CHAPTER 10 IMPLEMENTATION PLAN

10.1 Transport Implementation Plan

10.1.1 Staging Plan

(1) Basic Concept of Staging Plan

Staging plan is divided into three phases, namely short term (-2020), middle term (2021-2025) and long term (2026-2030). The targets to be achieved in each phase are:

- Long term (2026 - 2030)
  - Establishment of sustainable transport with high mobility, safety and comfort.
- Middle Term (2021 – 2025)
  - Implementation of Priority Project
  - Establishment of all the systems necessary for achieving long term target
- Short Term (-2020)
  - Strengthening of institutional framework for planned development
  - Solving urgent issues
  - Commencement of disaster prevention measures

Based on the targets, the concept in each phase for land use development, road development and public transport development is shown in Figure 10.1.1.

	Short Term (-2020)	Middle Term (2021-2025)	Long Term (2026-2030)
Target	・Strengthening of institutional framework for planned development ・Solving urgent issues ・Commencement of disaster prevention measures	・Implementation of priority projects. ・Establishment of all the systems necessary for achieving the long term target	・Establishment of sustainable transport with high mobility, safety and comfort
Land Use	・Selection of pilot urban development area and Implementation. ・Enforcement and diffusion of land pooling system. ・Establishment of strict building and development control system.	・Development of priority urban area with land use control and building control. ・Implementation of land pooling system by PPP scheme.	・Development of all the new urban area. ・Equipping necessary roads and open spaces in urbanized area.
Road	・Implementation of emergency projects including improvement of Bottlenecks. ・Establishment of system for land acquisition in densely inhabited areas.	・Development of priority arterial roads. ・Development of roads by established land acquisition system.	・Development of all the roads proposed by MP
Public Transport	・Institutional reinforcement of public transport management ・Restructuring of bus routes including pilot route project.	・Introduction of BRT to primary corridor. ・Establishment of organization for operation of new public transport system.	・Introduction of rail transit system. ・Development of area around terminals of rail transit system.

Source: JICA Study Team

Figure 10.1.1 Target and Basic Concept for Staging Plan

(2) Staging Plan for Each Sector

1) Land Use Staging Plan

Land use staging plan is divided into institution, land development and rearrangement and disaster management. Institution is for the establishment of a system to realize the planned development and land use and building control. Land development and readjustment is regarding new land development and development around major terminals by TOD concept. Disaster management is reinforcement of buildings along Emergency Transport Road Network and building structure control.

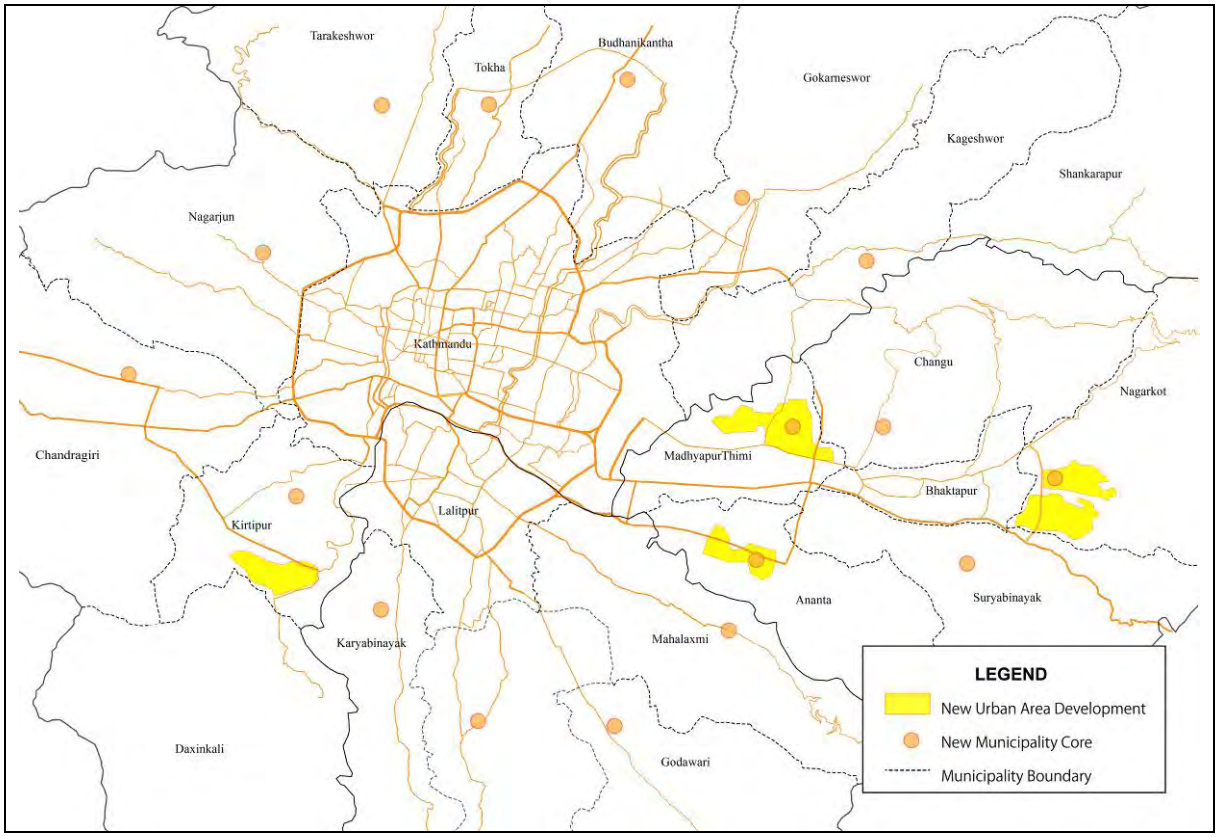
Basic strategy for land use staging plan is described in Table 10.1.1.

Table 10.1.1 Basic Strategy for Land Use Staging Plan

		1st Phase Present to 2020	2nd Phase 2021 to 2025	3rd Phase 2026 to 2030
Land use	Institution	・ Establishment/enactment of strict land use and development control system. ・ Study/technical assistance for reinforcement of land pooling system.	・ Establishment of land development system by public and private partnership. ・ Establishment of LP system with multi-level replotting.	・ Diffusion of new urban development system/by public and private partnership. ・ Development around terminal area by TOD concept.
	Land development and readjustment	・ Selection of priority urban development area and establishment of institutional system for large scale development.	・ Development of priority urban area with land use control and building control.	・ Development of all the new urban area. ・ Development of terminal area by TOD concept
	Disaster management	・ Assessment of buildings along the emergency transport road network. ・ Establishment of system for subsidising building reinforcement along emergency transport road network.	・ Reinforcement of buildings along the emergency transport road network. ・ Continuous strict control of structure	・ Continuous strict control of structure

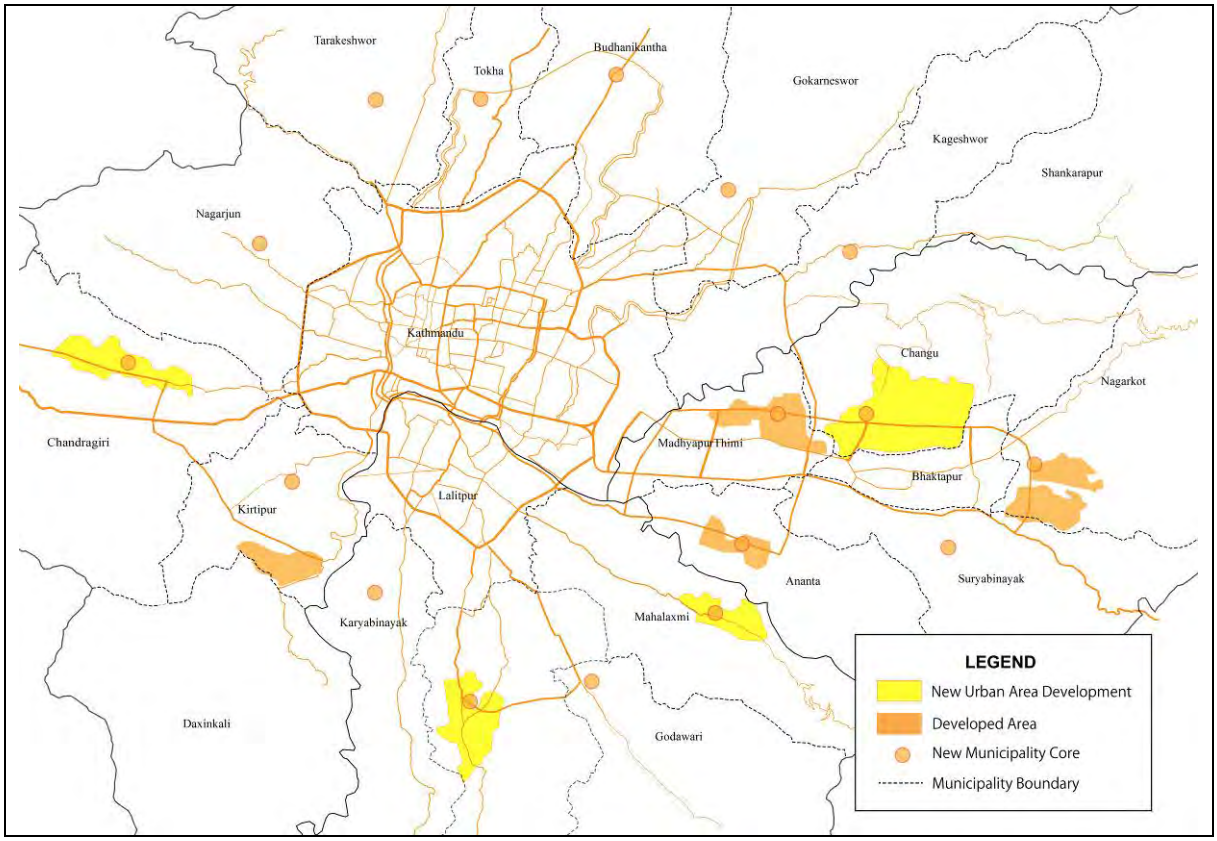
Source: JICA Study Team

New urban development in the short term, middle term and long term is shown in Figure 10.1.2, Figure 10.1.3 and Figure 10.1.4, respectively.



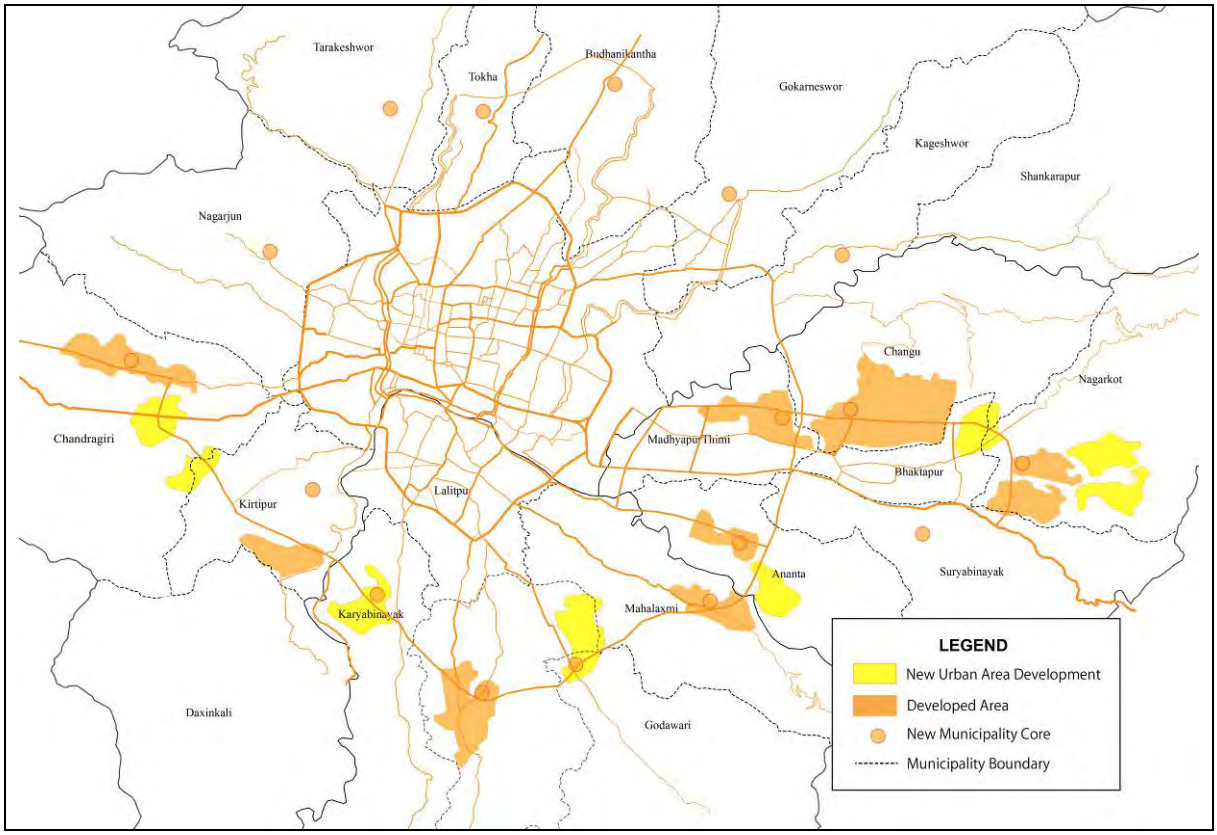
Source: JICA Study Team

Figure 10.1.2 Land Use Staging Plan in Short Term (2020)



Source: JICA Study Team

Figure 10.1.3 Land Use Staging Plan in Middle Term (2025)



Source: JICA Study Team

Figure 10.1.4 Land Use Staging Plan in Long Term (2030)

2) Road Network Staging Plan

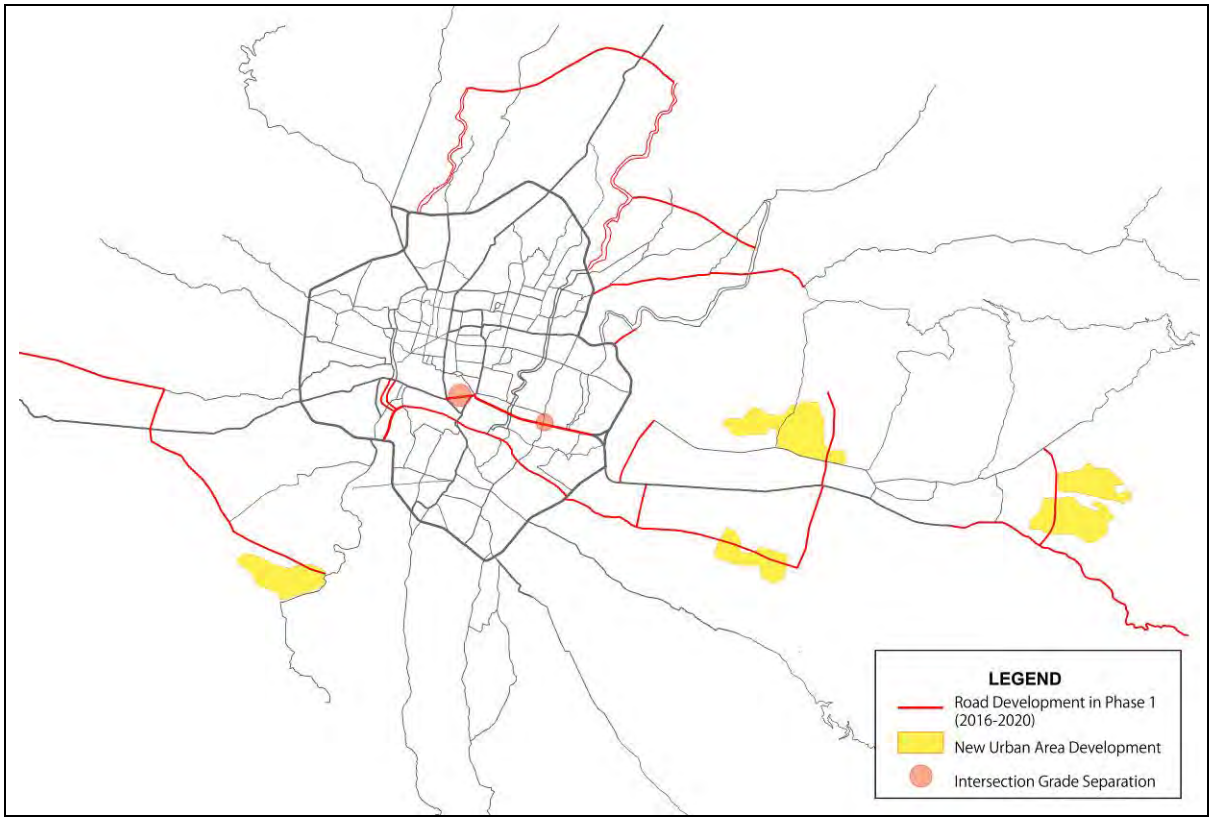
Basic strategy of road development staging plan is described in Table 10.1.2.

Table 10.1.2 Basic Strategy for Road Development Strategy Plan

		1st Phase Present to 2020	2nd Phase 2021 to 2025	3rd Phase 2026 to 2030
Road	Institution	・ Establishment of measures for land acquisition in densely inhabited areas. ・ Establishment of institution for planning and implementation of urban road development.	・	・
	Road	・ Implementation of emergency projects including improvement of Bottlenecks. ・ Development of roads connecting pilot development areas. ・ Development of roads proposed in emergency transport network plan. ・ Preparatory study for implementation of Inner Ring Road.	・ Development of Inner Ring Road. ・ Development of roads connecting selected priority development areas. ・ Development of Outer Ring Road connecting new urban areas. ・ Construction/improvement of roads for primary corridors for public transport.	・ Development of entire Outer Ring Road. ・ Development of all the roads proposed by MP.
	Road related facility	・ Establishment of regulation for obligated parking lots	・ Building multi-story parking lot by public-private partnership scheme.	

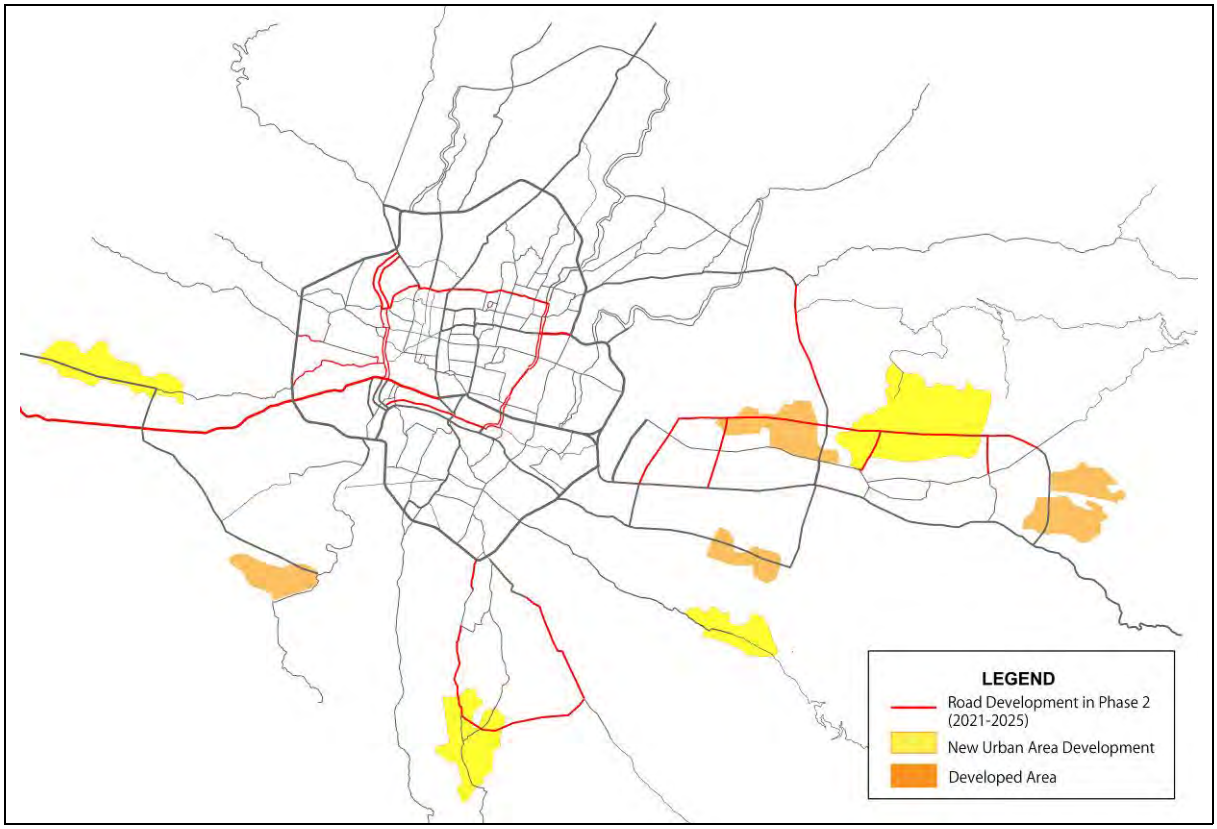
Source: JICA Study Team

New road developments in the short term, middle term and long term are shown in Figure 10.1.5, Figure 10.1.6 and Figure 10.1.7, respectively.



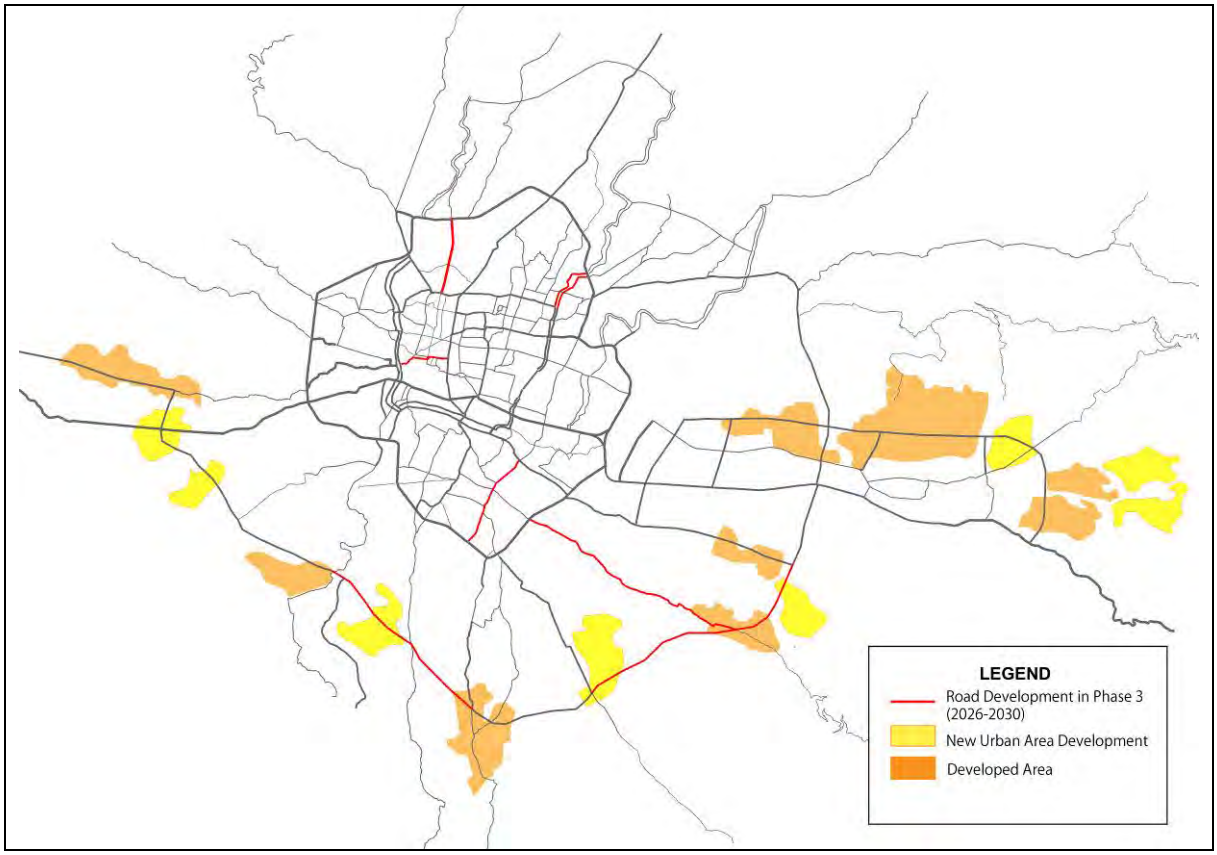
Source: JICA Study Team

Figure 10.1.5 Road Network Staging Plan in Short Term (2020)



Source: JICA Study Team

Figure 10.1.6 Road Network Staging Plan in Middle Term (2025)



Source: JICA Study Team

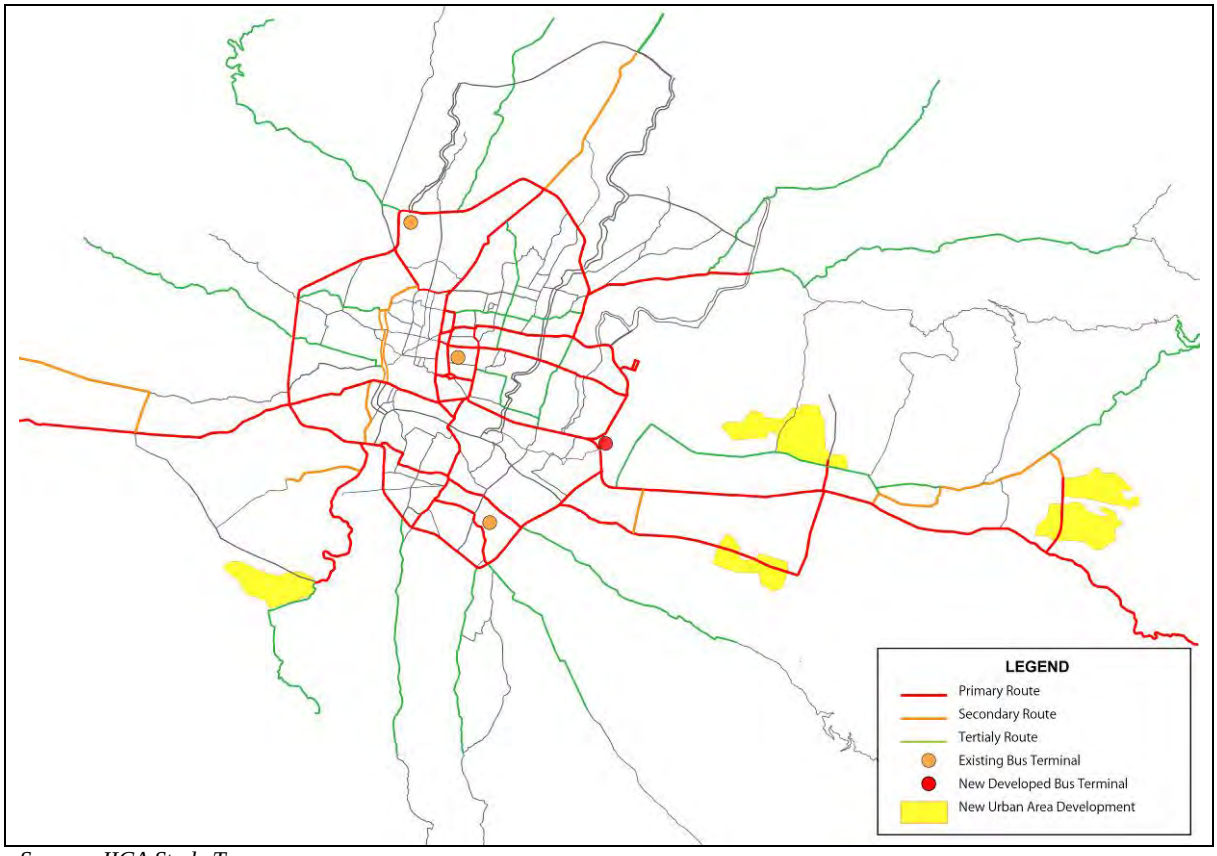
Figure 10.1.7 Road Network Staging Plan in Long Term (2030)

3) Public Transport Staging Plan

Basic policy and planed road network in each phase is described as follows:

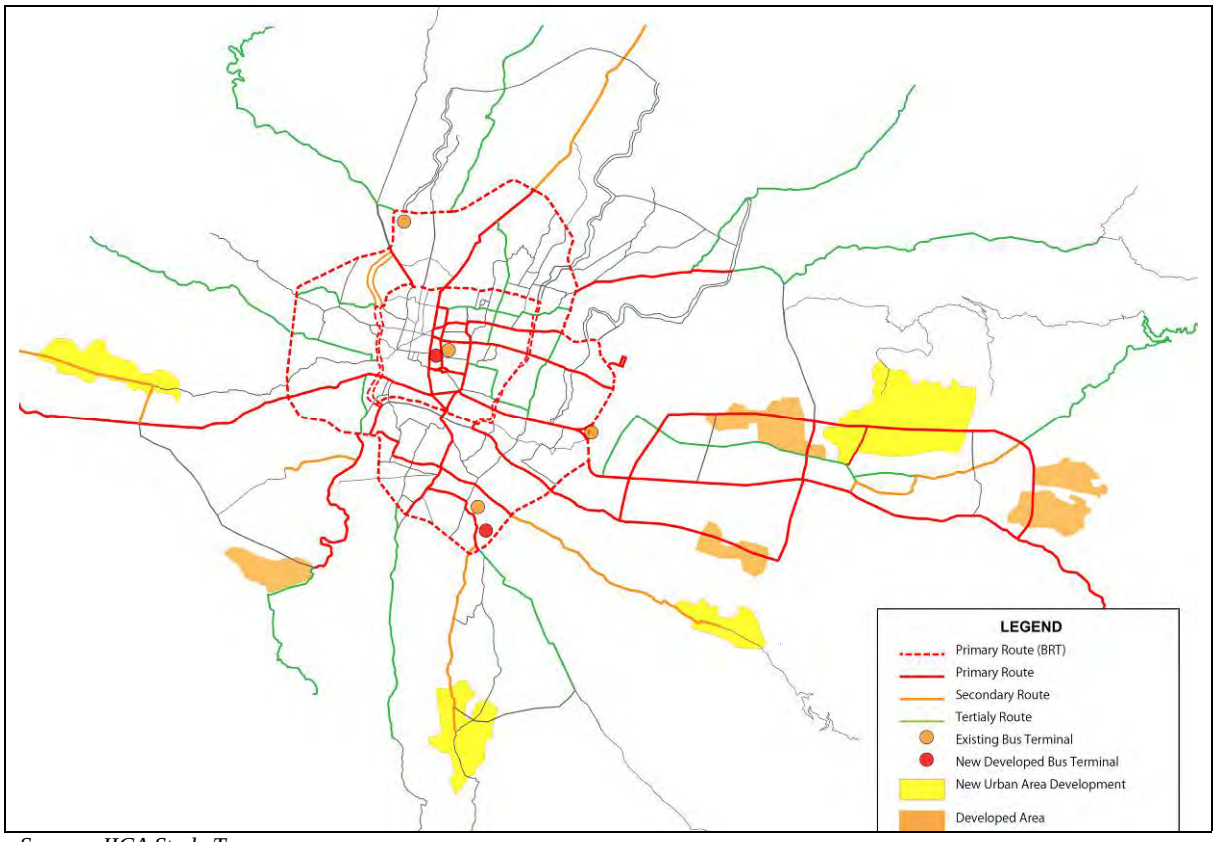
Table 10.1.3 Basic Strategy for Public Transport Strategy Plan

		1st Phase Present to 2020	2nd Phase 2021 to 2025	3rd Phase 2026 to 2030
Public transport	Institution	· Institutional reinforcement and capacity development of DOTM · Reorganization of small entrepreneurs to large scale consortium.	· Establishment of organization for operation of BRT	· Establishment of operator for new public transport system
	Public transport	· Implementation of pilot route project. · Restructuring of bus routes.	· Introduction of bus BRT to primary route. ·	· Introduction of new public transport system (AGT) · Expansion of BRT to secondary and tertiary routes.
	Public transport related facility	· Development of bus depots.	· Land acquisition and development of terminals along primary route.	· Land acquisition for rail yard for new public transport system · Land acquisition and development of terminals along secondary and tertiary route.



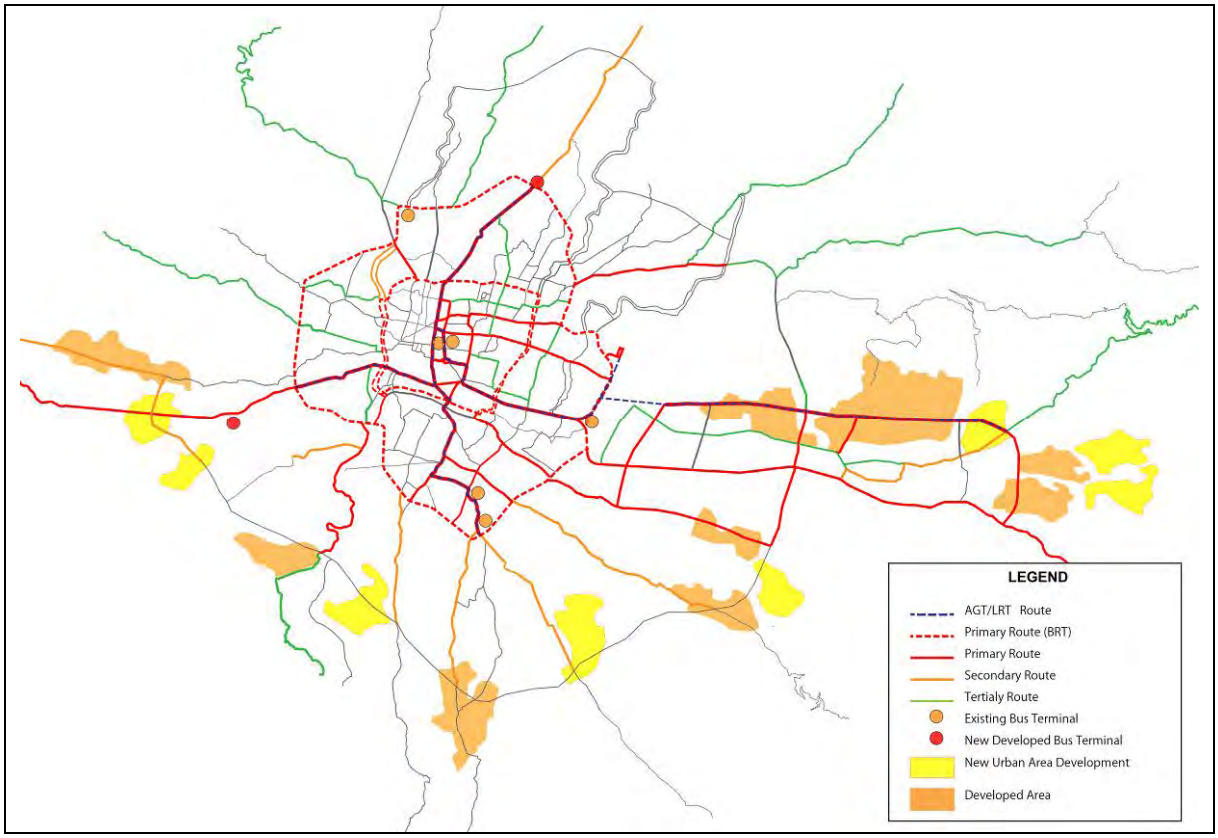
Source: JICA Study Team

Figure 10.1.8 Public Transport Network Staging Plan in Short Term (2020)



Source: JICA Study Team

Figure 10.1.9 Public Transport Network Staging Plan in Middle Term (2025)

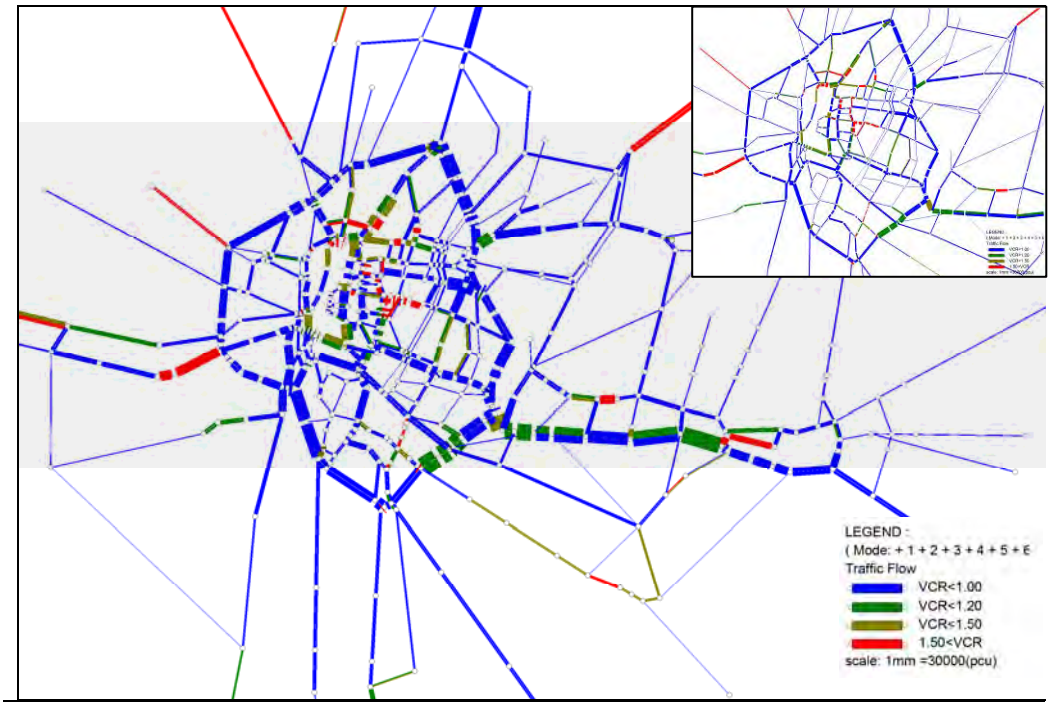


Source: JICA Study Team

Figure 10.1.10 Public Transport Network Staging Plan in Long Term (2030)

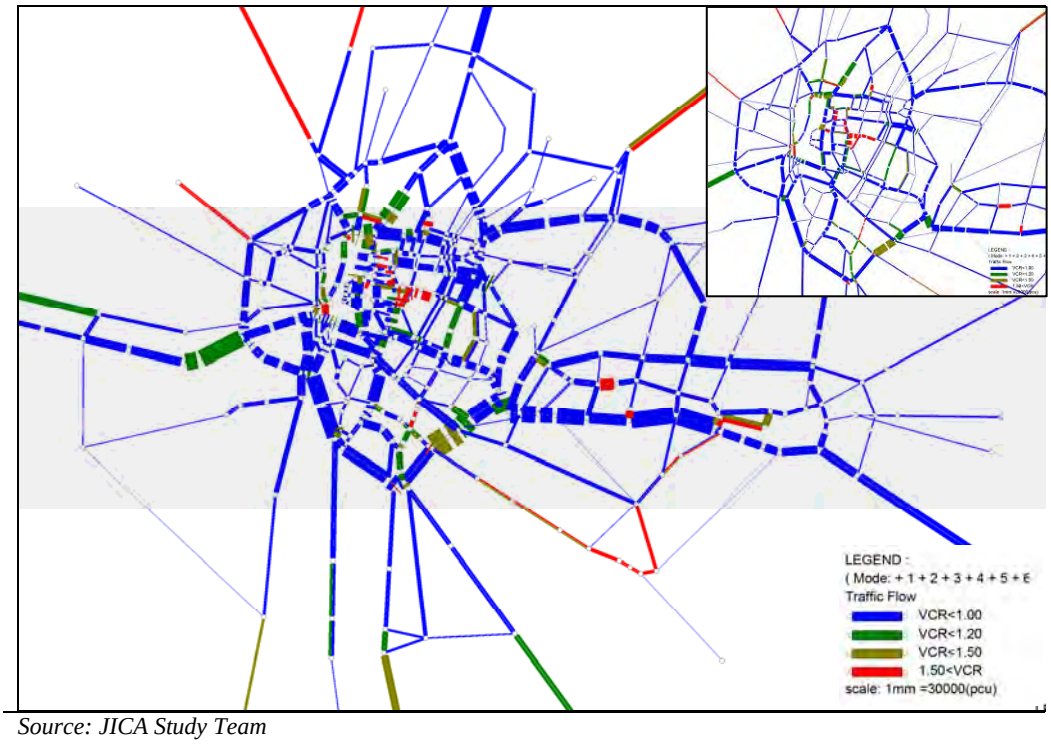
(3) Traffic Demand Forecast in Short Term and Middle Term

Figure 10.1.11 and Figure 10.1.12 shows the V/C (Volume/Capacity) ratio in short term and middle term.



Source: JICA Study Team

Figure 10.1.11 V/C Ratio in Short Term



Source: JICA Study Team

Figure 10.1.12 V/C Ratio in Middle Term

Table 10.1.4 shows the result of traffic assignment in the short term and middle term. VT-Hour, VT-KM and V/C ratio decreases a little even though increasing traffic demand.

Table 10.1.4 Result of Traffic Assignment

	VT-Hour '000Hr	VT-KM '000km	Average V/C
2020	181.6	8,269.6	0.53
2025	171.5	7,967.2	0.52

Source: JICA Study Team

10.1.2 Institutional Plan

10.1.2.1 Direction of KUTMP Implementation

(1) Legal Framework and Development Policies

Among the laws and policies reviewed in Chapter 3, the following laws are key to the implementation of KUTMP:

- Kathmandu Development Authority Act 1988
- Local Self-Governance Act 1999
- Town Development Act 1998

Kathmandu Development Authority Act 1988 is the basis of KVDA which replaced former KVTDC. It is responsible for the physical development of the valley. Local Self-Governance Act 1999 is the legal basis for local bodies to prepare their plans for physical development. Town Development Act 1998 is the basis for land pooling and guided land development projects.

The major laws that govern road administration are:
Public Road Act 2031 (1974);
Roads Board Act, July 2002; and
Urban Road Standards (being prepared by HABTAT).

The 20 Year Road Plan of DOR and the District Transport Master Plans (Kathmandu, Lalitpur, and Bhaktapur) are the basic policy documents.

Public Road Act is an Act that gives DOR authority to acquire land and develop roads—Highways and feeder roads. Road Board Act is to create the Road Board to finance repair and maintenance.

Motor vehicle and public transport related law is the Motor Vehicles and Transport Management Act, 20490 (1993). Chapter 6 Transport Management, Motor Vehicles and Transport Management Act is the critical chapter for implementing KUTMP. Issuance, renewal and revocation of route permits is stipulated. As for policy studies, ADB has conducted a Public Transport Restructuring study and has proposed a three tier structure of Transport Coordination Committee, Bus Agency and bus operators.

(2) KUTMP Implementation Directions

KV20SDMP [FD] already mentions some of the components of KUTMP. The intention is to incorporate KUTMP into Kathmandu Valley 20 Years Strategic Development Master Plan as the transport component of the strategic plan. When KV20SDMP [FD] is finalized (as it will include the contents of KUTMP), it will become the basis of KUTMP implementation.

However, KV20SDMP is a strategic policy; KVDA still has to prepare the Physical Development Plan which is mandated in the Kathmandu Development Authority Act 1988. When all the contents of KUTMP is integrated in the Physical Development Plan and the plan is implemented, KUTMP as a result will be implemented. The long-term planning period of KUTMP is up to 2030; therefore, the

physical development planning efforts by KVDA shall be accelerated. To accelerate preparation of Physical Development Plan, the two tier planning concept of regional and local levels of planning, introduced in KV20SDMP [FD], shall be further refined. The Physical Development Plan's role is to set the development framework for the valley, while, detailed local planning shall be prepared by local bodies and stakeholders will be included in the process of plan making.

Although some issues have been raised on the urban road standards, the primary and secondary road network development of KUTMP may have little institutional or technical difficulties other than financial affairs, since DOR already has technical capacity in developing and maintaining roads and bridges. DOR will have to update the 20 Year Road Plan and to adjust the10 Year Priority Investment Plan to meet the development direction of KUTMP.

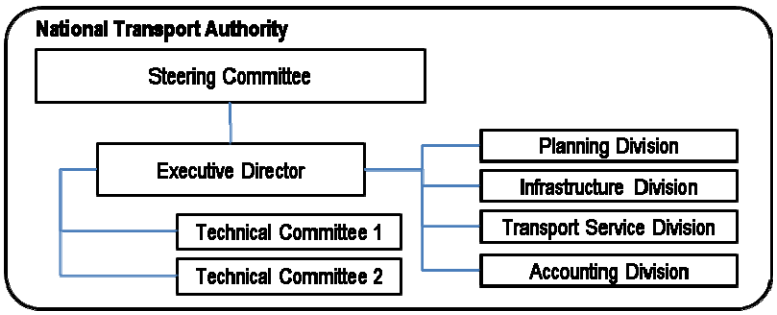
Kathmandu Development Authority Act 1988 defines the role of physical development in the valley, while Local Self-Governance Act 1999 defines similar roles for local bodies. Both planning capacities are weak; therefore, both regional and local levels of planning need to be harmonized to strengthen each other. KVDA shall be strengthened to support local bodies in plan preparation, and the planning capacity of local bodies with assistance from KVDA shall be strengthened to truly become independent autonomous local bodies. Planning consistency, conformity, cooperation and coordination will be required from both sides to implement KUTMP.

10.1.2.2 Current Institutional Development

(1) National Transport Authority

In line with the National Transport Management Strategy 2070 (2014), a draft basic institutional plan was proposed. After discussion within government, it will be enacted and the National Transport Authority will be established.

According to the National Transport Management Strategy 2070 (2014), the National Transport Authority will be established. The board of the Authority will be chaired by the Secretary of MOPIT.



Note: Simplified from the National Transport Management Strategy 2070 (2014)

Figure 10.1.13 Structure of National Transport Authority

The Steering Committee of the National Transport Authority will be chaired by Minister of MOPIT. The members will be:

- Secretary, Ministry of Federal Affairs and Local Development;
- Secretary, Ministry of Home Affairs;
- Secretary, Ministry of Urban Development;
- Director General, DoLIDAR;
- Director General, DoR;
- Traffic Senior Superintendent of Police;
- Director General, DOTM;
- Joint Secretary, Ministry of Finance;
- Joint-Secretary, Ministry of Science, Technology and Environment;
- Joint Secretary, National Planning Commission;

- Representative from Federation of National Transportation Entrepreneurs and Enterprises (FNTTEE);
- Representative from freight transportation business;
- Transport Expert;
- Secretary, MOPIT: Member Secretary.

The National Transport Management Committee established by the National Transport Authority will be chaired by Secretary of MOPIT. The members will be from:

- National Planning Commission;
- Ministry of Home Affairs;
- MOPIT;
- Ministry of Federal Affairs and Local Development;
- Ministry of Urban Development;
- Ministry of Finance;
- Ministry of Science, Technology and Environment;
- DoR;
- DoLIDAR;
- DoTM;
- Nepal Police;
- KVDA
- Representative, Kathmandu Metropolitan City;
- Representatives from the public transport business (Nominated);
- Representative from freight transport business (Nominated);
- Transport Expert (Nominated);
- Nepal Telecommunication Authority;
- Nepal Electricity Authority;
- Kathmandu Valley Drinking Water Ltd.; and
- DOTM: Member Secretary.

Under the National Transport Authority, the Kathmandu Valley Transport Management Committee will be established.

(2) Kathmandu Valley Transport Management Committee

According to the Strategy, the Kathmandu Valley Transport Management Committee will be chaired by the Commissioner of KVDA and proposed to have the following members:

- Executive Officers from Kathmandu, Lalitpur, Bhaktapur, Madhyapur and Kirtipur Municipalities;
- Deputy Supervisor of Police, Traffic Police;
- Head, DOTM, Bagmati Zone;
- Senior Divisional Engineer, Road and Traffic Division, DOR;
- Representative, Kathmandu Valley Drinking Water Supply Ltd. / Sewage Disposal;
- Representative, Chief District Administration Office;
- Representative, Nepal Telecommunication Ltd.;
- Representative, Nepal Electricity Authority;
- Representative, Municipality level transport union (Nominated);
- Representative, Municipality level labor union (Nominated);
- Transport Expert (Nominated); and
- DOTM: Member Secretary.

Among the members, DORW has not been included; since the KUTMP includes AGT development, DORW shall be included as a member.

The Kathmandu Valley Transport Management Committee shall have the following coordinating and policy approving functions:

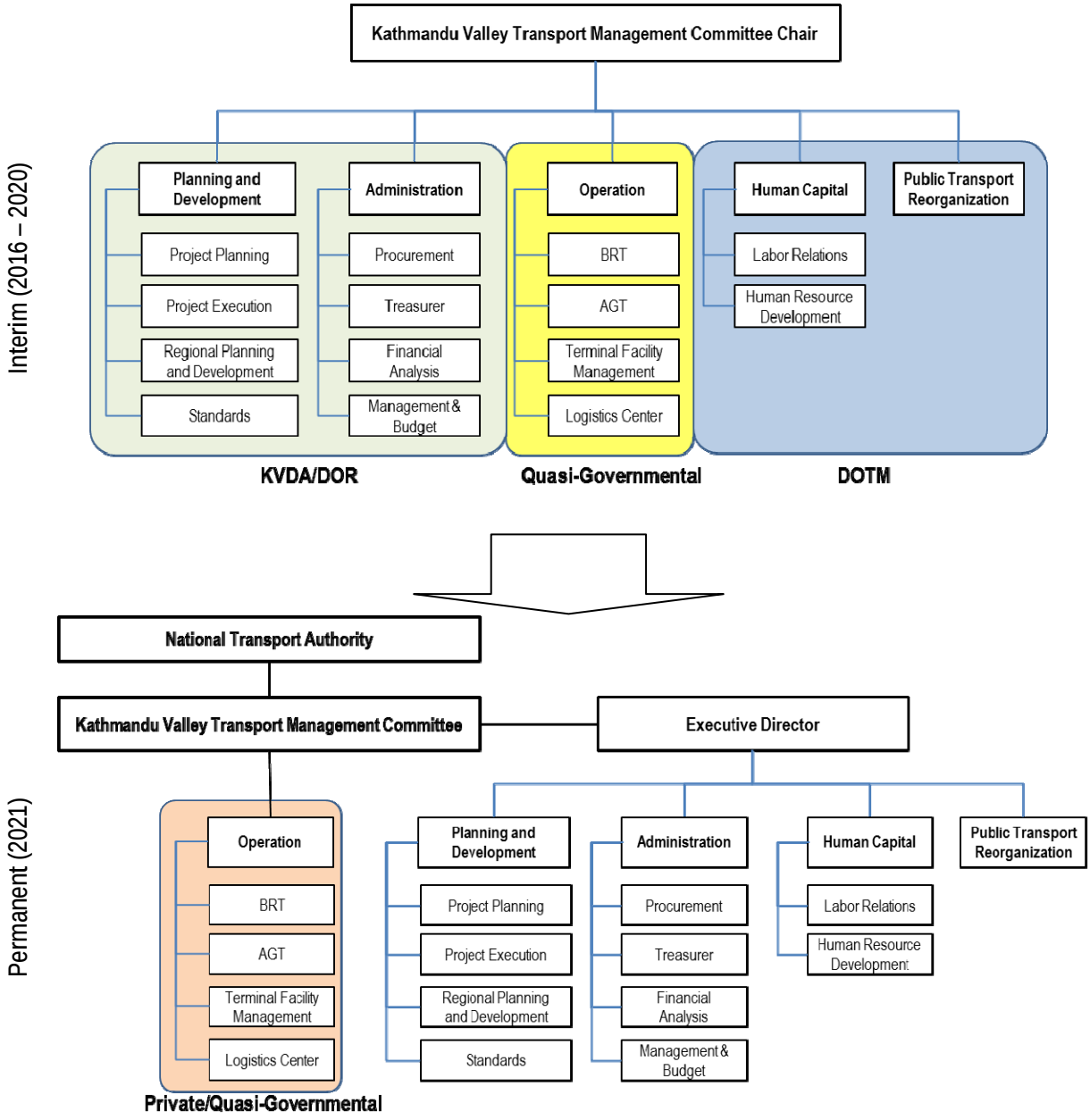
- To resolve inter-municipal issues;
- To approve project and programs of member line agencies;
- To approve capital investment plan of member line agencies;
- To approve operation plans and budgets of the sub-committees;

10.1.2.3 Basic Direction of Institutional Arrangement

The policy of establishing the National Transport Authority and Kathmandu Transport Management Committee is a recent initiative. It may take some time for the institution to function; therefore, the institutional plan has two phases: Interim Phase (2016-2020); and Permanent Phase (2021-). During the interim phase, existing organizations shall be utilized fully under the Chair of the Kathmandu Valley Transport Management Committee (KVTMC).

Five sub-committees are proposed to function under KVTMC: Planning and Development; Administration; Operation; Human Capital; and Public Transport Reorganization. A combination of KVDA and DOR shall mainly be responsible for: the Planning and Development; and Administration, and DOTM shall be responsible for Human Capital and Public Transport Reorganization. Quasi-governmental organizations shall be established for operating new transit systems and facility management.

In the second phase planned from 2021, all activities of sub-committees shall be executed under the executive director appointed by the Kathmandu Valley Management Committee to ensure integrated execution of KUTMP, and the operations of new transit systems and facilities shall be moved more towards the private sector that directly reports to the Kathmandu Valley Management Committee.



Source: JICA Study Team

Figure 10.1.14 Basic Institutional Arrangement

(1) Planning and Development Sub-Committee

Responsibilities of the Planning and Development Sub-Committee are:

- All transport development project planning and execution in the Kathmandu Valley area;
- Preparation of capital investment plans and programs;
- Updating KUTMP every five years;
- Regional planning and coordination; and
- Drafting standards and regulations.

1) Project Planning Section

The proposed development projects derived from the Sector Program in Chapter 10 in KUTMP are:
(1) Hierarchical road network,

(2) Grade Separated Intersections including Tripureswor - Maitighar Flyover
(3) Emergency road network;
(4) BRT;
(5) AGT;
(6) Terminals;
(7) Logistics centers; and
(8) Non-motorized transport.

The Project Planning Section will be responsible for preparing detailed project planning based on the Sector Program in Chapter 10 of this report. For detailed design works and financial planning, international and local consultation will be required.

2) Project Execution Section

Responsibilities of the Project Execution are:
- Land acquisition;
- Preparation of contracts;
- Contracts on construction materials; and
- Contract management and quality control during construction of the planned projects.

Implementation of route development for BRT in KUTMP can generally be achieved under the current organizational setting and existing laws and regulations. New roads for BRT—Inner Ring Road and Outer Ring Road--can be developed by DOR in areas less developed by directly purchasing land for road development in accordance with Land Acquisition Act and Public Road Management and Land Acquisition Directive (2002). In densely developed areas, KVDA could implement guided land development projects or land pooling projects to allocate land for road development. Land acquisition for other transport-facility-development projects can be achieved in a similar manner.

Construction will be conducted through a bidding process which will be managed by the Procurement Section of the Administration Sub-Committee. The Project Execution Section shall prepare contracts including bill of quantities that are necessary for bidding. During actual construction, the construction management task itself can be outsourced to local or international consultants.

Table 10.1.5 Road Development and Maintenance

item	Implemented by	Regulation/Standards
Construction of New Roads	Direct land purchase and development by DOR	National Road Standards Urban Road Standards
	Right-of-way allocation using the GLD by KVDA and road construction by DOR.	Guided Land Development Regulation Urban Road Standards
	Land Pooling by KVDA or local bodies	Land Pooling Regulation Urban Road Standards
Road Widening	KVDA, Acquisition of Right-of-way, DOR, Construction	Guided Land Development Regulation National Road Standards Land Pooling Regulation Urban Road Standards
Bridge Development	DOR	National Road Standards Urban Road Standards Bridge Development Standards
Elevated Section of the Inner Ring Road	DOR	No structural standards
Maintenance	DOR, local bodies	Road maintenance standards

Source: JICA Study Team

Currently funds for road development and maintenance have two streams, through MOFALD and MOPIT. DDCs, Municipalities and Divisional Road Offices carry out the actual implementation of development and maintenance works.

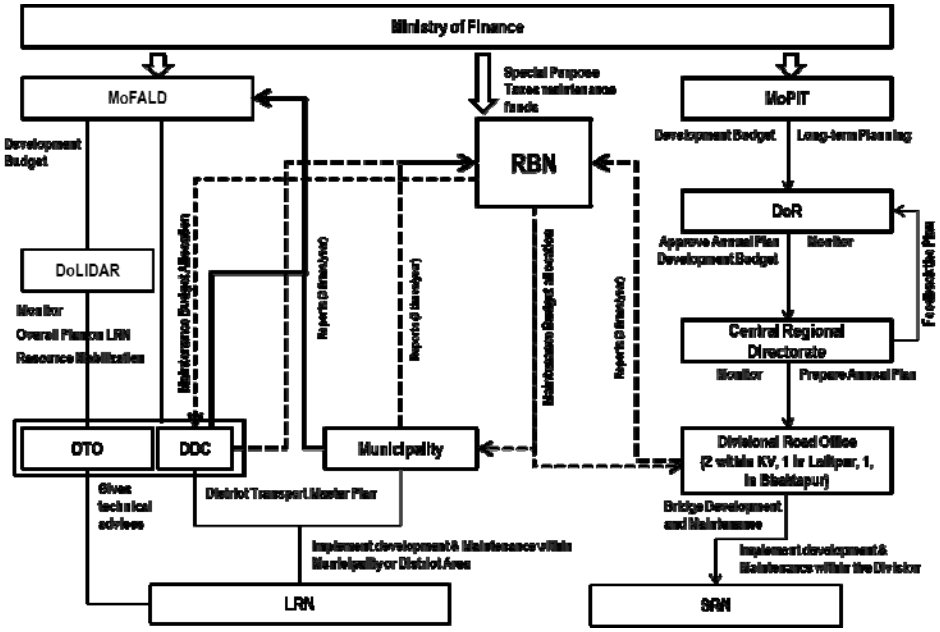


Figure 10.1.15 General Road Development and Maintenance Implementation Structure

As for administrative roles, the classification of national roads, feeder roads, district roads and urban roads are specified in the National Road Standards, and with the classification, roles of DOR, DDCs and municipalities are defined. As an interim measure, DDCs are in operation in the newly established municipalities, but from the fiscal year starting in mid-July 2015, all the planning and operation regarding local road administration will be handed over to eighteen (18) newly established municipalities. The current District Transport Master Plan will become Municipal Transport Master Plans or road development and maintenance plans for municipalities.

Table 10.1.6 Current Road Classification/Standards and Application of the Urban Road Standards

Classification	Current Standards	Application of the Urban Road Standards
National Highways	National Road Standards	within Municipality Area (path--primary arterial)
Feeder Roads	National Road Standards	within Municipality Area (Sadak--Secondary Arterial)
District Roads	DOLIDAR	within Municipality Area (Marg--Tertiary Arterial (Collector))
Urban Roads	Varies from Municipality to Municipality	The standards within municipal (urban) areas are defined.

Table 10.1.7 Municipalities in Kathmandu Valley

No	Name	Note
1	Kathmandu Metropolitan City	Existed
2	Lalitpur Sub-metropolitan City	Existed
3	Bhaktapur Municipality	Existed
4	Madhyapur Thimi Municipality	Existed
5	Kirtipur Municipality	Existed
6	Tokha Municipality	New
7	Budhanilkantha Municipality	New
8	Gokarneshwor Municipality	New
9	Kageshwori-Manohara Municipality	New
10	Shankharapur Municipality	New
11	Changunarayan Municipality	New
12	Mahamanjushree - Nagarkot Municipality	New
13	Suryabinayak Municipality	New
14	Mahalaxmi Municipality	New
15	Anantalingeshwor Municipality	New
16	Godawari Municipality	New
17	Karyabinayak Municipality	New
18	Dakshinkali Municipality	New
19	Chandragiri Municipality	New
20	Nagarjun Municipality	New
21	Tarakeshwor Municipality	New

3) Regional Planning and Coordination Section

Responsibilities of the Regional Planning and Coordination Section are:

- Periodical Updating of KUTMP
- Integrated Land and Planning Information System Development and Maintenance
- Plan and Policy Coordination and Consistency Review
- Technical Support in Local Land Use Planning and Zoning Regulation

a) Periodical Updating of KUTMP

KUTMP shall not be considered as the end-product. It shall be updated according to socio-economical and other environmental changes that were supposed to be premises of plan making. KUTMP shall be updated periodically at least every five years. Traffic demand and census and other statistical data shall be used to update the plan.

b) Integrated Land and Planning Information System Development

KVDA plans to establish Kathmandu Valley Information Center as it integrates all planning related data and information in one integrated system. The Regional Planning and Coordination Section shall utilize a GIS to plan and to support planning of local bodies as it coordinates with KVDA when such system will be established. Data and information on the Risk Sensitive Land Use Plan and KUTMP shall be included also.

c) Plan and Policy Coordination and Consistency Review

Local Self-Governance Act has the clause on local bodies to plan physical development on its own; while KVDA has the role of physical development in the Kathmandu Valley area according to Kathmandu Valley Development Authority Act of 1988. The Regional Planning and Coordination Section with KUTMP shall coordinate regional and local plans.

All the plans prepared by local bodies shall be reviewed by the Regional Planning and Coordination Sub-Committee to ensure: 1. Consistency with KUTMP; 2. and Conformity with Risk Sensitive Land Use Plan. Example contents of consistency and conformity review guidelines would include: 1) circulation system including BRT and AGT routes and right-of-

way; 2) concentration of economic activities -- planned TOD areas; 3) other transport facilities such as bus terminals and parks of regional significance. After the review, the local plans shall be certified by the Planning and Development Sub-Committee. The Transport Master Plan prepared by District Development Committee shall also be reviewed by the Sub-Committee. Local plan guidelines and Transport Master Plan review guidelines shall be developed by the Sub-Committee.

d) Technical Support in Local Land Use Planning and Zoning Regulation

Since most of the municipalities have less capacity in local land use and transport plans preparation, the Regional Planning and Coordination Section shall support the preparation of local land use plans. This is to support the physical and transport development elements stipulated under Section 96 of the Local Self-Governance Act, 2055 (1999): (b) Relating to Physical Development; and (f) Relating to Works and Transport. Section 96 has other functions and power of Municipality.

Section 96 (b) Relating to Physical Development states:

(1) To frame land-use map of the Municipality area and specify and implement or cause to be implemented, in the industrial, residential agricultural, recreational areas etc.
(2) To prepare housing plan in the area of Municipality and implement or cause to be implemented the same.
(3) To carry out plans on drinking water and drainage in the areas of Municipality and operate, maintain and repair or cause to be operated, maintained and repaired the same.
(4) To develop, or cause to be developed, green zones, parks and recreational areas in various places in the Municipality area.
(5) To arrange for or cause to be arranged for, public toilets in various places in the Municipality area.
(6) To approve or cause to be approved designs of houses, buildings etc. to be constructed in the Municipality area.
(7) To build community buildings and houses.

The elements from (1) to (4) potentially affect the implementation of KUTMP. The Regional Planning and Coordination Section shall support land use planning of local bodies in a way to make the plans consistent with the contents and direction of KUTMP.

4) Standards

Responsibilities of the Standards Section are:
- Preparation of Standards;
- Drafting Regulations; and
- Capacity development of local bodies adopting standards and regulations.

a) Road

(i) Urban Road Standards Application

As for the administrative roles, the classification of national roads, feeder roads, district roads and urban roads are specified in the National Road Standards, and with the classification, roles of DOR, DDCs and municipalities are defined. As an interim measure, DDCs are in operation in the newly established municipalities, but from the following fiscal year, all the planning and operation regarding local road administration will be handed over to newly established municipalities. The new municipalities will hire the required engineers to conduct management works on planning and maintenance for the respective municipality areas.

Table 10.1.8 Current Road Classification/Standards and Application of the Urban Road Standards

Classification	Current Standards	Application of the Urban Road Standards
National Highways	National Road Standards	within Municipality Area (Path*--primary arterial)
Feeder Roads	National Road Standards	within Municipality Area (Sadak--Secondary Arterial)
District Roads	DOLIDAR	within Municipality Area (Marg--Tertiary Arterial (Collector))
Urban Roads	Varies from Municipality to Municipality	The standards within municipal areas will be defined.

*Note: *A Nepalese word*

(ii) Emergency Road Network Standards

DOR, KVDA and municipalities shall designate the emergency road network. Structure and conditions of the buildings along the emergency roads shall be registered and monitored. Non-compliant buildings and structures shall be upgraded with subsidy programs to accelerate safety along the emergency routes.

(iii) Pedestrian/Bicycle Paths Standards

The Urban Road Standards prepared by HABITAT will have the new urban road standards. For NMT development, other than the road standards, operational guidelines will become necessary.

(iv) Adoption of Urban Road Standards

DOR and all local bodies will adopt the Urban Road Standards when the Standards will have been approved by MOPIT, MOUD and MOFALD. One concern is that some parts of municipalities are still rural; application of the Urban Road Standards shall consider local conditions.

b) Land Use Control

(i) Delineation of Development Control Areas—Overlay Zones (Town Development Area)

The land use plan for KUTMP has been prepared; however, it does not mean that land use plans for local bodies are automatically available. Since it would take time to prepare land use plans in all the municipalities, the proposed development areas in KUTMP will have to be secured as soon as possible. To do this, all the municipalities that do not have land use plans shall adopt the Risk Sensitive Land Use Plan as the municipal land use plan with planned roads, TOD areas defined. The status of the Risk Sensitive Land Use Plan is that it remains a policy until a law or regulation defining requirements for the physical development of local bodies becomes available.

To actually define the areas, KVDA or DDC shall prepare base maps with lot lines or building footprints, and KVDA and DOR use the base maps to draw new roads, planned widening areas, and TOD areas. The municipalities use the land use maps which may or may not be Risk Sensitive Land Use Plan, with planned road and transit routes and facilities to avoid issuing building permits in the areas unless the development projects are in line with the development policies and directions of KUTMP. New town development areas and AGT corridor development areas shall be delineated and approved in the municipal councils so that unwanted spot developments will be avoided.

(ii) Subdivision Regulation—Land Pooling Standards

New residential projects along the new town areas and along the planned AGT will require different types of standards other than the existing development standards by offering larger lot sizes with sufficient open space, car parking, public facilities, utilities and conservation areas. Different development patterns with more amenities and flexibilities shall be offered to different targets with different income levels. For low income residential development, not

only single detached housing, but duplex, triplex, and quadruplex development shall be considered, and design standards shall be prepared.

(2) Administration Sub-Committee

Responsibilities of the Administration Sub-Committee are:
- Procurement related to construction;
- Treasurer;
- Budgeting;
- Asset Management; and
- Financial Analysis.

Procurement is crucial for sourcing goods and services for the Committee activities. The Procurement Section shall act as the chief prescribed in the Public Procurement Act, 2063 (2007) to ensure fair public procurement processes. The role of this Section cannot be overemphasized, since other than regular road development and maintenance, planning and development proposed in KUTMP will be new to the government of Nepal, international or local engineering consulting work will become necessary. The type of consulting work may require highly technical GIS and amending laws and regulations as new guidelines and standards will have to be developed. Supervision of construction may have to be outsourced. The domain of the Procurement Section excludes procurement regarding operation and maintenance work of the Operation Sub-Committee.

The Treasurer Section reports annual accounts and the Budgeting Section prepares the annual budget. The administration processes are already available in Nepal.

The Asset Management Section manages all the assets in the Sections under Sub-Committees. Until operations of public transits and terminal facilities become privatized, it is the responsibility of the Asset Management Section to manage assets related to TOD and new transit systems. They include terminal buildings, depots, bus terminals, logistics centers and associated facilities.

The Financial Analysis Section conducts performance analyses of the transit and terminal service operations to recommend modification of fare of BRT and AGT as well as fees for tenants to terminal buildings. Project based information shall be gathered in the Section so that possible redistribution of profit generated from TOD would be transferred to the operation of public transport.

The operating costs/revenue shall be reported from the Operating Sub-Committee; the Financial Analysis Section analyzes the transit operating performance by calculating performance indicators such as daily weekday passenger boarding, cost effectiveness, cost recovery, average subsidy per passenger, and others. When the performance is not satisfactory, the Section recommends operational improvements to the respective Sections in the Operation Sub-Committee.

(3) Operation Sub-Committee

Responsibilities of the Operations Sub-Committee are:
- BRT;
- AGT;
- Terminal facility;
- Logistics Center;
- Marketing and Promotion; and
- All other operation and maintenance of transport facilities.

Quasi-governmental organizations shall be formed to run the transit systems and transport related facilities to ensure a financially independent operation. Once the operation systems have been established, the quasi-governmental operation shall be privatized. The government shall subsidize the costs for acquiring vehicles and cars for BRT and AGT.

The Sections are responsible for managing personnel and facilities including procurement necessary for operation and maintenance. Each section prepares annual operation plan, budget and annual financial report. In order to promote use of the transit services and facilities, the Marketing and Promotion Section prepares plans and implements marketing and promotion activities.

(4) Human Capital Sub-Committee

Responsibilities of the Human Resource Sub-Committee are:
- All personnel related matters;
- Labor relations;
- Human resource development.

The human capital sub-committee shall be separately established since labor relationship among private sector reorganizations will be expected to be complex. The Sub-Committee shall communicate with labor unions and transport unions at the local level, and at the same time coordinating with FNNTE. Working closely with the Public Transport Reorganization Sub-Committee, the Human Capital Sub-Committee shall create a human resource database including the private transport operators. The Sub-Committee shall prepare human resource development plans and programs for those who may join a bus or other public transport agencies run by quasi-governmental organizations.

The Labor Relations Section is set to resolve possible issues that may arise between workers and employers. Salary, working conditions and potential troubles shall be resolved before the situation gets into Banda.

The Human Resource Development Section prepares human resource development plans and programs to meet human capital requirements for KUTMP implementation. The area of investment needs to be selected since the capacity of the government is limited. The basic policy shall be when a job can be outsourced to the private sector, the work shall be outsourced to minimize the human resource development costs on the government. The government officials shall be more on supervision, administrative system development and policy formulation.

The roles that shall not be outsourced are fundamental data management. In transport, traffic, trip and accident data are fundamental data along with population and socio-economic data. Geographic information is significant in land use planning and transport planning. In this regard, expert training shall be focused on database management, statistics, GIS and mapping.

Another area is planning coordination. Before a plan or project is implemented, it needs to be known by stakeholders including residents and private real-estate owners. Planning coordinators will have to make the plan known and build consensus among different stakeholders.

(5) Public Transport Reorganization Sub-Committee

Responsibilities of the Public Transport Reorganization Sub-Committee are:
- All matters related to reorganizing transport operators in the Kathmandu Valley area;
- Development of incentive packages for rerouting and retirement,

The Sub-Committee's major task is to make a reorganization plan for private operators with incentive packages and to create a bus agency.

To replace the old and small capacity fleet of public transport, it requires political will on the part of the government. The route permit of the old vehicles that have reached the maximum vehicle age shall be revoked. To accelerate reallocation of public transport fleets, the government needs to give incentives and disincentives for their actions.

As BRT will be in operation, private operators may have incentives to join the operation since some rationalization would be expected in competitive routes. With options of taking part in the BRT operation, the bus operators could be reorganized.

If existing bus operators are to join the operation of BRT, they shall be trained. New items of training would be on: transit signal priority; queue jump lanes; turning radius; intelligent transportation system; familiarization with infrastructure such as lanes and stations.

10.1.2.4 Laws and Regulations

(1) Amendment to Existing Laws

1) Land Acquisition Act, 2034

Section 25. Special Powers to Acquire Land in Special Circumstance, in Land Acquisition Act, 2034 (1977) shall be applied to accelerate significant road and transport facility development projects to accelerate implementation of KUTMP. Such land acquisition shall be applied to:

- Segments of Inner Ring Road development areas;
- AGT right-of-way and surrounding areas for AGT stations;
- Bus terminal and parking areas;
- Designated emergency road project areas;
- TOD development and surrounding areas; and
- Logistics center development areas.

2) Ancient Monument Preservation Act, 2013 (1956)

One of the factors that can delay land acquisition is Ancient Monuments defined in Ancient Monument Preservation Act, 2013 (1956). It is possible that there could be ancient monuments within the road alignment and other land development areas specified in KUTMP. Unless the areas are declared as the preserved monument areas, ancient monuments may be relocated to other areas for smooth implementation of KUTMP. The matter shall be discussed with the Department of Archaeology and local bodies after a thorough study to identify ancient monuments within the road alignment or other land development areas recommended in KUTMP.

10.1.2.5 Capacity Development Planning

(1) Basic Directions

To implement the plans, projects and programs, there shall be three types of persons: policy makers, specialists and coordinators. Policy-oriented leaders integrate different plans and projects to fit under the visions and missions. Specialists are engineers, planners, legal experts or others who understand methods and standards. Coordinators play important roles in consensus building.

For policy-oriented-human resources, drafting acts, regulations and directives will become necessary. With college or university level education for engineers and planners, they need to understand real life situations and new development methods and standards.

(2) Method

KVDA has proposed an information system infrastructure—Kathmandu Valley Information Center (KVIC). As KVDA is a relatively new organization, such information center with learning facility will be necessary for monitoring projects and providing geographic data for local bodies. As for DOR, it has a computer room for training; it shall utilize the facility for IT related training.

For training program development, international assistance will become necessary with local assistance on specific subjects on GIS or spatial data infrastructure development. Training materials

to be prepared would become standards and guidelines; therefore, stakeholders will have to be involved and approval from proper authorities on policy related training sought.
Target human resources are categorized as policy makers, specialists and coordinators. The subjects necessary for plan implementation are listed in the following table:

Table 10.1.9 Capacity Development Plan (Draft)

Human Resource	Subjects	Method	Training Material	Training Infrastructure	Technical Assistance
Policy makers	Regional Planning (Physical development plan)	Lecture, workshop	Regional Development Guidelines, Case Studies	-	International
	Strategic planning and problem solving, system development	Lecture, workshop	System development training materials	-	International
	Development control administration	Lecture, workshop	Administrative procedure development and manual preparation	-	International /local
Specialists	JICA STRADA	Lecture, Hands-on-Session	JICA STRADA Manual, on-line manual	PC, JICA STRADA	International
	Land Pooling	Lecture, workshop	Case studies Land pooling standards	PC, CAD	International /local
	Newtown development	Lecture, workshop	Land development guidelines and standards	PC, CAD	International
	CAD/GIS	Lecture, Hand-on-Sessions	GIS Manual, KVTMP, RSLUP, on-line manual	PC, GIS Software	International /local
	Database/Statistics	Lecture, Hand-on-Sessions	Population, socio-economic, traffic, accident, others	PC, GIS/Database Software	International /local
	Urban design	Lecture, Workshop	Urban design guidelines (landscape, street design, signage, others)	PC, GIS/CAD Software	International /local
	Financial Analysis	Lecture	Financial Analysis	PC, Spreadsheet Software	Local Academics
Coordinators	Project Management	Lecture, Workshop	TOD, BRT, AGT	PC, Project Management Software	International /local, local academics
	Local Land Use Planning/Transport Network Planning and Coordination	Lecture, Workshop	Land Use/Transport Network Planning Guidelines, Consensus Building Guidelines	-	International/ local
	Public Transport Reorganization	Lecture, Workshop	Operation guidelines	-	International /local

Source: JICA Study Team

All DDG or higher ranking officers, planners, architects, engineers shall take the "policy makers" training. All planners in local bodies and KVDA shall take the "coordinators" training. The "specialists" training shall be developed in collaboration with academics in Nepal so that the subjects will become available in colleges and universities in the future.

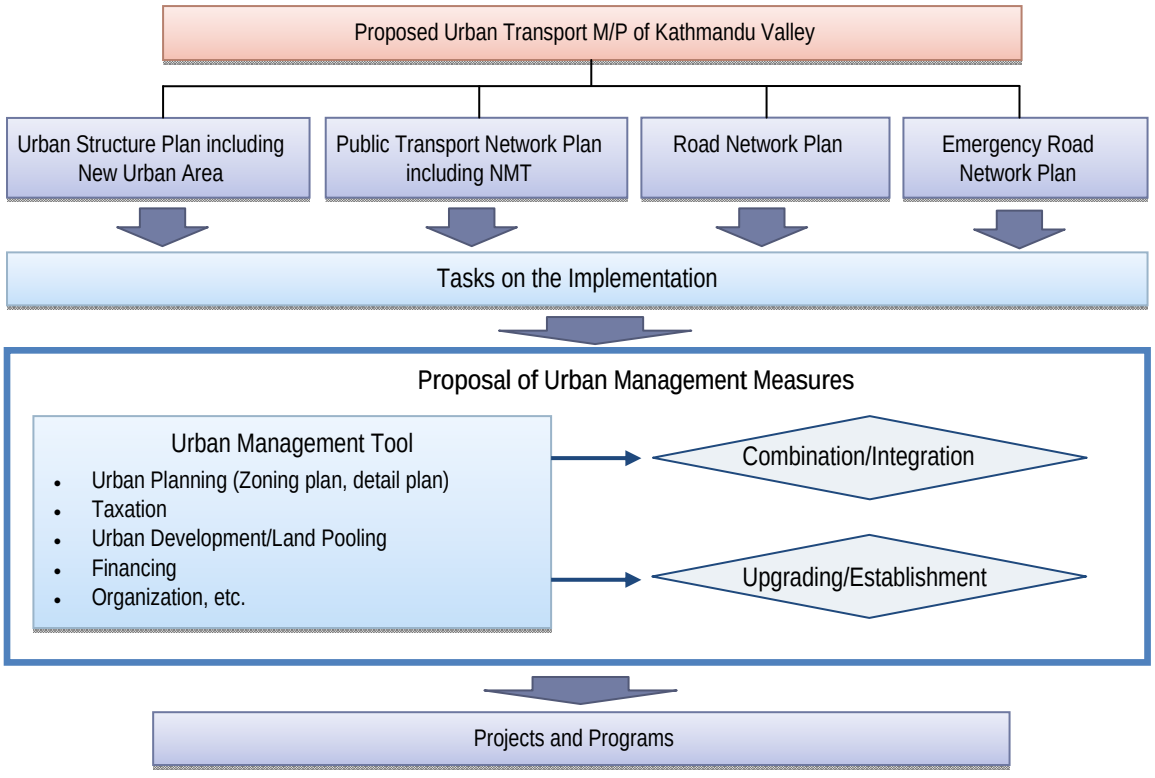
10.2 Urban Management Measures

10.2.1 Outline

In this M/P study, sector development plans such as i) urban structure plan including new urban area, ii) public transport network plan including non-motorized transport, iii) road network plan, and iv) emergency road network plan have been proposed. For the implementation, it is necessary to establish appropriate urban management measures performing the following tasks:

- Control buildings and developments for appropriate land use
- Conserve agricultural lands and traditional buildings
- Promote new urban area development
- Promote integrated urban development with public transport network based on TOD concept
- Acquire lands for road widening in built-up areas
- Secure emergency roads for disaster prevention

Urban management measures should be based on a combination and integration with plural urban management tools in consideration of effectivity and sustainability of implementation. Figure 10.2.1 shows the orientation of proposal of urban management measures for the implementation of the proposed plans.



Source: JST

Figure 10.2.1 Orientation of Proposal of Urban Management Measure

10.2.2 Urban Management Measures for Land Use Control

(1) Concept

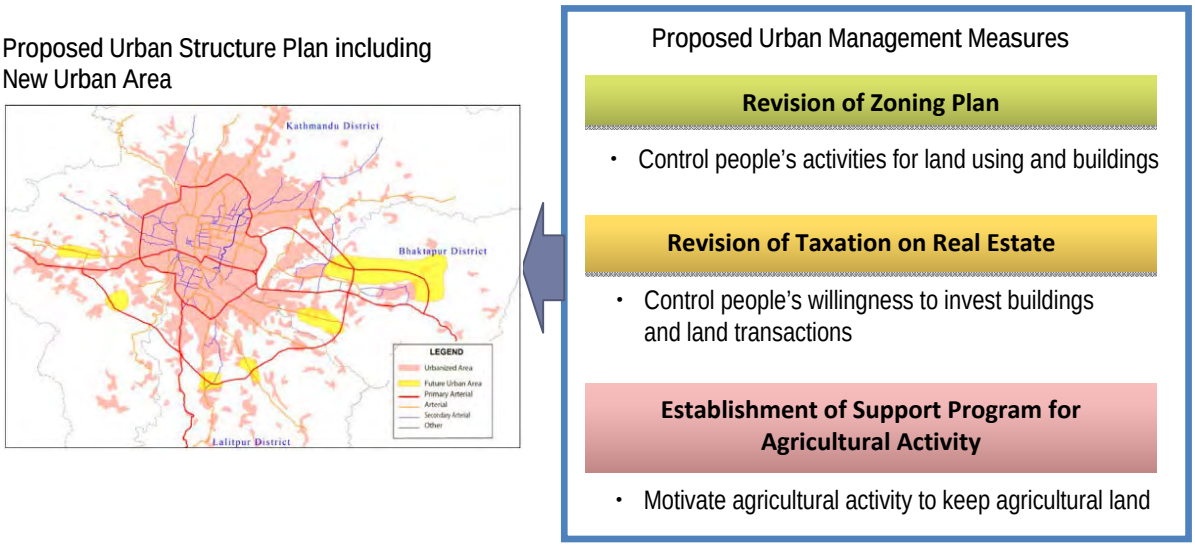
Establishment of appropriate urban management measures should be realized for the implementation of land use control based on proposed urban structure plan through the following tasks:

- Promote building activities and urban land use in urbanization promotion areas including new urban areas
- Restrict buildings and land use changes for agricultural areas to be conserved
- Encourage people's willingness to invest in buildings and land transactions

Zoning plan currently serves to control individual buildings and development activities in KV. However, it should be revised to promote high-density land use in existing urbanized areas and new urban areas, and to restrict buildings and development activities in agricultural land in suburbs. Although zoning plan is one of the effective measures to control people's activities, another approach is required for further land use control. Taxation on real estate is one of those measures. For instance, tax exemption and tax reduction promote private investment, and high tax rate reduces people's motivation on investment. Current taxation on real estate just focuses on the land value without considering type of land use and promotion of building from the viewpoint of urban management. Revision of the taxation is required for appropriate land use.

Moreover, it is necessary to improve the current situation of agricultural business to control land use changes in agricultural land. Current low productivity and low profitability of the agricultural business are the main causes of land use change and land transactions. Technical and financial support should be established to encourage people to continue agricultural activities in the suburbs.

Concept of proposed urban management measures for land use is shown in Figure 10.2.2.



Source: JST

Figure 10.2.2 Concept of Proposed Urban Management Measures for Land Use Control

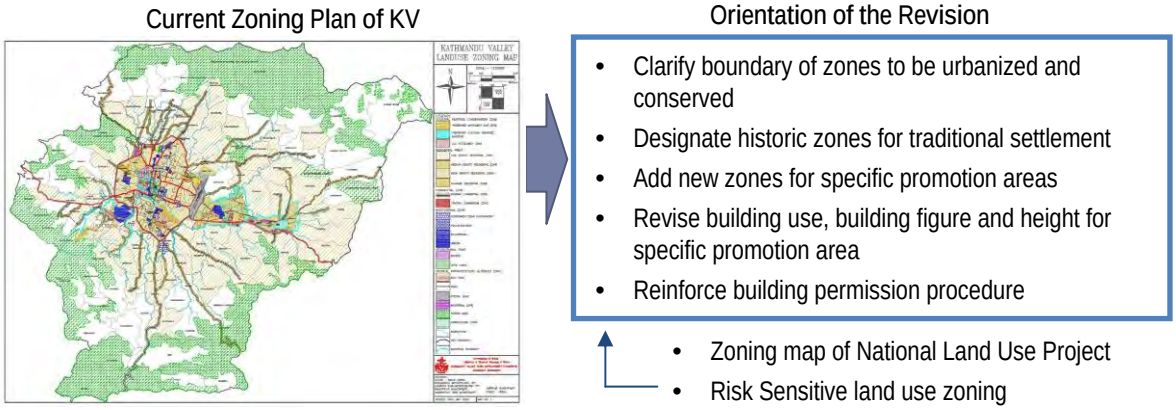
(2) Revision of Zoning Plan

Orientation of the revision of current zoning plan of KV is proposed as follows:

- Clarify boundary of zones to be urbanized (urbanization promotion area) and to be conserved (urbanization control area)
- Add new zones for specific promotion areas such as new urban area, station surrounding area, development corridor
- Revise building use, building figure and height for specific promotion areas to increase the urban density and development potential
- Designate historic zones for traditional settlements to be conserved
- Reinforce building permission procedure to restrict illegal land use and building design

In addition, designation of conservation areas should examine the following zoning maps:

- Zoning map of National Land Use Project under the Ministry of Land Reform and Management, which aims to conserve agricultural areas and natural resources
- Risk Sensitive Land Use Zoning by UNDP



Source: JST

Figure 10.2.3 Orientation of Revision of Zoning Plan of KV

(3) Revision of Taxation on Real Estate

At present, taxation on real estate in KV consist of four kinds of taxation such as i) land registration tax, ii) property tax, iii) municipal house tax and iv) cultivate land tax. JST proposes revision of the taxation system in KV to control the people's attitude to land use as follows:

1) Land Registration Tax

Land registration tax is levied as stamp duty on land, house and apartment which the owner will be charged when selling and transferring ownership. Revision of this tax can control people's motivation to real estate transactions and urban land use. Orientation of the revision is proposed as follows:

- To levy lower tax rate for land transactions in urbanization promotion areas to encourage building and development activities
- To levy higher tax rate for land transaction involving agricultural land in urbanization control areas to discourage building and development activities

2) Property Tax

Property tax is annually levied on the integrated property in municipal areas. The current tax rate is from 0.00% to 1.50% per year, depending on the property value. The revision can control people's attitude to urban land use. Orientation of the revision is proposed as follows:

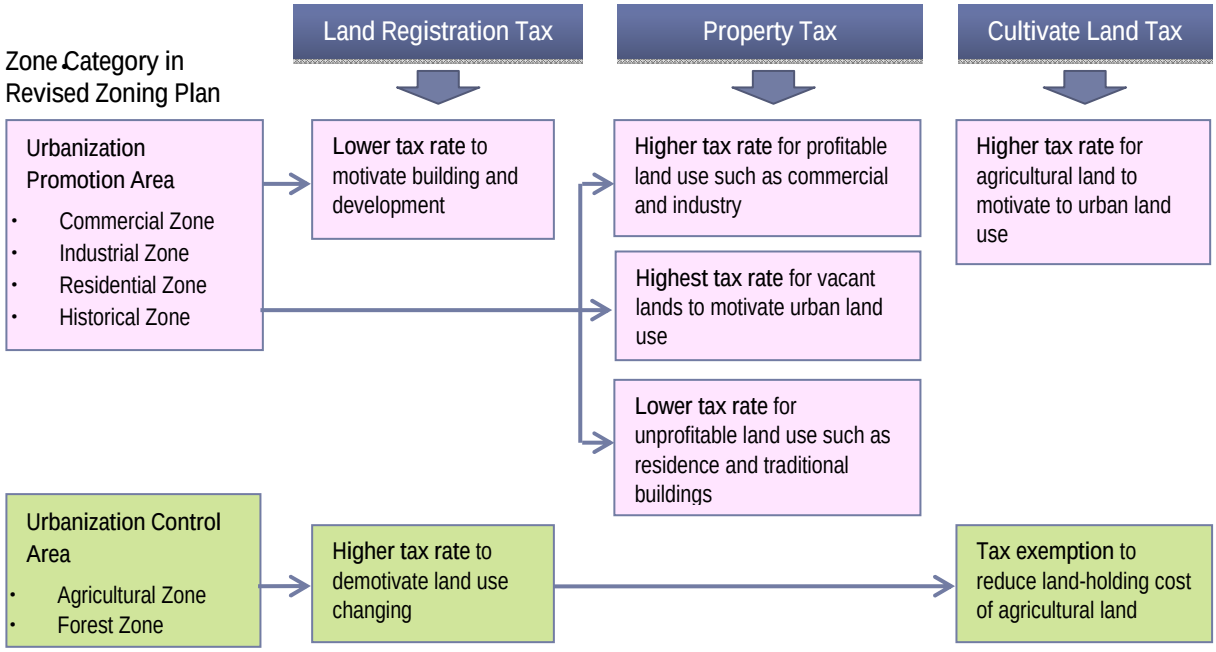
- To levy the highest tax rate for vacant lands in urbanization promotion areas to encourage urban land use
- To readjust tax rate in consideration of the profitability: higher tax rate for profitable land use such as commercial and industry, and lower tax rate for unprofitable land use such as residence and traditional buildings

3) Cultivate Land Tax

Cultivate land tax is annually levied on the agricultural land. The current tax rate is depending upon the productivity. The revision can control people's attitude to land use change. Orientation of the revision is proposed as follows:

- To exempt tax on agricultural lands in urbanization control areas to reduce the land holding cost
- To levy higher tax rate on agricultural lands in urbanization promotion areas to encourage land use change

Figure 10.2.4 shows the summary of taxation revision on real estate.



Source: JST

Figure 10.2.4 Orientation of Revision of Tax Rate on Real Estate

(4) Establishment of Support Program for Agricultural Activity

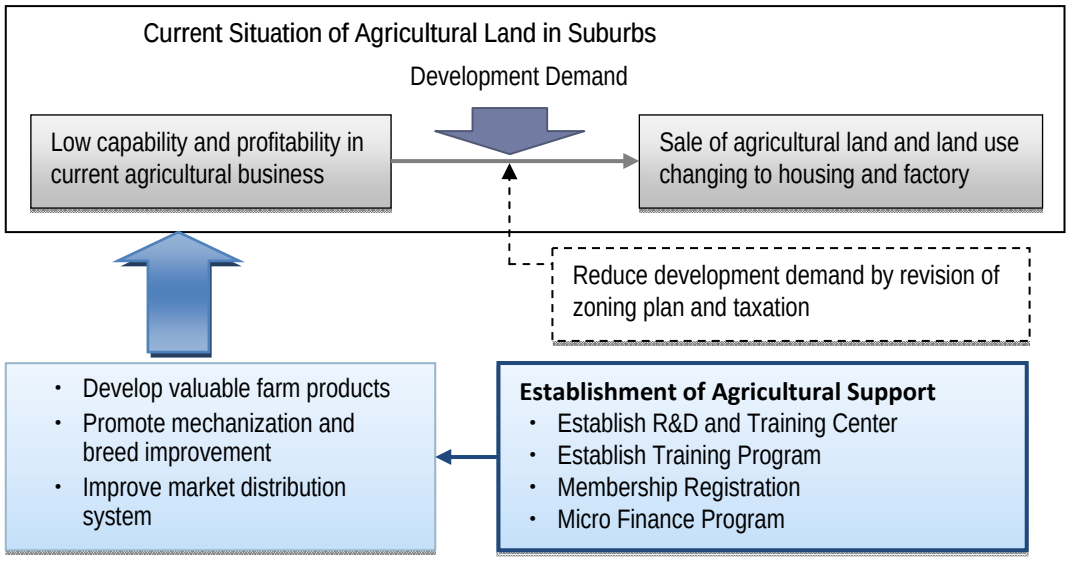
To improve the productivity and profitability of agriculture in the suburbs of KV, JST proposes establishment of support program for agricultural activity as follows:

- Establishment of R&D and Training Center
- Establishment of Training Program
- Membership Registration System

- Micro Finance Program

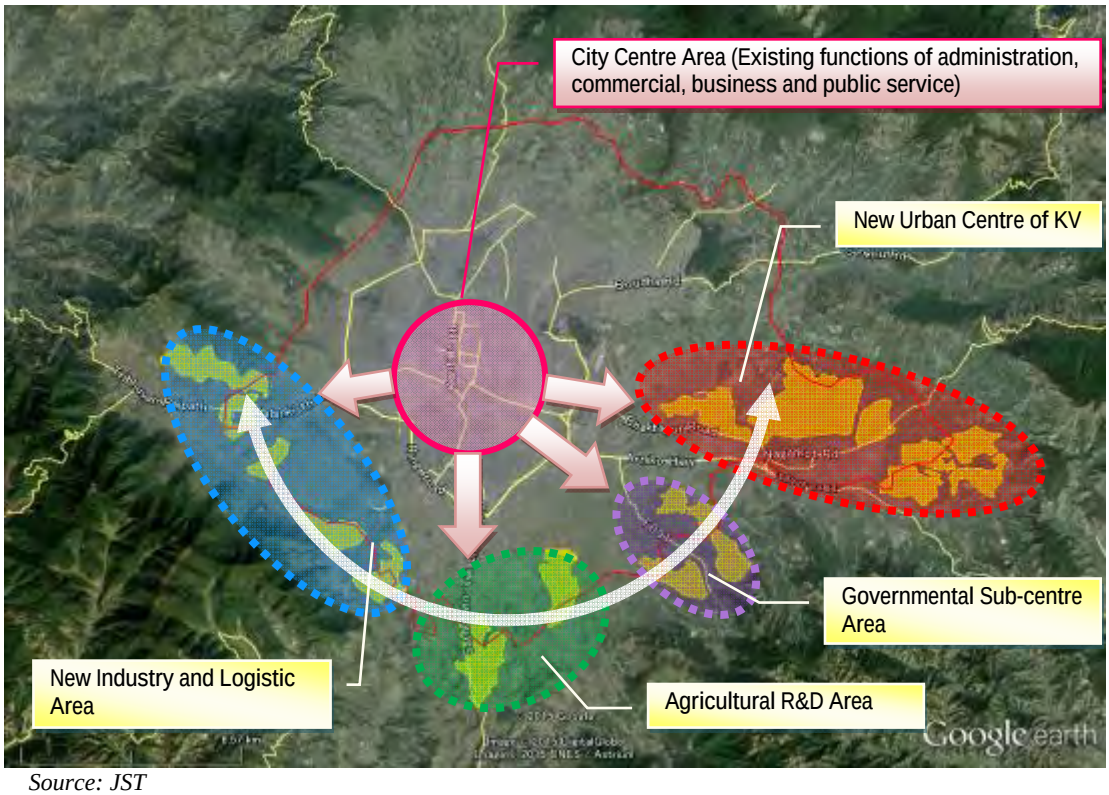
These programs are aimed at the development of valuable farm products, promotion of mechanization and breed improvement, and improvement of market distribution system. The agricultural land which has been proposed as new urban area can be a priority area for the support program.

Figure 10.2.5 and Figure 10.2.6 show the support program for agricultural activities and function of agriculture and pharmaceutics.



Source: JST

Figure 10.2.5 Orientation of Establishment of Agricultural Support



Source: JST

Figure 10.2.6 Proposed Function of New Urban Area

10.2.3 Urban Management Measures for TOD

Integrated urban development and intermodal facilities are the keys for implementation of public transport network plan including non-motorized transport based on TOD concept. The concepts of the integrated urban development and intermodal facilities are explained in this section.

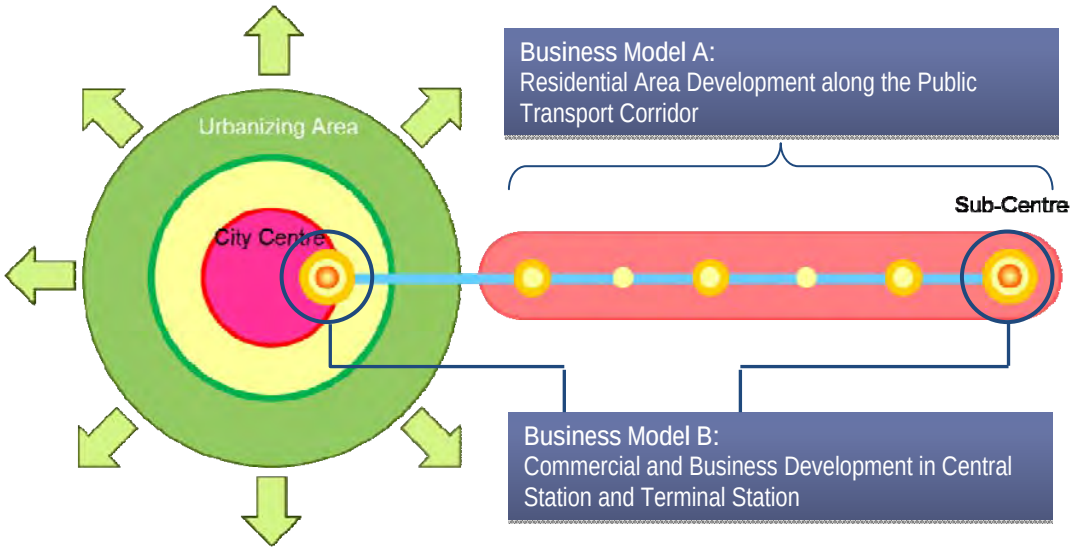
(1) Integrated Urban Development based on TOD

TOD aims at synergy of the following effects:

- Enhancement of development potential in station surroundings by public transport development
- Increase the number of public transport users by urban development such as central area development and residential development

For implementation of TOD, it is necessary to promote integrated urban development based on two types of business models as follows:

1) Business Model A: Residential Area Development along the Public Transport Corridor
2) Business Model B: Commercial and Business Area Development in Central Station and Terminal Station

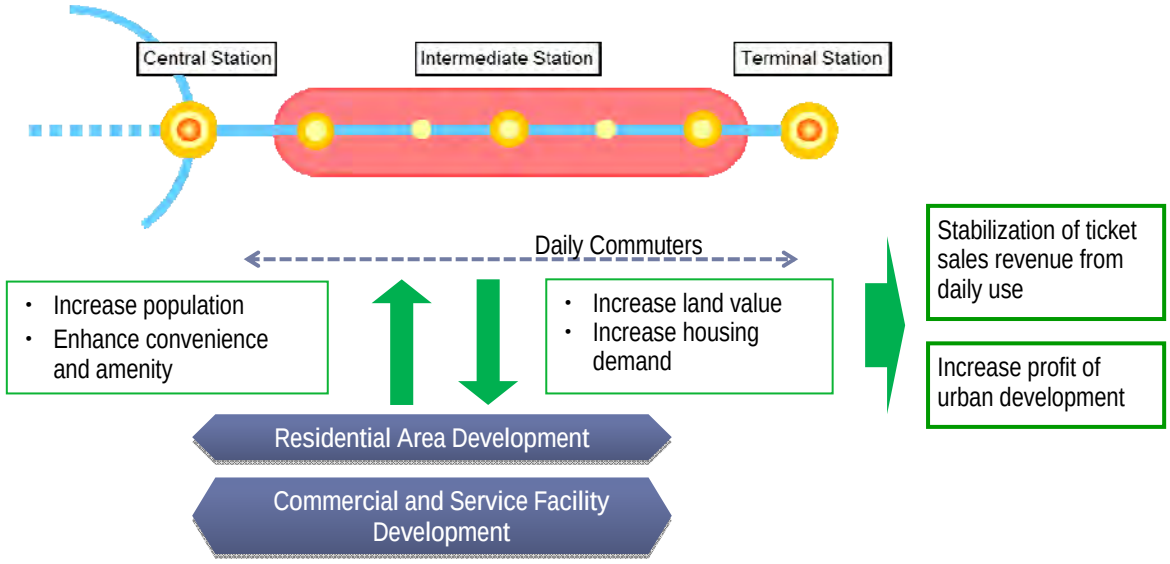


Source: JST

Figure 10.2.7 Concept of Integrated Urban Development based on TOD

1) Business Model A: Residential Area Development along the Public Transport Corridor

Business Model A aims at both stabilization of revenue from daily-use ticket sales and increase of profit from urban development. Urban development in residential areas including enhancement of commercial and service facilities increases population, and enhances convenience and amenity in the station surroundings. These effects increase the number of commuters and stabilize revenue from ticket sales. Meanwhile, railway development increases land value and housing demand. The concept of business model A is shown in the Figure 10.2.8.

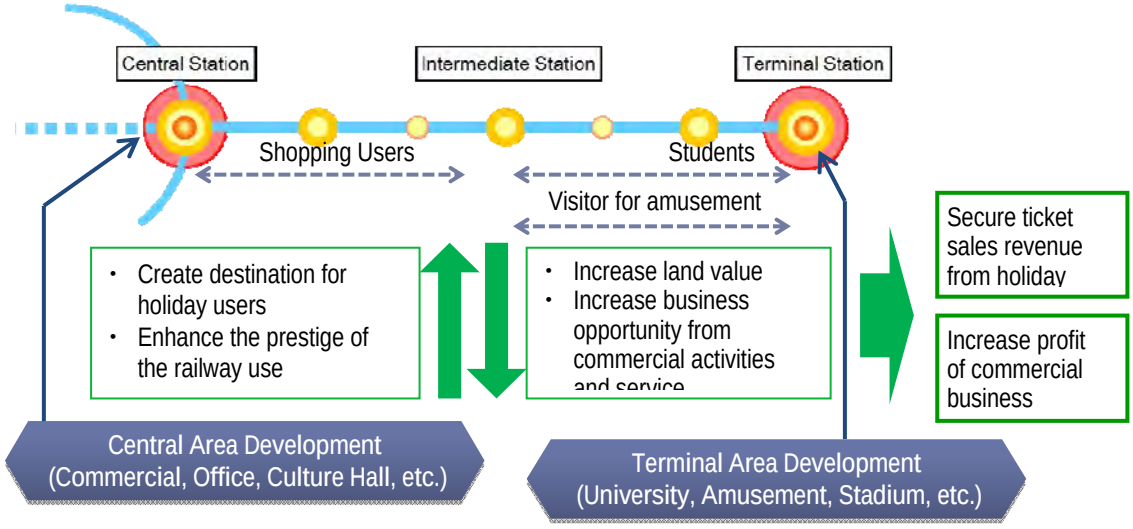


Source: JST

Figure 10.2.8 Business Model A: Integrated Urban Development based on TOD

2) Business Model B: Commercial and Business Area Development in Central Station and Terminal Station

Business model B aims at both securing revenue from holiday-use ticket sales and increased profit from commercial business such as tenant business, hotel and amusement. Development of commercial and office buildings, amusement and services create destination for holiday railway users, and enhances the prestige of the railway usage. These effects increase the number of holiday railway users and secure revenue from the ticket sales. Meanwhile, railway development increases land value and business opportunity from commercial activities and services in the station surroundings. The concept of business model B is shown in the Figure 10.2.9 below.

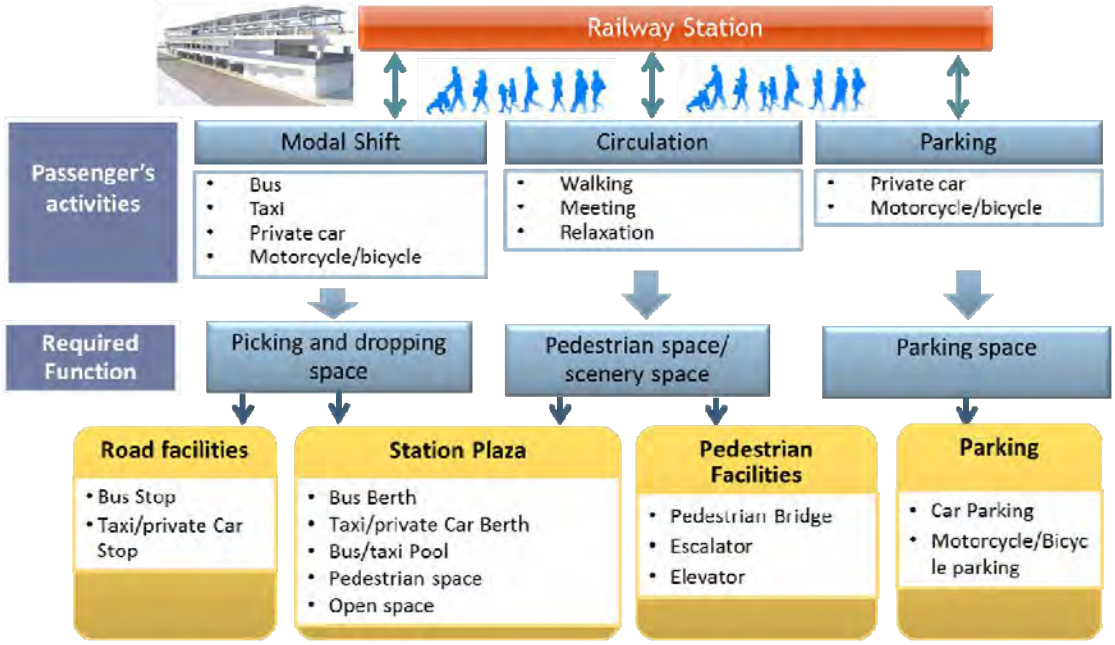


Source: JST

Figure 10.2.9 Business Model B: Integrated Urban Development based on TOD

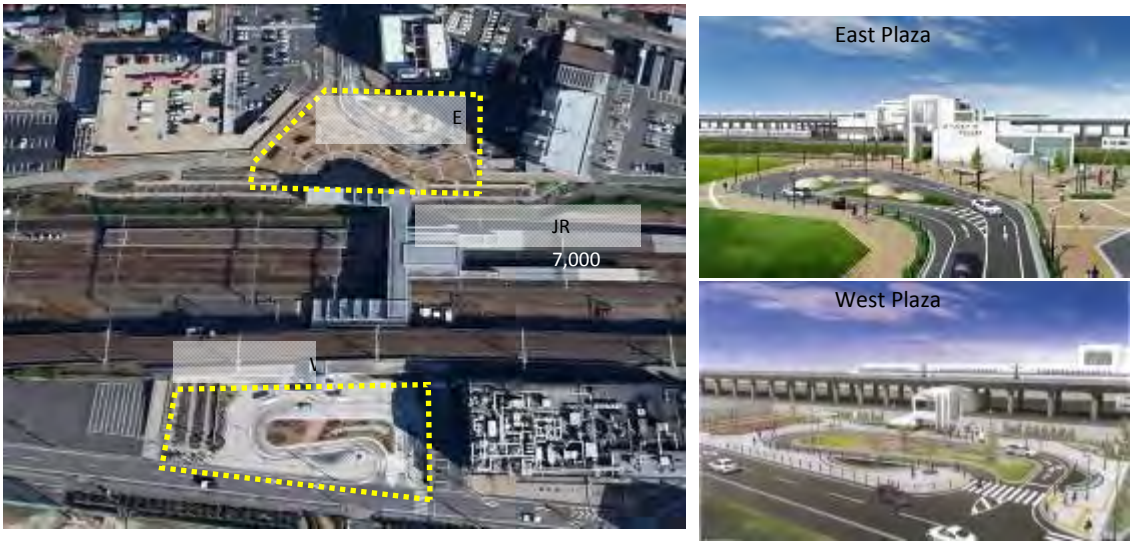
(2) Intermodal Facilities

Development of intermodal facilities such as station plaza and pedestrian facilities are required to secure safety and convenience and to attract people to public transport. Passengers have various objectives such as switching of transport modes and parking in the surroundings of a railway station. Major function of intermodal facilities and example of station plaza are shown in the Figure 10.2.10 and Figure 10.2.11 below.



Source: JST

Figure 10.2.10 Major Functions of Intermodal Facilities



Source: Kiyosu City

Figure 10.2.11 Examples of Station Plaza (JR Biwajima Station)

(3) Summary of Urban Management Measures for TOD

JST proposes to establish appropriate urban management measures to implement TOD by performing the following tasks:

- To secure land within the station surroundings for integrated urban development and intermodal facilities
- To legislate detailed land use plan, building plan and infrastructure plan to maximize the development potential within the station's surrounding areas
- To promote private investment in integrated urban development

- To establish proper coordination between railway development and urban development projects

JST proposes the concept of urban management measures for TOD as follows:

(1) Before implementing the integrated urban development within station surroundings, zoning plan system should be revised to control individual building activities and land transactions, and to secure the land for development. A fixed land price in the target area also can reduce the land acquisition cost for the railway development and integrated urban development. JST proposes revision of the zoning plan that designates urbanization promotion zone for the above objectives.

(2) Regulation of the detailed land use plan is important for integrated management of huge urbanization areas which will be developed in multiple urban development projects. An integrated policy and manner should guide the planning of land use, building and intermodal facility to maximize the effectiveness of TOD. JST proposes formulation of a detailed plan for development target areas.

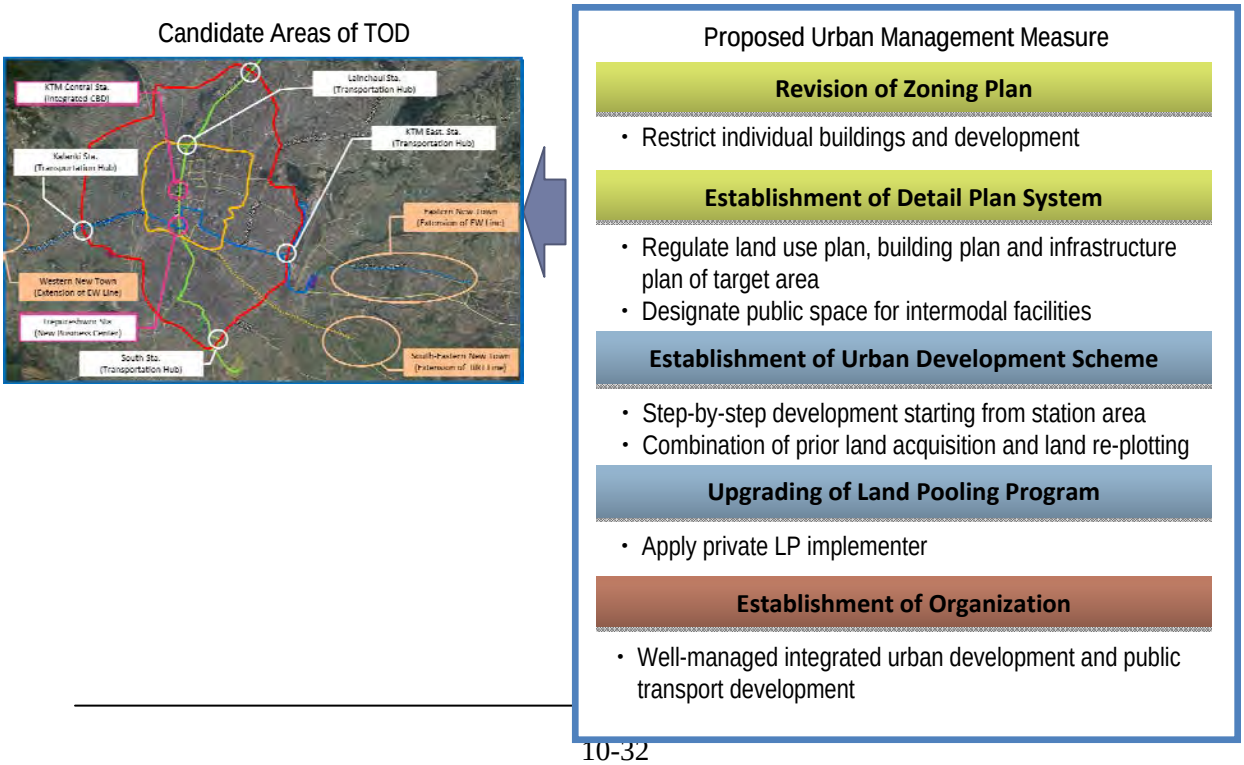
(3) There is always a risk in land investment such as failing agreement and losing money. Reduction of investor's risk is essential to promote private investment on land. If nothing is done before railway development, development potential within station surroundings will remain low and private sector will not be attracted to invest. Step-by step development is required to encourage private investors. In addition, a land re-plotting system of LP program is useful in reducing land acquisition cost. JST thus proposes the combination of land acquisition and land re-plotting.

(4) JST proposes establishment of a new organization and restructuring of the existing urban management system for coordination between railway development and urban development project.

The concept of proposed urban management measures for TOD is shown in the

Figure 10.2.12 Concept of Proposed Urban Management Measures for TOD

below.



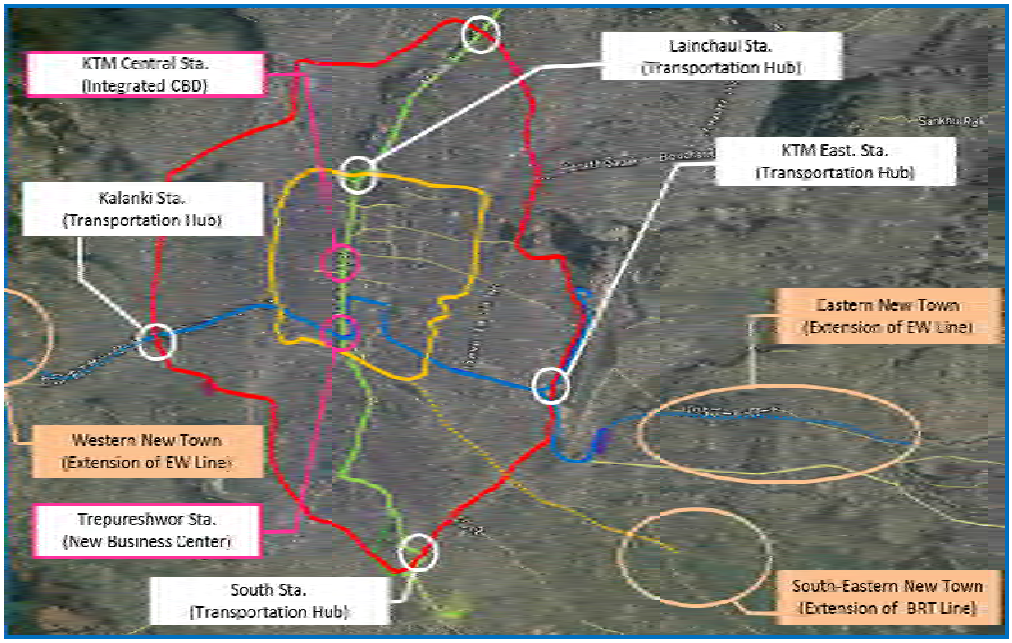
Source: JST

Figure 10.2.12 Concept of Proposed Urban Management Measures for TOD

10.2.4 Urban Management Measures for Integrated Urban Development

(1) Candidate Areas for Integrated Urban Development

In the proposed transport network plan, ten candidate areas of integrated urban development with AGT and BRT have been proposed as shown in the Figure 10.2.13. These candidate areas are categorized into two kinds of business models A and B of TOD in consideration of the location and the function as a transportation hub. Candidate areas of business model B are located in the existing urbanized areas and include development target areas such as vacant land, industrial area and public market.



Source: JST

Figure 10.2.13 Candidate Areas of Integrated Urban Development

Table 10.2.1 Categories of Candidate Areas for Business Model of TOD

Business Model	Name of Station/New Urban Area	Function	Public transport plan
Business Model A and B	Eastern new urban area	Sub-center of KV	Extension of AGT
	South-eastern new urban area	Sub-center of KV	Extension of BRT
	Western new urban area	Logistic and New Industrial Area	Extension of AGT
Business Model B	KTM Central station	Integrated CBD	AGT, BRT
	Trepureshwor station	New business center	AGT, BRT
	Lainchau station	Transportation hub	AGT, BRT
	KTM east station	Transportation hub	AGT, BRT
	Kalanki station	Transportation hub	AGT, BRT
	Narayan Gopal Chowk station	Transportation hub	AGT, BRT
	South station	Transportation hub	AGT, BRT

Source: JST

The following section explains the planning approach and urban development scheme for South Station Area with business model A, and for Eastern New Urban Area with business model A and B.

(2) Case of South Station Area (Business Model A)

This is an example of planning TOD in existing urban area. Business model A can be applied to development of south station area along with AGT line. The layout plan and land use plan have been formulated with the following two points:

- Designation of railway alignment and location for effective use of seed lots
- Land acquisition for ROW of railway and intermodal facilities

1) Current Situation

Two alignments for AGT NS line are proposed in consideration of current road network and connection with BRT line: candidate A and candidate B. There is a state-owned industrial park founded in the 1970s which is comprised of handicraft workshops. This park can be altered to seed lots to implement TOD since the location has a potential for development.

Source: JST

Figure 10.2.14 Current Condition in South Station Area

2) Comparison of Railway Alignment Candidates

The railway alignments have been comparatively evaluated in terms of development effectiveness of TOD and the possibility of land acquisition for ROW of railway and intermodal facilities. JST recommends candidate B as AGT NS line.

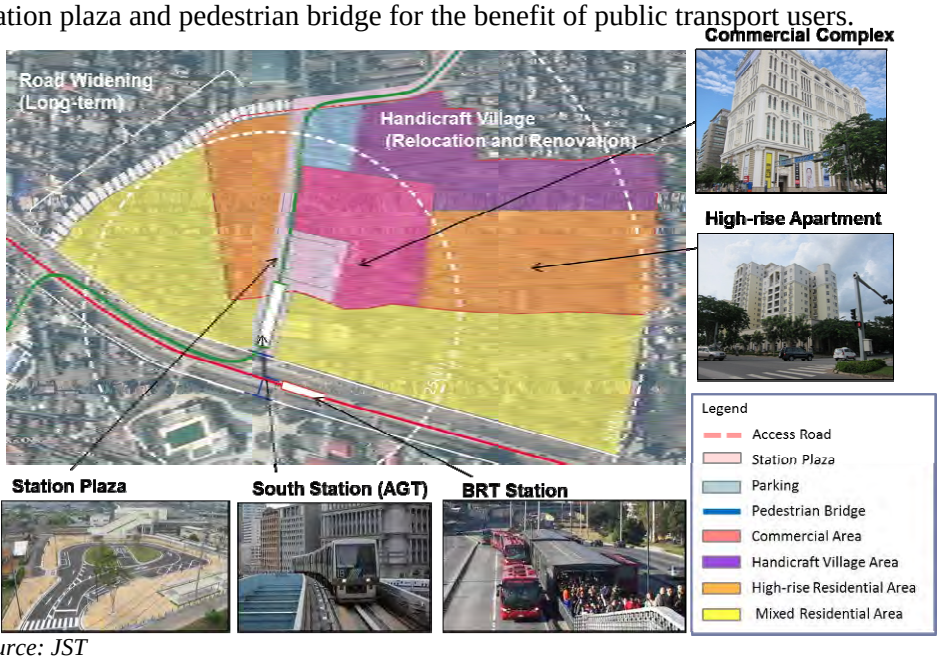
	Layout Plan of Railway line and Station
Candidate A • Needs road widening for railway development • Difficult to acquire land for railway and station plaza in short-term • Target area cannot be covered by walk distance	
Candidate B • Easier to acquire land for railway and station plaza in short-term • Target area can be covered by walk distance	

Source: JST

Figure 10.2.15 Comparison of Layout Plan in South Station Area

3) Draft Land Use Plan

Figure 10.2.16 shows the draft land use plan of south station area. JST proposes development of commercial complex and high-rise apartments in seed lots which is currently the industrial park. The existing handicraft workshops can be renovated and relocated to a new handicraft village which will be a new tourist destination. Development in front of the station is also necessary such as station plaza and pedestrian bridge for the benefit of public transport users.



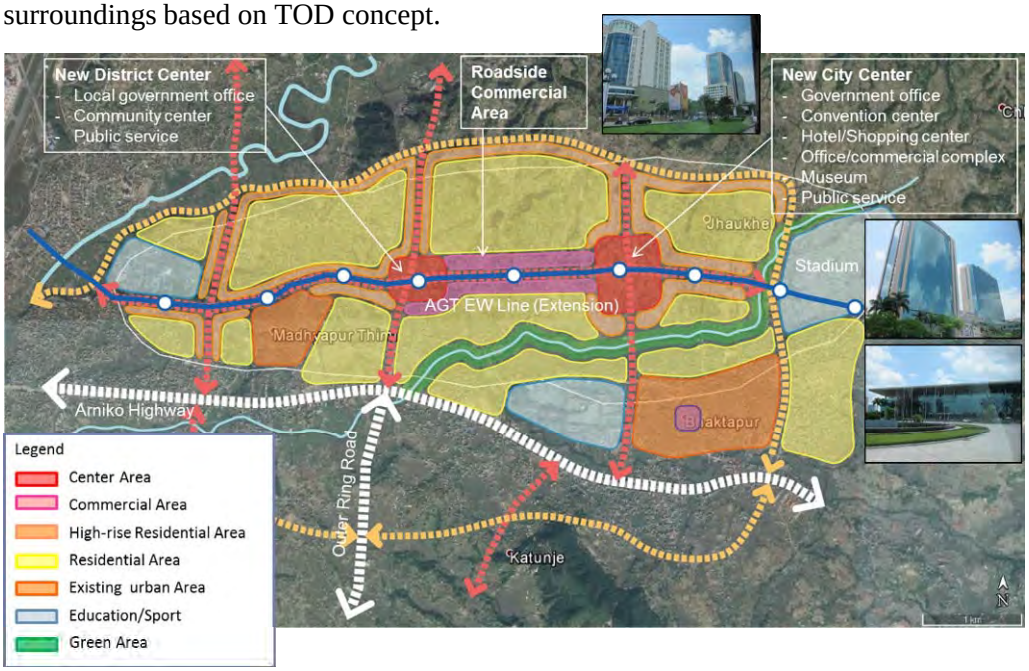
Source: JST

Figure 10.2.16 Draft Land Use Plan of South Station Area

(3) Case of Eastern New Urban Area (Business Model A and B)

1) Draft Land Use Plan

Figure 10.2.17 shows the draft land use plan in eastern new urban area. Profitable land use such as center area, commercial area and high density residential area is laid out along AGT line and station surroundings based on TOD concept.



Source: JST

Figure 10.2.17 Draft Land Use Plan of Eastern New Urban Area

2) Development Scheme

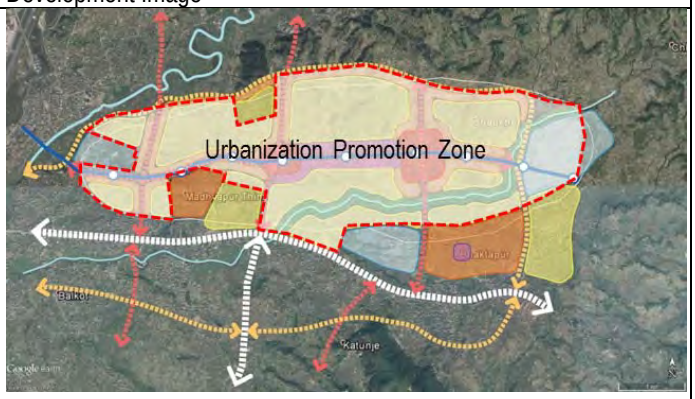
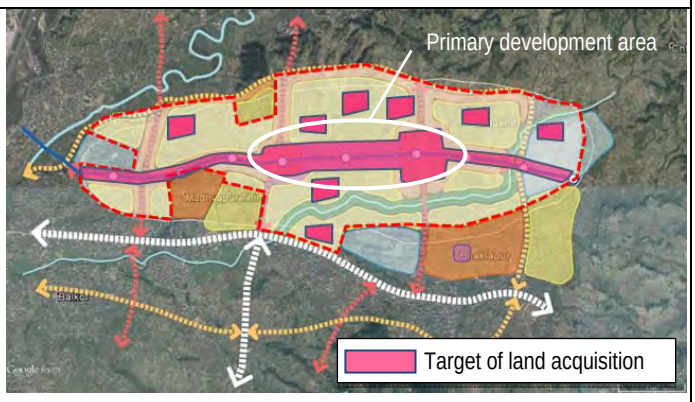
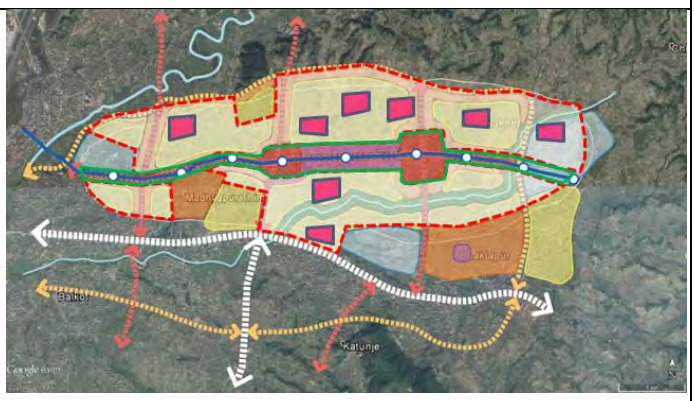
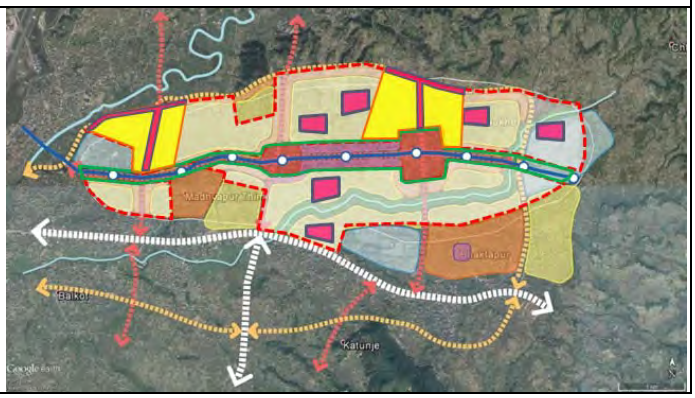
JST proposes a development scheme for the eastern new urban area. This scheme consists of 4 steps: i) Formulation of zoning plan, ii) Prior land acquisition and designation of detailed plan, iii) Integrated urban development of AGT and station surroundings, iv) Private land pooling project.

i) Formulation of zoning plan aims at restriction of private building activities and land transactions in consideration of reduction of compensation cost in upcoming urban development projects.

ii) Prior land acquisition means acquisition of high potential lands for integrated urban development of AGT and station surroundings, and detailed plan is required to guide adequate land use for TOD.

iii) Integrated urban development of AGT and station surroundings means development of AGT, intermodal facilities and station area.

iv) Private land pooling project will be utilized to increase development potential within station surroundings.

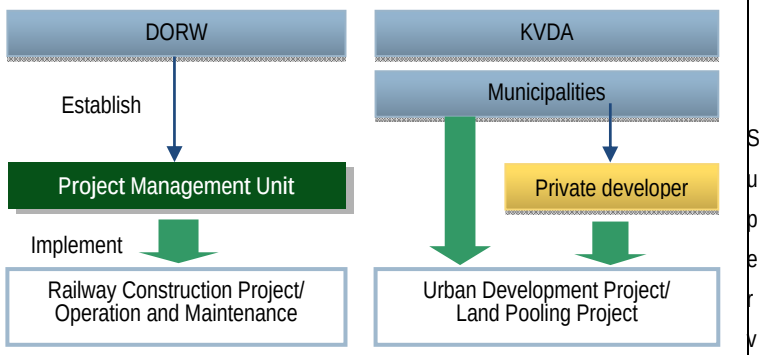
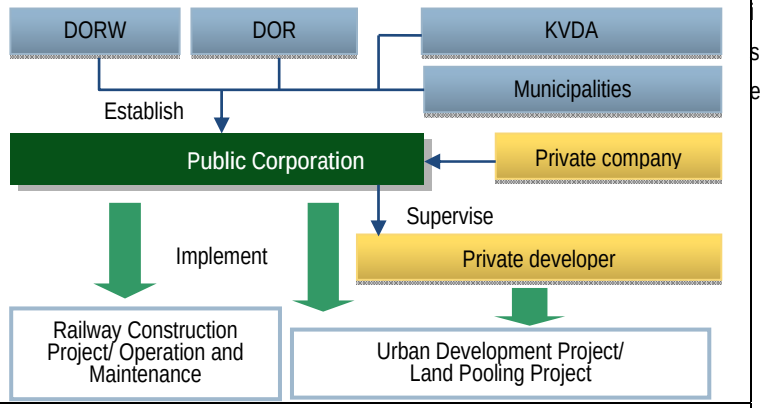
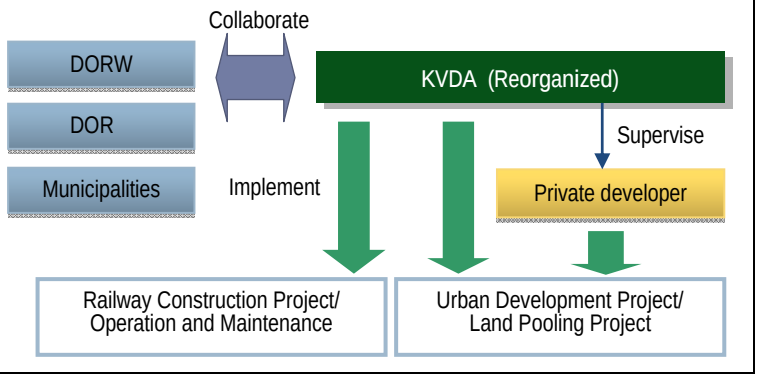
Development Phase	Development Image
Step 1: Formulate Zoning Plan • Designate urbanization promotion zone to restrict private buildings and developments, and fix the land price	
Step 2: Land Acquisition and Detail Plan • Acquire lands for ROW of AGT, primary development area and the surroundings (No need to acquire existing lands that will join LP project) • Formulate Detail Plan for primary development areas with center areas along AGT	
Step 3: Develop AGT and Center Area • Develop AGT and station plaza by donor fund • Implement private LP project for primary development area with participation of existing land owners	
Step 4: Private LP projects • After increased development demand, start urban development in surrounding area by private LP project in a step-by step manner • Re-plot acquired land into ROW of arterial roads and public services	

Source: JST

Figure 10.2.18 Proposed Development Measures for Eastern New Urban Area

(4) Establishment of Organization to Implement TOD

Establishment of new organization is essential for the implementation of TOD. JST recommends Options B and C for integrated management of AGT development and urban development. Comparison of organizational scheme for implementation of TOD is shown in the Figure 10.2.19 below.

Type of organization/advantage	Organization Scheme
Option A: Separated Organization (Normal case) Advantage: ・Follow current role of each organization Disadvantage: ・Difficult financial cooperation between railway project and urban development project ・Need clear role sharing in integrated urban development	
Option B: Public Corporation Advantage: ・Possible to integrate management of railway project and urban development Disadvantage: ・Need institutionalization for public corporation ・Need legal arrangement to invest in a public corporation	
Option C: Reorganization of KVDA Advantage: ・Possible to integrate management of railway project and urban development Disadvantage: ・Need legal arrangement for allocation of work operations of KVDA	

Source: JST

Figure 10.2.19 Proposed Organization for Implementation of TOD

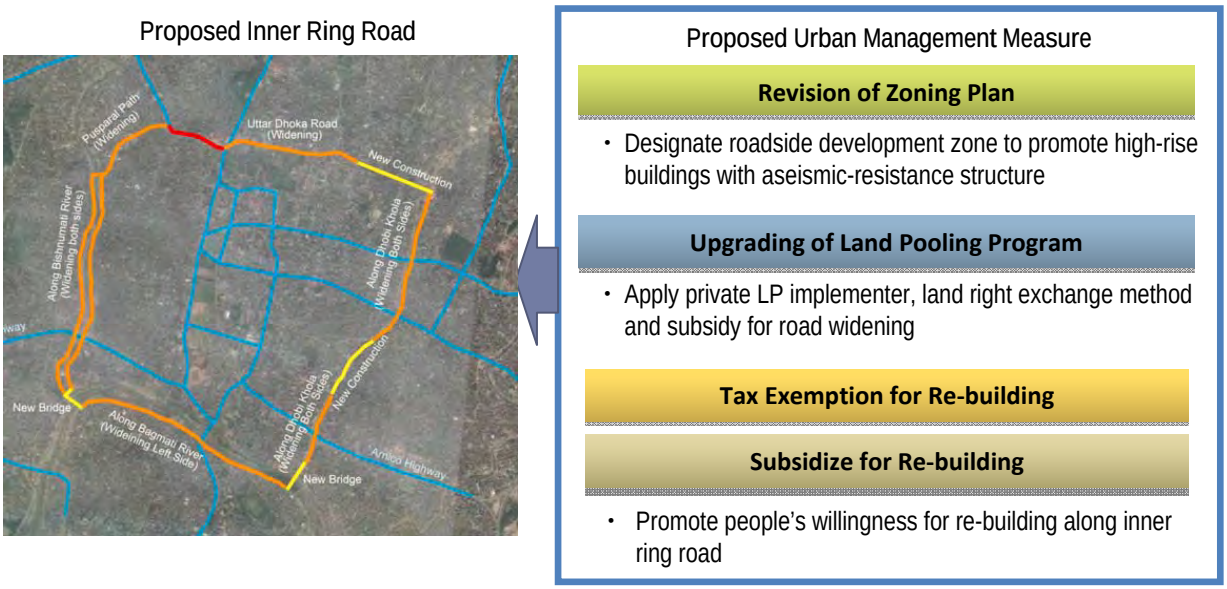
10.2.5 Urban Management Measures for Road Network Development

(1) Inner Ring Road Development

The following tasks are required to realize the proposed Inner Ring Road as BRT line together with appropriate urban management:

- Secure land for road widening
- Promote roadside land use based on the concept of TOD for BRT

Road widening has been proposed in some parts of the Inner Ring Road. However, there are many buildings along the proposed roads. The land acquisition is quite difficult in terms of the negotiation and the compensation cost. In addition, BRT line has been proposed on inner ring road. For securing financial feasibility for BRT operation, road side land use should be promoted based on the concept of TOD. As an urban development tool for promotion, integrated road development using land pooling program is effective. For application of the integrated road development, land pooling program requires some upgrade such as use of private implementer and land right exchange method converting with real estate value. Tax exemption and subsidy program for remodeling is also effective to attract people to land utilization.



Source: JST

Figure 10.2.20 Proposed Urban Management Measure for Inner Ring Road Development

(2) Emergency Road Network Development

For the implementation of development of the proposed emergency road network plan, it is necessary to establish appropriate urban management measures performing the following tasks:

- Control building height and structure along the proposed emergency roads
- Secure land for road widening
- Promote people's willingness for seismic retrofit

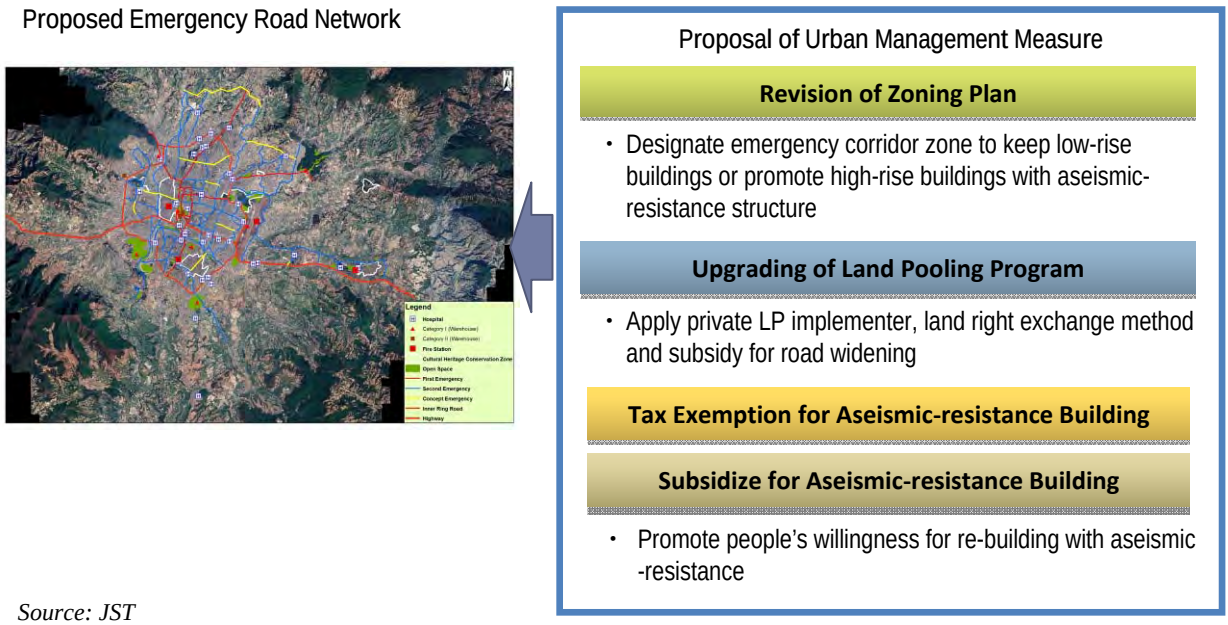
JST proposes three types of emergency roads, namely i) primary emergency road, ii) secondary emergency road and iii) new emergency road in emergency road network plan.

Primary and secondary emergency roads have enough width for evacuation and emergency activities and do not require road widening. For keeping the current emergency function, height and structure of buildings along the emergency roads should be controlled under the zoning plan. JST proposes orientation of the building control as follows:

- Conserve the existing low-rise buildings with vulnerable structure such as bricks
- Approve high-rise buildings with a seismic structure

The new emergency road requires road widening. However, there are many buildings along the proposed emergency road. The land acquisition is quite difficult in terms of the negotiation and the compensation cost same as land acquisition for inner ring road. JST proposes integrated urban

development using land pooling program for land acquisition. Tax exemption and subsidy program for seismic retrofit are also effective for promotion of people's willingness to undertake remodeling.



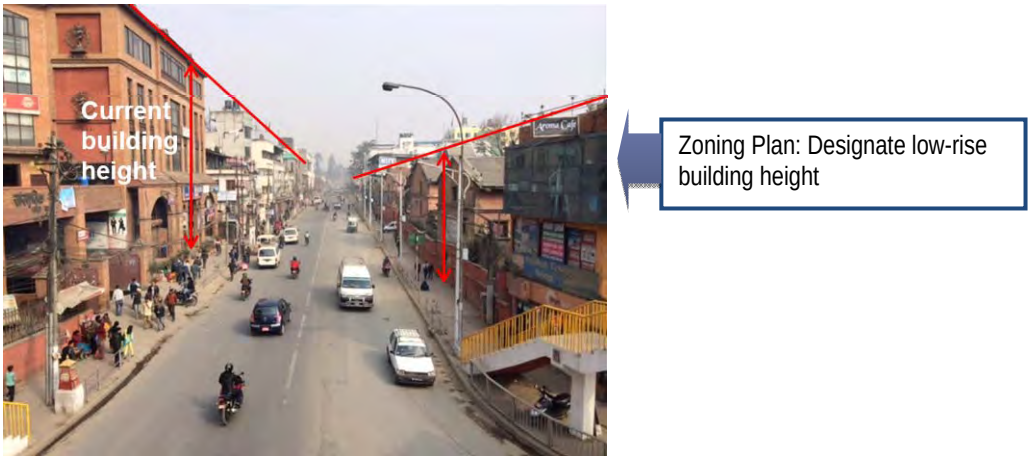
Source: JST

Figure 10.2.21 Concept of Proposed Urban Management Measure for Emergency Road Network Development

(3) Control of Building Height and Structure by Zoning Plan

1) Control of Building Height (without Road Widening)

Zoning plan is one of the measures to control building height along the proposed emergency road. However, this is a provisional approach which only maintains the current building situation and does not improve disaster resilience and urban density along the proposed emergency road.



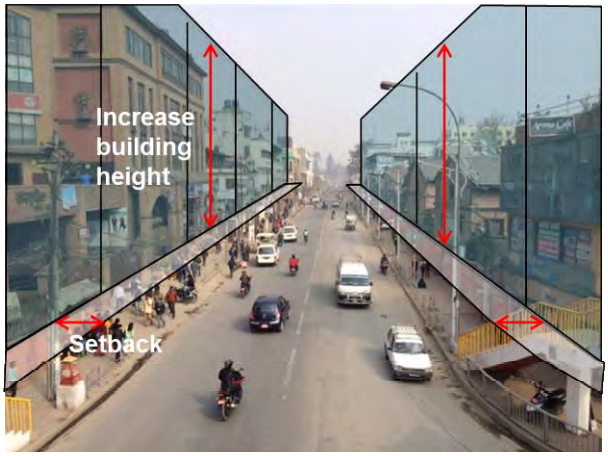
Source: JST

Figure 10.2.22 Control Building Height (without Road Widening)

2) Seismic Retrofit (without Road Widening)

This measure is to approve construction of high-rise buildings along the proposed emergency road under the design conditions designated by zoning plan. For application of this measure, revision of zoning plan is required to designate emergency corridor zone with a special permission for high-rise aseismic buildings and setback line. Subsidies and tax exemption for seismic retrofit can also

be utilized. This measure improves urban density along the proposed emergency road as well as disaster resilience.



- Zoning Plan: Designate emergency corridor zone with special permission for high-rise building with aseismic-resistance structure and setback line
- Taxation: Tax exemption on property tax and house tax during specified period
- Financing: Subsidize buildings with aseismic-resistance structure

Source: JST

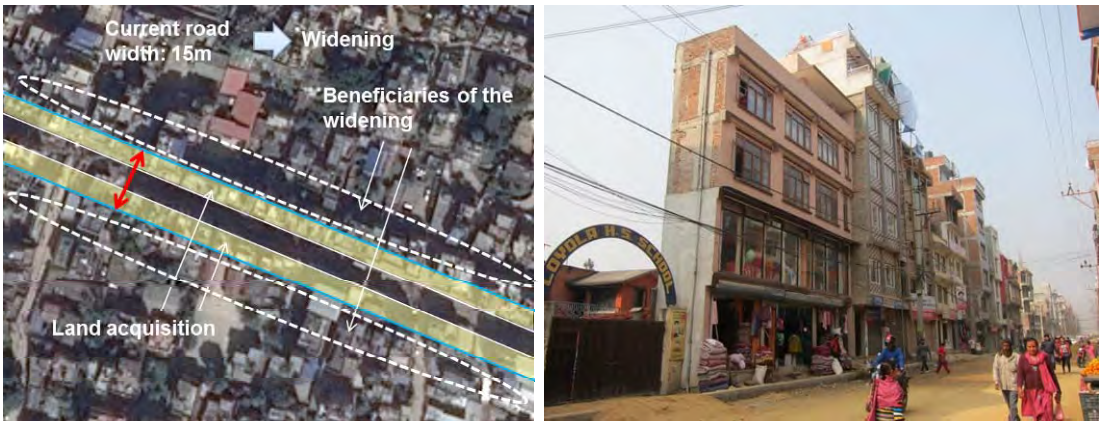
Figure 10.2.23 Rebuilding with Aseismic-resistance Structure (without Road Widening)

(4) Integrated Road Development with Land Pooling

1) Current Issues in Road Widening

Most of road widening in KV has currently been implemented with guided land development (GLD). Although GLD is useful in terms of reduction of land acquisition cost, GLD for road widening in urbanized area will cause the following issues:

- High compensation cost for existing buildings
- Less available land in the neighborhood for resettlement
- Only land owners located right behind the road can earn the economic benefit from the widening.
- Incommodious buildings due to the cutting



Source: JST

Figure 10.2.24 Current Measure of Road Widening and Incommodious building by the Cutting

2) Scheme of Integrated Road Development with Land Pooling

JST proposes integrated road development using land pooling program to develop the proposed new emergency road network. The key points of the proposal are as follows:

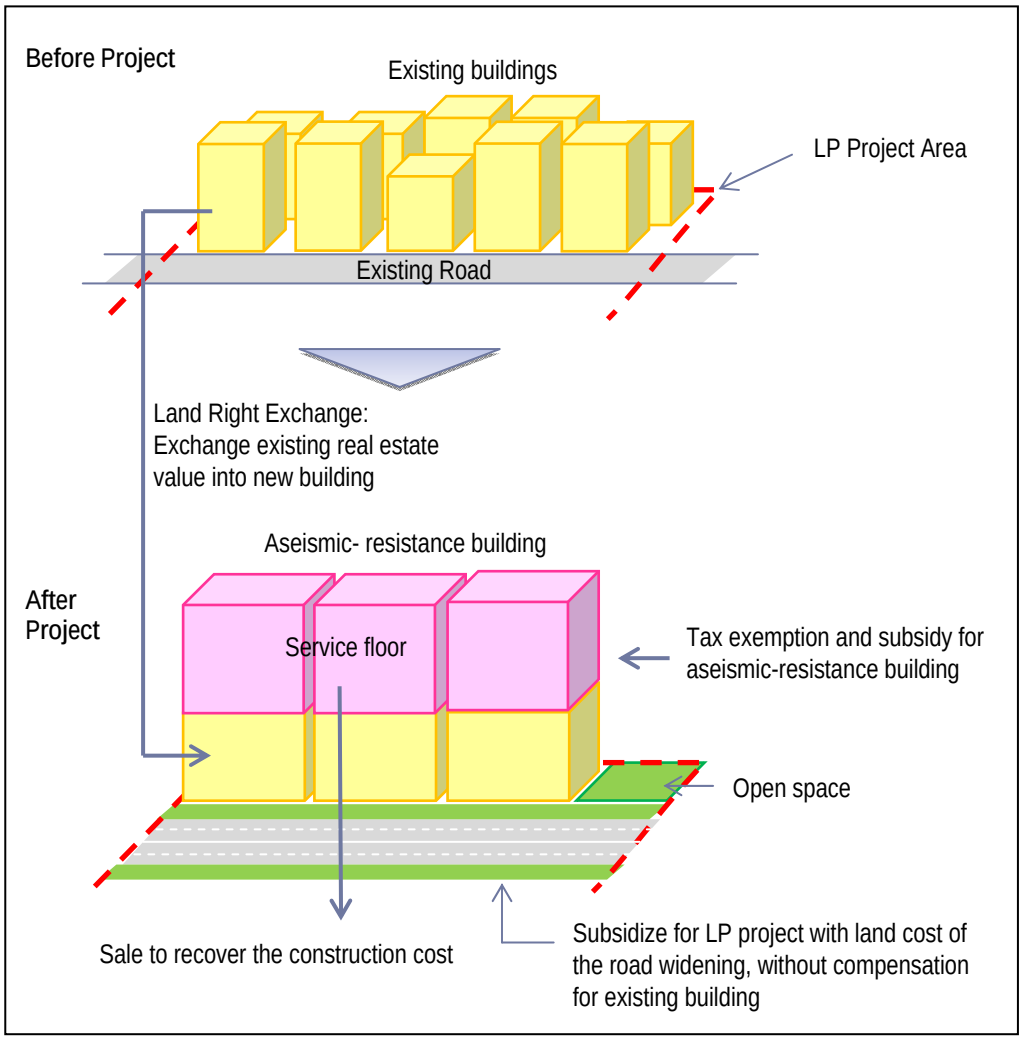
- Zoning Plan: Designate emergency corridor zone with a special permission for high-rise aseismic buildings and setback line

- Updating of LP program: Apply land right exchange system and use a private LP implementer
- Taxation: Tax exemption on property tax and house tax during specified period
- Financing: Subsidy for seismic retrofit and land cost for road widening

Development Phase	Development Image
Step1: Designate Emergency Corridor Zone on Zoning Plan • Allow high-rise buildings with aseismic-resistance • Designate high FAR (floor area ratio) and building height • Designate setback line	
Step2: Establish LP project • Designate LP project boundary Involving surrounding land owners who will be the beneficiaries of the widening • Select private LP implementer	
Step3: Implement LP project with land right exchange • Local government constructs widening road at the same time of LP project.	

Source: JST

Figure 10.2.25 Development Phasing of Integrated Road Development using Land Pooling



Source: JST

Figure 10.2.26 Project Scheme of Integrated Road Development using Land Pooling with Land Right Exchange

10.2.6 Summary of Proposed Urban Management Measures

Table 10.2.2 shows the summary of proposed urban management measures.

Table 10.2.2 Summary of Proposed Urban Management Measures

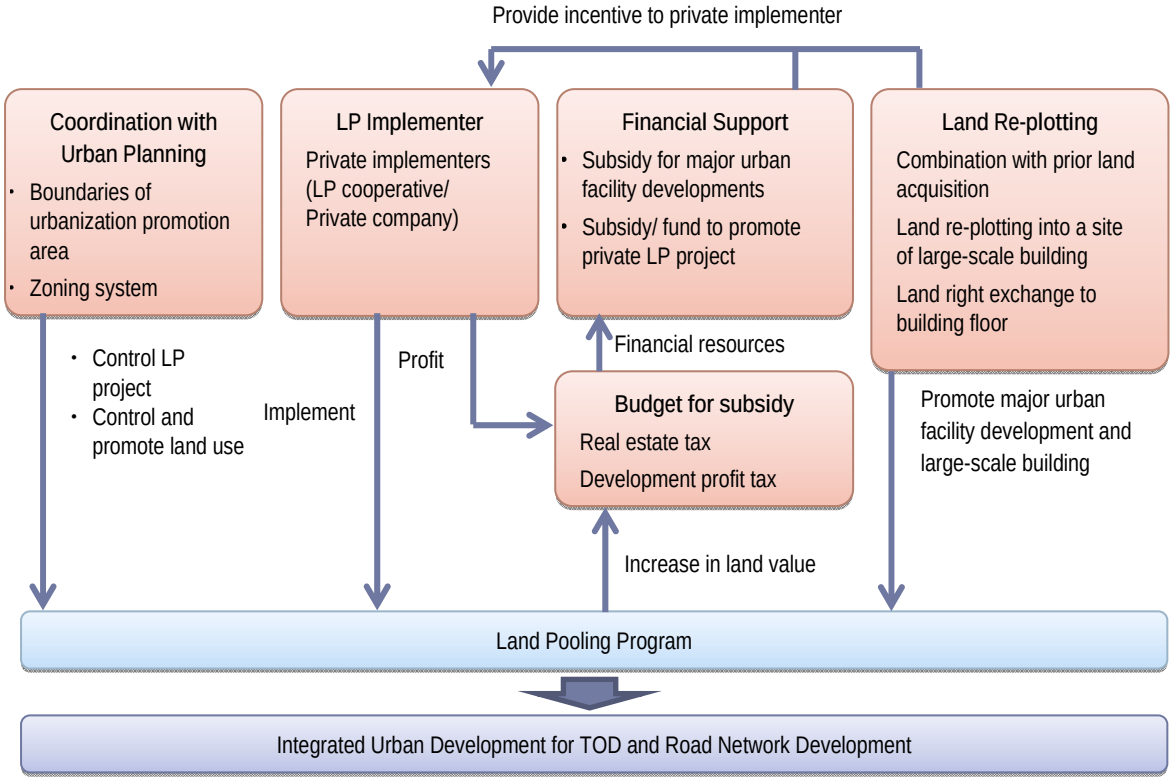
Proposed Plan	Task on the Implementation	Proposed Urban Management Measure
Urban Structure Plan including New Urban Area	・Promote building activity and urban land used in urbanization promotion areas ・Restrict building and land use changing in agricultural area to be conserved ・Control people's willingness to invest in buildings and land transactions	Urban Management Measures for Land Use Control ・Revision of Zoning Plan ・Revision of Taxation on Real Estate ・Establishment of Support Program for Agricultural Activity
Public Transport Network Plan including NMT	・Regulate detail land use plan, building plan and infrastructure plan to maximize the development potential in station surrounding area ・Secure land in the surrounding of stations for integrated urban development and intermodal facilities ・Promote private investment for integrated urban development ・Proper coordination between railway development and urban development project	Urban Management Measure for TOD ・Revision of Zoning Plan ・Establishment of Detail Plan System ・Establishment of Integrated Urban Development Scheme ・Upgrading of Land Pooling Program ・Establishment of Organization
Road Network Plan (Inner ring road) Emergency Road Network Plan	・Control building height and structure ・Secure public space for road widening ・Promote integration of land use for large-scale building ・Promote people's willingness for re-building with aseismic-resistance	Urban Management Measure for Integrated Road development ・Revision of Zoning Plan ・Upgrading of Land Pooling Program ・Revision of Taxation on Real Estate ・Establishment of Subsidy for Aseismic-resistance Building

Source: JST

10.2.7 Upgrade of LP Program

(1) Concept

LP program plays the main role in the proposed urban management measures. Keys for upgrading LP program are summarized in the Figure 10.2.27 below. In the updating, role of the private LP implementer is the most important from the viewpoint of development of huge urbanized area. Other keys are concerned with urban planning, financial support, subsidy budget and land re-plotting function to control and promote private LP projects.



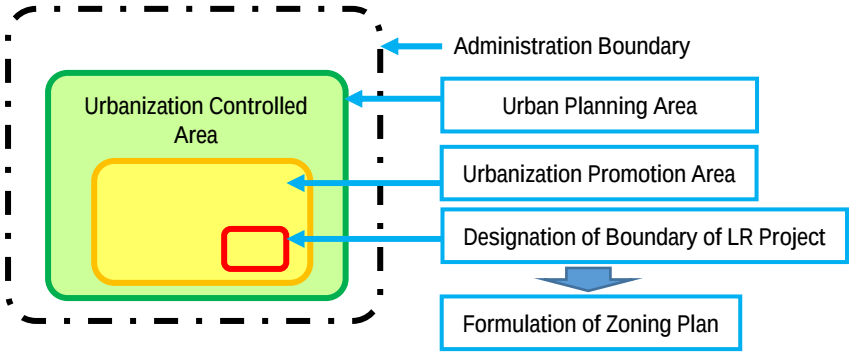
Source: JST

Figure 10.2.27 Keys for Upgrading LP Program

(2) Coordination with Urban Planning

1) Boundaries of Urbanization Promotion Area and Zoning System

In Japan, two types of legal boundary that is i) urban planning area and ii) urbanization promotion area are designated in urban plan to control urbanization under urban management policy. Outside of urbanization promotion area within urban planning area is defined as urbanization controlled area where any urban development and building activities are restricted. Land readjustment project can be basically implemented within the urbanization promotion area. The boundary of LR project must be designated in the urban plan by the local government in advance of the project approval. In addition, zoning plan for LR project area must be formulated by the local government before approval of the land re-plotting plan to control land use. Through these processes, LR project is officially coordinated with urban planning under the urban management policy.



Source: JST

Figure 10.2.28 Coordination System with Urban Planning and LP Project in Japan

2) Detailed Planning prior to LP Project

In Colombia, where LR program has been already adopted, local government must formulate detailed plan (called Partial Plan in Colombia) based on the city master plan in advance of the project approval. The Partial Plan designates land use and figures of buildings to increase the development potential of the LR project.

(3) LP Implementer

In other countries, private sector such as landowners' organization and private companies are given the authority to implement LR project under the legal system.

Table 10.2.3 Implementer of Land Pooling and Land Readjustment Project

Countries		Nepal	Japan	Thailand	Mongolia	Colombia
Year of establishment of LP/LR		1988	1919	2004	2013	1997
Public Sector		• KVDA • Municipality • Town Development Committee	• Local government • Central government • Government corporations	• National and local authority • Government agency • Other government agency	• Prefecture governor/ city mayor (as special case)	-
Private Sector	Land owners' organization	-	• Individual • LR cooperatives	• LR association	-	-
	Land owners' organization with private company	-	• LR cooperatives with the outsourcing agent • LR company	-	-	-
	Private company	-	-	-	• Private company	• Private company

Source: JST

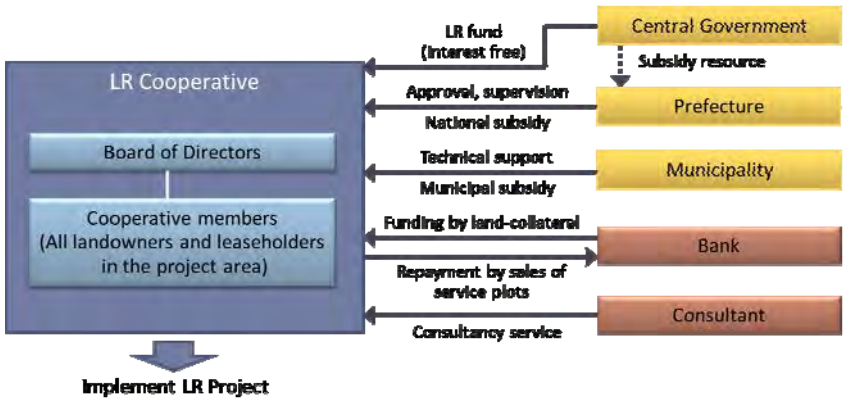
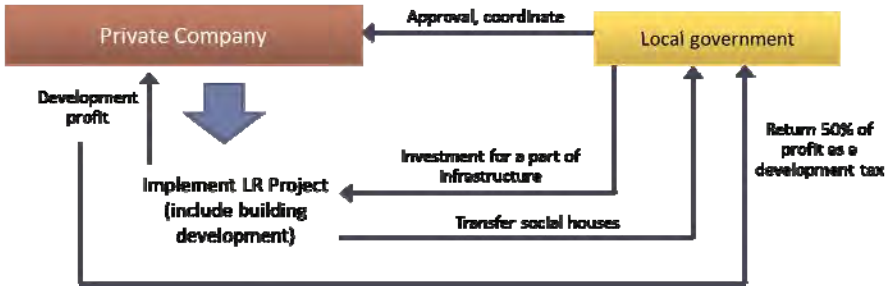
1) LR Cooperatives

In Japan, LR cooperatives organized by the landowners and leaseholders in the project area are one of the major LR implementers, and have implemented approximately 5,800 LR projects with the total project area of approximately 120,000 ha. LR cooperatives have a legal power to implement the LR project under the LR Law. LR cooperatives can be given technical and financial support from municipality and national government.

2) Private Company

In Mongolia and Colombia, private company is the major implementer of LR project. Colombian and Mongolian LR projects develop lands and infrastructure as well as buildings to convert from land right to building floor right. Private company can directly receive development profit from building activities in LR project. In the case of Colombia, private company has responsibilities to develop social houses and return 50% of development profit to local government while making profit from LR project.

Table 10.2.4 Scheme of Private LP Implementer in Japan and Colombia

Type	Concept
LR Cooperatives in Japan	
Private Company in Colombia	

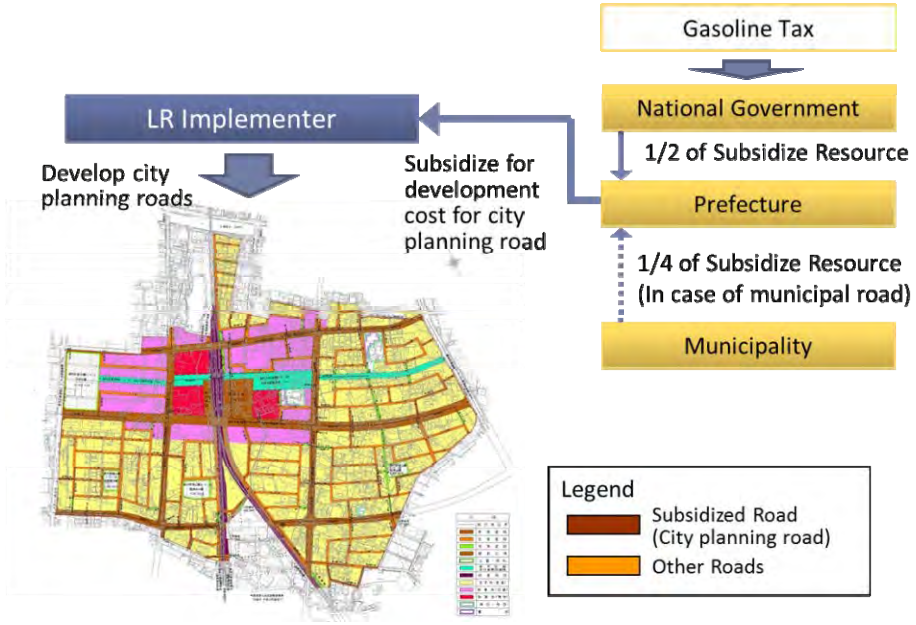
Source: JST

(4) Financial Support

Two methods using LR program in Japan are explained as an example of LP program for development of major urban facilities as follows:

1) Subsidy for Development of City Planning Road in LR Project

In Japan, LR project can be subsidized for the development of city planning roads, which are designated in the LR project site. The amount of the subsidy consists of land acquisition cost, construction cost and compensation for existing buildings and structures. Although the land for city planning roads must be created through land contribution from the private land owners, subsidy for the land acquisition cost can be used for other purposes in the LR project. Thus the area of service plots necessary for the project implementation can be reduced. As a result, land contribution for the city planning roads does not affect total area of the land contribution in the project. This subsidy scheme has been formulated to develop urban road network and to promote implementation of the LR project in Japan.

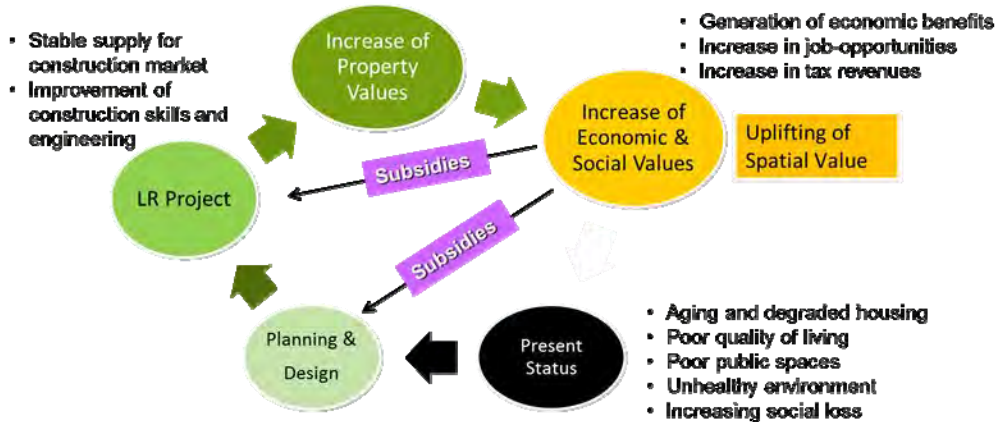


Source: JST

Figure 10.2.29 National Subsidy for City Planning Road for LR Project in Japan

2) Subsidy for Private LP Project

In Japan, many municipalities have the subsidy program to promote LR projects implemented by LR cooperatives. The subsidy program aims at 'Cycling Mechanism of Economic Benefits from LR Project', and the budget is created from the local taxation. The targets of the subsidy are mostly preparation costs to approval, a part of construction costs of urban infrastructure and administration cost.



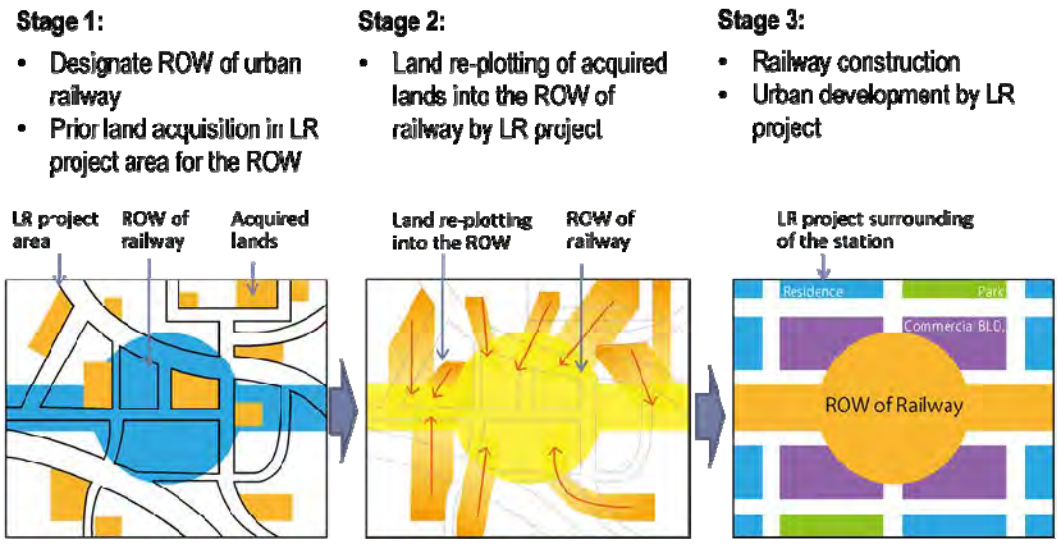
Source: JST

Figure 10.2.30 Concept of Cycling Mechanism of Economic Benefit from and to LP Project

(5) Land Re-plotting

1) Combination with Prior Land Acquisition and Land Re-plotting

Combination with prior land acquisition and LR project is one of the integrated urban development methods using LR program which had been applied for development of Tsukuba Express of urban railway in Japan. This method was established based on the concept of TOD. Tsukuba Express has a total length of 58km and 22 stations. A part of the right of way and 15 station areas were developed using this method. The main steps are shown in the Figure 10.2.31 below.



Source: JST

Figure 10.2.31 Combination with Prior Land Acquisition and Land Re-plotting

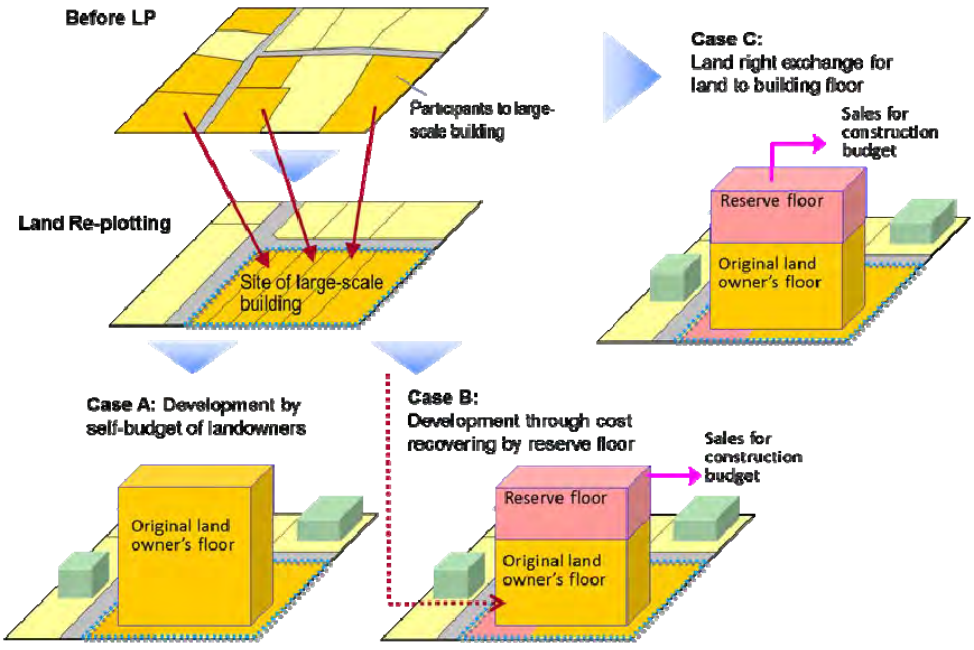
2) Land Re-plotting for Large-scale Building

a) Land Re-plotting into a Site for Large-scale Building (Case A and B)

Lands where the owners participate in large-scale building development are re-plotted into the building site. The figure of each re-plotted land parcel must be narrow to restrict individual buildings. After the re-plotting, the landowners group develops a large-scale building. Regarding the funding, there are two cases: i) self-budget of landowners (Case A) and ii) cost recovery by reserve floor (Case B). Some floors are reserved for sale to recover the construction cost and the remaining floors are for the original land owners.

b) Land Right Exchange from Land to Building Floor (Case C)

Lands where the owners participate in large-scale building development are directly converted to the building floor without land re-plotting process. Regarding the funding, it is same as Case B.



Source: JST

Figure 10.2.32 Land Re-plotting for Large-scale Building

10.2.8 Proposal of Programs and Projects for Urban Management Measures

The related agencies need to take action for further study, amendment of legal framework and formulation of plans and programs after approval of proposed master plan to implement the proposed urban management measures. The following table is a proposal for programs and projects as a next step.

Table 10.2.5 Proposed Programs and Projects for Establishment of Urban Management Measures

Category	Proposed Urban Management Measure	Action	Related Agency	Technical Assistance
Urban Planning	Revise Zoning Plan and the Code	• Revise Zoning Plan and the Code • Strengthen permission procedure	MOUD, **DUDBC, KVDA**, Municipalities	Urban planning system and capacity upgrading project
	Establish Detail Planning System	• Amendment of legal system • Formulate detail plans for urban development area		
Urban Development/ LP	Integrated urban development plan with public transport	• Feasibility study for public transport and urban development • Organize integrated development	**DORW,** DOR, **KVDA,** Municipalities	Feasibility study for integrated urban development
	Upgrading of LP program	• Amendment of legal system • Revise LP manual • Establish subsidy system	MOUD, **KVDA, Municipalities**	Urban development system and capacity upgrading project
Taxation	Revision of taxation on real estate	• Amendment of legal system • Revision of tax rate on real estate • Establish new taxation • Tax exemption for aseismic-resistance building	**MOLR**, **Municipalities**	Taxation system improvement project
Financing	Financial support for aseismic-resistance building	• Formulate guidelines • Establish subsidy for aseismic-resistance building	MOUD, DUDBC, **Municipalities**	Aseismic-resistance strengthening project
Agricultural support	Establishment of support system for agricultural activities	• Establish R&D and training center • Establish training program • Establish micro finance program	**Ministry of Agricultural Development**	Capability improvement project for agriculture in urban area

Source: JST

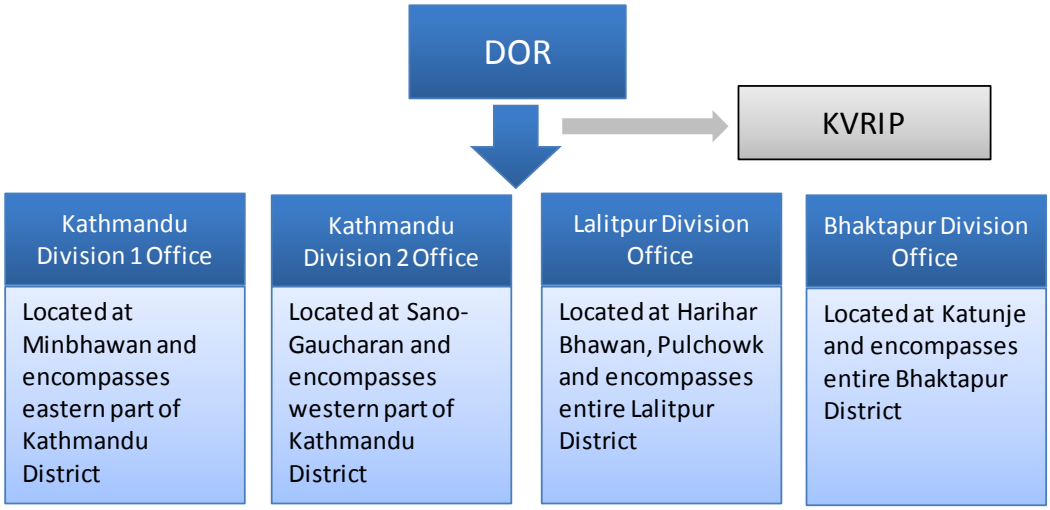
CHAPTER 11 FINANCIAL AND ECONOMIC ANALYSIS

11.1 Cost Estimates

11.1.1 Recent Road Work History and Planning

Under DOR, there is a separate project "Kathmandu Valley Road Improvement Project (KVRIP)" which covers certain portions throughout the valley. The important strategic road networks (SRN) in Kathmandu valley has been frequently suffering traffic congestion. The rapidly growing traffic volume is ultimately beyond the capacity of the two lane roads in Kathmandu valley. Government of Nepal has been allotting a fund in budget to widen such an important SRN from two lanes to four or more lanes. The project KVRIP started in September 2007 to work extensively in these SRN.

There are on-going road improvement projects throughout the valley and the projects are allocated to KVRIP and four division offices under DOR as an implementing agency. KVRIP covers road improvement works such as road widening and providing pedestrian footpath along roads. Road division offices carry out new road/bridge construction works as well as road improvement works.



Source: JICA Study Team

Figure 11.1.1 Relationship of DOR, KVRIP and Division Road Offices

11.1.2 Target Projects

Target projects for cost estimates are selected and defined in short, mid and long-term plans of the M/P. The projects are summarized as follows:

(1) Road Works

- Circular Roads
  - New construction of Outer Ring Road
  - New construction of Inner Ring Road
- Radial Roads
- Transversal Roads
- Urban Roads
- NMT Projects

(2) Public Transportation Works

- AGT lines
  - Line-1, North-South route
  - Line-2, East-West route
- BRT lines

  - Line-3-4, Ring Road
  - Line-5-9, Inner Ring Road and radial direction
- Transport Terminals
  - Central Station (Tundikhel)
  - East Station (Tinkune)
  - West Station (Kalanki)
  - South Station (Satdobato)

(3) Non Target Projects

According to DOR, several road improvement projects are going to be implemented under DOR initiative in years to come. Such projects have been preceded and the budget is allocated to some of them. On-going projects thus are excluded from the cost estimates for the M/P.

The list below shows the projects which are important to comprise the proposed transportation network but are deducted from cost estimates of the M/P for the above reason.

- Widening and improvement of Ring Road (South as well as North half)
- Improvement of Kalanki – Nagdhunga Road and construction of tunnel
- Construction of Kathmandu – Hetauda Fast Track Project
- Widening of Tripureshwor – Kalanki Road
- Other widening projects on KVRIP

11.1.3 Conditions of Cost Estimates

(1) Estimate Level

Cost estimate level is decided in consideration of its study stage. At M/P stage, establishment of basic framework of the projects is focused as a project purpose. Therefore cost estimate is based on rough method but partially full cost estimate is applied to some items if necessary.

(2) Funding Scheme for Implementation

JST assumes the fund for implementation, either the government own fund or foreign aids, will be prepared for each project.

(3) Base Year Used in Estimating Cost

Future expenses are estimated from the cost in point of 2015 as base year.

(4) Exchange Rate

Exchange rate for cost estimates is an average of three months from January to March, 2015 as per Nepal Rastra Bank.

- 0.836 NRs per 1.00 JPY
- 99.64 NRs per 1.00 USD

(5) Implementation Cost Components

Before completion of construction works, the cost items shown in Table 11.1.1 are needed and they are referred to as implementation cost.

Table 11.1.1 Implementation Cost Components

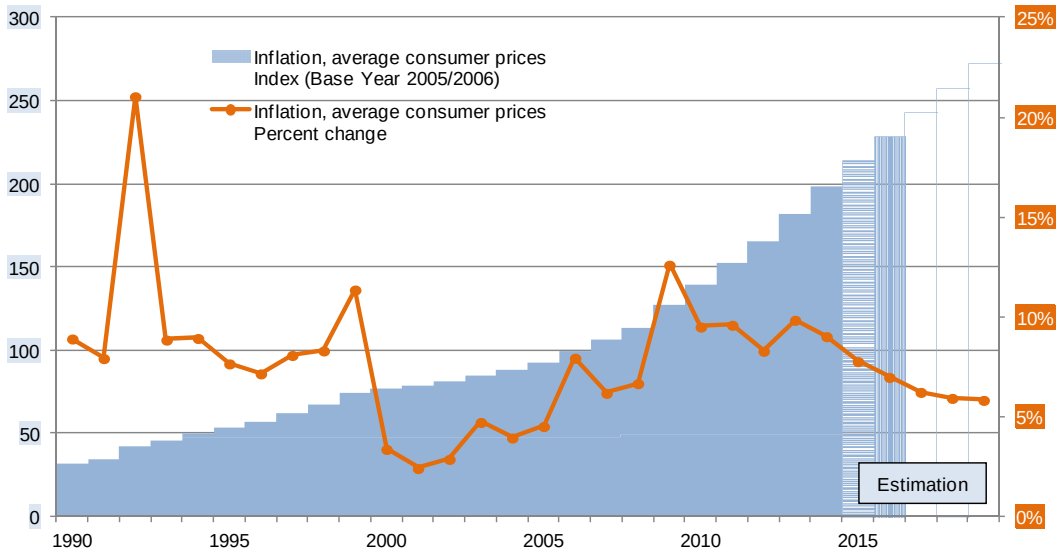
Implementation cost	Construction cost	Construction	
		Procurement of Equipments	
	Design and Supervision cost	Civil design and supervision	execution design
			Supervision
		Soft component Architectural design and supervision Equipment design and supervision	
	Physical contingency		
	Land acquisition and compensation cost		
	Engineering cost Administration cost		
	VAT		

Source: JICA Study Team

(6) Price Escalation Trend and Physical Contingency

Average consumer prices in Nepal have a tendency to rise by about 6 percent every year and the trend is assumed to continue. The following figure shows the average consumer price records and future estimations by IMF.

Thus price escalation as well as change of work quantities should be considered as a part of contingency for construction works when estimating future project costs. In this study, 10 percent of construction cost is applied as physical contingency.



Source: World Economic Outlook Database, October 2014
Note: - Latest actual data is prior to 2013/14 and after 2015 indicate IMF estimation
- Missing data points prior to 2010 is spliced (ratio spliced) using the old CPI series
- Base year is 2005/06. Average of 2005 and 2006 = 100

Figure 11.1.2 Price Escalation in Nepal

(7) Engineering Cost and Administration Cost

Engineering services occupy 15 percent of construction cost. Administration cost occupies 0.5% of engineering cost.

(8) Value-Added Tax

Government of Nepal imposes 13% of VAT on goods and services consumed in Nepal or exported outside. It is noted that if the construction project is implemented through grant aid scheme, cost estimation shall presuppose the tax exemption.

11.1.4 Environmental Issues

(1) Related organization

Ministry of Land Reform and Management (MoLRM) is the arbitrator, safe guarder for the land ownership, tenancy rights, keeper of land ownership records and organ for collection of revenue (registration fees, service charges) and administrator for the land management. Execution of these activities is geared towards increment of productivity, poverty alleviation and better environmental protection. There are 83 land revenue offices and 21 land reform offices all over the country and in Kathmandu Valley 5 land revenue offices are located at Dillibazar, Chabahil, Kalanki, Lagankhel and Bhaktapur.

(2) Land Acquisition

At the end of every Nepalese fiscal year, district land revenue offices evaluate all the private land of municipality and VDC (former administrative area) through an evaluation committee chaired by Chief District Officer for the purpose of fixing registration fee. The value of land parcel is fixed based on proximity to different types of roads and trails and location of land based on guidelines prepared by Department of Land Reform and Management, and fundamentals for every municipality and VDC.

For the fiscal year 2070/2071 the valuation of land for different municipality and VDC in Kathmandu Valley has been fixed, which is given in the following table, in the range based on the data available. The information obtained from the land revenue offices has been summarized for different municipality and VDC by classifying the land as commercial, residential, agricultural or other.

Table 11.1.2 Valuation Range of Land in Kathmandu Valley

(Unit: NRs./ana)

	Commercial area				Residential area		Agricultural area	
	Main		Other					
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Kathmandu District								
Kathmandu Municipality	2,400,000	4,000,000	1,400,000	2,400,000	800,000	1,400,000	150,000	800,000
Kirtipur Municipality	-	-	500,000	700,000	250,000	475,000	50,000	200,000
VDCs	-	-	100,000	450,000	150,000	700,000	10,000	100,000
Lalitpur District	-	-						
Lalitpur Municipality	-	-	687,500	2,312,500	200,000	525,000	62,500	200,000
VDCs	-	-	237,500	431,250	31,250	618,750	6,250	100,000
Bhaktapur District	-	-						
Madhyapur Municipality	-	-	333,795	953,700	95,370	302,005	50,000	69,938
Bhaktapur Municipality	-	-	450,000	800,000	140,000	360,000	60,000	80,000
VDCs	-	-	450,000	800,000	60,000	540,000	5,000	180,000

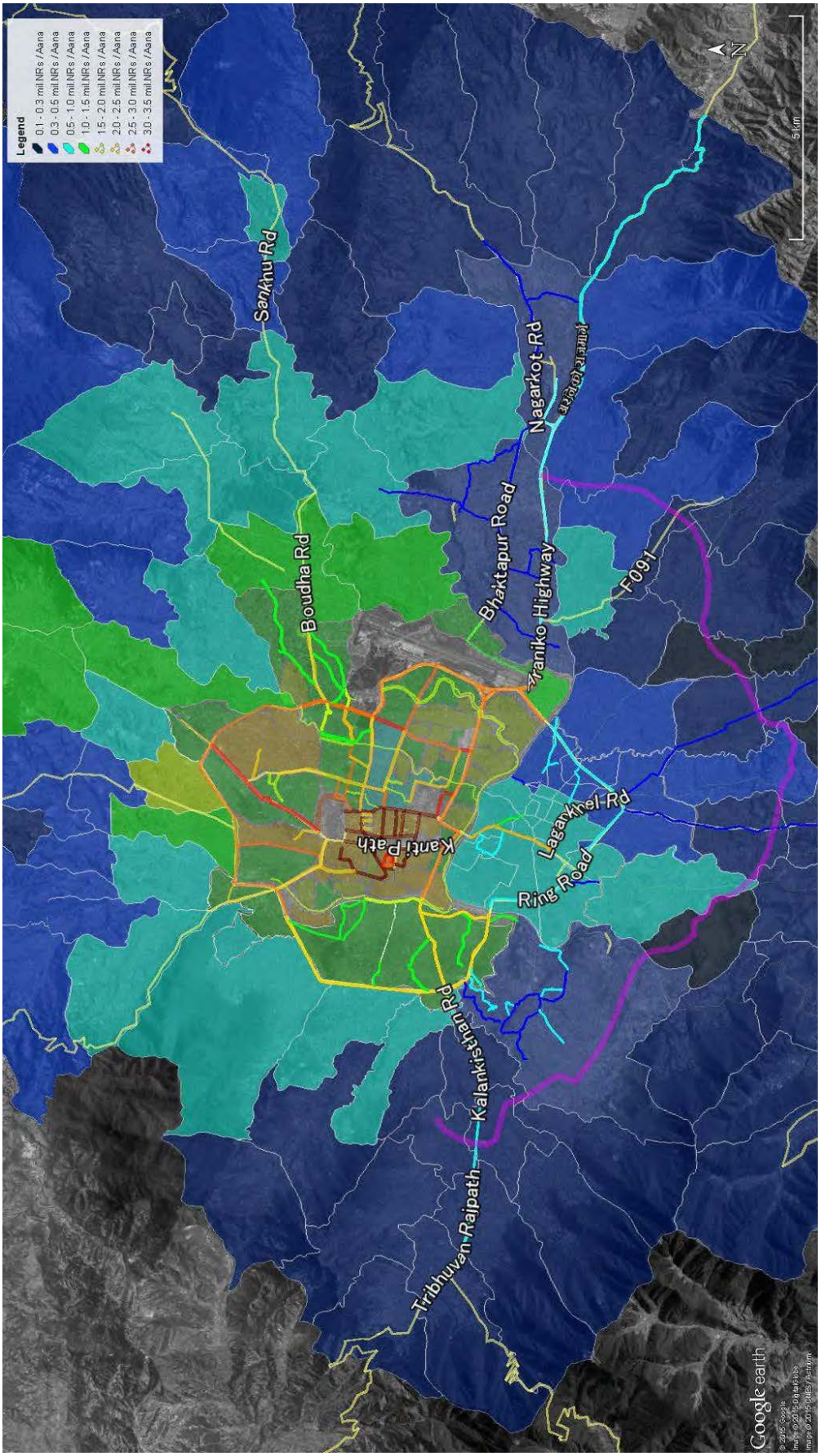
(Unit: NRs./m2)

	Commercial area				Residential area		Agricultural area	
	Main		Other					
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Kathmandu District								
Kathmandu Municipality	75,495	125,826	44,039	75,495	25,165	44,039	4,718	25,165
Kirtipur Municipality	-	-	15,728	22,020	7,864	14,942	1,573	6,291
VDCs	-	-	3,146	14,155	4,718	22,020	315	3,146
Lalitpur District								
Lalitpur Municipality	-	-	21,626	72,743	6,291	16,515	1,966	6,291
VDCs	-	-	7,471	13,566	983	19,464	197	3,146
Bhaktapur District								
Madhyapur Municipality	-	-	10,500	30,000	3,000	9,500	1,573	2,200
Bhaktapur Municipality	-	-	14,155	25,165	4,404	11,324	1,887	2,517
VDCs	-	-	14,155	25,165	1,887	16,986	157	5,662

Source: MoLRM

Note : - 1 anna = 31.79 m2

- The value of land on the periphery of Kathmandu decrease as it is getting away from the center of valley as terrain also becomes hilly.



Source: Valuations were provided by Department of Land Reform and Management, and edited by JICA Study Team with Google Earth Pro

Figure 11.1.3 Distribution map of Land Acquisition Value

(3) Building Compensation

There is a separate provision for valuation of buildings considering the material of construction, age of the building, and depreciation.

1) Building Valuation

Building valuation is fixed depending on the structure/material type of building but detailed investigation is required to clarify actual applications for the related building to the M/P. Therefore building value is estimated by using the following table which is provided by MoLRM.

Table 11.1.3 Building Valuation

SN	Description of Building made	Rate excluding tax (per sq foot)	
		FY 2009/10	FY 2012/13 (Proposed Rate)
1	Building having raw brick at inner side burnet brick at outer side with mud mortar and roof of CGI sheet/ Tile/ Asbestos.	834	985
2	Building having burnet brick with mud mortar and roof of CGI sheet/ Tile/ Asbestos.	1072	1266
3	Building having burnet brick with mud mortar and roof of CGI sheet/ Tile/ Asbestos and cement plaster on both side.	1192	1408
4	Building having burnet brick with mud mortar and cement plaster on both side and roof of Reinforced Brick concrete/ Reinforced cement concrete.	1254	1481
5	Building having burnet brick with Surkhi mortar and roof of CGI sheet/ Tile/ Asbestos.	1223	1445
6	Building having burnet brick with Surkhi mortar and roof of CGI sheet/ Tile/ Asbestos and cement plaster on both side.	1331	1572
7	Building having burnet brick with Surkhi mortar, Roof Reinforced Brick concrete/ Reinforced cement Concrete and cement plaster on both side.	1385	1636
8	Building having burnet brick with cement mortar and roof of CGI sheet/ Tile/ Asbestos.	1341	1584
9	Building having burnet brick with cement mortar, Roof Reinforced Brick concrete/ Reinforced cement Concrete.	1388	1640
10	Building having Reinforced cement Concrete frame structure.	1466	1762
11	Building having Reinforced cement Concrete frame structure with Lift facilities.	1418	1675
12	Building made up of timber and roof of CGI sheet/ Tile/ Asbestos.	1283	1516

Source: MoLRM
Note : - Above rate has not included Deprecation, hence during valuation depreciation need to be considered.
- Above Item Rate is including contractor 15 % overhead.

2) Building Depreciation

Depreciation is calculated counting number of complete years after completion of the house at the defined depreciation rate. Depreciation rates are based on technology of house constructed, quality of house, type of house, serviceable life of house or life of house.

Government and other agencies use different methods to find depreciation. As per notice Nepal Gazette part 4 (Rajpatra) dated 1989-03-25, the highest rate for depreciation is for RCC frame structure having 0.50% per year and the lowest value of depreciation is for mud mortar house having 2 % per year. As per Nepal Rastriya Banijya Bank, the highest value of depreciation is for modern commercial building having 60 years life period and the depreciation rate is 1.67 % per year. The lowest value of depreciation is for temporary (raw) factory having life of 10 years and the depreciation rate is 10 % per year.

3) Compensation for Buildings

In this study, straight line method is adopted. With this method, depreciation value is equal for all years. As a result, compensation for buildings is estimated to be 9,000 NRs/m2.

11.1.5 Quantities

(1) Road Works

Quantities of road works including new construction, improvement and widening are summarized in the table below.

Table 11.1.4 Quantities of Road Works

ID	New Const /Improve /Widening	Name of Roads	Completion Year	Length (km)	Signal (nos)	Bridge, Flyover and Underpass Length (m)
Ring Roads (C:Circular)						
C1-S1	New	H21: Outer Ring Road (Section 1)	2020	6.93	9	120
C1-S2	New	H21: Outer Ring Road (Section 2)	2030	4.10	5	60
C1-S3	New	H21: Outer Ring Road (Section 3)	2025	3.18	4	20
C1-S4	New	H21: Outer Ring Road (Section 4)	2030	5.17	7	15
C1-S5	New	H21: Outer Ring Road (Section 5)	2020	3.00	4	40
C5-W	Impr	Inner Ring Road (West Section)	2025	4.41	6	260
C5-W	Impr	Inner Ring Road (West Section) Renovation of Crossing Bridge	2025	0.00	0	60
C5-NG	Widening	Inner Ring Road (North Section) Ground	2025	2.10	3	80
C5-NE	Widening	Inner Ring Road (North Section) Elevated	2025	1.90	2	30
C5-ES	Impr	Inner Ring Road (East Section)	2025	3.60	5	480
C5-EN	Impr	Inner Ring Road (East Section) Connection road	2030	1.25	1	0
C5-E	Impr	Inner Ring Road (East Section) Renovation of Crossing Bridge	2025	0.00	0	270
C5-S	New	Inner Ring Road (South Section for BRT)	2025	2.69	0	105
C6-N	New	Bagmati River Road North Section	2020	6.70	9	0
C7	New	Extension of BRT along Bagmati River	2025	2.17	0	110
C7	Impr	BRT along Bagmati River, Renovation of Crossing Bridge	2025	0.00	0	110
Radial Roads						
R2	New	New Road for Anantalingeshwor Sub-center	2020	4.52	6	30
R3	Widening	Golf Course-Bagmati Link	2020	0.89	1	75
R5	New (Bypass)	F072 Lubhu Road Bypass 2	2030	0.90	1	20
R7	New (Bypass)	F024 Bypass Road for Godawari Road	2025	2.10	3	0
R9	New (Bypass)	F023 Bypass Road for Chapagaun Road	2025	1.24	1	0
R10	New	Access Road to Nagdhunga TN	2020	1.19	1	45
R12	New	Bishnumati River Disaster Road	2020	3.72	5	20
R13	New	Dhobi Khola Disaster Road	2020	5.34	7	0
R16	Widening	F026: Bodha Road (Chabahil-Jorpati-Bagmati), completed by 2018	2020	4.56	6	0
R17-W	New	2nd Bhaktapur Road West Section	2025	1.56	2	0
R17-M	New	2nd Bhaktapur Road Middle Section	2025	7.99	11	70
R17-E	New	2nd Bhaktapur Road East Section	2020	2.16	3	70
Transverse Road						
T1-N	Widening	F092: Thimi-Gokarna Road North Section	2025	3.15	4	45
T1-S	Widening	F092: Thimi-Gokarna Road South Section	2020	2.48	3	45
T2	New	Billigal-Thimi Road	2025	1.39	1	60
T4	New	Manohara-Imadol Road	2020	0.88	1	50
T5	New	Sallaghari-Duwakot Road	2025	1.03	1	0
T6	New	Mandev Marg Road	2025	1.03	1	0

T7	New	Disaster Road 1	2020	5.12	7	20
T8	New	Disaster Road 2	2020	3.10	4	0
Urban Roads						
U2	New	H02-H03: Tripureswor-Maitigar Network (Viaduct)	2020	1.55	2	1,550
U4	Improvement	H03: Upgrading of Arniko Road including New Baneswor Underpass	2020	3.10	4	160
U7	Widening	F081: Samakhusi Marg	2030	2.33	3	25
U8	Widening	H075: Bhimsen-Ganga-New Road	2030	1.31	1	80
U9	Widening	F075: Museum Marg	2025	0.87	1	0
U10	Widening	Gyanodaya Marg-Tahachal Marg	2025	2.21	3	0
U11	Widening	Shankhamulghat-Patan Disaster Road	2030	1.65	2	80
U12	Widening	Mahalaxmisthan Road	2030	0.84	1	0
U14	Widening	Rato pul - Gaushala Road	2025	0.65	0	0
NMT Projects						
N1	New	NMT Road (Maitighar-Ratna Park-Thamel)	2020	2.98	0	0
N2	New	NMT on Bagmati River Road Left Bank (R19)	2030	5.81	0	0
N3	New	NMT on Bodha Road (R16)	2030	4.56	0	0

Source: JICA Study Team
Note : Missing ID number is the projects not listed as target of the M/P.

(2) Public Transport Works

Quantities of public transportation works including AGT lines, BRT lines and transport terminals are summarized in the table below.

Table 11.1.5 Quantities of AGT Lines and BRT Lines

Line	New Const /Improve	Project Name	Completion Year	Length (km)				Depot & Workshop
				Ground	Bridge / Flyover	Under-pass	Total	
AGT								
Line-1	New	North-South Route	2030	0.60	10.30	0.00	10.90	Y
Line-2	New	East-West Route, Main Line and Feeder Line (Airport access)	2030	10.75	12.50	1.80	25.05	Y
	New	East-West Route, Extension for Eastward	after 2030					
	New	East-West Route, Extension for Westward	after 2030					
BRT								
Line-3,4	Improve	BRT around the Ring Road, 2030	2030	27.35	0.00	0.00	27.35	Y
Line-5 ~ 9	New	BRT around the Inner Ring Road, 2025	2025	15.51	1.90	0.00	17.41	Y

Source: JICA Study Team

Table 11.1.6 Quantities of Required Vehicle

Line NO.		1	2	3	4	5	6	7	8	9
Mode		AGT		BRT						
Location/Direction		North-South	East-West	Ring Road		Inner Ring Road				
				Clockwise	Anti-clockwise	Anti-clockwise	Clockwise North-West	Clockwise North-East	Clockwise South-East	Clockwise South-West
Required vehicle unit	unit	5	11	9	9	5	6	5	6	5
Reserved vehicle unit	unit	1	1	1	1	1	1	1	1	1
Cars per unit	nos	6	6	1	1	1	1	1	1	1
Total Car	nos	36	72	10	10	6	7	6	7	6
	nos	108		20		32				

Source: JICA Study Team

Table 11.1.7 Quantities of Transport Terminal

ID	Location	New Const/ Improve/ Widening	Name of Projects	Completion Year	Asphalt paved Area (m2)	Pedestrian Area (m2)	Total Area (m2)
T-C	Center	New	Central Station (Tundikhel)	2025	15,000	15,000	30,000
T-E	East	New	East Station (Tinkune)	2020	15,000	15,000	30,000
T-W	West	New	West Station (Kalanki)	2030	15,000	15,000	30,000
T-S	South	New	South Station (Satdobato)	2025	15,000	15,000	30,000

Source: JICA Study Team

11.1.6 Unit Price Established

Project cost is calculated from principal quantities of construction work and unit price established.

(1) Road Works

The construction unit price (per km) is set for each road depending on type of cross section and each road is labeled as type of typical cross section. The rates are decided with reference to information from DOR, such as list of recent road project cost records as well as engineer's official unit rates of breakdown construction items. Collected engineer's rate has been prepared by each DOR division office in Kathmandu, Lalitpur and Bhaktapur, and their unit rates are all different. According to DOR, they will integrate the entire rate and the division offices will use common price uniformly from next fiscal year, 2072/73.

Electric signal system will be installed at intersections in variable intervals. The cost of signal installation is 7,440,000 NRs per unit by referring to other projects implemented in the valley. At crossing river section, unit price for structural works is applied to planned bridge length. The unit price for each typical cross section is shown in Table 11.1.8.

Table 11.1.8 Unit Price for Road Works

Typical cross section Class/Type	Carriageway No. Lane	Formation width (m)	ROW (m)	Road Construction unit price (thou.NRs/km)	Bridge / flyover / underpass Construction unit price (NRs/m)
Class-A, Type-1	6	40.0	45.0	146,315	1,195,600
Class-A, Type-2	6	36.0	40.0	127,773	1,673,840
Class-A, Type-3	6	29.5	35.0	100,441	1,673,840
Class-A, Type-5	4	25.5	30.0	90,506	1,195,600
Class-A, Type-6	6	40.0	45.0	112,559	2,343,376
Class-B, Type-2	4	29.5	35.0	104,703	1,195,600
Class-B, Type-3	4	19.0	25.0	64,088	1,195,600
Class-B, Type-4	4	15.0	15.0	-	4,483,920
Class-B, Type-5	4	28.5	30.0	72,744	1,195,600
Class-B, Type-6	4	32.5	35.0	86,592	1,195,600
Class-C, Type-2	2	19.5	25.0	65,819	854,000
Class-C, Type-3	2	12.5	15.0	45,062	854,000
Class-C, Type-4	2	8.5	8.5	N/A	2,540,888
Class-C, Type-5	2	12.5	15.0	17,348	854,000
W=4m Sidewalk	0	4.0	5.0	7,839	N/A

Source: JICA Study Team

(2) Public Transport Introduction Works

Public transportation such as AGT and BRT includes introduction of civil structures and control systems. Unit price of each work is decided referring to project cost estimation in other countries.

Table 11.1.9 Unit Price for AGT Introduction Works

Item	Unit	Rate per Unit (mil. NRs)	Description
Civil Works			
Main Line (Box-Type)	km	3204.41	BOX
Main Line (U-Type)	km	1121.50	U-TYPE
Main Line (Ramp)	km	743.83	Earth Work and Retaining Wall
Main Line (Ground)	km	370.28	Earth Work
Main Line (Ground)	km	10.00	Without Earth Work
Main Line(Tunnel- Twin)	km	3948.85	T.B.M
Main Line(Bridge -Type)	km	1017.41	Steel Box Girder
Track(Main Line)	km	65.05	Reinforced Concrete - 2 Lane
Station(Box-Type)	each	874.37	Reinforced Concrete
Station(Bridge - Type)	each	309.28	St. Box Girder, R.C composit
Station(Ground - Type)	each	62.69	
System			
Machinery(Station box-Type)	each	572.97	
Machinery(Station bridge-Type)	each	417.10	
Machinery(Main-Ventilator)	each	197.48	
Machinery(CTC center)	each	98.31	centralized traffic control
Communication, Signal, Electric-Power Distribution	km	280.22	main line +station
Electric-Traction Substation	each	334.06	

Electric -3rd Rail	km	100.92	
Electric-SCADA	each	466.37	centralized traffic control
Electric-Station	each	158.41	
Facilities			
Station(Box-Type)	each	209.27	include transition
Station(Bridge or Ground Type)	each	429.76	include transition
Centralized traffic control Center	set	342.99	
Depot & Workshop			
Civil (Include Track), Architecture, Machinery(include Inspection), Communication, Signal, Electric (Ordinery,Workshop)	set	8,442.46	
Vehicle			
AGT Vehicle	nos	105.49	

Source: JICA Study Team

Table 11.1.10 Unit price for BRT Introduction Works

Item	unit	Rate per Unit (mil. NRs)	Description
Civil Works			
Runway (At-grade)	km	94.48	including Pedestrian Bridge, Access Ramp (At-grade), Staircase
Elevated Runway Viaduct, (U-turn: Single Lane), (Platform), Ramp (Embankment)	km	819.88	including Access Ramp (Elevated)
At-Grade Station Split Type	nos	14.01	
At-Grade Station Double Face	nos	6.85	
At-Grade Station Landscape	nos	18.06	
Elevated Station Platform	nos	27.70	
Electrical Lighting and Landscaping	km	12.77	
Intersection Improvement with Signal	nos	17.62	
Relocation	LS	26.71	
Traffic diversion	LS	50.50	
Facilities			
Fare Collection System & ITS	nos	6.32	
Depot & Workshop			
Depot Facility	nos	62.46	
Workshop Equipment	nos	73.36	
Depot Civil Works	sqm	0.004573	
Access-way to Depot	km	51.15	
GPS System	nos	125.39	
Vehicle			
Bus	nos	8.73	

Source: JICA Study Team

The cost for transport terminal works is estimated from the cost for pavement for vehicle parking and pedestrians. Area for vehicles shall be paved with asphalt concrete same as general road section. DOR engineer's unit rate was referred to in deciding the unit price for pavement.

Table 11.1.11 Unit Price for Transport Terminal Introduction Works

	Unit rate (NRs/m2)
Asphalt paved area	4,028
Pedestrian area	2,970

Source: JICA Study Team

11.1.7 Operation and Maintenance Cost

(1) Road and Bridge Maintenance

Maintenance cost of new constructed road infrastructure is based on 20 Years Road Plan issued by DOR in 2001. As typical road maintenance, routine maintenance, recurrent maintenance, periodic maintenance and emergency maintenance are listed.

Table 11.1.12 Road Maintenance Items and Cost

Work item	Description	Cost		Remarks
		Unit price	Unit	
Routine maintenance	Cleaning of drains, roadways, cutting grass, bushes and other routine activities required to keep the road and drains clean and safe.	21,800	NRs/km/year	Terrain : Hill
		46,900	NRs/km/year	Terrain : Urban
Recurrent maintenance	e.g., pot hole repair, shoulder repair, minor repairs of culverts, drains, walls, safety barriers, minor repair of bridge elements, etc.	49,100	NRs/km/year	Width : 10.0
Periodic maintenance	Single surface dressing should be used for resealing of blacktop roads and 15 cm of re-gravelling for gravel roads.	850,000	NRs/km/5year	Width : 10.0
Emergency maintenance	necessary to open the road following sudden closure or in threatened situation e.g. clearing the debris, making diversion and temporary crossings etc.	1,550	NRs/km/year	-

Source: 20 Years Road Plan , DOR

For bridge maintenance, periodic maintenance, replacement of expansion joints, replacement of bearings and major repair are listed.

Table 11.1.13 Bridge Maintenance Items and Cost

Work item	Description	Cost	
		Unit price	Unit
Periodic Maintenance	Painting of steel bridges	10,000	NRs/m/year
Replacement of Expansion Joints	Tightening of nut bolts including replacement, if any	45,000	NRs/m/year
Replacement of Bearings	Lubrication of bearings etc.	49,500	NRs/nos./year
Major Repair	Replacement of poor bridges	10,000,000	NRs/5years

Source: 20 Years Road Plan , DOR

(2) Operation and Maintenance of Public Transport

Cost for operation and maintenance of public transport is calculated with per kilo meter unit. Reference was made to other similar project cost estimation within/outside Nepal.

Table 11.1.14 AGT Operation and Maintenance Cost per km

Work item	Description	Cost	
		Unit price	Unit
Operation	Electric Energy	506.89	mil. NRs / 10 years
	Vehicle Running		
	Operation		
Maintenance	Civil Maintenance	348.75	mil. NRs / 10 years
	System Maintenance		
	Vehicle Maintenance		

Source: JICA Study Team

Table 11.1.15 BRT Operation and Maintenance Cost per km

Work item	Description	Cost	
		Unit price	Unit
Operation	Vehicle Running	130.36	mil. NRs / 10 years
	Fuel		
	Contingency		
Maintenance	Vehicle Maintenance	3.01	mil. NRs / 10 years

Source: JICA Study Team

11.1.8 Project Implementation Cost Estimates

Initial investment cost for implementation includes land acquisition cost and building compensation cost as well as construction investment. Estimated implementation costs for road works and public transportation works are shown in the following tables.

Table 11.1.16 Summary of Road Works Implementation Cost Estimates

	ID	Name of Project	Completion Year	Implementation Cost (mil. NRs)						
				Direct Cost	Physical Contingency	Engineering Services + Administration cost	VAT	Land acquisition	Building compensation	TOTAL
Outer Ring Road	C1-S1	H21: Outer Ring Road (Section 1)	2020	1,224.40	122.44	128.56	191.80	3,923.07	202.50	5,792.77
	C1-S2	H21: Outer Ring Road (Section 2)	2030	708.83	70.88	74.43	111.04	912.56	113.40	1,991.13
	C1-S3	H21: Outer Ring Road (Section 3)	2025	518.96	51.90	54.49	81.29	1,517.15	113.00	2,336.78
	C1-S4	H21: Outer Ring Road (Section 4)	2030	826.46	82.65	86.78	129.47	1,108.66	166.05	2,400.07
	C1-S5	H21: Outer Ring Road (Section 5)	2020	516.53	51.65	54.24	80.91	1,698.30	91.13	2,492.76
Inner Ring Road	C5	Inner Ring Road	2025	2,588.31	258.83	271.77	405.46	11,614.20	857.75	15,996.32
	C6-N	Bagmati River Road North Section	2020	496.35	49.64	52.12	77.75	1,875.35	399.60	2,950.80
	C7	BRT along Bagmati River and Renovation of Crossing Bridge	2025	263.10	26.31	27.63	41.21	2,642.40	0.00	3,000.65
Radial Road	R2~R17	Radial Road	2020	1,748.52	174.85	183.59	273.91	5,950.14	420.66	8,751.68
	R2~R17	Radial Road	2025	1,366.56	136.66	143.49	214.07	5,111.86	264.56	7,237.19
	R2~R17	Radial Road	2030	83.76	8.38	8.79	13.12	94.33	10.13	218.50
Transverse Road	T1~T8	Transverse Road	2020	948.54	94.85	99.60	148.59	5,152.20	285.67	6,729.44
	T1~T8	Transverse Road	2025	714.01	71.40	74.97	111.85	3,574.04	281.83	4,828.10
Urban Roads	U2	Tripureswor-Maitigar Network (Viaduct)	2020	3,953.26	395.33	415.09	619.28	1,627.94	47.25	7,058.14
	U4~U14	Urban Roads	2020	2,916.59	291.66	306.24	456.88	0.00	0.00	3,971.38
	U4~U14	Urban Roads	2025	210.21	21.02	22.07	32.93	2,225.53	183.65	2,695.40
	U4~U14	Urban Roads	2030	666.13	66.61	69.94	104.35	5,412.42	396.56	6,716.00
NMT Projects	N1	NMT Projects	2020	23.36	2.34	2.45	3.66	0.00	0.00	31.81
	N2,N3	NMT Projects	2030	81.30	8.13	8.54	12.73	0.00	0.00	110.70
				19,855.16	1,985.52	2,084.79	3,110.31	54,440.13	3,833.70	85,309.61

Source: JICA Study Team
Note : Missing ID number is the projects not listed as target of the M/P.

Table 11.1.17 Road Works Implementation Cost Estimates for each project

ID	New Const / Improve / Widening	Name of Roads	Completion Year	Length (km)	Implementation Cost (mil. NRs)						
					Direct Cost	Physical Contingency	Engineering Services + Administration cost	VAT	Land acquisition	Building acquisition	TOTAL
Ring Roads (C:Circular)											
C1-S1	New	H21: Outer Ring Road (Section 1)	2020	6.93	1,224.40	122.44	128.56	191.80	3,923.07	202.50	5,792.77
C1-S2	New	H21: Outer Ring Road (Section 2)	2030	4.10	708.83	70.88	74.43	111.04	912.56	113.40	1,991.13
C1-S3	New	H21: Outer Ring Road (Section 3)	2025	3.18	518.96	51.90	54.49	81.29	1,517.15	113.00	2,336.78
C1-S4	New	H21: Outer Ring Road (Section 4)	2030	5.17	826.46	82.65	86.78	129.47	1,108.66	166.05	2,400.07
C1-S5	New	H21: Outer Ring Road (Section 5)	2020	3.00	516.53	51.65	54.24	80.91	1,698.30	91.13	2,492.76
C5-W	Impr	Inner Ring Road (West Section)	2025	4.41	676.30	67.63	71.01	105.94	2,651.44	218.30	3,790.62
C5-W	Impr	Inner Ring Road (West Section) Renovation of Crossing Bridge	2025	0.00	51.24	5.12	5.38	8.03	0.00	0.00	69.77
C5-NG	Widening	Inner Ring Road (North Section) Ground	2025	2.10	299.81	29.98	31.48	46.97	2,477.16	283.50	3,168.90
C5-NE	Widening	Inner Ring Road (North Section) Elevated	2025	1.90	222.71	22.27	23.38	34.89	1,635.03	94.05	2,032.33
C5-ES	Impr	Inner Ring Road (East Section)	2025	3.60	872.97	87.30	91.66	136.75	1,547.62	194.40	2,930.69
C5-EN	Impr	Inner Ring Road (East Section) Connection road	2030	1.25	98.37	9.84	10.33	15.41	589.80	67.50	791.25
C5-E	Impr	Inner Ring Road (East Section) Renovation of Crossing Bridge	2025	0.00	230.58	23.06	24.21	36.12	0.00	0.00	313.97
C5-S	New	Inner Ring Road (South Section for BRT)	2025	2.69	136.34	13.63	14.32	21.36	2,713.16	0.00	2,898.80
C6-N	New	Bagmati River Road North Section	2020	6.70	496.35	49.64	52.12	77.75	1,875.35	399.60	2,950.80
C7	New	Extension of BRT along Bagmati River	2025	2.17	131.59	13.16	13.82	20.61	2,642.40	0.00	2,821.57
C7	Impr	BRT along Bagmati River, Renovation of Crossing Bridge	2025	0.00	131.52	13.15	13.81	20.60	0.00	0.00	179.08
Radial Roads											
R2	New	New Road for Anantalingeshwor Sub-center	2020	4.52	553.77	55.38	58.15	86.75	1,820.73	95.76	2,670.52
R3	Widening	Golf Course-Bagmati Link	2020	0.89	130.07	13.01	13.66	20.38	594.91	0.00	772.02
R5	New (Bypass)	F072 Lubhu Road Bypass 2	2030	0.90	83.76	8.38	8.79	13.12	94.33	10.13	218.50
R6	Widening	F024: Widening of Godawari Road	2025	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ID	New Const / Improve / Widening	Name of Roads	Completion Year	Length (km)	Implementation Cost (mil. NRs)						
					Direct Cost	Physical Contingency	Engineering Services + Administration cost	VAT	Land acquisition	Building acquisition	TOTAL
R7	New (Bypass)	F024 Bypass Road for Godawari Road	2025	2.10	160.54	16.05	16.86	25.15	330.23	57.38	606.20
R8	Widening	F023: Widening of Chapagaun Road	2025	2.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R9	New (Bypass)	F023 Bypass Road for Chapagaun Road	2025	1.24	89.06	8.91	9.35	13.95	194.99	22.05	338.30
R10	New	Access Road to Nagdhunga TN	2020	1.19	137.51	13.75	14.44	21.54	187.13	19.80	394.16
R12	New	Bishnumati River Disaster Road	2020	3.72	221.91	22.19	23.30	34.76	1,112.88	104.49	1,519.53
R13	New	Dhobi Khola Disaster Road	2020	5.34	292.71	29.27	30.73	45.85	1,723.75	159.03	2,281.35
R14	On-going (BoT)	Kathmandu-Hetauda Fast Track Project (BoT)	Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R15	On-going (JICA)	Nagdhunga Tunnel	2021	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R16	Widening	F026: Bodha Road (Chabahil-Jorpati-Bagmati), completed by 2018	2020	4.56	80.39	8.04	8.44	12.59	0.00	0.00	109.46
R17-W	New	2nd Bhaktapur Road West Section	2025	1.56	114.86	11.49	12.06	17.99	490.62	90.00	737.02
R17-M	New	2nd Bhaktapur Road Middle Section	2025	7.99	1,002.11	100.21	105.22	156.98	4,096.02	95.13	5,555.67
R17-E	New	2nd Bhaktapur Road East Section	2020	2.16	332.17	33.22	34.88	52.03	510.75	41.58	1,004.63
Transverse Road											
T1-N	Widening	F092: Thimi-Gokarna Road North Section	2025	3.15	413.38	41.34	43.40	64.76	2,268.61	102.94	2,934.42
T1-S	Widening	F092: Thimi-Gokarna Road South Section	2020	2.48	335.79	33.58	35.26	52.60	1,424.80	93.42	1,975.44
T2	New	Billigal-Thimi Road	2025	1.39	150.17	15.02	15.77	23.52	262.29	75.06	541.83
T3	Widening	F086: Jadibuti-Pepsi-Manohara Road	2015	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T4	New	Manohara-Imadol Road	2020	0.88	143.42	14.34	15.06	22.47	287.83	41.18	524.30
T5	New	Sallaghari-Duwakot Road	2025	1.03	75.23	7.52	7.90	11.79	680.34	51.91	834.69
T6	New	Mandev Marg Road	2025	1.03	75.23	7.52	7.90	11.79	362.81	51.91	517.16
T7	New	Disaster Road 1	2020	5.12	299.88	29.99	31.49	46.98	1,988.71	87.62	2,484.66
T8	New	Disaster Road 2	2020	3.10	169.45	16.95	17.79	26.54	1,450.86	63.45	1,745.05
Urban Roads											
U2	New	H02-H03: Tripureswor-Maitigar Network (Viaduct)	2020	1.55	3,953.26	395.33	415.09	619.28	1,627.94	47.25	7,058.14

ID	New Const / Improve / Widening	Name of Roads	Completion Year	Length (km)	Implementation Cost (mil. NRs)						
					Direct Cost	Physical Contingency	Engineering Services + Administration cost	VAT	Land acquisition	Building acquisition	TOTAL
U4	Improvement	H03: Upgrading of Arniko Road including New Baneswor Underpass	2020	3.1	674.63	67.46	70.84	105.68	0.00	0.00	918.61
		- (Underpass part)	2020	3.1	2,241.96	224.20	235.41	351.20	0.00	0.00	3,052.76
U7	Widening	F081: Samakhusi Marg	2030	2.33	201.54	20.15	21.16	31.57	2,922.07	143.91	3,340.40
U8	Widening	H075: Bhimsen-Ganga-New Road	2030	1.31	187.04	18.70	19.64	29.30	1,667.23	80.93	2,002.84
U9	Widening	F075: Museum Marg	2025	0.87	46.64	4.66	4.90	7.31	513.13	47.25	623.89
U10	Widening	Gyanodaya Marg-Tahachal Marg	2025	2.21	121.91	12.19	12.80	19.10	1,390.36	115.92	1,672.27
U11	Widening	Shankhamulghat-Patan Disaster Road	2030	1.65	216.27	21.63	22.71	33.88	622.78	118.80	1,036.06
U12	Widening	Mahalaxmisthan Road	2030	0.84	61.27	6.13	6.43	9.60	200.35	52.92	336.70
U14	Widening	Rato pul - Gaushala Road	2025	0.65	41.66	4.17	4.37	6.53	322.05	20.48	399.25
NMT Projects											
N1	New	NMT Road (Maitighar-Ratna Park-Thamel)	2020	2.98	23.36	2.34	2.45	3.66	0.00	0.00	31.81
N2	New	NMT on Bagmati River Road Left Bank (R19)	2030	5.81	45.55	4.55	4.78	7.13	0.00	0.00	62.02
N3	New	NMT on Bodha Road (R16)	2030	4.56	35.75	3.57	3.75	5.60	0.00	0.00	48.68
				132.51	19,855.16	1,985.52	2,084.79	3,110.31	54,440.13	3,833.70	85,309.61

Source: JICA Study Team
Note : Missing ID number is the projects not listed as target of the M/P.

Table 11.1.18 Public Transport Implementation Cost Estimates

	ID	Name of Projects	Completion Year	Implementation Cost (mil. NRs)							
				Direct cost (include Depot)	Physical contingency	Engineering services + Administration cost	VAT	Vehicle	Land acquisition	Building compensation	TOTAL (Excludes vehicle cost)
AGT	Line-1	North-South Route	2030	37755.00 (8442.00)	3,775.50	3,964.28	0.00	3797.74	377.48	20.88	45,893.14
	Line-2	East-West Route, Main Line and Feeder Line (Airport access)	2030	52291.00 (8442.00)	5,229.10	5,490.56	0.00	7595.48	780.12	46.98	63,837.76
BRT	Line-3,4	BRT around the Ring Road, 2030	2030	1587.00 (329.00)	158.70	166.64	248.60	174.70	0.00	0.00	2,160.94
	Line-5 ~ 9	BRT around the Inner Ring Road, 2025	2025	4516.00 (339.00)	451.60	474.18	707.43	279.52	0.00	0.00	6,149.21
Transport terminal	T-C	Central Station (Tundikhel)	2025	104.97	10.50	11.02	16.44	-	0.00	0.00	142.93
	T-E	East Station (Tinkune)	2020	104.97	10.50	11.02	16.44	-	0.00	0.00	142.93
	T-W	West Station (Kalanki)	2030	104.97	10.50	11.02	16.44	-	542.55	78.30	763.78
	T-S	South Station (Satdobato)	2025	104.97	10.50	11.02	16.44	-	0.00	0.00	142.93
				96,568.88	9,656.89	10,139.73	1,021.81	11,847.44	1,700.15	146.16	119,233.62

Source: JICA Study Team

11.2 Financial Plan

11.2.1 Budget Allocation

The national budget of Nepal in the past five years is shown below. Both the national budget and financial assistance from international donors have been increasing.

Table 11.2.1 Budget Allocation in Nepal (2010/11 ~ 2014/15)

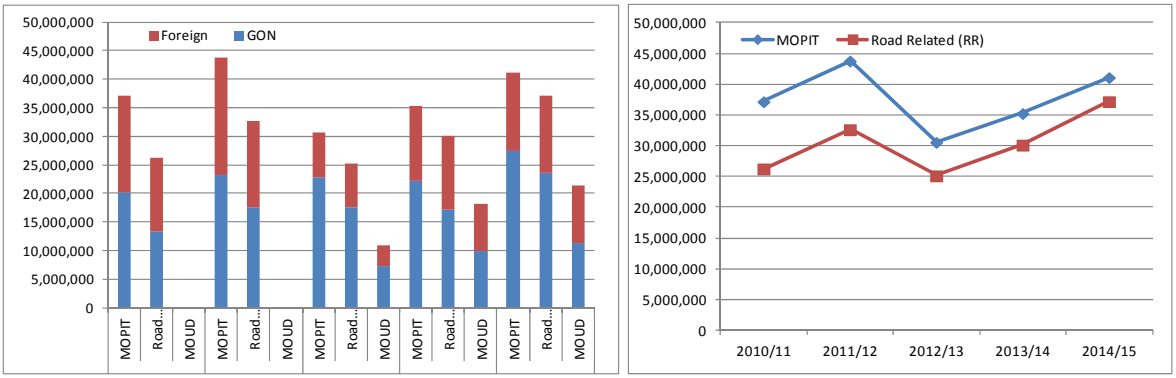
in thousand NRs

		GON	Foreign*	Total
2010/11	National	250,324,355	67,575,645	317,900,000
	MOPIT	20,121,392	17,074,863	37,196,255
	Road Related**	13,412,245	12,867,231	26,279,476
	MOUD	0	0	0
2011/12	National	285,113,114	99,786,886	384,900,000
	MOPIT	23,236,069	20,558,609	43,794,678
	Road Related	17,560,664	15,084,571	32,645,235
	MOUD	0	0	0
2012/13	National	332,000,000	72,824,700	404,824,700
	MOPIT	22,772,334	7,827,275	30,599,609
	Road Related	17,576,338	7,578,016	25,154,354
	MOUD	7,208,585	3,684,953	10,893,538
2013/14	National	404,000,000	113,240,000	517,240,000
	MOPIT	22,248,912	13,027,884	35,276,796
	Road Related	17,128,369	13,027,884	30,156,253
	MOUD	9,926,564	8,346,846	18,273,410
2014/15	National	495,185,306	122,914,694	618,100,000
	MOPIT	27,515,629	13,605,488	41,121,117
	Road Related	23,599,116	13,605,488	37,204,604
	MOUD	11,230,599	10,231,107	21,461,706

*Foreign= Grant + Loan,
**Road Related = Highways, Feeder Roads, Urban Roads, Road Maintenance, Bridges, Miscellaneous Projects, and Tourism Road
Source: Red Book, Ministry of Finance

(1) Road Related Budget

Table 11.2.1 also shows the road-related budget allocation in the budget of MOPIT. The road-related budget accounts for 80 to 90 % of the budget of MOPIT. Although the total budget of MOPIT and road-related budget once decreased due to reorganization of the central government ministries in 2012, the road-related budget demonstrates an upward trend. Figure 11.2.1 shows the budget component and trend of the budget for reference.



Source: JST

Figure 11.2.1 Budget Component and trend of the budget (MOPIT and Road Related)

(2) Estimation of the Road Related Budget

JICA Study Team has estimated the budget allocation upto 2030 based on the trend of the current budget allocation and GDP growth rate (5%). The result is shown in Table 11.2.2. About 90% of MOPIT's budget is estimated to go to road-related budget.

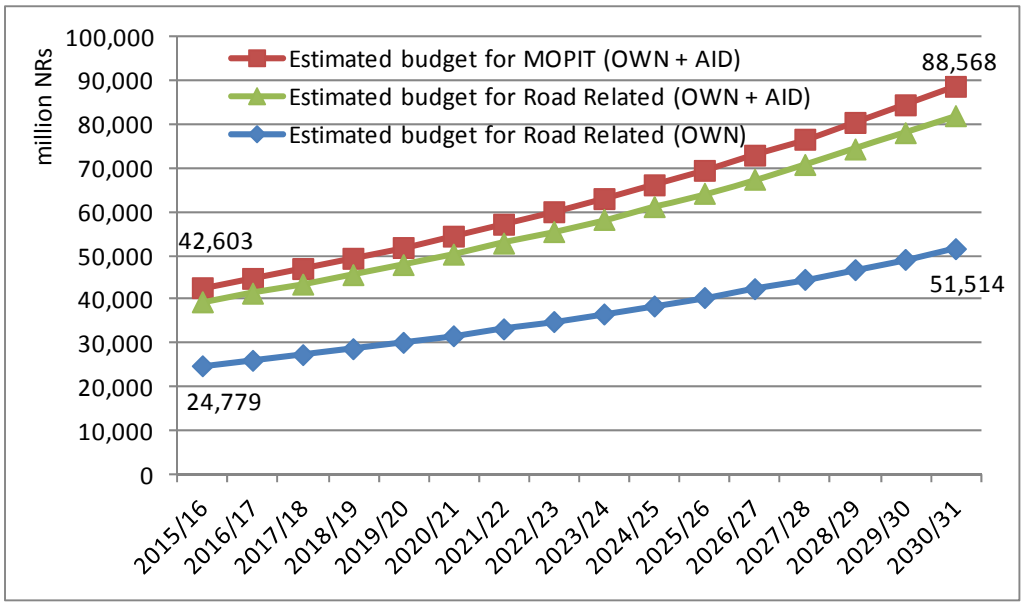
MOPIT budget (Own + Aid) in 2012 is 30,600 million NRs. After 2012, average growth rate of MOPIT budget is 4.68%. Road-related budget (Own + Aid) in 2012 is 25.154 million NRs. After 2012, average growth rate of road-related budget is 4.81%. Average MP Project cost between 2016 and 2030 is 14.167 million NRs per year. Annual MP Project cost accounts 21.9% of MOPIT budget (Own + Aid) or 23.7% of road-related budget (Own + Aid). Average growth rate of annual MP Project cost is 5.8%.

Table 11.2.2 Estimated Budget Allocation up to 2030

*Unit thousand NRs

	Estimated budget for MOPIT (OWN)	Estimated budget for Road Related (OWN)	Estimated budget for MOPIT (OWN + AID)	Estimated budget for Road Related (OWN + AID)
2015/16	28,891,410	24,779,072	42,602,639	39,384,491
2016/17	30,335,981	26,018,025	44,732,771	41,353,715
2017/18	31,852,780	27,318,927	46,969,410	43,421,401
2018/19	33,445,419	28,684,873	49,317,880	45,592,471
2019/20	35,117,690	30,119,117	51,783,774	47,872,095
2020/21	36,873,574	31,625,072	54,372,963	50,265,700
2021/22	38,717,253	33,206,326	57,091,611	52,778,985
2022/23	40,653,116	34,866,642	59,946,192	55,417,934
2023/24	42,685,772	36,609,975	62,943,501	58,188,831
2024/25	44,820,060	38,440,473	66,090,677	61,098,272
2025/26	47,061,063	40,362,497	69,395,210	64,153,186
2026/27	49,414,116	42,380,622	72,864,971	67,360,845
2027/28	51,884,822	44,499,653	76,508,219	70,728,887
2028/29	54,479,063	46,724,635	80,333,630	74,265,332
2029/30	57,203,017	49,060,867	84,350,312	77,978,598
2030/31	60,063,167	51,513,911	88,567,828	81,877,528

Source: JST



Source: JST

Figure 11.2.2 Estimated Budget Allocation up to 2030

Percentage of the MP project cost to the regional GDP (GRDP) is average 2.55% between 2016 and 2030. The growth rate of GRDP averages about 5%, project cost of MP project accounts for half of GRDP growth.

Table 11.2.3 Percentage of the MP Project Cost to the Regional GDP

	GDP per capita (current US$)	Population	Regional GDP (Current US$)	Project Cost (million NRs)	Ratio
2012		2,527,632			
2013		2,601,678			
2014		2,675,724			
2015	1,259.7	2,749,770	3,463,886,741		
2016	1,308.0	2,823,816	3,693,674,348	*9100.0*	2.42%
2017	1,356.4	2,897,862	3,930,621,171	*9671.5*	2.41%
2018	1,404.7	2,971,908	4,174,727,209	*10278.8*	2.41%
2019	1,453.1	3,045,954	4,425,992,464	*10924.4*	2.42%
2020	1,501.4	3,120,000	4,684,416,935	*11610.4*	2.43%
2021	1,549.8	3,183,800	4,934,121,794	*12339.5*	2.45%
2022	1,598.1	3,247,600	5,189,995,223	*13114.5*	2.48%
2023	1,646.4	3,311,400	5,452,037,223	*13938.1*	2.51%
2024	1,694.8	3,375,200	5,720,247,794	*14813.4*	2.54%
2025	1,743.1	3,439,000	5,994,626,935	*15743.6*	2.57%
2026	1,791.5	3,496,000	6,262,992,625	*16732.3*	2.62%
2027	1,839.8	3,553,000	6,536,869,420	*17783.1*	2.67%
2028	1,888.2	3,610,000	6,816,257,321	*18899.9*	2.72%
2029	1,936.5	3,667,000	7,101,156,326	*20086.8*	2.77%
2030	1,984.8	3,724,000	7,391,566,438	*21348.3*	2.83%
	*World Bank	*Study Team	*Study Team	Average	**2.55%**

*Nepal Human Development Report 2014 (UNDP)

Source: JST

11.2.2 Economic and Financial Evaluation

(1) Economic Evaluation

JICA Study Team has conducted economic analysis based on Cost-Benefit analysis to verify the feasibility of the proposed project.

1) Economic Cost

The economic costs are calculated by removing transfer items such as import duties and taxes from the financial costs (at market prices) so as to convert them into real resource values. In this Study, the Standard Conversion Factor (SCF = 0.91), which is average value used in the previous studies[1], is applied to obtain the economic costs. The results of cost estimates at market prices (financial costs) are presented in 11.1, Chapter11.

The operation and maintenance (O&M) costs after the completion of road construction and the installation of public transport (BRT and AGT) are estimated as shown in 11.1, Chapter11 and converted into the economic costs as well.

2) Economic Benefit

a) Quantified Economic Benefits

The following two kinds of economic benefits are estimated quantitatively in this Study:

- Saving in Vehicle Operating Cost (VOC)
- Saving in Travel Time Cost (TTC)

When the road widening/construction projects are completed, those who are obliged to take longer detour routes to avoid congested area will return to the proper routes. This type of benefit is estimated as the savings in VOC and TTC attributed to the shorter travel distance. Thus the total vehicle-km and vehicle-hour in the whole road network of Kathmandu Valley will either increase or decrease in "with project" case depending on the conditions of the road network and traffic movement pattern (OD pattern).

It should be noted that all kinds of benefits are estimated quantitatively based on the traffic demand forecasts for both "with project" and "without project" cases in the whole road network of KV. The benefits of traffic accident reduction are not included to the calculation due to the lack of necessary information in relation to accident cost.

b) Unit VOC and Unit TTC

The values of unit VOC (in terms of NRs/km/vehicle) and unit TTC (in terms of NRs/hour/vehicle) are prepared for the following two cases:

- Unit VOCs based on the latest data provided by Kathmandu Sustainable Urban Transport Project, 2010, ADB.
- Unit TTCs estimated utilizing the statistical data in Nepal and the result of Data Collection Survey on Traffic Improvement in Kathmandu Valley by JICA, 2012.

Since the unit VOC in Nepal is calculated using HDM model, the model is also used in this Study.

c) Application of HDM-4 Model (VOC Module)

Table 11.2.4 shows the basic data for calculation of VOC presented in the KSUTP report. The unit VOC in this study is calculated using HDM-4 (VOC Module) model which is suitable to

[1] SCF=0.92 : Feasibility Study Report for Upgrading of Birgunj to Narayanghat Section (Draft ver), 2011
SCF=0.90 : Kathmandu Sustainable Urban Transport Project Final Report, 2010

obtain the unit VOC (NRs/km/vehicle). The VOC in KSUTP report is described in 2009 price level and thus the value has to be adjusted to present (2015) price level.

Table 11.2.4 Basic Data for Vehicle Operating Cost Calculation (2009 Price)

	Motorcycle	Car Small	Four-Wheel Drive	Utility	Truck Light	Truck Medium	Microbus	Bus Light	Bus Medium
Economic Unit Costs									
New Vehicle Cost (Rs/vehicle)	62,260.00	547,430.00	832,600.00	671,800.00	620,760.00	1,355,550.00	1,440,000.00	959,470.00	1,233,350.00
Fuel Cost (Rs/litre for MT, Rs/MJ for NMT)	47.62	47.62	45.00	45.00	44.46	44.46	44.46	44.46	44.46
Lubricant Cost (Rs/litre)	156.35	156.35	156.35	156.35	156.35	156.35	156.35	156.35	156.35
New Tyre Cost (Rs/tyre)	770.00	2,518.45	7,695.00	2,517.00	11,892.69	16,439.89	6,390.00	7,695.27	11,892.69
Maintenance Labour Cost (Rs/hour)	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Crew Cost (Rs/hour)	0.00	0.00	43.63	43.63	40.63	109.38	68.75	68.75	128.13
Interest Rate (%)	12.00	12.00	12.00	12.00	152.00	12.00	12.00	12.00	12.00
Utilization and Loading									
Kilometres Driven per Year (km)	10,000.00	20,000.00	30,000.00	30,000.00	67,000.00	84,000.00	45,000.00	42,000.00	53,000.00
Hours Driven per Year (hr)	300.00	500.00	750.00	750.00	2,100.00	2,800.00	1,400.00	1,300.00	1,700.00
Service Life (years)	10.00	15.00	15.00	15.00	10.00	12.00	10.00	10.00	12.00
Percent of Time for Private Use (%)	100.00	10.00			0.00	0.00	0.00	0.00	0.00
Gross Vehicle Weight (tons)	0.25	1.20	1.80	1.50	7.00	13.00	2.00	5.00	9.00

Source: KSUTP Final Report, Appendix

It should be noted that the application of the HDM-4 model in this evaluation is limited to the part of the VOC Module, and it is not necessary to use other models in HDM-4 such as road deterioration and maintenance effects models.

The adjusted VOC data is shown in Table 11.2.5 and estimated values of VOC derived from the HDM-4 model based on the data of KSUTP are shown in Table 11.2.6.

Table 11.2.5 Basic Data for Vehicle Operating Cost Calculation (2015 Price)

2015 Price

	Motorcycle	Safa Tempo	Car	Taxi	Truck Light	Microbus	Mini Bus	Bus	Truck
Economic Unit Costs									
New Vehicle Cost (NRs/vehicle)	96,333	847,019	1,288,252	1,039,452	960,480	2,228,060	1,484,553	1,908,318	2,816,020
Fuel Cost (NRs/liter)	71.28	71.28	67.35	67.35	70.52	70.52	70.52	70.52	60.75
Lubricant Cost (NRs/liter)	233.56	233.56	233.56	233.56	233.56	233.56	233.56	233.56	154.73
New Tire Cost (NRs/tire)	1191.39	3896.71	11906.20	3894.46	18401.13	9887.02	11906.61	18401.13	22621.00
Maintenance Labor Cost (NRs/hour)	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	46.42
Crew Cost (NRs/hour)	0.00	0.00	67.51	67.51	62.87	106.37	106.37	198.25	81.23
Interest Rate (%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Utilization and Loading									
Kilometers Driven per Year (km)	10,000	20,000	30,000	30,000	67,000	45,000	42,000	53,000	60000
Hours Driven per Year (hr)	300	500	750	750	2,100	1,400	1,300	1,700	2500
Service Life (years)	10	15	15	15	10	10	10	12	10
Percent of Time for Private Use (%)	100.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Vehicle Weight (tons)	0.25	1.20	1.80	1.50	7.00	2.00	5.00	9.00	30.00

Source: JST

Table 11.2.6 Vehicle Operating Cost at 2015 Price

Speed (km/hr)	Motorcycle	Car	Taxi	Light Truck	Truck	Micro Bus	Mini Bus	Bus	Safa Tempo
5	6.127	34.162	32.296	47.660	76.268	43.398	49.198	58.843	23.407
10	5.975	32.906	31.076	45.351	72.600	42.057	47.734	55.988	22.437
15	5.801	31.484	29.713	42.999	68.814	40.493	46.009	52.903	21.380
20	5.604	29.891	28.204	40.599	64.909	38.701	44.011	49.606	20.237
25	5.383	28.123	26.546	38.142	60.884	36.672	41.728	46.127	19.006
30	5.135	26.176	24.736	35.617	56.739	34.398	39.144	42.501	17.689
35	4.857	24.048	22.773	33.008	52.475	31.870	36.240	38.787	16.288
40	4.545	21.740	20.661	30.292	48.096	29.085	32.999	35.068	14.812
45	4.195	19.262	18.412	27.429	43.601	26.039	29.397	31.472	13.282
50	3.795	16.651	16.068	24.345	38.993	22.753	25.419	28.218	11.747
55	3.322	14.056	13.792	20.854	34.241	19.320	21.102	25.699	10.395

Source: JST

d) Determination of Unit TTC

The saving in TTC is another important component of road users' benefit. JICA Study Team has calculated the unit TTCs applying the most recent data of income per capita, percentage of the trip purpose, etc. The unit TTCs (in NRs/hour/vehicle) are shown in Table 11.2.7.

Table 11.2.7 Travel Time Cost at 2015 Price

	Motorcycle	Car	Taxi	Light Truck	Truck	Micro Bus	Mini Bus	Large Bus	Tempo
Income per capita (NRs/hour)	54.09	54.09	54.09	54.09	54.09	54.09	54.09	54.09	54.09
Average No. of Passengers	1.10	1.90	2.00	1.80	1.90	13.50	18.50	33.50	7.80
% of Trip Purpose									
Work	44.0%	57.5%				28.5%	28.5%	28.5%	28.5%
Non-Work	56.0%	42.5%				71.5%	71.5%	71.5%	71.5%
Passenger Weighted Time Value (NRs/hr/Vehicl	37.29	73.65				382.14	523.68	948.28	220.79
Crew Wage (NRs/hr/Vehicle)			68.91	95.33	112.95	169.27	192.24	215.21	34.46
Total Time Value (NRs/hr/Vehicle)	**37.29**	**73.65**	**68.91**	**95.33**	**112.95**	**551.41**	**715.92**	**1163.49**	**255.25**

*Income per capita: Estimated using Living Standard Survey 2010/11 and GDP per capita

*Average No. of Passengers, % of Trip Purpose: Data Collection Survey on Traffic Improvement in Kathmandu Valley (2012)

*Crew Wage: Convert from Working Paper Vehicle Operating Costs and CPI

Source: JST

e) Estimated Economic Benefits

VOC and TTC saving benefits are obtained by applying the above unit values of road user cost (RUC) to the results of traffic demand forecasts (vehicle-km, vehicle-hour) for both "with project" and "without project" cases. The estimated economic benefits are summarized in Table 11.2.8.

Table 11.2.8 Benefit of Case 1 and Case 2

Case 1

Year	Vehicle Type	Motorcycle	Safa Tempo	Car	Utility	Light Truck	Truck	Micro Bus	Mini Bus	Bus	Total
2020	VOC Savings	622.61	44.90	1,091.04	427.68	427.32	184.07	412.14	418.53	44.37	3,672.67
	TTC Savings	204.69	30.58	175.26	74.15	55.52	23.52	297.24	315.41	60.76	1,237.11
	Total	827.30	75.48	1,266.30	501.82	482.83	207.59	709.38	733.94	105.13	4,909.78
2025	VOC Savings	1,192.61	50.56	1,521.82	541.98	840.56	389.10	404.24	718.02	57.94	5,716.83
	TTC Savings	408.62	37.32	266.76	109.49	103.82	45.47	324.92	496.36	76.03	1,868.77
	Total	1,601.23	87.88	1,788.58	651.47	944.38	434.57	729.16	1,214.37	133.97	7,585.60
2030	VOC Savings	2,199.33	93.08	3,610.17	1,395.92	2,155.36	1,014.55	720.23	1,351.13	129.56	12,669.35
	TTC Savings	771.24	70.83	658.28	279.90	276.50	119.67	573.34	979.77	166.16	3,895.69
	Total	2,970.57	163.92	4,268.45	1,675.82	2,431.86	1,134.22	1,293.57	2,330.90	295.72	16,565.03

Case 2

Year	Vehicle Type	Motorcycle	Safa Tempo	Car	Utility	Light Truck	Truck	Micro Bus	Mini Bus	Bus	Total*
2020	VOC Savings	622.61	44.90	1,091.04	427.68	427.32	184.07	412.14	418.53	44.37	3,672.67
	TTC Savings	204.69	30.58	175.26	74.15	55.52	23.52	297.24	315.41	60.76	1,237.11
	Total	827.30	75.48	1,266.30	501.82	482.83	207.59	709.38	733.94	105.13	4,909.78
2025	VOC Savings	1,527.57	240.78	2,713.35	1,123.24	1,113.02	544.20	2,369.61	3,669.53	266.43	13,382.26
	TTC Savings	511.36	122.98	381.84	163.95	133.47	56.28	1,314.16	2,245.18	250.70	5,491.31
	Total	2,038.93	363.76	3,095.18	1,287.19	1,246.48	600.48	3,683.77	5,914.71	517.13	18,873.57
2030	VOC Savings	2,633.87	423.28	5,407.99	2,164.30	2,427.75	1,175.98	3,113.72	5,342.13	427.35	23,036.06
	TTC Savings	941.38	223.59	849.11	360.43	323.55	138.55	1,819.11	3,408.91	419.24	9,729.24
	Total	3,575.25	646.88	6,257.09	2,524.73	2,751.30	1,314.53	4,932.83	8,751.04	846.59	32,765.30

Unit: Million NRs/year, *: including benefit of diversion to NPT
Source: JST

3) Evaluation Method

In general, the economic benefits of road projects are estimated as the difference of RUC such as VOC and TTC between "Without project" case and "With project" case.

"With project" case in this study means all project components are implemented in accordance with the implementation schedule while "Without project" case means no project is implemented. The other road network conditions remain the same in "With project" case and the "Without project" case.

4) Preconditions for Cost-Benefit Analysis

The preconditions set for the cost-benefit analysis are as follows:

1) Price Level (Base Year) : 2015 prices

2) Opening Year of the Project : 2020, 2025, 2030

3) Evaluation Period : 20 years from 2030 (after opening AGT)

4) Residual Values : No residual values are counted

5) Opportunity Cost of Capital (Discount Rate) : 12%

The following are the cases set for evaluation:

Case 1: Implementation of road development

Case 2: Implementation of road and public transport development

5) Results of Analysis

The result of the economic evaluation for case1 and case2 are shown in Table 11.2.9 and the cost-benefit stream (cash flow) is presented in Table 11.2.10 and Table 11.2.11.

Table 11.2.9 Result of Economic Analysis

	Case 1	Case 2
1) Economic Internal Rate of Return (EIRR)	14.7%	17.4 %
2) Benefit/Cost Ratio (B/C)	1.26	1.35
3) Net Present Value (NPV), in million NRs	11,058.6	27,119.4

The above result indicates the both cases are economically feasible with a value of EIRR higher than the opportunity cost of capital (>12%), B/C ratio higher than 1.0, and positive value of NPV (>0).

Table 11.2.10 Cost Benefit Stream (Case 1)

Unit: Million NRs

Year	ECONOMIC COST				ECONOMIC BENEFIT			B-C
	Investment	Maintenance Cost		Total Cost	VOC Savings	TTC Savings	Total Benefit	
		Routine	Periodic					
2014								
2015	0.00			0.00			0.00	0.00
2016	6925.04			6925.04			0.00	-6925.04
2017	6925.04			6925.04			0.00	-6925.04
2018	8701.14			8701.14			0.00	-8701.14
2019	8601.29			8601.29			0.00	-8601.29
2020	8588.84	145.22	0.00	8734.06	3672.67	1237.11	4909.78	-3824.28
2021	5509.42	145.22	0.00	5654.65	4081.50	1363.44	5444.95	-209.70
2022	5509.42	145.22	0.00	5654.65	4490.33	1489.78	5980.11	325.46
2023	5509.42	145.22	0.00	5654.65	4899.17	1616.11	6515.27	860.63
2024	4830.51	145.22	48.87	5024.60	5308.00	1742.44	7050.44	2025.84
2025	3523.31	236.21	0.00	3759.52	5716.83	1868.77	7585.60	3826.08
2026	2134.69	236.21	0.00	2370.90	7107.33	2274.15	9381.49	7010.59
2027	1950.34	236.21	0.00	2186.54	8497.84	2679.54	11177.37	8990.83
2028	2630.73	236.21	0.00	2866.94	9888.34	3084.92	12973.26	10106.32
2029	2179.49	236.21	83.24	2498.93	11278.84	3490.30	14769.15	12270.21
2030	680.39	252.80	0.00	933.19	12669.35	3895.69	16565.03	15631.84
2031		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2032		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2033		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2034		252.80	104.98	357.78	12669.35	3895.69	16565.03	16207.25
2035		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2036		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2037		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2038		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2039		252.80	104.98	357.78	12669.35	3895.69	16565.03	16207.25
2040		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2041		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2042		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2043		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2044		252.80	104.98	357.78	12669.35	3895.69	16565.03	16207.25
2045		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2046		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2047		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2048		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
2049		252.80	104.98	357.78	12669.35	3895.69	16565.03	16207.25
2050		252.80	0.00	252.80	12669.35	3895.69	16565.03	16312.23
	74199.09	7215.92	552.03	81967.05	330997.12	102656.00	433653.12	351686.08

EIRR	14.7%
B/C (*)	1.26
NPV (*)	11058.6

(*):Discount Rate=12%
in Million NRs

Source: JST

Table 11.2.11 Cost Benefit Stream (Case 2)

Unit: Million NRs

Year	ECONOMIC COST				ECONOMIC BENEFIT			B-C
	Investment	Maintenance Cost		Total Cost	VOC Savings	TTC Savings	Total Benefit	
		Routine	Periodic					
2014								
2015	0.00			0.00			0.00	0.00
2016	6925.04			6925.04			0.00	-6925.04
2017	6925.04			6925.04			0.00	-6925.04
2018	8701.14			8701.14			0.00	-8701.14
2019	8657.25			8657.25			0.00	-8657.25
2020	9489.70	145.45	0.00	9635.15	3672.67	1237.11	4909.78	-4725.37
2021	6466.24	145.45	0.00	6611.70	5614.59	2087.95	7702.54	1090.84
2022	6466.24	145.45	0.00	6611.70	7556.51	2938.79	10495.30	3883.60
2023	11728.90	145.45	0.00	11874.35	9498.42	3789.63	13288.06	1413.70
2024	11049.99	145.45	51.19	11246.63	11440.34	4640.47	16080.81	4834.18
2025	9742.79	445.19	0.00	10187.98	13382.26	5491.31	18873.57	8685.59
2026	8126.29	445.19	0.00	8571.48	15313.02	6338.90	21651.92	13080.44
2027	24291.30	445.19	0.00	24736.49	17243.78	7186.49	24430.26	-306.23
2028	24971.69	445.19	0.00	25416.88	19174.54	8034.07	27208.61	1791.73
2029	29278.01	445.19	90.20	29813.40	21105.30	8881.66	29986.96	173.56
2030	16804.12	3647.96	0.00	20452.09	23036.06	9729.24	32765.30	12313.22
2031		3647.96	0.00	3647.96	23036.06	9729.24	32765.30	29117.34
2032		3647.96	0.00	3647.96	23036.06	9729.24	32765.30	29117.34
2033		3647.96	0.00	3647.96	23036.06	9729.24	32765.30	29117.34
2034		3647.96	114.26	3762.23	23036.06	9729.24	32765.30	29003.08
2035		3647.96	0.00	3647.96	23036.06	9729.24	32765.30	29117.34
2036		3655.18	0.00	3655.18	23036.06	9729.24	32765.30	29110.12
2037		3655.18	0.00	3655.18	23036.06	9729.24	32765.30	29110.12
2038		3655.18	0.00	3655.18	23036.06	9729.24	32765.30	29110.12
2039		3655.18	114.26	3769.45	23036.06	9729.24	32765.30	28995.86
2040		4366.57	0.00	4366.57	23036.06	9729.24	32765.30	28398.73
2041		4366.57	0.00	4366.57	23036.06	9729.24	32765.30	28398.73
2042		4366.57	0.00	4366.57	23036.06	9729.24	32765.30	28398.73
2043		4366.57	0.00	4366.57	23036.06	9729.24	32765.30	28398.73
2044		4366.57	114.26	4480.84	23036.06	9729.24	32765.30	28284.46
2045		4377.40	0.00	4377.40	23036.06	9729.24	32765.30	28387.90
2046		4377.40	0.00	4377.40	23036.06	9729.24	32765.30	28387.90
2047		4377.40	0.00	4377.40	23036.06	9729.24	32765.30	28387.90
2048		4377.40	0.00	4377.40	23036.06	9729.24	32765.30	28387.90
2049		4377.40	114.26	4491.67	23036.06	9729.24	32765.30	28273.64
2050		5444.47	0.00	5444.47	23036.06	9729.24	32765.30	27320.83
	189623.75	88626.10	598.44	278848.29	607758.69	254940.49	862699.18	583850.89

EIRR	17.4%
B/C (*)	1.35
NPV (*)	27119.4

(*):Discount Rate=12%
in Million NRs

Source: JST

6) Sensitivity Analysis

The sensitivity analysis is carried out in order to examine the robustness of economic feasibility by changing the values of cost and benefit within a probable range against the base case. The following cases are prepared for the sensitivity tests:

1) Project costs go up by: +10%, +15%, and +20%

2) Project benefits go down by: -10%, -15%, and -20%

3) Combinations of all the above

The result of the sensitivity analysis is summarized in Table 11.2.12 below. In case of increasing project cost or decreasing project benefit, EIRR will be lower than 12.0%. Therefore, it is necessary to estimate the cost and benefit precisely when the feasibility study is conducted.

Table 11.2.12 Sensitivity Analysis (Case 1)

Sensitivity Analysis		Benefit			
		Base Case	- 10%	- 15%	- 20%
Cost	Base Case	14.7%	13.4%	12.8%	12.1%
	+ 10%	13.6%	12.4%	11.7%	11.1%
	+ 15%	13.0%	11.9%	11.3%	10.6%
	+ 20%	12.6%	11.4%	10.8%	10.2%

Source: JST

Table 11.2.13 Sensitivity Analysis (Case 2)

Sensitivity Analysis		Benefit			
		Base Case	- 10%	- 15%	- 20%
Cost	Base Case	17.4%	15.4%	14.4%	13.3%
	+ 10%	15.6%	13.7%	12.7%	11.7%
	+ 15%	14.8%	12.9%	12.0%	11.0%
	+ 20%	14.0%	12.2%	11.3%	10.3%

Source: JST

(2) Financial Evaluation

1) General

Financial analysis is generally conducted for projects which generate revenues/income. Unlike the economic analysis, the purpose of financial analysis is to investigate the financial viability of a project comparing the revenues with costs in terms of market prices (financial costs). The financial analysis of the public transport project (AGT and BRT) is conducted only for the Case 2.

2) Calculation of BRT and AGT Fare Revenues

The expected conditions of BRT and AGT operation are presented in Table 11.2.14. Fare revenues which will be generated by the future traffic demand of BRT and AGT are calculated based on the conditions.

Table 11.2.14 Expected Conditions of the BRT and AGT Operation

	BRT	AGT
Operation	From 2025	From 2030
Fare	Depend on the distance	Rs. 30
	BRT+AGT: BRT Fare + 10Rs	
Passenger Volume	Based on the result of Traffic Demand Forecast Assumed growth rate: 2%/year	

Source: JST

3) Financial Evaluation

The financial cash flows are shown in Table 11.2.15. All cost items are in market prices (financial costs) and compared with future fare revenues. The Financial Internal Rate of Return (FIRR) is not computed (lower than 0%) since investment cost is high, but the yearly Operation and Maintenance (O&M) cost is covered by the revenue. Thus Government of Nepal needs financial assistance for investment cost. However the result of economic evaluation for installation of new public transport indicates it is feasible, and there is benefit by installation of new public transport system.

Table 11.2.15 Financial Cash Flow (BRT and AGT)

Unit: Million NRs

Year	FINANCIAL COST				REVENUE	BALANCE			
	Investment	Maintenance Cost		Total Cost					Accumulated Surplus
		Routine	Periodic						
2014									
2015	0.00	0	0	0.00		0.00	1		
2016	0.00	0	0	0.00		0.00	2		
2017	0.00	0	0	0.00		0.00	3		
2018	0.00	0	0	0.00		0.00	4		
2019	69.72	0	0	69.72		-69.72	5		
2020	1116.08	0.255	0.00	1116.34		-1116.34	6		
2021	1185.80	0.255	0.00	1186.05		-1186.05	7		
2022	1185.80	0.255	0.00	1186.05		-1186.05	8		
2023	6952.49	0.255	0.00	6952.75		-6952.75	9		
2024	6952.49	0.255	2.55	6955.30		-6955.30	10	(O & M)/R	
2025	6952.49	229.656	0.00	7182.15	2702.08	-4480.07	11	8.5%	-4480.07
2026	6667.04	229.656	0.00	6896.70	2756.12	-4140.57	12	8.3%	-8620.64
2027	24638.86	229.656	0.00	24868.51	2811.25	-22057.27	13	8.2%	-30677.91
2028	24638.86	229.656	0.00	24868.51	2867.47	-22001.04	14	8.0%	-52678.95
2029	29784.07	229.656	7.65	30021.38	2924.82	-27096.56	15	8.1%	**-79775.51**
2030	17718.39	3730.948	0.00	21449.33	4134.61	-17314.73	16	90.2%	-17314.73
2031		3730.948	0.00	3730.95	4217.30	486.35	17	88.5%	-16828.38
2032		3730.948	0.00	3730.95	4301.65	570.70	18	86.7%	-16257.68
2033		3730.948	0.00	3730.95	4387.68	656.73	19	85.0%	-15600.95
2034		3730.948	10.20	3741.15	4475.43	734.28	20	83.6%	**-14866.66**
2035		3730.948	0.00	3730.95	4564.94	833.99	21		
2036		3738.882	0.00	3738.88	4656.24	917.36	22		
2037		3738.882	0.00	3738.88	4749.36	1010.48	23		
2038		3738.882	0.00	3738.88	4844.35	1105.47	24		
2039		3738.882	10.20	3749.08	4941.24	1192.16	25		
2040		4520.632	0.00	4520.63	5040.06	519.43	26		
2041		4520.632	0.00	4520.63	5140.86	620.23	27		
2042		4520.632	0.00	4520.63	5243.68	723.05	28		
2043		4520.632	0.00	4520.63	5348.56	827.92	29		
2044		4520.632	10.20	4530.83	5455.53	924.69	30		
2045		4532.533	0.00	4532.53	5564.64	1032.10	31		
2046		4532.533	0.00	4532.53	5675.93	1143.40	32		
2047		4532.533	0.00	4532.53	5789.45	1256.92	33		
2048		4532.533	0.00	4532.53	5905.24	1372.70	34		
2049		4532.533	10.20	4542.73	6023.34	1480.61	35		
2050		5705.133	0.00	5705.13	6143.81	438.68	36		
	127862.09	89461.73	51.00	217374.83	120665.64	-96709.19			

Source: JST

CHAPTER 12 PRIORITY ACTION PLAN

12.1 Criteria for Selection of Priority Project

"Establishment of sustainable urban transport network with high mobility, safety and comfort" is instituted as the vision for the Urban Transport Improvement for Kathmandu Valley in Chapter 6, 6.2.

The following criteria is selected as the factors which correspond the envisaged vision.

Number of Beneficiaries

Number of beneficiaries of the projects or studies is an important factor for the sustainable development and also setting the priority of the projects. For instance, the economic feasibility of projects requires a large amount of capital investment and also longer implementation period. The projects covering wider areas and serving more people shall be considered to have additional advantage over the small size projects.

Urgency

Traffic congestion is hampering the sustainable development of the valley. The decongestion of the traffic bottleneck shall be urgently improved. Accordingly, the urgent requirements for the implementation of projects especially to alleviate the traffic congestion directly or indirectly shall be evaluated highly.

Readiness

The maturity of the projects is also an important factor in the evaluation of the projects. Land acquisition and resettlement due to construction of the projects may result in longer delay of the implementation of the projects disturbing sustainable development of the valley.

Consistency with the Policies

KUTMP proposes projects through the comprehensive transport development plan based on the newly established land use plan. To invest in a project from the limited government resources, the implementation of the project shall be consistent with the national, regional and sector-wide development plans, land use plan and policies. A project which is already authorized in the list of governmental plans or policies, or may strongly contribute to the achievement of such policies shall be considered more important.

Contribution to Disaster Measures or Traffic Safety

Safety issues such as disasters and traffic accidents are hampering the people's urban life and disturbing the sustainable development. The proposed projects in KUTMP are expected to contribute towards alleviating these issues.

Environmental/Social Evaluation

Projects which improve the environmental condition or have little effect on the environment contribute to sustainable development. For example, improvement of air quality and noise level has high priority; projects with heavy impact on preserved forest, increased danger of landslides or existence of involuntary resettlement are given less priority.

12.2 Selection of Priority Projects

12.2.1 Projects to be Implemented in Phase 1

Priority projects shall be selected from the projects in 1st phase (Short term) of the staging plan described in Chapter 11. Long list of the projects regarding institutional improvement in 1st phase is shown in Table 12.2.1.

Table 12.2.1 Long list of Institutional Improvement Project in 1st Phase (2016-2020)

Sector		Objective	Project
1. Land Use	1.1 Institution	・ Establishment/enactment of strict land use and development control system.	**[1.1.1] Technical assistance for land use control system** Technical assistance for establishment of land use and development control system
		・ Study/technical assistance for reinforcement of land pooling system.	**[1.1.2] Pilot study on land pooling system** Implementation of pilot study and technical assistance for reinforcement of land pooling system
	1.2 Land development and readjustment	・ Selection of pilot urban development area and establishment of institutional system for large scale development.	**[1.2.1] FS for new urban development** Selection of priority development area and implementation of FS for selected development area. Finding out necessary institutional arrangement and financial system.
	1.3 Disaster management	・ Assessment of buildings along emergency transport road network	**[1.3.1] Assessment of buildings along ETRN** Assessment of building condition along ETRN and evaluate blockade of the network
		・ Establishment of system for subsidising building reinforcement along emergency transport road network.	**[1.3.2] Study on reinforcement of building along ETRN** Implementation of study for measures to strengthen building along ETRN from financial and institutional aspect
2. Road	2.1 Institution	・ Establishment of measures for land acquisition in densely inhabited area.	**[2.1.1] Study on land acquisition system for roads** Study on land acquisition system for new roads in urbanized area including application of land pooling system.
		・ Establishment of institution for planning and implementation of road development in urban area.	**[2.1.2] Establishment of comprehensive administrative body for urban transport** Study and consensus building for comprehensive administrative body for urban transport planning and development
	2.2 Road development	・ Implementation of emergency projects including improvement of Bottlenecks.	**[2.2.1] T-M flyover** **[2.2.2] New Baneshwor underpass** **[2.2.3] Improvement of Arniko HW** **[2.2.4] Bagmati River Road north section** **[2.2.5] Boudha Road (F026)** **[2.2.6] Access Road to Nagdhunga TN** **[2.2.7] Inner Ring Road east-south section connection**

Sector		Objective	Project
			[2.2.8]Jadibuti-Pepsi Cola Road **[2.2.9] Surbyabinayak-Dhulikhel road** **[2.2.10] Golf course-Bagmati Link**
		・ Development of roads connecting pilot development area	**[2.2.21] New Road for Anantalingeshwor Sub-center** **[2.2.22] Outer Ring Road west section** **[2.2.23] Outer Ring Road east section** **[2.2.24] Bhaktapur east road** **[2.2.25] Manohara-Imadol road**
		・ Development of roads proposed in emergency transport network plan.	**[2.2.31] Dhobi Khola disaster road** **[2.2.32]Bishnumati river disaster road** **[2.2.33] Bishnumati-Dhobi Khola disaster road connection** **[2.2.34] Dhobi Khol-Makaibari disaster road**
		・ Detailed study for development of Inner Ring Road.	**[2.2.41] Preparatory study for implementation of Inner Ring Road** Analysis of effectiveness and issues in implementation of Inner Ring Road
	2.3 Road related facility	・ Establishment of regulation for obligated parking lot	**[2.3.1] Technical assistance for parking control** Study and technical assistance for development of parking facilities and regulation for obligated parking lot.
3. Public transport	3.1 Institution	・ Institutional reinforcement and capacity development of DOTM	**[3.1.1] Institutional reinforcement of DOTM** Institutional reinforcement and capacity development of DOTM.
		・ Reorganization of small entrepreneurs to large scale consortium.	**[3.1.2] Reorganization of bus operators** Reorganization of small bus entrepreneurs to large scale consortium and capacity development for controlled bus operation.
	3.2 Public transport	・ Implementation of pilot route project.	**[3.2.1] Implementation of pilot route project** Implementation of pilot routes proposed by KSUTP
		・ Restructuring of bus routes.	**[3.2.2] Restructuring of bus routes** Review of bus operation routes and restructuring bus operation routes
	3.3 Public transport related facility	・ Development of bus depot.	**[3.3.1] Development of bus depot**

Source: JICA Study Team

12.2.2 Evaluation of Priority Projects

Although economic and financial feasibility is the most important factor to prioritize the projects, these feasibility evaluations were conducted only for the limited projects whose economic and financial benefits were quantifiable. Accordingly, in addition to the results of environmental and social consideration, a multi-criteria analysis was preliminarily conducted for the selection of priority projects. The following evaluation factors were deployed for the multi-criteria analysis.

For the evaluation of priority projects, a threshold is defined for each evaluation criteria as shown in Table 12.2.2.

Table 12.2.2 Ranking Threshold by Evaluation Criteria for Selecting Priority Projects

Criteria	Weight	Indicator	High (10pt.)	Mid (5pt.)	Low (1pt.)
Number of beneficiaries by decongestion	0.2	Number/ Coverage area	Very large	Large	Medium
Urgency	0.2	-	Direct/quick effects	A certain effects	Not much urgent
Readiness	0.1	-	Ready to implement	Will be ready soon	Still planning
Consistency with the Policies (i.e. KVDA Vision Paper, authorized plan by GoN)	0.1	-	Already planned	Consistent	Not consistent
Contribution to disaster measures or traffic safety	0.2	-	Direct contribution	Indirect Contribution	No contribution
Environmental/Social Consideration	0.2	SEA Result	Little impact Large improvement	Some impact Some improvement	Serious impact No improvement

Source: JICA Study Team

After applying the criteria and its ranking, the result of analysis is obtained as shown in Table 12.2.3.

Table 12.2.3 Summary of Multi-criteria Analysis Results

Project Name	Evaluation						Total Score
	Number of beneficiaries	Urgency	Readiness	Consistency	Contribution	Environmental /Social Evaluation	
	Weight						
	0.2	**0.2**	**0.1**	**0.1**	**0.2**	**0.2**	
[1.1.1] Technical assistance for land use control system	10	5	1	5	5	10	6.6
[1.1.2] Pilot study on land pooling system	1	5	10	5	5	10	5.7
[1.2.1] FS for new urban development	10	5	10	5	5	10	7.5
[1.3.1] Assessment of buildings along ETRN	5	5	1	5	10	10	6.6
[1.3.2] Study on reinforcement of buildings along ETRN	5	5	1	5	10	10	6.6

[2.1.1] Study on land acquisition system for roads	1	5	1	5	5	10	5.2
[2.1.2] Establishment of comprehensive administrative body for urban transport	5	1	1	5	1	10	4.0
[2.2.1] T-M flyover	5	10	10	5	10	10	8.5
[2.2.2] New Baneshwor underpass	5	10	10	5	10	10	8.5
[2.2.3] Improvement of Arniko HW	10	5	5	10	10	5	8.5
[2.2.4] Bagmati River Road north section	10	10	5	10	10	1	7.7
[2.2.5] Boudha Road (F026)	1	5	1	5	5	1	3.0
[2.2.6] Access Road to Nagdhunga TN	1	1	1	1	1	5	2.6
[2.2.7] Inner Ring Road weast-south section connection	10	10	5	10	10	1	7.7
[2.2.8]Jadibuti-Pepsi Cola Road	1	5	10	5	1	10	4.9
[2.2.9] Surbyabinayak-Dhulikhel road	10	10	5	10	5	10	8.5
[2.2.10] Golf course-Bagmati Link	5	5	10	5	1	10	5.7
[2.2.21] New Road for Anantalingeshwor Sub-center	10	5	1	5	5	5	5.6
[2.2.22] Outer Ring Road west section	10	1	5	10	5	5	5.7
[2.2.23] Outer Ring Road east section	10	1	5	10	5	5	5.7
[2.2.24] Bhaktapur east road	10	5	1	5	5	10	6.6
[2.2.25] Manohara-Imadol road	10	5	1	5	5	10	6.6
[2.2.31] Dhobi Khola disaster road	5	5	1	1	10	10	6.2
[2.2.32]Bishnumati river disaster road	5	5	1	1	10	10	6.2
[2.2.33] Bishnumati-Dhobi Khola disaster	5	5	1	1	10	5	5.2

road connection							
[2.2.34] Dhobi Khol-Makaibari disaster road	5	5	1	1	10	1	4.4
[2.2.41] Preparatory study for implementation of Inner Ring Road	10	10	5	10	5	10	8.5
[2.3.1] Technical assistance for parking control	5	5	1	1	5	10	5.2
[3.1.1] Institutional reinforcement of DOTM	1	5	10	5	5	10	5.7
[3.1.2] Reorganization of bus operators	10	10	5	5	1	10	6.2
[3.2.1] Implementation of pilot route project[1]	1	5	5	5	1	1	2.6
[3.2.2] Restructuring of bus routes	10	5	5	5	1	1	4.4
[3.3.1] Development of bus depot	10	5	1	5	1	5	4.8

Source: JICA Study Team

12.2.3 Result of Evaluation

As a result of the evaluation, projects shown in Table 12.2.4 are selected as high priority projects. Among the high priority projects, implementation of [2.2.10] Surbyabinayak-Dhulikhel road has already commenced, therefore the number of high priority projects proposed in this study reduces to six.

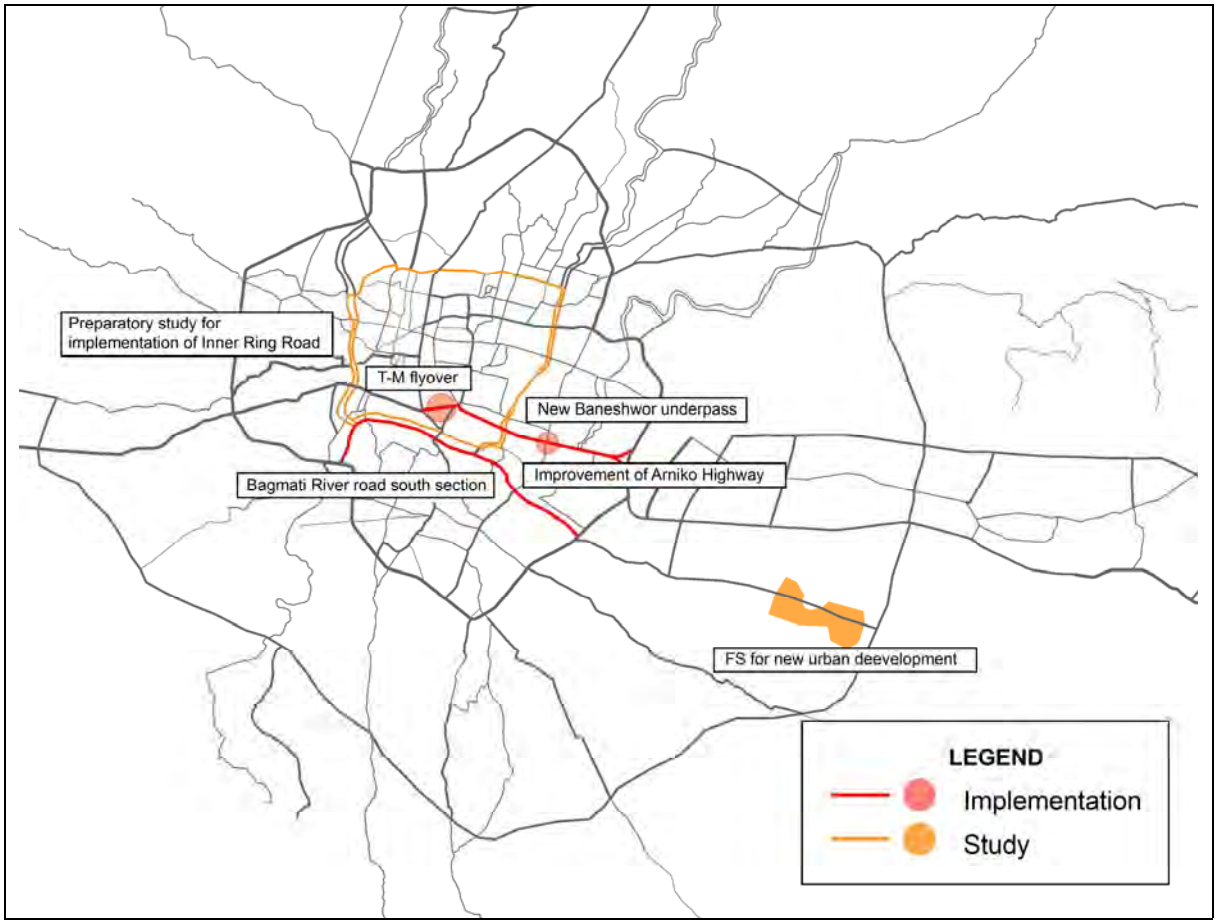
Table 12.2.4 Selected High Priority Projects

	Project Name	Score
1	[2.2.41] Preparatory study for implementation of Inner Ring Road	8.5
1	[2.2.1] T-M flyover	8.5
1	[2.2.2] New Baneshwor underpass	8.5
1	[2.2.3] Improvement of Arniko HW	8.5
1	[2.2.10] Surbyabinayak-Dhulikhel road	8.5
2	[2.2.4] Bagmati River Road north section	7.7
3	[1.2.1] FS for new urban development	7.5

Source: JICA Study Team

For the [1.2.1] FS for new urban development, new urban area in east southeast area is most appropriate because of its smaller area. Location of priority projects is shown in Figure 12.2.1.

[1] Pilot route referres to the Project "Selection of Pilot Routes, March, 2013" by KSUTP, explained in 3.2.2, (2) (P3-28)



Source: JICA Study Team

Figure 12.2.1 Location of Priority Projects

12.3 Cost Estimates

Cost estimates have been already conducted in Chapter 11. Table 12.3.1 shows the estimated cost for the priority projects.

Table 12.3.1 Cost Estimates for Priority Projects

Unit: million NRP

	Cost (Including land acquisition and building compensation)	Cost (Excluding land acquisition and building compensation)
T-M flyover	7,292.7	5,617.5
New Baneshwor underpass	2,242.0	2,242.0
Improvement of Arniko HW	674.6	674.6
Bagmati River Road north section	2771.3	496.4

Source: JICA Study Team

Regarding the two study projects, necessary cost will be estimated after scrutinizing the TOR.

12.3.1 Selection of Pilot Project

Based on the aforesaid basic Policy, Pilot project is selected by the following procedure:

(1) 1st STEP: Candidate Pilot Project

Basic policy one stipulates the priority projects are the candidate for Pilot Project. Priority projects are selected in 12.2 as shown in Table 12.3.2. Suryabinayak-Dhulikhel road which has been commenced, is excluded from the candidate Pilot Project.

Table 12.3.2 Candidate Pilot Project

Project Name
1. Preparatory study for implementation of Inner Ring Road
2. T-M flyover
3. New Baneshwor underpass
4. Improvement of Arniko HW
5. Bagmati River Road north section
6. FS for new urban development

Source: JICA Study Team

(2) Evaluation of Candidate Project

Candidate pilot project is evaluated by its conformity with the basic policy two, three and four. Description of evaluation is shown in Table 12.3.3.

Table 12.3.3 Evaluation of Candidate Pilot Project

	Basic policy 2 Immediate Efficacy	Basic policy 3 Consensus	Basic Policy 4 Project method	Overall
1. Preparatory study for implementation of Inner Ring Road	Completion of the project will take time. Efficacy will appear in mid-term.	Necessity of project can be acknowledged by citizen, but prudent discussion with PAPs is necessary.	Appropriate method should be developed for the implementation. After that the method will be expanded.	Implementation of the project was determined as mid-term. Implementation method other than Pilot Project shall be discussed.
Validity as PP	Low	Low	High	Low
2. T-M flyover	Without large land acquisition from residents, the project will be implemented in short duration.	Consensus among citizen can be acquired. Consent of relevant organization will be acquired by alternative plan.	First implementation of flyover project in built-up area and method will be expanded in KV.	High validity for Pilot Project. Alternative plan is necessary for the certainty of the project.
Validity as PP	Highest	High	Highest	Highest
3. New Baneshwor underpass	Without land acquisition from residents, the project will be implemented in short duration.	No difficulty in consensus building.	Short bridge and installation of wall are common technology in KV.	Although the project will be conducted without difficulty, will not bring about new methodology.
Validity as PP	Highest	Highest	Low	High
4. Improvement of Arniko HW	Without land acquisition from residents, the	Arniko HW was just improved in 2014. Frequent	Expansion is unlikely since no other road has	Although the project will be conducted without

	project will be implemented in short duration.	improvement may be controversial.	service road in KV.	difficulty, the extent of outcome will not expand beyond the project.
Validity as PP	Highest	Low	Low	Low
5. Bagmati River Road north section	The project requires land acquisition from residents and will take time.	Necessity of project can be acknowledged by citizen, but prudent discussion with PAPs is necessary.	Ordinary construction by ordinary technology.	Implementation of the project will take time and implementation method other than Pilot Project shall be discussed.
Validity as PP	Low	Low	Low	Low
6. FS for new urban development	Completion of the project will take time. Efficacy will appear in mid-term.	Necessity of project can be acknowledged by citizen, but prudent discussion with PAPs is necessary.	Development of new urban area by LP project should be expanded in KV area.	The outcome of the project will appear in mid-term.
Validity as PP	Low	Low	Highest	Low

Source: JICA Study Team

As the result of evaluation, Tripureshwor- Maitighar flyover (T-M flyover)project is selected as the Pilot Project. Implementation method other than Pilot Project shall be discussed.

CHAPTER 13 PRE-FEASIBILITY STUDY ON T-M FLYOVER (TRIPURESHWOR INTERSECTION – MAITIGHAR INTERSECTION)

13.1 Background

13.1.1 Background

Thapathali intersection is one of the most saturated intersections in Kathmandu Valley as most of the traffic in the north-south direction and east-west direction is forced to pass through the intersection. Moreover, there is no connection to Arniko Highway (National Road H03) and Tribhuvan Highway (National Road H02) on the section between Maitighar intersection and Tripureshwor intersection. Hence, construction of the section between Tripureshwor intersection and Maitighar intersection is proposed in the Master Plan and Pre-feasibility Study (Pre-FS) on Tripureshwor - Maitighar Flyover (T-M Flyover) is selected as the Pilot Project of the study.

13.1.2 Objective and Scope of the Study

(1) Objective

The objective of the Pilot Project is to verify the effectiveness and feasibility of the project proposed in the Master Plan, and to conduct the study for realization of the project.

Objective of Pre-feasibility study on Tripureshwor-Maitigharis flyover is to conduct preliminary design, evaluate environmental and economic effects, prove viability and effectiveness and consequently accelerate the materialization of the project.

(2) Scope of the Study

The scope of the study is shown as follows:

1) Investigation of present condition of the study area
2) Examination of present traffic condition of the study area
3) Clarification of function and drawing up of plan options
4) Preliminary engineering design
5) Cost estimates
6) Traffic analysis
7) Environmental and social considerations
8) Construction plan and implementation plan
9) Maintenance plan
10) Conclusion and Recommendation

13.1.3 Study Area of Pilot Project

The study area of the Pilot Project is the area which includes Tripureshwor intersection, Thapathali intersection, Maitighar intersection and Prithvi Path, and its surrounding area as shown in Figure 13.1.1.

Source: JST

Figure 13.1.1 Study Area of Pilot Project

13.1.4 Basis of the Study

Basic condition for conducting Pre-FS on T-M Flyover is as follows:

1) Target year

   Target year of the construction of T-M Flyover is 2020.

2) Free road

   In order to secure free traffic movement, T-M Flyover will be operated as free road.

3) Traffic during construction

   Considering current traffic condition, traffic movement will be maintained during construction.

4) AGT route

   The Master Plan proposes AGT route in the study area of Pilot Project. The structure of the Flyover shall take AGT into consideration.

5) Pedestrian

   Many pedestrians are concentrated within the study area of Pilot Project. The plan shall secure the safety and convenience of pedestrians.

13.2 Present Condition of Study Area

13.2.1 Physical Condition

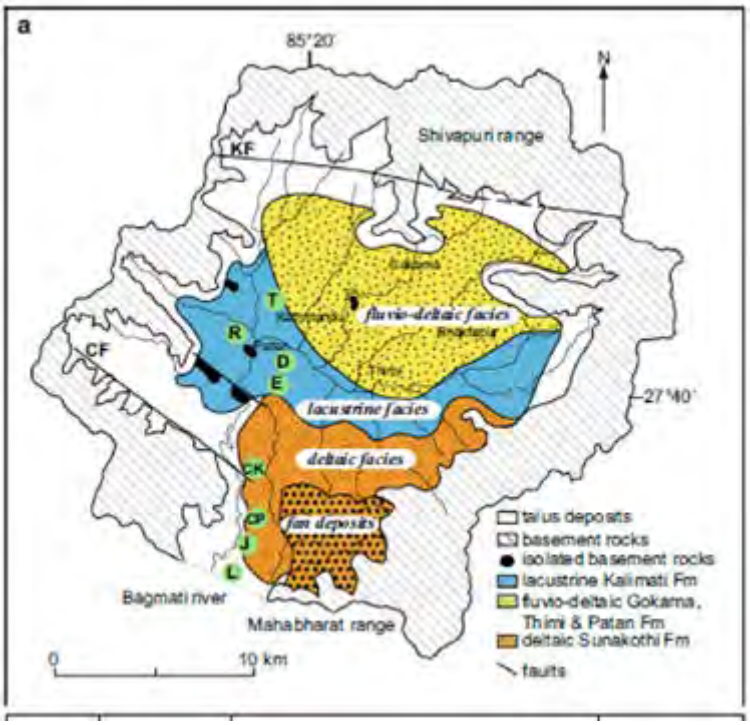
13.2.1.1 Land Form

The Southern part of the proposed area is bounded by Bagmati River with bank elevation of about 1279 m (Tukucha & Bagmati Confluence Ponit), The average ground level of built up area between Maitighar to Tripureswar via Thapathali is roughly 1290m and that of north side area (road joining Sundhara, Sahidgate, Bhadrakali and Tundikhel) is about 1300m. This means, the land for the proposed project can be categorically divided into three profiles, the upper land having average level of 1300m, the middle land having average level of 1290m and lower land or river bank level with average level 1280m. Tukucha River flows in the North-South direction nearly bisecting the project

area in the middle. It collects most of the local drains of the area and carries them to Bagmati River. Some drains follow the catch drains constructed along the roads either side.

13.2.1.2 Sub-soil Condition

As per the geological classification, the proposed project area entirely belongs to Kalimati Formation as shown in Figure 13.2.1.



Source: https://earth-planets-space.springeropen.com/articles/10.1186/s40623-016-0413-5

Figure 13.2.1 Sub-soil Condition of the Study Area

Kalimati Formation is defined as Lacustrine Plains (or lake plains) made after getting filled by incoming sediment in a lake over a time period. A sub-soil investigation (bore hole 40m deep) conducted at Maitighar also confirms the same formation. It does not contain any strong strata to take the load expected from the structures. Only the frictional piles are feasible to transmit the load of the structure founditions under such sub soil condition.

13.2.1.3 Public Utilities

Since the proposed project area is a built up area and located at the very centre of Kathmandu Valley Settlement, there are all types of public utilities that have been developed and used throughout this area. The major public utlities that will be interfered with by the project are telecommunication networks, drinking water supply networks, sewerage networks, electricity networks etc. Discussions were made with the utility companies concerning the affected services within the project area and information was collected regarding the layout plans of the affected utilities. Detailed discussion with these entities will be required in future to discuss their relocation and other means of handling their interference to the project. Solicitation and suggestions from these entities will be entertained and accorded their due importance. The details of the data collected on several utilities from various service providers have been briefly presented below.

(1) Kathmandu Uptyaka Water Supply Limited

The Kathmandu Upatyaka Water Supply Limited, KUKL, is supplying the drinking water in Kathmandu Valley urban area. The KUKL is serving water supply in the Project Area through its network as shown in the map below. This map does not show the network of pipes (smaller sized

pipes) joining individual houses. The design of road and bridge has to be carried out taking into account the main water pipes at Tripureswor and Maitighar intersections.

Source: KUKL

Figure 13.2.2 Water Supply Line around the Study Area

(2) Local Sewer Line and Drainage

Kathmandu Upatyaka Water Supply Limited is also basically responsible for collecting the domestic waste water (effluent from house) and conveying to the nearest drainage outfall. The sewer lines follow the gravity flow on both sides of the roads (of the proposed alignment). Detailed information of layout can be made available from the KUKL.

(3) Nepal Doorsanchar Company (Nepal Telecom)

As requested to the Nepal Telecom's Wireline and Customer Services Directorate, Planning Department (Chhauni, Kathmandu) provided the following information:

- On the proposed alignments, Tripureswor to Maitighar via Thapathali and Tripureswor to Maitighar via Sundhara, NT has already installed its network, mostly on both sides of the road. The lines have been laid at 1.6m below the road. Many manhole structures are also constructed.
- The exact layout details can be made available at site if requested officially.

(4) Nepal Electricity Authority (NEA)

Nepal Electricity Authority is one of the utility providers in the Project Area. It has two types of electricity grid networks in the area. The networks developed over the ground can be easily identified.

However, a 66 KVA network is also running through Teku-Tripureswor-Thapathali Singhdurbar that is known as K-3 Line. It is brought up to the substation inside Singh Durbar premises. This underground line (K-3 Line) was constructed a long time ago by the Contractor (M/S Sumitomo and Kinden Corporation) and handed over to the NEA and is presently under maintenance of Grid Operation Department, NEA.

13.2.1.4 Drainage

As explained above, the project area, based on the ground level, is approximately divided into three steps with 10m interval, namely, the higher area including Sundhara-Bhadrakali- Tundikhel, the middle area including Maitighar – Thapathali Tripureswar and the lower area, that includes the banks of the rivers Bagmati and Tukucha. Tukucha River bisects the project area almost in the middle and is the main source to drain out of the area. The roads also collect the drain through their side drains and pass the water to the lower part. The sewage effluent of the built up area has been sent to the lower area through intercepting drains, basically on both sides of the rivers including Bagmati and Tukucha. The intercepting project is under construction at present. A general layout of the Interceptor Drains has been presented below.

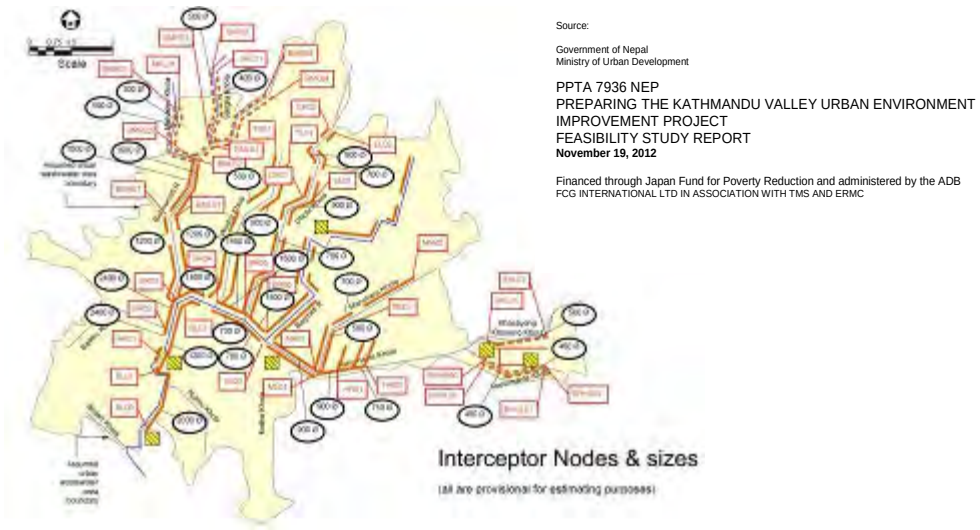


Figure 13.2.3 Drainage System around the Study Area

13.2.2 Traffic Condition of Study Area

13.2.2.1 Present Traffic Data

Traffic survey in Kathmandu Valley was conducted in 2011 by the "Data Collection Survey on Traffic Improvement in Kathmandu Valley" and in 2014 by this study. In the study area of the Pilot Project, roadside traffic count was conducted at Bagmati Bridge in 2014, and intersection traffic count was conducted at Thapathali intersection in 2011.

(1) Roadside Traffic Count

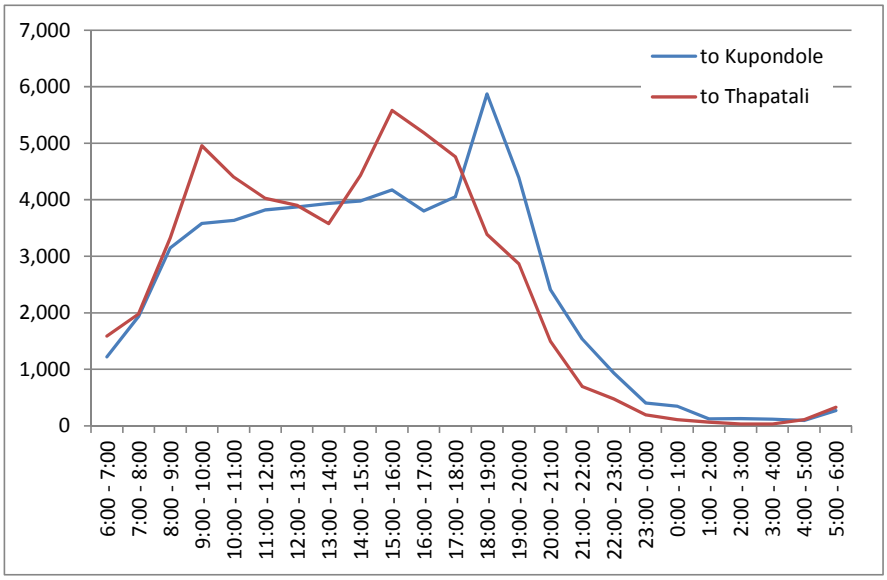
Roadside traffic count was conducted at Bagmati Bridge along Kopundole Road in 2014. The total number of traffic by type of vehicle in 24hrs is shown in Table 13.2.1. Total number of vehicles of both directions is 115,000 and motorcycles occupy 63% of total number of vehicles.

Table 13.2.1 24 hour Traffic Volume at Bagmati Bridge

	Passenger / 4-Wheel Drive vehicle	Taxi	Light Truck	Tempo	Micro Bus	Mini Bus	Large Size Bus	Heavy Goods Vehicle	Bicycle	Motor cycle	Total except 2weel	Total
Thapatali to Kupondole	12,160	5,375	590	1,081	1,445	581	176	164	1,992	34,213	21,572	57,777
Kupondole to Thapatali	10,066	3,268	622	809	1,895	648	251	176	1,599	38,165	17,735	57,499
Both Direction	22,226	8,643	1,212	1,890	3,340	1,229	427	340	3,591	72,378	39,307	115,276

Source: JST

Figure 13.2.4 below shows hourly variation of traffic volume at Bagmati Bridge. Peak hour of traffic to Thapathali is from 15:00 to 16:00 and peak hour of traffic to Kupondole is from 18:00 to 19:00.



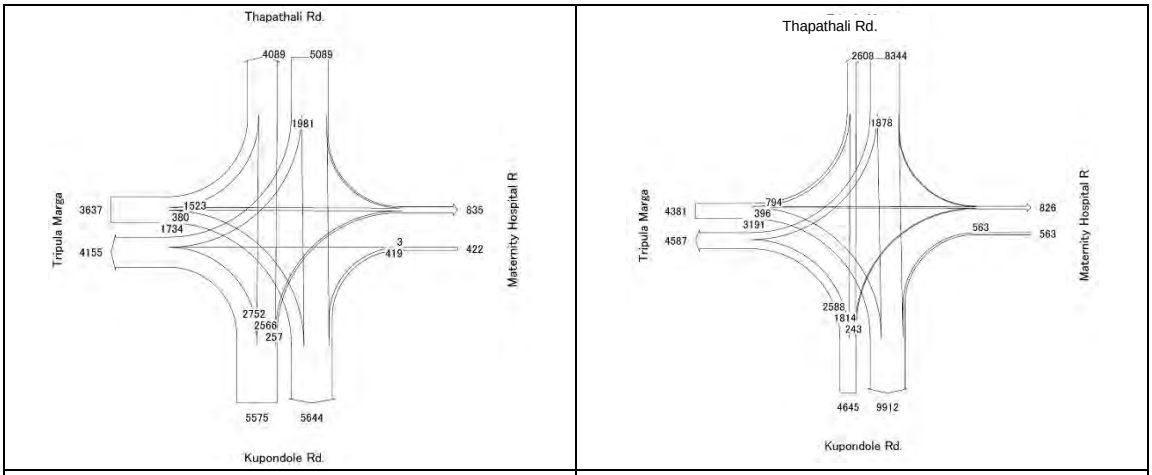
Source: JST

Figure 13.2.4 Hourly Variation of Traffic Volume at Bagmati Bridge

(2) Intersection Traffic Count

Intersection traffic count was conducted in 2011 at ten intersections in Kathmandu Valley. At the intersections, traffic volume by direction was counted in the morning peak hour (from 7:00 to 10:00) and evening peak hour (from 16:00 to 19:00). Based on the result of traffic count, saturation degree was calculated and Figure 8.2.11 in Chapter 8 shows the saturation degree of ten intersections. Thapathali intersection is one of the most heavily saturated intersections in Kathmandu Valley along with New Baneshwor intersection.

Figure 13.2.5 shows traffic volume by direction at morning peak hour and evening peak hour at Thapathali intersection which is the only intersection where traffic count survey was conducted. Traffic going to Kupondole surpasses other directions both morning peak and evening peak.



Morning Peak	Evening Peak

Source: JST

Figure 13.2.5 Hourly Traffic Volume by Direction at Thapathali Intersection

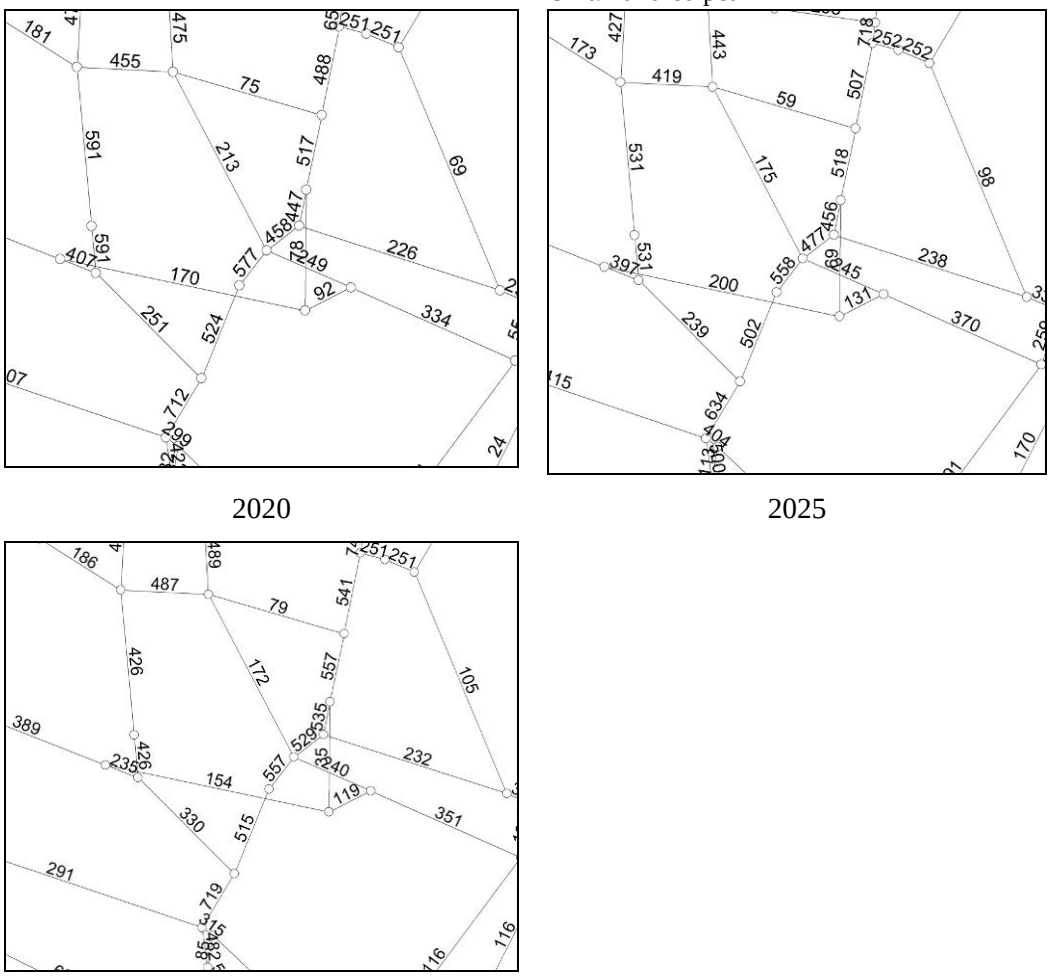
13.2.2.2 Future Traffic Demand Forecasted in the Study Area

Future traffic demand was forecasted as described in Chapter 9. The target years of the demand forecast is 2020 (short term), 2025 (mid-term) and 2030 (long term). In each target year, two networks were applied for demand forecast: one was the present network (Without Case) and the other was the planned network by the Master Plan (With Case) which included T-M flyover project.

Figure 13.2.6 shows the result of traffic demand forecast in the study area of Pilot Project by With Case. More than 150,000 pcu traffic is observed on the T-M Flyover in each target year. Traffic demand in these three cases forms the basic data for traffic analysis of the Pilot Project.

Table 13.2.2 shows the road capacity applied for traffic analysis in this study. According to the traffic demand forecast by the Master Plan shown in Figure 13.2.6, capacity of a two lane road fulfills the traffic demand in 2030.

Unit: hundred pcu



2020 2025

2030

Source: JST

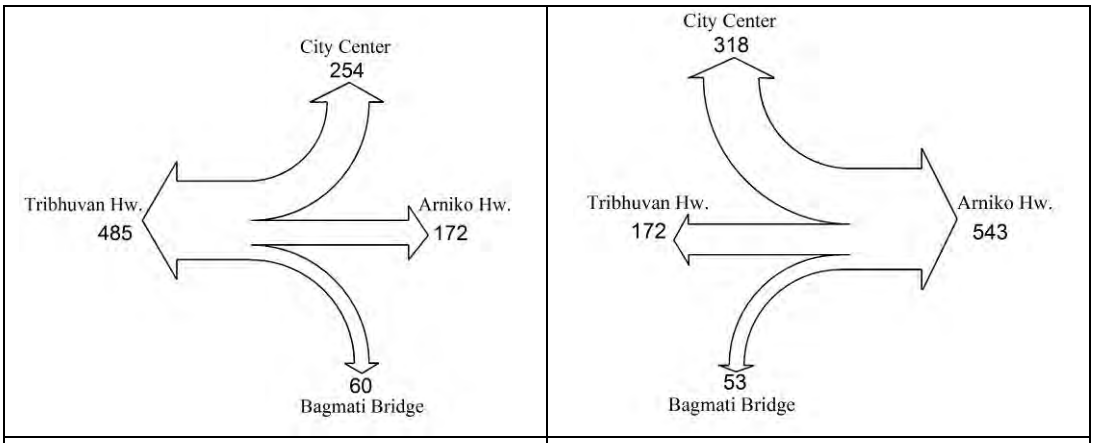
Figure 13.2.6 Vehicle Traffic Demand in the Study Area by With Case

Table 13.2.2 Road Capacity by Type of Road for Traffic Analysis

	Direction	Inside the Ring Road	pcu/lane	Outside the Ring Road
Roads with narrow 2 lanes Less than 4m	Both	6,000	3,000	7,000
	One way	14,000	7,000	17,000
Roads with 2 lanes 4-5.9 m	Both	17,000	8,500	20,000
	One way	27,000	13,500	33,000
Roads with wider 2 lanes 6-11.9m	Both	22,100	11,050	26,000
	One way	35,100	17,550	42,900
Roads with 4 lanes 12-17.9m	Both	52,000	13,000	57,000
Roads with 6 lanes 18-23.9m	Both	75,000	12,500	83,000
Roads with 8 lanes over 24 m	Both	98,000	12,250	109,000

Source: JST referring to Data Collection Survey and Nepal Road Standard

Figure 13.2.7 shows the future traffic volume by direction from Tribhuvan Highway and Arniko Highway in 2030. From Tribhuvan Highway, 25,400 pcu out of 48,500 pcu (52.4%) is going to city center. From Arniko Highway, 31,800 pcu out of 54,300 pcu (58.6%) is going to city center. Generally flyover is built for the direction with the largest traffic demand. However flyover is proposed to connect Tripreshwor intersection and Maitighar intersection because national road H02 and H03 is not connected in this section. And along the northward roads, many active institutional buildings are lining up closely to the road specifically on Putli Sadak. Therefore T-M Flyover is the best measure for intersection improvement.



From Tribhuvan Hw.	From Arniko Hw.

Unit: hundred pcu

Figure 13.2.7 Traffic Volume by Direction from Tribhuvan Highway and Arniko Highway in 2030

13.2.2.3 Planned AGT Route in the Study Area

Public transport network plan is established as shown in 8.3, Chapter 8. Development of two AGT routes is envisaged in the long term (2030). AGT Line-1 is shown in Figure 8.3.14 and AGT Line-2 is shown in Figure 8.3.16. Both routes pass through the study area of the Pilot Project as shown in Figure 13.2.8, therefore structure of the flyover should be decided considering the future construction of AGT route.

Source: JST

Figure 13.2.8 Planned AGT Route in Study Area

13.3 Design Condition

13.3.1 Number of Lanes for T-M Flyover

In 13.2.2, it is found out that the capacity of two-lane road can fulfil the traffic demand in 2030. However, the flyover is semi-permanent structure with service life more than 50 years. Hence, considering the traffic increase during service life, Pre-FS for two-lane flyover and four-lane flyover are conducted as described in 13.4 and 13.5 respectively. Judgement of number of lanes will be done at the next stage.

The different traffic demand is applied to two-lane case and four-lane case. For two-lane case, traffic demand of the network by the Master Plan is applied. For four-lane case traffic demand of without project case is applied. The purpose is to analyze the traffic condition by minimum traffic demand for two-lane case and maximum traffic demand for four-lane case. Detailed condition of traffic demand is shown in Figure 13.3.1.

Table 13.3.1 Applied Traffic Demand for Two-lane analysis and Four-lane Analysis

	Title of traffic demand	Feature of traffic demand	OD Table	Transport network
Two-lane case	With Case	Minimum traffic demand	Future OD table of the traffic demand in which all the planned road network and the planned public transport network are completed	Future network in which all the planned road network and the planned public transport network are completed
Four-lane case	Without Case	Maximum Traffic demand	Future OD table of the traffic demand in which all the road network and the public transport network are not constructed	Present network

Source: JST

13.3.2 Anticipated Function of the T-M Flyover

Tripureswor Intersection, Thapathali Intersection and Maitighar Intersection are most saturated intersections in Kathmandu Valley. The connecting link between National Road H03 (Arniko Highway) and National Road H02 (Tribhvan Highway) is also missing. T-M flyover aims to connect both highways and consequently alleviate traffic congestion. A preliminary traffic analysis carried out in the Master Plan shows that about 30% of the traffic volume between Tripureswor and Thapathali Intersection and Thapathali and Maitighar intersection will be shifted to T-M flyover, if connected.

13.3.3 Design Standard

Preliminary engineering design of M-T Flyover was carried out based on the following design standards.

- Nepal Road Standards 2070
- Nepal Urban Roads Standard 2071 Concept Paper (Draft)
- AASHTO-LRFD Bridge Design Specifications 2004
- IRC Standard Specification and Code of Practice for Roads and Bridges

Similarly, the following data and information were selected as the basis for preliminary engineering design.

- One 40m boring at Maitighar intersection
- Visual public utility and drainage condition survey
- Traffic data prepared during the Master Plan Study (Target Year 2030)
- Topo-map prepared from Satellite Images

13.3.4 Design Speed

Comparison of design speeds of 60km/h and 40km/h was made from view point of minimizing affected properties (buildings and compounds) along the alignment as shown in Source:JST

Figure 13.3.1 below.

Since there is no significant difference in the number of buildings and total area of compounds affected, the speed of 60km/h is determined as the design speed of T-M Flyover.

Source:JST

Figure 13.3.1 Alignments for Design Speeds 60km/h and 40km/h

13.3.5 Pavement Structure

The pavement structure of Kathmandu-Bhaktapur Road Improvement Project (Arniko Highway) as shown in Figure 13.3.2 was applied for preliminary design of the approach road of T-M Flyover.

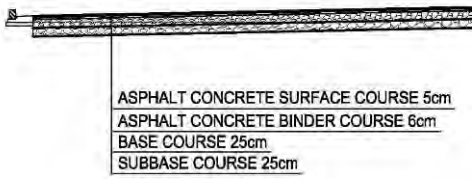


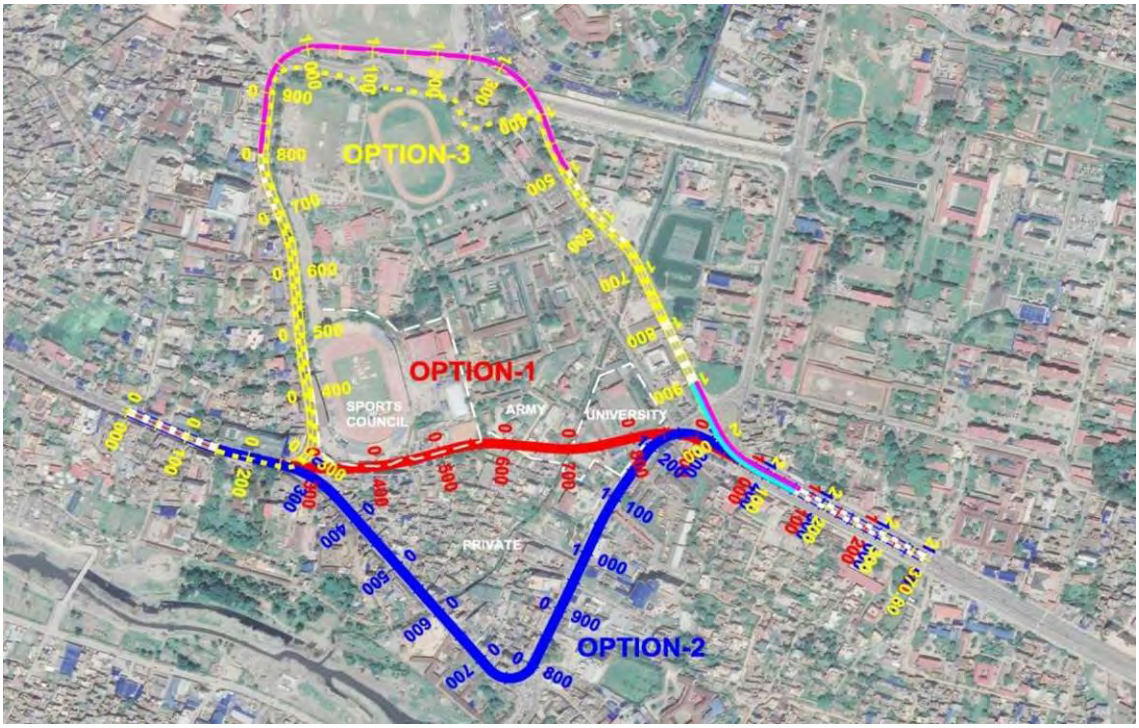
Figure 13.3.2 Pavement Structure Applied for Approach Road of T-M Flyover

13.4 Pre-FS for Two-lane Flyover

In 13.2.2, it is found out that the capacity of two-lane road can fulfil the traffic demand in 2030. However, the flyover is semi-permanent structure with service life more than 50 years. Hence, considering the traffic increase during service life, Pre-FS for two-lane flyover and four-lane flyover are conducted in parallel. In this section, study on two-lane case is described. For two-lane case, traffic demand of the network by the Master Plan is applied to analyze the traffic condition in minimum demand.

(1) Preliminary Options and Preliminary Evaluation

For the evaluation of the alignment of T-M flyover, three plan options are formulated as shown in Figure 13.4.1



Source: JST

Figure 13.4.1 Preliminary Plan Options

The function of three plan options is shown in Table 13.4.1 below.

Table 13.4.1 Function of Plan Options

Plan Option	Function
Option-1	Original alignment planned in the Master Plan.
Option-2	Alignment proposed in "Basic Configuration Design Report" issued by DOR in 2011.
Option-3	Counterproposal in case consensus for Option-1 is not built by stakeholders.

Source: JST

Preliminary evaluation of plan option is conducted as shown in Table 13.4.2. As a result of preliminary evaluation, Option-2 is eliminated from the plan options.

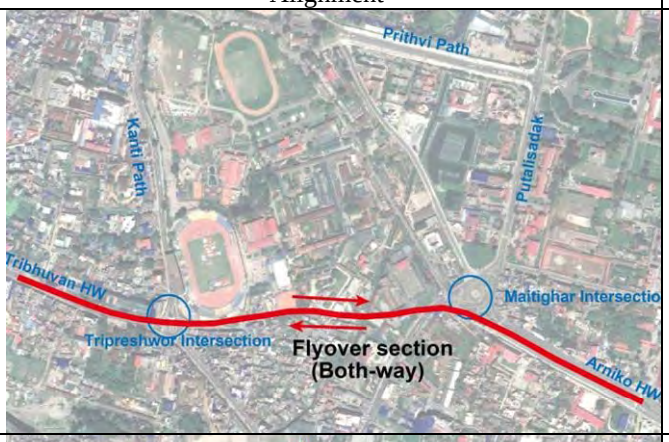
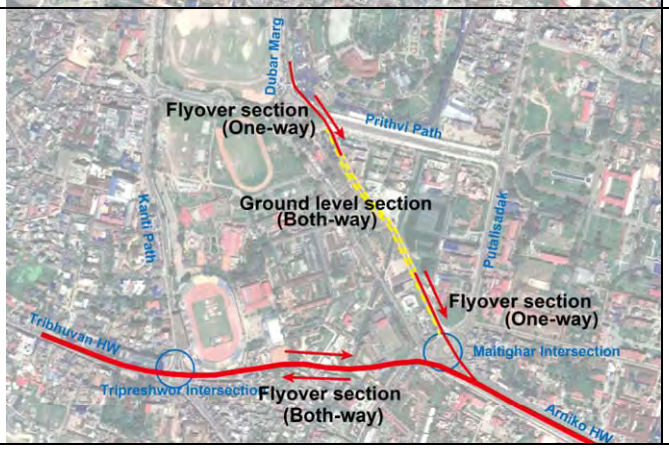
Table 13.4.2 Preliminary Evaluation of Plan Options

Plan Option	Advantage	Disadvantage
Option-1	- Shortest route with least travel time - Least disturbance to existing traffic flow during construction	- Huge land acquisition and resettlement which may delay the implementation schedule greatly
Option-2	- Utilize existing traffic operation route	- Slice cutting of building will be required along entire section of the road - Huge impact to existing traffic flow during and after construction - Design speed is 40 km/h due to sharp curves
Option-3	- Minimum land acquisition without any resettlement - Relatively smaller impact to existing traffic flow during construction	- Re-arrangement of existing traffic network and operation - Longest route with highest travel time - Design speed is less than 40 km/h due to sharp curves

Source: JST

(2) Established Plan Options

As a result of preliminary evaluation, two plan options are selected. Additionally, Option-4 is set up by the unification of Option-1 and Option-3. Alignment and intended function of each option are shown in Figure 13.4.2.

	Alignment	Function
Option-1		Option-1 is the Base case and overflies Tripureshwor intersection and Maitighar intersection and connects Tribhuvan Highway And Arniko Highway directly.
Option-3		Option-3 creates diversion route in the northern side and disperses the traffic concentrating Thapathali intersection by: - Connecting Kanti Path and Bhadrakal Bypass by one way flyover - Flyover on Maitighar intersection.
Option-4		Option-4 is the unification of Option-1 and Option-3 and intends to strengthen the project effect by: - Flyover on Prithvi Path. - Access Ramp from Bhadrakali Bypass to T-M Flyover.

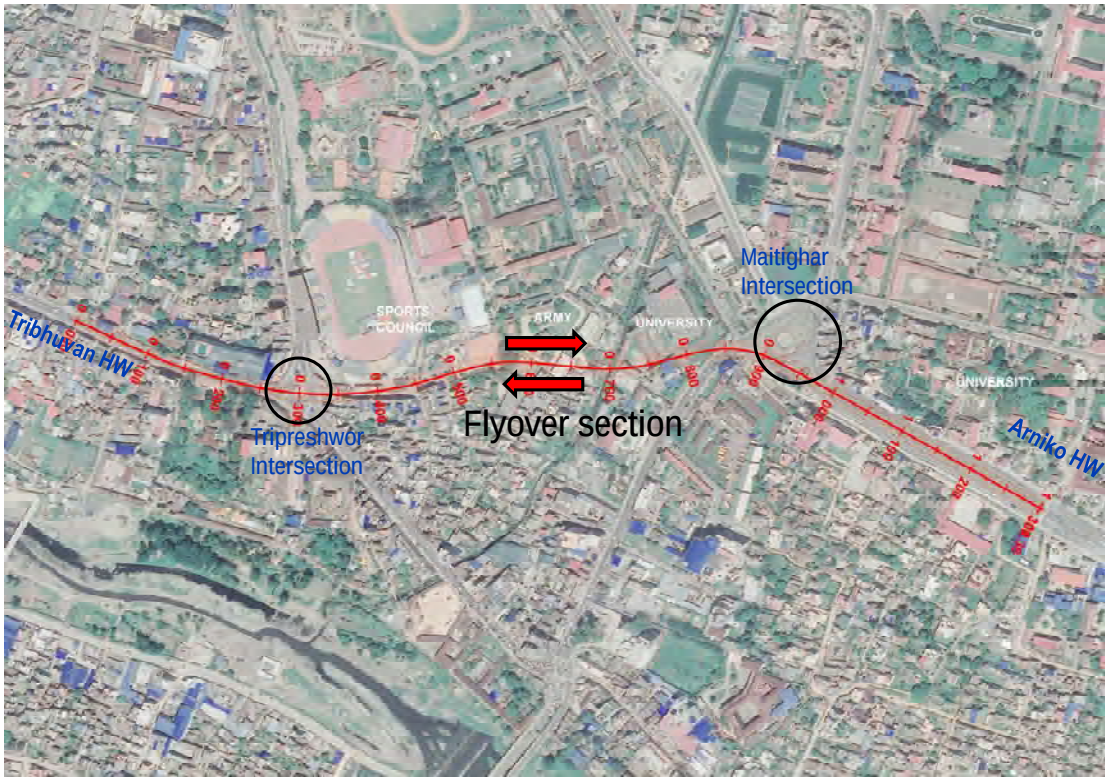
Source: JST

Figure 13.4.2 Established Plan Options

(3) Conceptual Alignment of Plan Options

1) Option-1

Conceptual alignment of Option-1 is shown in Figure 13.4.3.

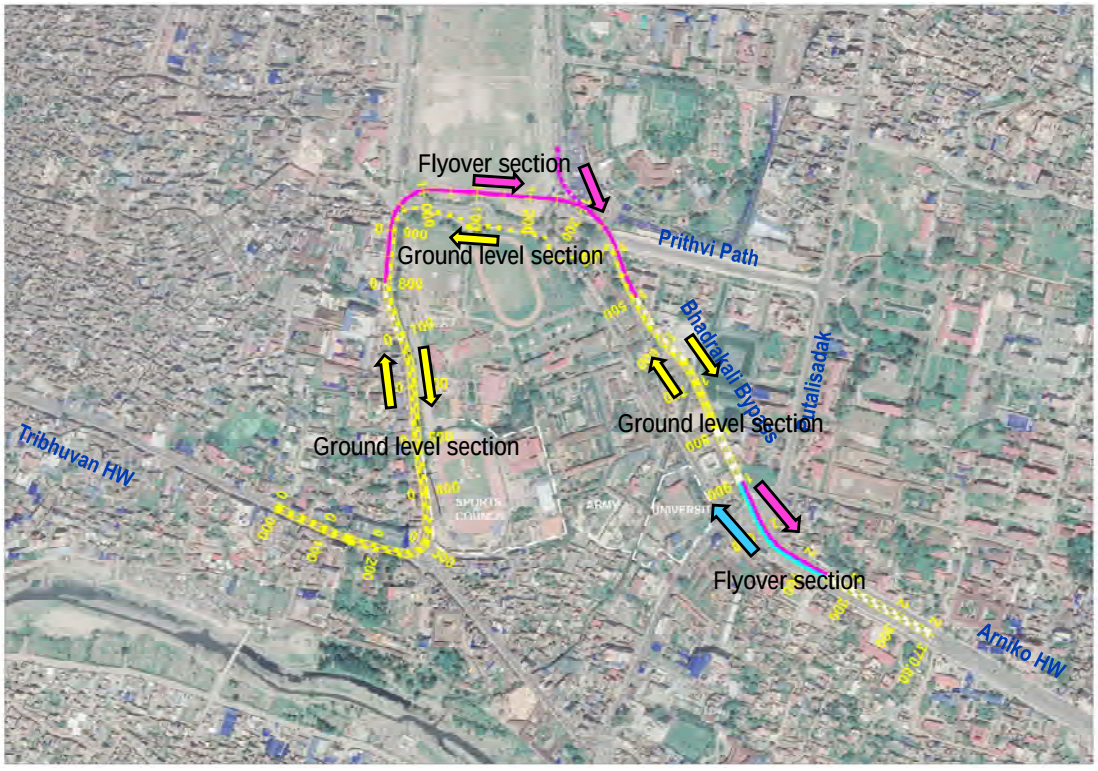


Source: JST

Figure 13.4.3 Conceptual Alignment of Option-1

2) Option-2

Conceptual alignment of Option-2 is shown in Figure 13.4.4

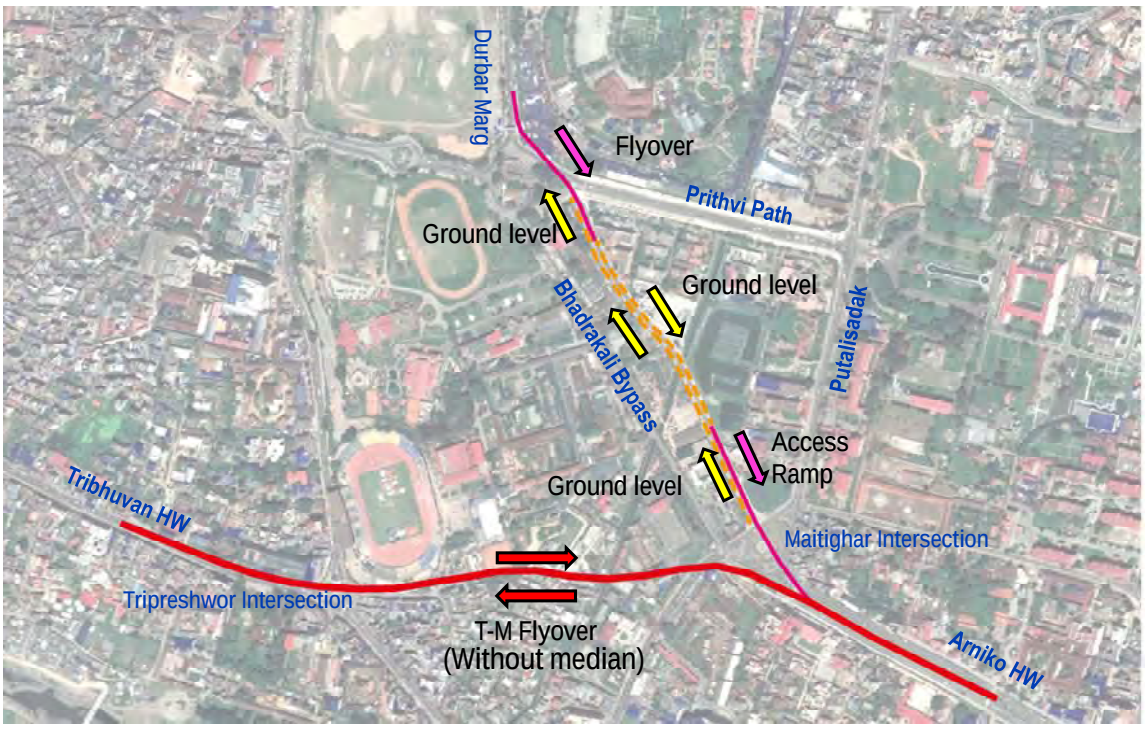


Source: JST

Figure 13.4.4 Conceptual Alignment of Option-3

1) Option-4

Conceptual alignment of Option-2 is shown in Figure 13.4.5.



Source: JST

Figure 13.4.5 Conceptual Alignment of Option-4

13.4.2 Preliminary Engineering Design

13.4.2.1 Geometric Design Criteria

The Geometric Design Criteria based on Nepal Road Standards 2070 as presented in the Table 13.4.3 below, are proposed for the design of the Project Road.

Table 13.4.3 Geometric Design Criteria

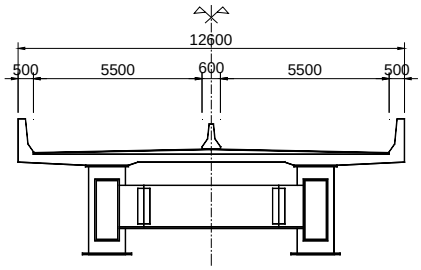
Design Elements			Type/Value	Remarks
1	Design Speed (km/h)		60	
2	Cross-Sectional Elements	Basic Lane Width (m)	3.5	
		Number of Lanes	2	
		Total Formation Width (m)	10.6 (8.0)	() for Approach Road
		Carriageway Width (m)	2 x 3.5 (3.25)	() for Approach Road
		Outer Shoulder Paved Width (m)	2 x 1.0 (0.25)	() for Approach Road
		Parapet Width (m)	2 x 0.5	
		Median Separator / Widening at Curves (m)	0.6	For Radius 100-300m
		Crossfall of Roadway (%)	2.5	
3	Horizontal Alignment	Min. Radius of Horizontal Curve (m)	125	Se=6%
		Max. Superelevation (Se)	6.0	Applied
		Min. Length of Transition Curve (m)	55	Radius = 125m

Design Elements			Type/Value	Remarks
4	Vertical Alignment	Max. Vertical Gradient (%)	7.0	
		Applied Max. Vertical Gradient (%)	6.0	
		Critical length of 6% Gradient (m)	400	
		Min. Radius of Summit Curve (m)	940	Radius=100*(K-value)
		Min. Radius of Valley Curve (m)	420	
5	Minimum Vertical Clearance (m)		5.0	

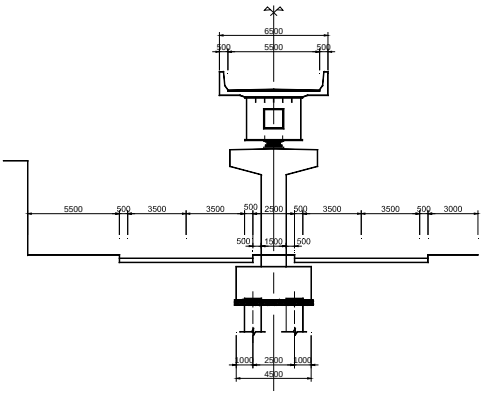
Source: NRS2070

13.4.2.2 Typical Cross Sections

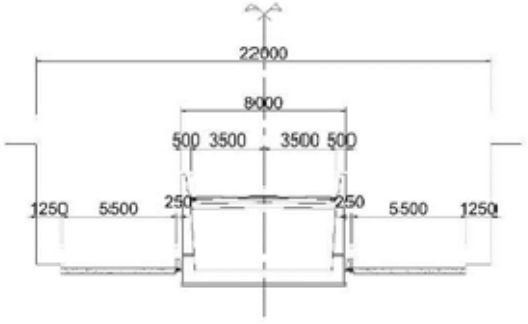
Typical cross sections were prepared and presented as shown in Figure 13.4.6 below (i) Cross Sections at approaches, Tirpureswor and Maitighar within existing ROW (ii) Two-Lane with median and single-lane flyover with 5.5m road way width (3.5m for carriageway and 2.0m for outer shoulder) allowing two lane operation in emergency or exceptional cases in accordance with the NRS2070. At Tripreshwor approach, road width is narrowed to contain the road within the existing width. The termination of median barrier by installing flexible rubber poles or traffic cones shall be done within the approach road section. However the narrow carriageway width and the lane separation by rubber cone has risks for traffic safety and traffic choking. In this regard, possibility of widening shall be examined in the next stage.



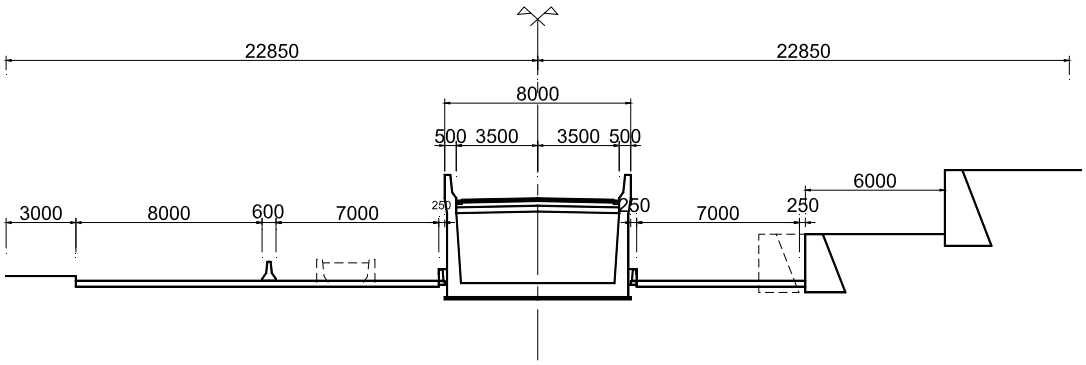
Two-lane Flyover with median



Single-lane Flyover



Tripureswar side approach road



Maitighar side approach road

Source: JST

Figure 13.4.6 Typical Cross Sections

13.4.2.3 Horizontal Alignment

Horizontal alignment for Option 1 and Option 3 are shown in Source: JST

Figure 13.4.7 to Source: JST
Figure 13.4.9 below.

Source: JST

Figure 13.4.7 Horizontal Alignment of Option 1

Source: JST

Figure 13.4.8 Horizontal Alignment of Option 3

Alignment of Option 4 was designed combining Option 1 and Option 3 as shown in Source: JST Figure 13.4.9 below.

Source: JST

Figure 13.4.9 Horizontal Alignment of Option 4

13.4.2.4 Structure Design

(1) Applicable Span Arrangement and Superstructure Types

1) Selection of Preliminary Superstructure Type

In order to choose the bridge (superstructure) type, the following conditions will be considered.

- Road design conditions and flyover width composition
- Horizontal alignment with curved section and vertical alignment
- External factors based on social environment around the construction site
- Erection method, constructability at the crowded/narrow area and soft ground
- Environmental construction conditions at densely urbanized area

Selection of the type of superstructure

Considering the space available at the existing intersections and arterial roads, the components of the proposed flyover bridge can be divided into the following two parts:

- Overpass at Large Intersections:
  As per the alignment study conducted, the segment of the flyover bridge that need to cross intersections at Maitighar and Tripureswor with required span of more than 70m will be adopted as a continuous type of steel or pre-stressed concrete bridge.
- Standard Section (Narrow and curved horizontal alignment):
  In between Maitighar and Thapathali Intersections, standard sections of flyover bridge will be adopted with due consideration for minimized land acquisition, access roads and other local constraints.

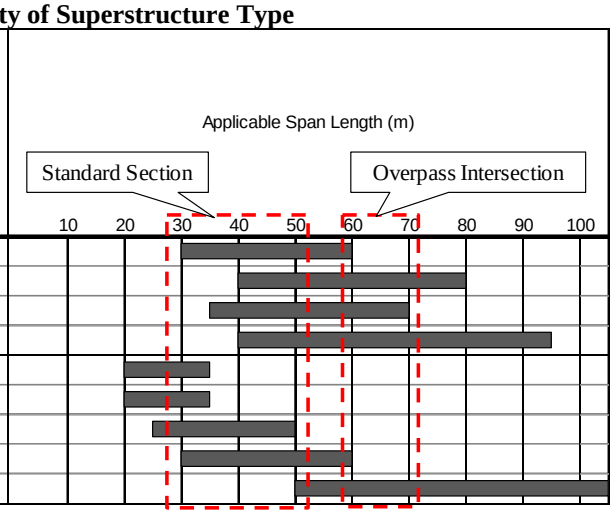
Besides the above two parts, two approach segments will be constructed at either end adopting necessary guidelines.

As part of the study of flyover superstructure, a comparison of various segments (parts) can be considered as helpful in deciding the type selection based on applicability of superstructure type which is presented in Table 13.4.4 below.

- Overpass large-sized intersection
- Standard section with curved horizontal alignment and located at densely urbanized area

Table 13.4.4 Applicability of Superstructure Type

Type		Deck Slab type/ Erection method	Horizontal curved section	Overpass Intersection	Curved Section
Steel	I Girder (Conventional)	RC (Timbering)	○ R＞700m		
	Box Girder (Conventional)	RC (Timbering)	◎		■
	I Girder (Fewness)	Composite	○ R＞700m	■	
	Narrow Box Girder	Composite	○ R＞300m	■	
Concrete	PC Voided Slab	All staging	◎		■
	PC Rigid Slab	All staging	○		
	PC I Girder	Track crane	△		
	PC Box Girder	All staging	◎		■
	PC Box Girder	Cantilever erection	○	■	



Source : Design Data book, etc., Japan Bridge Association

The recommendation for the selected bridge with its characteristics based on advantages and disadvantages can be made.

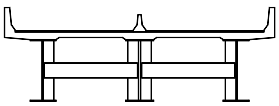
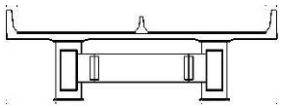
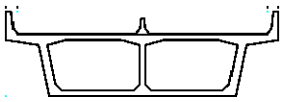
2) Flyover Superstructure Type - Overpass Large Intersection

The proposed T-M Flyover connects two intersections, Maitighar and Tripureswor at both ends overpassing the existing arterial roads with maximum span of 60m and 70m respectively. At the intersections, the residences are densely packed. In accordance to Table 13.4.4 above, the types of superstructure that need to be adopted, in general, are

- Continuous Steel I-shaped (fewness) Girder with continue deck slab
- Continuous Steel (narrow) Box Girder with composite deck slab
- Continuous Pre-stressed Concrete Box Girder (Cantilever erection method)

A comparison of the bridge types for long span, continuous steel narrow box girder and continuous steel I girders (fewness) are made in the Table 13.4.5 below.

Table 13.4.5 Comparison of Alternatives for Overpass Intersection

Location		Over Passing at Large-sized Intersection, Required Max. Span 60 ~ 70m					
Type		Continuous Steel I Girder (Fewness) with Composite deck slab		Continuous Steel Narrow Box Girder with Composite deck slab		Continuous PC Box Girder (Cantilever erection method)	
Cross-section		 Girder depth 2.9m		 Girder depth 2.9m		 Girder depth 4.5m on pier~2.5m	
Acceptable Range of Span		35m~70m		40m ~ 95m		50m ~ 110m	
Required Horizontal Arraignment		Straight ~ Curved section > R=700m		Straight ~ Curved section > R=300m		Straight ~ Curved section	
Advantage and Disadvantage for Structural future and surrounding environment	Structural Feature	Light superstructure is suitable for flyover because the size of substructure becomes smaller	◎	Light superstructure is suitable for flyover because the size of substructure becomes smaller	◎	Heavy superstructure and large girder depth on pier needs a large substructure and girder depth at the support becomes higher than steel girder	○
	At radius Horizontal Curve	Effective for horizontal curve section more than radius 700m	○	Effective for horizontal curve section more than radius 300m	○	Box shape of girder is having high flexural rigidity and torsional rigidity for horizontal small curve	◎
	Against Earthquake	Isolated bearing used to minimize the total construction cost for earthquake protection	○	Isolated bearing used to minimize the total construction cost for earthquake protection	○	Weight is bigger than other concrete bridges, especially long span. Large isolated bearings are required	△
	Erection method at Intersection	Launching erection during night time will be applied. Composite deck slab will minimize site works	◎	Launching erection during night time will be applied. Composite deck slab will minimize site works	◎	Cantilever erection method will be applied to use the limited space at the intersection	○
	Influence on Urban Roads	Since the size of substructure becomes smaller, less influence in crowded/intersection area	◎	Since the size of substructure becomes smaller, less influence in crowded/intersection area	◎	Large influence on urban roads since the size of substructure becomes large	△
	Pile Foundation at Proposed Span (Reverse circulation pile)	Required reverse circulation bored pile method. Reduce the pile number and length due to light superstructure weight than PC bridge (9nos.-D1.0m x L=28m)	◎	Required reverse circulation bored pile method. Reduce the pile number and length due to light superstructure weight than PC bridge (9nos.-D1.0m x L=28m)	◎	Heavy weight of concrete girder with high unit cost of pile foundation method is causing cost rise (9nos.-D1.0m x L=40m)	△
	Construction Period	It will be the shortest construction period among these alternatives. Superstructure: 10M (1.0)	○	It will be the shortest construction period among these alternatives. Superstructure: 10M (1.0)	◎	It will be long construction period at site since it will require pre-casting girder segment and pre-casting PC slab. (1.5)	△
	Maintenance	Anti-corrosion steel be used since less re-painting at saturated intersection	○	Anti-corrosion steel be used since less re-painting at saturated intersection	○	It is necessary to replace expansion joint at bearing shoes once per 20-30 years.	○
Cost Ratio (including substructure)		1.00 440 thousand NRs. per sq.m		1.05 450 thousand NRs. per sq.m		1.10 460 thousand NRs. per sq.m	
Aesthetic		Due to smooth surface of girder, side view looks clear. It is possible to improve aesthetics by modifying girder shape.		Due to smooth surface of girder, side view looks clear. It is possible to improve aesthetics by modifying girder shape.		It gives less heaviness than PC-I Girder since the number of girder is less than PC-I Girder. Smooth surface of girder makes side view look clear.	
Overall Evaluation		**Recommended in straight alignment section**		**Recommended in curved alignment section**			

◎Advantage, ○Acceptable, △Disadvantage

Source: JST

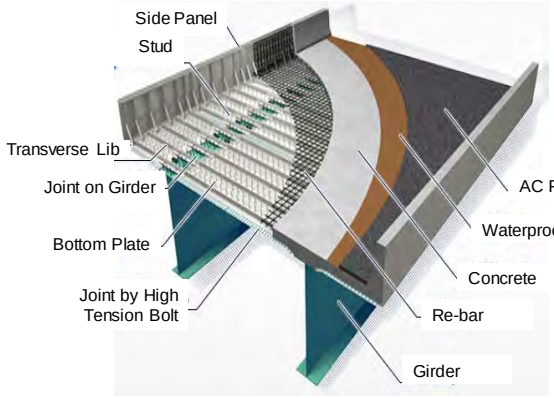
Introduction of Recommended Structure (i)

Steel-Concrete Composite Deck Slab

Steel-Concrete Composite Deck Slab is a new technology for Nepal. Unlike RC timbered deck slab on steel girder, it provides a composite floor slab made by integrally combining a bottom steel plate and reinforced concrete in which the bottom steel plate can be processed with ease and the strength of the floor slab is improved.

This deck slab is a suitable method for combination with new steel bridge of fewer number of I-girder and/or narrow box girder for the flyover passing through the densely populated urban area. Characteristics of this deck slab method are as follows;

- High quality steel deck slab can be fabricated at factory and/or casting yard in a short time without support and form.
- Formwork and scaffolding are not required since steel deck plate plays its role at the time of slab concreting, thus making work faster.
- It can reduce the production of waste materials, noise and vibration at site since the precast plates and panels are applied.
- By the long over hanged deck slab (max. 2.5m), substructure can be compacted better than conventional box or I-shaped girders
- The durability and the rigidity of the composite deck slab is higher than RC deck slab and also contribute to the minimization of life cycle costs.
- The steel deck plate plays a role as the formwork and scaffolding at the time of the slab construction, hence assembling and dismantling of hanging scaffolding for slab construction is unnecessary.



Source: SC Deck by Kawata Engineering, Japan
Sketch of Composite Deck Slab (one instance)

Therefore, the narrow steel box girder and fewer I-shaped steel girder with steel-concrete composite deck slab is recommended for constructability above the intersection or built up and densely populated areas.

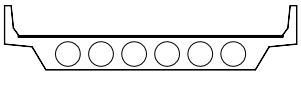
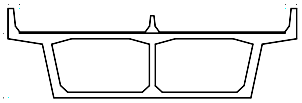
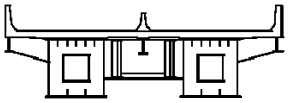
3) Flyover Superstructure Type - Standard Section

Between the two intersections (Maitighar and Tripureswor), the flyover runs in the land area that is acquired and densely packed. Also it runs at some small curved horizontal alignment section in order to avoid big buildings and houses. In such conditions, generally, the required continuous bridge consisting of steel I girder, steel box girder and PC box girder are adopted for reasonable superstructure. The following superstructure types are able to apply under such conditions:

- Continuous Pre-stressed Voided Slab (or Ribbed Slab)
- Continuous Pre-stressed Concrete Box Girder
- Continuous Steel Box Girder

As per the result of the comparison of the bridge type at horizontal curved alignment area, continuous steel box girder type is selected based on the Table 13.4.6 presented below.

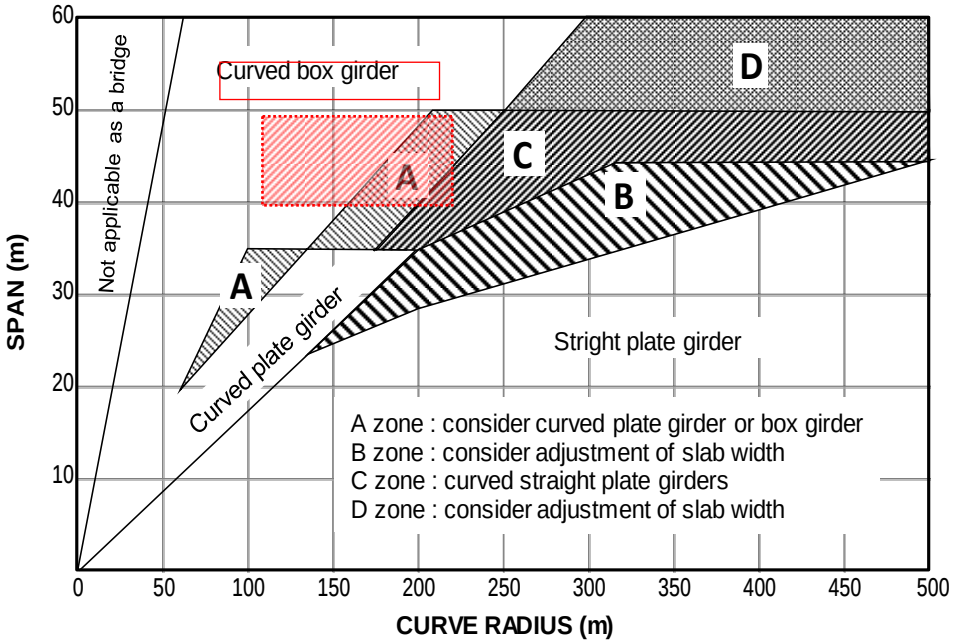
Table 13.4.6 Comparison of Alternatives for Standard Section (Narrow and Curved Section)

Location		Narrow, curved horizontal Alignment section and densely populated area					
Type		Continuous PC Voided Slab		Continuous PC Box Girder		Continuous Steel Box Girder with RC deck slab	
Cross-section							
Proposed/Economical Span Length (Acceptable range of span)		@30m (20m~35m)		@40m (30 ~ 60m)		@45m (40m~80m)	
Advantage and Disadvantage for Structural future and surrounding environment	At Small Radius Horizontal Curve (Min. R=125m)	Effective for horizontal curve section	◎	Effective for horizontal curve section	◎	Box shape of girder is having high flexural rigidity and torsional rigidity for horizontal small curve	◎
	Narrow Site Space at both sides of Bridge in high densely populated area	Selected all staging erection method (cast-in-place concrete) on the soft ground requires soil stabilization	○	Selected all staging method launching erection is not allowed for no big production space at both ends of bridge and at the surrounding	○	Track crane and bent at narrow site	◎
	Against Earthquake	Weight is bigger than steel bridge. Isolated bearing shall be adopted for heavy weight of super-structure	○	Weight is bigger than other concrete bridges, especially long span. Large isolated bearings are required	△	Isolated bearing used to minimize the total construction cost for earthquake protection	○
	Constructability (Erection method in soft ground)	Required reinforcement of soft ground by soil stabilization for all staging support. Special treatment is required to avoid floatation	△	Required costly improvement of the soft ground for staging due to heavy weight and massive cast-in-place concrete superstructure	△	Required ground support for the bent on soft ground Therefore, steel bridge is more effective on the soft ground	○
	Pile Foundation at Proposed Span (Reverse circulation pile)	Required less vibration and expensive pile method after earthquake in densely urbanized area. Foundation shall be suffered its heavy weight of concrete girder 9-D1.0m x L=38m	○	Heavy weight of concrete girder with high unit cost of pile foundation method is causing cost rise 9-D1.0m x L=40m	△	Required reverse circulation bored pile method. Reduce the pile number and length due to light superstructure weight than PC bridge 9-D1.0m x L=28m	◎
	Construction Period	It will be not short construction period at site since it is used cast-in-place slab and large number of piers. (1.25)	○	It required long construction period at the site because it uses cast-in-place concrete girder with prestressing work. (1.5)	△	It will have the shortest construction period among these alternatives. Superstructure: 10M (1.0)	◎
	Maintenance	It is required to inspect the voids through the drain hole using a fiber scope due to water seepage.	△	It is necessary to replace expansion joint at bearing shoes once per 20-30 years.	○	Weathering steel be used due without repainting at densely urbanized area	○
Cost Ratio (including substructure)		1.00~1.05 400 thousand NRs. per sq.m (Stabilization of the soft ground)		1.10 440 thousand NRs. per sq.m		1.00 400 thousand NRs. per sq.m	
Aesthetic		It gives the most heaviness among these alternatives since there are many girders.		It gives less heaviness than PC-I Girder since the number of girder is less than PC-I Girder. Smooth surface of girder makes side view looks clear.		Due to smooth surface of girder, side view looks clear. It is possible to improve aesthetics by modifying girder shape.	
Overall Evaluation						**Recommended**	

◎Advantage, ○Acceptable, △Disadvantage

Source: JST

The general applicability of conventional steel bridge type to curved horizontal alignment is presented in Figure 13.4.10. In case of curve with the radius less than 200m and economical span of 40-50m, steel box girder will be a possible alternative type.



Source: Road Design Guideline, MLIT JAPAN

Figure 13.4.10 Applicable Curve Radius for Span Length and Steel Girder Type

(2) Applicable Substructure Types

1) Selection of Foundation Types

There are some sections where many houses, buildings and shops are located on both sides of frontage road. Therefore, foundation and pile cap need to be constructed under restricted condition. Besides, quick, safe and eco-friendly type should be selected.

Based on boring survey (length 40m), Sandy Clay or Silty Clay is distributed deeply and N value is less than 14 until 40m depth. And soil distribution at Kathmandu shows Project road is located at “Kalimati Formation”, and gray to dark silty clay spread more than 450m depth.

Table 13.4.7 shows applicability criteria of foundation type;

Table 13.4.7 Applicability Criteria of Foundation Type

Type / Applied Condition			Foundation	Spread Foundation	Pile Foundation																Caisson Foundatio		Steel Pile Sheet Pile Foundation
					Driving Pile Method			Pile Boring Method						Steel Pipe Pile Soil Cement Piles	Preboring Method	Cast-in-Place Piles Method			Spinning Method	Pneumatic	Open	
					PHC piles・SC piles	Steel Pipe Piles		PHC piles SC piles			Steel Pipe Piles					All Casing Method	Reverse Circulation Drill Method	Earth Drill Method				
						Percussion Method	Vibratory Hammer Method	Final Driving Method	Jetting and Mixing Method	Concrete Placement Method	Final Driving Method	Jetting and Mixing Method	Concrete Placement Method									
Ground Condition	Bearing Layer Condition	Depth	less than 5m	○	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
			5～15m	△	○	○	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	△
			15～25m	×	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			25～40m	×	○	○	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	○
			40～60m	×	△	○	○	△	△	△	○	○	○	○	○	△	○	×	○	△	○	○
			over 60m	×	×	△	△	×	×	×	×	×	×	△	△	×	△	×	○	×	△	△
		Soil	sand, sandy gravel (30≦N)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			clay (20≦N)	○	○	○	○	○	△	×	○	△	×	△	△	○	○	○	△	△	△	○
			soft rock・hardpan	○	×	○	△	○	△	×	○	△	×	△	△	○	○	○	△	○	○	○
			hard rock	○	×	×	×	×	×	×	×	×	×	×	×	△	△	△	×	△	×	×
Type of support			Bearing Pile		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
			Friction Pile		○	○	○	×	×	×	×	×	×	○	×	○	○	○	×			
Construction Condition (Environment)			Vibration and Noise Control	○	×	×	△	△	○	○	△	○	○	○	○	○	○	○	○	○	○	×
			Effects on Adjacent Structures	○	×	△	△	△	○	○	△	○	○	○	○	○	○	○	○	△	△	△

Note : ○: Suitable, △: Possible, ×: Impossible
Source : Specifications for Highway Bridges, Japan Road Association

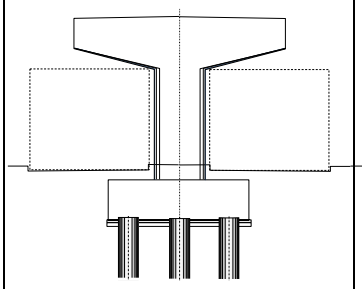
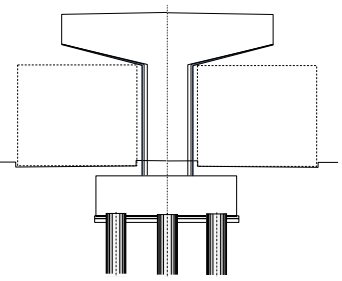
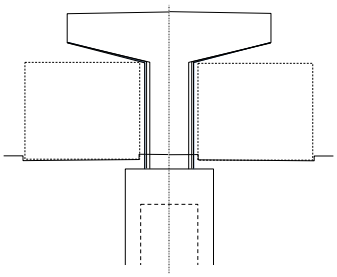
The following foundation types can be applied;

- Steel Pipe Pile Foundation (Vibratory Hammer Method)
- Steel Pipe Soil Cement Pile Foundation
- Cast-in-Place Pile Foundation (Reverse Circulation Drill Method)
- Open Caisson Foundation (PC Well Method)

Here, the Project road is located in a residential area filled densely with private brick-made houses, therefore, sound and vibration should be minimize as much as possible. Steel Pipe Pile Foundation (Vibratory Hammer Method) can be applied, but considering the effect to houses adjacent the construction site, it should be omitted.

Therefore, “Cast-in-Place Pile Foundation (Reverse Circulation Drill Method)”, “Steel Pile Soil Cement Pile Foundation” and “Open Caisson Foundation (PC Well Method)” are compared in detail as shown in Table 13.4.8 below.

Table 13.4.8 Comparison of Alternatives for Foundation Type

Location		Pilling at intersection, residential area and narrow job site						
Type		Cast-in-place Concrete Pile (Reverse Circulation Drill Method)		Steel Pipe Soil Cement Pile		Open Caisson Foundation PC Well		
Cross-section								
Substructure Type		RC Pier + RC Pier Head		RC Pier + RC Pier Head		RC Pier + RC Pier Head		
Structural Aspects		Most typical foundation type, however it requires enough construction yard Bearing capacity is calculated by skin friction resistance at outer surface		In case of low bearing capacity due to soft soil sub-ground, this steel pipe soil cement pile shall be adopted with its excellent earthquake resistance similar to bored piles, produces little surplus soil and has low noise and vibration.		Maximum depth of foundation is about 60m. Bearing capacity is only expected from skin friction resistance at outer surface of foundation only. Due to non-excavation, skin friction becomes bigger by compressing surrounding soil.		
Foundation Size (assumption)		Design: Skin friction pile Dia. = 1,000mm N=9, Length 30~40m		Design: Skin friction pile Steel Pipe: Dia.=800mm, with Soil Cement: Dia.=1,000mm N=9, Length 30~40m		Design: Skin friction Dia. = 5,000~6,000mm		
Advantage and Disadvantage for Structural future and surrounding environment	Constructively (Construct at narrow yard)	It requires enough construction yard Need sediment/ drainage system in order to avoid leakage of bentonite water to outside of the construction yard	○	It Requires import of order-made steel pipe with manufactured outer ribs in Vietnam or Japan. Non-excavation method at piling, site becomes clean and compact.	○	Due to large diameter of foundation, necessary to connect each segment at site. It is required to secure enough space as construction site and stockyard.	△	
	Environmental Issues (Construct at quiet residential area)	Expect low noise and vibration during piling work	◎	Expect low noise and vibration during piling work To reduce the volume of surplus construction soil	◎	Expect low noise and vibration during construction Requires cover sheet for excavated soil and tire washing equipment for truck in order to avoid dust	◎	
	Construction Period	1.2 month per pier	○	1.2 month per pier	○	2.5 month per pier	△	
Experience in Nepal		No. New excavation method Refer to the introduction (ii)		No. New Technology Refer to the introduction (iii)		No		
Cost Ratio (including substructure)		1.0 Construction cost is cheapest		1.2~1.5 Required to import all of custom made steel pile		2.0~2.5		
Overall Evaluation		**Recommended**		**Recommended (2)**				

◎Advantage, ○Acceptable, △Disadvantage

Source: JST

Introduction of Recommended Structure (Pile Foundation) (ii)

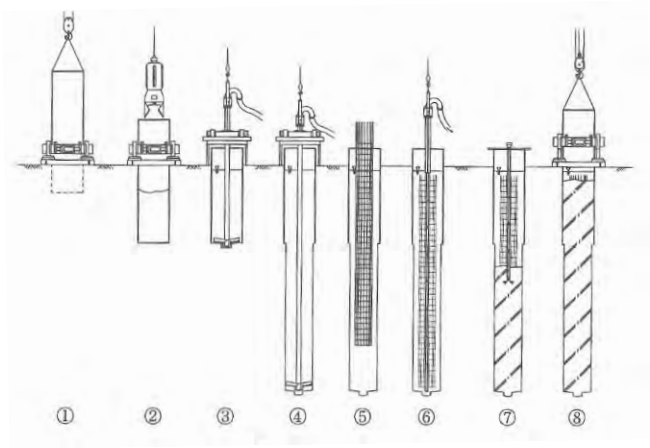
Cast-in-Place Concrete Pile (Reverse Circulation Drill Method)

Reverse circulation drill method is a type of cast-in-place concrete pile method which is formed by drilling a hole in the ground and filling it with reinforced concrete. Advantages of cast-in-place concrete pile method are the following;

- Low noise and less vibration
- Pile proof stress can be set by combination of pile dimension and concrete strength.
- Soil conditions can be confirmed from the excavated soil.
- Even if there is a hard layer in an intermediate layer, the excavation is possible.
- Highly vertical precision

Reverse circulation drill method is excavated by circulation of muddy water in the direction reverse to usual boring excavation. The drill bit turns to cut ground and excavated soil and water in the hole flush out by suction pump or air lift system. And stand pipe can protect the hole wall. Advantages of reverse circulation drill method are the following;

- It is possible to construct the pile with larger diameters and deep depths.
- Natural muddy water can protect the hole wall.
- Special drill bit can excavate the bedrock.



The construction steps for reverse circulation drill method:

1. Set the hydraulic jack according to the pile center and erect the stand pipes in pile hole.
2. Stand pipes are pushed by the hydraulic jack to excavate the soil inside the pipes.
3. Rotary table is installed horizontally and the drill bit begins to excavate the hole.
4. After confirmation of load bearing layer, excavate the embedment portion and conduct the first treatment of the bottom of hole.
5. Erect the cages to the hole center vertically.
6. Insert the tremie pipe and connect to the kelly bar. Conduct the second treatment of the bottom of hold by suction pump.
7. Placing of concrete
8. Extract the stand pipes and backfill the excavation portion.

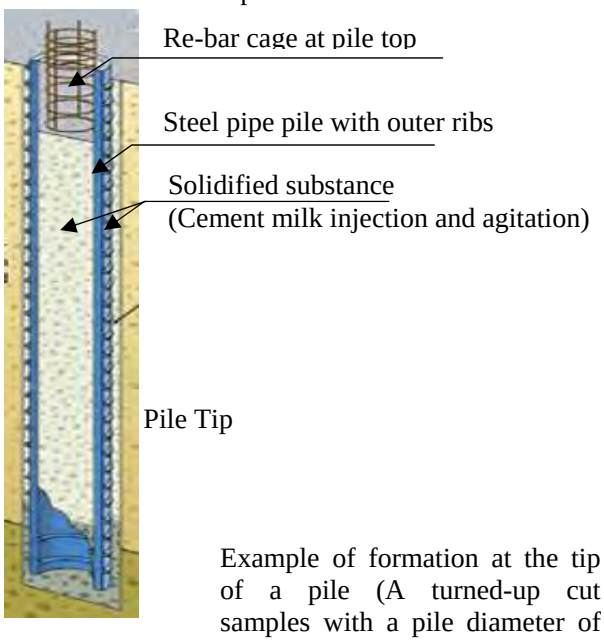
Introduction of Recommended Structure (Pile Foundation) (iii)

Steel Pipe Soil Cement Pile

Steel Pipe Soil Cement Pile is a new technology that has been developed in Japan. This method involves composite piles consisting of steel pipe with outer ribs and soil cement that is formed by pouring cement milk into ground and through mixing & agitation.

Main features of the pile are as follows;

- High bearing capacity
- Steel Pipe Soil Cement Pile is a composite pile consisting of steel pipe with outer ribs and soil cement column (diameter of the soil cement column in steel pipe +200~400mm), and bearing capacity can be calculated by area of soil cement column. Therefore, it has high bearing capacity rather than usual steel pipe pile and the number of piles can be reduced.
- Can be treated as friction pile
- During construction, soil is not loosed and it is possible to maintain not only end bearing capacity but also skin friction stably. Therefore, the pile can be treated as friction pile.
- Low environmental effect
- Cement milk is directly poured into the ground, and soil and cement milk is mixed and composited as one structure. Therefore, volume of earth removal can be reduced. Furthermore, the pile can be installed with low noise and low vibration rather than other piles.



Example of formation at the tip of a pile (A turned-up cut samples with a pile diameter of 1,400mm and a steel pipe dia. of 1,000mm)

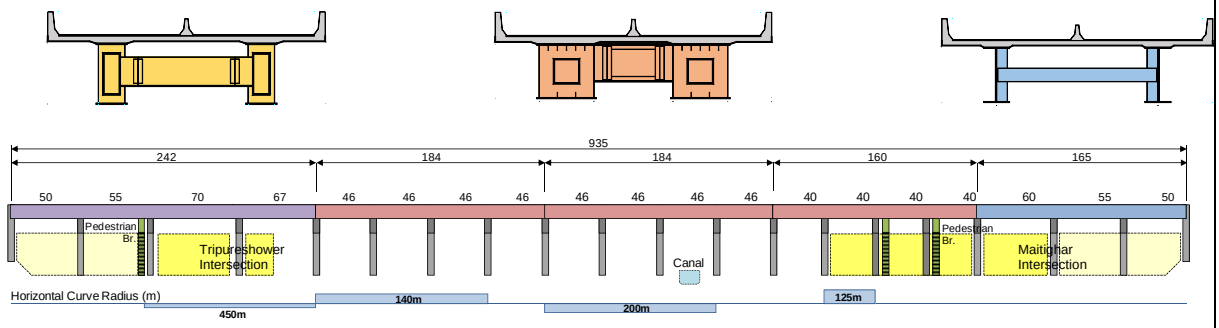
Steel pipe with outer ribs

(3) Applicable Foundation/Substructure Types

The resultant overview of Two-lane T-M Flyover as studied in the Pre-F/S is shown in Table 13.4.9.

Table 13.4.9 Bridge Overview of Two-Lane T-M Flyover

Bridge Type and Span Arrangement		Continuous steel girder bridge, 2 traffic lanes, total bridge width = 12.600m
Superstructure (overpass at)	Tripureshowor IS	Continuous steel box girder (2 cells, Narrow) (composite steel deck slab)
	Densely urbanized area	Continuous steel box girder (2 cells) (RC deck slab)
	Maitighar IS	Continuous steel I girder (Fewness) (composite steel deck slab)
Adopted measures		Seismic isolated bearing
Substructure	Abutments	Inverted T type RC abutment
	Piers	RC column/ RC pier head Portal frame pier
	Foundations	Cast-in-place RC pile (Reverse circulation method) (Friction pile, Dia. 1.0m)
Typical cross section and Profile		



Plan

Source: JST

13.4.2.5 Major Work Quantities and Cost Estimate

(1) Rate Analysis

Rate analysis of work items of roads are based on the Norms for Rate Analysis as per Standard Specifications for Road and Bridge Works, Department of Roads based on district rates and/or market rates in Kathmandu, Nepal in June 2016.

Rate analysis of work items for bridge works are carried out by way of comparing the actual unit prices of bridges constructed under Japanese ODA collected among the developing countries.

(2) Quantities

The quantities of earthwork, retaining structures and drainage structures are estimated from the preliminary design drawings and other plans prepared using Satellite images.

The quantities of related bridge works are estimated by calculating quantities for standard sections for each type of superstructure and sub-structure.

(3) Cost Estimates

The construction costs for Option 1, Option 3 and Option 4 have been calculated using unit rates of individual items based on rate analysis multiplied by quantities estimated. The construction costs for

the different options estimated are presented in Table 13.4.10 and the total project cost is presented in Table 13.4.11.

Table 13.4.10 Summary of Construction Cost Estimation for Option 1, Option 3 and Option4

(NPR)

No.	Works	Option 1	Option 3	Option 4
0200	Site clearance	6,145,090	8,427,332	9,635,628
04001	Temporally fencing with safety facilities	7,788,148	9,832,291	8,769,022
0900	Earthworks	34,246,930	50,501,468	49,670,056
1000	Subgrades	4,369,050	10,126,050	6,250,050
1200	Subbase, base, hard shoulder and gravel wearing course	4,436,187	11,573,689	4,757,410
1300	Bituminous surface and base course	43,162,423	60,065,289	50,047,681
1400	Kerbs and footpaths	11,917,750	12,920,713	13,770,250
1500	Traffic safety and control facilities	3,085,448	5,335,590	3,716,694
1600	Piling and foundation for structures	1,260,153,245	1,011,358,030	2,094,664,073
2000	Concrete works	306,145,603	329,152,105	432,679,276
2200	Structural steel works	2,935,307,967	2,029,802,395	3,883,655,841
1900	Bearings and expansion joint	478,440,900	547,368,150	756,553,400
2400	Miscellaneous structures	1,425,000	1,781,250	1,425,000
2600	Masonry for structure	3,230,000	4,037,500	3,230,000
0700	Pipe drains, pipe culverts and concrete channels	62,712,825	105,170,463	67,985,325
3100	Miscellaneous works	156,483,434	65,197,685	164,740,294
Total		5,319,050,000	4,262,650,000	7,551,550,000

Source: JST

Table 13.4.11 Total Project Cost

(Thousand NRS)

Descriptions	Construction	Physical Contingency	Administration cost	Land acquisition Cost	Building Compensation Cost	Engineering Services	VAT	Project Cost
Option-1	5,319,050	531,905	26,595	884,000	481,000	531,905	1,010,679	8,785,134
Option 3	4,262,650	426,265	21,313	0	5,863	426,265	668,506	5,810,863
Option 4	7,551,550	755,155	37,758	884,000	483,000	755,155	1,360,660	11,827,278

Source: JST

13.4.3 Traffic Analysis

13.4.3.1 Precondition for Traffic Analysis

Traffic analysis for T-M flyover is conducted by utilizing the result of traffic demand forecast for Master Plan. Basic precondition of traffic analysis were as follows:

1) Target year of traffic analysis is 2020 (short term), 2025 (mid-term) and 2030 (long term).

2) Transport network proposed by staging plan in the Master Plan except for T-M flyover is completed in each target year. Network in “Without Project” is planned network without T-M flyover and network in “With Project” is planned network with T-M flyover.

3) T-M flyover, the priority project in the Master Plan, is completed in short term.

For two-lane case, traffic demand of Master Plan, in which all the projects planned in the Master Plan are completed, is applied to analyze the traffic condition in minimum demand.

13.4.3.2 Method for Traffic Analysis

In the traffic demand forecast system for the Master Plan, partial development of road network affects the traffic movement in the entire forecast area and causal relation of the development and its effect is hard to clarify. Hence, traffic demand forecast is conducted in the limited area where the traffic movement is influenced by the development. The method is as follows:

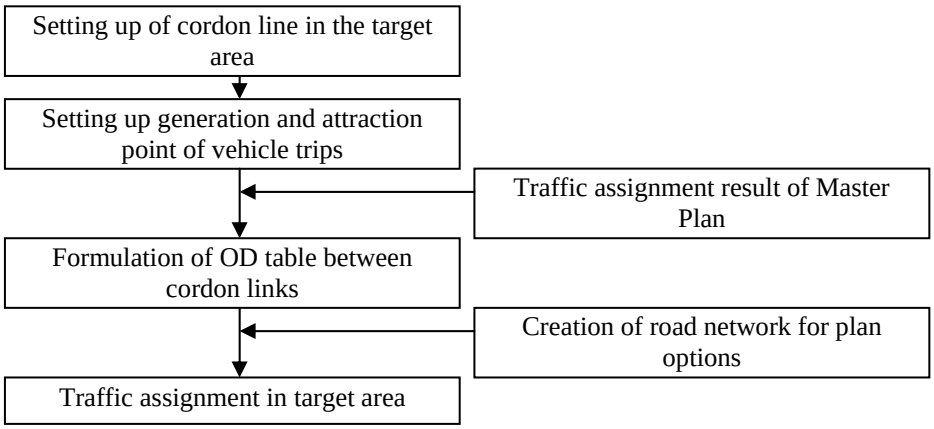
1) Cordon line, which encircles the project site and includes the area where traffic movement is affected by the project, is set up. Crossing points of road links with cordon line are set as generation and attraction points of vehicle trip.

2) Vehicle movement between cordon crossing points are extracted from the vehicle assignment result of Master Plan and vehicle OD table between cordon crossing points is formulated.

3) Road network within the cordon line is created for each plan options.

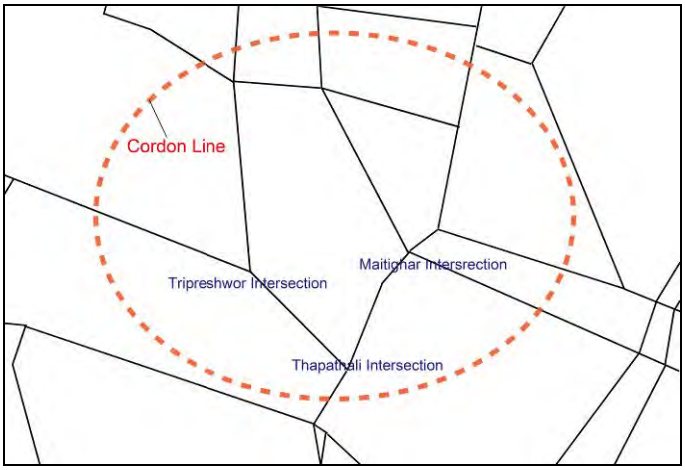
4) Traffic assignment is conducted to the road network by applying OD table between cordon crossing points.

Method of traffic demand forecast is shown in Figure 13.4.11 and disposition of cordon line is shown in Figure 13.4.12.



Source: JST

Figure 13.4.11 Method of Traffic Demand Forecast for T-M Flyover



Source: JST

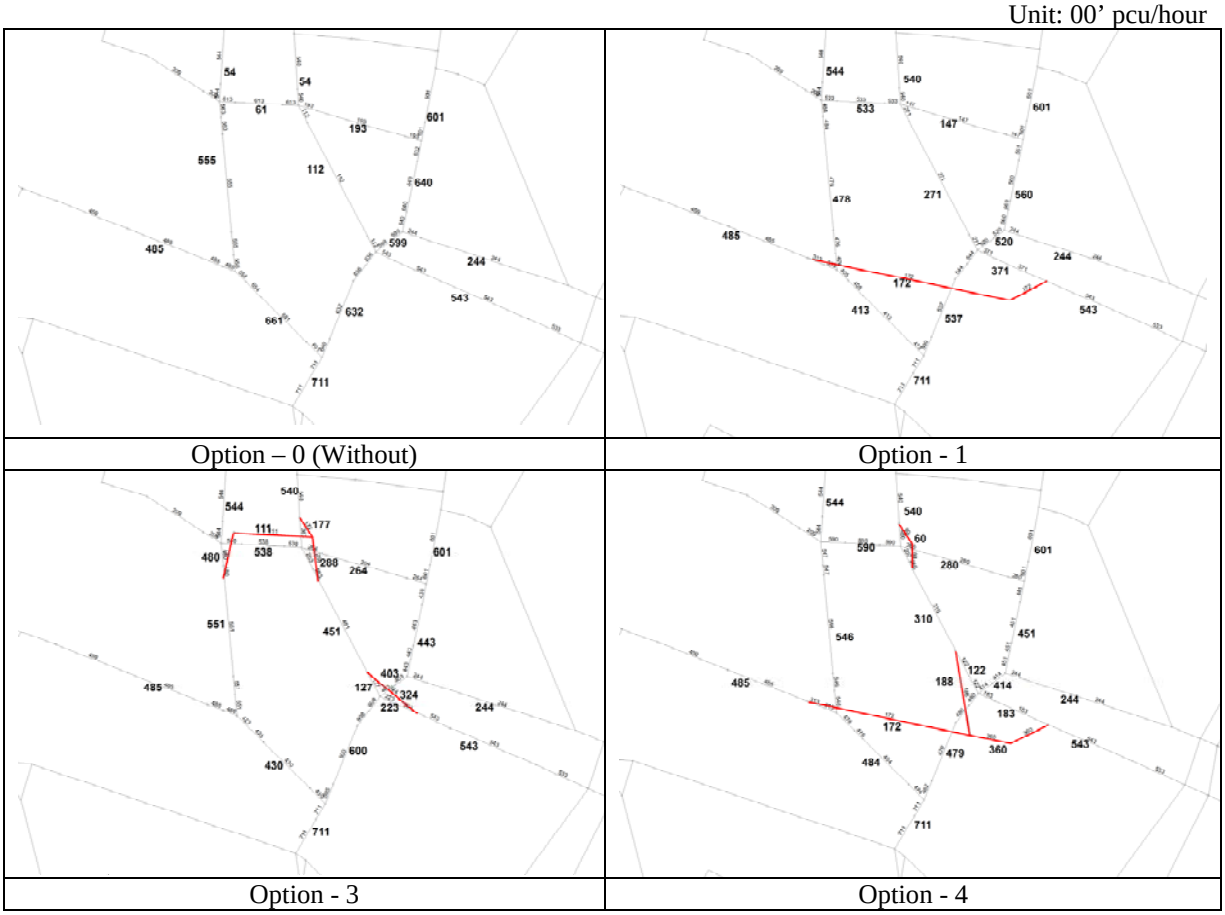
Figure 13.4.12 Disposition of Cordon Line

13.4.3.3 Traffic Demand Forecast

Traffic assignment for formulated plan options is conducted in short term (2020), mid-term (2025) and long term (2030) by the method described in 13. 7. 2.

The result of traffic assignment is shown in Figure 13.4.13. Average road congestion ratio, total travel time and total travel distance for each option by traffic assignment is shown in Table 13.4.12.

Unit: 00' pcu/hour



Source: JST

Figure 13.4.13 Traffic Assignment Result for Options in 2030

Table 13.4.12 Forecasted Average Road Congestion Ratio, Total Travel Time and Total Travel Distance by Traffic Assignment

	Year	Without project	Option-1	Option-3	Option-4
Average road congestion ratio (Volume/Capacity)	2020	0.715	0.707	0.705	0.703
	2025	0.729	0.709	0.717	0.710
	2030	0.799	0.783	0.798	0.790
Total travel distance (pcu km/day)	2020	350,236	341,825	356,568	348,799
	2025	363,807	344,851	362,273	352,406
	2030	389,568	378,835	401,547	391,693
Total travel time (hour/day)	2020	52,182	47,517	47,793	47,174
	2025	76,463	61,580	65,707	59,298
	2030	91,580	71,620	75,120	68,559

Source: JST

As a result, total travel distance and total travel time is smallest in Option-1. Average road congestion ratio (Total vehicle running distance (pcu)/ Total road capacity distance (pcu)) of Option-3 is smallest in 2020 and Option-1 is smallest in 2025 and 2030. In option-4, vehicles from Putali Sadak to Arniko

HW are divert to Bhadrakali Bypass via Prithivi Path, thus total travel distance is more than Option-1 while total travel time is less than Option-1.

13.4.4 Economic Evaluation

13.4.4.1 Economic Evaluation Method

(1) General

It is usual for the public sector that a decision is expected so often to allocate its limited budget to certain projects, while investment to other projects are postponed and/or suspended. The economic and financial evaluations provide several criteria to assist the decision makers to prioritize the projects.

The economic evaluation relates to the allocation of scarce national resources. Various benefits, which are expected to arise by the project, are considered and estimated. Cost to implement the project is estimated based on necessary project scale and technology. The costs are usually converted to the "economic cost", to represent the cost to the national economy by removing transfer factors.

The costs and the benefits are measured as the difference between "with" and "without" the project. The project needs additional costs to the economy, which otherwise could be allocated to the other projects. The project generates additional benefits to the economy. The economic analysis evaluates the additional costs and the additional benefits, which are measured by the difference between the "with" and the "without" project cases.

Major criteria to prioritize project's effectiveness and efficiency are EIRR (Economic Internal Rate of Return), NPV (Net Present Value) and B/C (Benefit Cost Ratio).

The EIRR is a discount rate, which satisfies the following equation.

$$\sum_{i=1}^{k} \{(\text{Net Benefit of } i^{th} \text{ year}) / (1 + \text{EIRR})^{i}\} = 0$$

where, k is the number of years of the project life.

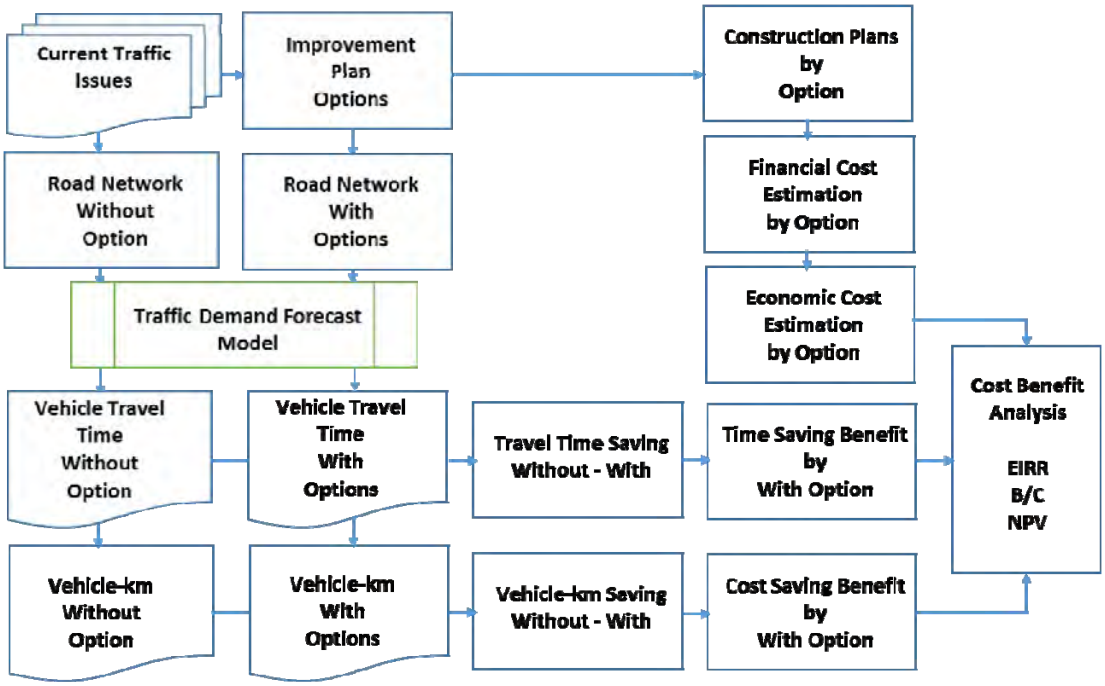
In other words, the EIRR is a discount rate, which makes the total net benefit of the project in present value to be zero. The EIRR indicates an investment efficiency of the project in terms of the national economy. The NPV is a gross volume of annual net benefit discounted by the social discount rate of the nation. This value indicates an amount of social surplus of the project to the economy. The B/C is a ratio of total benefit against total cost of the project. The benefit and the cost are discounted by the social discount rate of the economy. This value denotes the efficiency of the project as well as the EIRR.

Generally speaking, the EIRR and the B/C indicates an efficiency of the project, while the NPV shows an amount of net surplus of the project to the economy. If the scale of a project is large enough, the NPV has a tendency to become bigger, even if its EIRR is low. On the contrary, if the scale of the project is small, the NPV may be small, even if its EIRR is high.

The financial analysis evaluates profitability of the project to the entity that will implement the project and operate the business. The financial analysis deals with the financial cost and the financial revenue. These are measured by market price of the economy, because the analysis brings profitability of the business entity into focus. The cost and the revenue should be measured against the actual price which the entity pays.

With regard to the Arniko Highway (Tripureswor Intersection – Maitighar Intersection) Improvement Project, which is analyzed in this report, the DOR has no plan to collect charges or tolls from the improved section of the roads. The DOR will not work as a commercial entity but as a public service supplier for the road development and management. Therefore, financial analysis/evaluation was not conducted for this project.

Figure 13.4.14 below shows a schematic flow chart and correlation between the economic analysis work and other concerned works of this Study.



Source: JST

Figure 13.4.14 Schematic Flow Chart of Economic Analysis

(2) Major Premises

Major assumptions of the project evaluation are summarized below. A worksheet model analysis was utilized for the analyses.

- Project life: 50 years after the completion of the project(2020)
- Pricing date: 2015
- Social discount rate: 12%
- Exchange rate: US$1.00 = NRs.99.64, JPY1.00 = NRs.0.836

(3) Improvement Options

Options of the Arniko Highway (Tripureswor Intersection – Maitighar Intersection) Improvement Project, were summarized in Table 13.4.13 (refer to 13.4.1 Basic Condition and Plan Options). The Option 1 is the short-cut route overpassing the military area by viaduct road bridges, while the Option 3 is the detour route bypassing the military area to the north direction. The Option 1 has some alternatives as shown in the table, considering “median” and “ramp”, including the Option 4.

Table 13.4.13 Improvement Options

Option	Route	Median	Ramp
1	Short-cut	Yes	No
3	Detour	No	No
4	Short-cut	No	Yes

Source: JST

(4) Cost of the Project

1) General

Necessary cost for the improvement of the Arniko Highway (Tripureswor Intersection – Maitighar Intersection) Improvement Project is divided into two major components, which are capital investment cost and operation & maintenance cost. The economic costs of the project were estimated based on the financial costs in the previous Section 13.5.1 Preliminary Design.

2) Capital Investment Cost

The capital investment cost consists of 1) initial investment cost and 2) re-investment cost. However, the re-investment cost was not necessary, because the project life is shorter than the fifty years of useful life of road. No re-investment cost was appropriated. The residual value was appropriated at the last year of the project life as negative investment.

The capital investment costs in terms of economic cost of the project by option are summarized in Table 13.4.14. Transfer items, such as tax and subsidy are processed properly from the estimated financial cost. The estimated costs are modified again by SCF (Standard Conversion Factor) to offset the distortion of prices in Nepal to obtain economic cost. The SCF of Nepal was estimated to be 0.91 same as the Progress Report of the Master Plan of this Study, which is an average value in the previous studies. Another index was also used for the economic cost estimation to estimate the cost in constant 2015 price. According to the Volume 50 of Quarterly Economic Bulletin of Nepal Rastra Bank, wholesale price indices of Nepal were 292.8 and 315.2 in the second quarter (Dec./Jan.) of 2014/15 and 2015/16, respectively. Therefore, the Study Team obtained and applied the estimated 1.0765 for the economic cost estimation in constant prices.

Table 13.4.14 Initial Investment Cost by Year and by Option

Unit: NRs.Million, Economic cost, 2015 constant price

Option \ Year	2017	2018	2019	2020	Total
Option 1	1,643.0	1,643.0	1,643.0	1,643.0	6,572.0
Option 3	1,086.7	1,086.7	1,086.7	1,086.7	4,347.0
Option 4	2,033.4	2,033.4	2,033.4	2,033.4	8,133.6

Source: JST

3) Operation and Maintenance Cost

The operation and maintenance cost of the project in economic cost by option were estimated as shown in Table 13.4.15 according to the estimated financial operation and maintenance cost described in Section 13.4.2 Preliminary Design. The operation and maintenance cost consists of the annual cost and the periodic cost for every five years.

Table 13.4.15 Operation and Maintenance Cost by Option

Unit: NRs.000, Economic cost, 2015 constant price

Option	Annual Routine Cost	Periodic Cost (every 5 year)
Option 1	102.3	1,124.8
Option 3	169.8	1,867.6
Option 4	182.8	2,010.6

Source: JST

The economic costs were obtained from the financial cost in the same manner as the investment cost estimation.

(5) Benefit of the Project

Two kinds of economic benefit were estimated for the analysis. One is the time saving benefit and the other is the cost saving benefit.

1) Time Saving Benefit

Travel time is considered to be reduced by the completion of the intersection improvement project. The study team estimated the saved time by comparing the "without improvement" and the "with improvement" scenarios. In the "with case", total travel time of the study area is expected to decrease compared to the "without case".

Table 13.4.16 below shows the estimated travel time values by vehicle type, which are calculated in the Master Plan Study. These time values are used to estimate the time saving benefit by option, by year and by vehicle type.

Table 13.4.16 Travel Time Value by Vehicle Type

	Motorcycle	Car	Taxi	Light Truck	Truck	Micro Bus	Mini Bus	Bus	Tempo
Time Value (NRs/hour)	54.09	54.09	54.09	54.09	54.09	54.09	54.09	54.09	54.09
No. of Passenger	1.10	1.90	2.00	1.80	1.90	13.50	18.50	33.50	7.80
Trip Purpose									
Work (%)	44.0	57.5				28.5	28.5	28.5	28.5
Non-Work (%)	56.0	42.5				71.5	71.5	71.5	71.5
Weighted Time Value per Vehicle (NRs/hr)	37.29	73.65	0.00	0.00	0.00	382.15	523.68	948.29	220.80
Crew Wage (NRs/hr)			68.91	95.33	112.95	169.27	192.24	215.21	34.46
Time Value (NRs/vehicle)	37.29	73.65	68.91	95.33	112.95	551.42	715.92	1163.50	255.26

Source: JST

2) Cost Saving Benefit

The cost saving benefit was estimated based on the reduced vehicle-km of the study area, by comparing the vehicle-km of the "with" and "without" option cases. Unit cost of the vehicle operating cost by vehicle type and by travel speed, which was estimated by this Master Plan, is summarized in Table 13.4.17 below.

Table 13.4.17 Vehicle Operating Cost by Vehicle Type and by Travel Speed

(Economic cost, NRs/vehicle/km)

Speed (km/hr)	Motorcycle	Tempo	Car	Taxi	Light Truck	Truck	Micro Bus	Mini Bus	Bus
55	3.322	10.395	14.056	13.792	20.854	34.241	19.320	21.102	25.699
45	4.195	13.282	19.262	18.412	27.429	43.601	26.039	29.397	31.472
35	4.857	16.288	24.048	22.773	33.008	52.475	31.870	36.240	38.787
25	5.383	19.006	28.123	26.546	38.142	60.884	36.672	41.728	46.127
15	5.801	21.380	31.484	29.713	42.999	68.814	40.493	46.009	52.903
5	6.127	23.407	34.162	32.296	47.660	76.268	43.398	49.198	58.843

Source: JST

3) Estimated Benefit

Estimated time saving and cost saving benefits are summarized in Table 13.4.18.

Table 13.4.18 Estimated Time Saving and Cost Saving Benefit

NRs. Million, economic price in 2015

Option	Option 1		Option 3		Option 4	
Benefit	2020	2030	2020	2030	2020	2030
Cost Saving Benefit	134.3	168.6	-50.3	-89.1	91.4	64.4
Time Saving Benefit	251.5	869.1	252.8	651.8	285.5	975.3
Total Benefit	385.8	1037.7	202.5	562.7	376.9	1039.7

Source: JST

When it comes to the magnitude of the benefit, Option 1 showed the biggest benefit, while the Option 3, which is the detour route measure, was the smallest.

13.4.4.2 Economic Analysis and Evaluation

(1) Economic Analysis

Economic analyses were conducted by worksheet basis, by option. The worksheets by option are exhibit in Table 13.4.19 to Table 13.4.21.

In the analysis, it was assumed that the future time saving benefit increased in proportion to the per capita GDP growth in real term. Because, the time value of travelers is considered to increase in general. When his/her income grows, it would be likely that the magnitude of willingness to pay for the time saving would grow as well.

The Option 1 showed the EIRR of 14.3%.

The Option 3, which is the case of detour route improvement, showed the EIRR of 12.3%. The EIRR of Option 4 was 12.6%. The cost saving benefit of the Option 3 exhibited a negative value. The reason is considered to the increased travel distance caused by the detour route travel.

The Option 4, which is the case when the ramp was installed to increase convenience of travelers, showed almost the same EIRR as the Option 3 as mentioned above. The cost saving benefit of this Option is not negative. However, the construction cost is high. It is considered that the expensive construction cost for the ramp affected to the EIRR value.

Table 13.4.19 Economic Analysis of Option 1

EIRR: 14.3% **B/C: 1.28** **NPV:** 1,257.3 **Cost** **1.00** **Benefit: 1.00**

Unit: Million NRs. (Year 2015 Economic Price)

Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,309.8)	0.0	1,309.8
2018	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,169.5)	0.0	1,169.5
2019	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,044.2)	0.0	1,044.2
2020	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(932.3)	0.0	932.3
2021		0.1	0.1	137.4	383.1	520.5	520.4	263.7	263.7	0.1
2022		0.1	0.1	140.6	487.4	628.0	627.9	284.0	284.1	0.0
2023		0.1	0.1	143.8	620.2	764.0	763.9	308.5	308.6	0.0
2024		0.1	0.1	147.1	789.1	936.2	936.1	337.6	337.6	0.0
2025		1.2	1.2	150.5	1,003.9	1,154.4	1,153.2	371.3	371.7	0.4
2026		0.1	0.1	154.0	1,086.8	1,240.7	1,240.6	356.7	356.7	0.0
2027		0.1	0.1	157.5	1,176.4	1,333.9	1,333.8	342.4	342.4	0.0
2028		0.1	0.1	161.1	1,273.5	1,434.6	1,434.5	328.8	328.8	0.0
2029		0.1	0.1	164.8	1,378.6	1,543.4	1,543.3	315.8	315.8	0.0
2030		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	303.2	303.4	0.2
2031		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	270.9	270.9	0.0
2032		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	241.9	241.9	0.0
2033		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	216.0	216.0	0.0
2034		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	192.8	192.8	0.0
2035		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	172.1	172.2	0.1
2036		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	153.7	153.7	0.0
2037		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	137.3	137.3	0.0
2038		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	122.6	122.6	0.0
2039		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	109.4	109.4	0.0
2040		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	97.6	97.7	0.1
2041		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	87.2	87.2	0.0
2042		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	77.9	77.9	0.0
2043		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	69.5	69.5	0.0
2044		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	62.1	62.1	0.0
2045		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	55.4	55.4	0.0
2046		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	49.5	49.5	0.0
2047		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	44.2	44.2	0.0
2048		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	39.5	39.5	0.0
2049		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	35.2	35.2	0.0
2050		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	31.4	31.5	0.0
2051		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	28.1	28.1	0.0
2052		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	25.1	25.1	0.0
2053		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	22.4	22.4	0.0
2054		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	20.0	20.0	0.0
2055		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	17.8	17.8	0.0
2056		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	15.9	15.9	0.0
2057		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	14.2	14.2	0.0
2058		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	12.7	12.7	0.0
2059		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	11.3	11.3	0.0
2060		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	10.1	10.1	0.0
2061		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	9.0	9.0	0.0
2062		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	8.1	8.1	0.0
2063		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	7.2	7.2	0.0
2064		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	6.4	6.4	0.0
2065		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	5.7	5.7	0.0
2066		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	5.1	5.1	0.0
2067		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	4.6	4.6	0.0
2068		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	4.1	4.1	0.0
2069		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	3.7	3.7	0.0
2070		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	3.3	3.3	0.0
Total	6,572.0	16.4	6,588.4	8,271.0	69,383.8	77,654.8	71,066.5	1,257.3	5,714.3	4,457.0

Source: JST

Table 13.4.20 Economic Analysis of Option 3

EIRR: 12.3% **B/C: 1.04** **NPV:** 116.8 **Cost 1.00** **Benefit: 1.00**

Unit: Million NRs. (Year 2015 Economic Price)

Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	1,086.7	0.0	1,086.7	0.0	0.0	0.0	(1,086.7)	(866.4)	0.0	866.4
2018	1,086.7	0.0	1,086.7	0.0	0.0	0.0	(1,086.7)	(773.5)	0.0	773.5
2019	1,086.7	0.0	1,086.7	0.0	0.0	0.0	(1,086.7)	(690.6)	0.0	690.6
2020	1,086.7	0.0	1,086.7	0.0	0.0	0.0	(1,086.7)	(616.7)	0.0	616.7
2021		0.2	0.2	(53.3)	313.8	260.5	260.4	131.9	132.0	0.1
2022		0.2	0.2	(56.4)	367.0	310.6	310.4	140.4	140.5	0.1
2023		0.2	0.2	(59.7)	429.3	369.5	369.4	149.2	149.2	0.1
2024		0.2	0.2	(63.2)	502.1	438.8	438.6	158.2	158.2	0.1
2025		2.0	2.0	(67.0)	587.2	520.2	518.2	166.8	167.5	0.7
2026		0.2	0.2	(70.9)	686.8	615.9	615.7	177.0	177.0	0.0
2027		0.2	0.2	(75.1)	762.7	687.7	687.5	176.5	176.5	0.0
2028		0.2	0.2	(79.5)	847.1	767.6	767.4	175.9	175.9	0.0
2029		0.2	0.2	(84.1)	940.7	856.6	856.4	175.2	175.3	0.0
2030		2.0	2.0	(89.1)	1,044.8	955.7	953.7	174.2	174.6	0.4
2031		0.2	0.2	(89.1)	1,044.8	955.7	955.5	155.9	155.9	0.0
2032		0.2	0.2	(89.1)	1,044.8	955.7	955.5	139.2	139.2	0.0
2033		0.2	0.2	(89.1)	1,044.8	955.7	955.5	124.3	124.3	0.0
2034		0.2	0.2	(89.1)	1,044.8	955.7	955.5	110.9	111.0	0.0
2035		2.0	2.0	(89.1)	1,044.8	955.7	953.7	98.9	99.1	0.2
2036		0.2	0.2	(89.1)	1,044.8	955.7	955.5	88.4	88.5	0.0
2037		0.2	0.2	(89.1)	1,044.8	955.7	955.5	79.0	79.0	0.0
2038		0.2	0.2	(89.1)	1,044.8	955.7	955.5	70.5	70.5	0.0
2039		0.2	0.2	(89.1)	1,044.8	955.7	955.5	63.0	63.0	0.0
2040		2.0	2.0	(89.1)	1,044.8	955.7	953.7	56.1	56.2	0.1
2041		0.2	0.2	(89.1)	1,044.8	955.7	955.5	50.2	50.2	0.0
2042		0.2	0.2	(89.1)	1,044.8	955.7	955.5	44.8	44.8	0.0
2043		0.2	0.2	(89.1)	1,044.8	955.7	955.5	40.0	40.0	0.0
2044		0.2	0.2	(89.1)	1,044.8	955.7	955.5	35.7	35.7	0.0
2045		2.0	2.0	(89.1)	1,044.8	955.7	953.7	31.8	31.9	0.1
2046		0.2	0.2	(89.1)	1,044.8	955.7	955.5	28.5	28.5	0.0
2047		0.2	0.2	(89.1)	1,044.8	955.7	955.5	25.4	25.4	0.0
2048		0.2	0.2	(89.1)	1,044.8	955.7	955.5	22.7	22.7	0.0
2049		0.2	0.2	(89.1)	1,044.8	955.7	955.5	20.3	20.3	0.0
2050		2.0	2.0	(89.1)	1,044.8	955.7	953.7	18.1	18.1	0.0
2051		0.2	0.2	(89.1)	1,044.8	955.7	955.5	16.2	16.2	0.0
2052		0.2	0.2	(89.1)	1,044.8	955.7	955.5	14.4	14.4	0.0
2053		0.2	0.2	(89.1)	1,044.8	955.7	955.5	12.9	12.9	0.0
2054		0.2	0.2	(89.1)	1,044.8	955.7	955.5	11.5	11.5	0.0
2055		2.0	2.0	(89.1)	1,044.8	955.7	953.7	10.2	10.3	0.0
2056		0.2	0.2	(89.1)	1,044.8	955.7	955.5	9.2	9.2	0.0
2057		0.2	0.2	(89.1)	1,044.8	955.7	955.5	8.2	8.2	0.0
2058		0.2	0.2	(89.1)	1,044.8	955.7	955.5	7.3	7.3	0.0
2059		0.2	0.2	(89.1)	1,044.8	955.7	955.5	6.5	6.5	0.0
2060		2.0	2.0	(89.1)	1,044.8	955.7	953.7	5.8	5.8	0.0
2061		0.2	0.2	(89.1)	1,044.8	955.7	955.5	5.2	5.2	0.0
2062		0.2	0.2	(89.1)	1,044.8	955.7	955.5	4.6	4.6	0.0
2063		0.2	0.2	(89.1)	1,044.8	955.7	955.5	4.1	4.1	0.0
2064		0.2	0.2	(89.1)	1,044.8	955.7	955.5	3.7	3.7	0.0
2065		2.0	2.0	(89.1)	1,044.8	955.7	953.7	3.3	3.3	0.0
2066		0.2	0.2	(89.1)	1,044.8	955.7	955.5	3.0	3.0	0.0
2067		0.2	0.2	(89.1)	1,044.8	955.7	955.5	2.6	2.6	0.0
2068		0.2	0.2	(89.1)	1,044.8	955.7	955.5	2.4	2.4	0.0
2069		0.2	0.2	(89.1)	1,044.8	955.7	955.5	2.1	2.1	0.0
2070		2.0	2.0	(89.1)	1,044.8	955.7	953.7	1.9	1.9	0.0
Total	4,347.0	27.2	4,374.2	(4,261.0)	48,271.9	44,010.9	39,636.8	116.8	3,066.2	2,949.4

Source: JST

Table 13.4.21 Economic Analysis of Option 4

EIRR: **12.6%** **B/C:** **1.08** **NPV:** 423.8 **Cost** **1.00** **Benefit:** **1.00**

Unit: Million NRs. (Year 2015 Economic Price)

Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	2,033.4	0.0	2,033.4	0.0	0.0	0.0	(2,033.4)	(1,621.0)	0.0	1,621.0
2018	2,033.4	0.0	2,033.4	0.0	0.0	0.0	(2,033.4)	(1,447.3)	0.0	1,447.3
2019	2,033.4	0.0	2,033.4	0.0	0.0	0.0	(2,033.4)	(1,292.3)	0.0	1,292.3
2020	2,033.4	0.0	2,033.4	0.0	0.0	0.0	(2,033.4)	(1,153.8)	0.0	1,153.8
2021		0.2	0.2	88.3	433.8	522.0	521.9	264.4	264.5	0.1
2022		0.2	0.2	85.2	550.4	635.6	635.4	287.4	287.5	0.1
2023		0.2	0.2	82.3	698.4	780.7	780.5	315.2	315.3	0.1
2024		0.2	0.2	79.5	886.1	965.6	965.4	348.1	348.2	0.1
2025		2.2	2.2	76.7	1,124.3	1,201.1	1,198.9	386.0	386.7	0.7
2026		0.2	0.2	74.1	1,217.6	1,291.7	1,291.5	371.3	371.3	0.1
2027		0.2	0.2	71.5	1,318.6	1,390.1	1,389.9	356.8	356.8	0.0
2028		0.2	0.2	69.1	1,428.0	1,497.1	1,496.9	343.0	343.1	0.0
2029		0.2	0.2	66.7	1,546.5	1,613.1	1,612.9	330.0	330.1	0.0
2030		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	317.3	317.7	0.4
2031		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	283.7	283.7	0.0
2032		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	253.3	253.3	0.0
2033		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	226.1	226.2	0.0
2034		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	201.9	201.9	0.0
2035		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	180.1	180.3	0.2
2036		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	161.0	161.0	0.0
2037		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	143.7	143.7	0.0
2038		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	128.3	128.3	0.0
2039		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	114.6	114.6	0.0
2040		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	102.2	102.3	0.1
2041		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	91.3	91.3	0.0
2042		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	81.5	81.6	0.0
2043		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	72.8	72.8	0.0
2044		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	65.0	65.0	0.0
2045		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	58.0	58.0	0.1
2046		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	51.8	51.8	0.0
2047		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	46.3	46.3	0.0
2048		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	41.3	41.3	0.0
2049		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	36.9	36.9	0.0
2050		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	32.9	32.9	0.0
2051		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	29.4	29.4	0.0
2052		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	26.3	26.3	0.0
2053		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	23.4	23.4	0.0
2054		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	20.9	20.9	0.0
2055		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	18.7	18.7	0.0
2056		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	16.7	16.7	0.0
2057		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	14.9	14.9	0.0
2058		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	13.3	13.3	0.0
2059		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	11.9	11.9	0.0
2060		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	10.6	10.6	0.0
2061		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	9.5	9.5	0.0
2062		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	8.5	8.5	0.0
2063		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	7.5	7.5	0.0
2064		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	6.7	6.7	0.0
2065		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	6.0	6.0	0.0
2066		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	5.4	5.4	0.0
2067		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	4.8	4.8	0.0
2068		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	4.3	4.3	0.0
2069		0.2	0.2	64.4	1,674.7	1,739.1	1,738.9	3.8	3.8	0.0
2070		2.2	2.2	64.4	1,674.7	1,739.1	1,736.9	3.4	3.4	0.0
Total	8,133.6	29.2	8,162.9	3,332.5	77,868.2	81,200.7	73,037.9	423.8	5,940.5	5,516.8

Source: JST

Table 13.4.22 summarizes the result of economic analysis of the intersection improvement plan by option.

Table 13.4.22 Results of Economic Analysis by Option

Option	EIRR (%)	NPV NRs Million	B/C
1	14.3	1,257.3	1.28
3	12.43	116.8	1.04
4	12.46	423.8	1.08

Source: JST

(2) Conclusion

As a conclusion, it could be said that all the Options are feasible because all the EIRR exceeded the social discount rate of Nepal, which is 12.0%. However, the Study Team recommends Option 1 as the best improvement plan of the intersection, because the Option showed the highest EIRR and the biggest NPV among the Options.

Sensitivity analysis was conducted to confirm the feasibility of Option 1 as shown in Table 13.4.23. Option 1 showed a strong feasibility as in the Table. Even if the benefit decreases by 20%, the EIRR exceeds the social discount rate of 12.0%. Also, in case the cost increases by 20%, the EIRR still exceeds the social discount rate.

The Study Team conclude that Option 1 is strongly feasible.

Table 13.4.23 Sensitivity Analysis of Option 1

Sensitivity Test (EIRR:%)		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	14.3	13.3	12.8	12.2
	+10%	13.4	12.4	11.9	11.4
	+15%	13.0	12.0	11.5	11.0
	+20%	12.6	11.7	11.2	10.7

Source: JST

13.4.5 Environmental and Social Considerations

13.4.5.1 Objective

The objective is to grasp the positive and negative impact on environment by conducting comparative evaluation of Option 0 (without case), 1, 3, and 4.

13.4.5.2 Scoping

The environmental impact factors coming from implementation of the Pilot Project are exhaust gas of vehicles and land acquisition for road construction. Table 13.4.24 below shows the result of scoping conducted in accordance with JICA's Guideline for Environmental and Social Considerations, 2010 and considering the environmental impact factors.

Table 13.4.24 Scoping Result

Category		Impact Item	Rating		Reason for Rating
			Pre-C/C	Op	
Pollution	1	Air Quality	C-	B+/-	C: Exhaust gas and dust will be generated by construction machines. However, environmental impact assessment will be conducted after the construction plan is established. Op: Traffic flow will be smoothened and emission of air pollutants will be reduced due to improvement of congested intersection. However air pollution will be increased due to extension of travel distance in the options which take a detour.
	2	Noise and Vibration	C-	B+/-	C: Noise and vibration will be generated by construction machines. However, environmental impact assessment will be conducted after the construction plan is established. Op: Noise and vibration can either be improved or deteriorated due to change of road structure.
	3	Water Quality	D	D	C: No work that changes river area is expected. Op: Only rain water is expected to be drained, thus there will be no impact.
	4	Waste	C-	D	C: Replacement and demolition of affected buildings will cause generation of waste such as debris. However, environmental impact assessment will be conducted after which affected buildings will be fixed. Op: No activity that generates waste is expected.
	5	Soil Contamination	D	D	C: Proposed roads are a flyover and plane roads, and large scale excavation is not expected. Op: No activity that causes soil contamination is expected.
	6	Land Subsidence	D	D	C: Proposed roads are a flyover and plane roads, and large scale excavation and ground water pump up is not expected. Op: No activity that causes land subsidence is expected.
	7	Odor	D	D	C and Op: No work that causes odor is expected.
	8	Sediment	D	D	C: No work that changes river area is expected. Op: Only rain water is expected to be drained, thus there will be no impact.
Natural Environment	9	Protected Area	D	D	C and Op: The project is road improvement within urban area of the city. No work on protected area is expected.
	10	Ecosystem	D	D	C and Op: The project is road improvement within urban area of the city. No impact on ecosystem is expected.
	11	Hydrology/ Water Use	D	D	C and Op: There is neither river nor water use facility.
	12	Underground Water	D	D	C and Op: Proposed roads are a flyover and plane roads, and pump up of ground water is not expected.
	13	Topography and Geology	D	D	C and Op: Proposed roads are a flyover and plane roads, and large scale change on topography and geology is not expected.
	14	Soil Erosion	D	D	C and Op: Proposed roads are a flyover and plane roads, and soil erosion is not expected.
Social Environment	15	Involuntary Resettlement	B-	D	Pre-C: Involuntary resettlement is expected due to land acquisition for right of way.
	16	The Poor/ The Minority	D	D	C and Op: The project is road improvement within urban area of the city. No change to residential areas for the poor and the minority is expected.
	17	Local economy (employment/a means of	C+	D	C: Employment for construction work will be generated. However, environmental impact assessment will be conducted after the construction plan has been

Category		Impact Item	Rating		Reason for Rating
			Pre-C/C	Op	
		livelihood)			established. Op: No activity is expected that affects local economy.
	18	Public Health	D	D	C and Op: The project is road improvement within urban area of the city. No impact on public health is expected.
	19	Work Environment (work safety)	D	D	C and Op: The project is road improvement within urban area of the city. No impact on citizens' work environment is expected.
	20	Disaster, Infection such as HIV/AIDS	D	D	C and Op: The project is road improvement within urban area of the city. No impact on disaster and infection is expected.
	21	Landscape	D	D	C and Op: The project is road improvement within urban area of the city. There will be no big change on landscape.
Others	22	Accident	C-	C+	C: Accident related to construction machinery and vehicles may occur. However, environmental impact assessment will be conducted after construction plan is established. Op: While smoother traffic flow may contribute to reduction of accident, improvement of travel speed may result in increase of accident. Since a detailed plan of intersection is not fixed yet, comparative evaluation is not conducted.
	23	Global warming/ Climate change	C-	B+/-	C: Emission of CO2 is expected due to operation of construction machinery and vehicles. However, environmental impact assessment will be conducted after construction plan is established. Op: CO2 emission is expected to be reduced due to improved intersection and smoothened traffic flow. However CO2 emission will be increased due to extension of travel distance in the options which take a detour.

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.
Note: Pre-C: Pre-Construction stage, C: Construction stage, Op: Operation stage
Source: JST

13.4.5.3 Method of Environmental Impact Assessment

(1) Air Quality and Global Warming

The impact on air quality and global warming is estimated by multiplying emission unit by future traffic volume in each case. Since future traffic volume is estimated by vehicle type and travel speed (see Table 13.4.25), emission unit is also set by vehicle type and travel speed and is extracted from Environmental Impact Assessment Technique for Road Project (Edition of FY2012), National Institute for Land and Infrastructure Management MLIT Japan.

The calculated items are nitrogen oxide (NOx), suspended particle matter (PM10) for air pollution, and carbon dioxide (CO2) for global warming in 2020, 2025, and 2030.

Table 13.4.25 Traffic Volume 2020

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2020 Option0	50-60km/h	30017.8	829.3
	40-50km/h	31995.0	1214.1
	30-40 km/h	57380.6	1714.4
	20-30 km/h	9832.1	306.2
	10-20 km/h	0.0	0.0
	-10 km/h	56848.6	1781.1
2020 Option1	50-60km/h	39117.3	1057.9
	40-50km/h	37985.3	1446.4
	30-40 km/h	39289.5	1173.0
	20-30 km/h	13870.4	415.0
	10-20 km/h	0.0	0.0
	-10 km/h	51815.7	1645.1
2020 Option3	50-60km/h	36871.0	1004.1
	40-50km/h	41541.6	1505.8
	30-40 km/h	45480.4	1364.3
	20-30 km/h	11318.1	343.5
	10-20 km/h	0.0	0.0
	-10 km/h	50901.2	1623.2
2020 Option4	50-60km/h	35086.5	966.1
	40-50km/h	42877.0	1540.6
	30-40 km/h	32609.0	1004.4
	20-30 km/h	7523.8	217.7
	10-20 km/h	16039.1	455.4
	-10 km/h	56150.5	1766.1

Source: JST

Table 13.4.26 Traffic Volume 2025

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2020 Option0	50-60km/h	39623.9	1444.1
	40-50km/h	30326.4	1103.7
	30-40 km/h	68009.8	2198.6
	20-30 km/h	8410.0	268.3
	10-20 km/h	0.0	0.0
	-10 km/h	58103.5	1908.5
2020 Option1	50-60km/h	43179.7	1449.7
	40-50km/h	42724.7	1583.0
	30-40 km/h	51262.5	1706.1
	20-30 km/h	4889.6	143.3
	10-20 km/h	0.0	0.0
	-10 km/h	52281.9	1696.7
2020 Option3	50-60km/h	42978.9	1461.6
	40-50km/h	46121.9	1657.8
	30-40 km/h	50622.1	1707.5
	20-30 km/h	4889.6	143.3
	10-20 km/h	3243.0	138.1
	-10 km/h	51169.0	1602.4
2020 Option4	50-60km/h	40412.4	1385.1
	40-50km/h	46091.1	1622.5
	30-40 km/h	31999.6	1107.6
	20-30 km/h	22045.1	667.3
	10-20 km/h	5046.1	204.5
	-10 km/h	58301.3	1887.2

Source: JST

Table 13.4.27 Traffic Volume 2030

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2020 Option0	50-60km/h	55598.2	2170.1
	40-50km/h	28104.8	916.8
	30-40 km/h	61726.1	2029.1
	20-30 km/h	18153.8	677.5
	10-20 km/h	0.0	0.0
	-10 km/h	68444.9	2361.6
2020 Option1	50-60km/h	57638.5	2176.3
	40-50km/h	45356.2	1424.5
	30-40 km/h	49437.3	1684.6
	20-30 km/h	12882.8	564.6
	10-20 km/h	0.0	0.0
	-10 km/h	61029.8	2098.2
2020 Option3	50-60km/h	54519.5	2072.7
	40-50km/h	59420.3	1917.6
	30-40 km/h	41140.4	1421.6
	20-30 km/h	10171.2	426.3
	10-20 km/h	5544.6	294.5
	-10 km/h	63973.3	2210.5
2020 Option4	50-60km/h	60602.4	2279.8
	40-50km/h	38274.2	1229.2
	30-40 km/h	39179.3	1327.0
	20-30 km/h	26118.9	913.2
	10-20 km/h	2455.4	108.9
	-10 km/h	72979.8	2568.4

Source: JST

The slower the travel speed is, the larger the emission unit is as shown in Table 13.4.28 below. Thus air pollutants and greenhouse gasses are expected to be reduced in accordance with improvement in travel speed.

Table 13.4.28 Emission Unit

Travel Speed	NOx (g/Traveler Kilometer)		PM10 (g/Traveler Kilometer)		CO2 (g/Traveler Kilometer)	
	Small Vehicle	Large Vehicle	Small Vehicle	Large Vehicle	Small Vehicle	Large Vehicle
50-60km/h	0.000492	0.005324	0.040	0.463	89.7	517.9
40-50km/h	0.000471	0.006177	0.047	0.530	95.4	558.8
30-40 km/h	0.000756	0.007514	0.058	0.654	106.2	631.5
20-30 km/h	0.000958	0.009385	0.072	0.846	124.7	742.0
10-20 km/h	0.001465	0.010548	0.080	0.970	139.2	814.0
-10 km/h	0.001465	0.010548	0.080	0.970	139.2	814.0

Source: Environmental Impact Assessment Technique for Road Project (Edition of FY2012) , National Institute for Land and Infrastructure Management MLIT Japan

(2) Noise

Noise is calculated using road traffic noise prediction model “ASJ RTN-Model 2013”. Six cross sections with different traffic volume and road structure are examined as shown in Figure 13.4.15. Traffic volume for each cross section is presented in Table 13.4.29

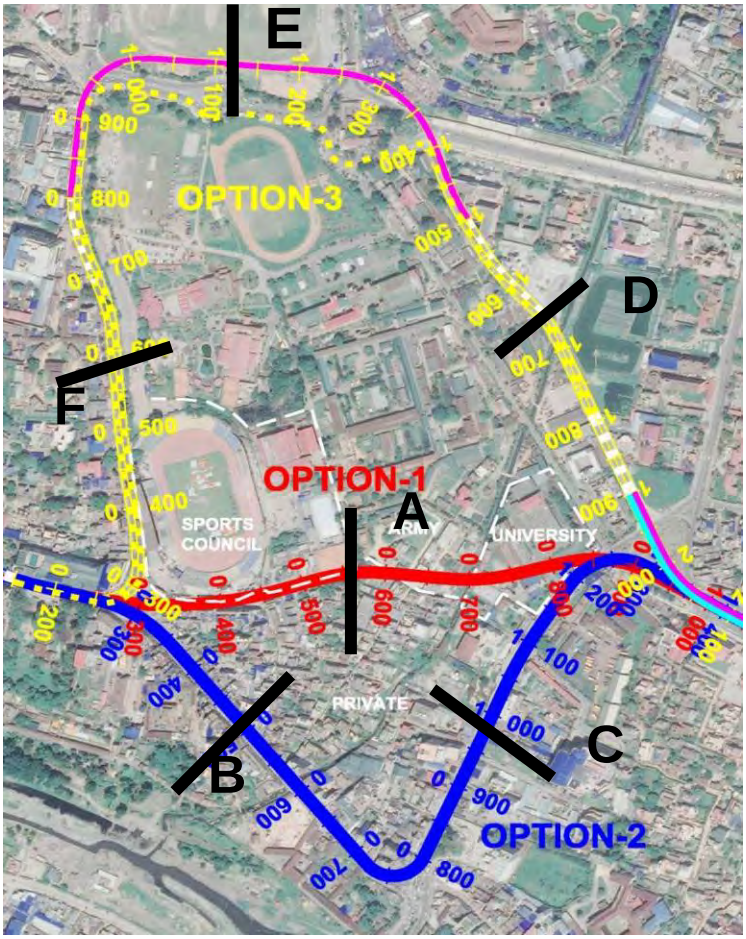


Figure 13.4.15 Cross Section for Noise Level Assessment

Table 13.4.29 Cross Section Traffic Volume 2030

Case	Cross Section	Traffic Volume(per Day)		
		Small Vehicle	Large Vehicle	Motor Bike
Option0	A	------	------	------
	B	43,330	1,538	44,262
	C	41,363	1,471	42,246
	D	6,495	244	6,596
	E	33,817	1,216	34,535
	F	34,686	1,232	35,418
Option1	A	11,680	427	11,899
	B	26,571	953	27,120
	C	34,874	1,243	35,617
	D	15,858	568	16,170
	E	28,493	1,020	29,087
	F	29,451	1,051	30,066
Option3	A	------	------	------
	B	28,535	1,021	29,134
	C	39,824	1,424	40,675
	D	26,084	937	26,629
	E	28,875	1,034	29,477
	F	34,296	1,223	35,027
Option4	A	11,680	427	11,899
	B	31,323	1,120	31,982
	C	30,890	1,109	31,542

	D	16,240	588	16,561
	E	32,428	1,155	33,110
	F	34,159	1,218	34,878

Source: JST

In option-4, vehicles from Putali Sadak to Arniko HW are divert to Bhadrakali Bypass and Kanti Path, thus traffic volume of Option-4 is larger than Option-1 in section B, D, F and E.

(3) Involuntary Resettlement

The properties likely to be affected have been grasped by overlaying the ROW of the proposed flyover on the satellite image. The current situation of the properties has been also confirmed through site survey. Resettlement will not occur for the sections other than flyover since the road improvement works will be done within the current ROW.

13.4.5.4 Evaluation Result

(1) Air Quality and Global Warming

1) NOx

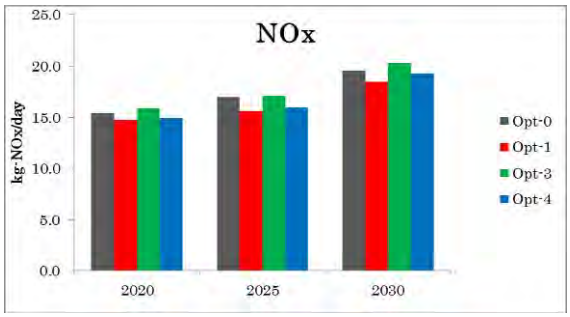
Table 13.4.30 and Figure 13.4.16 below presents the result of prediction. Option 1 has the smallest NOx emission for each year case, which is better than Option 0 (do nothing option). The reason for this is attributed to the fact that the travel distance in Option 1 is shorter than that of the others, and the travel speed is improved to the one with smaller emission unit. The reduction rate of Option 1 is the largest in 2025; NOx emission is expected to decrease by 7.9% compared to Option 0.

On the other hand, emission levels in Option 3 is larger than Option 1. This can be attributed to the longer travel distance and thus the longer total traveler kilometer. The emission amount is the largest in 2030 because the traffic volume is the largest. However the ranking of the options is the same for the predicted years (2020, 2025, and 2030).

Table 13.4.30 Evaluation Result (NOx)

	2020		2025		2030	
	kg-NOx/day	Reduction Rate	kg-NOx/day	Reduction Rate	kg-NOx/day	Reduction Rate
Option 0	15.4	0.0%	17.0	0.0%	19.6	0.0%
Option 1	**14.7**	**-4.4%**	**15.6**	**-7.9%**	**18.5**	**-5.6%**
Option 3	15.9	3.0%	17.1	0.8%	20.4	3.9%
Option 4	15.0	-2.9%	16.0	-5.7%	19.3	-1.2%

Source: JST



Source: JST

Figure 13.4.16 Evaluation Result (NOx)

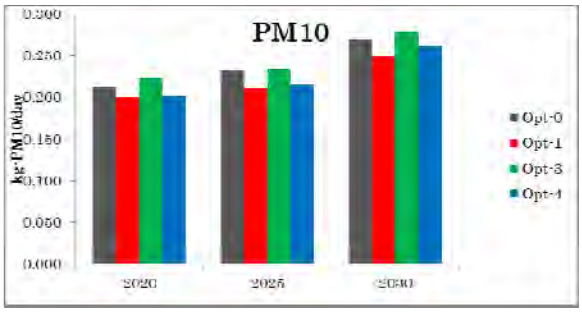
2) PM10

Table 13.4.31 and Figure 13.4.17 below shows the result of prediction. The result is similar to the one for NOx.

Table 13.4.31 Evaluation Result (PM10)

	2020		2025		2030	
	kg-PM10/day	Reduction Rate	kg-PM10/day	Reduction Rate	kg-PM10/day	Reduction Rate
Option 0	0.212	0.0%	0.232	0.0%	0.269	0.0%
Option 1	**0.201**	**-5.5%**	**0.211**	**-9.1%**	**0.249**	**-7.2%**
Option 3	0.223	4.9%	0.234	0.7%	0.280	4.0%
Option 4	0.203	-4.5%	0.216	-6.9%	0.261	-2.7%

Source: JST



Source: JST

Figure 13.4.17 Evaluation Result (PM10)

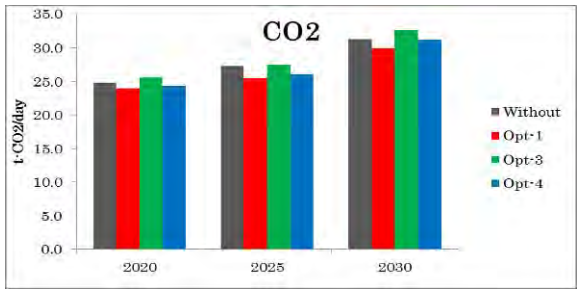
3) CO2

Table 13.4.32 and Figure 13.4.18 below shows the result of prediction. The result is similar to the one for NOx and PM10. The reduction rate of Option 1 is the largest in 2025; CO2 emission can be decreased by 6.7% compared to Option 0, which is expected to contribute to curbing global warming.

Table 13.4.32 Evaluation Result (CO2)

	2020		2025		2030	
	t-CO2/day	Reduction Rate	t-CO2/day	Reduction Rate	t-CO2/day	Reduction Rate
Option 0	24.8	0.0%	27.3	0.0%	31.4	0.0%
Option 1	**24.0**	**-3.4%**	**25.5**	**-6.7%**	**30.0**	**-4.4%**
Option 3	25.7	3.3%	27.5	0.7%	32.6	3.9%
Option 4	24.4	-1.8%	26.1	-4.4%	31.3	-0.3%

Source: JST



Source: JST

Figure 13.4.18 Evaluation Result (CO2)

(2) Noise

Table 13.4.33 below presents the result of prediction. Section A which is on the proposed flyover has the smallest noise level since the source of the traffic noise will be away from the ground. In Option 1 and 3, the noise level is decreased in all sections other than section D compared to Option 0. Comparing Option 0 and 4, the noise level will decrease only in section B and C.

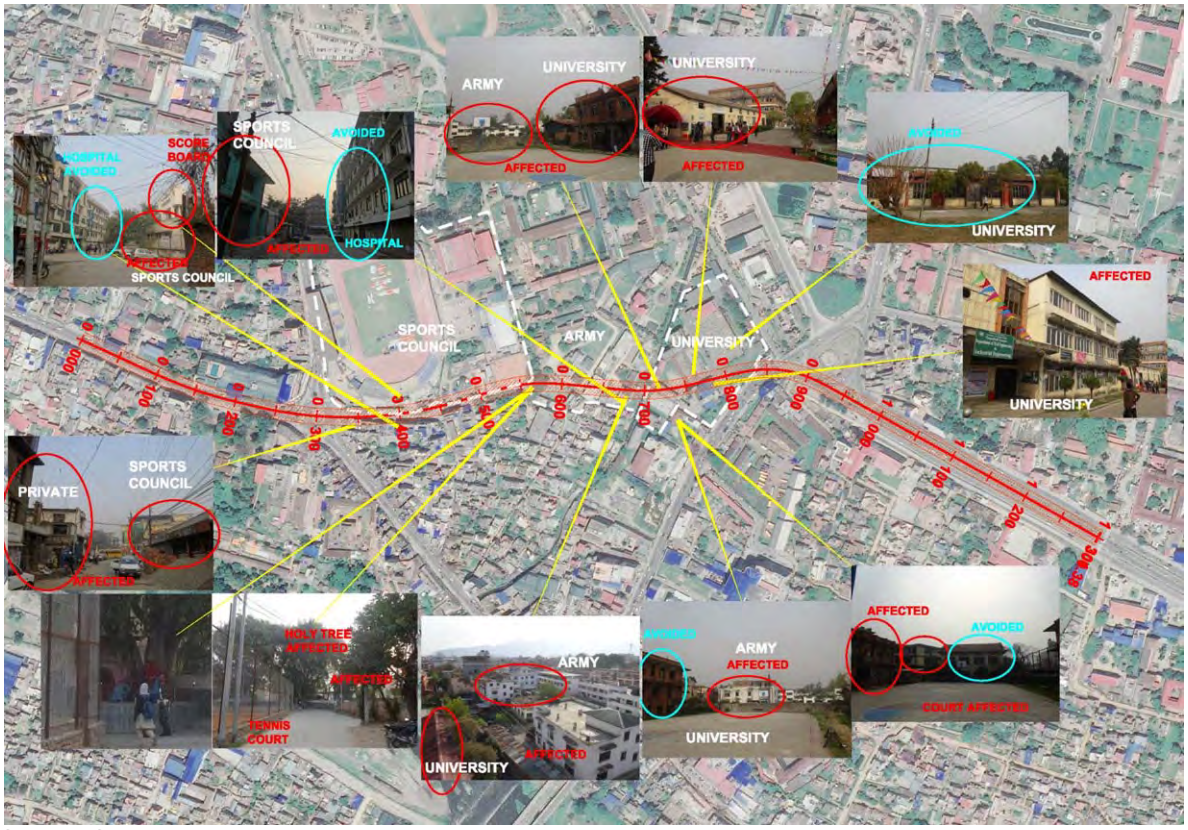
Table 13.4.33 Evaluation Result (Noise Level)

Section	A		B		C	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Option 0	---	---	74.4	68.4	74.2	68.2
Option 1	48.3	42.3	72.8	66.8	72.8	66.8
Option 3	---	---	72.5	66.6	74.0	68.0
Option 4	48.3	42.3	73.5	67.6	73.4	67.5
Section	D		E		F	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Option 0	66.1	60.2	73.3	67.3	73.4	67.5
Option 1	70.5	64.6	73.1	67.2	73.2	67.3
Option 3	72.1	66.2	72.8	66.9	69.5	63.6
Option 4	70.6	64.7	73.7	67.7	73.9	67.9

DAY:7am-7pm NIGHT:7pm-7am
National Noise Level Standard: DAY 65dB NIGHT 55 (Commercial Area)
Source: JST

(3) Involuntary Resettlement

Figure 13.4.19 below shows the overlaid image of ROW of the proposed flyover and satellite photo. 33 buildings in total are likely to be affected as summarized in Table 13.4.34. There are nine residential buildings and two commercial buildings out of 11 private properties. The study for actual resettlement is required based on the detailed design when the project comes to implementation.



Source: JST

Figure 13.4.19 Overlaying Fly Over Section ROW on existing buildings

Table 13.4.34 Summary of the Existing Buildings on ROW

Ownership	No. of Buildings
Army	10
University	4
Sports Council	8
Private	11
Total	33

Source: JST

13.4.5.5 Stakeholder Meeting

The stakeholder meeting for the Pilot Project was held on June 23, 2016. Table 13.4.35 and Table 13.4.36 presents outline of the stakeholder meeting and comments from the participants respectively. Since the discussion took place in Nepal for the convenience of the participants, the main focus of the meeting was to have their views and comments on the Pilot Project. The comments and inquiries have been taken into consideration and some of them are addressed in the report. Some comments and inquiries shall be addressed in the upcoming study stage. Table 13.4.37 summarizes the comments and responses.

Table 13.4.35 Outline of the Stakeholder Meeting

Date	June 23rd, 2016
Organizer	Ministry of Population and Environment Department of Environment JST
Venue	The Malla Hotel
Attendance List	<Ministries and relevant governmental organizations> Ministry of Population and Environment Ministry of Land Reform and Management Ministry of Federal Affairs and Local Development Kathmandu Valley Development Authority Department of Environment Department of Forests Department of Urban Development and Building Construction Geology and Social Unit, Department of Roads Kathmandu Valley Water Supply Management Board Kathmandu Metropolitan City Lalitpur Sub Metropolitan City Bhaktapur Municipality Madhyapur Thimi Municipality <NGOs> IUCN Nepal <Media> Nepal Forum of Environmental Journalists/ Ankhijyal <Individuals> Mr. Kulchandra Silwal
Agenda	1. Outline of the Project and Pre-Feasibility Study on T-M Flyover 2. Alternative Plans and Traffic Analysis 3. Economic Analysis 4. Prediction on Environmental Impact by the Project

Table 13.4.36 Comments from the Participants of the Stakeholder Meeting

	Summary of Comments
MOPE	➢ What is the status of soil tests and analysis? Based on last year earthquake, many public grievances are raised and need to be addressed including densely populated area, working time – day time vs. night time, erratic electricity supply, waste materials management, ground water conditions (including depletion and recharge) etc.
MLRM	➢ How is the compensation fixed? Do the affected people agree?
DOR	➢ Social issues are big challenge. Since road projects sometimes come to a halt due to the problems with the alignment, all social issues need to be solved before detailed design.
DOE	➢ Please check ozone also in the study. ➢ How will air pollution during construction time be controlled? ➢ How can the problems related to ground water recharge and water pollution be managed or controlled? ➢ They must be addressed in EIA report.
DOE	➢ How can different entities such as Ministry of Defense, university, Department of Sports help to make the project feasible? ➢ What are the basis for compensation for land and properties? ➢ How are those issues incorporated in the Master Plan?
Unknown	➢ Has the team considered emission level by increased number of PCU? The presentation says that NOx and PM will be reduced by realization of the Pilot Project. Need more explanation about how the team has come to this result.
MoFALD	➢ According to the presentation, air pollution and noise pollution is going to be reduced by the Pilot Project. What is the basis of the calculation?
Unknown	➢ Disturbance to the traffic by animals, vendors, maintenance shortage etc. are very common. How will you address these issues?
MOPE	➢ What is the basis of estimation of cost and time saving benefit? It seems that the project is made feasible on the desk. How can it be realized in practice?

Table 13.4.37 Summary of Comments and Responses

Category	Comment	Response
Involuntary resettlement	How is the compensation determined?	Resettlement Action Plan (RAP) will be established in accordance with "The Environmental and Social Management Framework (ESMF) (2007, DOR)" when the Pilot Project comes to implementation. In the RAP study, the compensation is examined. If the Pilot Project is implemented under JICA's support, the compensation has to be in line with JICA's Environmental and Social Guidelines, 2010 in addition to ESMP.
	All social related issues need to be solved before detailed design.	Issues related to land acquisition will be further examined at detailed design stage, when the alignment is fixed.
	How do the different entities that will be affected by the Project help to make the project feasible?	When alignment is determined and the affected properties are fixed, the project proponent needs to discuss the compensation.
Pollution	Check ozone in the study.	Since ozone is hardly generated from vehicle exhaust, it is not examined in the study.
	How will air pollution during construction be managed?	It will be studied when a concrete work plan is set.
	How the result was gained that NOx and PM will be reduced by the Pilot Project?	Emission Unit per PCU gets smaller due to improved travel speed and vehicle travel efficiency. Thus emission of NOx and PM will be reduced by the Pilot Project.
	What is the basis of the calculation that leads to reduction of noise pollution?	The source of noise pollution gets away from the ground because of the elevated road.

13.4.6 Evaluation of Plan Options

As a result of economic evaluation and environmental social consideration, evaluation of plan options is summarized as follows:

1) As a result of economic analysis, it is concluded that Option-1 is the most viable project.
2) As a result of environmental prediction, Option-1 and Option-4 have the most positive effect in air pollution, noise and vibration and global warming.
3) Therefore Option-1 is most effective plan to solve the traffic issues and environmental issues in the target area.
4) However Option-1 and Option-4 have the largest adverse effect on involuntary resettlement and existing social infrastructures and social services.
5) At the implementation stage, measures for compensation to the adversely affected shall be prudently scrutinized.

13.5 Pre-FS for Four-lane Flyover

In 13.2.2, it is found out that the capacity of two-lane road can fulfil the traffic demand in 2030. However, the flyover is semi-permanent structure with service life more than 50 years. Hence, considering the traffic increase during service life, Pre-FS for two-lane flyover and four-lane flyover are conducted in parallel. In this section, study on Four-lane case is described. For four-lane case, traffic demand of without project of Master Plan is applied to analyze the traffic condition in maximum demand.

13.5.1 Preliminary Engineering Design

13.5.1.1 Geometric Design Criteria

The Geometric Design Criteria based on Nepal Road Standards 2070 as presented in the Table 13.5.1 below, are proposed for the design of the Project Road

Table 13.5.1 Geometric Design Criteria

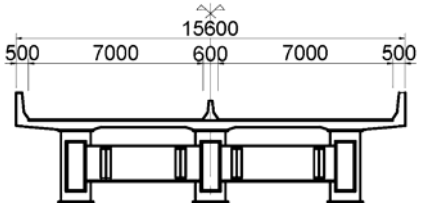
Design Elements			Type/Value	Remarks
1	Design Speed (km/h)		60	
2	Cross-Sectional Elements	Basic Lane Width (m)	3.0	
		Number of Lanes	4	
		Total Formation Width (m)	15.6	
		Carriageway Width (m)	4 x 3.0	
		Outer Shoulder Paved Width (m)	4 x 0.5	
		Parapet Width (m)	2 x 0.5	
		Median Separator (m)	0.6	
		Crossfall of Roadway (%)	2.5	
3	Horizontal Alignment	Min. Radius of Horizontal Curve (m)	125	Se=6%
		Max. Superelevation (Se)	6.0	Applied
		Min. Length of Transition Curve (m)	55	Radius = 125m

Design Elements			Type/Value	Remarks
4	Vertical Alignment	Max. Vertical Gradient (%)	7.0	
		Applied Max. Vertical Gradient (%)	6.0	
		Critical length of 6% Gradient (m)	400	
		Min. Radius of Summit Curve (m)	940	Radius=100*(K-value)
		Min. Radius of Valley Curve (m)	420	
5	Minimum Vertical Clearance (m)		5.0	

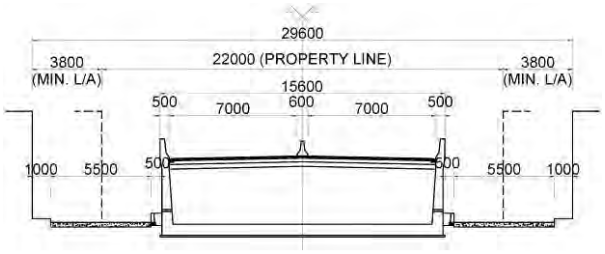
Source: NRS2070

13.5.1.2 Typical Cross Sections

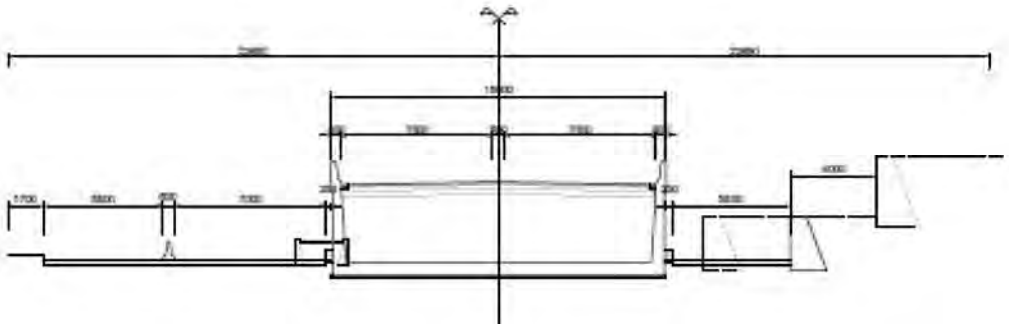
Typical cross sections of Option 1, 4 lanes case are as shown in Figure 13.5.1 below. For the 4-lane option, the cross sectional widths at the flyover and approach road sections are same. However, the termination of median barrier at the connection to existing road shall be done by transitioning where flexible rubber poles or traffic cones shall be installed to sufficient length for traffic safety.



Four-lane Flyover with median



Tripureswar side approach road



Maitighar side approach road

Source: JST

Figure 13.5.1 Typical Cross Section of Four-lane Flyover

13.5.1.3 Horizontal and Vertical Alignment

Horizontal and vertical alignment for Option 1, 4lanes case are as shown in Figure 13.5.2 and Figure 13.5.3.

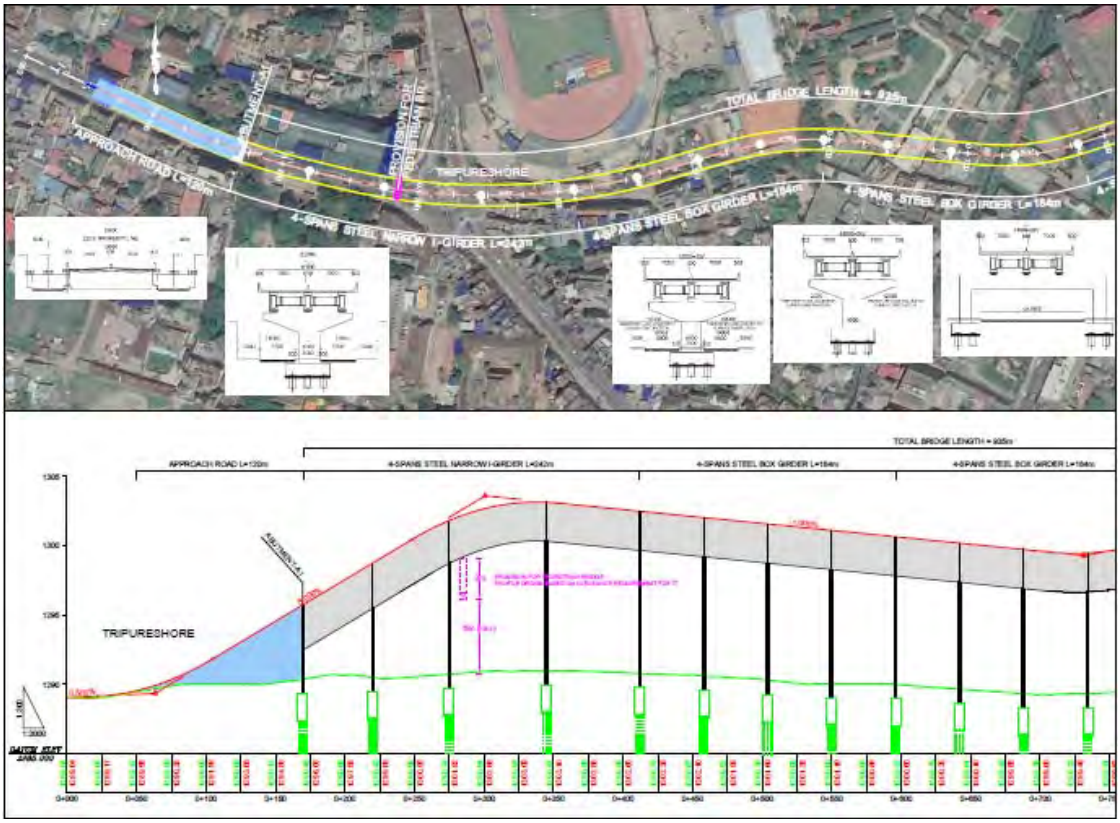


Figure 13.5.2 Plan and Profile of T-M Flyover (4lanes) (1/2)

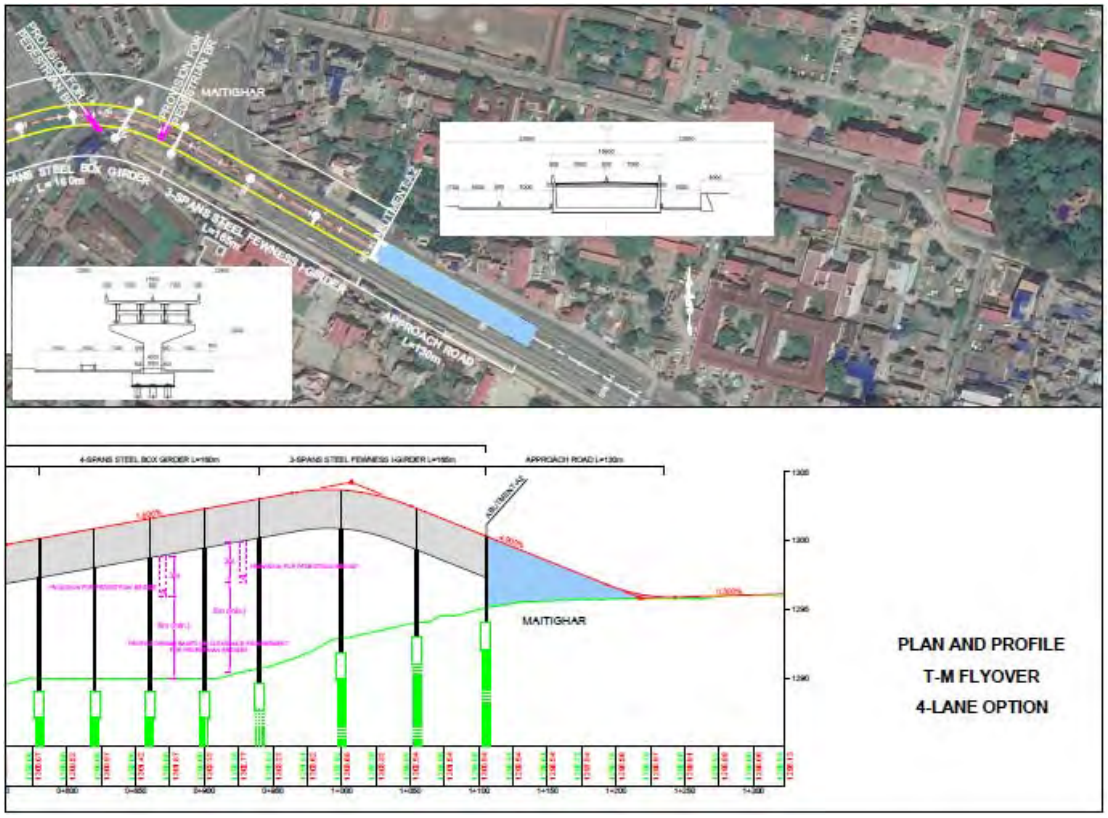


Figure 13.5.3 Plan and Profile of T-M Flyover (4lanes) (2/2)

13.5.1.4 Structure Design

(1) Applicable Structure Types

Basically, structure and method of Four-lane type of T-M Flyover will be selected with similar conditions as the Two-lane type. In order to select superstructure and substructure, the following special issues shall be considered.

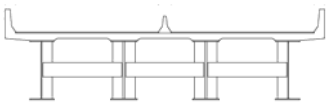
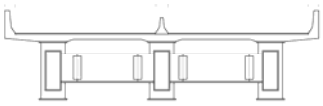
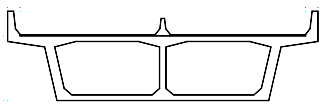
To consider soft ground (Kalimati formation),
To consider earthquake (April 2015 Nepalese earthquake occurred with a magnitude of 7.8M),
To consider erection in large-sized intersection and
Construction in densely populated urbanized area

In accordance with the above special issues, the following five (5) countermeasures (a ~ e) will be adopted.

a) Application of Steel Girder Bridge
- To reduce dead load of superstructure for better performance against seismic activity
- To avoid difficulties of erection in limited construction width along densely populated urbanized area and fabrication outside of the site
- Overpass at saturated intersection with traffic congestion also same condition
- One or two track crane/rough terrain crane will be used for erection and bridge surface works

Comparison of alternatives for three (3) superstructures is shown in Table 13.5.2.
- Continuous Steel I-shaped (fewness) Girder
- Continuous Steel Narrow Box Girder
- Continuous Pre-stressed Concrete Box Girder

Table 13.5.2 Comparison of Alternatives for Superstructure

Location		Passing through Intersection (Required Max. Span 60 ~ 70m) and Densely Urbanized Area					
Type		Continuous Steel I Girder (Fewness) with Composite deck slab		Continuous Steel Narrow Box Girder with Composite deck slab		Continuous PC Box Girder	
Cross-section		 Girder depth 2.9m		 Girder depth 2.9m		 Girder depth 4.5m on pier~2.5m	
Acceptable Range of Span (Erection method)		35m~70m		40m ~ 95m		35 ~ 60m (Staging) 50m ~ 110m (Cantilever)	
Required Horizontal Arraignment		Straight ~ Curved section > R=700m		Straight ~ Curved section		Straight ~ Curved section	
Advantage and Disadvantage for Structural future and surrounding environment	Structural Feature	Light superstructure and wide cantilever pier head due to use of composite slab is suitable for flyover because the size of substructure becomes smaller	◎	Light superstructure and wide cantilever pier head due to use of composite slab is suitable for flyover because the size of substructure becomes smaller	◎	Heavy superstructure and large girder depth on pier needs a large substructure and girder depth at the support becomes higher than steel girder	○
	At Radius Horizontal Curve	Effective for horizontal curve section with more than 700m radius	○	Effective for horizontal curve section with more than 300m radius	○	Box shape of girder is having high flexural rigidity and torsional rigidity for horizontal small curve	◎
	Against Earthquake	Isolated bearings used to minimize the total construction cost for earthquake protection	○	Isolated bearings used to minimize the total construction cost for earthquake protection	○	Since the site is located on soft ground, heavy weight of concrete structure is a disadvantage compared with the steel structure	△

	Erection Method in Intersection	Launching erection during night time will be applied. Composite deck slab will minimize the site work under restricted condition	◎	Launching erection during night time will be applied. Composite deck slab will minimize the site work under restricted condition	◎	Cantilever erection method will be applied to construct under restricted condition or in congested intersections	○
	Influence on Urban Roads	Since the size of substructure becomes smaller, less influence in crowded/intersection area	◎	Since the size of substructure becomes smaller, less influence in crowded/intersection area	◎	Large influence on urban roads since the size of substructure becomes large	△
	Pile Foundation at Proposed Span (Reverse circulation method)	Required reverse circulation bored pile method. Reduces the pile number and length due to light superstructure weight than PC bridge	◎	Required reverse circulation bored pile method. Reduces the pile number and length due to light superstructure weight than PC bridge	◎	Heavy weight of concrete girder with high unit cost of pile foundation method causes cost to rise	△
	Construction Period	It will be the shortest construction period among these alternatives. Superstructure: 10M (1.0)	○	It will be the shortest construction period among these alternatives. Superstructure: 10M (1.0)	◎	It will be a long construction period at site since it is used pre-casting girder segment and pre-casting PC slab. (1.5)	△
	Maintenance	Anti-corrosion steel be used since less re-painting at saturated intersection	○	Anti-corrosion steel be used since less re-painting at saturated intersection	○	It is necessary to replace expansion joint at bearing shoes once per 20-30 years.	○
Cost Ratio (including substructure)		1.00 440 thousand NRs. per sq.m		1.05 450 thousand NRs. per sq.m		1.10 460 thousand NRs. per sq.m	
Aesthetic		Due to smooth surface of girder, side view looks clear. It is possible to improve aesthetics by modifying girder shape.		Due to smooth surface of girder, side view looks clear. It is possible to improve aesthetics by modifying girder shape.		It gives less heaviness than PC-I Girder since the number of girders is less than PC-I Girder. Smooth surface of girder makes side view looks clear.	
Overall Evaluation		**Recommended at straight alignment area**		**Recommended at curved alignment area**			

◎Advantage, ○Acceptable, △Disadvantage Source: JST

b) Application of Cast-in-place RC Pile (Reverse Circulation Drilling Method)
- Friction pile is applied due to deep soft ground
- Cast-in-place pile by Reverse Circulation Drilling Method is used to reduce vibration and noise and to prevent deformation of houses/buildings along densely urbanized areas. (This pile can be applied over 60m depth)

c) Application of Isolated Bearing
- Earthquake resistant structure can be designed by making seismically isolated structure
- Slow vibration is ensured by dividing earthquake force into small components in seismically isolated structure, thus cost effective.

d) Application of Weathering Steel (Anti-corrosion) for Steel Bridge
- Re-painting is not required in weathering steel bridges, thus saving cost and avoiding traffic congestion and entry to sensitive army area during repainting
- Weathering steel bridges have a good track record in Kathmandu of more than 20 years.

e) Application of Steel-Concrete Composite Deck Slab (combination with steel girder bridge)
- High quality steel deck slab can be fabricated at factory and/or casting yard in a short time without support and form at the narrow job site.
- Formwork and scaffolding are not required since steel deck plate plays its role at the time of slab concreting, thus making work faster.
- A long hanging deck slab is advantageous in reducing the pier body size (transverse width of pier head) and hence cost effective for substructure.

The above mentioned relationship between special issue and countermeasures are summarized in Table 13.5.3.

Table 13.5.3 Summarized Countermeasures for Specific Issue of the Bridge Site

Countermeasures		Special Issue			
		Soft Ground	Earthquake	Overpassing at	
				Large-sized Intersection	Densely populated urbanized area
Required Condition		Costly friction pile shall be designed in Kalimati (soft ground) formation	Reduce the dead load of superstructure and the size of pier	Erection of the girder in a short period and minimize the site work in the intersection	Construct in a short period and minimize vibration and noise at the site
Countermeasure	Steel Bridge	◎Good Reduce the dead load of the superstructure	◎Good Reducing the dead load is effective against seismic activities	◎Good To avoid difficulties of erection in congested intersection and able to do it in a shorter period	◎Good To avoid difficulties of erection in limited construction width and able to it in a shorter period
	Cast-in-place RC Pile	◎Good Cast-in-place concrete pile enables large skin friction for support			◎Good Reverse circulation method can reduce vibration and noise
	Isolated Bearing	◎Good To minimize and make uniform the foundation by dividing earthquake force	◎Good To minimize the weight and size of substructure/ foundation	◎Good To minimize and make uniform the size of pier column stand at narrow median by dividing earthquake force	
	Weathering Steel			◎Good Re-painting is not required in the congested intersection in future	◎Good Re-painting is not required in densely urbanized and sensitive army area
	Composite Deck Slab (on steel girder)	○Fair Reduce the dead load of superstructure	○Fair Reduce the dead load of superstructure	◎Good Reduce the pier body size, construction site work and period	◎Good Reduce the pier body size, construction site work and period, less noise

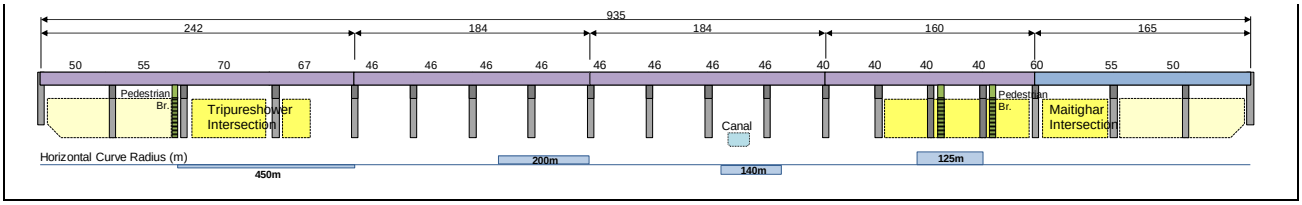
Source: JST

(2) Bridge Overviews for Four-lane Flyover

Based on the applicability of the superstructure and substructure, the resultant overview of Four-lane T-M Flyover as studied in the Pre-F/S is shown in Table 13.5.4.

Table 13.5.4 Bridge Overview of Four-lane T-M Flyover

Bridge Type and Span arrangement		Continuous steel girder bridge, 4 traffic lanes, total bridge width = 15.600m
Superstructure (overpass at)	Tripureshower IS.	Continuous steel box girder (3 cells, Narrow) (composite steel deck slab)
	Densely urbanized area	Continuous steel box girder (3 cells, Narrow) (composite steel deck slab)
	Maitighar IS.	Continuous steel I girder (Fewness) (composite steel deck slab)
Adopted measures		Seismic isolated bearing
Substructure	Abutments	Inverted T type RC abutment
	Piers	RC column/ RC pier head Portal frame pier
	Foundations	Cast-in-place RC pile (Reverse circulation method) (Friction pile, Dia. 1.0m)
Typical cross section and Profile		



Source: JST

13.5.1.5 Major Work Quantities and Cost Estimate

The construction costs of the Option 1, 4 lanes case have been calculated by unit rates of individual items based on rate analysis multiplied by quantities estimated. The construction costs of options estimated are presented in Table 13.5.5 and the total project cost is presented in Table 13.5.6.

Table 13.5.5 Summary of Construction Cost Estimation for Option 1, 4 Lanes Case

(NPR)

No.	Works	4 lanes case
0200	Site clearance	6,163,520
04001	Temporally fencing with safety facilities	7,788,148
0900	Earthworks	56,422,419
1000	Subgrades	11,950,050
1200	Subbase, base, hard shoulder and gravel wearing course	5,530,805
1300	Bituminous surface and base course	55,709,549
1400	Kerbs and footpaths	11,917,750
1500	Traffic safety and control facilities	3,085,448
1600	Piling and foundation for structures	1,424,808,718
2000	Concrete works	434,230,722
2200	Structural steel works	3,554,042,758
1900	Bearings and expansion joint	712,750,800
2400	Miscellaneous structures	1,425,000
2600	Masonry for structure	3,230,000
0700	Pipe drains, pipe culverts and concrete channels	62,712,825
3100	Miscellaneous works	155,731,488
Total		6,507,500,000

Source: JST

Table 13.5.6 Total Project Cost of Four-lane Flyover

(Thousand NRS)

Descriptions	Construction Cost	Physical Contingency	Administration cost	Land acquisition Cost	Building Compensation Cost	Engineering Services	VAT	Project Cost
Four-lane Flyover	6,507,500	650,750	32,358	1,102,000	917,000	650,750	1,281,870	11,142,407

Source: JST

13.5.2 Traffic Analysis

(1) Method and Cases for Analysis

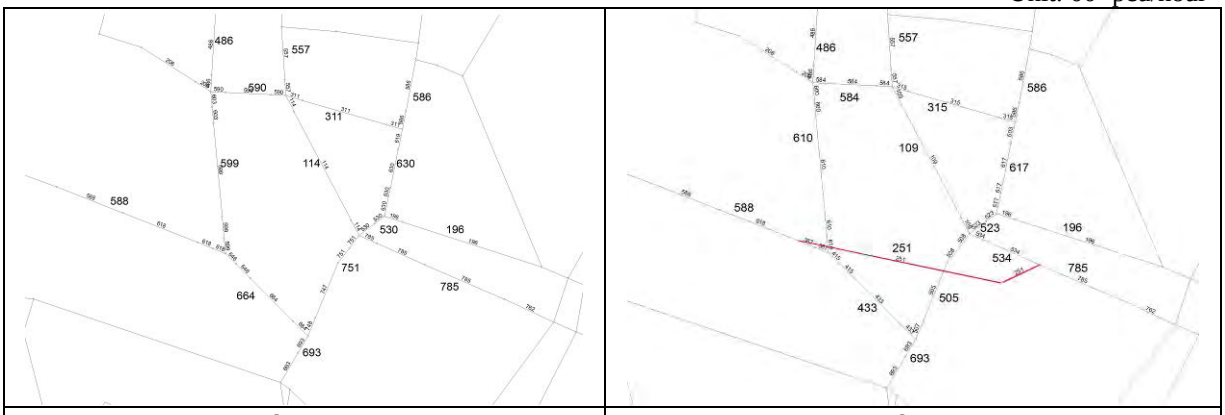
Method of traffic analysis for four-lane flyover is same as the method for two-lane flyover described in 13.4.3.2. Target year of analysis is short term (2020), mid-term (2025) and long term (2030).

For four-lane case, traffic demand of without project of Master Plan is applied to analyze the traffic condition in maximum demand.

(2) Traffic Demand Forecast

The result of traffic assignment is shown in. Average road congestion ratio, total travel time and total travel distance for each option by traffic assignment is shown in Table 13.4.12. Average road congestion ration is far larger than two-lane case shown in Table 13.5.7, because maximum traffic demand is applied to this case.

Unit: 00' pcu/hour



Without case | With case

Source: JST

Figure 13.5.4 Traffic Assignment Result for Four-lane Flyover in 2030

Table 13.5.8 Forecasted Average Road Congestion Ratio, Total Travel Time and Total Travel Distance by Traffic Assignment

	Year	Without project	Option-1
Average road congestion ratio (Volume/Capacity)	2020	1.532	1.191
	2025	1.553	1.201
	2030	1.918	1.497
Total travel distance (pcu km/day)	2020	350,236	341,825
	2025	363,807	344,851
	2030	389,568	378,835
Total travel time (hour/day)	2020	52,182	47,517
	2025	76,463	61,580
	2030	91,580	71,620

Source: JST

13.5.3 Economic Evaluation

13.5.3.1 Economic Evaluation Method

(1) Major Premises

Major assumptions of the project evaluation are same as the Two-lane Flyover in the previous section and are summarized below. A worksheet model analysis was utilized for the analyses as well.

- Project life: 50 years after the completion of the project (2020)
- Pricing date: 2015
- Social discount rate: 12%

- Exchange rate: US$1.00 = NRs.99.64, JPY1.00 = NRs.0.836

(2) Improvement Plan

Improvement plan of the Arniko Highway (Tripureswor Intersection – Maitighar Intersection) is the same as described in Option 1 in the Two-lane Flyover except for the number of lanes as described in 13.5.1 Preliminary Engineering Design.

(3) Cost of the Project

1) General

Necessary cost for the improvement of the Arniko Highway (Tripureswor Intersection – Maitighar Intersection) Improvement Project is divided into two major components, which are capital investment cost and operation & maintenance cost. The economic costs of the project were estimated based on the financial costs in the previous Section 13.5.1 Preliminary Engineering Design.

2) Capital Investment Cost

The capital investment cost consists of 1) initial investment cost and 2) re-investment cost. However, the re-investment cost was not necessary, because the project life is shorter than the fifty years of useful life of road just like in the previous section. No re-investment cost was appropriated. The residual value was appropriated at the last year of the project life as negative investment.

The capital investment costs in terms of economic cost of the project are summarized in Table 13.5.9. Transfer items, such as tax and subsidy are processed properly from the estimated financial cost. The estimated costs are modified again by SCF (Standard Conversion Factor) to offset the distortion of prices in Nepal to obtain economic cost. The SCF of Nepal was estimated to 0.91 (same as the Progress Report of the Master Plan of this Study), which is an average value in the previous studies. Another index was also used for the economic cost estimation to estimate the cost in constant 2015 price. According to the Volume 50 of Quarterly Economic Bulletin of Nepal Rastra Bank, wholesale price indices of Nepal were 292.8 and 315.2 in the second quarter (Dec./Jan.) of 2014/15 and 2015/16, respectively. Therefore, the Study Team obtained and applied the estimated 1.0765 for the economic cost estimation in constant prices.

Table 13.5.9 Initial Investment Cost of Four-lane Flyover by Year

Unit: NRs.Million, Economic cost, 2015 constant price

Year	2017	2018	2019	2020	Total
Initial Investment Cost	2,083.9	2,083.9	2,083.9	2,083.9	8,335.4

Source: JST

3) Operation and Maintenance Cost

The operation and maintenance cost of the project in terms of economic cost by option were estimated as shown in Table 13.5.10 according to the estimated financial operation and maintenance cost as described in Section 13.5.1 Preliminary Design. The operation and maintenance cost consists of the annual cost and the periodic cost for every five years.

Table 13.5.10 Operation and Maintenance

Unit: NRs.000, Economic cost, 2015 constant price

Type of Cost	Annual Routine Cost	Periodic Cost (every 5 year)
O/M Cost	102.3	1,124.8

Source: JST

The economic costs were obtained from the financial cost in the same manner as the investment cost estimation.

(4) Benefit of the Project

Two kinds of economic benefits were estimated for the analysis just like in the Two-lane Flyover plans. One is the time saving benefit and the other is the cost saving benefit.

1) Time Saving Benefit

Travel time will be reduced upon completion of the intersection improvement project. The study team estimated the saved time by comparing the "without improvement" and the "with improvement" scenarios. In the "with case", total travel time of the study area is expected to decrease compared to the "without case".

Estimated time values by vehicle time used to calculate the time saving benefit of the project is exhibited in Table 13.4.16 in the previous section.

2) Cost Saving Benefit

The cost saving benefit was estimated based on the reduced vehicle-km of the study area, by comparing the vehicle-km of the "with" and "without" option cases. Unit cost of the vehicle operating cost by vehicle type and by travel speed, which was estimated by this Master Plan, is summarized in Table 13.4.17 in the previous section.

3) Estimated Benefit

Estimated time saving and cost saving benefits are summarized in Table 13.5.11.

Table 13.5.11 Estimated Time Saving and Cost Saving Benefit

NRs. Million, economic price in 2015

Option / Benefit	Four-lane Flyover		
	2020	2025	2030
Cost Saving Benefit	219.5	261.0	317.9
Time Saving Benefit	367.7	3128.2	4928.5
Total Benefit	587.2	3389.2	5246.5

Source: JST

The estimated benefit of the Four-lane Flyover is larger than two-lane case (Option-1) because traffic demand is larger than two-lane case, thus travel time increases on the peripheral road.

13.5.3.2 Economic Analysis and Evaluation

(1) Economic Analysis

Economic analysis was conducted by worksheet basis. The worksheet is exhibited in Table 13.5.12.

In the analysis, it was assumed that the future time saving benefit increased in proportion to the per capita GDP growth in real terms as mentioned in the previous section.

Table 13.5.12 Economic Analysis of Four-lane Flyover

	EIRR:	**28.0%**	**B/C:**	**4.53**	**NPV:**	**19,965.5**	**Cost**	**1.00**	**Benefit:**	**1.00**
									Unit: Million NRs. (Year 2015 Economic Price)	
Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	2,083.9	0.0	2,083.9	0.0	0.0	0.0	(2,083.9)	(1,661.2)	0.0	1,661.2
2018	2,083.9	0.0	2,083.9	0.0	0.0	0.0	(2,083.9)	(1,483.2)	0.0	1,483.2
2019	2,083.9	0.0	2,083.9	0.0	0.0	0.0	(2,083.9)	(1,324.3)	0.0	1,324.3
2020	2,083.9	0.0	2,083.9	0.0	0.0	0.0	(2,083.9)	(1,182.4)	0.0	1,182.4
2021		0.1	0.1	227.2	700.5	927.7	927.6	470.0	470.0	0.1
2022		0.1	0.1	235.2	1,114.3	1,349.6	1,349.5	610.4	610.5	0.0
2023		0.1	0.1	243.5	1,772.6	2,016.1	2,016.0	814.2	814.3	0.0
2024		0.1	0.1	252.1	2,819.8	3,071.9	3,071.8	1,107.7	1,107.8	0.0
2025		1.2	1.2	261.0	4,485.6	4,746.6	4,745.4	1,527.9	1,528.3	0.4
2026		0.1	0.1	271.5	5,092.8	5,364.3	5,364.2	1,542.1	1,542.1	0.0
2027		0.1	0.1	282.4	5,782.3	6,064.7	6,064.6	1,556.6	1,556.7	0.0
2028		0.1	0.1	293.8	6,565.0	6,858.8	6,858.7	1,571.8	1,571.9	0.0
2029		0.1	0.1	305.6	7,453.8	7,759.4	7,759.3	1,587.7	1,587.7	0.0
2030		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	1,604.0	1,604.2	0.2
2031		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	1,432.3	1,432.3	0.0
2032		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	1,278.8	1,278.9	0.0
2033		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	1,141.8	1,141.8	0.0
2034		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	1,019.5	1,019.5	0.0
2035		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	910.1	910.3	0.1
2036		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	812.7	812.7	0.0
2037		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	725.7	725.7	0.0
2038		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	647.9	647.9	0.0
2039		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	578.5	578.5	0.0
2040		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	516.4	516.5	0.1
2041		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	461.2	461.2	0.0
2042		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	411.8	411.8	0.0
2043		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	367.6	367.6	0.0
2044		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	328.2	328.3	0.0
2045		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	293.0	293.1	0.0
2046		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	261.7	261.7	0.0
2047		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	233.6	233.6	0.0
2048		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	208.6	208.6	0.0
2049		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	186.3	186.3	0.0
2050		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	166.3	166.3	0.0
2051		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	148.5	148.5	0.0
2052		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	132.6	132.6	0.0
2053		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	118.4	118.4	0.0
2054		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	105.7	105.7	0.0
2055		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	94.4	94.4	0.0
2056		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	84.3	84.3	0.0
2057		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	75.2	75.2	0.0
2058		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	67.2	67.2	0.0
2059		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	60.0	60.0	0.0
2060		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	53.5	53.5	0.0
2061		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	47.8	47.8	0.0
2062		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	42.7	42.7	0.0
2063		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	38.1	38.1	0.0
2064		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	34.0	34.0	0.0
2065		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	30.4	30.4	0.0
2066		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	27.1	27.1	0.0
2067		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	24.2	24.2	0.0
2068		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	21.6	21.6	0.0
2069		0.1	0.1	317.9	8,462.8	8,780.7	8,780.6	19.3	19.3	0.0
2070		1.2	1.2	317.9	8,462.8	8,780.7	8,779.5	17.2	17.2	0.0
Total	8,335.4	16.4	8,351.8	15,406.7	382,762.4	398,169.0	389,817.2	19,965.5	25,618.1	5,652.6

Source: JST

Table 13.5.13 below summarizes the result of economic analysis of the Four-lane Flyover. The EIRR is 28.0% which exceeds the two-lane case. Therefore, Net Present Value (NPV) and the Benefit Cost Ratio (B/C) viable value.

Table 13.5.13 Results of Economic Analysis of Four-lane Flyover

EIRR (%)	NPV NRs Million	B/C
28.0	19,965.5	4.53

Source: JST

(2) Conclusion

According to the result of economic analysis, it could be said that the Four-lane Flyover option is also feasible. However, further analysis is expected in the next stage of the implementation, since the EIRR nearly equals to 12.0%.

Table 13.5.14 Sensitivity Analysis of Four-lane Flyover

Sensitivity Test (EIRR:%)		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	28.0	26.6	25.8	25.0
	+10%	26.7	25.3	24.6	23.8
	+15%	26.1	24.7	24.0	23.3
	+20%	25.5	24.2	23.5	22.8

Source: JST

13.5.4 Environmental and Social Considerations

13.5.4.1 Objective

The objective is to understand the environmental impact of the Pilot Project with four lanes based on the result of assessment for the Project with two lanes. Items that have exactly the same social and environmental impact as the two-lane plan in the four lane plan were omitted from the scoping target.

13.5.4.2 Scoping

Scoping about four lane case was conducted by comparative evaluation between “with” case and “without” case. Traffic volume and ROW of four lane case are the difference from two lane case. Thus Air Quality, Noise, Vibration, and Global Warming which are items related to traffic volume, and involuntary resettlement which is an item related to widening of ROW are selected.

Table 13.5.15 Scoping Result of Social Environment

Category		Impact Item	Rating		Reason of Rating
			Pre-C/C	Op	
Pollution	1	Air Quality	C-	B+	C: Exhaust gas and dust will be generated by construction machines. However, environmental impact assessment will be conducted after the construction plan is established. Op: Traffic flow will be smoothened and emission of air pollutants will be reduced due to improvement of congested intersection.
	2	Noise and Vibration	C-	B+	C: Noise and vibration will be generated by construction machines. However, environmental impact assessment will be conducted after the construction plan is established. Op: Noise and vibration can either be improved or deteriorated due to change of road structure.

Category		Impact Item	Rating		Reason of Rating
			Pre-C/C	Op	
Social Environment	3	Involuntary Resettlement	B-	D	Pre-C: Involuntary resettlement is expected due to land acquisition for right of way. In case of four-lane plan, the number of obstacle buildings might be increased from the two-lane plan.
Others	4	Global warming/ Climate change	C-	B+	C: Emission of CO2 is expected due to operation of construction machinery and vehicles. However, environmental impact assessment will be conducted after construction plan will be established. Op: CO2 emission is expected to be reduced due to improved intersection and smoothened traffic flow.

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: JST

13.5.4.3 Method of Environmental Impact Evaluation

(1) Air Quality and Global Warming Gas

Emission of air pollutant (NOx and PM10) and greenhouse gas(CO2) were calculated based on the traffic volume by travel speed for the case of with/without four lane flyover and emission unit. Traffic volume are shown in Table 13.5.13、Table 13.5.14 and Table 13.5.15. Emission unit of NOx, PM10 and CO2 are shown in Table 13.4.28.

Table 13.5.16 Traffic Volume 2020

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2020 Without Flyover	50-60km/h	4410.5	126.5
	40-50km/h	5520.8	288.9
	30-40 km/h	19905.6	799.7
	20-30 km/h	27040.5	1464.0
	10-20 km/h	78748.9	2563.1
	-10 km/h	69748.2	2564.8
2020 With Flyover	50-60km/h	17259.0	609.3
	40-50km/h	8458.7	466.2
	30-40 km/h	19248.2	738.1
	20-30 km/h	33330.0	1556.9
	10-20 km/h	64628.4	2120.9
	-10 km/h	58938.3	2188.5

Source: JST

Table 13.5.17 Traffic Volume 2025

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2025 Without Flyover	50-60km/h	5848.9	202.1
	40-50km/h	0.0	0.0
	30-40 km/h	54276.4	2251.7
	20-30 km/h	9932.8	398.8
	10-20 km/h	63852.1	2139.5
	-10 km/h	78073.7	2667.5
2025 With Flyover	50-60km/h	20532.9	745.5
	40-50km/h	2473.5	135.7
	30-40 km/h	52293.9	2072.6
	20-30 km/h	19243.5	638.6
	10-20 km/h	57776.7	1945.2
	-10 km/h	55556.4	1967.1

Source: JST

Table 13.5.18 Traffic Volume 2030

Case	Travel Speed	Traveler Kilometer/Day	
		Small Vehicle	Large Vehicle
2030 Without Flyover	50-60km/h	0.0	0.0
	40-50km/h	2317.4	57.2
	30-40 km/h	3915.6	201.9
	20-30 km/h	57112.3	2429.6
	10-20 km/h	70813.6	3275.1
	-10 km/h	136137.4	5074.2
2030 With Flyover	50-60km/h	14412.2	522.5
	40-50km/h	9104.3	400.1
	30-40 km/h	4323.0	208.8
	20-30 km/h	60173.9	2458.8
	10-20 km/h	75626.8	3306.5
	-10 km/h	100861.5	3929.3

Source: JST

(2) Noise

Noise was calculated by the prediction formula “ASJ RTN-Model 2013” for the six cross sections same as the case of two lanes. The six cross sections to be evaluated are shown in Figure 13.5.16, and traffic volume for each cross section is presented in Table 13.4.29

Table 13.5.19 Cross Section Traffic Volume 2030

Case	Cross Section	Traffic Volume(per Day)		
		Small Vehicle	Large Vehicle	Motor Bike
2030 Without Flyover	A	------	------	------
	B	40701	1678	36392
	C	45773	1886	40937
	D	7035	303	6258
	E	36167	1491	32334
	F	36719	1516	32830
2030 With Flyover	A	15492	650	13508
	B	26674	1109	23297
	C	31108	1281	27168
	D	6761	297	5873
	E	35957	1481	31416
	F	37557	1547	32813

(3) Involuntary Resettlement

The properties likely affected have been grasped by overlaying the ROW of the proposed flyover on the satellite image similarly to the two-lane plan.

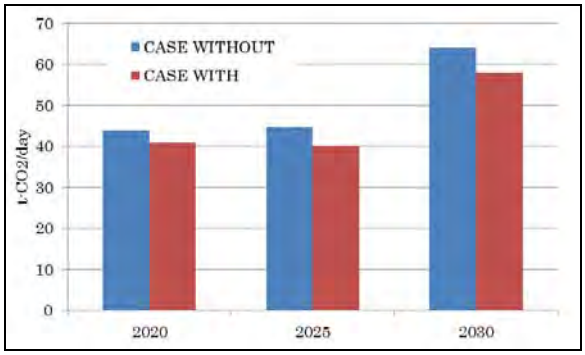
13.5.4.4 Evaluation Result

(1) Air Quality and Global Warming Gas

In the case with four-lane flyover, air pollutant emission and greenhouse gas emissions were reduced from the case without four-lane flyover. The item of the largest reduction rate is PM10 and the reduction rates are over 10% at each target year; NOx and CO2 are also reduced if four-lane flyover will be constructed. Thus installation of flyover be able to contribute improve air quality and global warming.

Table 13.5.20 Evaluation Result (NOx)

	2020		2025		2030	
	kg-NOx/day	Reduction Rate	kg-NOx/day	Reduction Rate	kg-NOx/day	Reduction Rate
CASE WITHOUT	0.0192	0.0%	0.0191	0.0%	0.0275	0.0%
CASE WITH	0.0179	7.1%	0.0174	8.8%	0.0253	8.2%

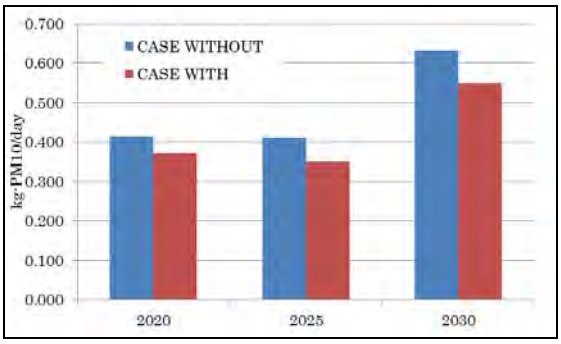


Source: JST

Figure 13.5.5 Evaluation Result (NOx)

Table 13.5.21 Evaluation Result (PM10)

	2020		2025		2030	
	kg-PM10/day	Reduction Rate	kg-PM10/day	Reduction Rate	kg-PM10/day	Reduction Rate
CASE WITHOUT	0.4139	0.0%	0.4104	0.0%	0.6304	0.0%
CASE WITH	0.3707	10.4%	0.3511	14.5%	0.5490	12.9%



Source: JST

Figure 13.5.6 Evaluation Result (PM10)

Table 13.5.22 Evaluation Result (CO2)

	2020		2025		2030	
	t-CO2/day	Reduction Rate	t-CO2/day	Reduction Rate	t-CO2/day	Reduction Rate
CASE WITHOUT	43.86	0.0%	44.59	0.0%	64.14	0.0%
CASE WITH	40.84	6.9%	40.19	9.9%	57.93	9.7%

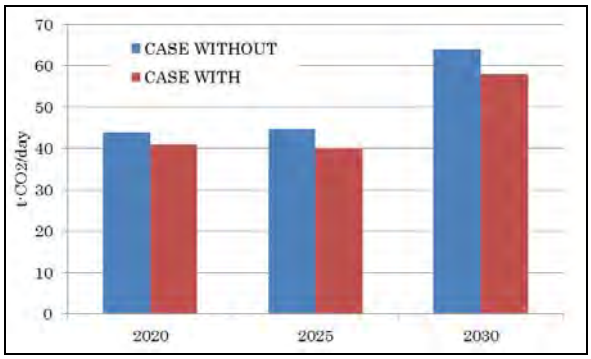


Figure 13.5.7 Evaluation Result (CO2)

(2) Noise

In the case of with four lane Noise level is lowered at each cross section from the without case. Noise level of section A as the flyover cross section is satisfied National Noise Level Standards. Environmental improvement effect will be able to be expected about noise pollution as well when the flyover will be introduced.

Table 13.5.23 Evaluation Result (Noise Level)

unit :dB

Section	A		B		C	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
WITHOUT	---	---	74.5	68.7	75.0	69.3
WITH	54.2	47.5	72.6	66.9	73.3	67.5
Section	D		E		F	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
WITHOUT	67.0	61.2	74.2	68.4	74.0	68.3
WITH	66.6	60.9	73.9	68.2	73.9	68.2

DAY:7am-7pm NIGHT:7pm-7am
National Noise Level Standard: DAY 65dB NIGHT 55 (Commercial Area)
Source: JST

(3) Involuntary Resettlement

Figure 13.4.19 below shows the overlaid image of the ROW of the proposed flyover and the satellite photo. 50 buildings are likely to be affected, an increase of 17 buildings from the two-lane plan as summarized in Table 13.5.24. There are 24 private properties. The study for actual resettlement is required based on the detailed design when the project comes to implementation.

Figure 13.5.8 Additional Land Acquisition Area of 4-Lane Plan

Table 13.5.24 Summary of the Existing Buildings on the Proposed ROW

Ownership	No.of Buildings		
	2-Lane	4-Lane	Increase
Army	10	10	--
Government	-	3	3
University	4	5	1
Sports Council	8	8	0
Private	11	24	13
Total	33	50	17

Source: JST

Figure 13.5.9 Additional Obstacle Buildings 4-Lane Plan

13.6 Implementation Plan

13.6.1 Construction Plan and Traffic Safety and Control during Construction Stage

Tribhuvan Highway will be widened to 4 lanes with ROW of 22m in which width can accommodate spaces for pedestrians (1.25m) and vehicles (4.35m) during construction as shown in Figure 13.6.1 and Figure 13.6.2.

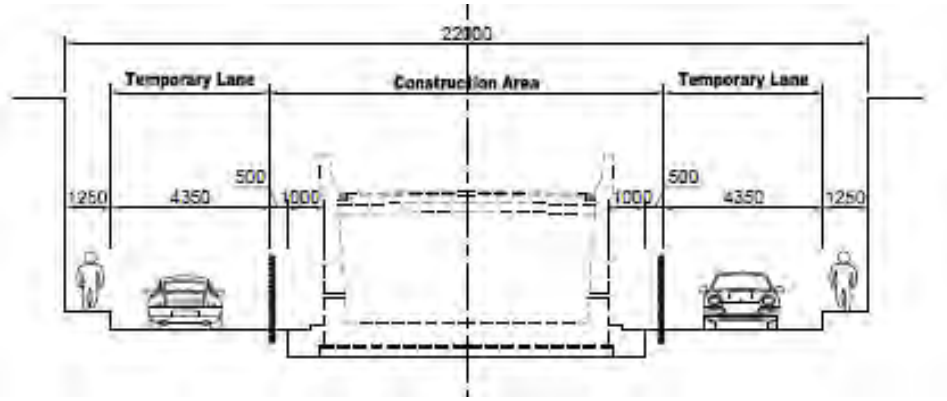


Figure 13.6.1 Lane Arrangement during Construction in Tribhuvan Highway

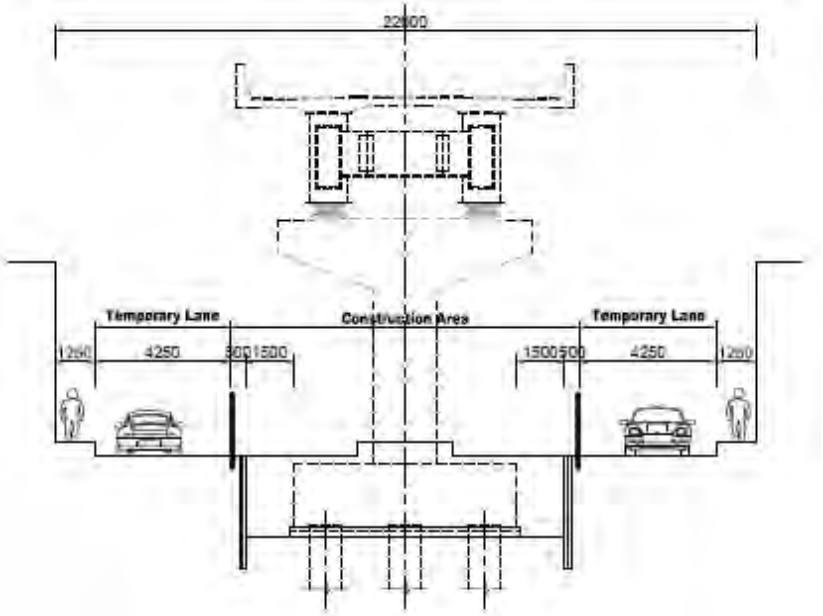


Figure 13.6.2 Lane Arrangement for Sub-structure Construction in Tribhuvan Highway

Basic construction procedure in Tribhuvan Highway will be as shown in Figure 13.6.3 below.

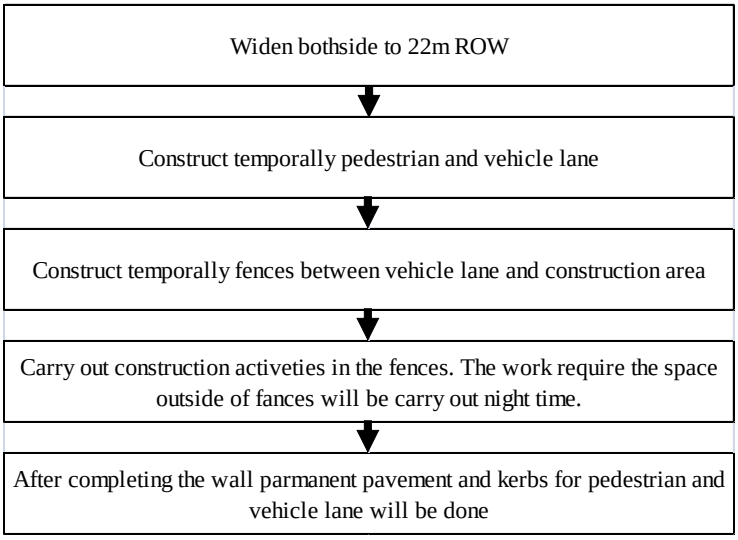


Figure 13.6.3 Construction Procedure in Tribhuvan Highway

Arniko Highway widening to 8 lanes can be accommodated with sufficient construction space by shifting all traffic to service road as shown in Figure 13.6.4.

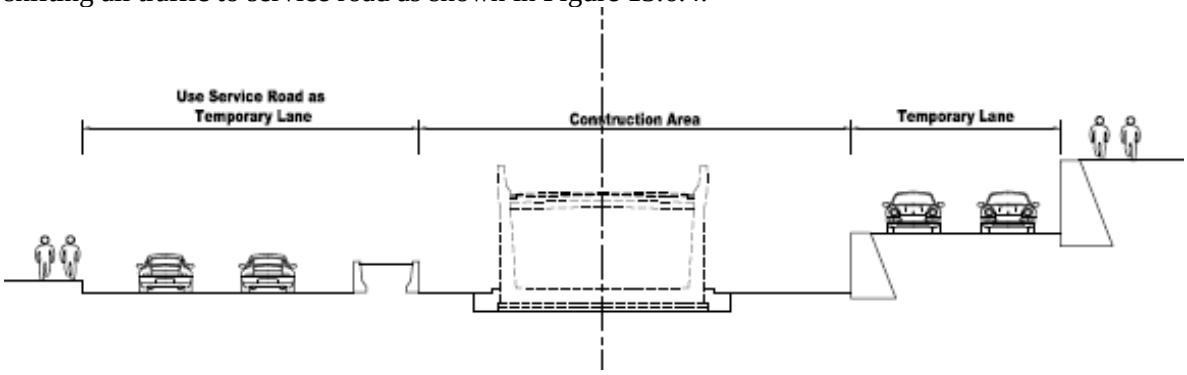


Figure 13.6.4 Lane Arrangement During Construction in Arniko Highway

The section between Tripreswar Intersection and Mitighar Intersection, minimum 20m of ROW for construction has to be secured for construction as shown in Figure 13.6.5.

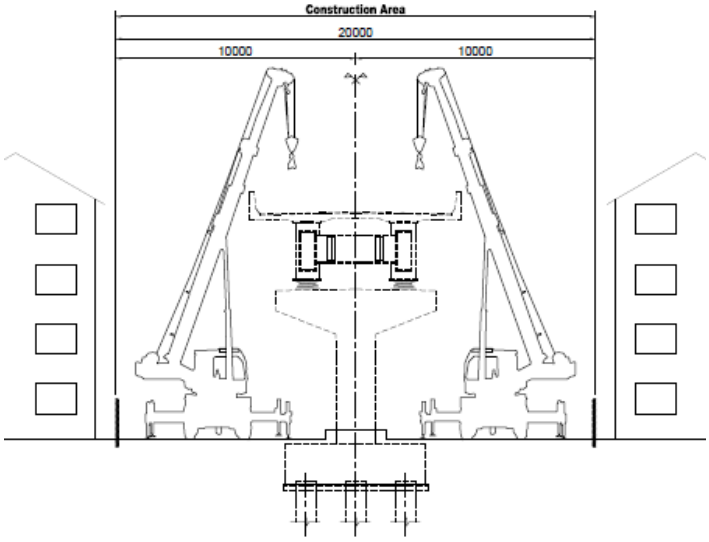


Figure 13.6.5 Construction Image between Tripreswar Intersection and Mitighar Intersection

Along with the construction of the flyover, improvement of Tripureshore and Maitighar intersections is also recommended. The tentative improvement plans for both the intersections are as shown in the following figure. The pedestrian bridges are also recommended at both the intersections, which have already been considered in determining the profile of the flyover. The improvement plans require restrictions on some turning movements, which need to be discussed with all stakeholders before implementation.

Source: JST

Figure 13.6.6 Intersection Improvement Plan for Tripreshwor Intersection and Maitighar Intersection

13.6.2 Construction Period

According to the experiences of similar scale of Flyover Construction Projects in developing countries, 36 months (3 years) construction period will be justifiable for Triprespur-Mitighar Flyover Construction Project.

13.6.3 Subjects to be Examined at Full Scale FS

The following subjects are to be examined at full scale FS stage.

- Review of horizontal alignment based on the consultation with stakeholders.
- Pedestrian network coordinating horizontal alignment and interchange lay-out utilizing pedestrian bridge and pedestrian signal.
- Lifeline removal plan in construction stage and completion stage.
- Flow planning for vehicles and pedestrians synchronized with the construction progress

13.7 Study on the Effects of Increased Development on the T-M Flyover

13.7.1 Objectives

In the selection of priority project described in Chapter 12,2.3, New Baneshwor underpass is high priority project. Moreover, New Baneshwor intersection is on the National Highway 03 (Arniko HW), connected to the T-M Flyover. Therefore in this section, effect of development of New Baneshwor underpass together with T-M flyover is studied.

13.7.2 Present Condition of the new Baneshwor Intersection

13.7.2.1 Physical Condition

Although there are signals installed at New Baneshwor intersection by a Japanese grant aid project, they currently do not function currently. The unstable power supply in Kathmandu valley is one of the big factors. The present conditions of New Baneshwor are as follows.

- Manual Traffic control by police.
- Poor drainage; the road is pitted with puddles after rainfall.
- There are few large trucks, but many buses and private vehicles.
- The city environment is inhibited by noise from the aging large vehicles.
- There is disorderly congestion of vehicles and pedestrians at the intersections.
- There are no road markings and the traffic lanes are unclear.
- The footpath is small, and congested with pedestrians.
- The sidewalks lack flatness and pose difficulty for the passing pedestrians.

Source: JST

Figure 13.7.1 Present Condition of New Baneshwor Intersection

13.7.2.2 Traffic Condition

The New Baneshwor intersection has heavy traffic volume in the straight direction of the main lane, and traffic from the access road can hardly pass in peak hours. Also, control of the main line traffic by police causes traffic congestion over a short period of time.

According to the traffic volume by direction captured at the traffic survey in 2011, the saturation degree of New Baneshwor Intersection is 2.27 which far exceeds the threshold degree of 0.9. As the intersections do not satisfy the saturation degree, it is necessary to examine for grade separation.

13.7.3 Preliminary Engineering Design for Grade Separation

13.7.3.1 Design Criteria

(1) Geometric Design

Geometric design of the Project is to be made in accordance with geometric parameters for a design speed of 50 km/h, as described in the Japanese Standard.

Table 13.7.1 Geometric Design Parameters

Design Speed(km/h)				50
Horizontal	Min. Horizontal Curve Radius (m)	Desirable Min Absolute		150 100 80
	Min. Length of Curve (m)	θ＜７° Absolute		600/θ 80
	Min. Radius for use of Transition Curve (m)	Transition Curve Length Omission	Standard Limit	40 700 350
Vertical	Gradient	Max（%）		6.0
		Min（%）		0.3※

	Vertical Curve (m)	Crest	Min Desirable	800 1,200
		Sag	Min Desirable	700 1,000
		Vertical Curve Length		40
Sight Distance (m)				55

※The Minimum vertical gradient for road surface drainage processing
Source: JST

(2) Method of Grade Separation

In case of at-grade intersection of heavy traffic volume, it is important to examine grade separation for upgrading the city. There are two types of grade separation, namely; "Overpass" and "Underpass". General advantages and disadvantages of overpass and underpass are shown below.

Table 13.7.2 Comparison of grade separation

	Overpass	Underpass
Image		
Structure	Bridge	Tunnel or Culvert
Advantages	◆ There is less influence on underground utilities than underpass. ◆ No particular problems with crime are encountered. ◆ Bridge creates high value for the surrounding as a symbolic structure.	◆ Grade separation length is shorter than overpass. ◆ There are few noise measures required.
Disadvantages	◆ Grade separation length is longer than underpass. ◆ Noise measures are necessary for surrounding buildings and commercial area.	◆ Crime prevention measures are necessary because the underground is hard to see from the public eye ◆ **Drainage pump is necessary, when surface water is not able to flow naturally. The pump drainage takes high maintenance cost.** ◆ The relocation of underground utilities is necessary.

Source: JST

Pump drainage in the underpass is not desirable since the supply of electricity in Kathmandu city is unstable.

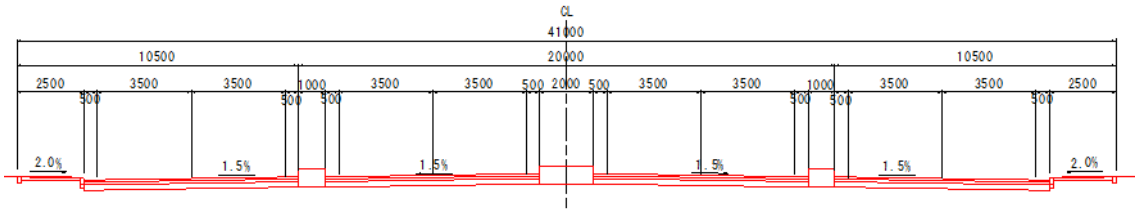
The underpass is adopted when surface water can flow naturally from the topographical condition. If surface water cannot flow naturally by the topography condition, overpass is adopted.

(3) Typical Cross Section

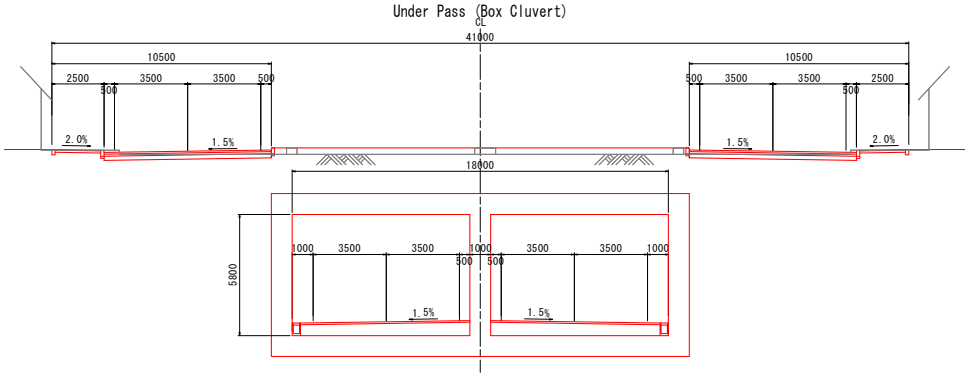
The carriageway at standard section is 8traffic lanes of 3.5m each, 2.0m center median and 2.5m footpath. The total width is 41m.

New Baneshowor intersection is a down gradient where the present topography is gentle from the east side to the west side. In addition, there is Tobi Kola River on the west side. Therefore, an underpass plan is possible since the topographical condition is allows for flow of the surface water.

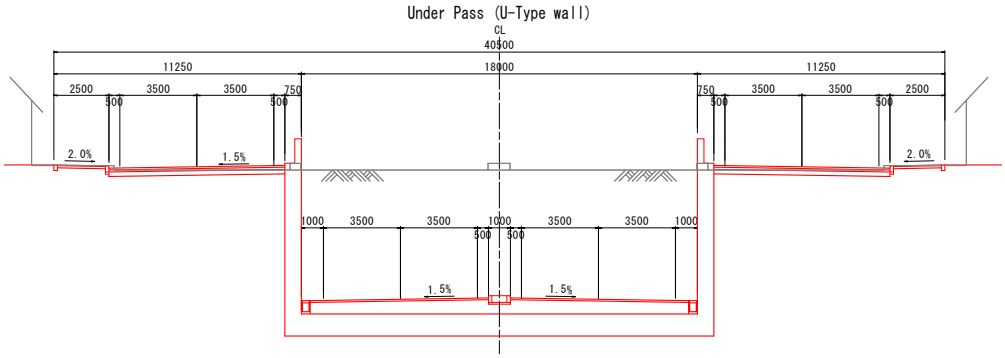
The same number of traffic lanes as the current number will be secured. 4 traffic lanes on the Main line and 4 traffic lanes on the frontage road will be secured.



Standard Section



Box culvert section for underpass



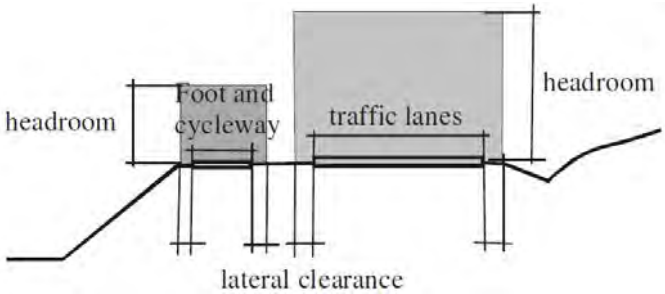
U-Type wall section for underpass

Figure 13.7.2 Typical Cross Section of New Baneshwor Underpass

(4) Clearance (headroom)

Clearance is the required height to allow traffic to pass safely under objects on the road. It should normally be provided over the full width of the carriageway.

In this project, a clearance 5.0m is secured.



Source: JST

Figure 13.7.3 Clearance

13.7.3.2 Preliminary Engineering Design for New Baneshwor Intersection

(1) Horizontal and Vertical Alignment

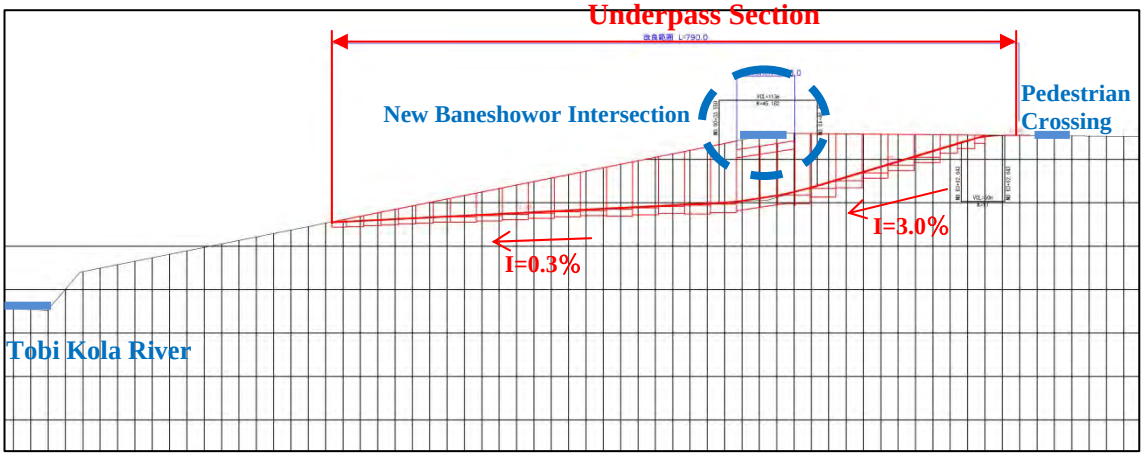
Upgrading of the target road will satisfy the geometric standards for road safety. The control points of the horizontal and vertical alignment are as follows.

- The influence of the improved area is limited to up to the existing pedestrian crossing (Arniko Highway)
- Drainage vertical gradient is secured in the underpass section.

Planned horizontal alignment and vertical alignment of New Baneshwor underpass is shown in Figure 13.7.4and Figure 13.7.5 respectively.

Source: JST

Figure 13.7.4 Horizontal Alignment of New Baneshwor Underpass

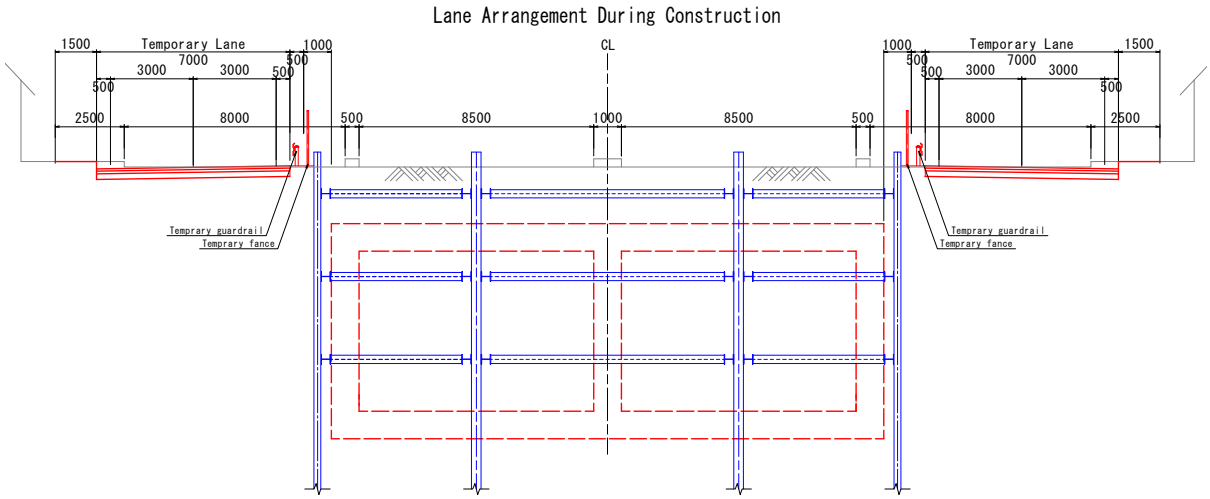


Source: JST

Figure 13.7.5 Vertical Alignment of New Baneshwor Underpass

(2) Structure Design

Underpass should be designed as a two-cell box culvert with a partition wall. A U-type wall is recommended for the retaining wall at portal sections because present frontage road is secured for traffic flow during a construction.



Source: JST

Figure 13.7.6 Structure design

(3) Cost Estimates

Construction cost is estimated based on the bill of quantities made by the JICA Survey Team. The current unit rate of each item in the bill of quantities has been obtained from leading domestic contractors and compared with DOR's recent rate to confirm its reliability. If the proposed rates from leading domestic contractors are judged as not suitable, the rates made by the JICA Survey Team will be used for the cost estimate.

Furthermore, the rates for bridge superstructure works are calculated by the JICA Survey Team based on the standard cost estimating method of JICA due to the lack of similar works in Kathmandu.

Table 13.7.3 Summary of Construction Cost Estimation for New Baneshwor Underpass

(NPR)

No.	Work items	Cost
200	Site clearance	13,934,209
900	Earthworks	257,008,792
1000	Subgrades	36,024,000
1200	Subbase, base, hard shoulder and gravel wearing course	22,941,600
1300	Bituminous surface and base course	42,154,400
1400	Kerbs and footpaths	38,843,510
1500	Traffic safety and control facilities	3,759,357
1600	Piling and foundation for structures	0
2000	Concrete works	802,995,475
2200	Structural steel works(Temporary Sheet Pile)	1,400,294,529
1900	Bearings and expansion joint	0
2400	Miscellaneous structures	0
2600	Masonry for structure	0
700	Pipe drains, pipe culverts and concrete channels	79,850,825
3100	Miscellaneous works	28,720,693
Total		2,726,527,390

Source: JST

Table 13.7.4 Total Project Cost

(Thousand NRS)

Descriptions	New Baneshowor
Construction	2,726,527
Physical Contingency	272,653
Administration Cost	13,633
Land acquisition Cost	67,568
Building Compensation Cost	7
Engineering Services	272,653
VAT	435,895
Project Cost	3,788,936,

Source: JST

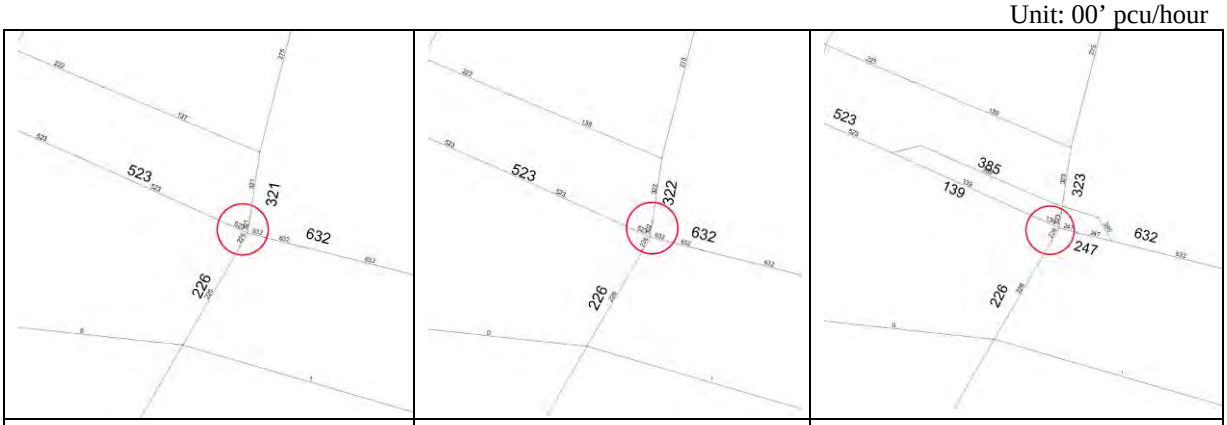
13.7.5 Traffic Analysis

(1) Traffic Demand Forecast

Traffic assignment for formulated plan options is conducted in short term (2020), mid-term (2025) and long term (2030) by the method described in 13. 7. 2.

Forecasted future traffic demand is shown in Table 13.7.8.

Unit: 00’ pcu/hour



Case-1 (Without T-M Flyover and New Baneshwor underpass)	Case-3 (T-M Flyover completed)	Case-3 (T-M Flyover and New Baneshwor underpass completed)

Source: JST

Figure 13.7.7 Traffic Assignment Result for Tree Cases in 2030

Table 13.7.5 Forecasted Average Road Congestion Ratio, Total Travel Time and Total Travel Distance by Traffic Assignment

	Year	Case-1	Case-2	Case-3
Average road congestion ratio (Volume/Capacity)	2020	0.560	0.545	0.527
	2025	0.670	0.650	0.628
	2030	0.760	0.737	0.713
Total travel distance (pcu km/day)	2020	642,89	639,321	639,147
	2025	773,533	767,909	768,038
	2030	871,241	862,896	863,125
Total travel time (hour/day)	2020	38,387	36,263	34,064
	2025	39,356	36,326	33,932
	2030	48,262	44,504	41,478

Source: JST

(2) Intersection Saturation Degree

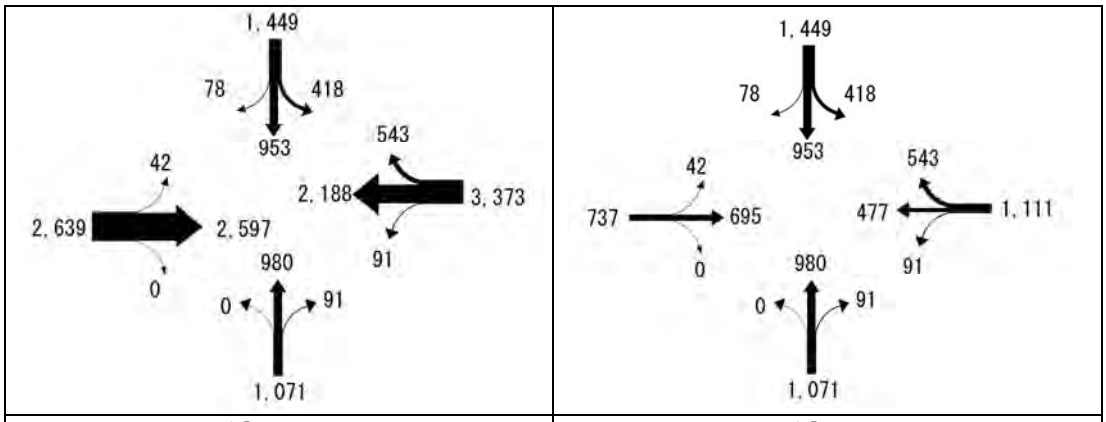
Based on the future traffic demand forecast at the New Baneshwor intersection, saturation degree at the intersection is analyzed. The saturation of the following two cases is calculated and effect of underpass is evaluated:

1) Saturation degree of Without case in 2030 (At-grade intersection)

2) Saturation degree of With case in 2030 (Underpass case)

Traffic volume by direction at peak hour is shown in

(Peak hour ratio=9.38%)



Without Case (At-grade intersection)	With Case (Underpass intersection)

Source: JST

Figure 13.7.8 Traffic Volume by Direction at Peak Hour in 2030

Based on the traffic volume, saturation degree is calculated. The result is exhibited in Table 13.7.6.

Table 13.7.6 Saturation Degree of New Baneshwor Intersection in 2030

Without case (At-grade intersection)	With case (Underpass intersection)
1.35	0.83

Source: JST

In the “without case”, saturation degree will reach to 1.35, whereas in the “with case”, saturation degree will decrease to 0.83. According to the result of saturation analysis, effect of development of underpass is huge.

Without Case	With Case

Source: JST

Figure 13.7.9 Lane Arrangement at New Baneshwor Intersection of Without Case and With Case

13.7.6 Economic Evaluation

13.7.6.1 Economic Evaluation Method

(1) Major Premises

Major assumptions of the project evaluation are same as the T-M Flyover in the previous section and are summarized below. A worksheet model analysis was utilized for the analyses as well.

- Project life: 50 years after the completion of the project(2020)
- Pricing date: 2015
- Social discount rate: 12%
- Exchange rate: US$1.00 = NRs.99.64, JPY1.00 = NRs.0.836

(2) Improvement Plan

Tree cases were assumed to capture the improvement effects, namely Case 1: Without Case, Case 2: Tripureswor Intersection – Maitighar Intersection was improved, Case 3: Case 2 plus New Baneshwor Intersection were improved.

(3) Cost of the Project

1) General

Necessary cost for the improvement of the Intersection improvement project by Case is divided into two major components as explained in the previous section, which are capital investment cost and operation & maintenance cost. The economic costs of the project were estimated based on the financial costs in the previous Chapter 13.5.1 and 13.7.3.

2) Capital Investment Cost

The capital investment cost consists of 1) initial investment cost and 2) re-investment cost. However, the re-investment cost was not appropriated, because the project life is assumed as fifty years which is same as the useful life of road as same as the previous section. No re-investment cost was appropriated. The residual value was not appropriated as mentioned in the previous section.

The capital investment costs in terms of economic cost of the project are summarized in Table 13.7.7. Transfer items, such as tax and subsidy are processed properly from the estimated financial cost. The estimated costs are modified again by SCF (Standard Conversion Factor) to offset the distortion of prices in Nepal to obtain economic cost. The SCF of Nepal was estimated to 0.91 as same as the Progress Report of the Master Plan of this Study, which is an average value in the previous studies. Another index was also used for the economic cost estimation to estimate the cost in constant 2015 price. According to the Volume 50 of Quarterly Economic Bulletin of Nepal Rastra Bank, wholesale price indices of Nepal were 292.8 and 315.2 in the second quarter (Dec./Jan.) of 2014/15 and 2015/16, respectively. Therefore, the Study Team obtained and applied the estimated 1.0765 for the economic cost estimation in constant prices.

Table 13.7.7 Initial Investment Cost of Expansion Development by Case and by Year

Unit: NRs.Million, Economic cost, 2015 constant price

Year	2017	2018	2019	2020	Total
Case 2	1,643.0	1,643.0	1,643.0	1,643.0	6,572.0
Case 3	2,220.0	2,220.0	2,220.0	2,220.0	8,880.1
Case 4	2,486.9	2,486.9	2,486.9	2,486.9	9,947.4

Source: JST

3) Operation and Maintenance Cost

The operation and maintenance cost of the project in economic cost by option were estimated as shown in Table 13.7.8 according to the estimated financial operation and maintenance cost as described in Chapter 13.7.3. The operation and maintenance cost consists of the annual cost and the periodic cost of every five year.

Table 13.7.8 Operation and Maintenance Cost by Case

Unit: NRs.000, Economic cost, 2015 constant price

Type of Cost	Annual Routine Cost	Periodic Cost (every 5 year)
Case 2	102.3	1,124.8
Case 3	163.4	1,797.0

Source: JST

The economic costs were obtained from the financial cost in the same manner as the investment cost estimation.

(4) Benefit of the Project

Two kinds of economic benefit were estimated for the analysis as same as Chapter 13.4.4. One is the time saving benefit and the other is the cost saving benefit.

1) Time Saving Benefit

Travel time is considered to be reduced by the completion of the intersection improvement projects. The study team estimated the saved time by comparing the "without improvement" and the "with improvement" scenarios. In the "with case", total travel time of the study area is expected to decrease compared to the "without case".

Estimated time values by vehicle type to calculate the time saving benefit of the project is exhibit in Table 13.4.16 in the previous section.

2) Cost Saving Benefit

The cost saving benefit was estimated based on the reduced vehicle-km of the study area, by comparing the vehicle-km of the "with" and "without" option cases. Unit cost of the vehicle operating cost by vehicle type and by travel speed, which was estimated by this Master Plan, is summarized in Table 13.4.17 in the previous section.

3) Estimated Benefit

Estimated time saving and cost saving benefits by Case are summarized in Table 13.7.9.

Table 13.7.9 Estimated Cost Saving and Time Saving Benefit

Option	Case 2		Case 3	
Benefit	2020	2030	2020	2030
Cost Saving Benefit	134.3	168.6	160.2	178.8
Time Saving Benefit	251.5	869.1	369.8	1,010.8
Total Benefit	385.8	1037.7	530.0	1,189.7

Source: JST

13.7.6.2 Economic Analysis and Evaluation

(1) Economic Analysis

Economic analysis was conducted by worksheet basis. The worksheets by Case are exhibit in Table 13.7.10 and Table 13.7.11.

In the analysis, it was assumed that the future time saving benefit increases in proportion to the per capita GDP growth in real term as mentioned in the previous section..

Table 13.7.10 Economic Analysis of Case 2

EIRR: 14.3% **B/C: 1.28** **NPV: 1,257.3** **Cost 1.00** **Benefit: 1.00**

Unit: Million NRs. (Year 2015 Economic Price)

Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,309.8)	0.0	1,309.8
2018	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,169.5)	0.0	1,169.5
2019	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(1,044.2)	0.0	1,044.2
2020	1,643.0	0.0	1,643.0	0.0	0.0	0.0	(1,643.0)	(932.3)	0.0	932.3
2021		0.1	0.1	137.4	383.1	520.5	520.4	263.7	263.7	0.1
2022		0.1	0.1	140.6	487.4	628.0	627.9	284.0	284.1	0.0
2023		0.1	0.1	143.8	620.2	764.0	763.9	308.5	308.6	0.0
2024		0.1	0.1	147.1	789.1	936.2	936.1	337.6	337.6	0.0
2025		1.2	1.2	150.5	1,003.9	1,154.4	1,153.2	371.3	371.7	0.4
2026		0.1	0.1	154.0	1,086.8	1,240.7	1,240.6	356.7	356.7	0.0
2027		0.1	0.1	157.5	1,176.4	1,333.9	1,333.8	342.4	342.4	0.0
2028		0.1	0.1	161.1	1,273.5	1,434.6	1,434.5	328.8	328.8	0.0
2029		0.1	0.1	164.8	1,378.6	1,543.4	1,543.3	315.8	315.8	0.0
2030		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	303.2	303.4	0.2
2031		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	270.9	270.9	0.0
2032		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	241.9	241.9	0.0
2033		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	216.0	216.0	0.0
2034		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	192.8	192.8	0.0
2035		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	172.1	172.2	0.1
2036		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	153.7	153.7	0.0
2037		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	137.3	137.3	0.0
2038		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	122.6	122.6	0.0
2039		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	109.4	109.4	0.0
2040		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	97.6	97.7	0.1
2041		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	87.2	87.2	0.0
2042		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	77.9	77.9	0.0
2043		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	69.5	69.5	0.0
2044		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	62.1	62.1	0.0
2045		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	55.4	55.4	0.0
2046		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	49.5	49.5	0.0
2047		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	44.2	44.2	0.0
2048		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	39.5	39.5	0.0
2049		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	35.2	35.2	0.0
2050		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	31.4	31.5	0.0
2051		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	28.1	28.1	0.0
2052		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	25.1	25.1	0.0
2053		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	22.4	22.4	0.0
2054		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	20.0	20.0	0.0
2055		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	17.8	17.8	0.0
2056		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	15.9	15.9	0.0
2057		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	14.2	14.2	0.0
2058		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	12.7	12.7	0.0
2059		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	11.3	11.3	0.0
2060		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	10.1	10.1	0.0
2061		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	9.0	9.0	0.0
2062		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	8.1	8.1	0.0
2063		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	7.2	7.2	0.0
2064		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	6.4	6.4	0.0
2065		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	5.7	5.7	0.0
2066		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	5.1	5.1	0.0
2067		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	4.6	4.6	0.0
2068		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	4.1	4.1	0.0
2069		0.1	0.1	168.6	1,492.3	1,661.0	1,660.8	3.7	3.7	0.0
2070		1.2	1.2	168.6	1,492.3	1,661.0	1,659.7	3.3	3.3	0.0
Total	6,572.0	16.4	6,588.4	8,271.0	69,383.8	77,654.8	71,066.5	1,257.3	5,714.3	4,457.0

Source: JST

Table 13.7.11 Economic Analysis of Case 3

EIRR: 13.2% **B/C: 1.14** **NPV: 833.6** **Cost 1.00** **Benefit: 1.00**

Unit: Million NRs. (Year 2015 Economic Price)

Cost & Benefit	Cost			Benefit			Net Benefit	Discounted Net Benefit	Discounted Benefit	Discounted Cost
Year	Investiment	OM	Total Cost	VOC Savings	Time Savings	Total Benefit				
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	2,220.0	0.0	2,220.0	0.0	0.0	0.0	(2,220.0)	(1,769.8)	0.0	1,769.8
2018	2,220.0	0.0	2,220.0	0.0	0.0	0.0	(2,220.0)	(1,580.2)	0.0	1,580.2
2019	2,220.0	0.0	2,220.0	0.0	0.0	0.0	(2,220.0)	(1,410.9)	0.0	1,410.9
2020	2,220.0	0.0	2,220.0	0.0	0.0	0.0	(2,220.0)	(1,259.7)	0.0	1,259.7
2021		0.2	0.2	174.5	537.9	712.4	712.3	360.9	360.9	0.1
2022		0.2	0.2	190.2	653.3	843.5	843.3	381.5	381.5	0.1
2023		0.2	0.2	207.3	793.4	1,000.7	1,000.5	404.1	404.2	0.1
2024		0.2	0.2	225.9	963.6	1,189.5	1,189.3	428.9	428.9	0.1
2025		2.0	2.0	246.2	1,170.3	1,416.5	1,414.5	455.4	456.1	0.6
2026		0.2	0.2	230.9	1,266.3	1,497.2	1,497.1	430.4	430.4	0.0
2027		0.2	0.2	216.6	1,370.2	1,586.8	1,586.6	407.3	407.3	0.0
2028		0.2	0.2	203.2	1,482.6	1,685.8	1,685.6	386.3	386.3	0.0
2029		0.2	0.2	190.6	1,604.1	1,794.8	1,794.6	367.2	367.2	0.0
2030		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	349.4	349.8	0.4
2031		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	312.3	312.3	0.0
2032		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	278.8	278.8	0.0
2033		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	248.9	249.0	0.0
2034		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	222.3	222.3	0.0
2035		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	198.3	198.5	0.2
2036		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	177.2	177.2	0.0
2037		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	158.2	158.2	0.0
2038		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	141.3	141.3	0.0
2039		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	126.1	126.1	0.0
2040		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	112.5	112.6	0.1
2041		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	100.5	100.6	0.0
2042		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	89.8	89.8	0.0
2043		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	80.2	80.2	0.0
2044		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	71.6	71.6	0.0
2045		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	63.8	63.9	0.1
2046		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	57.1	57.1	0.0
2047		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	50.9	50.9	0.0
2048		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	45.5	45.5	0.0
2049		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	40.6	40.6	0.0
2050		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	36.2	36.3	0.0
2051		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	32.4	32.4	0.0
2052		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	28.9	28.9	0.0
2053		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	25.8	25.8	0.0
2054		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	23.0	23.0	0.0
2055		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	20.6	20.6	0.0
2056		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	18.4	18.4	0.0
2057		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	16.4	16.4	0.0
2058		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	14.6	14.6	0.0
2059		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	13.1	13.1	0.0
2060		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	11.7	11.7	0.0
2061		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	10.4	10.4	0.0
2062		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	9.3	9.3	0.0
2063		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	8.3	8.3	0.0
2064		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	7.4	7.4	0.0
2065		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	6.6	6.6	0.0
2066		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	5.9	5.9	0.0
2067		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	5.3	5.3	0.0
2068		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	4.7	4.7	0.0
2069		0.2	0.2	178.8	1,735.7	1,914.5	1,914.4	4.2	4.2	0.0
2070		2.0	2.0	178.8	1,735.7	1,914.5	1,912.6	3.8	3.8	0.0
Total	8,880.1	26.1	8,906.2	9,217.4	81,006.0	90,223.4	81,317.1	833.6	6,856.3	6,022.6

Source: JST

Table 13.7.12 below summarizes the result of economic analysis of the Expansion Development. The Case 2 showed the higher EIRR than Case 3. However the EIRR of Case 3 still exhibit the values exceeding 12%, which is the social discount rate of Nepal. Net Present Value (NPV) and the B/C by case showed the same tendency as the EIRR.

Table 13.7.12 Results of Economic Analysis by Case

Case	EIRR (%)	NPV NRs Million	B/C
Case 2	14.3	1,257.3	1.28
Case 3	13.2	833.6	1.14

Source: JST

(2) Conclusion

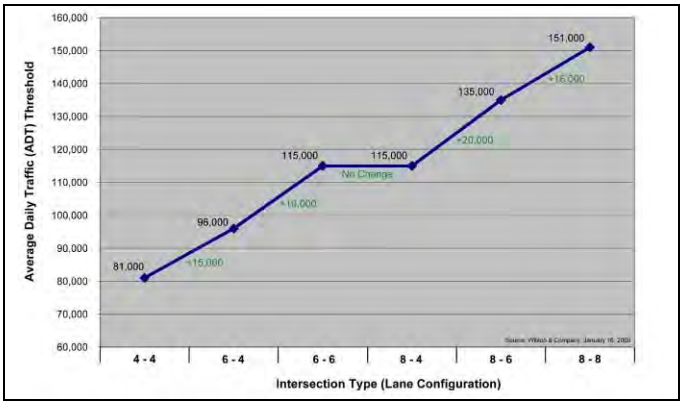
According to the result of economic analysis, it could be said that the even EIRR value decrease, Case 3 (development of T-M Flyover together with New Baneshwor underpass) is feasible. And the calculated saturation degree of with case and without case shown in Table 13.7.6 indicates that the improvement effect of underpass is very large. Hence, implementation of New Baneshwor underpass is strongly recommended.

13.8 Expansion Plan of the Project Method

13.8.1 Background

(1) Objective

Through the Pre-FS on T-M Flyover, development effect of flyover was identified. However it is possible to improve intersections by signalization and lane arrangement with widening of approach road. Figure 13.8.1 shows the maximum daily entering traffic volume thresholds by at-grade intersection. The figure shows even if an intersection is saturated at present, increase in number of lanes can afford more entering traffic volume.



Source: Wilson & Company, 2009

Figure 13.8.1 Maximum Entering Traffic volume Threshold by At-Grade Intersection

Kalimati intersection is one of the candidates for grade separation. Therefore in this section, a study is conducted for Kalimati intersection improvement by both flyover and at-grade improvement.

(2) Study Method

Improvement of Kalimati intersection is analyzed by the following two methods:

1) Flyover structure: the same procedure as New Baneshwor underpass
2) At-grade intersection improvement: intersection capacity enlargement by arrangement of lanes.
3) Comparison of land acquisition and necessary cost.

In addition to the congested intersection, Bishnumati Bridge which is close to Kalimati intersection, is suffering severe damage as described in Appendix-5. Although replacement of existing bridge is urgent, traffic on the bridge cannot be stopped since the road is one of the main arterial in the valley. Hence, replacement method of Bishnumati bridge is also studied in this section.

13.8.2 Present Condition of Kalimati Intersection

(1) Physical Condition

The present conditions of Kalimati intersection is same as New Baneshwor as follows:

- Manual Traffic control by police.
- Poor drainage; and the road is pitted with puddles after rainfall.
- There are few large trucks, but many buses and private vehicles.
- The city environment is inhibited by noise from the aging large vehicles.
- There is disorderly congestion of vehicles and pedestrians at the intersections.
- There are no road markings and the traffic lanes.
- The footpath is small, and congested with pedestrians.
- The sidewalks lack flatness and pose difficulty for the passing pedestrians.

Source: JST

Figure 13.8.2 Present condition of Kalimati Intersection

(2) Traffic Condition

Kalimati intersection is an intersection of three roads, and traffic going left from the east to the south side is heavy. In addition, it is necessary to examine the traffic operation in the market because the intersection on the north side has an access road to the market, and free entry and exit of traffic into the intersection from the neighborhood will cause congestion and increase the risk of accidents at the intersection.

The saturation degree of the signalized intersection is higher than 0.9.(traffic survey result in 2011) As the intersections do not satisfy the saturation degree, it is necessary to examine for grade separation.

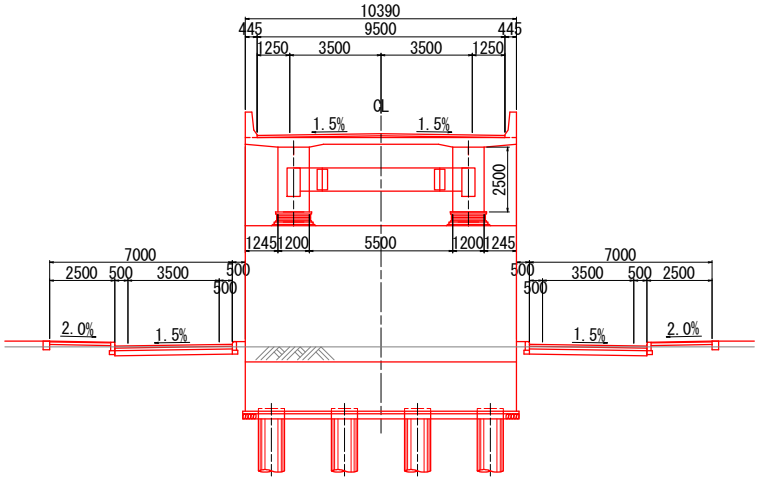
13.8.3 Pre-FS for Kalimati Flyover

13.8.3.1 Preliminary Engineering Design

(1) Typical Cross Section

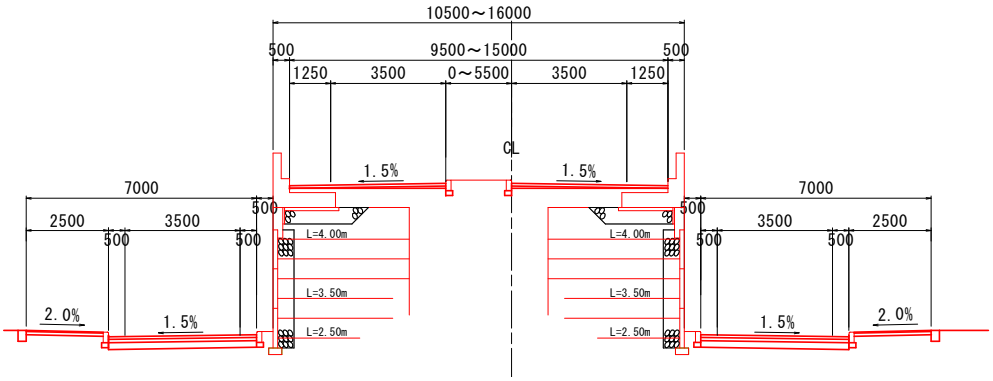
The Kalimati intersection geographically is in a sagging flat section and an underpass is impossible for natural drainage flow. Therefore an overpass is adopted for the Kalimati grade separation.

In addition, Kalimati intersection is planned in harmony with rebuilding the Bishnumati Bridge on the east side.

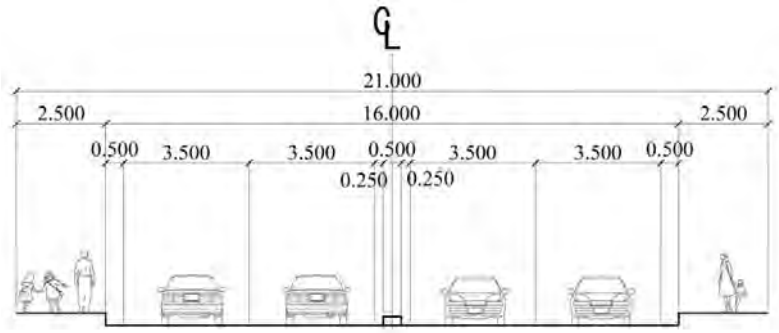


Bridge section

Approach(Reinforced Earth Wall)



Approach section



Standard Section

Source: JST

Figure 13.8.3 Typical Cross Section of Kalimati Flyover

(2) Horizontal Alignment

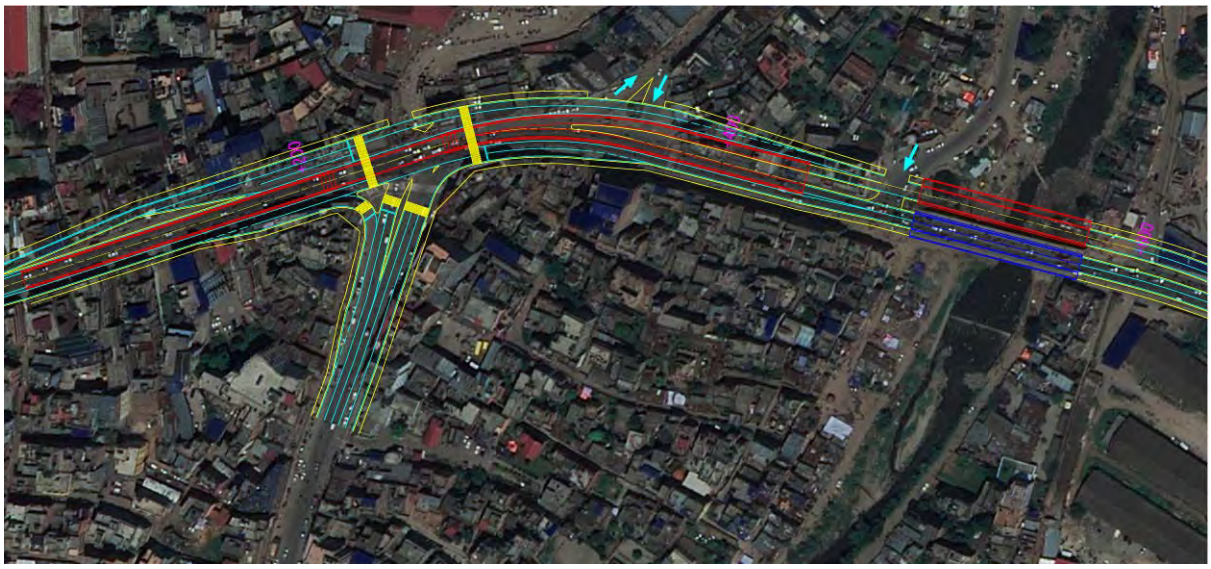
Upgrading of the target road will be conducted accordingly to satisfy the geometric standards for road safety. However, it is important that impact to both the social and natural environments is minimized. Accordingly, the following concepts of road alignment were applied, as a general rule:

- Alignment plan is based on the upgraded road keeping its existing alignment to accommodate the design speed.
- Alignment plan should minimize the number of affected houses and people.

- Alignment plan should minimize the negative impact to public facilities (schools, hospitals, etc.) and social facilities.
- Alignment plan should minimize the negative impacts to the living environment of residents.

In addition, the control points of the alignment plan are as follows.

- Horizontal alignment is widened on both sides of the existing road center.
- Horizontal alignment is adjusted in consideration of the rebuilding plan of Bishnumati Bridge.
- Straight alignment is planned for the bridge section (Bridge workability)



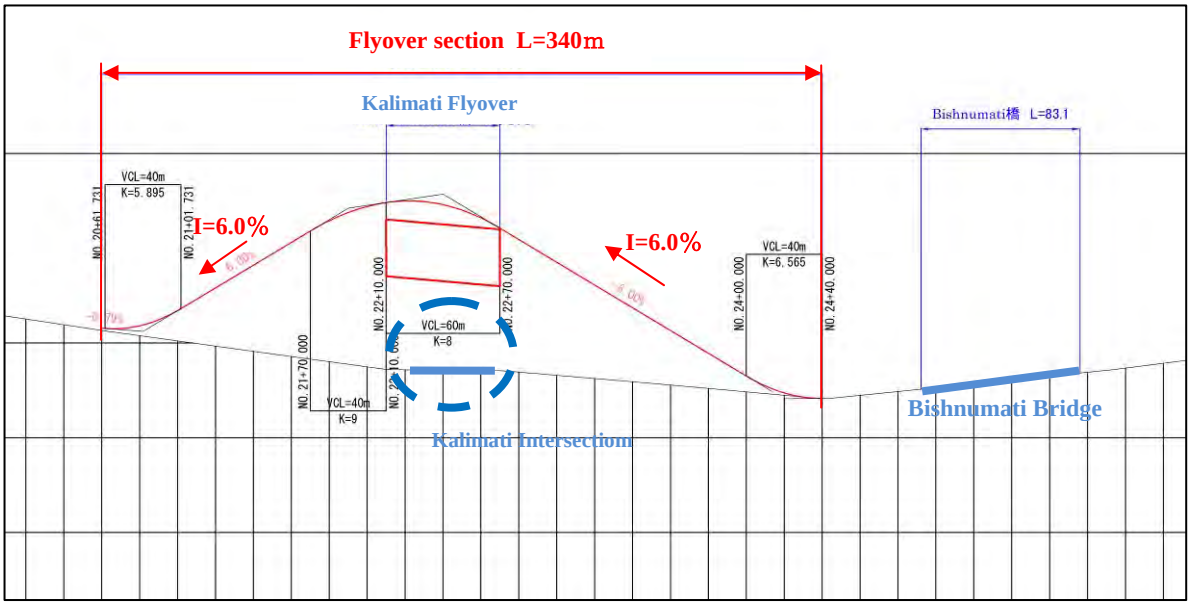
Source: JST

Figure 13.8.4 Horizontal Alignment of Kalimati Flyover

(3) Vertical Alignment

Vertical alignment should be traced accordingly to satisfy the adopted design parameters. In addition, the vertical alignment is planned to decrease the range of interference as much as possible for urban areas. The control points of the vertical alignment are as follows.

- Vertical gradient adopted is 6 percent.
- The Intersection is planned compactly, and the bridge span is kept short.
- Girder height adopted is 3.0m in the flyover plan.
- Bishnumati Bridge is planned at the existing road surface height.



Source: JST

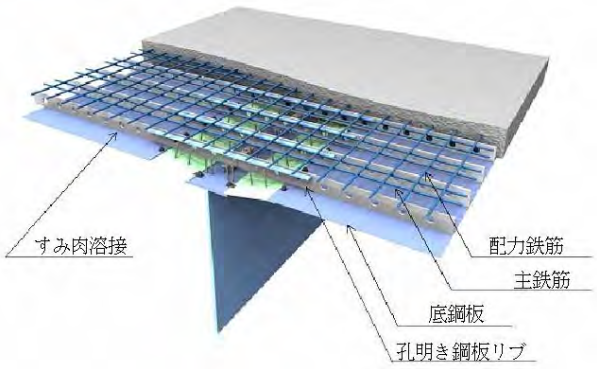
Figure 13.8.5 Vertical Alignment of Kalimati Flyover

(4) Structure Design

1) Kalimati Fly Over Bridge

Structural type : The reasons for selecting “Steel Narrow Box Girder with Composite deck slab”are as follows.

- Since it is assumed that a soft layer is deposited thickly, the steel bridge is lighter than the concrete bridge, and the scale of substructure and foundation can be reduced.
- The bridge length is approximately 60m. As steel narrow box girder with composite deck slabs are mostly constructed at 60 to 70m this method is highly applicable.
- Compared with the conventional steel box girder, by simplifying the structure inside the box (reducing the number of vertical ribs and eliminating lateral ribs), it is possible to reduce the cost of manufacturing the girder. Furthermore, by adopting composite deck slab (or prestressed concrete deck slab), the durability of the decks is improved, and maintenance cost can be reduced.



Example for the Steel Narrow Box Girder with Composite deck slab

Source: Japan Bridge Assciation.inc

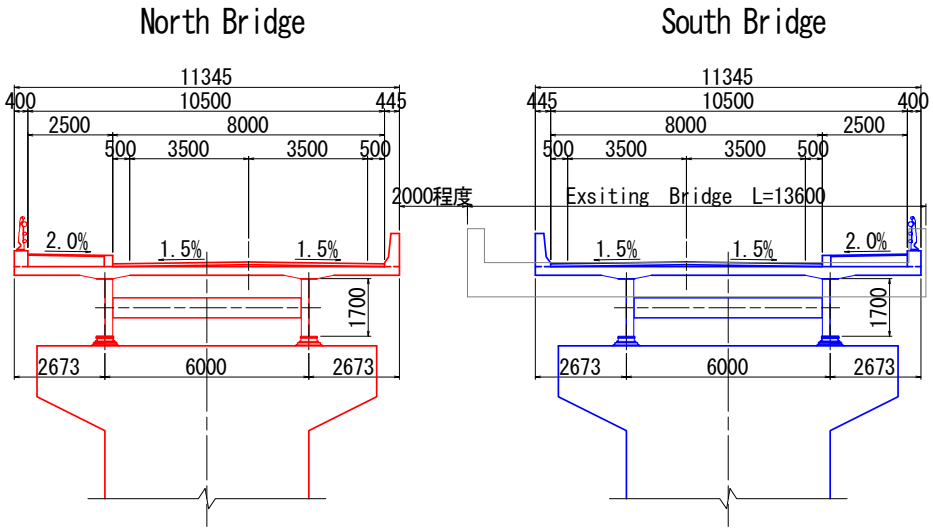
2) Bishunumati Bridge

Structural type : The reasons for selecting “Continuous Steel Girder with Composite deck slab”are as follows.

- Since it is assumed that a soft layer is deposited thickly, the steel bridge is lighter than the concrete bridge, and the scale of substructure and foundation can be reduced.

- The existing bridge, Bishunumti Bridge has a bridge length of 83.1m, and if it is assumed that the new bridge will be the same length as the existing bridge, three spans (span arrangement: 28m@3=84m) are considered reasonable for the bridge to be replaced. Although various types of bridge can be applied in consideration of the span arrangement, steel girder bridge type is appropriate.

- Continuous steel girder with composite deck slab is a structure that aims at rationalization by simplifying or omitting the cross beam/lateral bracing, etc, as well as reducing the number of main girders by increasing the span of decks using composite deck slab. It is expected to reduce the cost of manufacturing the girder and the erection cost, shorten the construction period and reduce the maintenance cost compared to the conventional multi-main girder bridge.



Source: JST

Figure 13.8.6 Rebuilding Plan of Bishnumati Bridge

(5) Cost Estimates

Construction cost is estimated based on the bill of quantities made by the JICA Survey Team.

The current unit rate of each item in the bill of quantities has been obtained from leading domestic contractors and compared with DOR's recent rate to confirm its reliability. If the proposed rates from leading domestic contractors are judged as not suitable, the rates made by the JICA Survey Team will be used for the cost estimate.

Furthermore, the rates for bridge superstructure works are calculated by the JICA Survey Team based on the standard cost estimating method of JICA due to the lack of similar works in Kathmandu.

Table 13.8.1 Summary of Construction Cost Estimation for Kalimati Flyover (NRs)

No.	Work items	Cost
200	Site clearance	8,907,408
900	Earthworks	76,485,304
1000	Subgrades	20,292,000
1200	Subbase, base, hard shoulder and gravel wearing course	14,011,800
1300	Bituminous surface and base course	30,428,750
1400	Kerbs and footpaths	29,984,845
1500	Traffic safety and control facilities	2,911,741

1600	Piling and foundation for structures	3,317,950
2000	Concrete works	158,564,576
2200	Structural steel works	216,655,956
1900	Bearings and expansion joint	38,504,450
2400	Miscellaneous structures	1,425,000
2600	Masonry for structure	1,508,087
700	Pipe drains, pipe culverts and concrete channels	56,399,125
3100	Miscellaneous works	30,405,492
Total		689,802,485

Source: JST

Table 13.8.2 Summary of Construction Cost Estimation for Rebuilding Bishnumati Bridge (NRs)

No.	Work items	Cost
200	Site clearance	22,783,294
900	Earthworks	7,588,693
1000	Subgrades	0
1200	Subbase, base, hard shoulder and gravel wearing course	0
1300	Bituminous surface and base course	4,108,560
1400	Kerbs and footpaths	0
1500	Traffic safety and control facilities	303,975
1600	Piling and foundation for structures	12,997,117
2000	Concrete works	196,991,765
2200	Structural steel works	301,343,853
1900	Bearings and expansion joint	162,807,580
2400	Miscellaneous structures	1,425,000
2600	Masonry for structure	1,508,087
700	Pipe drains, pipe culverts and concrete channels	0
3100	Miscellaneous works	38,094,169
Total		748,444,005

Source: JST

Table 13.8.3 Project Cost Estimates (NRs)

Descriptions	Kalimati Flyover	Bishumati Bridge
Construction	689,802,485	748,444,005
Physical Contingency	68,980,248	74,844,401
Administration Cost	3,449,012	3,742,220
Land acquisition Cost	431,302,935	0
Building Compensation Cost	81,160	0
Engineering Services	68,980,248	74,844,401
VAT	164,137,492	117,243,753
Project Cost	1,426,733,581	1,019,118,780

Source: JST

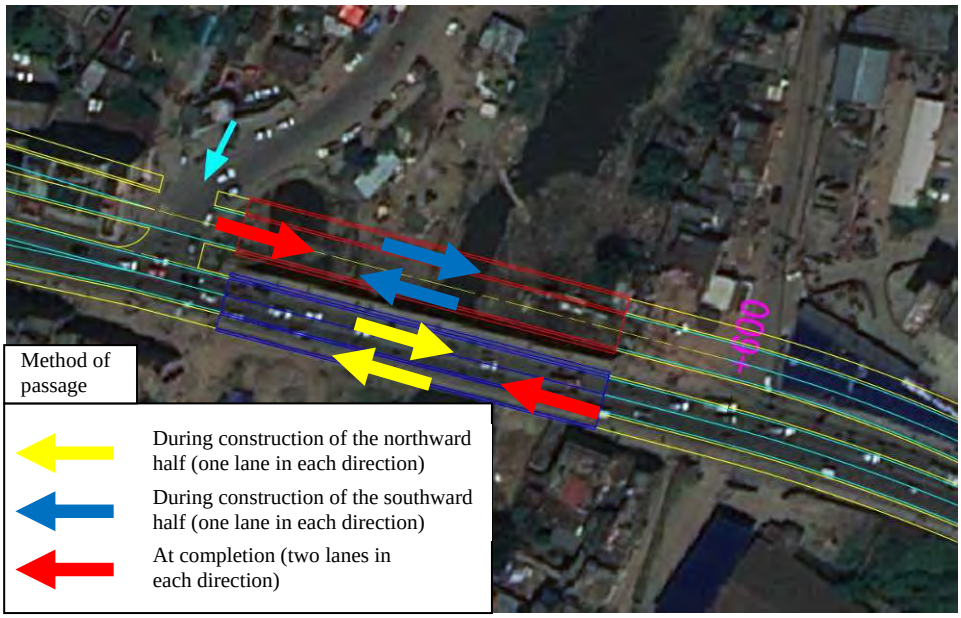
(6) Construction Plan

As the main road is 4 traffic lanes, it is necessary to secure 2 traffic lanes during construction. Also, from the viewpoint of efficient processing of traffic, it is desirable that construction of Kalimati Intersection is conducted after replacement of the Bishnumati Bridge.

The flow of construction is shown below

STEP1: Rebuilding Bishnumati Bridge

1) Construction of one half at the Bishnumati Bridge (New construction): 2 Lanes
2) Removal of the existing Bishnumati Bridge
3) Construction of the other half at Bishnumati Bridge (New construction): 2 Lanes (Construction the same position of the existing bridge)

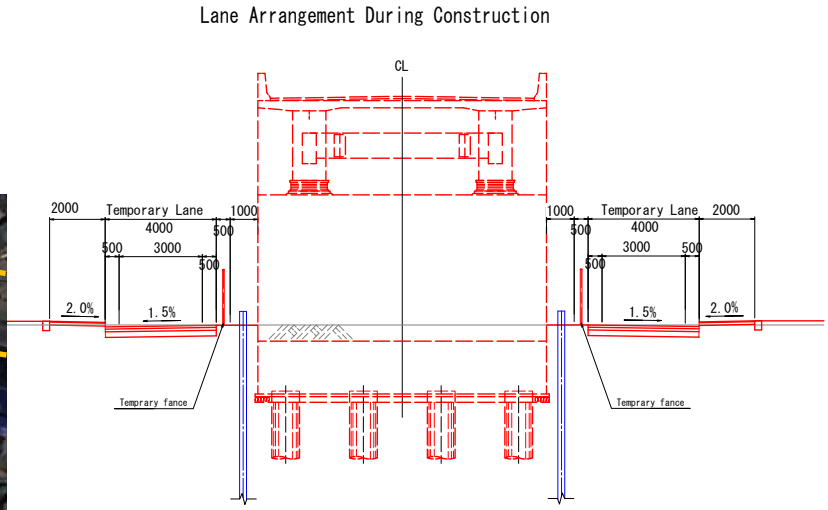


Source: JST

Figure 13.8.7 Traffic flow during the construction

STEP2: Kalimati Flyover

4) Temporary road for sub structure
5) Pile and sub structure.
6) Super Structure (Launching Method)
7) Reinforced retaining wall
8) Improvement of the Junction



Source: JST

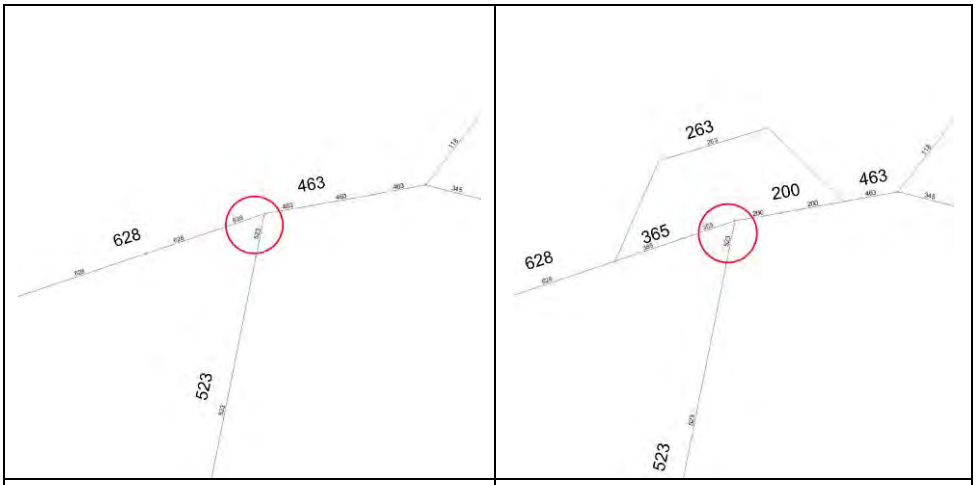
Figure 13.8.8 Cross section During the Construction

13.8.4 Traffic Analysis

(1) Traffic Demand Forecast

Traffic assignment for formulated plan options is conducted in short term (2020), mid-term (2025) and long term (2030) by the method described in 13. 7. 2.

Forecasted future traffic demand is shown in Figure 13.8.9



Without Case (Without Kalimatii Flyover)	With Case (Kalimati Flyover constructed)

Source: JST

Figure 13.8.9 Traffic Assignment Result for Without Case and With Case

(2) Intersection Saturation Degree

Based on the future traffic demand forecast at the New Baneshwor intersection, saturation degree at the intersection is analyzed. The calculated saturation degree in 2030 is 0.75 as shown in Table 13.8.4.

Table 13.8.4 Intersection Saturation Degree of With Case (Kalimati Flyover)

Intersection Saturation degree
0.68

Source: JST

13.8.5 Study on At-grade Improvement of Kalimati Intersection

(1) Intersection Traffic Analysis

Based on the traffic volume by direction at peak hour in 2030, Saturation flow rate was calculated. Result of calculation is shown in Table 13.8.5.

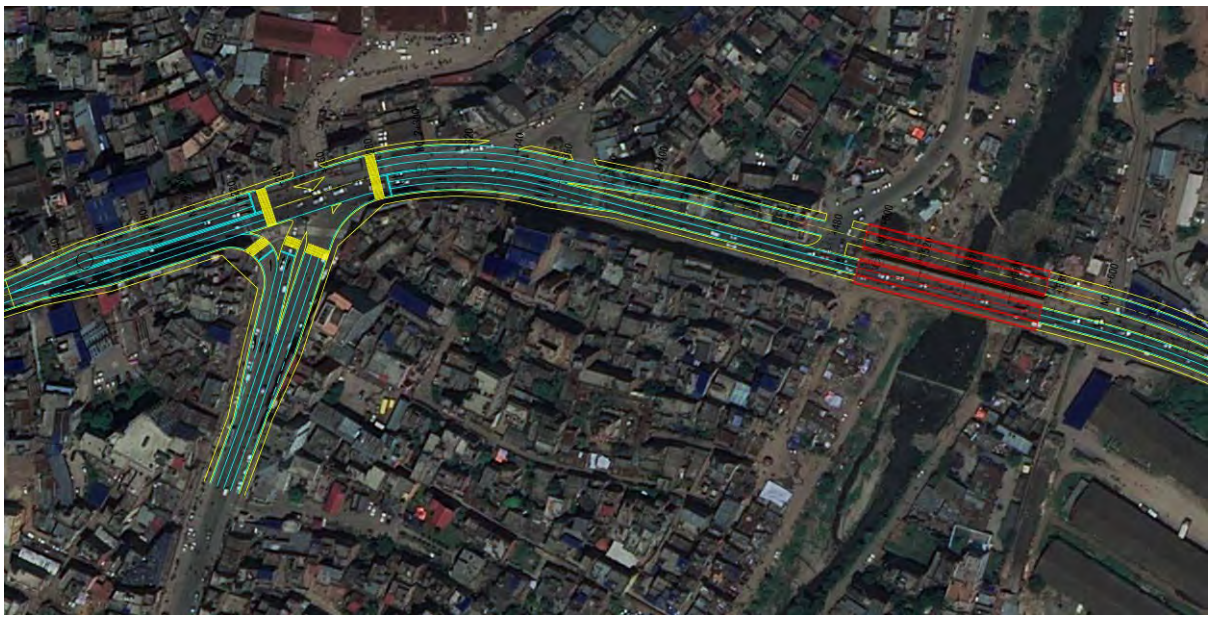
Table 13.8.5 Saturation Flow Rate and Normalized Traffic Volume of Kalimati Intersection

Access Road		A			B			C		
Lane		Left turn	Straight	Right turn	Left turn	Straight	Right turn	Left turn	Straight	Right turn
Number of Lanes		1	2	0	1	0	2	0	1	2
Ideal Saturation Flow Rate (vehicle/h(effective green time))		1,800	2,000	1,800	1,800	2,000	1,800	1,800	2,000	1,800
Adjustment Factor	Lane Width	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Approach Grade	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Heavy Vehicles	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Right Turns	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Left Turns	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Saturation Flow Rate (vehicle/h(effective green time))		1,800	4,000	0	1,800	0	3,600	0	2,000	3,600
Traffic Volume(pcu/h)		418	1,345	0	1,239	2,188	543	0	990	1,592
Normalized Volume		0.23	0.34		0.69		0.15		0.50	0.44
Degree of Saturation by Phase	Phase 1	0.23	0.34						0.50	
	Phase 2									0.44
	Phase 3						0.15			
Degree of Saturation		1.09								

Source: JST

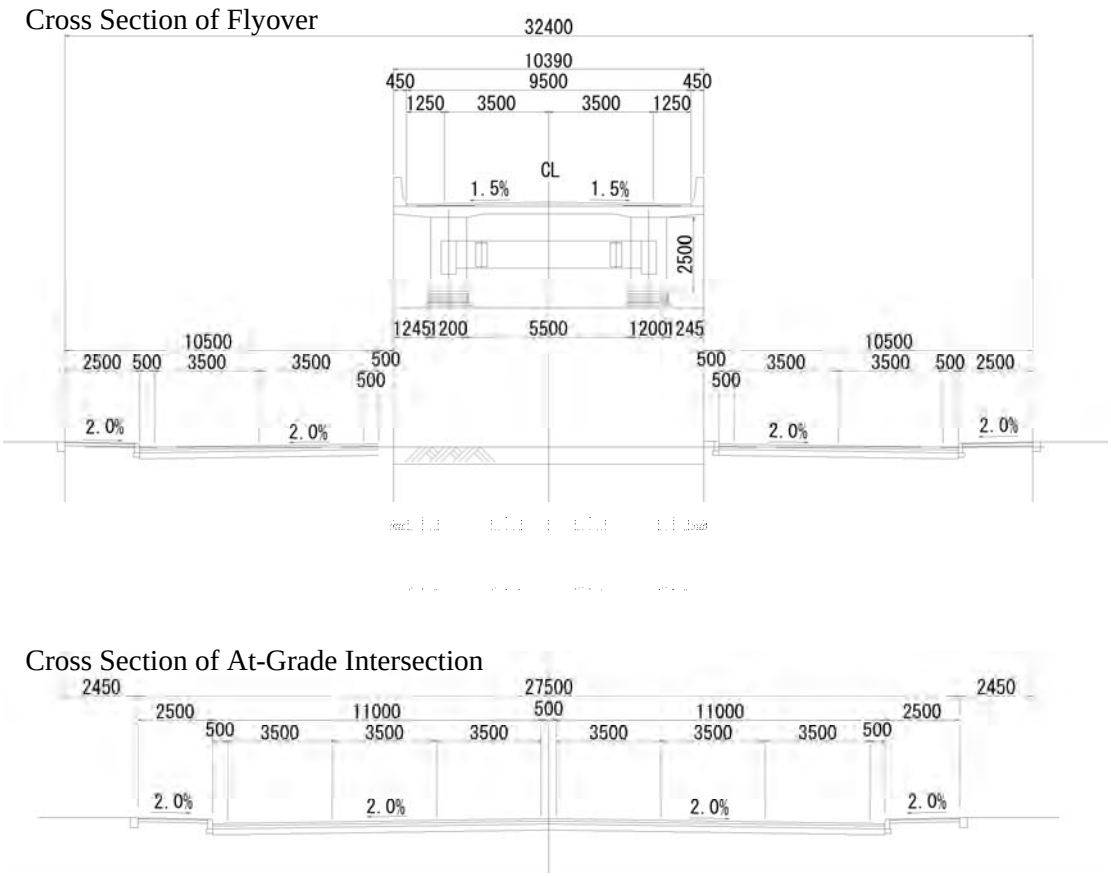
(2) Preliminary Design of At-Grade Intersection Improvement

Required number of lanes at intersection is analyzed in Table 13.8.5. In order to secure the required number of lanes, preliminary design is conducted. Horizontal alignment of at-grade intersection is shown in Figure 13.8.10.



Source: JST

Figure 13.8.10 Horizontal Alignment of At-Grade Improvement of Kalimati Intersection



Source: JST

Figure 13.8.11 Comparison of Necessary Width of Intersection (Interchange Improvement)

Figure 13.8.11 shows the comparison of intersection width of flyover intersection and at-grade intersection. In the at-grade intersection is higher in saturation degree, necessary width is narrower then flyover intersection.

13.8.6 Conclusion

Comparing the necessary width of interchange improvement, at grade intersection is smaller. According to this study, it became clear that sometimes improvement of intersection is possible by widening the approach section and without grade separation. Therefore when the improvement is required, study from both approach is necessary.