently in a proper system would contribute to prevention of future traffic accidents. • Combination with registration of vehicles and passing the inspection would highly reduce the accident numbers caused by	• Development of vehicle inspection standard • Promotion of vehicle inspection system	• Vehicle inspection standard development • Facilitation and promotion of vehicle inspection system

S/N	UN Pillar /Target	Name	Objective/Background	Issues	Contents
			lack of vehicle maintenance.		
8	Piller-3 Vehicles B; Mechanic	Vehicle registration Program	• Although vehicle inspection system exists in Nepal, considering the fact that poor vehicle condition is one of the major causes affecting the traffic safety on Passenger Service Vehicles (PSV) in particular, it is important to improve the capacity of the authorities. • Computerize to utilize the database and system to tackle with huge increment number of vehicles.	• Improvement of vehicle registration system • Development of vehicle registration database system	• Development of registration database system
9	Pillar-4 Users A: Drivers/Owners	Traffic Safety Education & Campaign Program	• The main factors of traffic accident are person, vehicle and road condition. In particular, person is most dominant factor on victim of traffic accident. • Hence, education, publication to enhance traffic safety awareness is one of the most important issues on traffic safety. • In line with strategies mentioned above, traffic safety education and campaign Program is necessary for traffic safety awareness, where the major target shall be pre-school and primary school students and the community.	• Promotion of consistent traffic safety education program • Formulation of safety framework between school and community • Development of instructor and teachers training system • Formulation of coordination system for sustainable safety awareness activities. • Development of sustainable community traffic safety. • Dissemination of traffic safety consciousness by media.	• Traffic safety education improvement at schools including kindergarten • Safe road crossing ability development • Parental education development program • Development of traffic safety zones (Safe routes to/from home- school) • Framework development between school and community • Black spots/hazardous spots identification in community
10	Pillar-4 Users A: Drivers/Owners	Drivers skill training and testing Program	• Development of driver's training and examination system • Promotion of driver's school privatization • Promotion of professional driver education and management system	• Need to evaluate the current driving training system and renovate the facilities • Need for training and examination materials	• Establishment of driving training center • Development of comprehensive training curriculum and materials for driving training and examination. • Promotion of the training center
11	Pillar 4 Users A: Drivers/Owners	Traffic Enforcement Strengthening Program	• Safe traffic flow can be achieved by proper knowledge and ability of road users. In this regard, traffic police needs to play important role as traffic regulator and traffic enforcer for inappropriate road users. Fundamental activities of the traffic police are guiding and instructing regulation to maintain road traffic order toward more effective traffic controls. • For this, human resource development program is prioritized with focus on the violations that are causing these traffic	• Need countermeasures targeted to vulnerable road users • Need to intensify enforcement capacity and capability of traffic police. • Need more cooperation and coordination between related organization on traffic safety such as sharing accident and traffic data to develop further activities • Need training to human resource	• Develop safety guidance for vulnerable road users such as pedestrians, bicycle and motorcycles. • Strengthening and intensifying traffic law enforcement • Coordination between concerned Ministries/Agencies for safety countermeasure • Develop recording and evaluation of traffic safety guidance and enforcement activities • Develop human resource on traffic

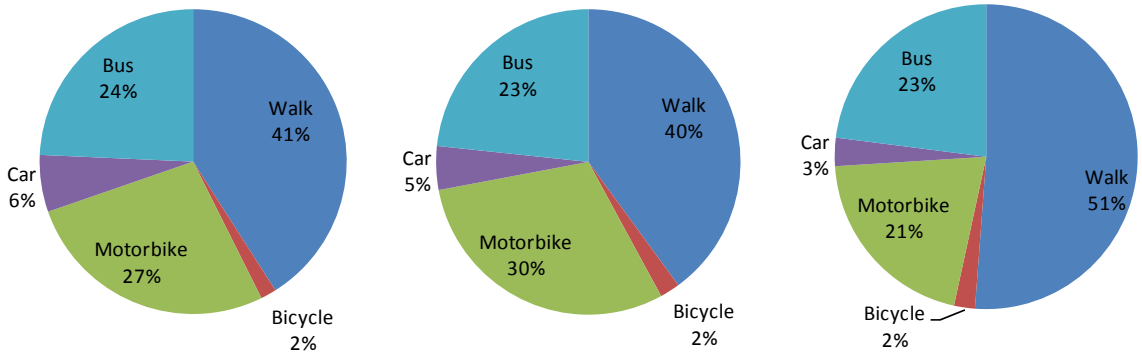
S/N	UN Pillar /Target	Name	Objective/Background	Issues	Contents
			accidents, which are identified from the traffic analysis. Following three strategies shall be indicated as objective of this program. a. To develop coordinated traffic regulation planning and implementation system among the concerned ministries & agencies. b. To promote efficient and effective traffic law enforcement activities c. To develop human resources in combination with applications of modern science and technology		safety guidance and enforcement

Source: JICA Study Team

8.7 Non-Motorized Transport (NMT) Plan

Non-motorized transport (NMT), pedestrian and NMT vehicles (bicycle/tricycles, wheelchairs, handcarts, animal drawn carts, etc.), is the primary mode of the transportation for people in developing countries as affordable transportation.

Walking is the main mode of trip in Kathmandu Valley as shown in the following figure based on the results of PT Survey by JST. On the other hand, the bicycle is still less in the valley.



Source: JST

Figure 8.7.1 Mode of Trip based on PT Survey

As well as in the other developing countries, NMT users are often neglected in the development of transportation infrastructure and vehicle-oriented development is prioritized due to its large social and economic impacts.

Pedestrian and vehicle on the road

No sidewalk

No pedestrian crossing

Unsafe overhead cabling on sidewalk

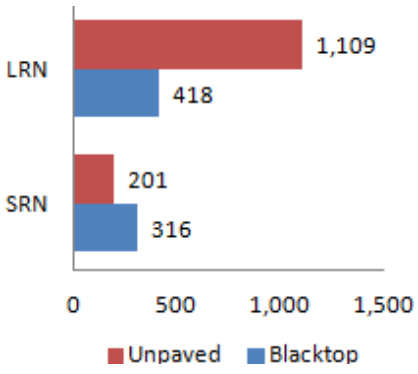
These neglected unsafe/inconvenient infrastructures discourage people from walking or cycling and further accelerate the vehicle-oriented development. It is quite essential for the sustainable development of the valley to include NMT in the plan.

The terrain in the valley is generally not steep and is able to accommodate the facility of NMT. Moreover, there are many historical sites such as UNESCO World Heritage in the valley within the bicycle access distance. Enhancement of NMT will be useful not only for the citizens of the valley but also for tourists.

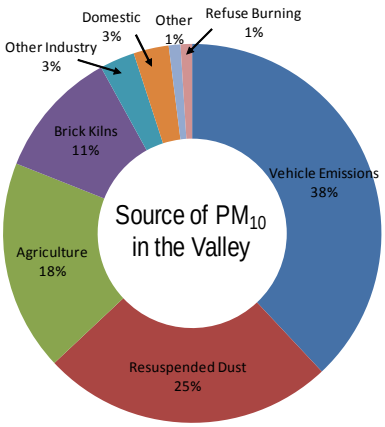
On the other hand, air pollution discourages people from using NMT. Air pollution is one of the most serious environmental concerns of the valley.

The major source of air pollution is the road sector such as "vehicle emissions (38%) " and "re-suspended Dust (25%) from unpaved roads". In parallel with the emission control, the road pavement works shall be accelerated.

Unpaved road length of LRN and SRN are 1,109 km and 201 km respectively. Recently, SRN (under DOR) has been constructing paved roads at an annual rate of 21 km for the last 4 years. SRN is probably going to be fully paved by 2025 at this pace. On the other hand, LRN (under DOLIDAR) will need to pave at an annual rate of 110kn for it to be fully paved by 2025 with the corresponding required increased budgeting shown in the below table. Otherwise, 54 years will be required in case the current budget is maintained.



Source: SSRN 2013/14 (DOR), DTMP (DOLIDAR)
(Surface Condition of SRN and LRN)



Source: CANN/CEN/UNHABITAT
(Source of Air Pollution)

Figure 8.7.2 Surface Condition of SRN/LRN and Source of Air Pollution

Table 8.7.1 Estimated Required Budget for Paving Works

Assumed Annual Paving Length (km/year) a	Assumed Average Width (m) b	Assumed Unit Cost (Rp/m2) c	Estimated Required budget (million Rp/year) d=a*b*c		Actual Budget (million Rp/year)
21	12	4,000	1,008	⟺	1,000 (*1)
110	6	4,000	2,640		1,000 (*2)

*Source *1: Annex of Business Plan, DOR*
*Source *2: DTMP (District Transport Masterplan) of 3 Districts, DOLIDAR*

8.7.1 Counterplan for NMT

(1) Counterplan for Pedestrians

1) Area to be covered by NMT improvement

Since the area covered by walk is spread over the Valley, target of counterplan for pedestrian is narrowed down into the following areas:

a) Access route to public transport terminal and public transport stop

Currently pedestrians concentrate to bus terminals in city center, New Bus Park and major bus stops along arterial roads. Appropriate pedestrian way is furnished around the peripheral area of the terminals and stops.

b) Access route to major facilities

Access road to major facilities where large amount of walk trips generate or attract, namely market, hospital and attraction.

c) Area where walk travel density is high

Many citizens and tourists stroll about towns and streets that preserve the historic atmosphere including heritage sites. Old towns in Kathmandu, Lalitpur and Bhaktapur should be designated as pedestrian priority area.

d) Protection of pedestrians at heavy traffic areas/spots

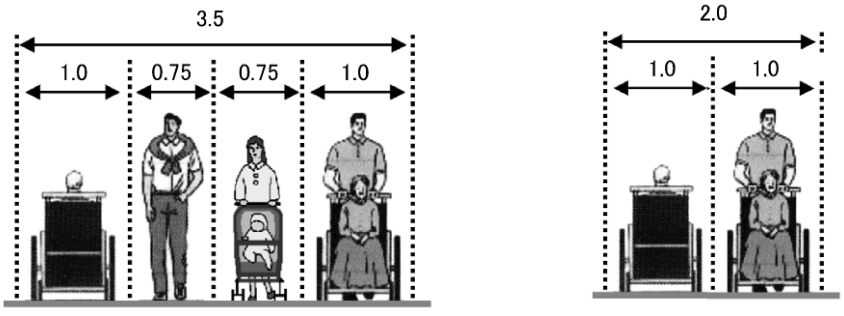
At the following areas/spots, measures for protection of pedestrians should be introduced:

(i) Roads where pedestrians have difficulty in crossing due to heavy traffic
(ii) Intersections where pedestrians have difficulty in crossing due to heavy traffic

2) Measures for improvement of pedestrian circumstances

a) Securement of necessary width for sidewalk

Since the budget and space for road development is constrained in the Valley, development of exclusive pedestrian way is difficult. Therefore sidewalk with sufficient width should be provided along the arterial roads. Figure 8.7.3 shows the necessary sidewalk width, for which 3.5m is required at the sidewalk with many pedestrians and 2.0m is required at usualsidewalk. This concept is introduced into the typical cross section described in 8.2.4.3.



Sidewalk with many pedestrians **Usual sidewalk**

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan

Figure 8.7.3 Concept for Necessary Width for Pedestrian Sidewalk

b) Installation of facilities for pedestrians

The following facilities are expected to secure pedestrian's safety and to put flow of pedestrians in order:

- Pedestrian crossing signal on the wide arterial road
- Pedestrian signal at intersection
- Pedestrian bridge at the narrow bridge with heavy traffic

(2) Counterplan for Bicycles

1) Objective of counterplan

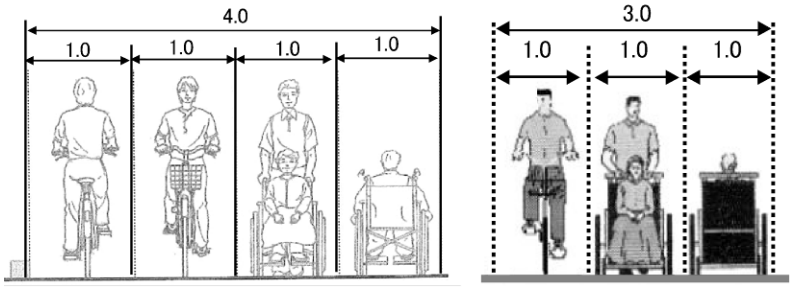
Currently traffic volume of bicycles is not large. However counterplan for bicycles is necessary for the following aspects:

- Bicycle is the substitute transport mode for vehicle. By the enhancement of bicycle use, number of motorcycles and passenger cars will be decreased.
- Currently bicycle users are at risk by vehicle traffic and occasionally suffer accident. Measures for protection of bicycles are required.
- On the other hand, as the traffic volume of bicycle increases, collision of bicycle and pedestrian increases. Measures for coexistence of bicycles and pedestrians should be taken.

2) Measures for improvement of bicycle circumstances

a) Securement of necessary width for sidewalk

Similar to pedestrian spaces, development of exclusive bicycle way is difficult. Therefore sidewalk with sufficient width should be provided as bicycle and pedestrian way along the arterial roads. Figure 8.7.4shows the necessary bicycle and pedestrian sidewalk width, for which 4.0m is required at the sidewalk with many pedestrians and 3.0m is required at usual sidewalk. This concept is introduced into the typical cross section described in 8.2.4.3.



Sidewalk with many pedestrians **Usual sidewalk**

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan

Figure 8.7.4 Concept for Necessary Width for Bicycle and Pedestrian Sidewalk

b) Establishment and enlightenment of cycling rule

For the orderly cycling and coexistence with other modes, rule for bicycle should be established and diffused among cyclist. The following article should be taken into for the cycling rule:

- On the roads which don't have sidewalk with aforesaid necessary width, bicycles should run on the carriageway. In this case, bicycles run at the left side of the carriageway.
- On the roads which have sidewalk with necessary width, bicycles should run at the carriageway side of the sidewalk.
- On the sidewalk, pedestrian is given priority. Bicycle should stop when it disturb the pedestrian walk.

8.8 Disaster Management Plan

8.8.1 Work Flow

This section explains how to formulate Emergency Transportation Road Network Plan (ETRNP).

1) Overview of Existing Plans (Step I)

First, existing plans and data of natural disaster in Kathmandu Valley will be reviewed in regard to the following six items and harmonizes with the report of The Project on Rehabilitation and Recovery from Nepal Earthquake (PRNE) by JICA.

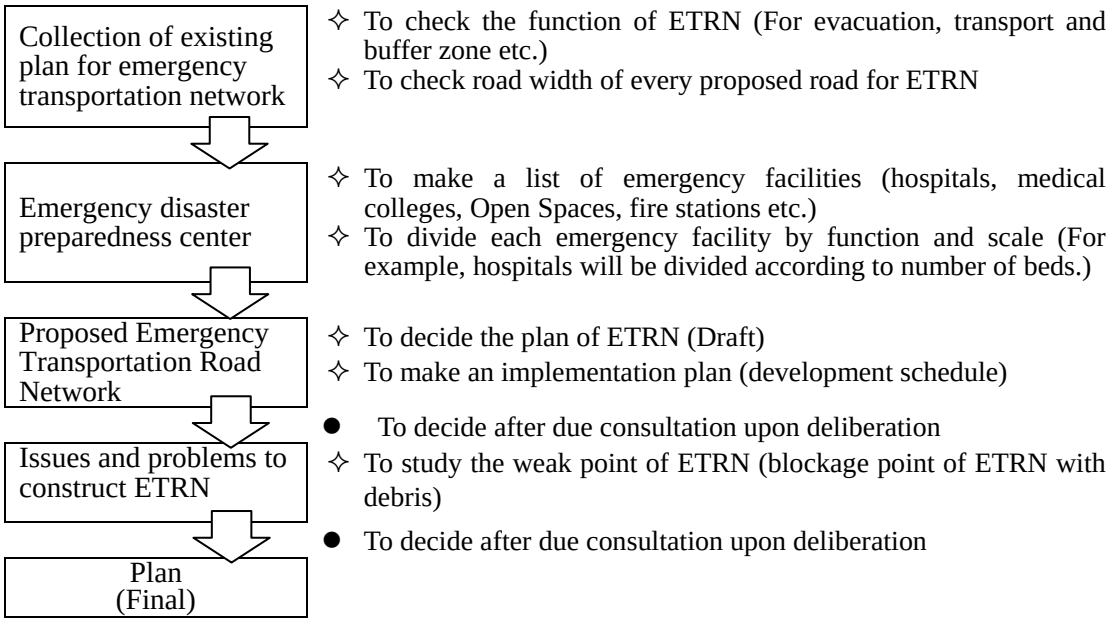
- Existing plans for protection against disasters (Hazard Risk Assessment, Earthquake Disaster Mitigation etc.)
- Organization structure and government system for protection against natural disaster (especially earthquake disaster)
- Measures of protection against disasters and reduction of the impact of natural disaster (revision of building code, disaster drill etc.)
- Record of disaster drill and training for protection against natural disaster
- Existing plans and record of disaster in Kathmandu Valley
- Emergency transportation system (not only road network but also the location of emergency warehouse and its capacity.)

2) Points of Attention (Step II)

The following points of attention must be considered to plan ETRNP.

- To understand alignments of wide lane roads such as Ring Road and Arniko Highway. (These two roads will not be blocked by debris.)
- To understand locations of base hospitals (with an inpatients' ward), Open Space (84 sites decided by government) (including 84th Open Space proposed by ETRNP), New Open Space (MOHA and KVDA), governmental offices, emergency warehouses, airport and educational facilities which should be connected to or should be stood near ETRNP.
- To understand the plan for Disaster Supplies Management and location of Open Space and New Open Spaces.
- To understand the result of simulation about blocked roads for three scenarios (Based on the Modified Mercalli Intensity scale, a medium (VIII), large (IX) and very large (X) were used as the three scenarios.[1]). (source: Vulnerable Transportation Networks and Earthquakes (A Case Study of the Kathmandu Valley, Nepal; Mr. Krista Carroll, May 12th 2011)
- To understand the result of simulation about blocked roads for four scenarios of earthquake.

[1] Source: Vulnerable Transportation Networks and Earthquakes (A Case Study of the Kathmandu Valley, Nepal), Mr. Krista Carroll, May 12th 2011



Source: JST

Figure 8.8.1 Work Flow

8.8.2 Definition of ETRNP

8.8.2.1 Case of Japan

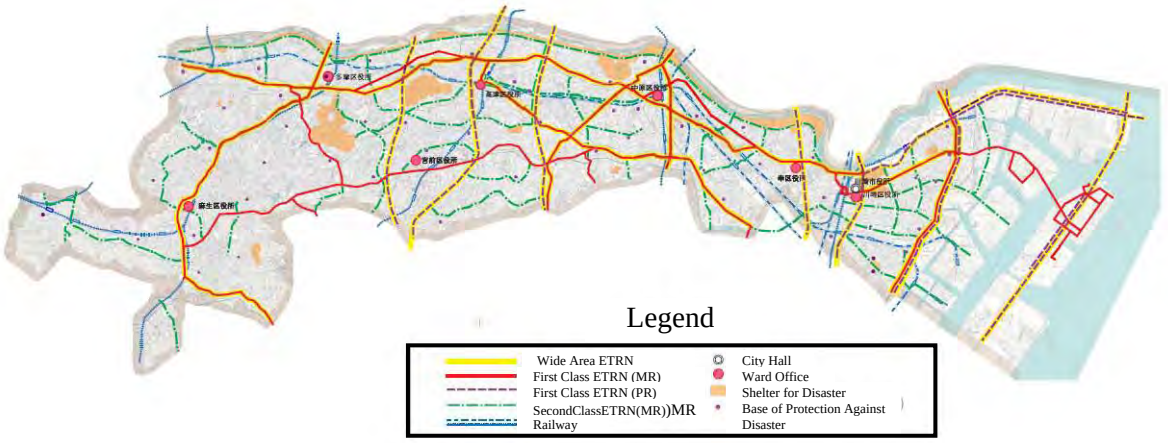
In Japan, Emergency Transportation Road Network (ETRN) had begun to be planned after the Great Hanshin Awaji Earthquake. It is crucial to transport relief supplies smoothly to the disaster victims immediately after the disaster. Japanese local governments classify ETRN in 3 classes.

- First class: Main emergency transportation road to connect head office of protection against disasters, government office, vital port and airport
- Second class: Emergency transportation road to connect main (first class) emergency transportation road, office of protection against disasters (government office, police, fire station and hospital)
- Third class: Emergency transportation road to connect first and second class emergency transportation roads and sub point for protection against disasters (terminal for physical distribution system, warehouse etc.)

Also, in order to prevent blockage of emergency transport roads, the government, in cooperation with private sector, must revise the building code as well as incentive system for retrofitting to enhance seismic resistance of roadside buildings.

(1) Emergency Transportation

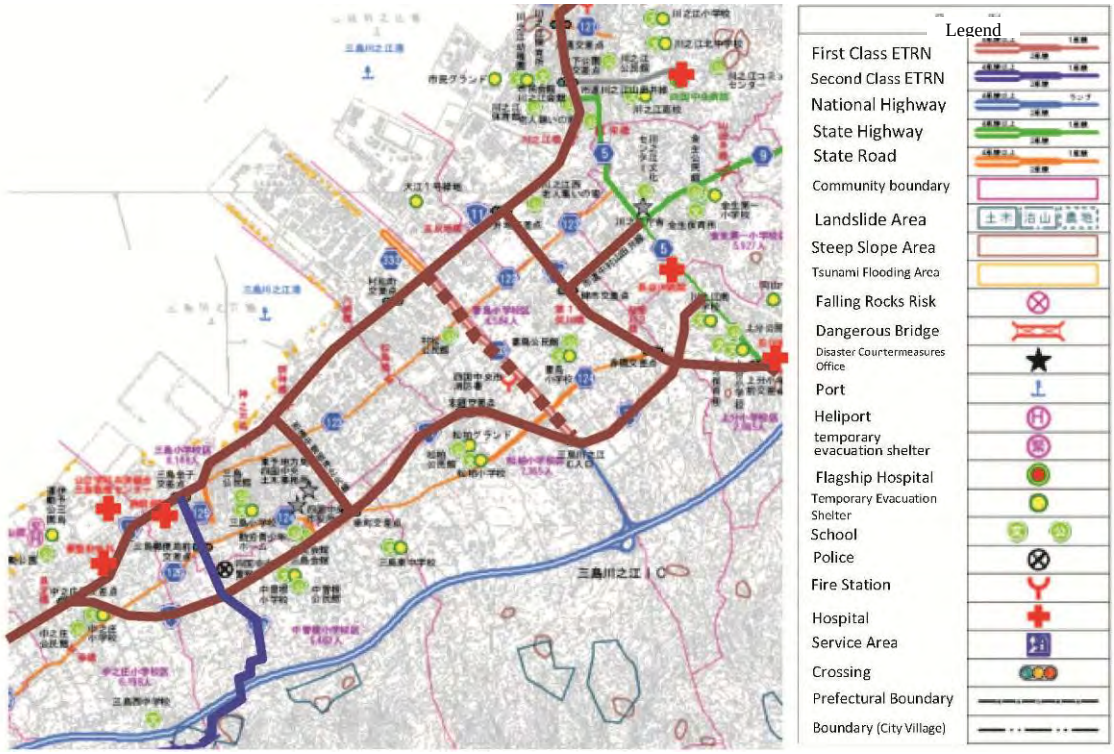
Emergency Transportation Road Network of Kawasaki city (population 1,425,512:2009) is shown in the following Figure 8.8.2. Red line indicates First ETRN and green line indicates Second ETRN. Even when a natural disaster strikes, police cars, fire engines and heavy equipment can go through ETRN.



Source: Kawasaki city HP

Figure 8.8.2 ETRN of Kawasaki City

Emergency Transportation Road Network of Shikoku-Chuo city, Japan is shown in the following Figure 8.8.3.



Source: JST based on Shikoku-Chuo City Emergency Transport Road Network

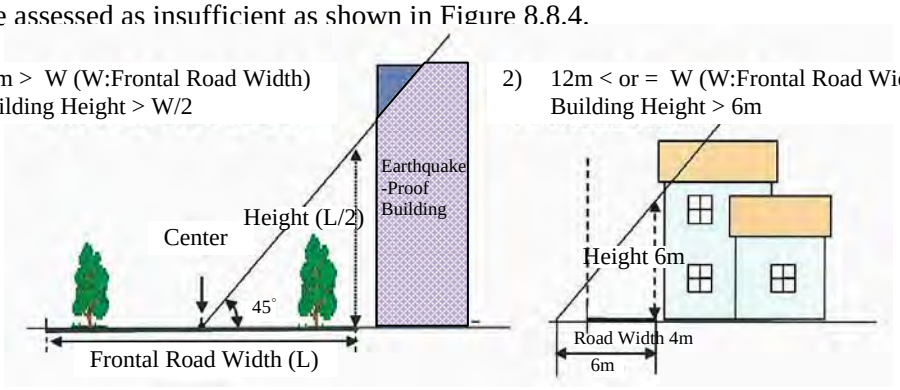
Figure 8.8.3 ETRN in Shikoku-Chuo City

In the map of Shikoku-Chuo city, not only ETRN but also hub of protection against disasters (for example hospitals, local government offices, fire stations etc.) are indicated. This map also shows where hazard risk exists.

(2) Promotion of Seismic Retrofit

Seismic promotion plan is a legal plan based on the " law on promotion of renovation for earthquake-resistant structures" which was enacted to enhance seismic resistance of the buildings constructed before the enactment of new seismic standards in May 1981.

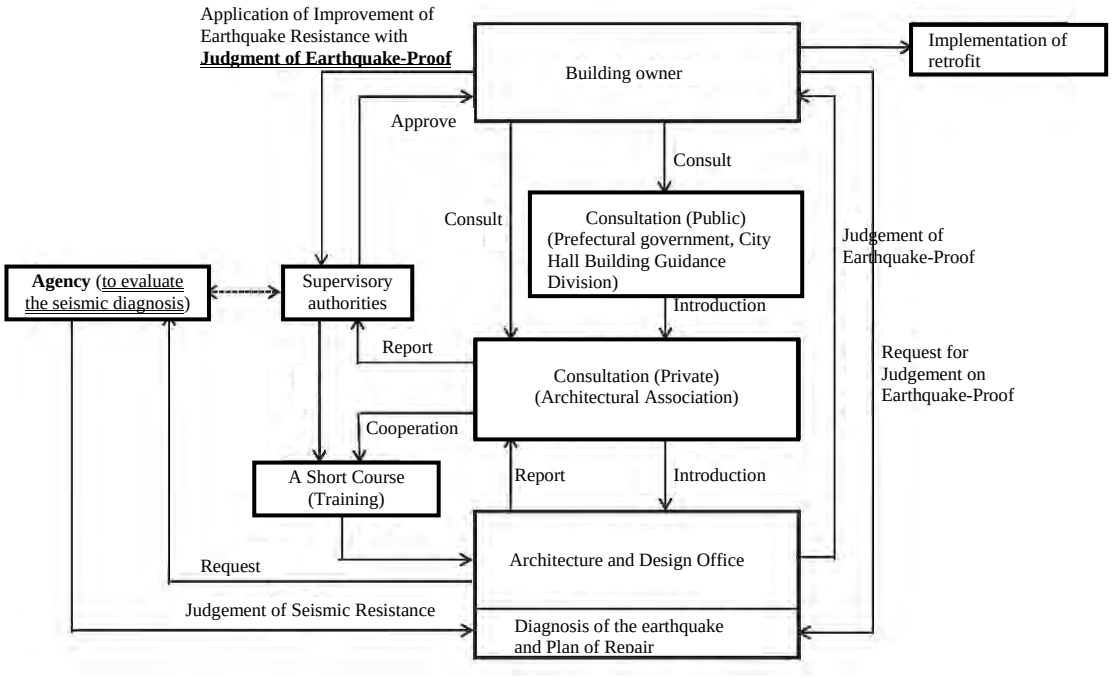
The plan intends to promote seismic retrofit of buildings on emergency transport roads whose seismic resistance are assessed as insufficient as shown in Figure 8.8.4.



Source: JICA Study Team based on Nagano Pref Shiojiri City. HP

Figure 8.8.4 Seismic Retrofit Promotion Plan

In this plan, buildings located along ETRN are plotted on GIS System. Buildings that are not earthquake-resistant will be retrofitted through earthquake resistance flow shown below based on Seismic Promotion Act. The government of Japan subsidizes for seismic retrofitting.



Source: JICA Study Team based on Okinawa Pref. HP

Figure 8.8.5 Flow Chart of Earthquake Resistance of Buildings

8.8.2.2 Existing Plan in Kathmandu Valley

There is no law and regulation for ETRN and promotion for earthquake-resistant building along ETRN. However, NSET and UNDP have planned emergency evacuation road plan of Kathmandu Valley utilizing the existing road network.

(1) Vulnerable Transportation Networks and Earthquakes (A Case Study of the Kathmandu Valley, Nepal; Mr. Krista Carroll, May 12th 2011)

The overall objective of the research is to create a sound understanding of the problem of earthquake vulnerability as it relates to transportation systems, identify possible vulnerabilities and highlight

ways of moving forward by developing recommendations for a response and recovery plan. This was done through a partnership with NSET-Nepal. More specifically the research seeks to:

1. Examine past earthquakes globally to see how transportation logistics were handled, determine the effects on recovery and lessons learned.

2. Identify the various transportation systems existing in the KV, assess their importance and categorize primary and secondary systems for emergency response/recovery.

3. Determine what resources are available for repairs/restoration/clearing of transportation systems immediately after earthquake

4. Determine the extent of planning by the government for transportation of aid post-earthquake in the Kathmandu Valley

5. Identify vulnerability of transportation systems (extent and type of failure, ie. landslide, building debris and bridge collapse)

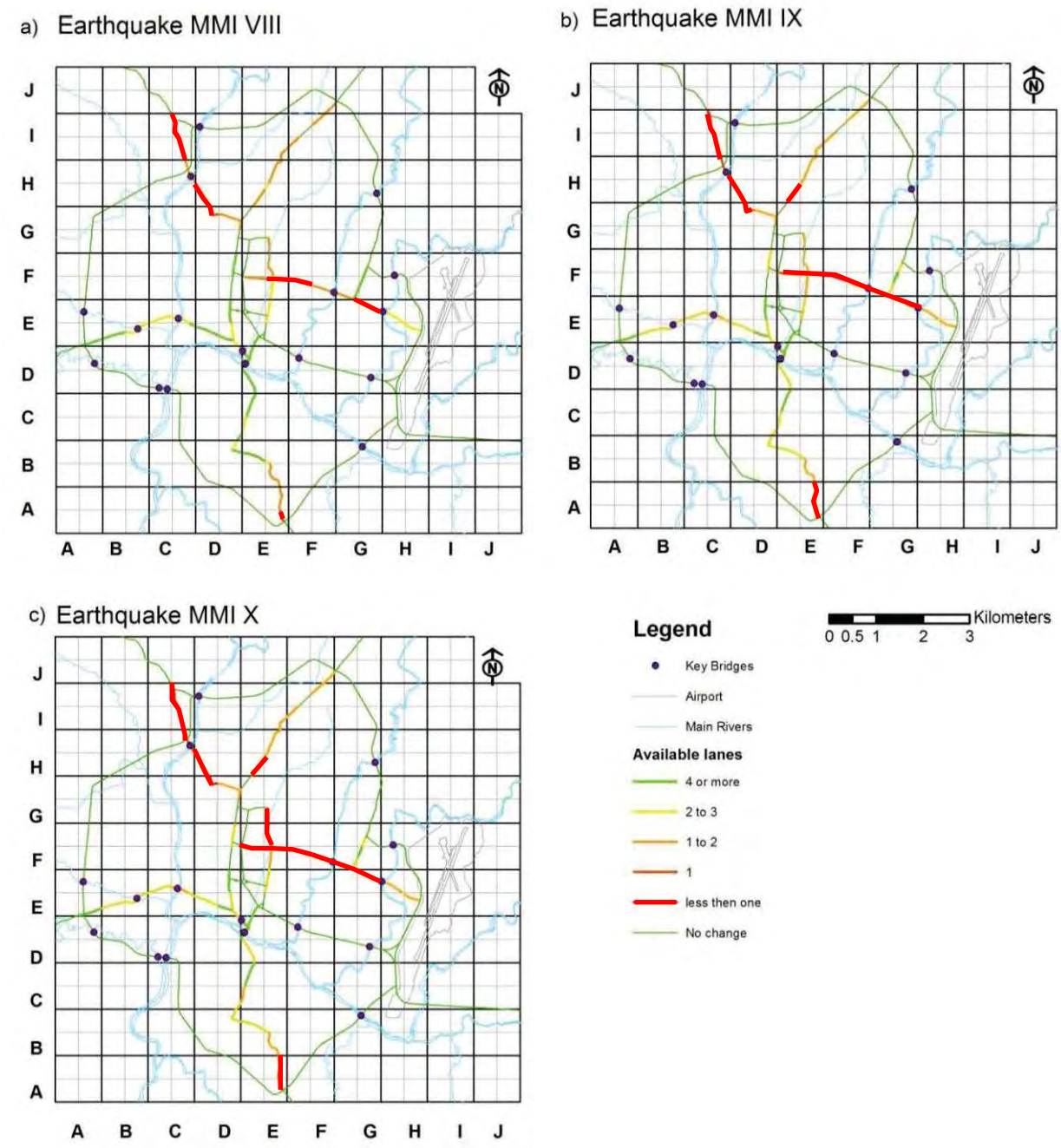
6. Examine possible means for sharing transportation information post-earthquake (ie. Way of disseminating knowledge of open and blocked roads)

7. Determine and map key transportation routes and systems.

8. Assess the importance of transportation networks and categorize primary and secondary systems for emergency response/recovery.

9. Develop recommendations to be implemented as part of emergency plans to facilitate transportation post-earthquake. (ie. Preparation, knowledge of priority roads, possible vehicle restriction laws post-earthquake, to prevent traffic jams from hindering supply delivery).

The output of this report ‘Road blockage’ is shown below.



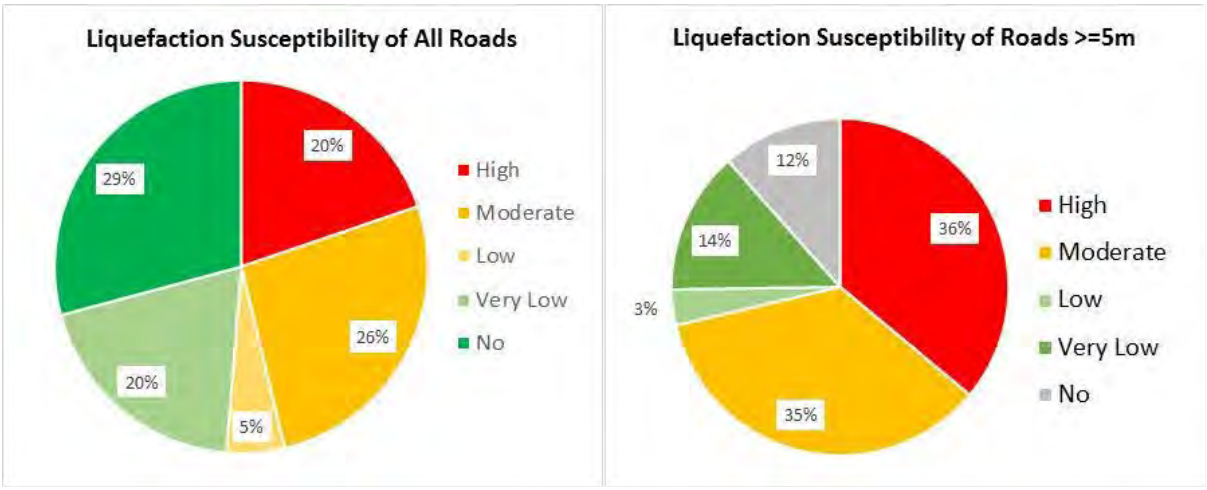
Source: Vulnerable Transportation Networks and Earthquakes (A Case Study of the Kathmandu Valley, Nepal; Mr. Krista Carroll, May 12th 2011)

Figure 8.8.6 The Result of Road Blockage in Kathmandu Valley Central Business Area

(2) Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal (Department of Geography Institute of Hazard Risk and Resilience MSc Risk and Environmental Hazards 2014)

The direct damage to roads is caused by ground failure due to subsidence or cracking of road due to the liquefaction (Caiado et al. 2012). It was observed that 20 percent of all the roads in the Kathmandu Valley are highly susceptible to liquefaction, 26 percent of the roads moderately susceptible and 5 percent with low liquefaction susceptibility. It was observed that 51 percent of all roads in Kathmandu Valley are susceptible to damage due to liquefaction during earthquake. Considering the roads wider than 5m or greater, it was observed that 36 percent of the roads fall into the category of high liquefaction susceptibility and 35 percent moderate susceptibility to liquefaction.

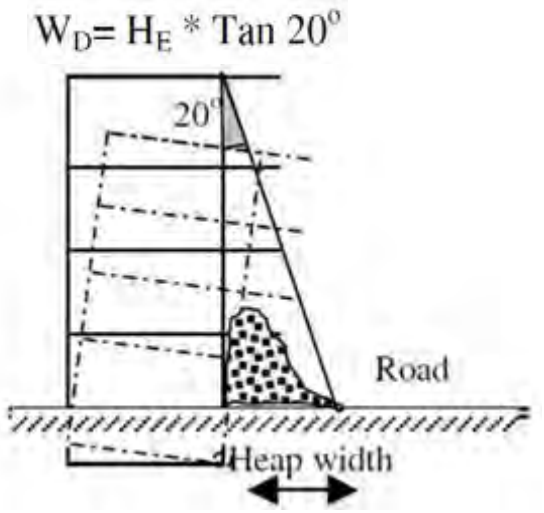
Only 26 percent of the total roads in Kathmandu Valley that are wider than 5m are safe from damage due to liquefaction in case of large earthquake.



Source: (2)Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal

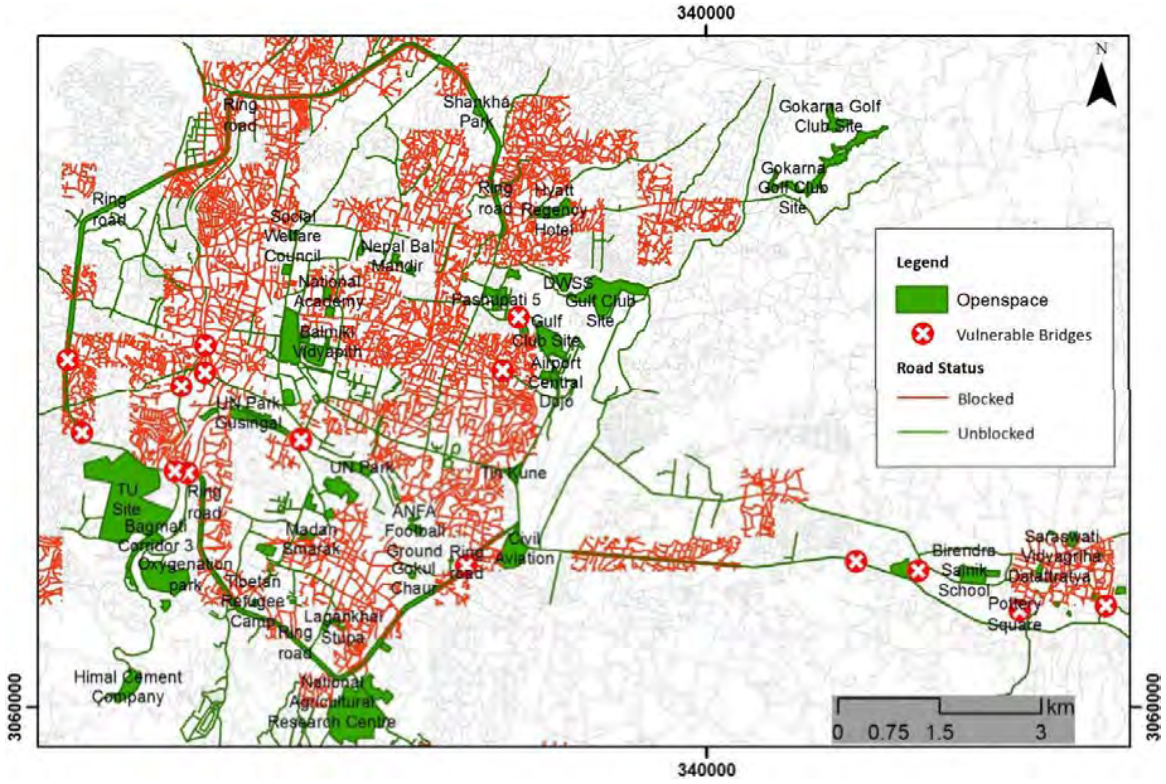
Figure 8.8.7 Liquefaction susceptibility of all roads in Kathmandu Valley

The indirect damage to the road is caused by debris due to collapsed buildings and infrastructures (Argyroudis et al. 2003). The debris from buildings blocking roadway was calculated as per Tung (2004), assuming that heap width due to damaged building is multiple of the height of the building and Tan 20 degrees. In all scenario earthquakes, it was observed that 92.6 percent of the roads linking to the inner cities could be blocked due to debris, and only 7.3 percent of the roads in the core city area will be accessible. Considering the roads wider than 5m, 77 percent of the roads will be safe from indirect damages and accessible after scenario earthquakes.



Source: (2)Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal

Figure 8.8.8 Illustration of calculation of debris width based on height of building



Source: Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal

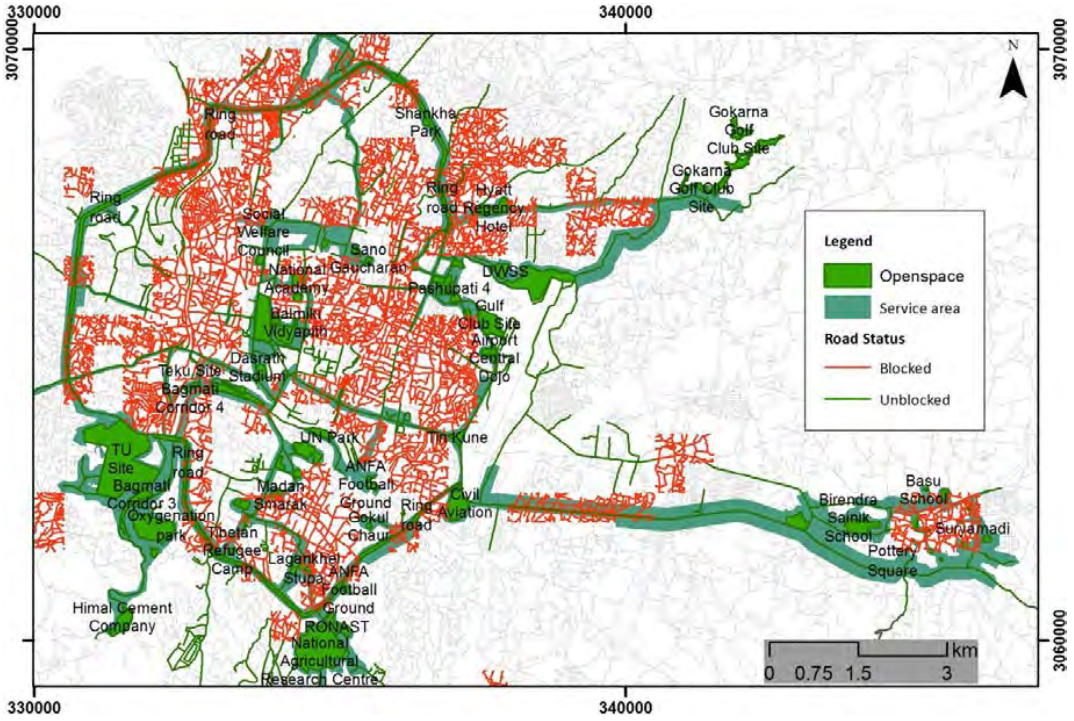
Figure 8.8.9 Post disaster accessibility condition

While performing the network analysis in GIS, it was observed that, among the 16 of the vulnerable bridges 10 of the bridges are critical for post disaster mobility and damage to these bridges could disrupt the interconnection among the hospitals as well as other identified open spaces. The critical bridges are listed in Table 8.8.1.

Table 8.8.1 List of critical bridges in Kathmandu Valley

List of critical bridges in Kathmandu Valley			
No.		No.	
1	Bafal Bridge	6	Kalanki-Khasi Bazzar
2	Balkhu Bridge	7	Koteshwor-Balkumari Bridge
3	Balkhu-Sanepa Bridge	8	Sallaghari Bhaktapur Bridge
4	Bhaktapur-Jagati Bridge	9	Thapathali_Bagmati_Bridge
5	Bhaktapur-Sallaghari Bridge	10	Tilganga-Gaushala Bridge

Source: Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal

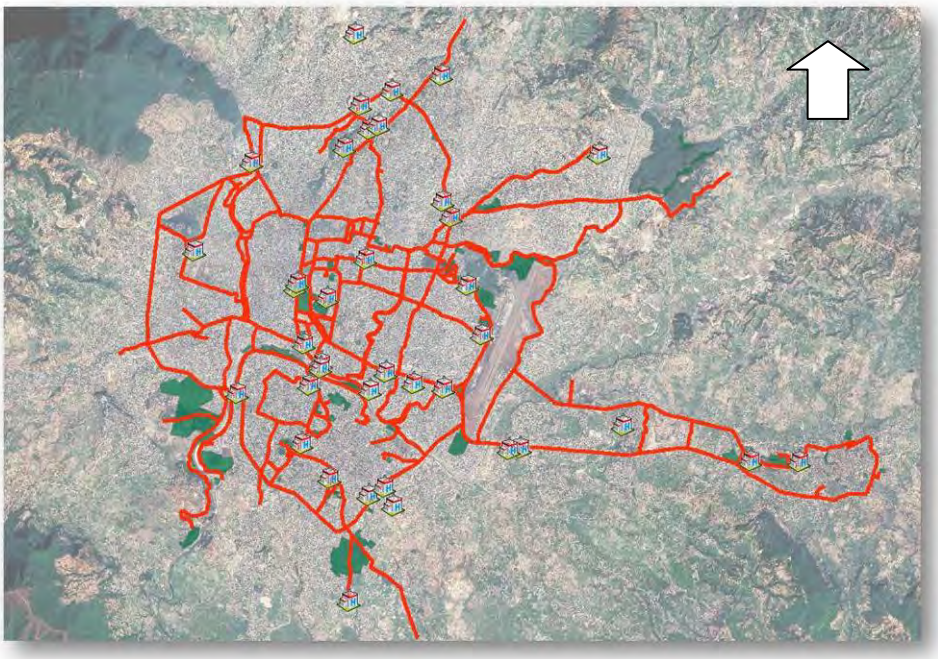


Source: Functionality of Open Spaces for Post-Earthquake Humanitarian Relief Activities in Kathmandu Valley, Nepal

Figure 8.8.10 Post Disaster Accessibility Modelling of Open Spaces

(3) Emergency Road Network Plan (Draft) (UNDP)

UNDP has planned an emergency rescue plan of Kathmandu Valley and in this plan, evacuation road network has been planned (Draft).



Source: UNDP Study Team

Figure 8.8.11 Emergency Road Network (UNDP)

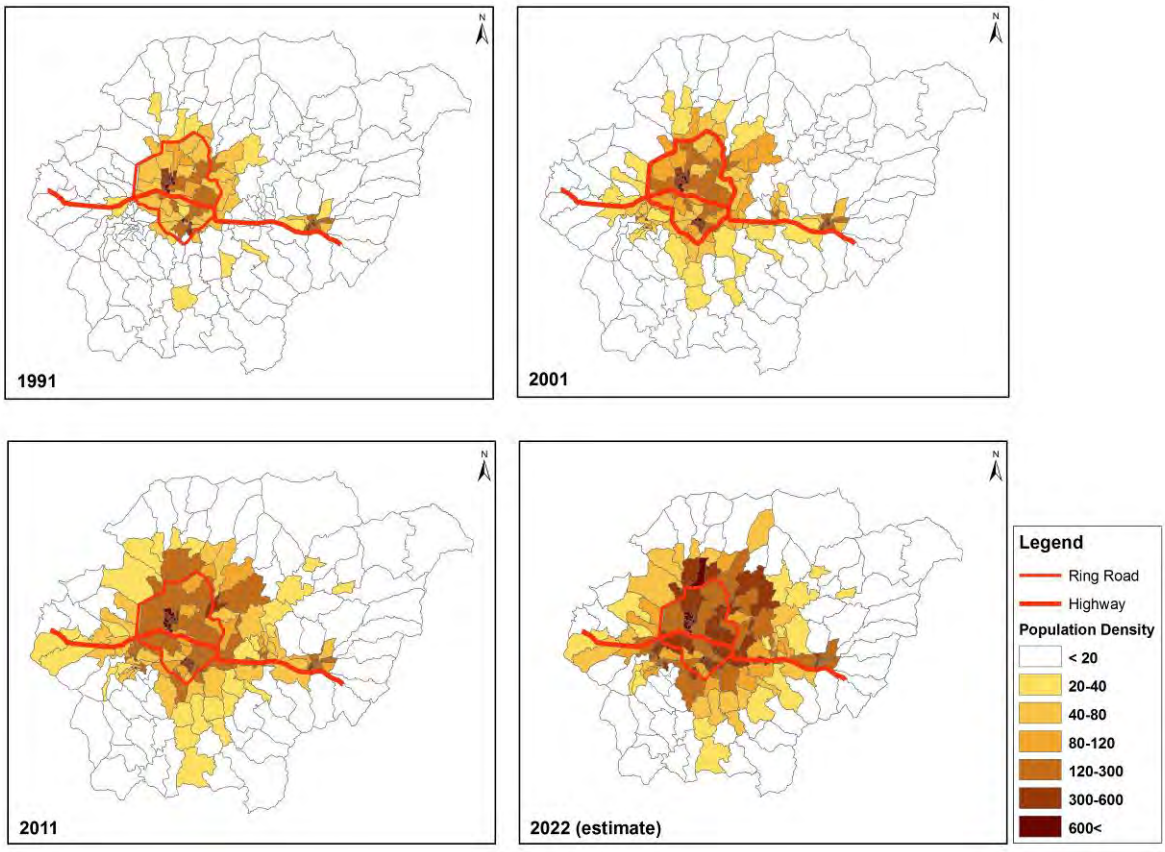
Emergency Road Network Plan proposed by UNDP Study Team has selected emergency roads that connect Open Space (MOUD) and large hospitals. However, this plan does not take account of the roadside building condition and does not clarify which road will be blocked with debris.

Further study on roadside building use and road blockage in case of earthquake is required.

8.8.3 Emergency Transportation Road Network Plan

8.8.3.1 Population Density of Kathmandu Valley

Current and future population density (1991-2011 and 2022 (Estimation)) of Kathmandu Valley is shown below.



Source: JST

Figure 8.8.12 Population Density by Ward (2001-2011, 2022(Projection))

The urban area had been within the Ring Road until 1991. However, the population outside of the Ring Road has been increasing gradually since 2011. This tendency will continue according to the result of population projection and urban area will also expand.

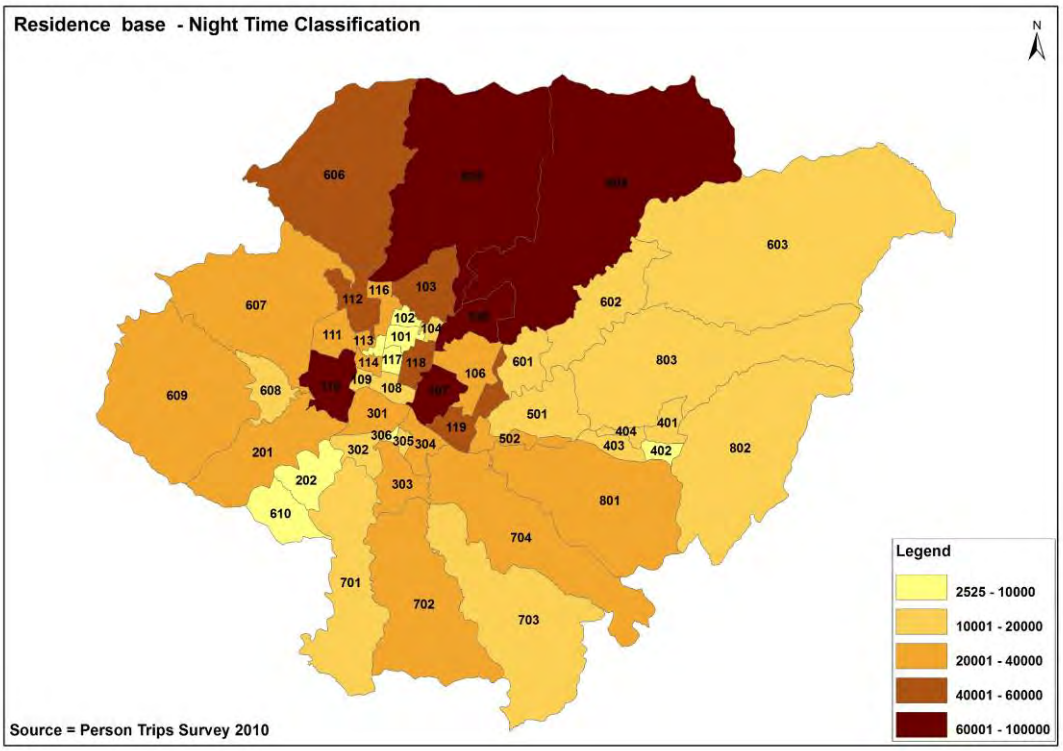
If such tendency continues, urban problem will be more serious.

- Damage inside the Inner Ring Road where the network consist of narrow roads will be serious.
- The current urban structure is mono-centric and traffic flow is concentrated in CBD area. If an earthquake strikes the city during day time, many roads will be blocked by vehicles and debris and cannot be used for emergency and evacuation.

- Land rights nearby Inner Ring Road are complicated, which will make it difficult to reconstruct the area after disaster.

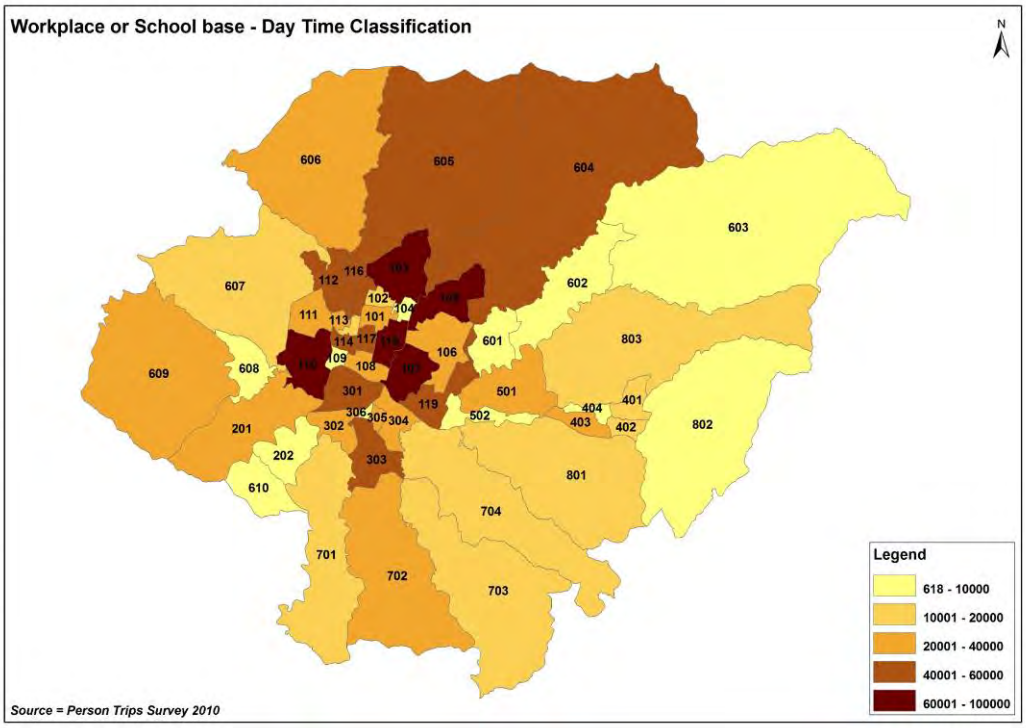
Based on the person trip survey in 2010 the daytime population is observed as follows:

- Many people work in the central zone of Kathmandu Valley and road side of Ring Road. The number of daytime population is big in these areas. The number of nighttime population in outside of Ring Road is bigger than that in inside of Ring Road.
- The difference between daytime and nighttime population is small inside of the Ring Road. There is a possibility that workplaces are integrated.
- The topography of the north of KV is steep slope and is also watershed area. It is necessary to control the urban expansion to this area.
- If large-scale disaster such as an earthquake occurs in daytime, the expansion of the damage is expected since a lot of people gather in the center of built-up area.



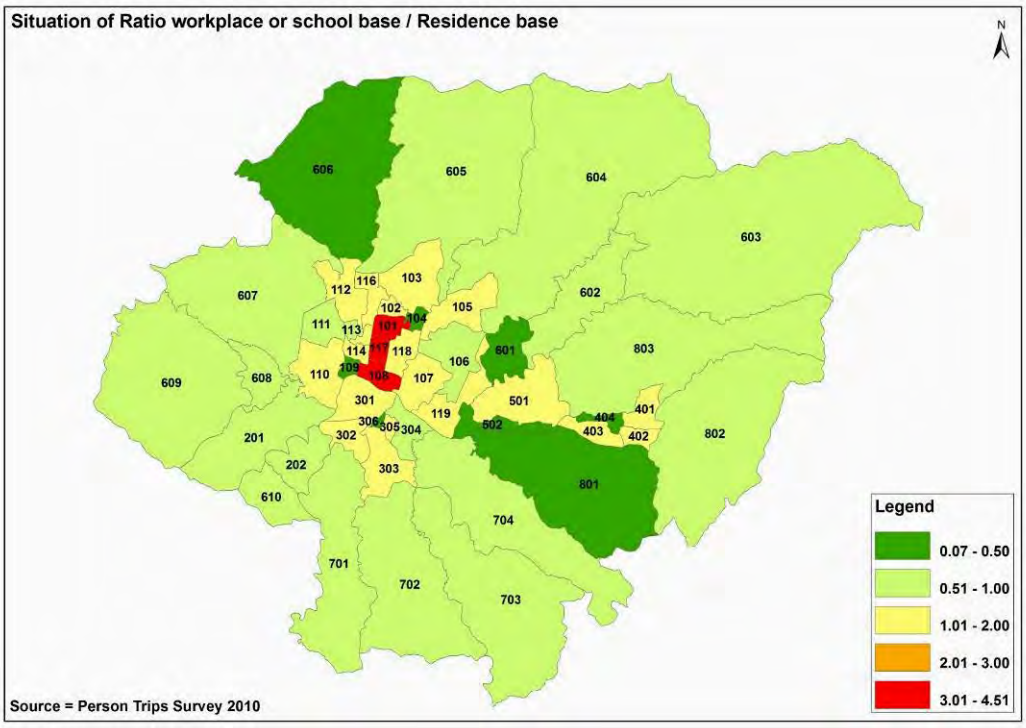
Source: JST

Figure 8.8.13 Work school base and residence base population



Source: JST

Figure 8.8.14 Work school base and residence base population

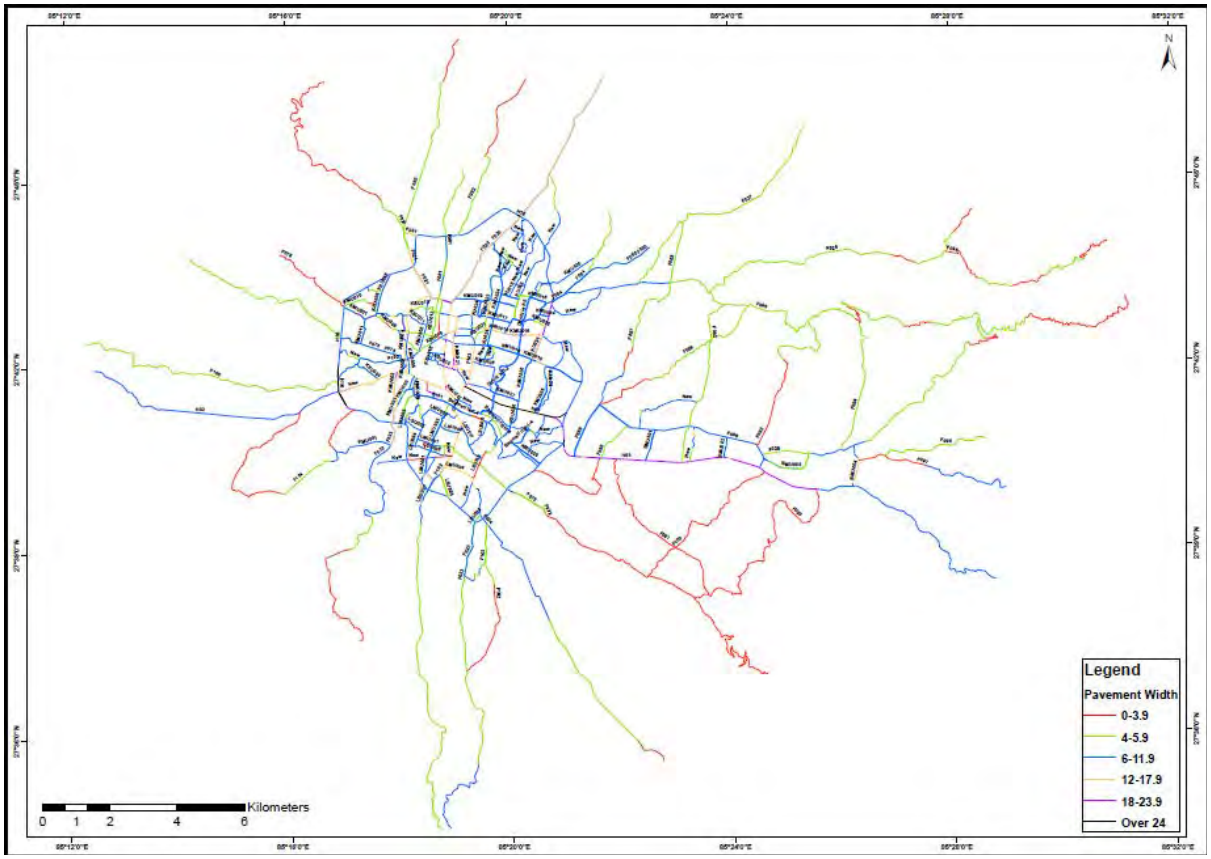


Source: JST

Figure 8.8.15 Situation of Ratio workplace or school base/Residence base

8.8.3.2 Existing Road Network

Existing road network of Kathmandu Valley is shown below.



Source: JST

Figure 8.8.16 Existing Road Network

- Planned width of Ring Road and Arniko Highway is over 20m. There will be no blockage point with debris of demolished buildings.
- Width of the existing roads in central business area are mostly over 12m. The road network of central business area will be able to work after big earthquake.
- Some radial roads are over 12m width. These roads can be selected for emergency transportation road.
- Narrow roads (road width is under 6m) are concentrated nearby Inner Ring Road. If a big earthquake occurs, many roads will not be able to work for emergency.

8.8.4 Plan of ETRN

(1) Concept of Interval of Emergency Road Network

ETRNP will be planned with the following concepts:

- Hubs for protection against disasters (hospital, Open Space, fire station etc.) will be accessed by dual ways to first or second Emergency Transport Road (Network).
- In central business area, second and concept Emergency Transportation Road will be planned 500m interval because of high density population. (Japanese regulation: arterial road interval is about 1km, but high density area about 500m)
- In the foot of a mountain, hubs for protection against disasters will not be connected by dead-end road.
- In a city with narrow road network where existing road network is insufficient for emergency transport, 'Concept Emergency Transport Road' will be planned on new arterial or sub-arterial

roads. The new arterial or sub arterial road must be proposed with a redevelopment plan of the area of the proposed roads.

(2) Hub of Protection against Disasters

Information on the hubs of protection against disasters are collected with the following lists:

1) Hospital

47 general hospitals (with function of inpatients' ward and comparatively large scale in terms of the number of staff and clinical departments) and one blood transfusion service are chosen as hubs of protection against disasters in Kathmandu Valley.

Table 8.8.2 List of Emergency Hospital

No.	Name of Hospital	Ward	Bed number	No.	Name of Hospital	Ward	Bed number
1	Kathmandu Model Hospital (Red Cross Blood Bank)	Baghbazar	120	25	Birendra Military hospital	Shyambhu	490
2	Janmaitri Hospital	Balaju	50	26	Kathmandu Medical College & Teaching hospital	Sinamangal	600
3	Shahid Ganga Lal Hospital	Bansbari		27	Teku Hospital	Teku	100
4	BP Memorial Hospital	Basundhara	105	28	Norvic Hospital	Thapathali	200
5	Bhaktapur Hospital/Bhaktapur Cancer Hospital (Red Cross Blood Bank)	Bhaktapur	62	29	Paropkar Maternity & Women Hospital	Thapathali	415
6	District Community Eye Center	Bhaktapur		30	Kantipur Hospital	Tinkune	
7	National Tuberculosis center	Bhaktapur	No Bed	31	Nepal Eye Hospital	Tripureshwor	98
8	Bir Hospital	Bhotahity	430	32	Tilganga Hospital	Tilganga	
9	Nepal Army Hospital	Bhotahity		33	Ishan Children & Women Hospital	Basundhara	25
10	Medicare National Hospital & Research center	Chabahil	100	34	Mental Hospital	Lalitpur	<150
11	Om Hospital & Research Center	Chabahil	150	35	Shukraraaj Tropical Hospital	Pachali	100
12	Grande International Hospital	Dhapasi	200	36	Tribhuvan University Teaching Hospital	Maharajgunj	700
13	Kist Medical College	Gwarko		37	Global Hospital	Gwarko	<150
14	Alka Hospital	Jawalakhel		38	Green City Hospital	Pragatinagar	<150
15	Nepal Medical College and Teaching Hospital	Jorpati	700	39	Nobel Hospital	Sinamangal	<150
16	Patan Hospital	Lagankhel	320	40	Everest Hospital	Patau Dhoka	<150
17	Sumeru Hospital	Lalitpur	100	41	Chirayu Hospital	Maharajgunj	>150
18	Mid City Hospital	Lokanthali		42	Nepal Orthopedic Hospital	Jorpati	<150
19	Miteri Hospital	Lokanthali		43	Vayodha Hospital	Kirtipur	<150
20	Kanti Bal Hospital	Maharajgunj	300	44	Nagrik Community Teaching Hospital	Gatthaghaghar	<150
21	manmohan cardiothoracic vascular and transplant center	Maharajgunj		45	Star Hospital	Jhamsikhel	<150
22	Teaching Hospital	Maharajgunj		46	Nepalese Army Institute of Health Sciences (NAIHS)	Ichangu Narayan	150
23	Civil Service Hospital	New Baneshwor	132	47	Korea Nepal Frendship Hospital	Thimi Bhaktapur	50
24	B & B Hospital	Satdobato	250	48	Central Blood Transfusion Service (Red Cross)	Balkumari	

Source: JST

2) Medical Collage

Medical collages located in Kathmandu Valley (six points) are positioned in disaster prevention centers. The information of medical collages (Name of medical collages, numbers of students and year established) are below.

Table 8.8.3 List of Medical Collage
(Seat recommended on Academic Session 2014)

No.	Medical College	Year Established	Degree/ Intake Student
1.	T. U. Institute of Medicine, Maharajgunj Campus	1978	MBBS 70
2.	Nepal Medical College, Jorpati	1996	MBBS 150 BDS 50
3.	Kathmandu Medical College, Sinamangal	1996	MBBS 150 BDS 50
4.	Kist Medical College, Gwarko, Lalitpur	2008	MBBS 135 BDS 40
5.	Patan Academy of Health Sciences, Lagankhel, Lalitpur	2010	MBBS 60
6.	Nepalese Army Institute of Health Sciences (NAIHS)	2011	MBBS 150

Source: JST based on Nepal Medical Council

3) Police, fire Station and City Hall

Police Headquarters and Police Stations, Fire Stations and City Halls are located in the center of each district and Tribhuvan International Airport. To position these public facilities is important bases for disaster prevention.

Table 8.8.4 Important prevention bases (Public facilities)

No.	Name of Police Station	No.	Name of Police Station
1	Nepal Police Headquarters	19	Metropolitan Police Circle
2	Metropolitan Police Commissioner's Office	20	Ward Police Office Boudha
3	Metropolitan Traffic Police Office	21	Metropolitan Police Circle Jansewa
4	Gaushala Police Station	22	Thapathali Police Station
5	Jagati Police Station	23	Sanepa Police Station
6	Metropolitian Police Circle, Madhyapur Thimi	24	Pulchowk Police Station
7	Metropolitan Police Station	25	Police Station, Satdobato
8	Imadol Police Station	26	Armed Police Force Dakshinkali Battalion
9	Police Station, Harisiddhi	No.	Name of Fire Station
10	Koteshwor Police Station	1	Juddha Barun Yentra Fire Station
11	Maharajgunj Police Station	2	Lalitpur Fire Station
12	Basundhara Police Station	3	Juddha Barun Yantra Office
13	Metropolitan Police Station Chagal	4	TIA Fire Station
14	Swayambhu Police Station	No.	Name of Government Office
15	Kalimati Police Station	1	Kathmandu Metropolitan City Office
16	Police Range	2	Lalitpur Sub Metropolitan Office
17	Central Police Forensic Science Laboratory	3	Bhaktapur Municipality Office
18	Armed Police Force	4	Madhyapur Thimi Municipality Office

Source: JST

4) Open Space

Location of Open Spaces is shown below.

Table 8.8.5 Open Space List

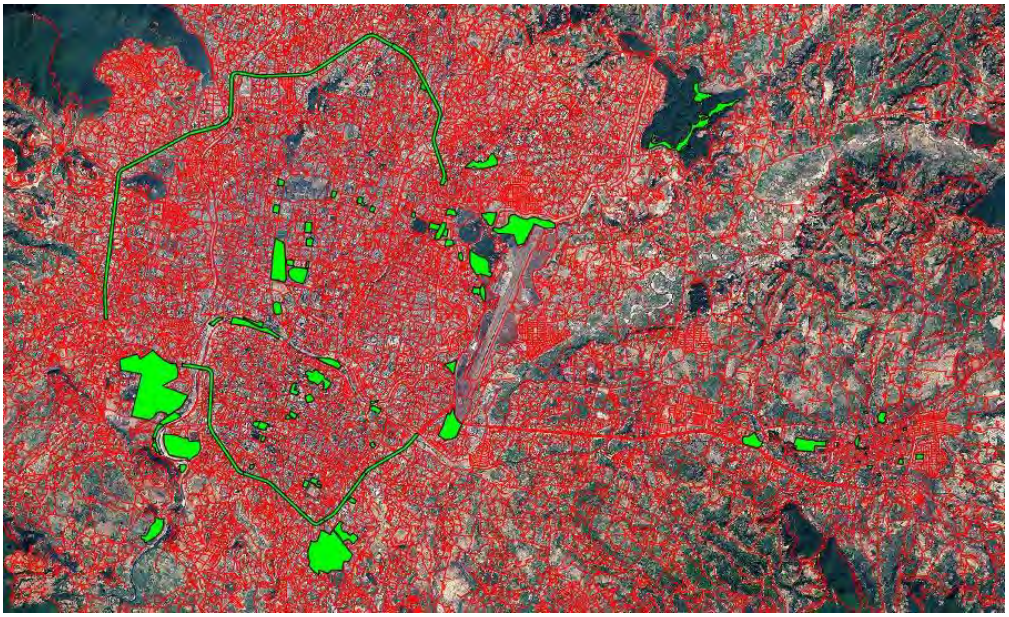
N0.	Name	Function								Area sq.m	Suggested Usages
		Mu	Me	S	H	V	Deb	LW	Dis		
1	Adarsa Azad Higher Secondary School		✓							2,171.66	Medical Assistance Area
2	Airport (Nepal Army Golf site)	✓			✓			✓		176,853.64	Multiple: Military installation , Civil Mall coordination center, warehousing, Humanitarian coordination area
3	Airport Central Dojo				✓					21,328.91	Humanitarian Coordination Area
4	ANFA Football Ground (north)			✓						18,238.22	Settlement/camp
5	ANFA Football Ground (south)					✓				11,405.23	Vulnerable population assistance area
6	Bagmati Corridor 1			✓						16,054.67	Settlement/camp
7	Bagmati Corridor 2	✓		✓				✓		19,450.14	Multiple: Settlement/camp, Logistics hub
8	Bagmati Corridor 3			✓						43,787.67	Settlement/camp
9	Bagmati Corridor 4	✓					✓			15,994.22	Multiple: Debris, dead body mgmt/morgue
10	Bagmati Corridor 5	✓					✓			20,705.69	Multiple: Debris, dead body mgmt/morgue
11	Bagmati Corridor 6						✓			6,261.10	Debris collection
12	Balmiki Vidyapith	✓	✓						✓	5,603.63	Multiple: Distribution and medical assistance area

N0.	Name	Function								Area sq.m	Suggested Usages
		Mu	Me	S	H	V	Deb	LW	Dis		
13	Basu School				✓					2,625.05	Humanitarian camp
14	Bhaktapur Bahumukhi Campus			✓						25970.81	Settlement/camp
15	Bhaktapur Durbar Square								✓	5936.30	Distribution area
16	Bhandarkhal			✓						21238.28	Settlement/camp
17	Bhelukhel							✓		4659.93	Logistics
18	Bhirkuti Mandap			✓						84138.70	Settlement/camp
19	Birendra Sainik School	✓	✓					✓		67089.78	Multiple: Civil-Mil coordination center, warehouse, medical assistance, helipad, humanitarian coordination, vulnerable population assistance, telecommunication, portable water source
20	Civil Aviation 1			✓						17457.82	Settlement/camp
21	Civil Aviation 3							✓		76292.66	Logistics
22	Dashrath Stadium	✓			✓					32249.58	Multiple: Humanitarian coordination, humanitarian camp, helipad
23	Datattratya		✓							1937.70	Medical assistance
24	DWSS			✓						45022.32	Settlement/camp
25	Election Commission Office	✓								16168.61	Multiple: Helipad, distribution area, telecommunication
26	End of Airport Site (Civil Aviation 2)							✓		142215.32	Warehousing
27	Gokarna Golf Club Site	✓	✓	✓				✓		290060.86	Multiple: Settlement/camp, assembly point for displaced, distribution area, warehouse, medical assistance, helipad, portable water
28	Gokul Chaur								✓	7328.13	Distribution area
29	Golf club site (royal)/airport	✓			✓			✓		141414.10	Multiple: Logistics, civil-mil coordination, warehouse, humanitarian camp, helipad, humanitarian coordination area, portable water
30	Himal Cement Company							✓		91756.67	Logistics
31	Hyatt Regency Hotel				✓					82979.29	Humanitarian Camp
32	Jawalakhel Football Ground			✓						7501.69	Settlement/camp
33	Khwopa College			✓						26692.29	Settlement/camp
34	Khwopa Engineering College			✓						11916.01	Settlement/camp
35	Kwathandu		✓							1531.74	Medical assistance
36	Lagankhel Football Ground	✓	✓					✓		11211.30	Multiple: warehouse, medical assistance, helipad
37	Lagankhel Stupa				✓					17717.58	Humanitarian coordination area
38	Lalitpur Municipality				✓					6359.01	Humanitarian coordination area

N0.	Name	Function								Area sq.m	Suggested Usages
		Mu	Me	S	H	V	Deb	LW	Dis		
	Office										
39	Madan Smarak								✓	13096.04	Distribution area
40	Maheshwori Football Ground			✓						8354.00	Settlement/camp
41	Modern Indian School			✓						14795.90	Settlement/camp
42	Narayan Chaur			✓						10266.17	Settlement/camp
43	NARC	✓	✓	✓				✓	✓	493702.60	Multiple: settlement/camp, logistics, medical assistance, distribution, helipad, telecommunications, portable water
44	Nasamana								✓	762.3	Distribution area
45	National Academy				✓					24423.20	Humanitarian camp
46	Nepal Bal Mandir			✓						14948.80	Settlement/camp
47	Oxygenation Park						✓			359400.56	Debris collection
48	Padma Higher Secondary School				✓					2230.23	Humanitarian coordination area
49	Padma Kanya Campus			✓						17093.61	Settlement/camp
50	Pashupati 1			✓						17981.45	Settlement/camp
51	Pashupati 2		✓							10753.01	Medical assistance
52	Pashupati 3			✓						19798.00	Settlement/camp
53	Pashupati 4		✓							11363.81	Medical assistance
54	Pashupati 5		✓							33103.66	Medical assistance
55	Pulchowk Engg. College	✓							✓	20516.28	Multiple: Distribution area, portable water
56	Pulchowk Engg. College 2	✓		✓						86406.82	Multiple: Settlement/camp, portable water
57	Rastriya Sabha Griha			✓						13589.23	Settlement/camp
58	Ratna Park	✓	✓							177228.49	Multiple use: camp, helipad, civil-mil coordination, medical assistance area, vulnerable population assistance area
59	Ringroad Balaju Kalanki			✓						308480.95	Settlement/camp
60	Ringroad Balkumari Gwarko						✓			78169.03	Debris collection
61	Ringroad Ekantakuna Balkhu	✓		✓					✓	166804.61	Multiple: Settlement/camp, distribution area
62	Ringroad Gwarko Satdobato						✓			71129.10	Debris collection
63	Ringroad Maharajgunj Balaju			✓						272338.98	Settlement/camp
64	Ringroad Maharajgunj Chabahil						✓			174041.10	Debris collection
65	Ringroad Satdobato Ekantakuna						✓			117111.31	Debris collection
66	RONAST	✓	✓		✓					73071.58	Multiple: camp, medical assistance, humanitarian coordination area
67	Sallaghari Tinkune			✓						66896.13	Settlement/camp
68	Sano Gaucharan								✓	8747.76	Distribution area

N0.	Name	Function								Area sq.m	Suggested Usages
		Mu	Me	S	H	V	Deb	LW	Dis		
69	Saraswati Vidyagriha							✓		2895.44	Logistics
70	Shankha Park	✓					✓	✓		10751.35	Multiple: Debris collection, Logistics
71	Sifal Ground			✓						7182.78	Settlement/camp
72										13319.00	Vulnerable population assistance area
73	St. Mary's School				✓					10825.32	Humanitarian camp
74	St. Xavier School				✓					21382.94	Humanitarian camp
75	Suryamadi								✓	795.61	Distribution area
76	Talako								✓	1054.47	Distribution area
77	Taumadi				✓					1998.70	Humanitarian coordination area
78	Tibetan Refugee Camp		✓							5982.58	Medical assistance
79	Tin Kune			✓						28372.15	Settlement/camp
80	Tribhuvan University	✓	✓	✓				✓	✓	1431956.83	Multiple: camp, assembly point for displaced, distribution, warehouse, medical assistance, helipad, portable water
81	UN Park Jwagal			✓						42300.46	Settlement/camp
82	UN Park Gusingal			✓						81380.22	Settlement/camp
83	Vidyarthi Niketan								✓	12324.70	Distribution area
84	Saibu Chaur (NSET)			✓						9,400.00	Settlement/camp

Source: JST: based on Summary of Open Spaces Allocation on report, NRRC and PRNE



Source: JST

Figure 8.8.17 Emergency Road Network (UNDP)

5) New Open Space

KVDA and NSET decided new open spaces (Atlas of Open Spaces KVDA). JICA Study Team extract 120 locations of these new open spaces.

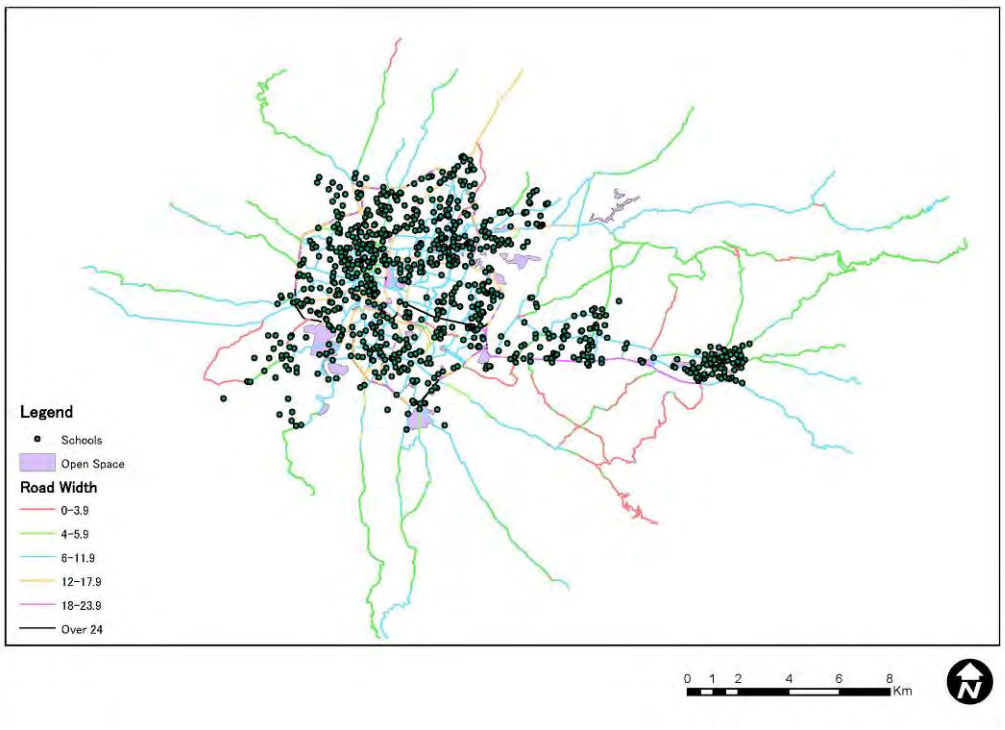
Table 8.8.5 New Open Space List

ID	Name	Area Ha	Type	ID	Name	Area Ha	Type	ID	Name	Area Ha	Type	ID	Name	Area Ha	Type
OS1	P1	1.43	Private	OS31	P25	0.13	Private	OS61	P53	0.54	Private	OS91	G23	1.77	Government
OS2	G1	1.06	Government	OS32	P26	0.28	Private	OS62	P54	0.94	Private	OS92	P67	0.20	Private
OS3	G2	2.55	Government	OS33	P27	0.21	Private	OS63	P55	0.35	Private	OS93	G7	0.08	Government
OS4	G3	2.60	Government	OS34	P28	0.25	Private	OS64	P56	0.73	Private	OS94	P68	0.24	Private
OS5	G4	1.73	Government	OS35	P29	0.30	Private	OS65	G10	0.83	Government	OS95	P69	0.19	Private
OS6	G5	1.69	Government	OS36	P30	0.08	Private	OS66	G11	0.74	Government	OS96	P70	0.14	Private
OS7	P2	0.44	Private	OS37	G6	3.13	Government	OS67	G12	0.14	Government	OS97	P71	0.11	Private
OS8	P3	0.09	Private	OS38	P31	0.25	Private	OS68	G13	0.24	Government	OS98	P72	0.28	Private
OS9	P4	0.17	Private	OS39	P32	0.18	Private	OS69	P57	0.45	Private	OS99	P73	0.08	Private
OS10	P5	0.22	Private	OS40	P33	0.17	Private	OS70	P58-2	0.54	Private	OS100	P74	0.13	Private
OS11	P6	0.33	Private	OS41	P34	5.76	Private	OS71	P58-1	0.14	Private	OS101	T2	0.35	Temple
OS12	P7	0.23	Private	OS42	P35	0.42	Private	OS72	P59	0.42	Private	OS102	P75	0.50	Private
OS13	P8	0.56	Private	OS43	P36	0.40	Private	OS73	P60	0.37	Private	OS103	P76	1.01	Private
OS14	P9	0.42	Private	OS44	P37	0.07	Private	OS74	G74	43.22	MilitaryArea	OS104	P77	0.15	Private
OS15	P10	0.86	Private	OS45	G8	0.12	Government	OS75	P61	0.30	Private	OS105	P78	0.09	Private
OS16	P11	0.54	Private	OS46	P38	0.05	Private	OS76	P62	1.09	Private	OS106	P79	0.09	Private
OS17	P12	0.47	Private	OS47	P39	0.10	Private	OS77	G14	0.64	Government	OS107	P80	0.05	Private
OS18	P13	0.28	Private	OS48	P40	0.28	Private	OS78	G15	0.36	Government	OS108	P81	0.09	Private
OS19	P14	0.21	Private	OS49	P41	0.07	Private	OS79	G16	0.09	Government	OS109	P82	0.62	Private
OS20	P15	0.18	Private	OS50	P42	0.59	Private	OS80	P91	0.72	Private	OS110	P83	0.52	Private
OS21	P16	0.19	Private	OS51	P43	0.73	Private	OS81	G17	0.49	Government	OS111	P84	0.19	Private
OS22	P17	0.31	Private	OS52	P44	0.20	Private	OS82	G18	4.28	Government	OS112	P85	0.22	Private
OS23	P18	0.34	Private	OS53	P45	0.19	Private	OS83	G19	1.22	Government	OS113	P86	0.60	Private
OS24	P19	0.17	Private	OS54	G9	0.14	Government	OS84	G20	0.82	Government	OS114	P87	2.14	Private
OS25	P20	0.10	Private	OS55	P46	0.33	Private	OS85	G21	2.18	Government	OS115	P88	0.38	Private
OS26	P21	0.21	Private	OS56	P48	0.20	Private	OS86	G22	0.40	Government	OS116	P89	0.21	Private
OS27	P22	0.28	Private	OS57	P49	0.38	Private	OS87	P63	0.27	Private	OS117	P90	2.18	Private
OS28	P23	0.40	Private	OS58	P50	0.49	Private	OS88	P64	0.29	Private	OS118	G24	25.89	Government
OS29	P24	0.06	Private	OS59	P51	0.25	Private	OS89	P65	0.21	Private	OS119	G25	5.10	Government
OS30	T1	0.63	Temple	OS60	P52	4.43	Private	OS90	P66	0.35	Private	OS120	G27	3.52	Government

Source: JST based on "Atlas of Open Space" KVDA and NAET

6) School

The Figure below shows school location.



Source: JST

Figure 8.8.18 School Location Map

8.8.4.2 Planning of Emergency Transportation Road Network (ETRN)

ETRN of Kathmandu Valley will consist of National, First, Second and Concept class emergency roads. The reasons for classifying ETR into four categories were following.

- According to the results of the report of N-SET ("Vulnerable Transportation Networks and Earthquakes"), Arniko Highway, Ring Road and several road network around Ratna Park will not blockade. These roads will be able to use ETR after big earthquake, and be classified National and First Emergency Roads.

- The second most important roads are the road that connect Ring Road and wide roads around Ratna Park. These radiating roads are important for ETRN because of connecting CBD and Ring Road. JICA Study Team classifies First Emergency Roads.

- In the existing urban area located inner Ring Road, many old high density buildings (6th to 8th stories) are located along the narrow road. If big earthquake will happen, the roads will be blocked by collapsed buildings. For this reason, roads connect large hospitals or Open Spaces functioning emergency to Ring Road or Arniko Highway are set Second Emergency Roads. JICA Study Team proposes road widening and earthquake-proof conversion of buildings located by Second Emergency Road.

- Some emergency points (Open Spaces, large hospitals and warehouses) located outside of Ring Road connect Second Emergency Roads. These roads are dead end roads. JICA Study Team proposes Concept Emergency Road that connects such Second Emergency Roads to eliminate the dead end.

(1) National Emergency Road

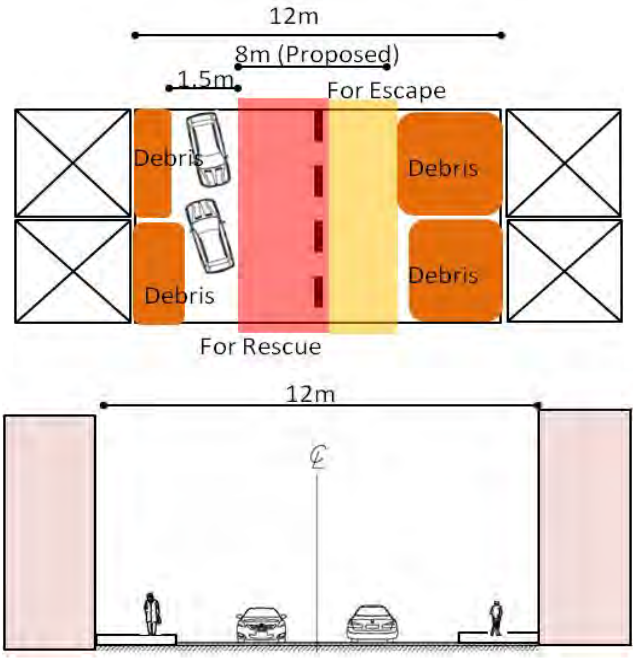
Definition of National Emergency Road is as follows:

- National Emergency Roads are Ring Road Arniko Highway and Tribhvan Highway. (Over 20m (Plan)).
- Even if a big earthquake occurs, two or more lanes are secured.
- Big hospitals and heavy equipment base are located along National Emergency Road.

(2) First Emergency Transportation Road Network

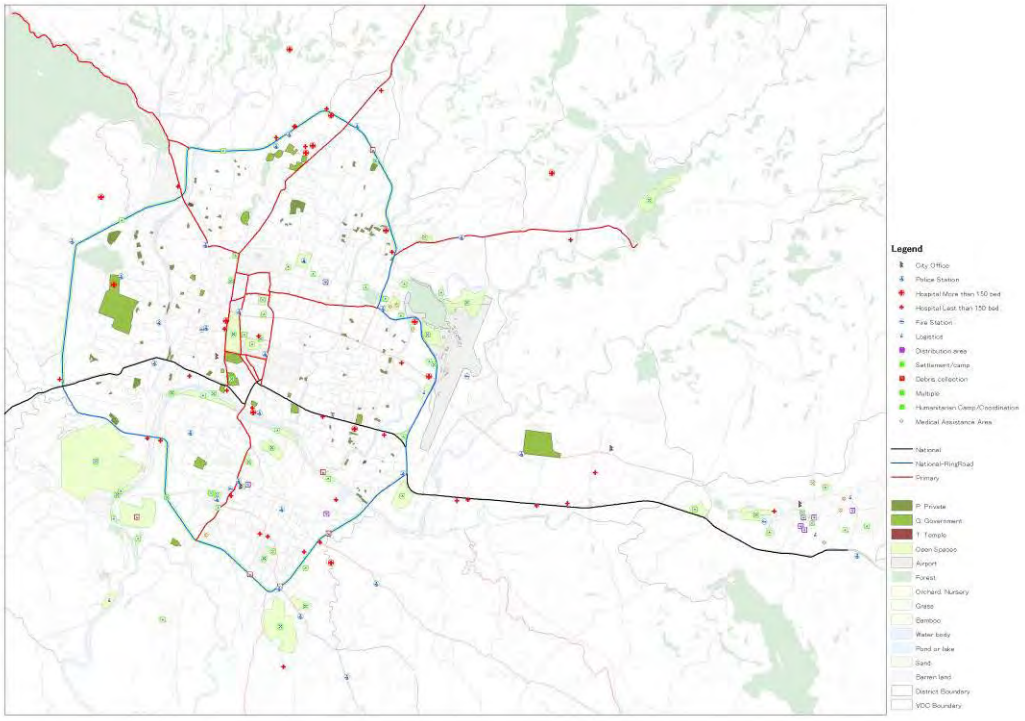
Definition of First Emergency Transportation Road is as follows:

- First Emergency Transportation Roads are connected with big hospitals, government offices, collages (Universities), Open Spaces, warehouses and airport.
- Case of scenario MMI X earthquake, maximum 2 lane spaces are secured.
- (Proposal) First Emergency Transportation Road needs to satisfy the following conditions:
    - ✧ To secure 4m road width for emergency transportation and evacuation. (Ambulance and fire engine can pass two ways. Heavy equipment (ex. wheel type loader (Vehicle width 3m)) can work to remove left vehicle) = A
    - ✧ To secure 4m road width for evacuation = B
    - ✧ A + B = C (8m)
    - ✧ To secure 1.5m road width for left vehicles = D (1.5m)
    - ✧ The standard First ETR width is 12m
    - ✧ Debris will be kept within 2.5m (12m – C – D = 12 – 8.0 - 1.5 = 2.5m).



Source: JST

Figure 8.8.19 Cross Section and Plan of First Emergency Transportation Road



Source: JST based on JICA- Rehabilitation & Recovery from Nepal Earthquake Map

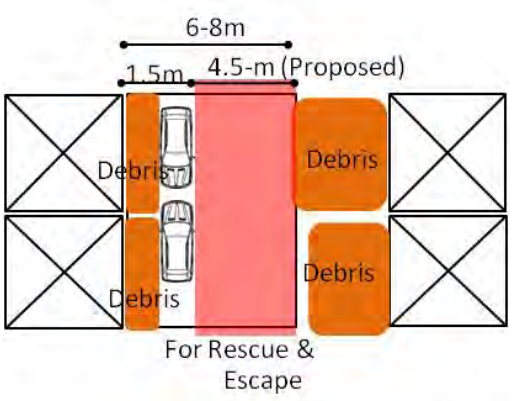
Figure 8.8.20 Plan of First Emergency Transportation Road

(3) Second Emergency Transportation Road

Definition of Second Emergency Transportation Road is as follows:

- The function of Second Emergency Transportation Road is to complement First Emergency Transportation Road.

- Recommended Road width of Second Emergency Transportation Road is 8m.
- To secure over 4.5m road width for emergency transportation and evacuation.
  - ✧ There is no space for debris in case of 6m width of Second ETR. In this case, roadside buildings must be setback and debris must be kept in private land.
  - ✧ In case of 8m road width, 2m can be used for debris, 1.5m for left vehicle and 4.5m for rescue and evacuation.



Source: JST

Figure 8.8.21 Cross Section and Plan of Second Emergency Transportation Road

Source: JST

Figure 8.8.22 Cross Section and Plan of Second Emergency Transportation Road

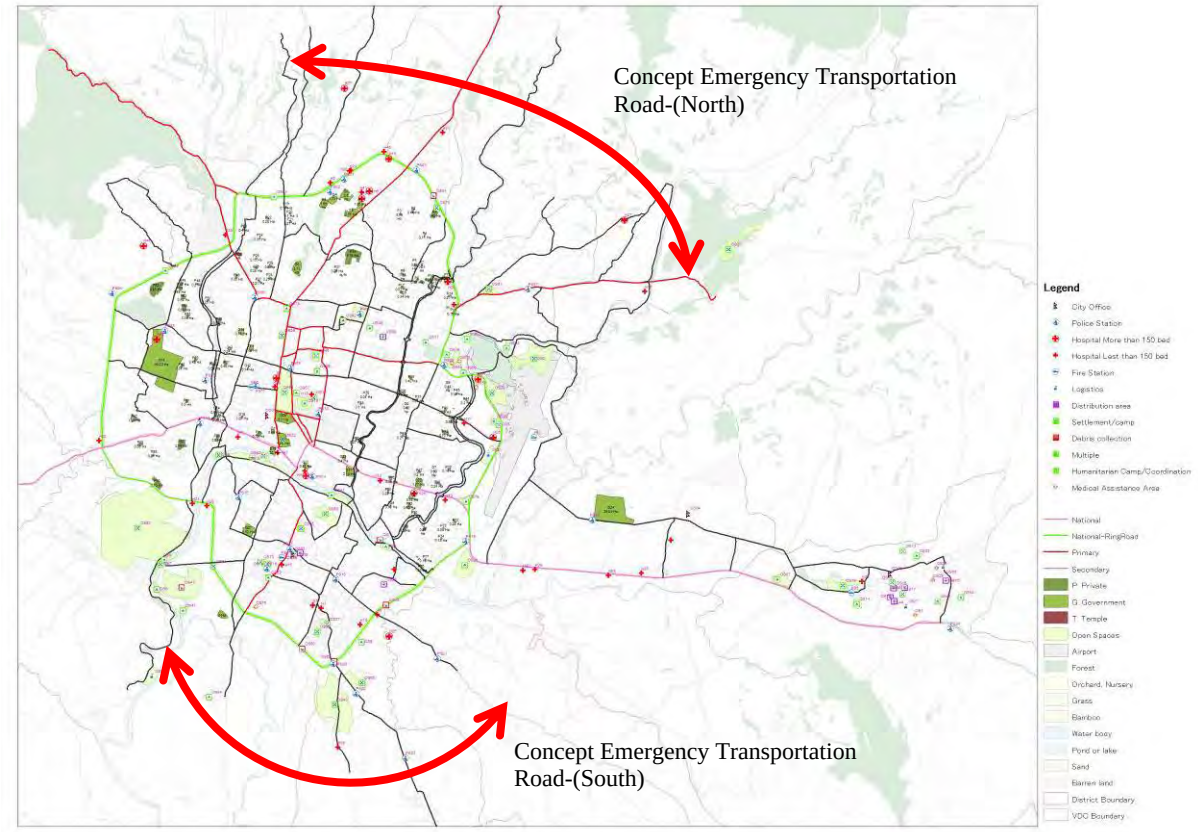
Source: JST based on JICA- Rehabilitation & Recovery from Nepal Earthquake Map

Figure 8.8.23 Plan of Second Emergency Transportation Road

(4) Concept Emergency Transportation Road

Concept Emergency Transportation Road is defined as follows:

- JICA Study Team proposes as “Concept Emergency Transportation Road (CETR)” with first and second ETRN.
- CETR is only concept without information of alignment, road width and detail of road.
- Development methods of Concept Emergency Roads must be proposed. (Land Pooling).



Source: JST based on JICA- Rehabilitation & Recovery from Nepal Earthquake Map

Figure 8.8.24 Plan of Concept Emergency Transportation Road

(5) Evaluation of ETRN at the time of Scenario Earthquakes

JICA Study Team evaluates the condition of ETRN at the time of Scenario Earthquakes. Figure 8.8.25 and Figure 8.8.26 are the maps that overlay future road network of Kathmandu Valley with Hazard Map that is the most serious damage case of The Project for Assessment of Earthquake Disaster Risk and JICA Study Team. The condition of ETRN on Hazard Map is following.

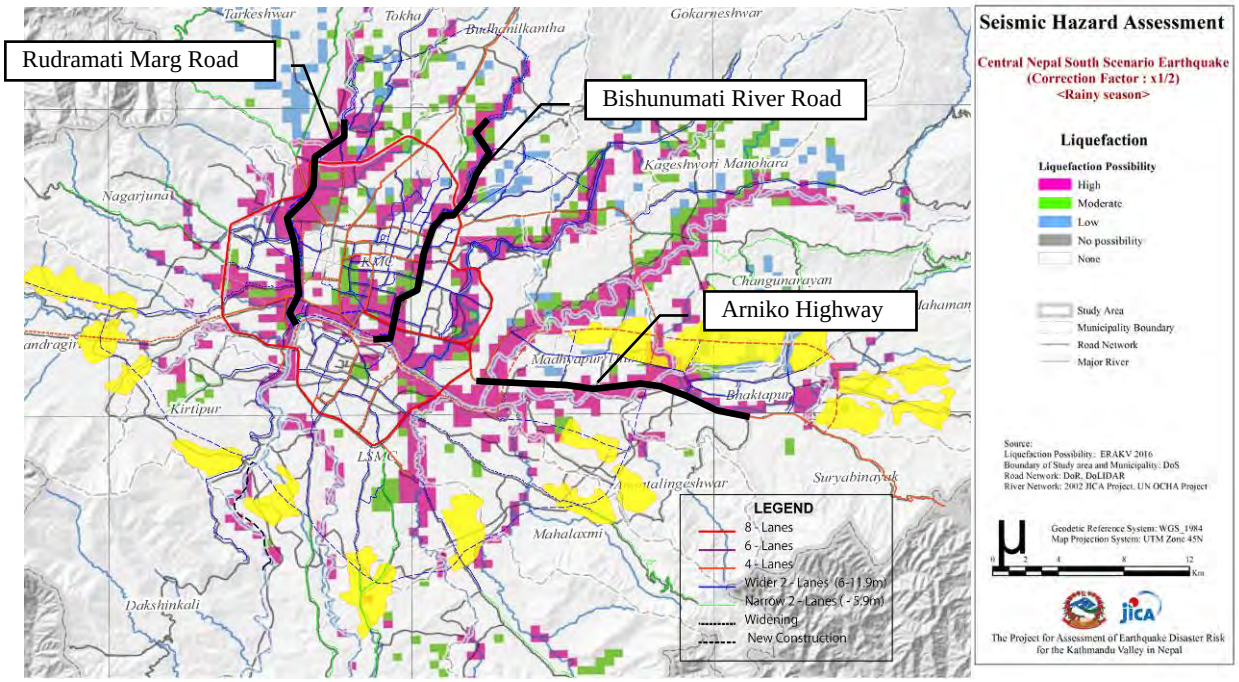
(Liquefaction)

According to Figure 8.8.25, Arniko Highway (Kathmandu - Bhaktapur), Rudramati Marg Road and Bishunumati River Road (Black line) alignment are located high risk area. If earthquake (Central Nepal South Scenario Earthquake x1/1) will happen, these three routes can use for emergency transportation. But Bagmati Road is connected to Arniko Highway with south-north roads, and Rudramati Marg Road and Bishunumati River Road are connected to Ring Road with several roads. ETRN forms many roads and if some ETR will be blockaded, other ETR support and the function of ETRN will be gone on.

Kathmandu Valley ETRN has three routes to bring necessities of life to Kathmandu Valley (from east, west and south). If Arniko Highway will be blockaded for earthquake and liquefaction, rescue team can choice west and south routes to access Kathmandu Valley. Furthermore, the route from west, government food markets are located by the roadside of Arniko Highway. The route from south, Food co-operation warehouses (storage of rice, 9,000t) is located near Ring Road and Dakchhinkali Road. If Arniko Highway is blockaded, rescue team use west and south routes and bring evacuation food from government markets, warehouses and others. At the same time, restoration work on Arnico Highway will be promptly done and after a few months, National and first ETR will be available.

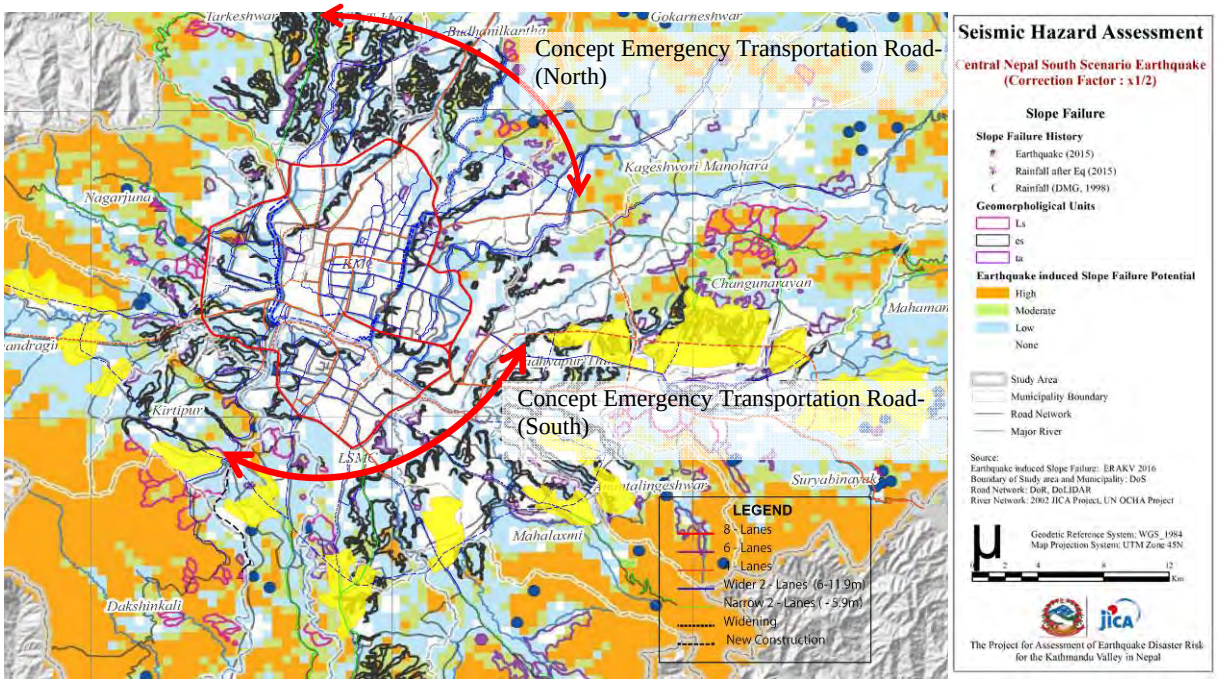
(Slope Failure)

According to Figure 8.8.26, some of ETR that located outside of Ring Road have a middle and low level risk of slope failure. JICA Study Team proposes CETR for connecting such ETR located outside of Ring Road.



Source: JST based on the result of Hazard Assessment (The Project of Assessment of Earthquake Disaster Risk for Kathmandu Valley in Nepal

Figure 8.8.25 Seismic Hazard Assessment (Liquefaction)
(Central Nepal South Scenario Earthquake Correction Factor:x1/1)



Source: JST based on the result of Hazard Assessment (The Project of Assessment of Earthquake Disaster Risk for Kathmandu Valley in Nepal

Figure 8.8.26 Seismic Hazard Assessment (Slope Failure)
(Central Nepal South Scenario Earthquake Correction Factor:x1/1)

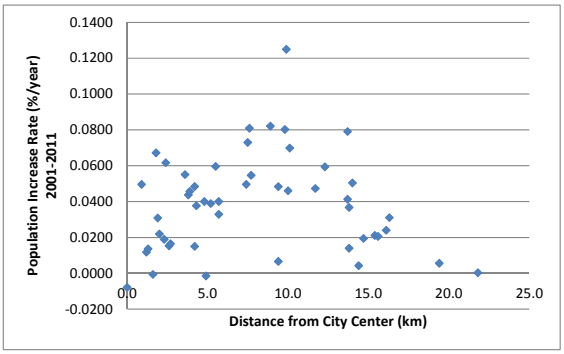
CHAPTER 9 TRAFFIC DEMAND FORECAST

9.1 Future Population Distribution

(1) Population Distribution for Base Case (Case-0)

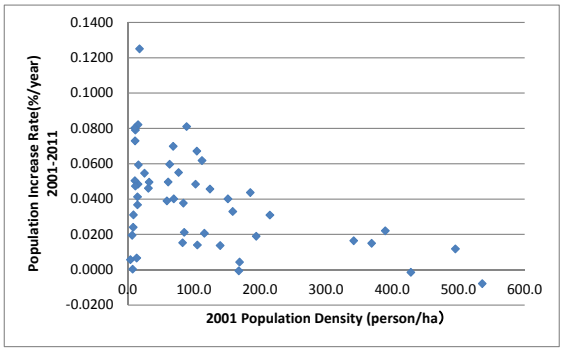
Total future population is discussed in detail in Chapter 3, which is also summarized in Table 6.1.5. In this Chapter, traffic demand forecast is conducted for Base Case (Case-0) and definitive Structure Plan Case-3 in Chapter 6, and traffic demand in both cases is analyzed. For the future traffic demand forecast, total population framework is required to be distributed into traffic zones. Population distribution for the Base Case is for Base Case land use scenario, which keeps the current trend of population increase.

Based on the population by 2001 Census and 2011 Census, factors which relate to population growth rate are analyzed. Factors to be focused on are distance from city center and present population density by zone. Figure 9.1.1 shows the relation between population growth rate and distance from city center, and Figure 9.1.2 shows the relation between population growth rate and population density in 2001.



Source: JICA Study Team

Figure 9.1.1 Relation between Population Growth Rate and Distance from City Center



Source: JICA Study Team

Figure 9.1.2 Relation between Population Growth Rate and Population Density 2011

According to the above figures the following tendencies are observed.

- Population growth rate gradually increases as the distance from the city center increases in the area within ten kilometers from the city center. On the other hand population growth rate decreases as the distance from the city center increases in the area outside the ten kilometers from the city center.
- In the area where population density is high, population growth rate is low.

For the population distribution for the current trend scenario, population distribution model is formulated taking account of the above observation.

$Y=aX^1+bX^2+c$

Y: Population increase rate per annum
X^1: Existing population density
X2: Distance from city center
A, b, c: Regression coefficient

By the multiple regression analysis, the following function formula was obtained:

Within 10km
$Y=-0.000094X^1+0.00287X^2+0.04154$
R=0.713
Outside 10 km

$Y=-0.00018X^1-0.0055X^2+0.1180$
R-0.898

Total population by district is controlled by the population framework, and population was distributed to each zone by the model.

(2) Population Distribution for Definitive Structure Plan (Case-3)

Population distribution for the definitive Structure Plan is formulated by the following procedure:

- Population is distributed preferentially to the new development area of Structure Plan.
- Population readjustment was conducted to other zones to keep consistency with control total population by framework.

9.2 Future Traffic Demand Forecast

9.2.1 General

Future traffic demand was forecasted basically in accordance with the "Data Collection Survey on Traffic Improvement in Kathmandu Valley" by JICA in 2012 (herein after referred to as JICA 2012). The Study conducted various surveys including a Home Interview Survey, which clarified movements of people and vehicles in the Kathmandu Valley. The Study conducted future traffic demand forecast based on the survey results. Regarding the zoning system and the traffic demand forecast models, this Study basically followed the JICA 2012 Study as mentioned above. However, new and different socioeconomic frameworks were introduced for future development of the Kathmandu Valley. New target years for the planning were set for future planning. Therefore, the Study Team conducted a revised traffic demand forecast based on the new socioeconomic frameworks in the target years of 2020, 2025 and 2030. Some modifications to the traffic demand forecast models were also made. New diversion models for the new public transport modes were analyzed and developed. The details are described below.

9.2.2 Major Premises

9.2.2.1 Four Step Procedure

The future traffic demand forecast was conducted by using the four step procedure, which is popular in the field of traffic demand forecast at the moment. The procedure consists of four steps of 1. Trip Generation/Attraction, 2 Trip Distribution, 3 Modal Split and 4 Traffic Assignment as shown in Figure 9.2.1.

i) Trip Generation/Attraction	Estimation of the number of trips generated from and attracted to each zone by trip purpose
⇩	
ii) Trip Distribution	Estimation of the number of trips between zones by trip purpose
⇩	
iii) Modal Split	Estimation of the number of trips between zones by mode and by trip purpose
⇩	
iv) Traffic Assignment	Estimation of the number of trips on each link of the transportation network

Source: JICA 2012

Figure 9.2.1 Four-Step Procedure

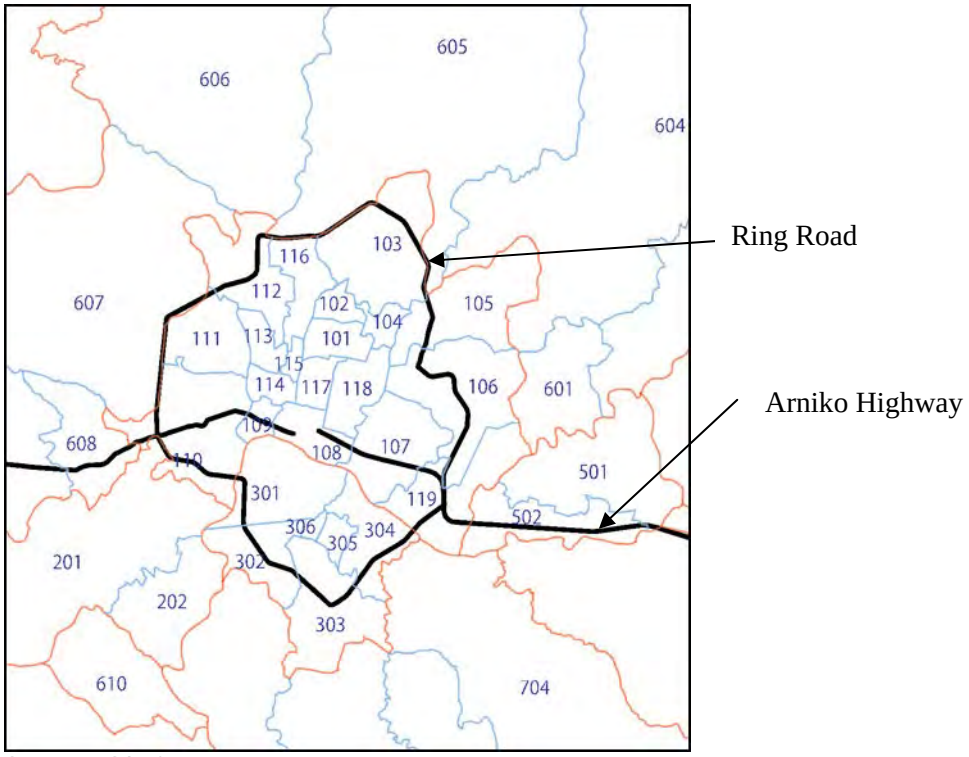
9.2.2.2 Traffic Zoning System

The study area was divided into 10 large zones, 50 small zones, and 86 traffic zones same as in JICA 2012 as shown in Table 9.2.1. Basic zoning system contains 50 small zones, each of which has average population of approximately 50,000. Most of the analyses including model building of future demand forecasting were based on the 50 small zones system (refer to Figure 9.2.2). The 86-small-zone system was used only for traffic assignment to the transportation network in order to ensure the accuracy of the traffic demand forecasts on each link (refer to Figure 9.2.3).
It should be mentioned that one outside zone was added in this Study to the existing zone system for traffic assignment, which is the "West-south" zone. The new outside zone was separated from the "Western Outside" zone (Refer to Figure 9.2.3).

Table 9.2.1 Number of Traffic Zones for Demand Forecasting in the Survey Area

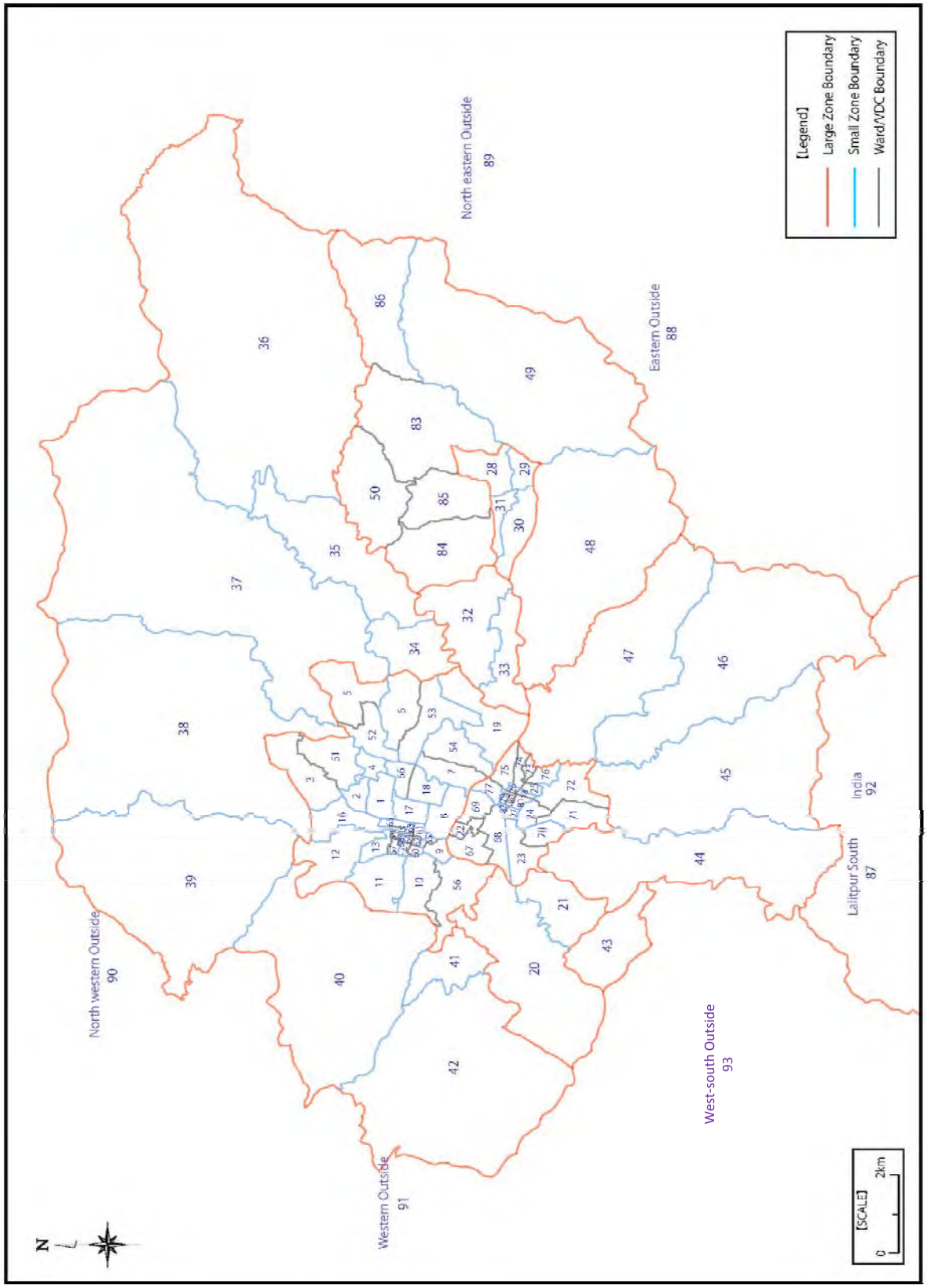
City	Population 2011 (persons)	Large Zone (10 zones)	Small Zone (50 zones)	Zones for Traffic Assignment (86 zones)
Kathmandu	1,719,630	3	31	47
Lalitpur	421,494	2	10	26
Bhaktapur	303,027	3	9	13
Total	2,444,151	8	50	86

Note: In addition to the above zones, the other seven zones outside Kathmandu Valley were used for the traffic demand forecast.
Source: JICA 2012



Source: JICA 2012

Figure 9.2.2 Small Zones around the Ring Road（50 Zones）



Source: JICA Study Team based on JICA 2012

Figure 9.2.3 Zones for Traffic Assignment in Kathmandu Valley

9.2.2.3 Trip Purpose

The nine trip purpose categories in the household interview survey were integrated into five purpose categories in the traffic demand forecast as shown in Table 9.2.2.

Table 9.2.2 Trip Purpose Categories in Demand Forecasting

Trip Purpose Categories in Household Interview Survey		Trip Purpose Categories in Demand Forecasting	
1	To Work (from Home)	1	To Work
2	To School	2	To School
3	To Home	3	To Home
4	Business	4	Business
5	Shopping	5	Others
6	Eating		
7	Leisure/Recreation		
8	Medical/Treatment		
9	Others		

Note: The private purpose categories, such as shopping, eating, leisure, medical and others, were integrated into the "others" category in the demand forecast.
Source: JICA 2012

9.2.2.4 Travel Mode

The nine person trip travel mode categories in the household interview survey were integrated into five categories for the analyses and model building in the demand forecast as shown in Table 9.2.3.

Table 9.2.3 Travel Mode Categories in Demand Forecasting

Travel Mode Categories in Household Interview Survey		Travel Mode Categories in Demand Forecasting	
1	Walk	1	Walk
2	Bicycle	2	Bicycle
3	Motorcycle	3	Motorcycle
4	Car	4	Car
5	Taxi		
6	Tempo	5	Bus
7	Microbus		
8	Minibus		
9	Large Bus		

Source: JICA 2012

9.2.2.5 Level of Service (LOS) by Mode

(1) LOS of Road Based Transport

Several conditions relating to the level of service of the existing or future transportation network were examined to forecast the future traffic demand. The following assumptions on road traffic capacities, velocities, bus fare and fuel costs were presented in Table 9.2.4 based on the traffic survey results in JICA 2012.

The capacity by road type was revised in this Study from the JICA 2012, which had four categories previously, to six categories as shown in a. Capacity of Roads.

Regarding the bus fare and fuel costs, price levels of JICA 2012 were used, because this Study adopted most of the traffic demand models developed in the study. It was assumed that the price level was the same as 2011 in real terms.

Table 9.2.4 Level of Service for Analysis and Demand Forecasting

a. Capacities of Roads **unit: pcu/day**

	Direction	Area Inside the Ring Road	Area Outside the Ring Road
Roads with narrow 2 lanes less than 4m	Both	6,000	7,000
	One way	14,000	17,000
Roads with 2 lanes 4 – 5.9m	Both	17,000	20,000
	One way	27,000	33,000
Roads with wider 2 lanes 6 – 11.9m	Both	22,100	26,000
	One way	35,100	42,900
Roads with 4 lanes 12 – 17.9m	Both	52,000	57,000
Roads with 6 lanes 18 – 23.9m	Both	75,000	83,000
Roads with 8 lanes over 24 m	Both	98,000	109,000

Note: Roads with wider 2 lanes were assumed to have 6.0 to 11.9m width.
Source: JICA Study Team based on JICA 2012

b. Velocities **unit: km/hour**

Type of Pavement	Condition of Surface	Velocity in Off Peak Hours (free speed)	Velocity in Peak Hours (congested speed)	Velocity on Average (average speed)
Asphalt	Good	60	20	40
	Fair	45	15	30
	Bad	30	10	20
Gravel	Good	50	20	35
	Fair	35	15	25
	Bad	20	10	15
Earthen	Good	40	15	30
	Fair	25	10	20
	Bad	10	10	10

Note: These velocities were applied to all transportation modes including cars, motorcycles, and buses on the road. In addition, buses include getting on/off times at each bus stop. Travel time of buses consists of both running time and getting on/off time. In this survey, getting on/off time at each bus stop of 2 minutes per 500 meters was added.
Source: JICA 2012

c. Fares and Costs

Bus fares	The 2011 fare level was set up by area and distance. For example: NPR 13 up to 5 km within the Ring Road	The fare table has been applied since October 30, 2011 by the Government of Nepal. New fare was increased by 9.9% of the old fare.
Taxi fares	In 2011, the minimum fare was NPR 30 within a distance of 1 km and an additional fare for distances beyond 1km is added at NPR 5.95 per 200 m. For example: NPR 149 for 5 km	
Petrol cost and Fuel efficiency	Petrol: NPR 114/L Car: 15 km/L, Motorcycle: 25 km/L	Petrol price was set at the price in Kathmandu City in January 2012.

Source: JICA 2012

(2) LOS of the New Transport System

The Bus Rapid Transit (BRT) and the Automated Guided Transit (AGT) were assumed as the future new transport system in the Kathmandu Valley (Refer to Chapter 10). The BRT is assumed to be

introduced in 2025, while the AGT is assumed to be in operation in 2030. Travel speed and fare level of the two systems were assumed as below.

- Operating Speed of BRT: 20 km /h (including stopping time at stations)
- Operating Speed of AGT: 30 km/h at the sections inside the Ring Road and 20 km/h at the outside (including stopping time at stations)
- Fare level of BRT: as same as the existing bus service
- Fare level of AGT: extra 10 NPR is assumed

It should be noted that the new transport system is an integrated mode, which consists of the BRT, AGT and existing bus services. The existing bus services are used as the access/egress transport to support the new transport system. For example, new transport passengers would use the existing bus (access mode) first, then BRT and/or AGT next, and finally would use the existing bus (egress mode). Therefore, it could be said that the new transport system is the combination of the three modes. Fare is calculated by total travel length based on the existing bus service fare system, plus 10 NPR if the mode includes the AGT. Travel time is the total of the combination of the modes, including stopping time of the existing bus service of every 500 meters.

The existing bus services are used as the access/egress transport to support the new transport system. For example, new transport passengers would use the existing bus (access mode) first, then BRT and/or AGT next, and finally would use the existing bus (egress mode)

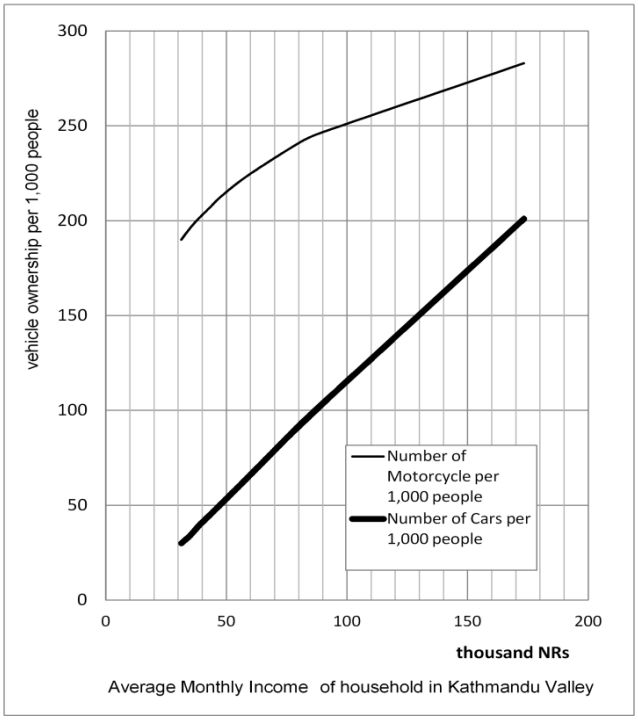
Regarding the planned route of the BRT and AGT, refer to Chapter 8.

9.2.2.6 Vehicle Ownership

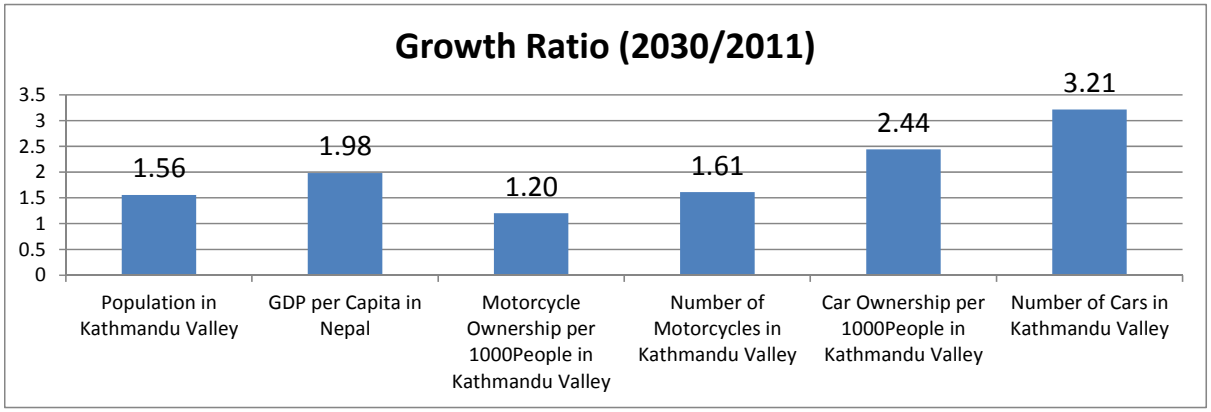
Car or motorcycle ownership greatly affects a person's decision on choosing their mode of travel. Car ownership level was still low at 25 vehicles per 1,000 people, although motorcycle ownership level was getting higher at 184 motorcycles per 1,000 people in 2011. Vehicle ownership ratios in 2011 were estimated by JICA 2011 based on the household interview survey. The ownerships in 2030, which is the final target year of this Study, were estimated by the Study Team as shown in Table 9.2.5.

Table 9.2.5 Vehicle Ownership Rate per 1,000 People in Kathmandu Valley

Item	Year	Motorcycle	Car
Total Number of Vehicles	2011	448,630	62,109
	2030	722,465	199,486
	Growth (2030/2011)	1.610	3.212
Number per 1,000 people	2011	184	25
	2030	221	61
	Growth (2030/2011)	1.201	2.440
Population	Growth (2030/2011)	1.557	
GDP per capita	Growth (2030/2011)	1.983	
Average Monthly Income of Household (NPRs)	2011	28,077	
	2030	55,677	
	Growth (2030/2011)	1.983	



Note: Estimations relating to vehicle ownership above were based on the household interview survey.
Source: JICA Study Team based on JICA 2012



Source: JICA Study Team based on JICA 2012

Figure 9.2.4 Growth Ratio of Population, GDP per Capita and Car Ownership

9.2.2.7 Forecast Cases

(1) Target Years

Three target years of 2020, 2025 and 2030 were assumed for future traffic demand forecast, which correspond to highway network planning, public transport planning and land use/population distribution planning. Several land use plans, which correspond to population distribution patterns, were consolidated into one.

(2) Highway Networks

Three highway networks were planned corresponding to the three target years. Details of the plans are described in Chapter 8 and 10.

(3) Simulation Cases

Definitive master plan is formulated as described in Chapter 8. In order to measure the traffic effectiveness of the master plan, four simulation cases are set up as shown in Table 9.2.6.

Table 9.2.6 Simulation cases for Demand Forecast

Case	Case Name	Forecast Year	Road Network	Public Transport
Case 0	Current Condition	2011	Present Network	Present Network
Case 1	Do-nothing Scenario	2030	Present Network	Present Network
Case 2	Road Development Only		Future Network	Present Network
Case 3	Definitive Master Plan		Future Network	Future Network

Source: JICA Study Team

Table 9.2.7 shows the forecast cases by exhibiting the plans and policy Measures by year. The Case 1 includes "Ongoing and Committed" projects in addition to the existing road network. The Case 2 includes road development plans by 2030 and road capacity improvement plans within the Ring Road (refer to Chapter 8 and 10), while Case 3 includes BRT plan, AGT plan and the Efficient Bus Transport policy measure in addition to the Case 2 (refer to Chapter 8 and 10).

The Efficient Bus Transport Plan aims at efficiency increase of bus transport by doubling average ridership of bus passengers. In addition, Tempo service is being integrated into the large bus service.

The number of bus vehicle trips in the target years, which consist of Tempo, Micro bus, Mini bus and Large bus, were divided by 2.0, because the average ridership is assumed to become double, in the first place. Next, Tempo vehicle trips are converted to the Large bus vehicle trips by multiplying (3.8/16.3) by origin-destination pair. The 3.8 and 16.3 are the average numbers of passengers of the Tempo and the Large bus, which were mentioned in the JICA 2012.

Table 9.2.7 Transport Plans and Policy Measures by Year

Case \ Year	2011	2020	2025	2030
Without				
Existing Road	○	○	○	○
Ongoing & Committed	-	○	○	○
With				
Road Plans	-	○	○	○
Road Capacity Improvement	-	○	○	○
BRT Plans	-	-	○	○
AGT Plans	-	-	-	○
Efficient Bus Transport	-	-	-	○

Source: JICA Study Team

9.2.3 Traffic Demand Forecast

9.2.3.1 Trip Generation and Attraction

(1) Trip Generation Rate and Vehicle Ownership

In general, trip generation and vehicle ownership have a close relationship with each other. In fact, the relationships were analyzed in the JICA 2012 and the rates were estimated by vehicle ownership category in addition to the zone location factor.

In this Study, the relationships were examined again by revising the vehicle ownership category. The revised category consists of three of 1.No Vehicle, 2.Motorcycle Only, and 3.Car Only and Car plus Motorcycle. Trip rates by the above category are shown in Table 9.2.8 by zone location.

Table 9.2.8 Trip Generation Rate by Vehicle Ownership (2011)

Area	Ownership	Trip Rate	2011	
			Population	Trips
Inside RR	No Vehicle	1.4567	326,483	475,600
	MC	1.4663	538,412	789,480
	Car	1.5617	114,095	178,180
	Total	-	978,990	1,443,260
Outside of RR	No Vehicle	1.3036	581,354	757,845
	MC	1.3915	778,489	1,083,291
	Car	1.5258	100,927	153,997
	Total	-	1,460,770	1,995,133
All Area	No Vehicle	-	907,837	1,233,445
	MC	-	1,316,901	1,872,771
	Car	-	215,022	332,177
	Total	-	2,439,760	3,438,393

Note: Car is summation of Car only and Car & Motorcycle
: Motorcycle means motorcycle only.
Source: Study Team based on JICA 2012

It is clear that vehicle owners have higher trip rates compared to non-owners and trip rates of inside Ring Road zones are higher trip.

(2) Vehicle Ownership Analysis

The Study Team conducted vehicle ownership analysis based on the Home Interview Survey results of the JICA 2012. The analysis consists of two steps. The first one is the vehicle ownership analysis, in which relationship between vehicle ownership and average monthly household income was examined. The other is the car ownership analysis, in which shares of car only and car plus motorcycle owners to the whole vehicle owners (including motorcycle only owners), were analyzed.

The logit models were used for the two ownership analyses, as shown below.

$$\text{Vehicle Ownership}^{i} = \frac{e^{f(xi)}}{1 + e^{f(xi)}}$$

where,

$f(x^i) = -0.43443 + 3.54E\text{-}05 * x^i$
(1.6328) (3.6382)

Vehicle Ownership ^{i}: Vehicle Ownership of i zone
x^i : Average Monthly Household Income of i zone

$$\text{Car Ownership}^{i} / \text{Vehicle Ownership}^{i} = \frac{e^{f(xi)}}{1 + e^{f(xi)}}$$

where,

$f(x^i) = -3.16784 + 4.33E\text{-}05 * x^i$
(7.4274) (2.7753)

x^i : Average Monthly Household Income of i zone

In this manner, future population by vehicle ownership category was forecasted by traffic zone.

(3) Future Trip Generation

Future total trip generation in 2030 was forecasted by using the procedure shown in Figure 9.2.5. It was assumed that future trip rate by vehicle ownership and by zone location is same as the rates in 2011.

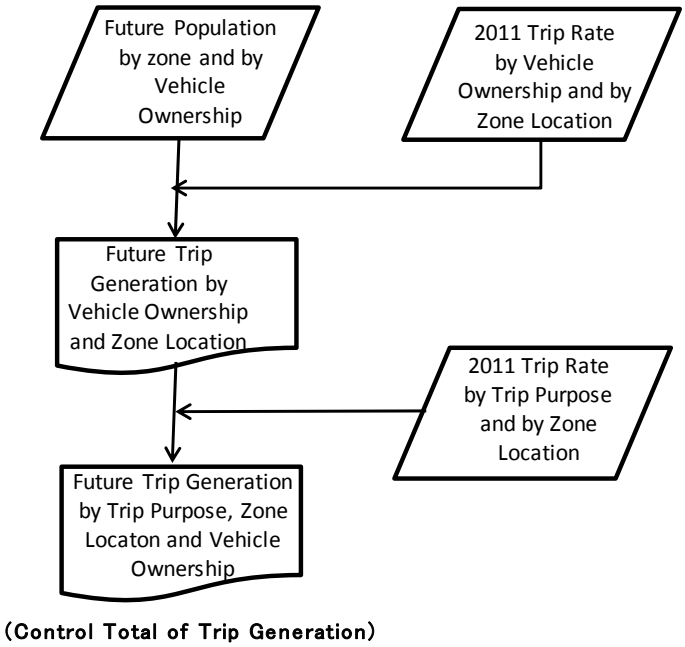


Figure 9.2.5 Flow Chart of Future Total Trip Generation

Table 9.2.9 exhibits the total future trip generation by zone location (inside the Ring Road or not) and by vehicle ownership situation.

Table 9.2.9 Estimated Trip Generation Total in Target Years

Area	Ownership	Trip Rate	2011		2020		2025		2030	
			Population	Trips	Population	Trips	Population	Trips	Population	Trips
Inside RR	No Vehicle	1.4567	326,483	475,600	282,685	411,798	223,842	326,079	174,058	253,557
	MC	1.4663	538,412	789,480	635,406	931,703	608,723	892,578	571,568	838,098
	Car	1.5617	114,095	178,180	219,209	342,334	299,635	467,934	428,773	669,607
	Total	-	978,990	1,443,260	1,137,300	1,685,836	1,132,200	1,686,591	1,174,400	1,761,262
Outside of RR	No Vehicle	1.3036	581,354	757,845	635,405	828,305	652,704	850,857	590,321	769,534
	MC	1.3915	778,489	1,083,291	1,129,400	1,571,595	1,326,867	1,846,376	1,458,309	2,029,281
	Car	1.5258	100,927	153,997	217,895	332,470	327,228	499,293	500,971	764,394
	Total	-	1,460,770	1,995,133	1,982,700	2,732,369	2,306,800	3,196,526	2,549,600	3,563,208
All Area	No Vehicle	-	907,837	1,233,445	918,090	1,240,103	876,547	1,176,936	764,379	1,023,091
	MC	-	1,316,901	1,872,771	1,764,806	2,503,298	1,935,590	2,738,954	2,029,877	2,867,378
	Car	-	215,022	332,177	437,104	674,804	626,863	967,227	929,744	1,434,001
	Total	-	2,439,760	3,438,393	3,120,000	4,418,205	3,439,000	4,883,117	3,724,000	5,324,470

Source: The Study Team based on JICA 2012
Note: Car is summation of Car only and Car & Motorcycle. Motorcycle means motorcycle only.

(4) Trip Generation and Attraction Model

This Study adopted the trip generation models developed by JICA 2012. The formula of the model is as below.

$$G^{i}_{k} = a_{k} * P^{i}$$

Where,
i : Zone Code,
k: Trip Purpose,

$G^{i}_{k:}$: Trip Generation of k purpose in i-zone,
P^{i} : Population of i-zone

The model consists of 8 models as shown in Table 9.2.10.

Table 9.2.10 Trip Generation Model by Trip Purpose

Area	Purpose	Paramater (Population)	Correlation Coefficient	Number of Samples
Zones Inside the Ring Road	To Work	0.2809	0.9733	22
	To School	0.2767	0.9920	22
	Business	0.0856	0.9218	22
	Others	0.1497	0.9858	22
Zones Outside the Ring Road	To Work	0.2431	0.9942	28
	To School	0.2841	0.9821	28
	Business	0.0436	0.8533	28
	Others	0.1277	0.9672	28

Source: JICA 2012

It should be noted that “To Home” trip generation model was not developed in JICA 2012. The "To Home" trips were estimated by using the estimated trips by mode and by purpose of the four trip purpose trips. The Study Team followed the methodology.

The "To Home" trips estimation procedure is shown below.

- By using "To Work" and "To School" trips by mode, "To Home" trips were estimated by mode assuming that the return trips would use the same mode. So, opposite direction trips of "To Work" and "To School" were considered as the "To Home" trips.
- A part of "Other" trips were also considered as the "To Home" trips by adjusting to the "Control Total", which is shown in Table 9.2.9 and Table 9.2.11. These trips of opposite direction were added to the "To Home" trips.

(5) Future Trip Generation and Attraction

Future trip generations by trip purpose and by zone were estimated by using the models mentioned above. However, trip attraction by zone and by trip purpose was estimated by using the ratio of attraction trip numbers to the generation trip numbers by zone and by trip purpose in 2011 basically. However, some zones were assumed to have higher attraction rates for "To Work", "Business" and "Others" trips in future, where intensive urban developments are expected (Refer to Appendix 1 of Appendix 2, Chapter 8 and the section 1 of this Chapter).

Total generated and attracted trips were adjusted to the Estimated Trip Generation Total in the target years, which is shown in Table 9.2.9.

The results of future trip generation by each trip purpose are shown in Table 9.2.11. Number of trips generated in 2020, 2025 and 2030 was estimated at approximately 4.4, 4.9 and 5.3 million, respectively. Estimated trip generation and attraction by small zone in the target years are shown in Appendix 2-1 to 2-3 of Appendix 2.

Table 9.2.11 Future Trip Generation in the Target Years

(Unit: person trips/day)

Area	Year / Purpose	2011	2020	2025	2030
Areas Inside the Ring Road	To Work	281,317	333,382	337,890	357,650
	To School	264,508	296,373	290,332	295,735
	Business	89,903	93,824	97,364	106,189
	Others	152,055	163,547	163,595	171,165
	To Home	983,991	798,709	797,410	830,523
	Sub Total	1,771,774	1,685,836	1,686,591	1,761,262
Areas Outside the Ring Road	To Work	353,144	497,303	586,656	661,452
	To School	392,522	526,630	608,647	666,046
	Business	63,566	113,339	136,438	158,631
	Others	192,142	278,764	326,402	364,753
	To Home	665,245	1,316,334	1,538,383	1,712,326
	Sub Total	1,666,619	2,732,369	3,196,526	3,563,208
Total	To Work	634,461	830,686	924,545	1,019,102
	To School	657,030	823,003	898,979	961,781
	Business	153,469	207,163	233,802	264,820
	Others	344,197	442,311	489,997	535,918
	To Home	1,649,236	2,115,042	2,335,793	2,542,849
	Total	3,438,393	4,418,205	4,883,117	5,324,470

Source: JICA Study Team

9.2.3.2 Trip Distribution

(1) Trip Distribution Model

1) Intra-zonal Trips

Intra zonal trip models were not developed the same way as the JICA 2012. Intra zonal trip ratios to the total generated trips were assumed to be same as the ratio in 2011.

2) Inter-zonal Trips

Gravity models were developed in the JICA 2012 to estimate future inter-zonal trips. The Study Team adopted the gravity models by trip purpose, because the Study Team assumed that drastic land use changes and extensive urban development within the Study Area would happen in the future. These changes are already incorporated in terms of the trip attraction ratio changes to the trip production, as explained in the previous section. Therefore, future trip distribution was estimated based on the above trip generation/attraction and the gravity models as shown below.

$$X_{ij} = k \cdot \frac{G_i^{\alpha} \cdot A_j^{\beta}}{T_{ij}^{\gamma}}$$

Where,

i, j: zone
Xij: number of trips between zone i and zone j
Gi: number of trips generated in zone i
Aj: number of trips attracted in zone j
Tij: distance (m) on the road between zone i and zone j
K, α, β, γ: parameter

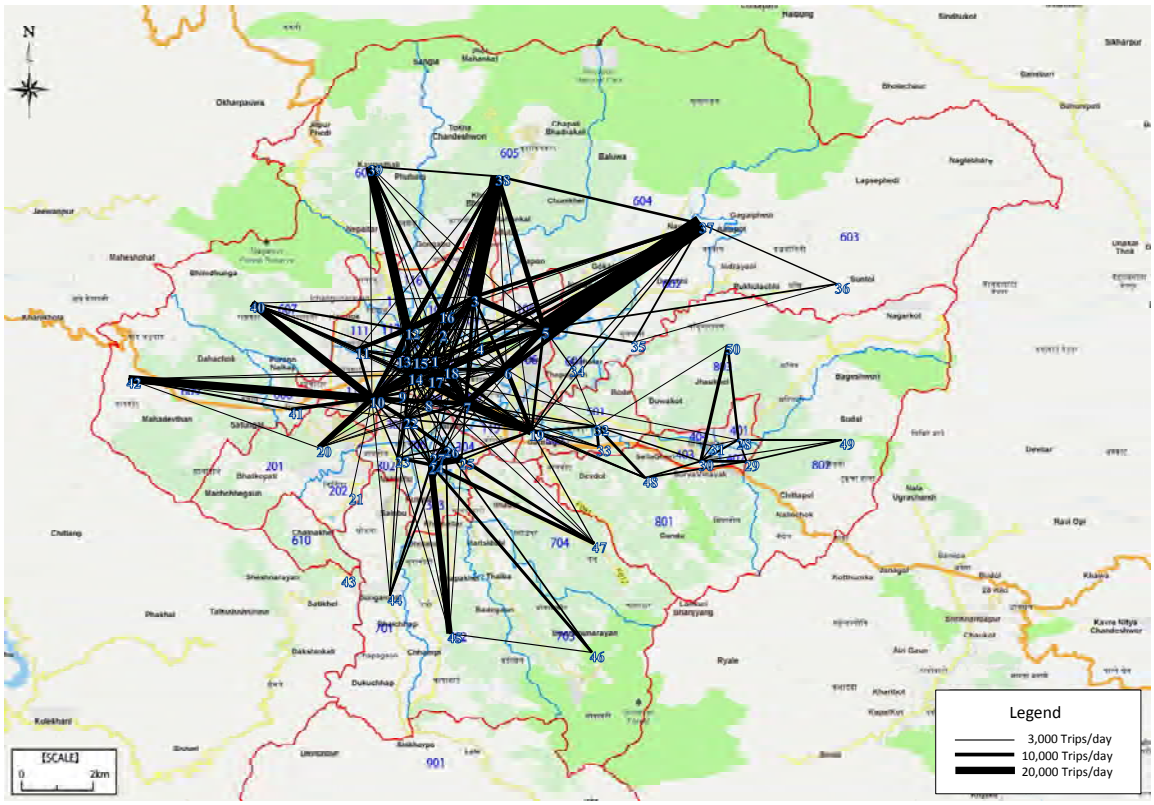
Table 9.2.12 Trip Distribution Model (Gravity Model)

OD Pattern	Purpose	α	β	γ	k	Multiple Correlation Coefficient	No of Samples
OD Trips Between Zones Inside the Ring Road	To Work	1.2258 (36.4323)	0.9295 (30.2113)	1.1782 (29.4246)	0.0103 (8.1343)	0.9275	756
	To School	1.4547 (21.0941)	0.9728 (20.2150)	1.5615 (24.2411)	0.0311 (3.6953)	0.8734	573
	Business	1.0799 (24.0849)	0.8538 (24.4850)	0.9338 (15.4473)	0.0455 (4.9914)	0.8886	441
	Others	1.1739 (20.3078)	0.8638 (23.7353)	1.0987 (15.1871)	0.0308 (4.9057)	0.8637	429
Other Trips Between Zones	To Work	1.1572 (34.4491)	0.7665 (32.5044)	1.2338 (23.7349)	0.6115 (0.7544)	0.8509	1,632
	To School	1.2816 (32.0311)	0.8886 (29.6258)	1.2746 (21.6385)	0.1526 (2.5034)	0.8355	1,850
	Business	0.4790 (12.1974)	0.4677 (15.4919)	0.6968 (10.6140)	36.4283 (4.7151)	0.6854	620
	Others	1.0238 (21.1111)	0.7545 (26.1031)	1.2248 (17.9565)	3.8163 (1.5311)	0.8039	1,179

Note: Number in ( ) means t-value.
Source: JICA 2012

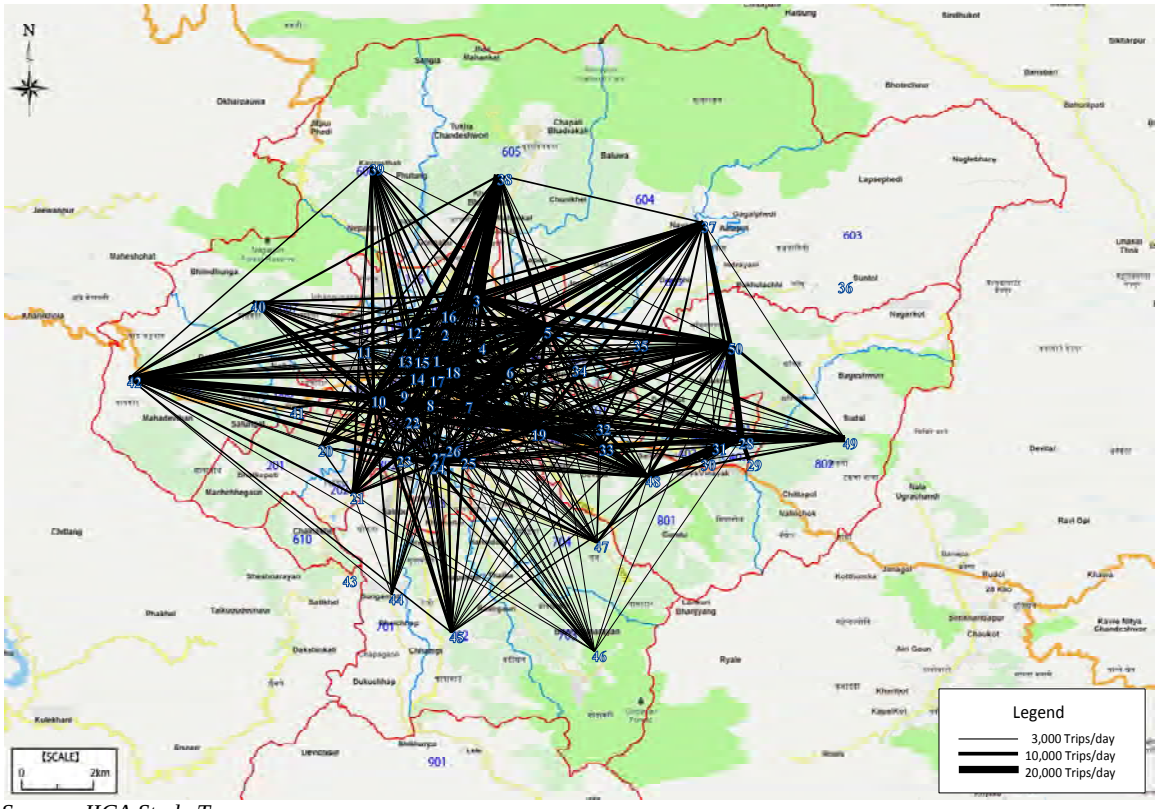
The gravity models were used to estimate future travel patterns in the area in the target years. Future trip distributions by trip purpose were estimated by the Fratar Method based on the estimated trip pattern by the gravity model and the future trip generation/attraction, which were explained in the previous section.

Figure 9.2.6 shows the desire line in the Study area in 2011, while Figure 9.2.7 shows that of 2030. These tables were drawn based on the estimated origin-destination tables of total trips between 50 small zones.



Source: JICA Study Team

Figure 9.2.6 Desire Line of Trips between 50 Small Zones in 2011



Source: JICA Study Team

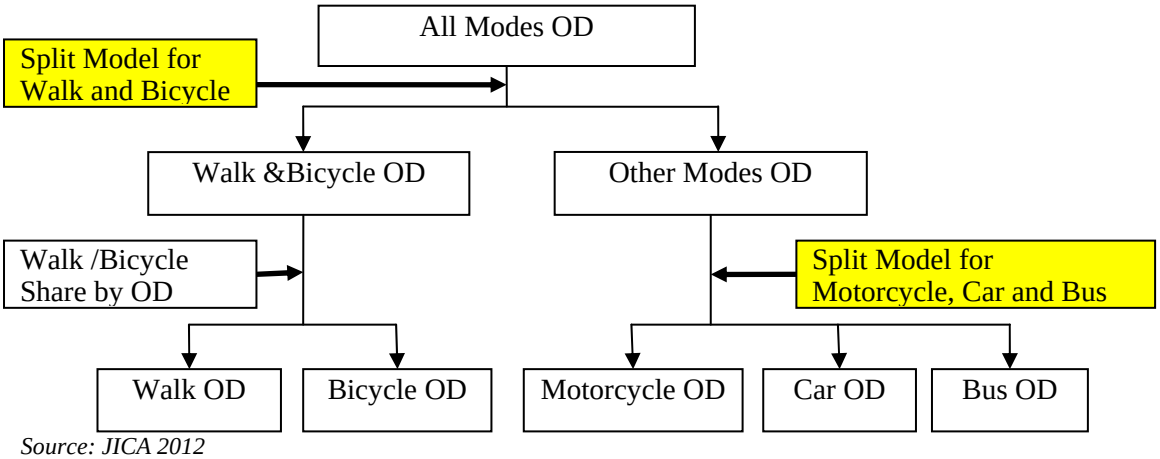
Figure 9.2.7 Desire Line of Trips between 50 Small Zones in 2030

9.2.3.3 Modal Split

The Study Team adopted the JICA 2012 method for the modal split models for the existing travel modes such as motorcycle, car and bus.

(1) Modal Split Hierarchy

As described in the JICA 2012, the modal split hierarchy for the model building process in this Study is shown in Figure 9.2.8 below. With regard to inter-zonal model, two models were developed, namely, a modal split model for walk and bicycle, and a modal split model for motorcycle, car and bus. Furthermore, intra-zonal model within a small zone was also developed.



Source: JICA 2012

Figure 9.2.8 Modal Split Hierarchy

(2) Inter-zonal Modal Split

1) Modal Split Model for Walk and Bicycle

Regarding the modal split between the motorized and non-motorized trips, the Study Team adopted the JICA 2012 models as below.

The share of walk and bicycle among all modes between zones was determined by trip length as shown in the following formula:

$$P_{ij} = \frac{1}{1+\alpha \cdot D_{ij}^{\ \beta}}$$

Where,
i, j: zone
Pij :share of walk and bicycle between zone i and zone j
Dij: distance (km) on the road between zone i and zone j
α, β: parameter

Table 9.2.13 Modal Split Model for Walk and Bicycle

Ownership	Purpose	α	β	Correlation Coefficient	No of Samples
Non-Owner	To Work	0.1976 (43.7712)	1.2403 (51.2910)	0.9208	474
	To School	0.1437 (48.0065)	1.2924 (46.2471)	0.9023	490
	Business	0.2623 (19.0624)	1.5075 (25.2700)	0.9086	137
	Others	0.2157 (29.2733)	1.3321 (38.9540)	0.9137	302
Owner	To Work	1.9559 (22.9728)	0.9080 (46.5037)	0.9268	357
	To School	0.5094 (20.5701)	1.1269 (50.0524)	0.9109	516
	Business	4.9054 (24.2167)	0.6937 (14.7748)	0.8243	105
	Others	0.9124 (2.4400)	0.9925 (40.6759)	0.9246	283

Note: Number in ( ) means t-value.
Source: JICA 2012

As for the modal split between bicycle and walk trips, zonal shares of walk and bicycle was assumed to be same as the existing proportion, which was obtained from the household interview survey. Therefore constant zonal shares are adopted for future demand forecast as well.

2) Modal Split Model for Motorcycle, Car and Bus

The Study Team adopted the modal split model developed by the JICA 2012 for motorized modes of motorcycle, car and bus as below.

A disaggregate model was developed to estimate the split among motorcycle, car and bus by trip purpose. In this model, travel time, travel cost, motorcycle and car ownership, and area classification whether trip is generated inside the Ring Road or not were used as explanatory variables.

$$P_i = \frac{e^{V_i}}{\sum_i e^{V_i}}$$

$$V_i = \beta_1 Z_{1i} + \beta_2 Z_{2i} + \cdots + \beta_k Z_{ki}$$

Where,
Pi : choice probability of mode i
Vi: utility of mode i
Zki: explanatory variable of mode i
β k: parameter of mode i

Table 9.2.14 Modal Split Model for Motorcycle, Car and Bus

Purpose	Mode	Time (min)	Cost (NRs)	Motorcycle Ownership	Car Ownership	Erea Dammy Variable (inside the Ring road)	Car Dammy Variable	Bus Dammy Variable	ρ^2	Hitting Ratio	No of Samples
To Work	Motorcycle	-0.0568 (-3.777)	-0.0550 (-4.727)	5.2757 (12.930)					0.4455	78.0%	900
	Car	-0.0568 (-3.777)	-0.0550 (-4.727)		4.3121 (15.858)		2.6908 (8.372)				
	Bus	-0.0568 (-3.777)	-0.0550 (-4.727)			0.5607 (3.109)		3.3082 (7.089)			
To School	Motorcycle	-0.0786 (-6.576)	-0.1011 (-9.682)	4.8951 (11.873)					0.3834	70.0%	810
	Car	-0.0786 (-6.576)	-0.1011 (-9.682)		2.7916 (10.222)		3.4937 (10.775)				
	Bus	-0.0786 (-6.576)	-0.1011 (-9.682)			1.5549 (7.702)		4.0686 (5.879)			
Business	Motorcycle	-0.1056 (-6.702)	-0.1310 (-8.715)	4.5720 (12.765)					0.4109	73.7%	900
	Car	-0.1056 (-6.702)	-0.1310 (-8.715)		3.3622 (14.307)		3.6821 (10.416)				
	Bus	-0.1056 (-6.702)	-0.1310 (-8.715)			0.3048 (2.021)		2.7693 (8.242)			
Others	Motorcycle	-0.0950 (-7.436)	-0.0283 (-3.586)	2.6649 (9.704)					0.3627	70.8%	750
	Car	-0.0950 (-7.436)	-0.0283 (-3.586)		2.9202 (12.062)		1.1966 (6.156)				
	Bus	-0.0950 (-7.436)	-0.0283 (-3.586)			2.1211 (10.849)		1.9938 (2.867)			

Source: JICA 2012

3) New Transport System

Introduction of a new transport system in the Kathmandu Valley was examined and planned in this Study. The details of the plans are described in Chapter 8.

As the new transport system is a new mode of transport, the Study team needed a demand forecast model to estimate future passengers of the new mode. Diversion models, which estimate diversion ratio from the old modes of the motorcycle, the car and the bus, to the new system, were developed in this Study. The models were developed based on the Stated Preference Survey results, which was conducted in this Study (refer to Appendix 1).

The newly developed diversion models by trip purpose and by mode are shown below (refer to Table 9.2.15).

$$\text{Diversion ratio from mode k} = \frac{e^{f(xi)}}{1 + e^{f(xi)}}$$

where,

$$f(x^i) = a + b * time + c * cost$$

time: travel time by new transport system - travel time by bus
cost: travel cost by new transport system - travel cost by bus
a, b, c: estimated parameter

Table 9.2.15 Diversion Models to the New Transport System

Mode	Trip Purpose	Item	a	b	c	RR
Car	To Work	t-value	-7.1129	-4.8043	-4.3025	
		coefficient	-3.6389	-0.2789	-0.3024	0.7625
	To School	t-value	-11.2743	-8.2819	-7.2382	
		coefficient	-2.5997	-0.2231	-0.2776	0.9180
	Business	t-value	-11.7046	-8.9526	-6.2582	
		coefficient	-3.2106	-0.2787	-0.2358	0.9058
	Others	t-value	-9.3281	-5.0842	-2.8654	
		coefficient	-4.5236	-0.2800	-0.0730	0.6090
	To Home	t-value	-3.3238	-6.2106	-1.1568	
		coefficient	-1.6925	-0.0790	-0.0183	0.8508
MC	To Work	t-value	-8.8029	-4.6969	-4.2169	
		coefficient	-4.5013	-0.2726	-0.2962	0.7546
	To School	t-value	-13.8027	-7.9643	-6.9518	
		coefficient	-3.1886	-0.2149	-0.2671	0.9118
	Business	t-value	-15.0841	-8.3374	-5.8127	
		coefficient	-4.2337	-0.2656	-0.2241	0.8928
	Others	t-value	-10.2395	-5.0392	-2.8363	
		coefficient	-4.9692	-0.2777	-0.0723	0.6047
	To Home	t-value	-3.3238	-6.2106	-1.1568	
		coefficient	-1.6925	-0.0790	-0.0183	0.8508
Bus	To Work, To School & Business	t-value	2.1152	-4.9860	-6.4004	
		coefficient	1.3452	-0.1213	-0.2379	0.9618
	To Work, To School & Business	t-value	2.1152	-4.9860	-6.4004	
		coefficient	1.3452	-0.1213	-0.2379	0.9618
	To Work, To School & Business	t-value	2.1152	-4.9860	-6.4004	
		coefficient	1.3452	-0.1213	-0.2379	0.9618
	Others	t-value	1.5440	-2.8389	-4.7656	
		coefficient	1.0304	-0.0725	-0.1858	0.9247
	To Home	t-value	2.5931	-0.8201	-5.0305	
		coefficient	1.3747	-0.0166	-0.1558	0.9288

Note 1: For Car & Motorcycle, the analysis data was obtained from simulation by the models developed in JICA 2012. To Home model of car and motorcycle is common for both modes, which were developed by using the SPS.

Note 2: For Bus, the models were developed by the Stated Preference Survey (SPS), which was conducted in this Study. Models for To Work, To School and Business are common for bus passengers.

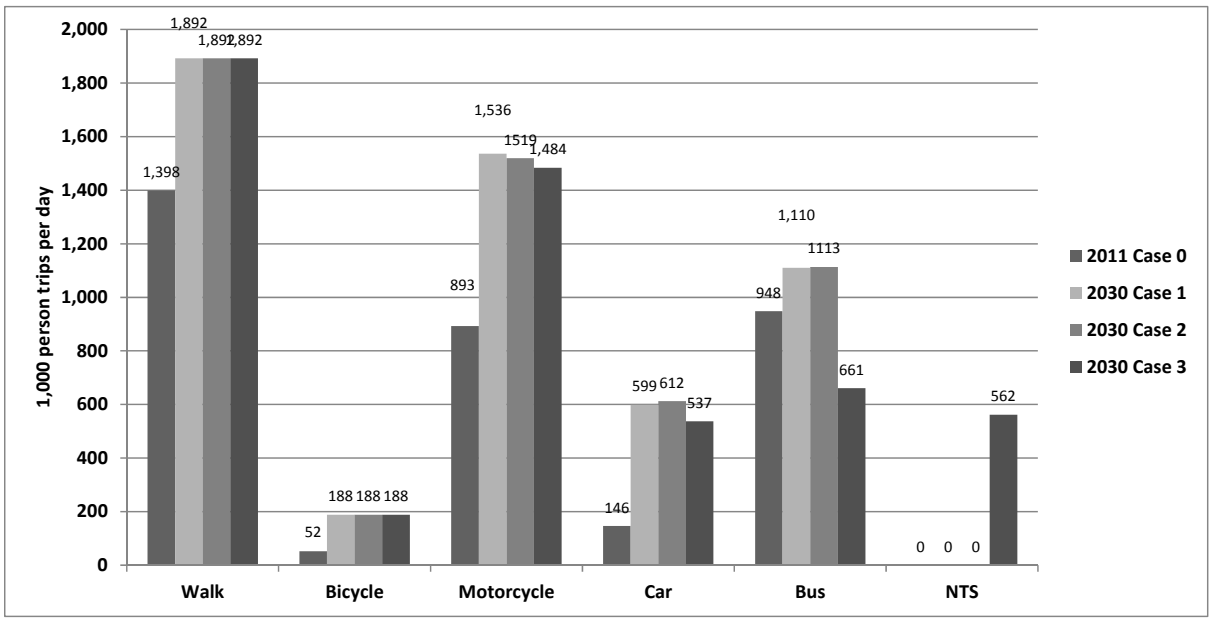
Source: JICA Study Team

(3) Intra-zonal Modal Split

The Study Team adopted the methodologies used in the JICA 2012 for the Intra-zonal modal split. Walk & Bicycle trip ratios to the total intra-zonal trips by zone are assumed to be same as those in 2011. Motorcycle and car trips are assumed to increase at the same growth rates of ownership as the population for both modes in the target years.

(4) Future Modal Split

As shown in Figure 9.2.9, number of trips in 2030 cases increases in every mode of transport when compared to 2011. Walk and bicycle trips are same in the three 2030 cases. Motorcycle, car and bus trips are almost same between Case 1 (without road development) and Case 2 (with road development). However, it is clear that the decrease of bus trips is remarkable in the Case 3 (New Public Transport development), where the New Public Transport System is introduced.



Source: JICA Study Team

Figure 9.2.9 Comparison of Person Trips by Mode and by Case

Table 9.2.16 and Figure 9.2.10 exhibit the number of trips by mode and by purpose in Case 0, 1, 2 and 3. It is notable that car shares increase in every trip purpose compared to Case 0 (2011). Motorcycle shares by trip purpose are also increased in 2030 except for "To Work" trips. On the contrary, the bus shares dropped down in every trip purpose both in Case 1 and 2. These were considered as the results of the future motorization progress in the area.

In Case 3, where the New Transport Public System is introduced, the bus shares decrease drastically as explained earlier. The bus trip shares by trip purpose decreased notably.

Table 9.2.16 Number of Trips by Mode and by Purpose

Trips by Mode and by Purpose (2011 Case 0) (Trips/day)

	Walk	Bicycle	Motorcycle	Car	Bus	NTS	Total
To Work	193,076	14,291	254,992	34,349	137,753	-	634,461
To School	364,601	4,157	69,324	5,167	213,781	-	657,030
Business	33,790	3,433	73,306	20,389	22,551	-	153,469
Others	121,501	5,924	85,167	21,863	109,742	-	344,197
To Home	685,410	24,640	410,337	64,212	464,637	-	1,649,236
Total	1,398,378	52,445	893,126	145,980	948,464	-	3,438,393

Trips by Mode and by Purpose (2030 Case 1) (Trips/day)

	Walk	Bicycle	Motorcycle	Car	Bus	NTS	Total
To Work	268,262	38,706	364,781	139,396	207,958	-	1,019,102
To School	471,327	29,142	160,946	34,907	265,459	-	961,781
Business	50,066	9,223	132,320	53,425	19,786	-	264,820
Others	158,675	23,294	183,000	100,343	70,606	-	535,918
To Home	943,729	87,747	694,552	270,944	545,877	-	2,542,850
Total	1,892,060	188,112	1,535,598	599,015	1,109,686	-	5,324,471

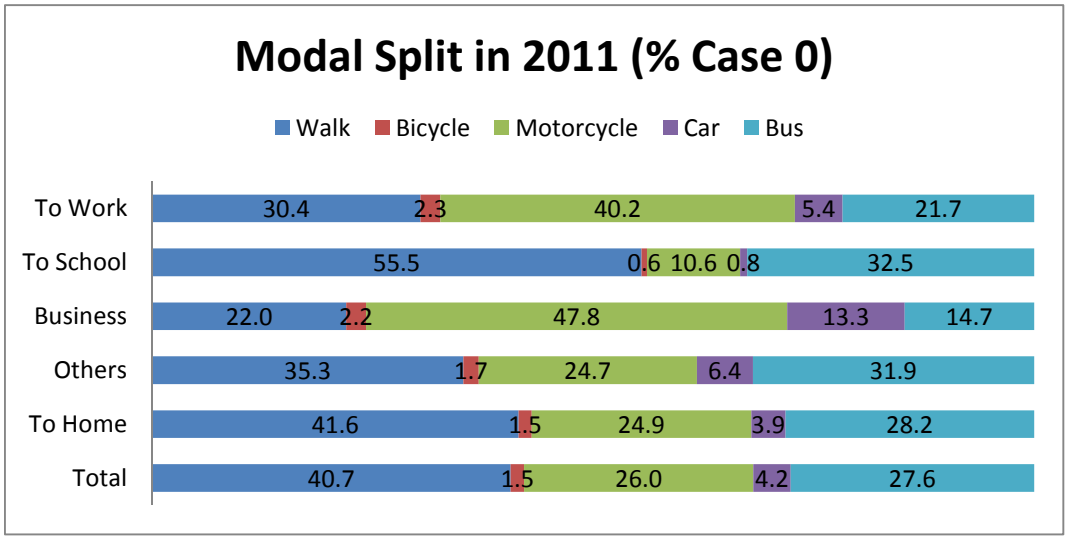
Trips by Mode and by Purpose (2030 Case 2) (Trips/day)

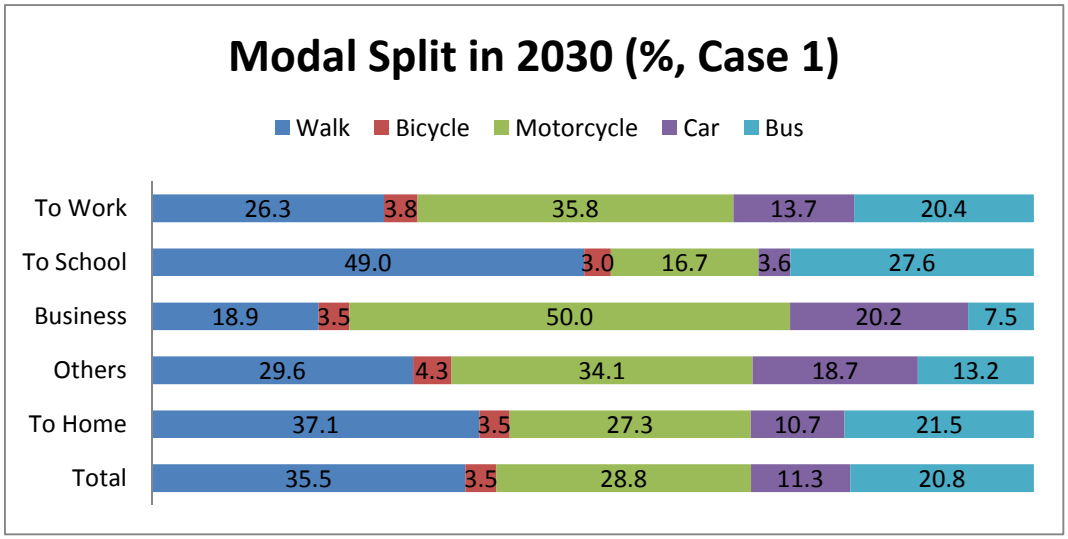
	Walk	Bicycle	Motorcycle	Car	Bus	NTS	Total
To Work	268,262	38,706	361,229	142,274	208,631	-	1,019,102
To School	471,327	29,142	160,131	36,471	264,708	-	961,781
Business	50,066	9,223	129,775	55,594	20,162	-	264,820
Others	158,675	23,294	180,262	101,187	72,500	-	535,918
To Home	943,729	87,747	687,925	276,085	547,364	-	2,542,850
Total	1,892,060	188,112	1,519,322	611,611	1,113,365	-	5,324,471

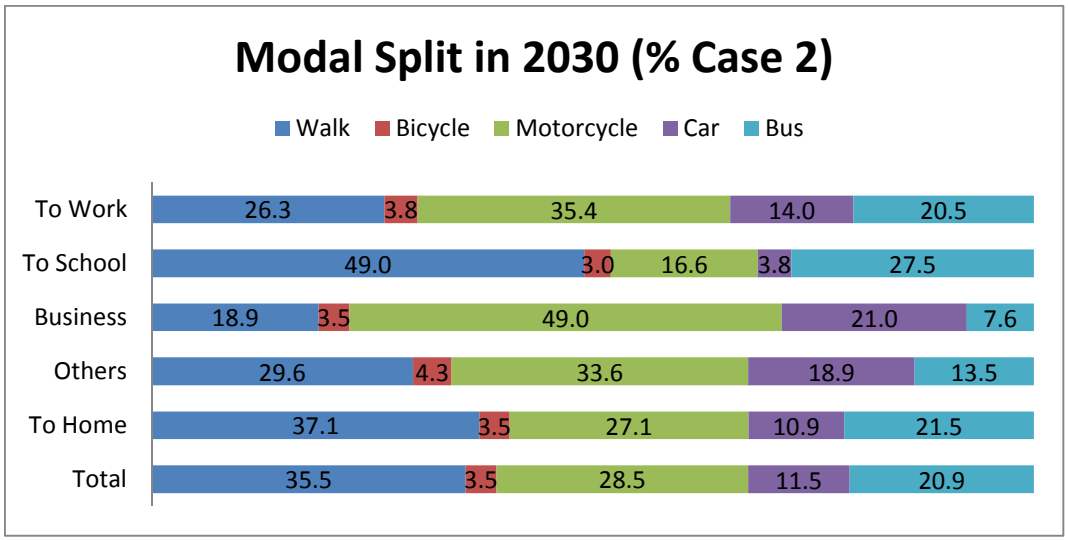
Trips by Mode and by Purpose (2030 Case 3) (Trips/day)

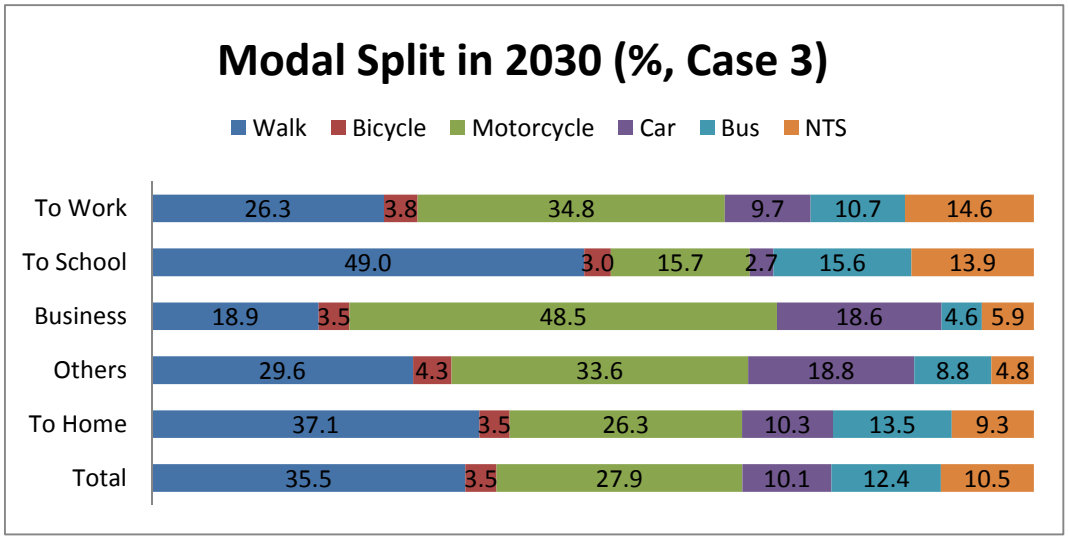
	Walk	Bicycle	Motorcycle	Car	Bus	NTS	Total
To Work	268,262	38,706	355,030	99,125	109,084	148,895	1,019,102
To School	471,327	29,142	151,263	25,852	150,402	133,794	961,781
Business	50,066	9,223	128,402	49,312	12,164	15,652	264,820
Others	158,675	23,294	180,230	100,910	47,000	25,810	535,918
To Home	943,729	87,747	669,687	262,251	342,023	237,413	2,542,850
Total	1,892,060	188,112	1,484,612	537,450	660,674	561,564	5,324,471

Source: JICA Study Team


Modal Split in 2011 (% Case 0)
Walk
Bicycle
Motorcycle
Car
Bus
To Work
30.4
2.3
40.2
5.4
21.7
To School
55.5
0.6
10.6
0.8
32.5
Business
22.0
2.2
47.8
13.3
14.7
Others
35.3
1.7
24.7
6.4
31.9
To Home
41.6
1.5
24.9
3.9
28.2
Total
40.7
1.5
26.0
4.2
27.6


Modal Split in 2030 (%, Case 1)
Walk
Bicycle
Motorcycle
Car
Bus
To Work
26.3
3.8
35.8
13.7
20.4
To School
49.0
3.0
16.7
3.6
27.6
Business
18.9
3.5
50.0
20.2
7.5
Others
29.6
4.3
34.1
18.7
13.2
To Home
37.1
3.5
27.3
10.7
21.5
Total
35.5
3.5
28.8
11.3
20.8


Modal Split in 2030 (% Case 2)
Walk
Bicycle
Motorcycle
Car
Bus
To Work
26.3
3.8
35.4
14.0
20.5
To School
49.0
3.0
16.6
3.8
27.5
Business
18.9
3.5
49.0
21.0
7.6
Others
29.6
4.3
33.6
18.9
13.5
To Home
37.1
3.5
27.1
10.9
21.5
Total
35.5
3.5
28.5
11.5
20.9



Source: JICA Study Team and JICA 2012

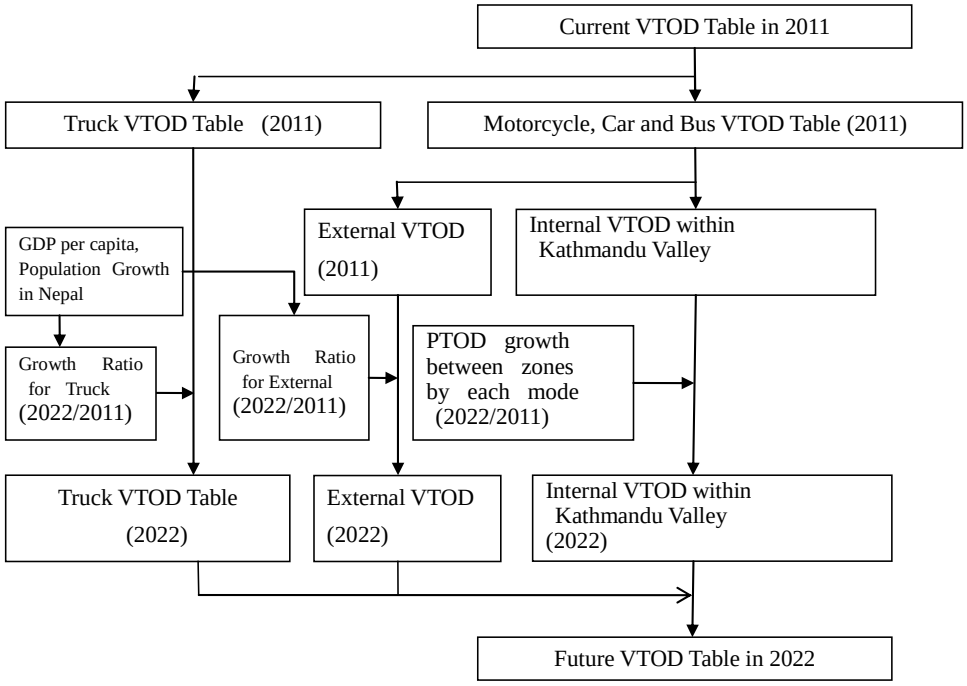
Figure 9.2.10 Modal Split by Mode and by Purpose

9.2.3.4 Traffic Assignment

(1) Future Vehicle Trip Distribution

The JICA 2012 estimated Vehicle Trip OD table in 2011 consisting of nine vehicle types based on various surveys during the Study period. The JICA 2012 forecasted future Vehicle OD tables based on the 2011 OD tables. Estimation flow chart is shown in Figure 9.2.11. The future vehicle OD tables were basically estimated by using the growth ratio of future person trip OD table to the 2011 OD table. The Study Team also adopted the same manner to forecast future vehicle OD tables.

The traffic zoning system of 86 zones with 7 outside zones was used for traffic assignment (refer to Table 9.2.1 and Figure 9.2.3).



Source: JICA 2012
Note: Target year was 2022 in the JICA 2012. The Study team defined the target years of 2020, 2025 and 2030 in place of 2022.

Figure 9.2.11 Flow Chart for Future VTOD Table Estimation

The traffic assignment method used in the JICA 2012 was the user equilibrium assignment, which is described in the final report of the JICA 2012.

(2) Result of Traffic Assignment

The Study Team used the JICA STRADA model for the road vehicle traffic assignment just like the JICA 2012. The User Equilibrium Traffic Assignment 3.5 of the model was used for this Study. The traffic assignment procedure was done by using future Vehicle OD tables and planned future highway networks in the target years. Results of the Assignment in Case 0, Case 1, Case 2 and Case 3 in 2011 and 2030 are shown in Figure 9.2.12, Figure 9.2.13, Figure 9.2.14 and Figure 9.2.15 respectively.

Traffic assignment of the New Transport System was conducted by an all or nothing method based on the minimum path procedure by using the software developed by the Study Team. Figure 9.2.16 shows the daily passenger traffic volume of the BRT and the AGT for both directions.

It should be noted that bus vehicle trips for the access/egress trips of the New Transport System were not included in the Figure 9.2.15, which illustrates the Case 3 traffic assignment of the road vehicles, because of technical reasons. However, necessary information, such as passenger-km and passenger hour by mode, for the project evaluation was estimated for the Case 3.

Heavy traffic volume is estimated in 2030 (Case 1: without road development), in which only on-going and committed road projects are assumed. Most of the road sections are estimated to saturate in the Case 1 as shown in the Figure 9.2.13. Average congestion ratio (volume / capacity ratio) reaches 1.28 inside the Ring Road area. Nearly half of the road sections in terms of distance are estimated to have the congestion ratio of over 1.25.

In Case 2, where the road development plan is realized, the congestion ratio decreased to 0.85 and 0.76 inside the Ring Road area and in the whole study area, respectively. More than 80 per cent of the road sections are estimated to show the congestion ratio of less than 1.25. The alleviated road congestion is also exhibited in the Figure 9.2.14.

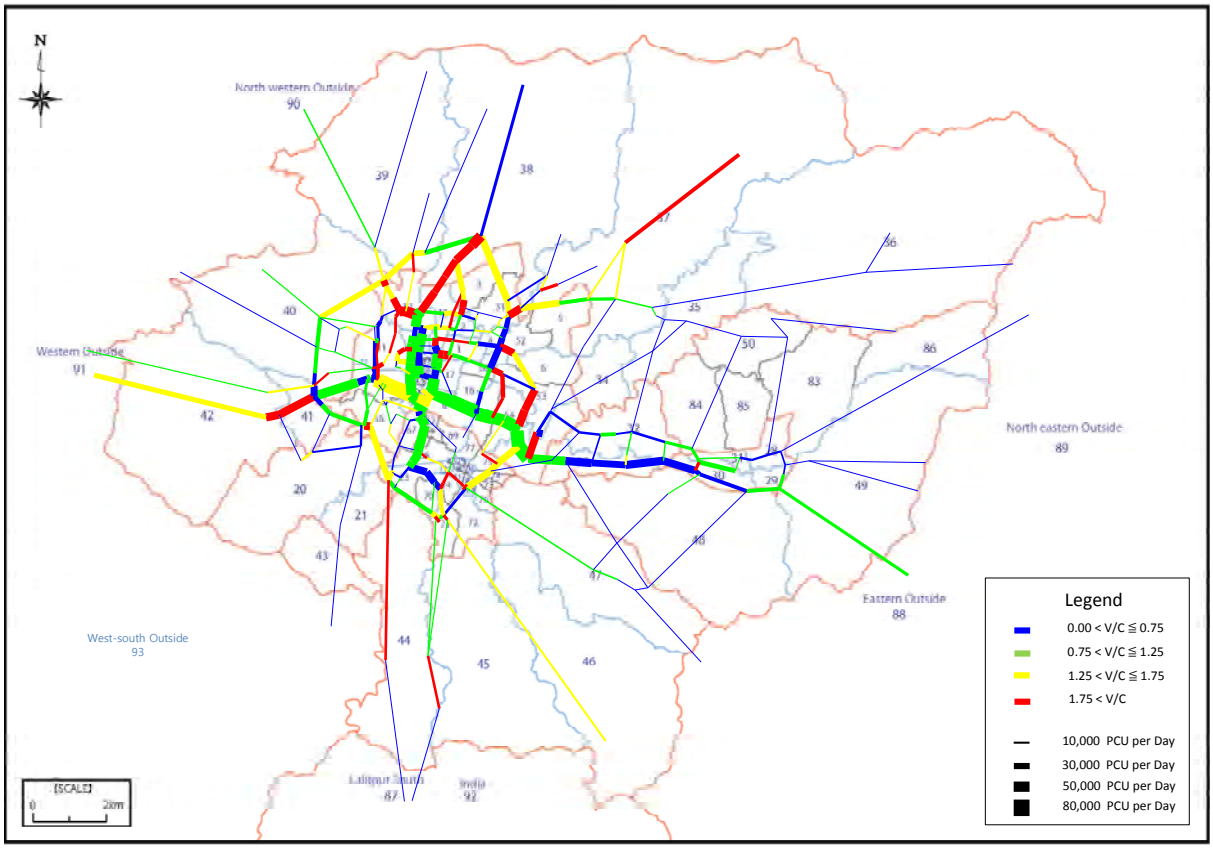
In Case 3, where the New Public Transport System is introduced and the bus transport efficiency improvement program is in operation (refer to Table 9.2.7) in addition to Case 2, the road congestion is further alleviated as shown in the Figure 9.2.15, because trips are diverted to the new transport system from the existing transport modes of car, motorcycle and bus. The road congestion ratios are also relieved further to 0.76 inside the Ring Road area and to 0.65 in the whole study area (refer to Table 9.2.17).

Regarding the average travel speed of the road network in the study area, it is estimated as 26.3 km/h, 33.0 km/h, 43.9 km/h and 45.0 km/h in the Case 0, 1, 2 and 3, respectively. Effects of the transport master plan development are clearly shown in the forecast results.

Table 9.2.17 Comparison of Congestion Ratio

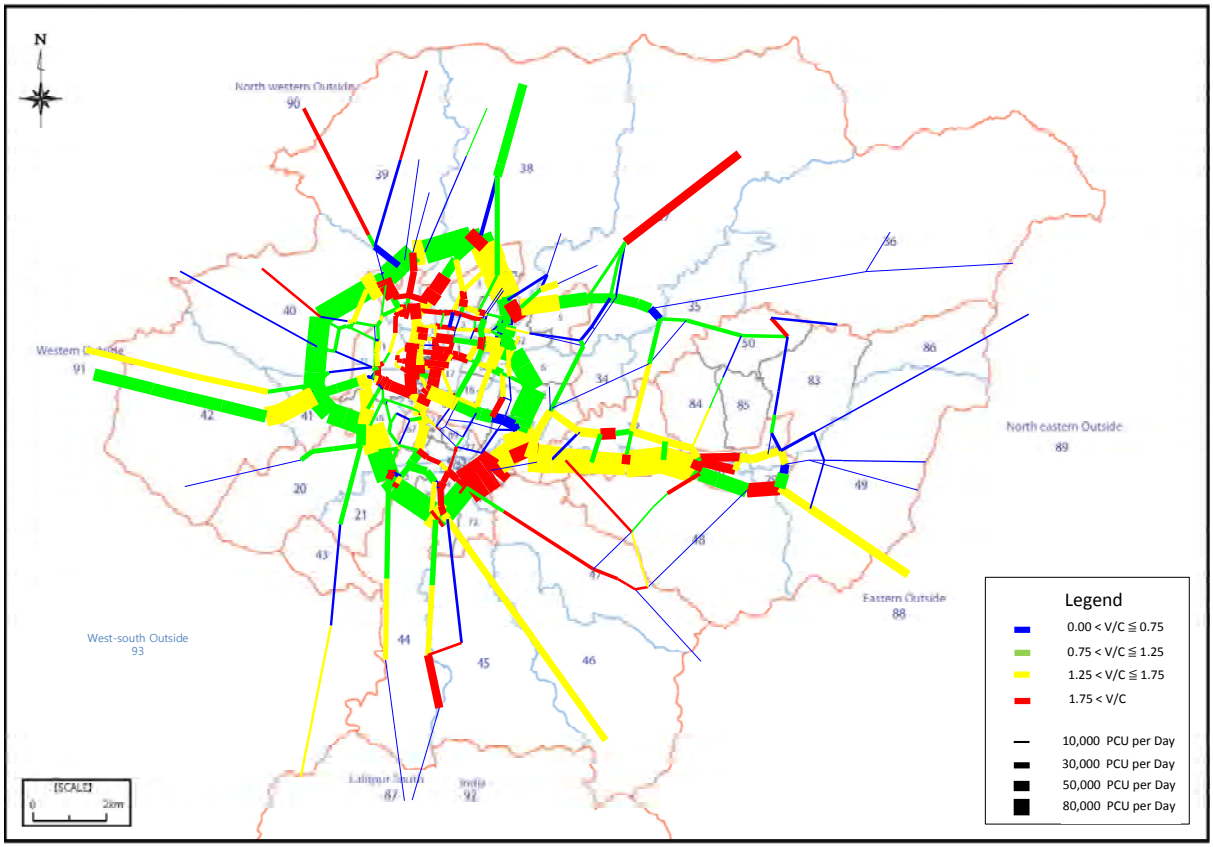
Indicators	Area	2011 Case 0		2030 Case 1		2030 Case 2		2030 Case 3	
Average Congestion Ratio	Inside the Ring Road	1.22		1.28		0.85		0.76	
	All Study Area	0.93		1.14		0.76		0.65	
Road Leght by Congestion Rank inside the Ring Road		Length (km)	Ratio	Length (km)	Ratio	Length (km)	Ratio	Length (km)	Ratio
	Less than 0.75	62.6	0.251	55.5	0.178	231.0	0.533	260.0	0.620
	0.75 - 1.25	80.5	0.322	123.2	0.395	126.2	0.291	102.6	0.245
	1.25 - 1.75	64.9	0.260	70.3	0.226	38.8	0.090	21.8	0.052
	Over 1.75	41.6	0.167	62.5	0.201	37.1	0.086	35.2	0.084

Source: JICA Study Team



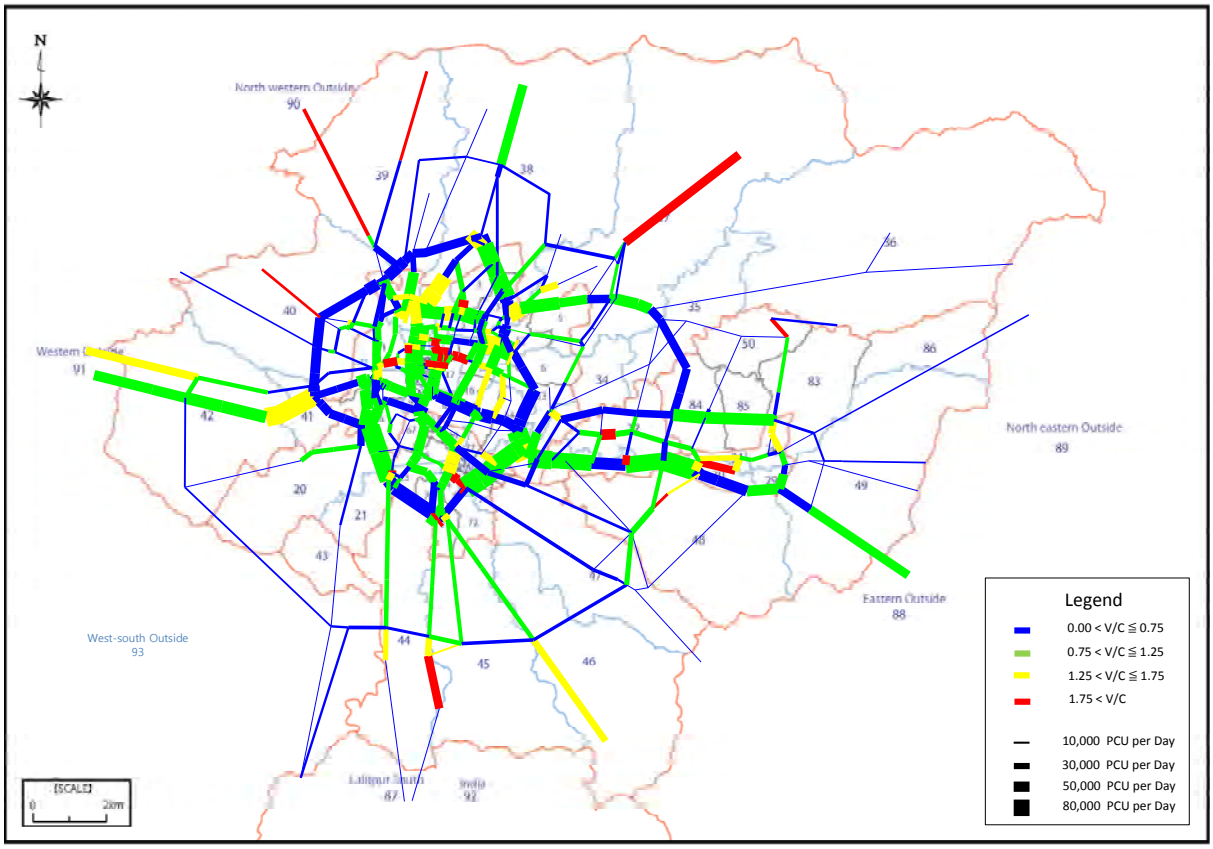
Source: JICA Study Team

Figure 9.2.12 Traffic Volume in 2011 Case 0



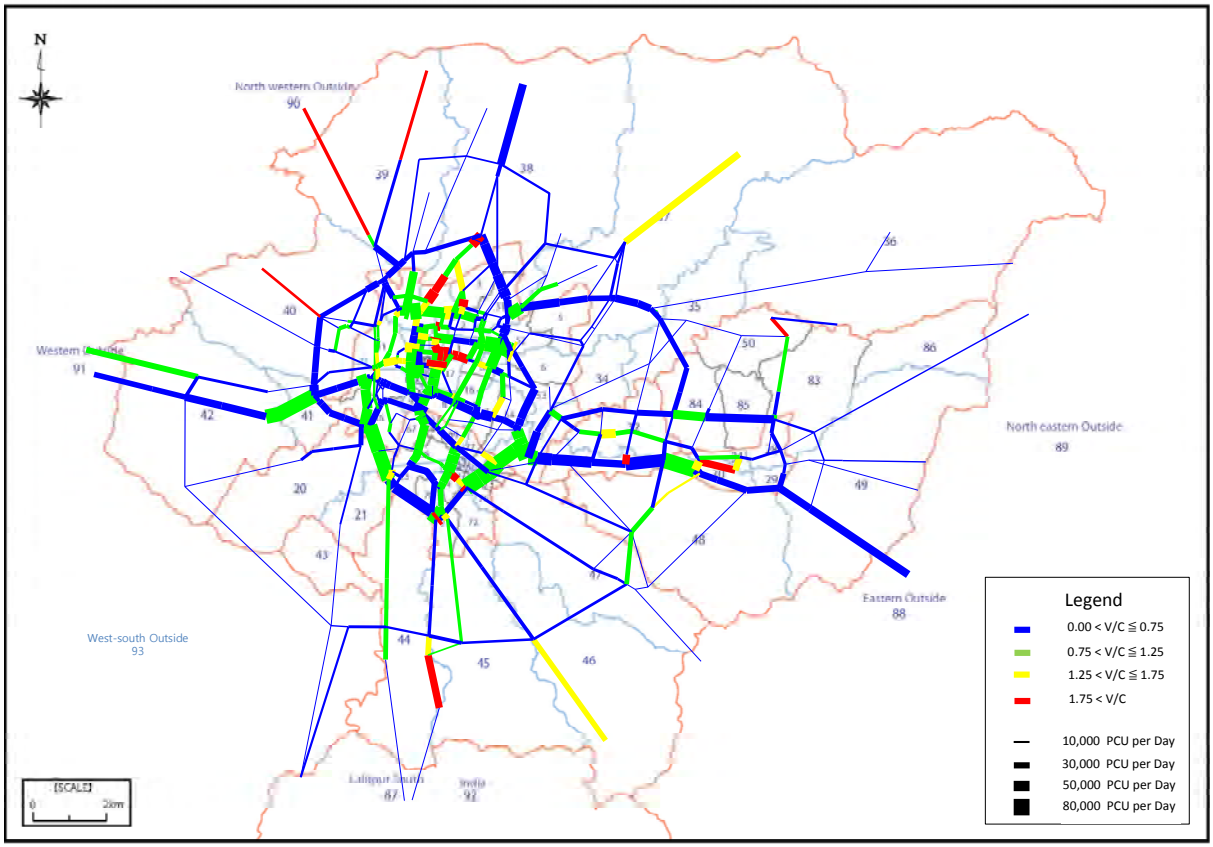
Source: JICA Study Team

Figure 9.2.13 Traffic Volume in 2030 Case 1



Source: JICA Study Team

Figure 9.2.14 Traffic Volume in 2030 Case 2



Source: JICA Study Team

Figure 9.2.15 Traffic Volume in 2030 Case 3

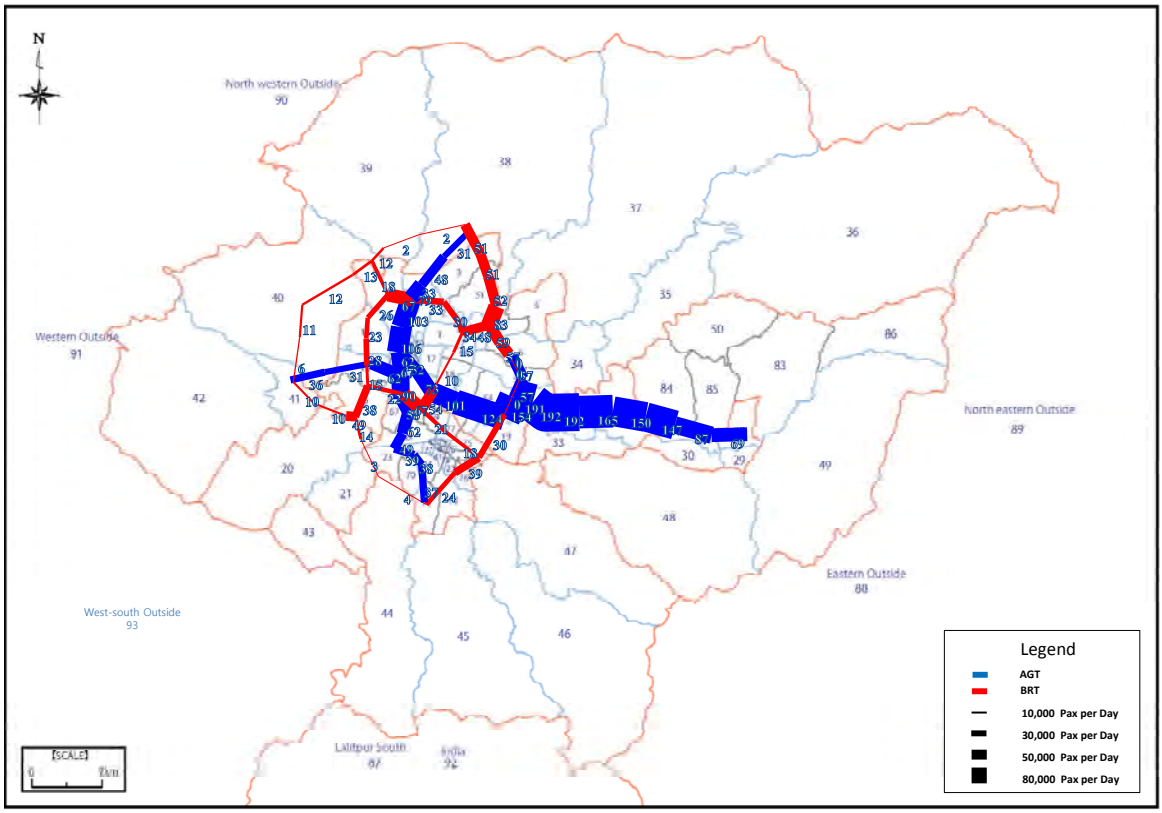
Figure 9.2.16 shows the daily passenger volume of the New Transport System for both directions. The blue line denotes the AGT, while red line shows the BRT.

The AGT system is assumed to be introduced in 2030 (Case 3) in addition to the BRT system, which is assumed to operate in 2025. The AGT system connects Karanki and Bhaktapur as the East-West axis. The AGT also connects Narayan Gopal Chowk in the north of the Ring Road and Satdobato in the south of the Ring Road (refer to Chapter 8). Number of passengers of the AGT is estimated to reach around 200,000 per day for both directions at the maximum volume along the Arniko Highway on the link near to the airport. The north-south axis of the AGT is estimated to have 30,000 to 100,000 passengers per day. The BRT passengers were estimated at 2,000 to 80,000 per day. On the north-western links of the Ring Road, the BRT passengers are estimated at 2,000 to 12,000 per day.

With regard to the New Transport System, a sensitivity analysis was conducted to get a potential demand increase of the NTS (New Transport System) in the case of peak-hour traffic condition. During the peak-hours, traffic congestion on the road system is commonly seen in the Kathmandu Valley. Travel speed of vehicles decrease drastically compared to the average travel speed. The Study Team could not dismiss the situation. In the circumstances, the NTS, which is free from the traffic congestion because of its segregated right of way, has an advantage in terms of travel speed, which is one important index of transport service characteristics.

The Study Team estimated the NTS passenger demand at the peak period in 2030 as the sensitivity analysis by using the "Velocity in Peak Hours" in Table 9.2.4. Daily passengers of the East-West line were estimated at 264,000 at the East section. On the North-South line, almost 140,000 passengers are expected.

The Study Team considers that this demand would be the maximum demand of the NTS in the target year of 2030. Actual future demand would be somewhere in between the two figures.



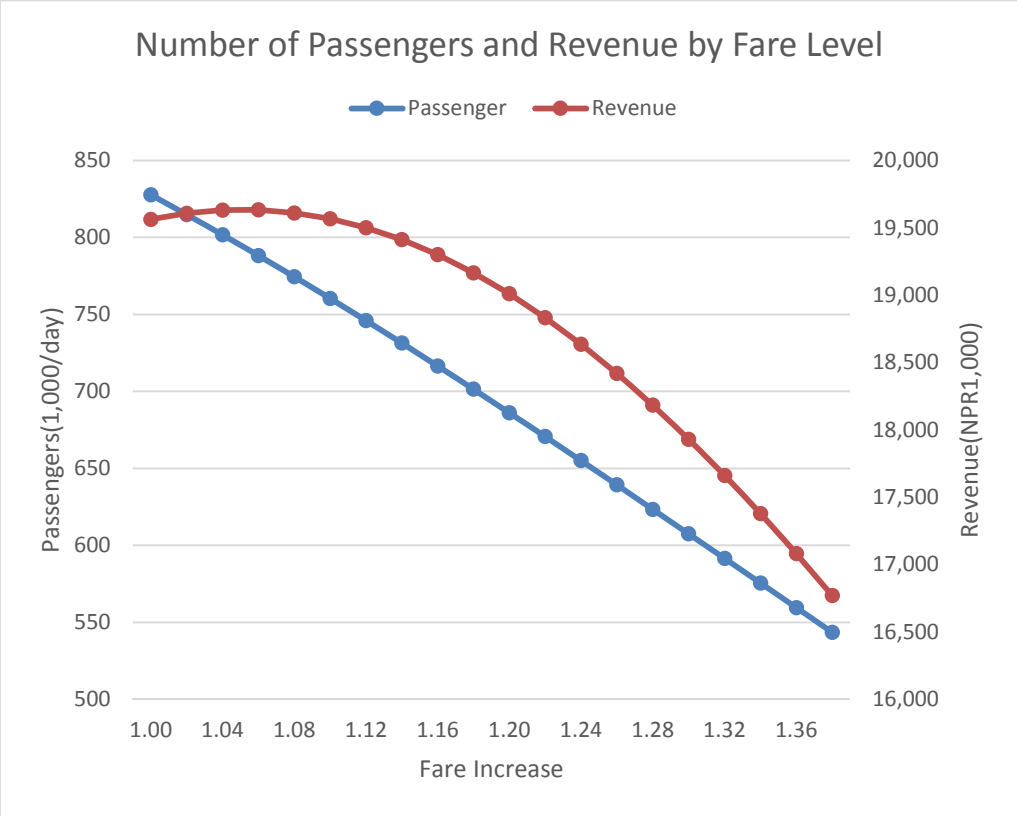
Source: JICA Study Team

Figure 9.2.16 Traffic Volume in 2030 Case 3, New Public Transport

The JICA Study Team conducted the fare elasticity analysis to identify the revenue maximum fare level. A series of fare levels of the new transport system was assumed starting from the current bus fare up to the 38 % increase by every 2%.

Figure 9.2.17 shows the result of the analysis. As the fare level increases, the number of passengers decreases from 828,000 to 543,000. The elasticity of the fare level to the demand was calculated as 0.82 when fare level increases by 10%. So, it can be said that the NPT demand is inelastic to the fare level changes.

Fare revenue increases when the demand does not decrease as much as the fare level. According to the analysis conducted in this Study, a 6% fare level increase would generate the maximum revenue to the NTS operator. Increase of the 6% fare level is equivalent to 1.50 NPR, as the average fare revenue per passenger was calculated as about 25 NPR.



Source: JICA Study Team

Figure 9.2.17 Number of NTS Passengers and Revenue by Fare Level