DIRECTORATE OF URBAN LAND TRANSPORT
THE REPUBLIC OF INDIA

PREPARATORY SURVEY REPORT ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA

FINAL REPORT

November 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
EAST NIPPON EXPRESSWAY COMPANY LIMITED

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Preface

The Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to NIPPON KOEI Co., Ltd. and EAST NIPPON EXPRESSWAY COMPANY LIMITED.

The survey team held a series of discussions with the officials concerned of the Government of Republic of India, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Republic of India for their close cooperation extended to the survey team.

November 2017

Itsu ADACHI
Director General,
Infrastructure and Peacebuilding Department
Japan International Cooperation Agency

Summary

1. Outline of the Country

India, located in South Asia, has the largest land area (3.28746 million km^2) among other South Asian countries and is second-ranked in the highest population in the world with 1.21057 billion people (Census Population Record, 2011).

The Bengaluru Metropolitan Area, which is the capital of the Karnataka State in India, is an industrial city having a population of around 8.7 million people (ranked 5th in India). It is referred to as India's Silicon Valley since this region is the largest “Information and Communication Industry” cluster in India. The Bengaluru Metropolitan Area is an important economic hub in Southern India where many Indian and overseas companies are starting to expand.

2. Background of the Project

The traffic in Bengaluru Metropolitan Area has been increasing and the development of road network has not kept up with the pace of the traffic demand. As a result, chronic traffic congestion has grown into a serious problem and is creating major problems for economic activities in the region. As a structural measure, the development of road infrastructure is underway to address further increase in traffic demand in the future.

Among these, the construction of the Peripheral Ring Road has been planned and its implementation through a Japanese yen-loan financed project has been studied. In addition, improvement of the radial roads and extension of the Bengaluru Metro are in progress.

In addition to such structural measures, non-structural measures aiming to mitigate traffic congestion and normalize traffic flow through effective utilization of road infrastructure are becoming more and more important. An Intelligent Transport System (hereinafter referred to as "ITS") is an important non-structural measure, whereby information and communications technology is applied in the field of road transportation management, and there are high expectations to the development of ITS in the Bengaluru Metropolitan Area.

Against this background, "The Master Plan Study on the Introduction of Intelligent Transport Systems (ITS) in Bengaluru and Mysore in India (January 2014 to June 2015)" (hereinafter referred to as "the Master Plan Study") was conducted by the Japan International Cooperation Agency (hereinafter referred to as “JICA”). The Master Plan Study proposes to develop various ITS in Bengaluru Metropolitan Area in phases: Short-term (Phase 1: 2015 to 2019), Mid-term (Phase 2: 2020 to 2024) and Long-term (2025 onwards).

In the Master Plan Study, the top priority issues on the Bengaluru Metropolitan Area were identified for implementation of the traffic information system and the signal system. With the background and situation, the Directorate of Urban Land Transport of Karnataka State Government (hereinafter referred to as “DULT”) requested a Grant Aid Project from the Japanese Government.

3. Outline of the Study Result and the Project

Considering the request from the Government of India, the Government of Japan decided to conduct the Preparatory Survey on the Project for Bengaluru Metropolitan Region ITS and JICA dispatched the JICA Study Team to Bengaluru five times from the 27th February 2016 to 14th July 2017. Activities done by the team during the survey in Bengaluru were: 1) discussion related to the Project among relevant agencies such as the DULT and Bengaluru Traffic Police (hereinafter referred to as "BTP"), 2) conduct of site survey, 3) evaluation of the location of target intersections, and 4) comparison examination of the type of the load side equipment. After coming back to Japan, the survey team completed the Preparatory Survey Report (draft). Then, JICA dispatched the survey team to Bengaluru from the 7th January to 18th January 2017 to explain and discuss the Project plan to the Indian side and agree on the contents of the Project.

Also, considering the request from DULT, on the basis that the Contractor of the Project will conduct the operation and maintenance (hereinafter referred to as "O&M") for five (5) years after the completion of the implementation, the JICA study team considered the scope of work and the framework of contract in the Project. The cost for the O&M is borne by DULT.

The Bengaluru Development Authority (hereinafter referred to as "BDA") and DULT find it critical to install ITS aiming to alleviate the serious traffic congestion. This grant aid project could contribute to the economic growth in the Bengaluru Metropolitan Area through installing ITS equipment.

The dispatch period of the preparatory survey is shown in Table-1.

Table-1 Dispatch Period of the Preparatory Survey

Item	Dispatch Period
First dispatch	2016/2/27 ～ 3/11
Second dispatch (first half)	2016/4/1 ～ 4/27
Second dispatch (latter half)	2016/6/23 ～ 7/22
Third dispatch (first half)	2016/12/7 ～ 12/15
Third dispatch (latter half)	2017/1/7 ～ 1/18
Fourth dispatch	2017/4/20 ～ 4/29
Fifth dispatch	2017/6/28 ～ 7/14

(Source: JICA Study Team)

The objectives and installation policies of each ITS component are summarized as shown in Table-2.

Table-2 Objectives and Installation Policies of ITS Components

ITS Component		Objective	Installation Policy
Traffic Information System	Centre System	Data collection, processing, storage and information provision	It will be installed in KSDC (*1).
	Probe System	Calculation of travel speed based on probe data collected from GPS units installed on 6,700 buses of BMTC (*2)	It will be installed in KSDC and receive probe data from BMTC system.
	Queue Length Measurement System	Supplement to the probe data for calculation of travel speed	At 12 intersections in the city where severe congestion chronically occurs
	Automatic Traffic Counter-cum-Classifier System (ATCC System)	Measurement of traffic volume (large/small) for the purpose of road management	At midpoint of major intersections of main roads (eight locations, 16 equipment)
	Variable Message Sign System (VMS System)	Provision of dynamic congestion information generated by above subsystems and traffic event information through VMS	Before diverting point of main roads (three locations)
	Internet System	Provision of dynamic congestion information generated by above subsystems through Internet	Information will be mainly provided to area up to the outer ring road.
Signal System		Optimization of traffic flow by automatic signal coordination according to traffic volume	At 29 intersections in the core area of the city where the effect of improvement of traffic flow is highly expected

(Source: JICA Study Team)

(*1) KSDC: Karnataka State Data Centre, (*2) BMTC: Bengaluru Metropolitan Transport Corporation

4. Project Plan

The Project schedule will be four months for the detailed design and 15.5 months for procurement/installation or a total of 19.5 months.

5. Project Evaluation

5-1. Relevance

In order to keep pace with the increase of the traffic demand at Bengaluru Metropolitan Area, the development of road infrastructure is underway as the structural measure. But the core area in Bengaluru which has a serious traffic congestion has not enough space to expand the roads. Therefore, the urgent non-structural measure is required.

The target area of the Project is the central commercial area which has a serious traffic congestion around the MG Road. The mitigation of the traffic condition in the area greatly contributes to the economic development of the Bengaluru.

DULT is now engaged in the reinforcement of its personnel capable of planning the future road transportation plan including the ITS and BTP already has experience in operating the existing signal system, the existing Variable Message Sign system and etc. With these backgrounds, both DULT and BTP have enough personnel organizations and finance to operate and maintain the introduced system on the Project.

Considering the emergency of the Project, the effect to the economy and the operation and maintenance, the relevance of the Project is greatly expected.

5-2. Effectiveness

(1) Direct Effects

Following direct effects are expected by the Project.

Table-3 Direct Effect

Index	Base Line (Measured Value in 2016)	Target Value (2022) <3 years after the completion of the Project>
Queue Length (Peak Hours 9:00-10:00)	Total of the longest queue length among all approaching roads at each junction (*1): 844.8 m	590 m (-30%)
	Total of the longest queue length of all approaching roads at each junction (*1): 1576.9 m	970 m (-40%) (*2)
Average Travel Speed (*3) (Peak Hours 9:00-10:00)	13 Km/h	15 Km/h

(Source: JICA Study Team)

(*1) 7 key junctions among all 29 junctions
(*2) Estimated value based on the reduction rate of 30% for the maximum length at each junction, also considering the reduction rate of approaching roads
(*3) Major arterial roads in the central area of the city

Table-4 Wasted Green Time at Key Junction

	Junction Name	Operating Hours of Traffic Signal Per Day (Minutes)	Wasted Green Time Per Day (*1)	
			Minutes	Percentage
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*2)	81	34%
07	Vivekananda/Bhaskaran Junction	900	510	57%

(*1) The wasted green time: If there is no vehicle passing through the junction during green signal indication due to absence of traffic, it shall be recorded with time as Wasted Green Time. Measured value in 2017.
(*2) The survey time at this junction was limited to the above indicated duration.
The reduction of the wasted green time will be expected by introducing the ITS systems on the Project.

(Source: JICA Study Team)

(2) Indirect Effects

Traffic jam improvement in the Bengaluru Metropolitan Area, improvement of advantage convenience by keeping a constant transit time and development of regional economic in Bengaluru Metropolitan Area are expected.

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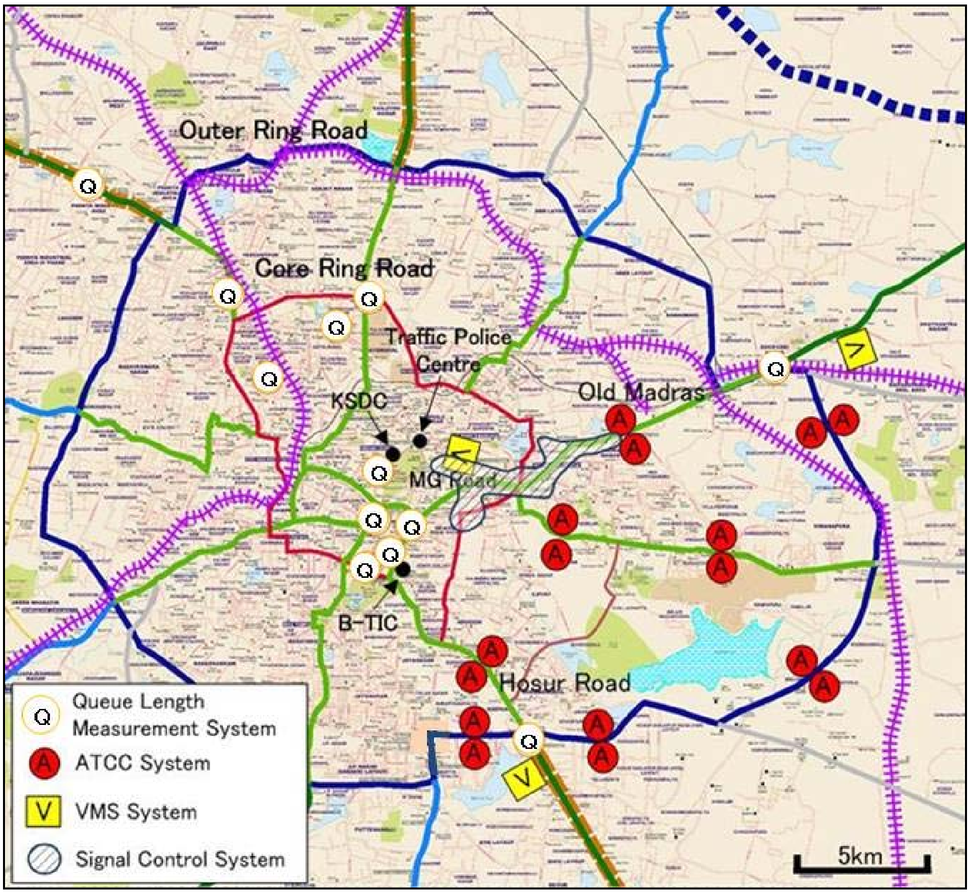
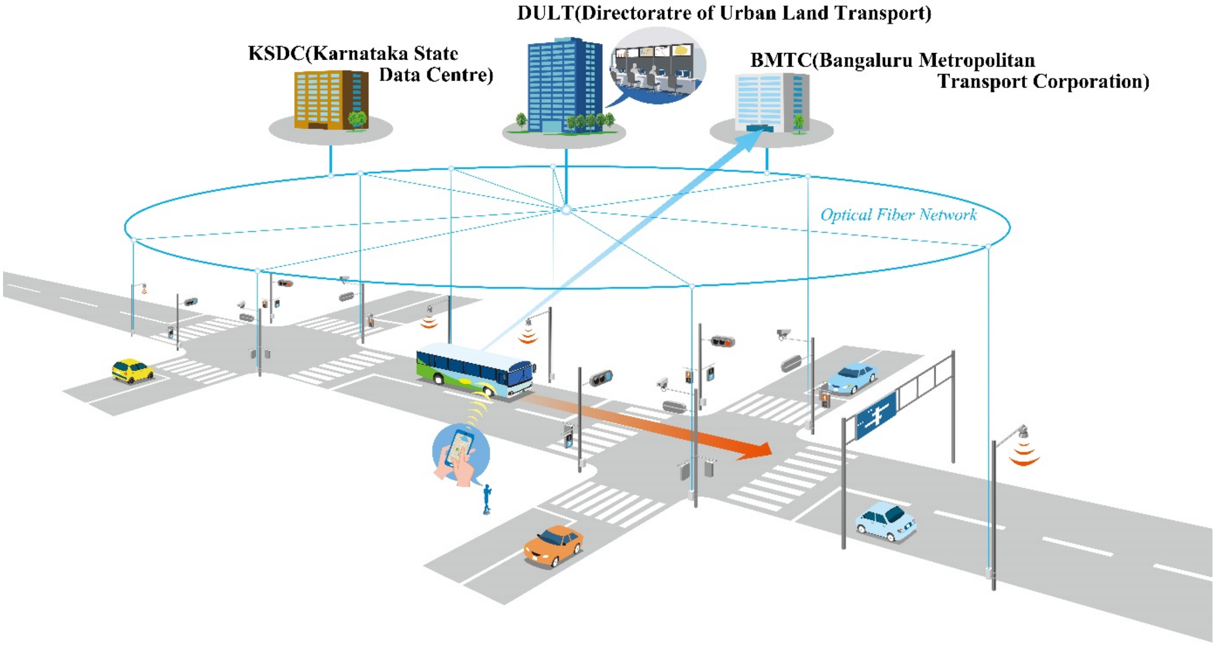
Location Map

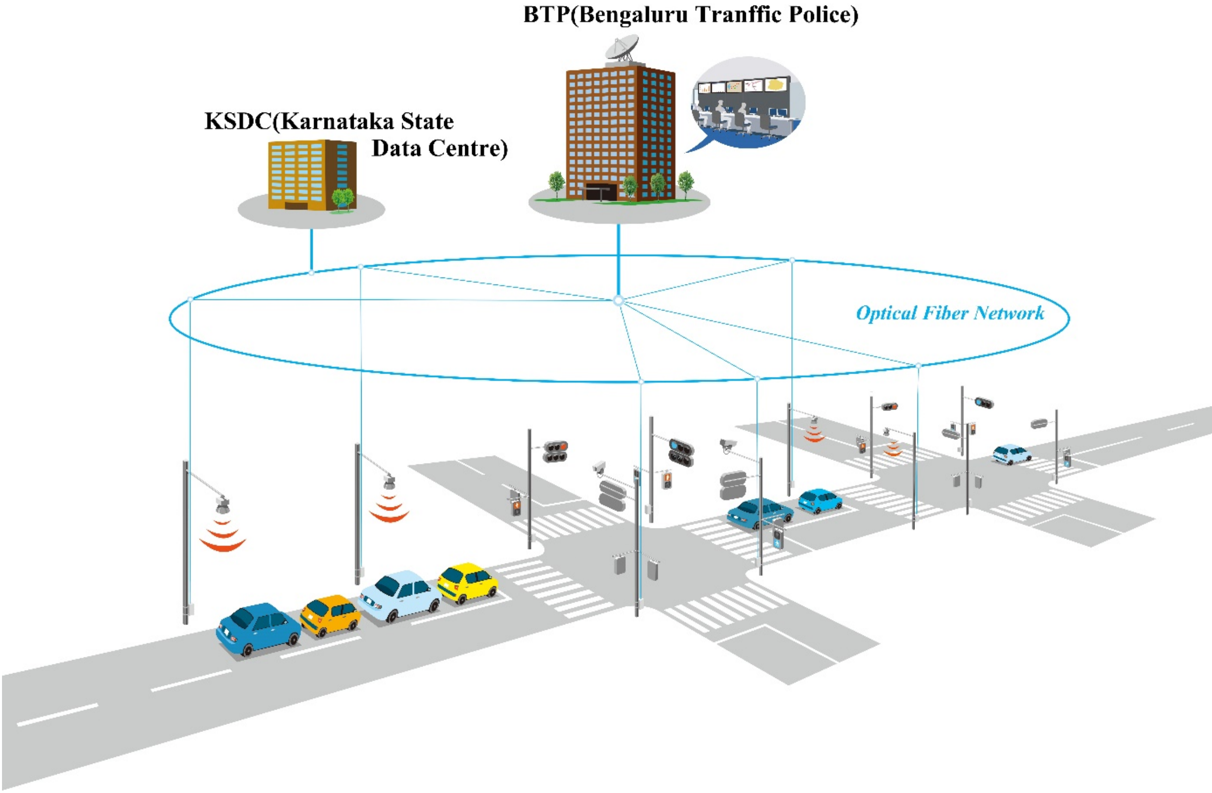


Perspective

Traffic Information System Perspective



Signal System Perspective



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Abbreviations

A/P	Authorization to Pay
ATCC	Automatic Traffic Counter-com-Classifier
B/A	Banking Arrangement
BBMP	Bruhat Bengaluru Mahanagara Palike
BDA	Bengaluru Development Authority
BEL	Bharat Electronics Ltd.
BETPL	Bengaluru Elevated Tollway Pvt. Ltd.
BMTC	Bengaluru Metropolitan Transport Corporation
BTIC	Bengaluru Traffic Information Centre
BTP	Bengaluru Traffic Police
DULT	Directorate of Urban Land Transport of Karnataka State Government
EGD	Electronic Government Division
E/N	Exchange of Note
FMC	Facility Management Contractor
FOB	Free on Board
G/A	Grant Agreement
GST	Goods and Services Tax
ITS	Intelligent Transport System
ITU	International Telecommunication Union
JICA	Japan International Cooperation Agency
KSDC	Karnataka State Data Centre
KSRTC	Karnataka State Road Transport Corporation
MDBs	Multilateral Development Banks
MoRTH	Ministry of Road Transport and Highway
NHAI	National Highway Authority of India
NTCIP	National Transportation Communications for ITS Protocol
OEM	Original Equipment Manufacturing
O&M	Operation and Maintenance
PIN	Personal Income Number
SOW	Scope of Work
SUTP	Sustainable Urban Transport Program
TIN	Tax Identity Number
TMC	Traffic Management Centre
VMS	Variable Message Signs
WB	World Bank
QBV	Quarterly Billing Value

Units / Measurements

Length	mm	Millimeters
	cm	Centimeters (10.0 mm)
	m	Meters (100.0 cm)
	km	Kilometers (1,000 m)
Area	cm^2 (cm2)	Square-centimeters (1/0 cm x 1.0 cm)
	m^2 (m2)	Square-meters (1.0 m x 1.0 m)
	km^2 (km2)	Square-kilometers (1.0 km x 1.0 km
Volume	cm^3 (cm3)	Cubic-centimeters (1.0 cm x 1.0 cm x 1.0 cm)
	m^3 (m3)	Cubic-meters (1.0 m x 1.0 m x 1.0 m)
Weight	g	Grams
	kg	Kilogram (1,000 g)
	ton	Metric ton (1,000 kg)

Currency	INR	Indian Rupee
	USD	United State Dollars
	JPY	Japanese Yen
Crore	1 Crore = 10^7	

Chapter 1 Background of the Project

1-1 Outline of the Grant Aid Project

The Bengaluru Metropolitan Area, which is the capital of Karnataka State in India, is an industrial city having a population of around 8.7 million people (ranked 5th in India). It is referred to as India's Silicon Valley since this region is the largest information and communication industry cluster in India. Bengaluru Metropolitan Area is an important economic hub in Southern India where many Indian and overseas companies are starting to expand.

The traffic in Bengaluru Metropolitan Area has been increasing and the development of road network has not kept up with the pace of the traffic demand. As a result, chronic traffic congestion has grown into a serious problem and is creating major problems for economic activities in the region. As a structural measure, development of road infrastructure is underway to address further increase in traffic demand in the future. Among these, construction of the Peripheral Ring Road has been planned and its implementation through a Japanese yen-loan financed project has already been studied. In addition, improvement of radial roads and extension of Bengaluru Metro are in progress.

Non-structural measures aiming to mitigate traffic congestion and normalize traffic flow through effective utilization of road infrastructure are becoming more and more important. An Intelligent Transport System (hereinafter referred to as “ITS”) is an important non-structural measure, whereby information and communication technology is applied in the field of road transportation management, and there are high expectations from the development of ITS in the Bengaluru Metropolitan Area.

Against this background, the Master Plan Study was conducted by Japanese International Corporation Agency (hereinafter referred to as “JICA”). The Master Plan Study proposes to develop various ITS in Bengaluru Metropolitan Area in three phases: Short-term (Phase 1: 2015 to 2019), Mid-term (Phase 2: 2020 to 2024), and Long-term (2025 onwards).

After the Master Plan Study, Directorate of Urban Land Transport of Karnataka State Government (hereinafter referred to as “DULT”) requested for a Grant Aid Project from the Japanese Government. The Grant Aid Project (hereinafter referred to as “The Project”) is for an implementation of the traffic information system and the signal system. Technical Review Study was done from April to December 2015 by JICA, and the top priority issues for the Bengaluru Metropolitan Area were identified as an implementation of the traffic information system and the signal system. Outline of the requested work is shown in Table 1-1 and quantity of equipment of each system is shown in Table 1-2.

Table 1-1 Outline of the Grant Aid Project

Item	Contents
Result	ITS equipment is installed in Bengaluru Metropolitan Area by the Grant Aid Project.
Purpose	In Bengaluru Metropolitan Area, Smooth and Stable traffic is offered.
Scope of area	Bengaluru, Karnataka State, India
Executing Agency	DULT

(Source: JICA Study Team)

Table 1-2 Quantity of equipment

ITS Component	Quantity		
	Request	Technical Review Study	Preparatory Survey
Centre System	1 set	1 set	1 set
Probe System	1 set	1 set	1 set
Queue Length Measurement System	5,000 units	13 locations (100 units)	12 locations (72 units)
Automatic Traffic Counter-cum-Classifier System (ATCC System)	56 units	8 locations (16 units)	8 locations (16 units)
Variable Message Sign System (VMS System)	6 units	3 units	3 units
Internet System	--	1 set	1 set
Signal System	20 intersections	20 intersections	29 intersections

(Source: JICA Study Team)

1-2 Natural Conditions

The implementation of the Project will be carried out basically within the right-of-way of the existing roads in the city; hence, there is no serious adverse impact on the natural and social environment, e.g., relocation of residents.

1-3 Environment and Social Considerations

In terms of impact on the environment, the Project falls under the Category ‘C’ in accordance with the “JICA’s Environment and Social Consideration Guidelines”, published in April 2010. Under this category, the Project is judged to have no impact on the natural environment.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The effectiveness of the Project, introduction of new traffic signals at 29 intersections together with a traffic control center, is estimated quantitatively as follows:

(1) 13% improvement of the average travel speed in the city center and

(2) 30% reduction of Queue Length of main intersections

The Project is also expected to bring about the following qualitative benefits:

(1) Long-term vitality of Bengaluru city's regional economy and

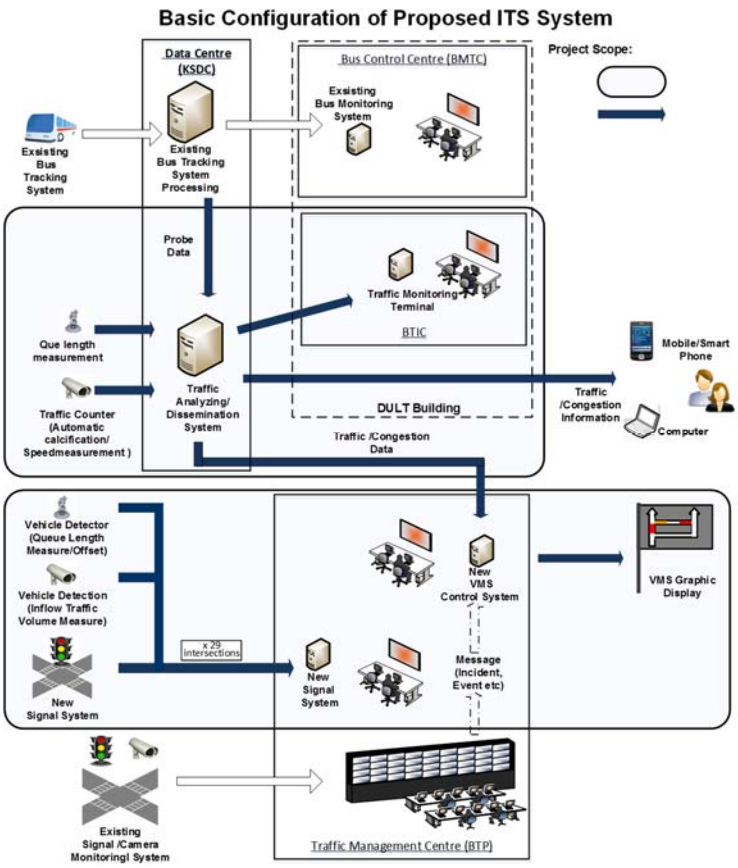
(2) Reduction of global warming.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Configuration of the Introduced ITS System

The system configuration is shown in Figure 2-1. The objectives and installation policies of each ITS component are summarized as shown in Table 2-1.



(Source: JICA Study Team)

Figure 2-1 Entire System Configuration

Table 2-1 Objectives and Installation Policies of ITS Components

ITS Component		Objective	Installation Policy
Traffic Information System	Centre System	Data collection, processing, storage and information provision	It will be installed in KSDC (*1).
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(*1) KSDC: Karnataka State Data Centre, (*2) BMTC: Bengaluru Metropolitan Transport Corporation

(Source: JICA Study Team)

2-2-1-2 Installation Policy of Each Party

The ITS equipment is installed in DULT, Bengaluru Traffic Police (hereinafter referred to as "BTP") and Karnataka State Data Centre (hereinafter referred to as "KSDC").

(1) DULT

DULT will be in charge of conducting the Operation and Maintenance (hereinafter referred to as "O&M") of the Centre system, Probe system, Queue length measurement system, ATCC system and Internet system. Bengaluru Traffic Information Centre (hereinafter referred to as "BTIC") will be established for the O&M on the second floor in the DULT building. DULT will prepare the centre with all required infrastructure such as server rooms, operator cabins, staff rooms, conference rooms and etc. including OA floor. The other facilities such as air conditioning, electrical and network arrangements, furnishing and etc. will also be prepared by DULT.

The layout of the BTIC including the installed ITS equipment such as a video wall, an operator console, a printer and etc. is shown in Figure 2-2.

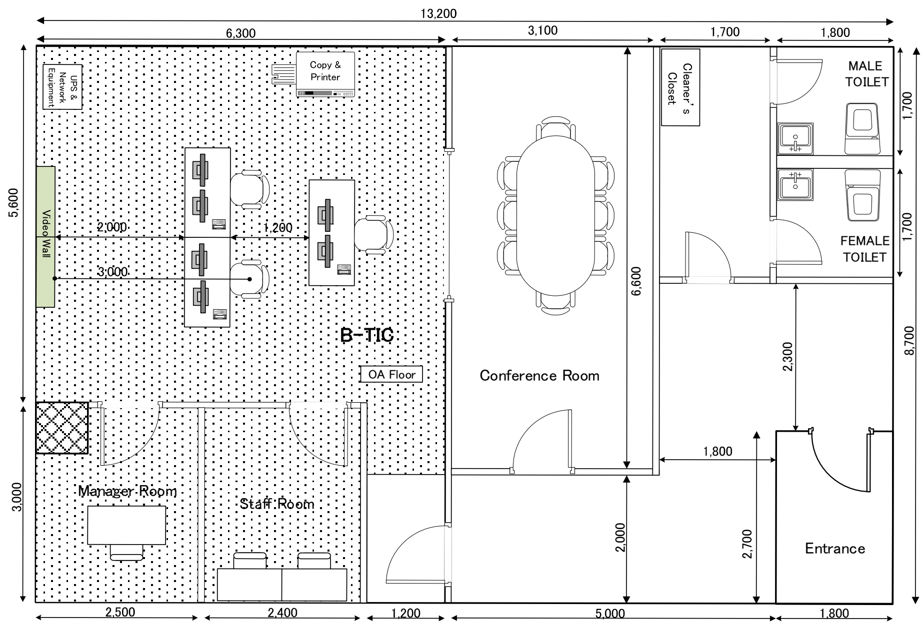


Figure 2-2 The layout of the BTIC

(2) BTP

BTP will be in charge of conducting the O&M of Signal system and VMS system. BTP already have the control centre known as called Traffic Management Centre (hereinafter referred to as "TMC") for operation of the existing traffic control system. TMC has enough space to accommodate the additional operator consoles for Signal system and VMS system of the Project. The installation image of the installed equipment of the Project is shown in Figure 2-3.

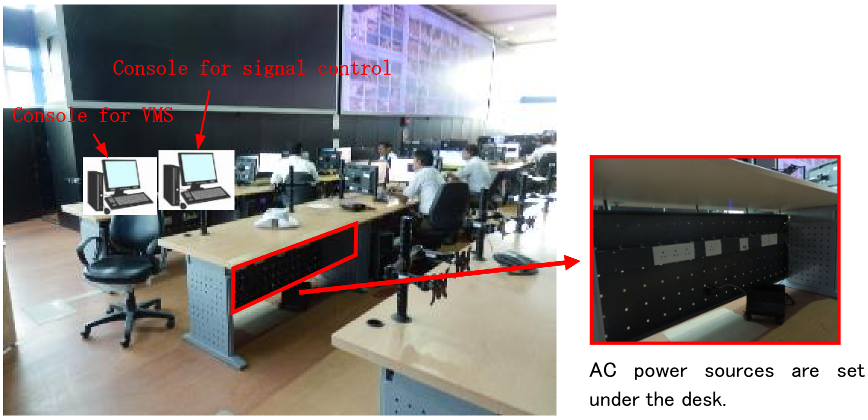


Figure 2-3 Installation Image of the ITS Equipment in TMC

(3) KSDC

KSDC is established in 2012 to host all state government department servers, data and applications. It is located in a secure environment and protected against un-authorized entry. Since both the traffic information system and the signal system are directly linking to the road safety, they will be installed at KSDC to ensure proper network security.

There are many existing server racks in KSDC regardless of whether or not they are used. All of the server racks have the AC power source from an UPS system. Twelve (12) racks out of the total are not used. The system servers of the Project will be hosted into these vacant racks designated by KSDC. The server room in KSDC is shown in Figure 2-4.

Figure 2-4 Server Room in KSDC

2-2-1-3 Socio-economic Condition

The target of the system is for road users of various modes such as passenger cars, auto rickshaws, bicycles and pedestrians. They are also the beneficiaries of the Project. For this reason, the system must consider the local traffic characteristics that vary among the countries.

The characteristics of the local traffic condition in Bengaluru City and the measures to be taken are summarized below.

(1) Pavement Markings

There are many cases that pavement markings such as lane and stop line are not clearly made at intersections and therefore these are not followed by the road users. Hence, the paint with high durability coating will be used at all 29 intersections.

(2) Pedestrian Signal

The existing signals lack pedestrian lanterns. Even if there are pedestrian lanterns, most of them allow very short time for crossing. As a result, the pedestrians cross the road when the vehicles are not running, which causes seriously dangerous situations. Therefore, pedestrian lanterns will be installed at almost all 29 intersections with a few exceptions.

2-2-1-4 Policy on the Conditions of Construction and Procurement

The local Contractors can provide construction machinery lease in Bengaluru. The basic materials for the construction can be procured from the local suppliers and Contractors. The materials such as cement and/or reinforcement bars will be procured in Bengaluru.

2-2-1-5 Policy of the Utilization of the Local Contractors and Consultants

The local Contractors in Bengaluru have enough ability in ordinary construction. The electrical construction companies in Bengaluru also have enough ability in common electrical works required for the Project.

2-2-1-6 Policy of O&M

(1) Demarcation of the O&M

After completion of the implementation of the system by the Project, the O&M of the system will be commenced by Indian side.

In conducting the O&M, the system of which DULT will be in charge is called the BTIC System and the system of which BTP will be in charge is called the TMC System. The component of these systems are shown in Table 2-2. The basic role of the parties for the O&M is summarized as shown in Table 2-3.

Table 2-2 The O&M Implementation Structure

ITS Component		System Name called for O&M	Charge of O&M
Traffic Information System	Centre System Probe System Queue Length Measurement System ATCC System Internet System	BTIC System (*1)	DULT
	VMS System	TMC System (*2)	BTP
Signal System			

(*1) BTIC System: Systems implemented by the project and operated at BTIC under DULT, consist of Centre System, Probe System, ATCC System, Queue Length Measurement System, Internet System and VMS System.

(*2) TMC System: Systems implemented by the project and operated at TMC under BTP, consist of Signal System and VMS System without existing systems of BTP.

(Source: JICA Study Team)

Table 2-3 Basic Role of the Parties for the O&M

Name	Basic Role
DULT	DULT is an Employer of the O&M Service and is in charge of securing the budget for O&M.
BTP	BTP is a representative of the employer for the O&M Service of TMC System.
Contractor	The Contractor who conducts the O&M Service.

(Source: JICA Study Team)

(2) Policy for Proper O&M

Efficient operation by the competent personnel after completion of the system is required for the signal system to exhibit its intended functions. Currently, BTP is in-charge of the O&M of the existing signal. However, there is no expert from the signal system that controls the traffic on real-time basis; thus, the existing signals are usually attended only when a malfunction occurs. No review is made for signal phasing and signal timing. The traffic information system is a system which automatically collects and processes the traffic information.

Therefore, the organization’s capability is required to be strengthened and the O&M need to be appropriately carried out. In order to realize this, (i) instructions on O&M will be provided by the Contractor and (ii) technical assistance for operations will be provided as soft component under the Project to gain required knowledge.

Furthermore, the maintenance shall be outsourced from either the supplier that delivers the system or the subcontractor of the supplier. This is for the purpose of obtaining the most efficient and appropriate maintenance through technical transfer to the parties that are equipped with sufficient knowledge in the details of the system.

2-2-1-7 Policy for Selection of Facility and Equipment

Malfunctions of devices and software of the centre system cause serious impact on the system, operation, and consequently traffic flow. Thus, high functionality and reliability are required. In particular, the traffic information system software and the signal system software are the key components of the system that determine the functionality and performance of the system.

For these reasons, Japanese products must be selected for control software and local controller for their reliability and functionality.

There is no restriction on the country of origin for servers and network devices as long as the product is made by reputable manufacturers and maintenance service is available in Bengaluru City.

The signal pole and signal cable can be procured in India as long as they comply with the specifications required.

2-2-1-8 Policy for Construction Method

The signal cable that connects the local controller to the lanterns at the intersections will be laid through the underground conduit that will be constructed.

The conduit line will be constructed by a horizontal auger method and no open cut method will be made. Thus, the traffic flow will not be affected and pavement will not be damaged.

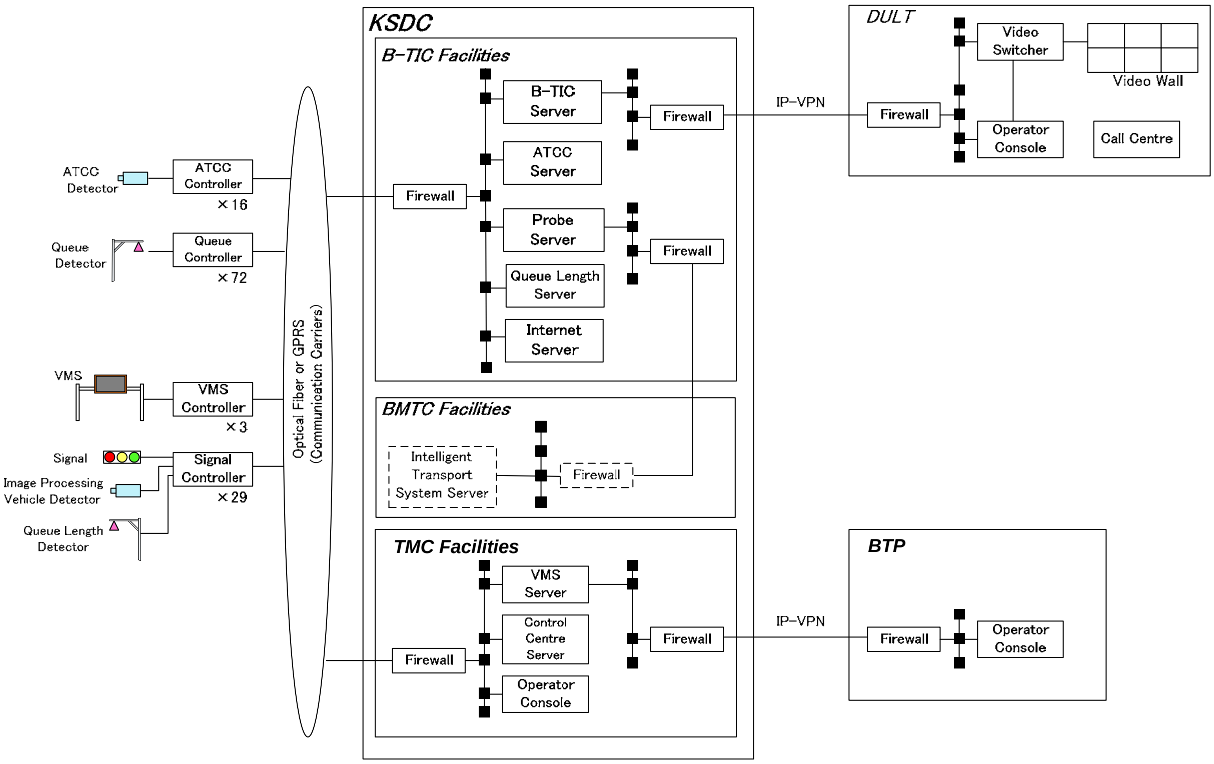
As the construction work needs a certain period, the work must start as early as possible, so as to ensure earlier completion than the signal installation work to avoid long construction time.

It has been confirmed that the above method has already been applied to some construction works in India and there are local companies that have capabilities and experiences in the said construction method.

2-2-2 Basic Plan

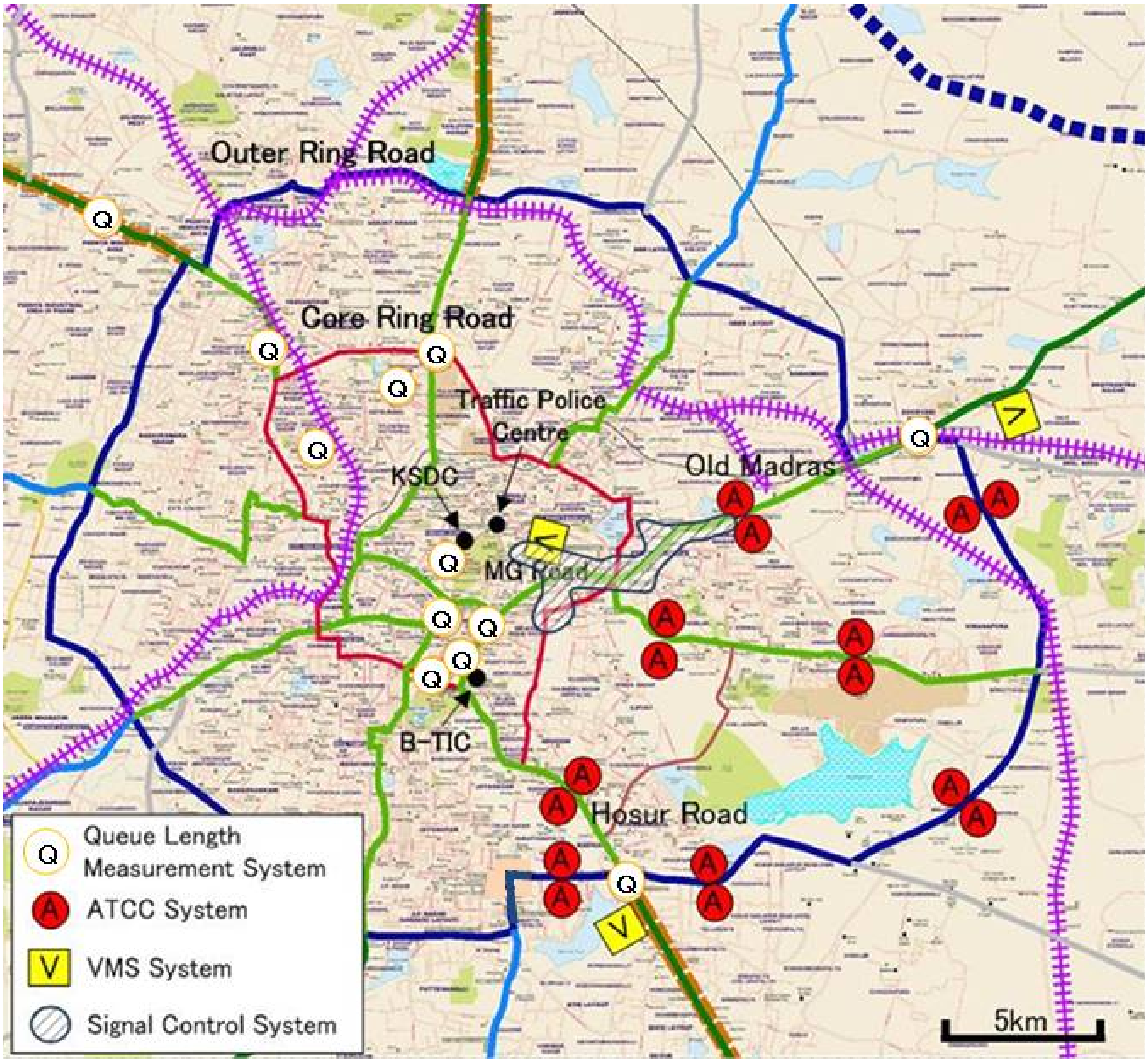
2-2-2-1 Overall Plan

The configuration of the system to be introduced by the Project is shown Figure 2-5. All system servers will be implemented in KSDC with high reliable network security. The overview of the installation locations of roadside equipment such as vehicle detectors, signals and VMS are shown in Figure 2-6. The data collected from roadside equipment will be accumulated and centrally managed in the servers.



(Source: JICA Study Team)

Figure 2-5 System Configuration



(Source: JICA Study Team)

Figure 2-6 Locations of Roadside Equipment

2-2-2-2 Traffic Information System

The traffic Information system will be introduced to achieve three objectives as described below.

- To disseminate the processed traffic information to road users.
- To utilize stored quantitative data for effective road transportation planning, and O&M.
- To share the information among related government agencies.

The traffic information system will comprise the following subsystems:

(1) Centre System

1) Purpose

The centre system aims to accumulate the traffic data from each subsystem for long period for a data analysis.

2) Basic Functions

The centre system shall have the following functions:

A) **Database Control Function**

The centre system shall have a function of storing the processed data by the database management system for around ten years for the statistical use and shall output the data with MS-Excel or equivalent file formats.

B) **Sub System Monitoring Function**

The centre system shall have a function of monitoring the operation of each sub-system of the traffic information system.

C) **Network Monitoring and Configuration Function**

The centre system shall have a function of monitoring the network of traffic information system using a network management protocol (SNMP or equivalent protocol).

D) **System Parameter Monitoring and Altering Function**

The centre system shall have a function of monitoring and setting the system parameters. All other subsystems can also monitor its own parameter but the centre system is the only one that can alter the parameters.

E) **Report Editing and Printing Function**

The centre system shall have a function of automatically editing and printing accumulated data as daily, monthly and annual reports. Also, these reports shall be editable by the operator.

(2) Probe System

1) Purpose

The probe system aims to collect the bus location data from 6700 buses of the Bengaluru Metropolitan Transport Corporation (hereinafter referred to as “BMTC”) equipped with GPS devices and to generate the traffic information for road users.

2) Basic Function

Probe system shall have the following functions:

A) **Information Receiving Function**

Probe system shall have the function of receiving the bus location data from the existing probe system of BMTC and the queue length data from the queue length measurement system. The frequency of receiving the data from BMTC shall be at one (1) minute interval. The data format shall be the CSV format or equivalent.

B) **Information Generating Function**

The probe system shall have a function of generating the traffic information that will be disseminated by the VMS system and the internet system. The probe system can generate the traffic information by map matching based on the received traffic data.

Especially at remarkable congested intersection, the queue length data shall be used as priority in generating the traffic information. The processing time is fifteen (15) minutes for collecting the probe data and five (5) minutes for the processing and dissemination. The information disseminated on the VMS board shall be updated at every five (5) minutes. These processes shall be executed with pipeline processing.

The traffic information generated by the probe system is as follows.

- Traffic condition data of each link (*1) and section (*2)
- Traffic information for displaying on the VMS
- Average travel time displayed on the VMS
- Traffic information for disseminating in the internet

(*1) Link: The distance of each link is considered approximately 100 meters. Actual distance will be determined by using a Digital Road Map.

(*2) Section: The section is composed of links. It is defined as the distance between a certain point to a major destination which displays the travel time in a schematic map that is to be displayed on the VMS.

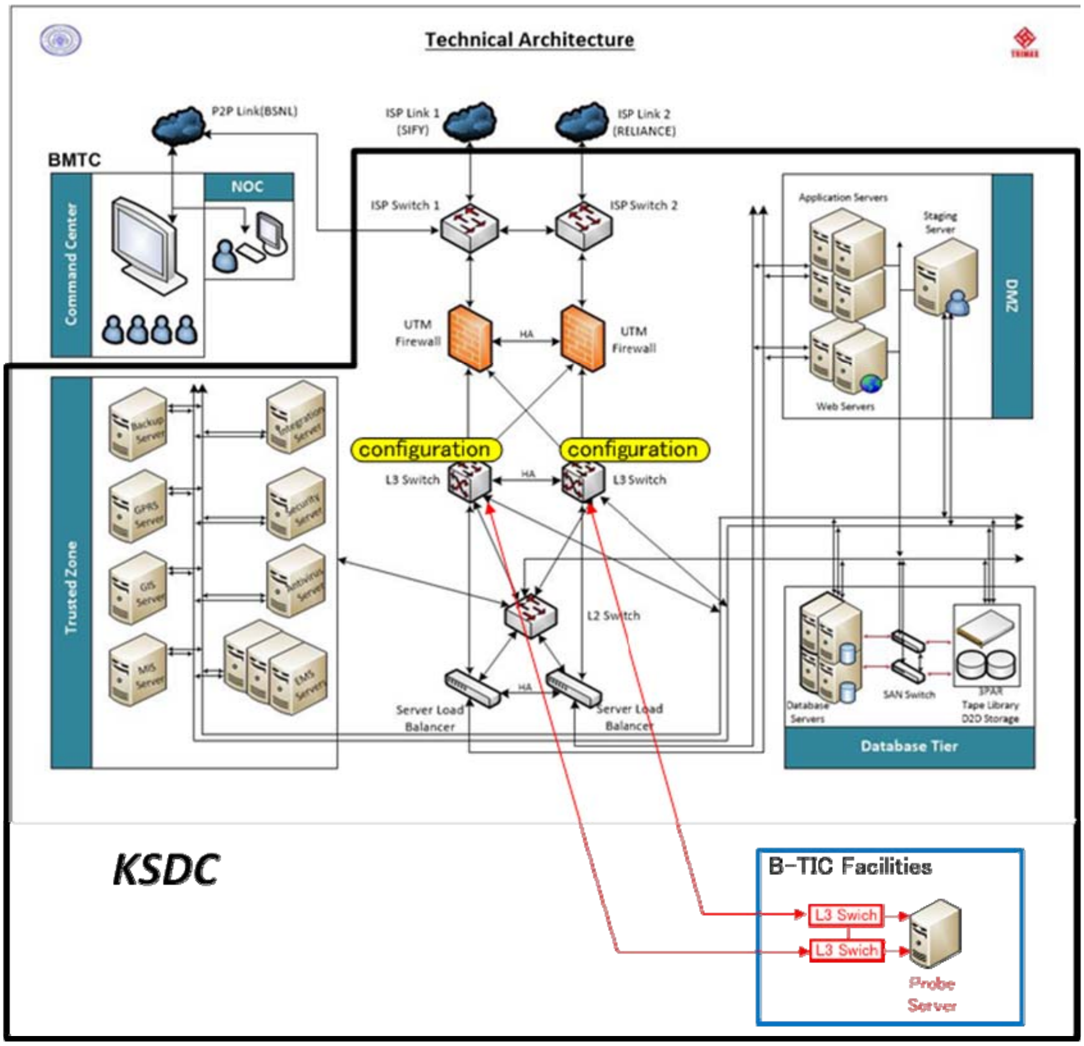
3) Bus Probe Data Correction Function

The bus stop location data shall be possible to be registered in the probe system. Based on the bus stop location data, the bus probe data shall be corrected and approximated to the data of general vehicles that would not stop at bus stops. In case that the location of the bus stop has changed it shall be enabled to update the old data by overwriting the data.

4) Data Transmission from BMTC Probe System to Our Probe System

The network configuration between the BMTC probe system and our probe system is shown in Figure 2-7. The BMTC prove system collects the bus probe data every ten (10) seconds. The BMTC probe system will transmit the probe data for the latest six (6) times to our probe server every sixty

(60) seconds. Partial modifications of the BMTC probe system will be required for the transmission. It is agreed that BMTC will conduct the required modification in their budget. Also, BMTC allows DULT to use their bus probe data.



(Source: JICA Study Team)

Figure 2-7 Network Configuration relating to Probe System

5) Data Format Transferred from BMTC

The data format transferred from BMTC is shown in Table 2-4. The BMTC server transfer the data to the probe server as CSV.

Table 2-4 Data Format of BMTC Server

Sr. No.	Data Name
1	Header
2	Device Serial Number
3	Packet Code
4	Miscellaneous Byte
5	Ignition Status
6	Accumulated Distance (in meters)
7	Signal Strength
8	Country Code
9	Network Code
10	Location Area Code
11	Cell ID
12	Number of Satellites in view
13	External Battery Voltage
14	Internal Battery Voltage
15	Sensor Information
16	Digital Input
17	Digital Output
18	Analog Input
19	Maximum Speed
20	String Heading
21	GPS Device Time
22	Long Lat Info
23	GPS Device Date
24	String
25	Server Date and Time

The longitude and latitude information of buses

(Source: JICA Study Team)

(3) Queue Length Measurement System

1) Purpose

The queue length measurement system aims to grasp the congestion level by determining the queue length. The queue length is determined by calculating the consecutive vehicle occupancy from the stop line at the intersection to the installation position of detectors. Vehicle detectors shall be installed at points of 300m, 600m, and 900m backward from the stop line of target intersections.

2) Basic Function

The queue length measurement system shall have the following functions:

A) Information Receiving Function

The queue length measurement server shall receive following data from vehicle detectors installed at roadside every sixty (60) seconds.

- Number of passing vehicle
- Time occupancy rate
- Equipment status

B) Information Generation Function

The queue length measurement server shall aggregate the collected data of one (1) minute period in a data of five minutes period and generate the following three kinds of data. The generated data shall be transferred to the probe server every five (5) minutes.

- Traffic volume
- Average occupancy
- Average queue length

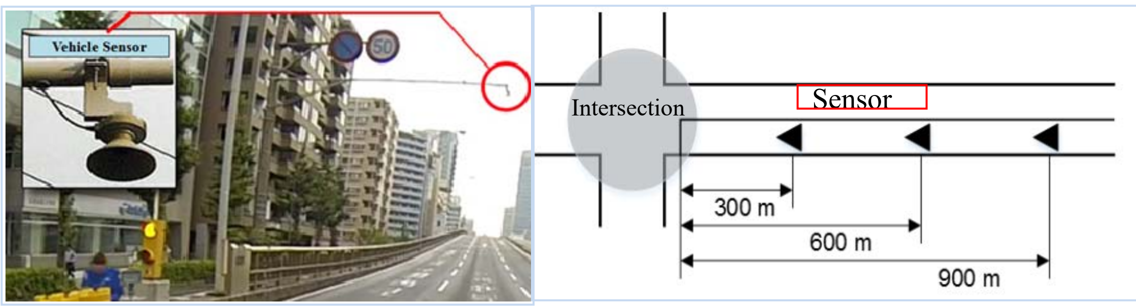
C) Information Storing Function

The queue length measurement server shall compile the generated data per hour, day and month and store the data in a certain period (about three months or more). The data beyond keeping period is erased from oldest order and the data should be stored in storage devices of the centre system. The store data is capable of outputting as files (MS Excel etc.).

3) Installation Policy of the Vehicle Detector (Ultrasonic Type)

For the measurement of queue length, the ultrasonic type vehicle detectors shall be installed at 300 m, 600 m, and 900 m backward from the stop line of target intersections.

The vehicle detector sensors shall be placed in a way that allows it to monitor passing vehicles on an overtaking lane.



(Source: JICA Study Team)

Figure 2-8 Image and Installation Policy of Vehicle Detector (Queue Length Measurement System)

(4) Automatic Traffic Counter-cum-Classifier System (ATCC System)

1) Purpose

The ATCC system aims to collect the traffic volume and the average vehicle speed to grasp the traffic situation. The vehicle detectors of ATCC system shall be installed at the middle point of the major intersections on arterial roads to collect the traffic data.

2) Basic Function

The ATCC system shall have the following functions:

A) **Information Receiving Function**

The ATCC server shall receive the following data from the vehicle detector every sixty (60) seconds.

Traffic volume of large / small-size vehicle

- Average vehicle speed
- Equipment status

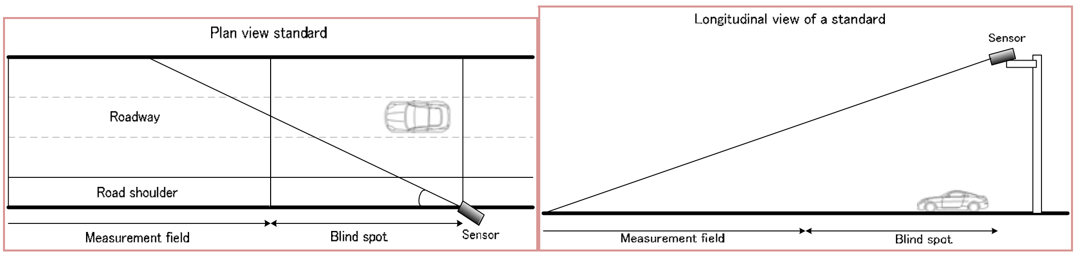
B) **Information Storing and Controlling Function**

The ATCC server processes the one-minute measured data into a five-minute data. The traffic volume will be a sum of the five one-minute data. The vehicle speed data will be the arithmetic average of the five one-minute data. The five-minute traffic volume data will be accumulated as one-hour data and the one-hour data as a 24-hour data.

All processed data will be stored in the ATCC server and the data will be transferred to the centre system. The centre system stores data for ten (10) years to be analysed for future usage.

3) Installation Policy of the Vehicle Detector (Image Processing Type)

The installation location will be selected from the place where the measurement area can be secured using an image processing method taking into consideration the traffic situation at site that the vehicles do not follow the lane. The installation policy of the ATCC System is shown in Figure 2-9.



(Source: JICA Study Team)

Figure 2-9 Installation Policy of Traffic Counter (ATCC System)

(5) Variable Message Sign System (VMS system)

1) Purpose

The VMS system aims to disseminate the traffic information generated by the probe systemby displaying it on the VMS board.

2) Basic Function

VMS system shall have the following functions:

A) **Information Receiving Function**

The data processed by the probe server shall be received by the VMS server every five minute.

B) **Information Generation Function**

The traffic information data received from the probe system shall be converted into the data for displaying it on the VMS board.

C) **Information Distribution Function**

The traffic information data generated by the VMS system can be displayed on the VMS board and it shall be updated every five (5) minutes.

D) **Information Storing and Controlling Function**

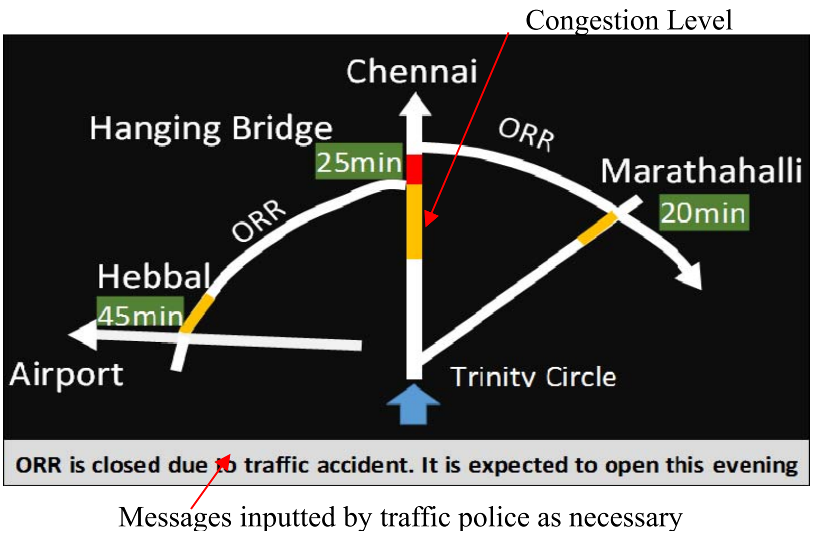
Collecting data transferred to the VMS and operation log by hour, day and month should be kept in a certain period (ten (10) years or more) as file data.

3) Image of dissemination by the VMS system

A multi-display type message board will be adopted. The board will have a schematic road map and message display line. The congestion level on the major roads and estimated time to the major destinations ahead will be displayed on the schematic road map. The information to be displayed will be processed by the probe server of the traffic information system and automatically transferred to the VMS server under BTP.

The operator at BTP will manually input necessary message such as traffic event and the message will be displayed on the message display line on the board.

Figure 2-10 shows an image of the VMS board and the information to be displayed.



(Source: JICA Study Team)

Figure 2-10 Example of VMS (MG Road at Trinity Metro Station)

(6) Internet System

1) Purpose

To disseminate the road/traffic information processed by the probe server to users on a real-time basis on the Internet.

2) Basic Function

Internet system will be equipped with the following functions:

A) **Information Receiving Function**

The data processed by the probe server should be received at a five-minute interval.

B) **Information Distribution Function**

The traffic information data transferred to the Internet. It updates every five (5) minutes.

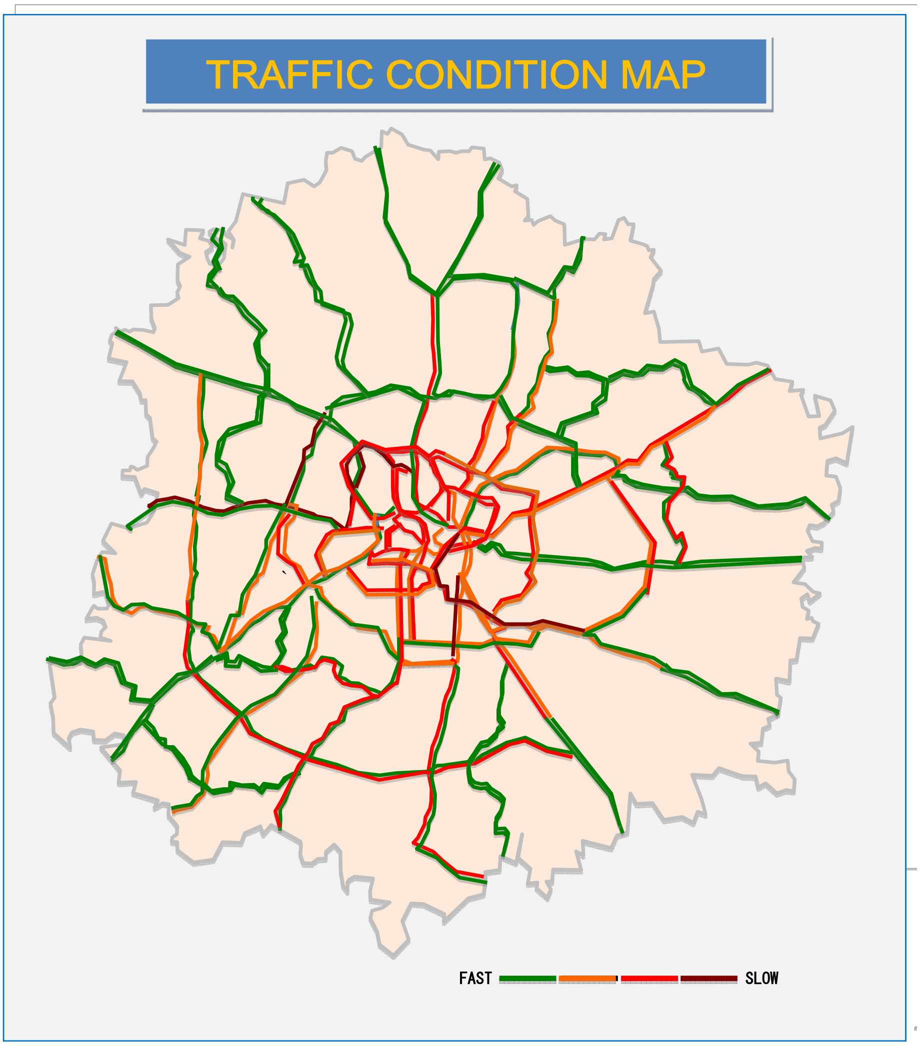
C) **Information Store and Control Function**

Collecting data transferred to the VMS and operation log by hour, day, month should be kept in a certain period (three months or more) as file data. The data beyond keeping period is erased from oldest order and the data should be stored in storage devices of the BTIC server. The data also include operation information. The store data is capable of output as files (MS Excel etc.).

3) Image of dissemination by the Internet system

The congestion level on the major roads in Bengaluru will be shown on the road map and provided through Internet. Other information like accidents or major events, such as road closure and construction works, that are considered to have an impact on traffic in the city will also be displayed as necessary.

Figure 2-11 shows an image of the Internet information to be displayed.



(Source: JICA Study Team)

Figure 2-11 Image of Internet Information Provision

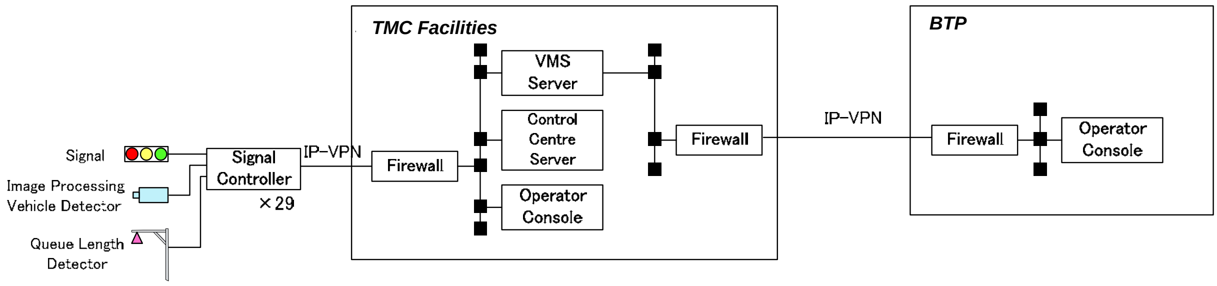
2-2-2-3 Signal System

(1) Purpose

A mismatch between an actual traffic demand and a current signal phase setting contributes to the significant traffic congestion in Bengaluru city. The signal system automatically controls optimal signal timing according to the actual traffic volume measured by roadside sensors. Controlling optimal signal timing mitigatestraffic congestion and normalize traffic flow.

(2) System Configuration

System Configuration of the signal system is shown in Figure 2-12.

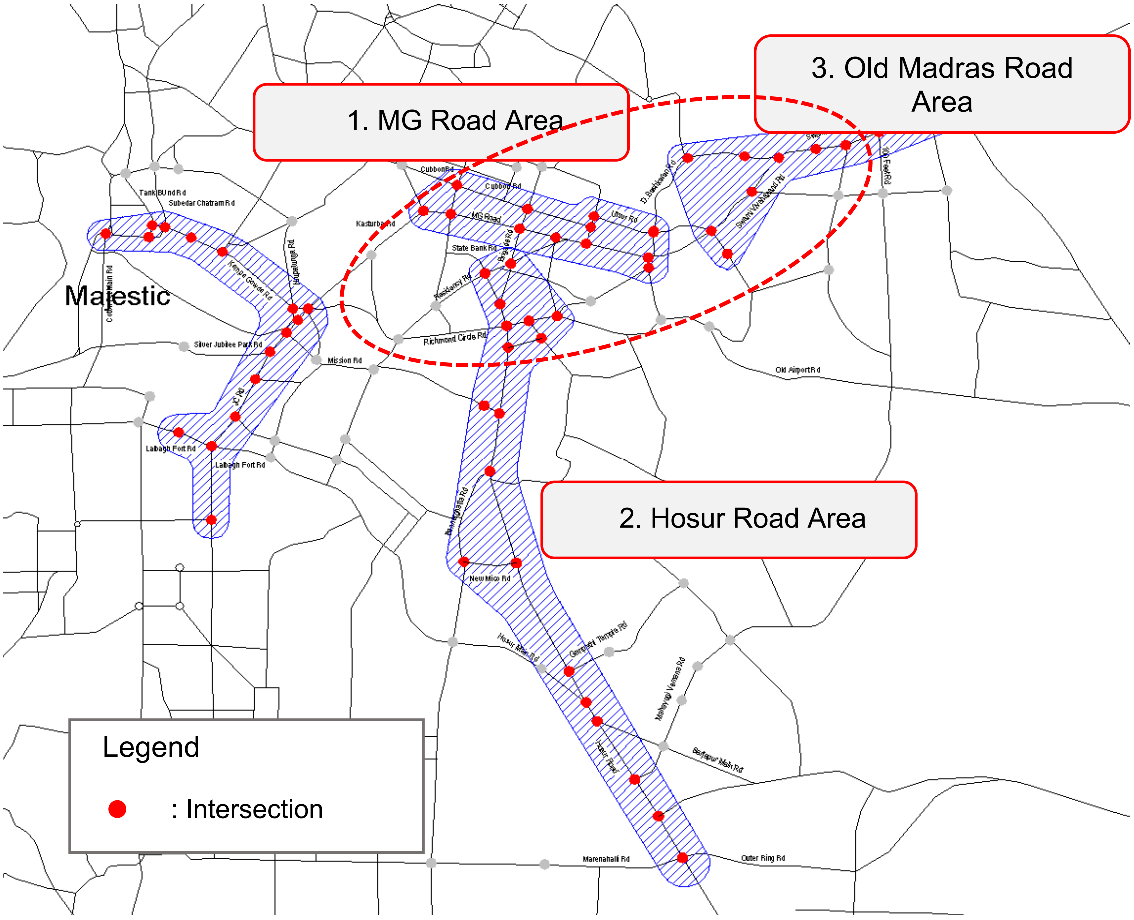


(Source: JICA Study Team)

Figure 2-12 Signal System Configuration

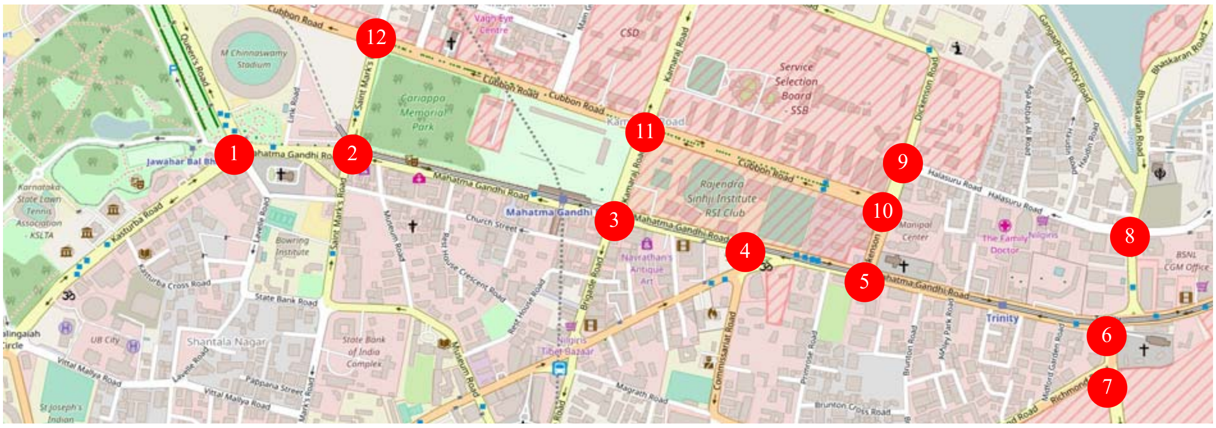
(3) Target Intersections

Twenty-nine target intersections were selected from the MG Road Area (twelve (12) locations), Hosur Road Area (nine (9) locations), and Old Madras Road Area (eight locations) because they have strong traffic demand and are enough successive to make the most of the effect of the signal system. The target section is shown in Figure 2-13. More detailed locations of each area are shown in from Figure 2-14 to Figure 2-16.



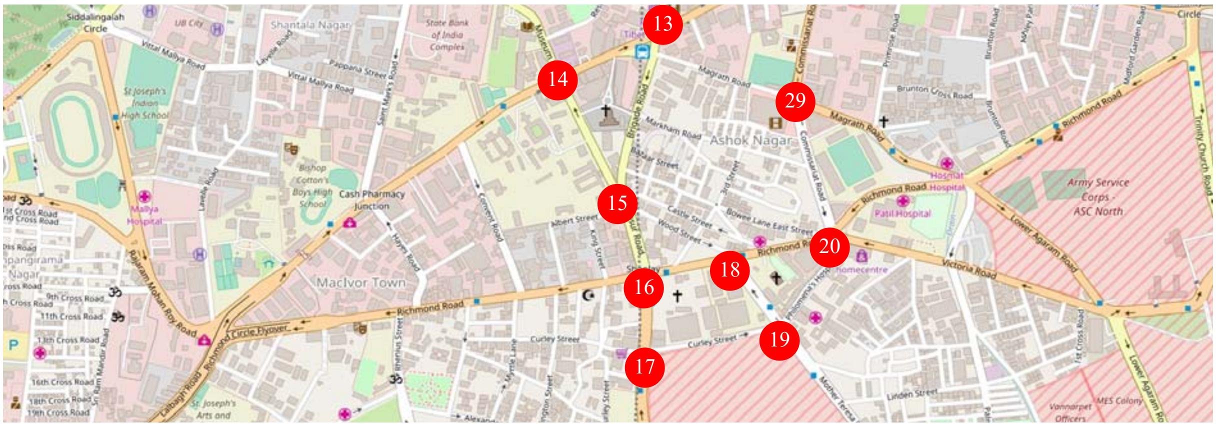
(Source: JICA Study Team)

Figure 2-13 Selected Target Intersections in Bengaluru



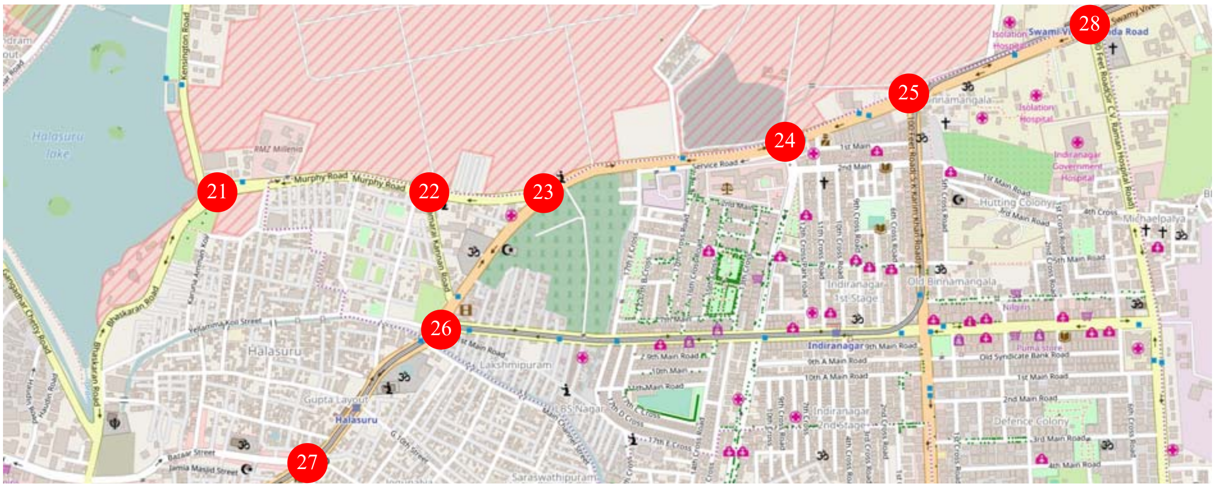
(Source: JICA Study Team)

Figure 2-14 Selected Target Intersections in MG Road Area



(Source: JICA Study Team)

Figure 2-15 Selected Target Intersections in Hosur Road Area



(Source: JICA Study Team)

Figure 2-16 Selected Target Intersections in Old Madras Road Area

The list of the details of each intersection are shown in Table 2-5.

Table 2-5 List of Details of Target Intersections

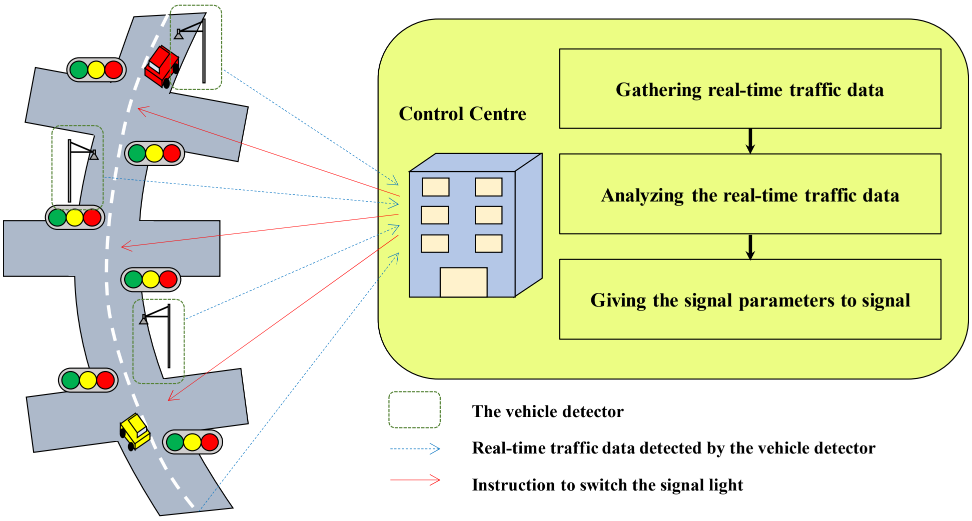
No.	Name of Cross Road or Intersection Name			Dir	Area
1	Queens Rd	Kasturba Rd	MG Rd	5	MG Road
2	MG Rd	St Marks Rd		4	MG Road
3	MG Rd	Kamraj Rd	Brigad Rd	4	MG Road
4	MG Rd	Commisionrate Rd	Preseidency Rd	3	MG Road
5	MG Rd	Dickenson Rd		3	MG Road
6	Trinity Circle			4	MG Road
7	General KS Thimayya Rd	Trinity	Church Rd	3	MG Road
8	Kensington Rd	Ulsoor Rd	Bazaar St	4	MG Road
9	Dickenson Rd	Ulsoor Rd		3	MG Road
10	Cubbon Rd	Dickenson Rd		3	MG Road
11	Kamraj Rd	Cubbon Rd		4	MG Road
12	Central St	Cubbon Rd		4	MG Road
13	Residency Rd	Brigade Rd		4	Hosur Road
14	LIC India Circle			4	Hosur Road
15	Musuem Rd	Brigade Rd		4	Hosur Road
16	Brigade Rd	Hosur Rd	General KS Thimmaya Rd	4	Hosur Road
17	Leona Rd	Campbell Rd	Hosur Rd	4	Hosur Road
18	Generak KS Thimmaya Rd	Wood St	Mother Teresa Rd	4	Hosur Road
19	Mother 2-22eresa Rd	St. Philomena Rd	Campbell Rd	4	Hosur Road
20	VictoriaRd	General Ks Thimmaya Rd	St Philemena	5	Hosur Road
21	Kensington Rd	D Bhaskaran Rd		3	Old Madras Road
22	D Bhaskaran Rd	Thamarai kannad rd		3	Old Madras Road
23	Swami Vicekanand Rd	D Bhaskaran Rd		3	Old Madras Road
24	Swami Vivekananda Rd	Paramahansa Dayanand Rd		3	Old Madras Road
25	Swami Vivekananda Rd	100 Ft Road		3	Old Madras Road
26	Swami Vivekananda Rd	Yellaman 2nd Cross Rd	Chinmaya Mission Hospital Rd	4	Old Madras Road
27	Swami Vivekananda Rd	Cambridge Road-Bazaar St		4	Old Madras Road
28	Swami Vivekananda Rd	80 Ft Rd		3	Old Madras Road
29	Commissariat Rd	Magrath Rd		4	Hosur Road

(Source: JICA Study Team)

(4) Basic Concept of Signal Control

1) Basic System Configuration

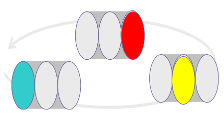
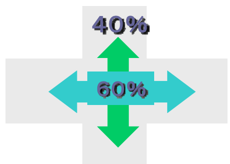
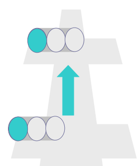
The traffic condition varies depending on various factors such as time or day (rush-hour, normal-hour, off-hour, holiday, weekday, etc.). In order to alleviate traffic congestion and reduce the number of traffic accidents it is important to optimize the signal control based on the current traffic condition. The traffic control center gathers the real-time traffic data from the vehicle detectors on the road. Then the central computer analyzes the data and gives the appropriate signal parameters to each signal. Figure 2-17 summarizes the basic system configuration. There are 3 fundamental parameters of traffic signal: Cycle, Split and Offset shown in Table 2-6.



(Source: JICA Study Team)

Figure 2-17 Basic System Configuration

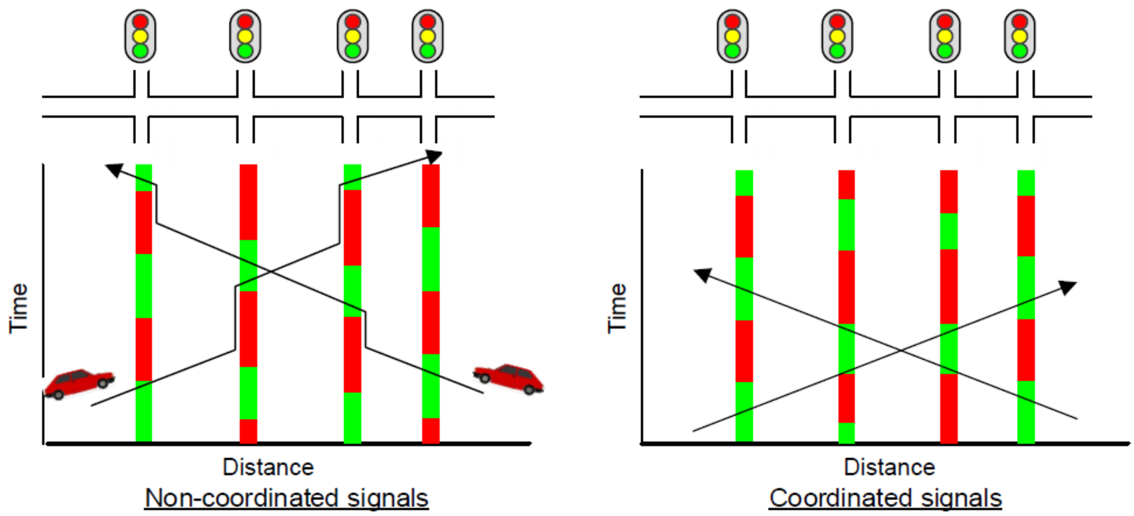
Table 2-6 Fundamental Signal Parameters

Cycle	Split	Offset
		
Time required for a complete sequence of indications e.g. from green indication to next green indication.	Portion of time allocated to each phase within a cycle at an intersection.	Time difference of coordinated phases between two traffic signals.

(Source: JICA Study Team)

2) Signal Coordination

Signals installed at short distance need to be coordinated to offer green wave, in which vehicle that has passed an intersection during green will be given green at next signal to allow the vehicle to pass through next intersection without stopping. The reduction of waiting time at signals is illustrated in Figure 2-18. To provide green wave, neighboring two signals must operate with the same cycle length and they must be coordinated.



(Source: JICA Study Team)

Figure 2-18 Signal Coordination

(5) Required Measures: Reduction of Congestion Length and Area-wise Control

As shown in the「(3) Target Intersections」, the sections of MG road, Old Madras road and Hosur road in the core area of the city and adjacent areas of these sections are selected as the target area for the signal system. These roads, MG road, Old Madras road and Hosur road, are major trunk roads in Bengaluru. In particular, the congestion is severe on the sections of these roads in the core area of the city. It is critical to reduce the congestion length on this target areas. It is also important that the traffic flow in the adjacent areas with chronic congestion shall be smoothened, synchronizing with these trunk roads by 'area-wise control'. For example, it will be more effective to synchronize the signals on Gabon road running in parallel with MG road and in the areas in the vicinity of Brigade road.

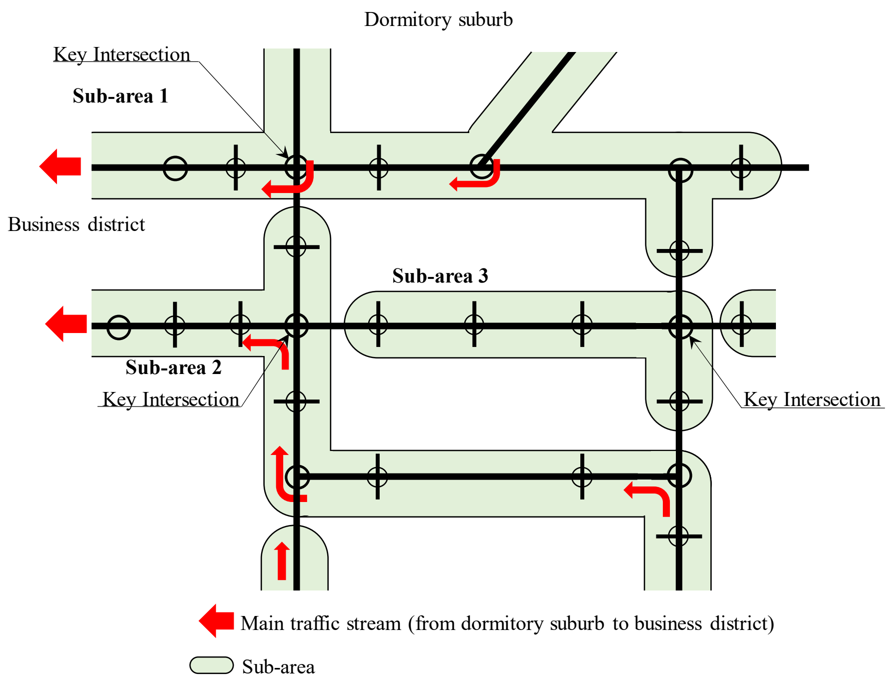
Therefore, reducing congestion length on these target areas by area-wise control is important.

1) Area-wide Signal Control

A) Area Segmentation

Regarding the wide area (e.g. Bengaluru city), it includes various areas which are in different traffic conditions. For the area-wide signal control it is essential that the signal control is conducted by small area in an analogous the feature of traffic.

The system makes a sub-area and conducts the signal control by the sub-area adapting to the feature of the traffic condition of each area. Figure 2-19 shows the example of the sub-area (sub-area 1~3). The sub-area is composed of key intersections which is on an arterial road and other normal intersections.



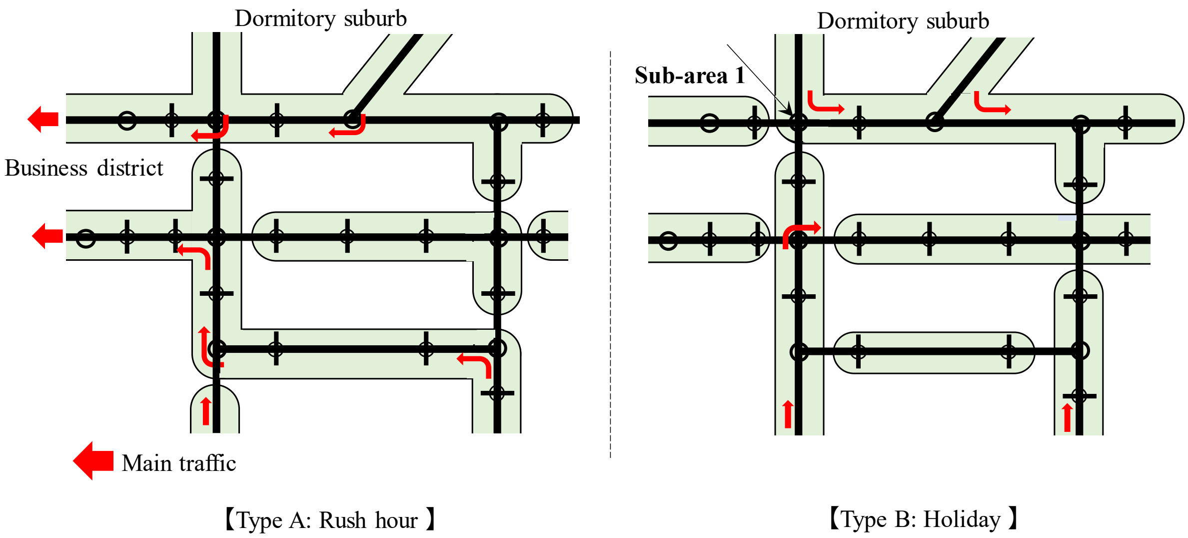
(Source: JICA Study Team)

Figure 2-19 Example of Sub-areas

B) Dynamic Transition of Sub-area

The traffic condition varies depending on even a period of time in a day. In order to adapt to the temporal variation of traffic condition, the system dynamically changes the conformation of the sub-area by integrating and cutting off sub-areas.

The example of the dynamic transition of the sub-area is shown in Figure 2-20. Type A is the conformation in a rush hour. In the rush hour neighboring sub-areas are connecting along the main traffic stream (from dormitory suburb to business district). On the other hand, in holiday they are connecting along the main traffic stream (from dormitory suburb to resort area).

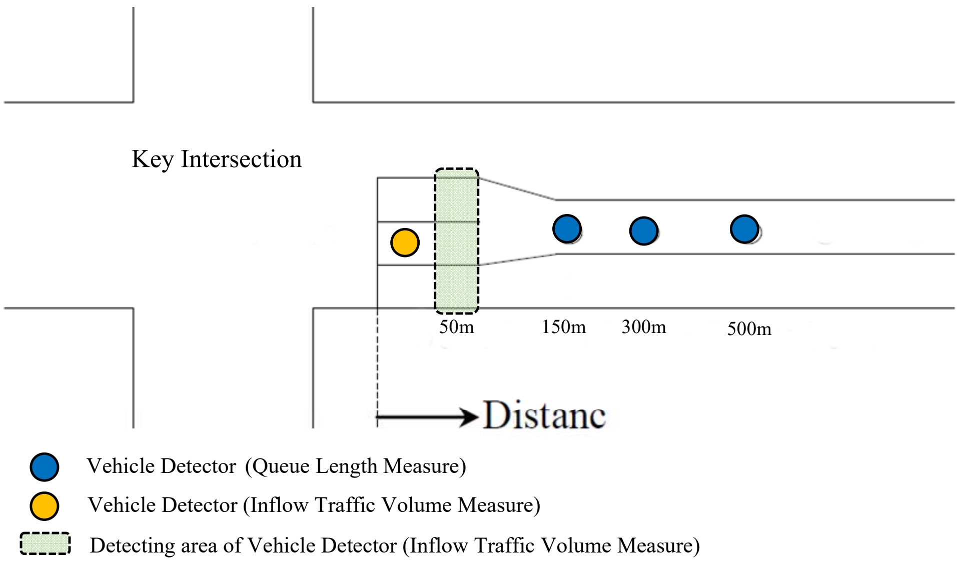


(Source: JICA Study Team)

Figure 2-20 Transition of Sub-area

2) Decrease of Queue Length

When congestion occurs the decrease of queue length is also essential for the signal control. The system controls signal to decrease the queue length based on the detection of it. The vehicle detector (Queue Length Measure) is installed at the point of about 150 m, 300 m, and 500 m (maximum) away from the key intersection and measures how long the queue is running. The vehicle detector (Inflow Traffic Volume Measure) is installed at close roadside to the key intersection and detects the inflow volume around the traffic lane 50 m away from the key intersection. Figure 2-21 shows the configuration of queue length measurement.



(Source: JICA Study Team)

Figure 2-21 Configuration of Queue Length Measurement

(6) Vehicle Detector

1) Type of Vehicle Detector

The type of vehicle detector for the real-time vehicle detection is shown in Table 2-7.

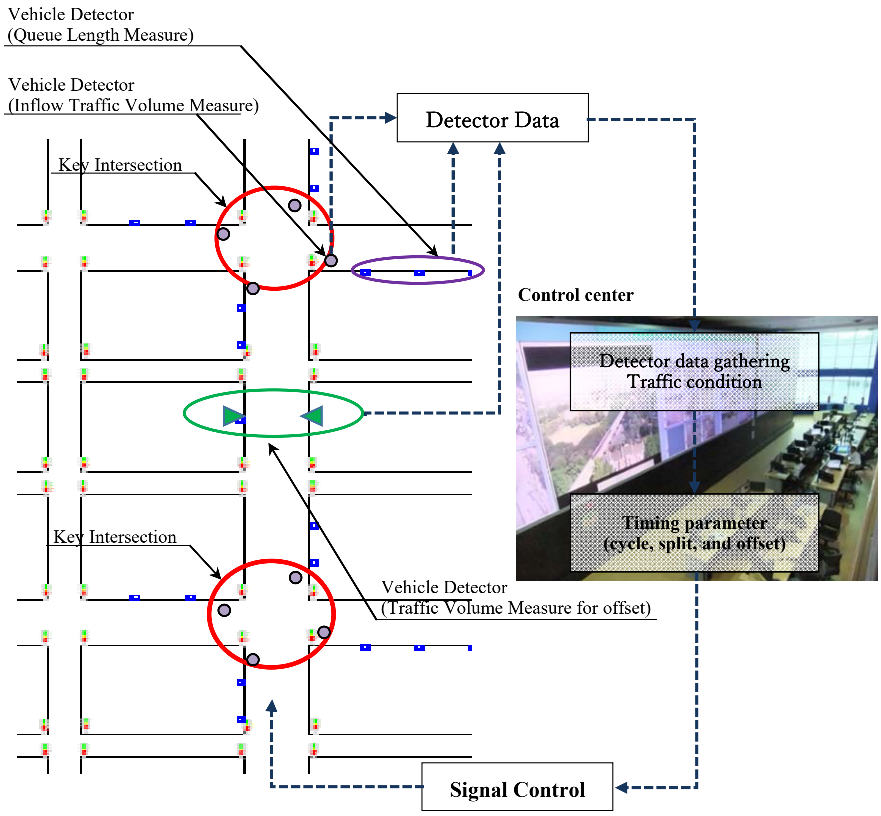
Table 2-7 The list of Vehicle Detector

Type	Function and Installation
Vehicle Detector (Queue Length Measure)	It measures the queue length heading to the key intersection. It is installed roadside at the point of about 150 m, 300 m, and 500 m (maximum) away from the key intersection.
Vehicle Detector (Inflow Traffic Volume Measure)	It measures the inflow traffic volume at the close roadside to key intersection. It is installed adjacent roadside of Key intersection.
Vehicle Detector (Traffic Volume Measure for Offset)	It measures the traffic volume for the setting of offset time. It is installed at the middle point between two key intersections.

(Source: JICA Study Team)

2) Configuration

The configuration of vehicle detectors is shown in Figure 2-22.

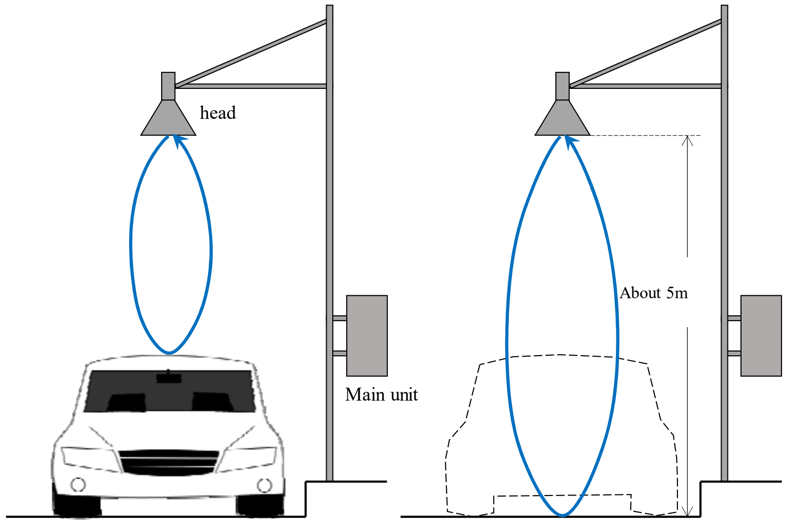


(Source: JICA Study Team)

Figure 2-22 Configuration of Vehicle Detectors

3) Equipment

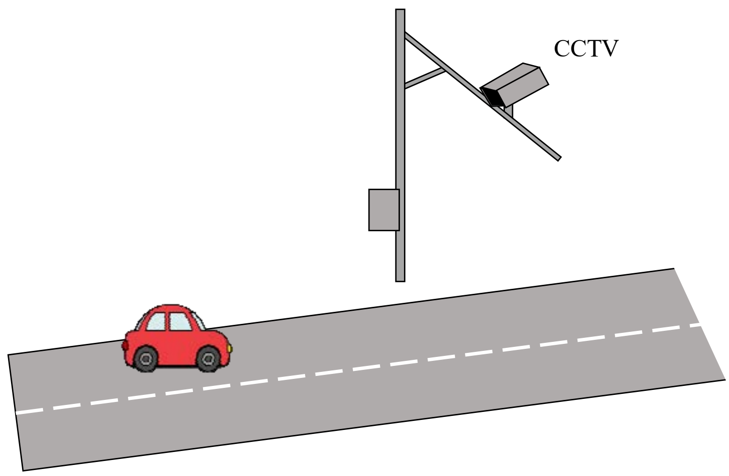
The ultrasonic sensor shown in Figure 2-23 is used for the vehicle detector (Queue Length Measure) and the vehicle detector (Traffic Volume Measure for offset). It detects the vehicle by calculating the reflecting time of ultrasonic. The CCTV sensor shown in Figure 2-24 is used for the vehicle detector (Inflow Traffic Volume Measure). It detects vehicles flowing at intersection by image processing.



・Vehicle Detector (Queue Length Measurement)
・Vehicle Detector (Traffic Volume Measurement for offset)

(Source: JICA Study Team)

Figure 2-23 Image of Ultrasonic Sensor



・Vehicle Detector (Inflow Traffic Volume Measurement)

(Source: JICA Study Team)

Figure 2-24 Image of CCTV Sensor

4) Communication Method of Traffic Signal at Intersection

A) Wi-Fi Communication or Fixed Line Communication

There is a discussion as to which type of communication method, either Wi-Fi connection or fixed line connection, shall be applied to traffic signal at intersection. The communication method of traffic signal at intersection is shown in Figure 2-25.

The fixed line connection needs to be applied due to the following reasons;

- Critically high reliability and instantaneousness are required for communication between controller and signals at intersection.
- All signals need to be synchronized (Green, Yellow, Red). There is a chance that the delay occurs at any of the signals due to transmission delay by Wi-Fi communication.
- There is a possibility that Green is indicated by all signals due to transmission delay by Wi-Fi connection. (Green will be blinked by fail-safe function in this case)
- The signal is usually controlled by one second. It is difficult to control by one second by Wi-Fi connection.

B) Aerial Cable or Buried Cable

The buried cable is recommended due to the following reason:

- The aerial cable spoils sight view.
- The aerial cable is exposed to danger of being disconnected.

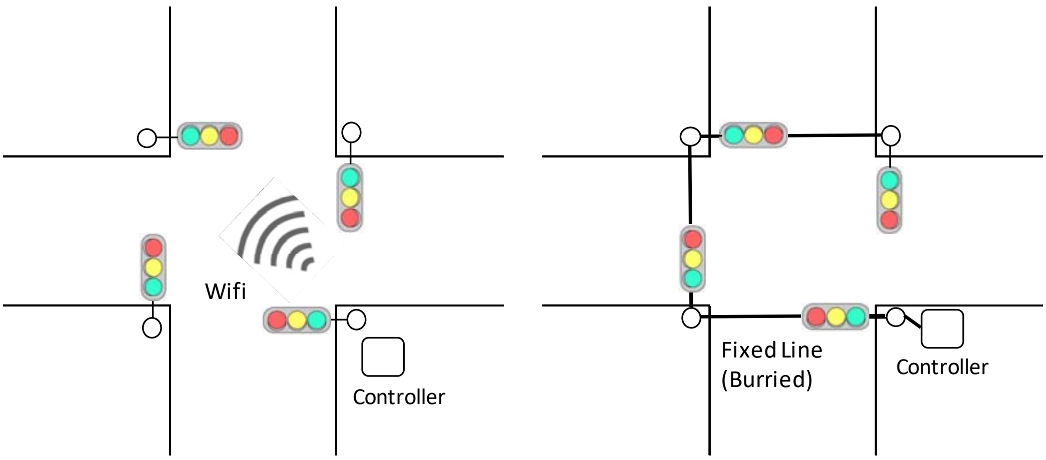


Figure 2-25 Communication Method of Traffic Signal at Intersection

2-2-2-4 Connectivity and Procurement of Equipment for Expansion

(1) Signal System

1) Expansion of the Signal System Server

The signal system server which will be procured by the Project is based on the Universal Traffic Management System (UTMS), and is capable of controlling signals of 128 intersections. Thus, the signal system server is capable of expansion from 29 intersections in the Project to 128 intersections, and software modification of the signal system server is not necessary even if the signals are additionally procured. It's also possible to expand the number of intersection into more than 128 only by adding an auxiliary equipment to the signal system server.

2) Expansion of Roadside equipment

A) **Signals and Signal Sensors**

The Indian local companies could manufacture the signals and sensors (ultrasonic type) by themselves because the interface (controller to signals and sensor) conforms to the international standards. When adopting the local products, we should carefully consider the quality and reliability.

The interface between the signal controller which control the signals and the signal sensors and the signal system server is based on international standard (ISO 14827-1, 2 and ISO 15784).

B) **Signal Controllers**

The interface between the signal controllers and the signals/vehicle detectors is based on international standard (ISO 14827-1, 2 and ISO 15784) and the functional requirement is seen in the specifications. Therefore, it is possible for many companies to manufacture the controllers.

If additional procurement is necessary in the immediate term, the controllers can be purchased from several different Japanese companies. It is also possible that Japanese companies provide the main parts to the local Indian companies so that the controllers will be locally manufactured by the OEM.

The additional controllers can be connected to the signal system server without modification of the signal system.

(2) Traffic Information System

1) Expansion of Queue Length Measurement System and ATCC System

The interface between the vehicle detectors (ultrasonic method) of queue length measurement system and the vehicle detectors (image recognition method) of ATCC System is based on international standard (ISO 14827-1, 2 and ISO 15784).

The Indian local companies could manufacture the sensors (ultrasonic method) by themselves because the interface (controller to signals and sensors) conforms to the international standards. When adopting the local products, we should carefully consider the quality and reliability.

2) Expansion of VMS System

In general, the VMS system is based on American standard; NTCIP for ITS Protocol, which is adopted by India already. The VMS system in the grant aid project is also based on this standard.

The Indian local companies could manufacture the VMS by themselves and OEM. When adopting the local products, we should carefully consider the quality and reliability. The Indian local companies have already manufactured according to NTCIP.

2-2-2-5 Intersection Improvement Policy

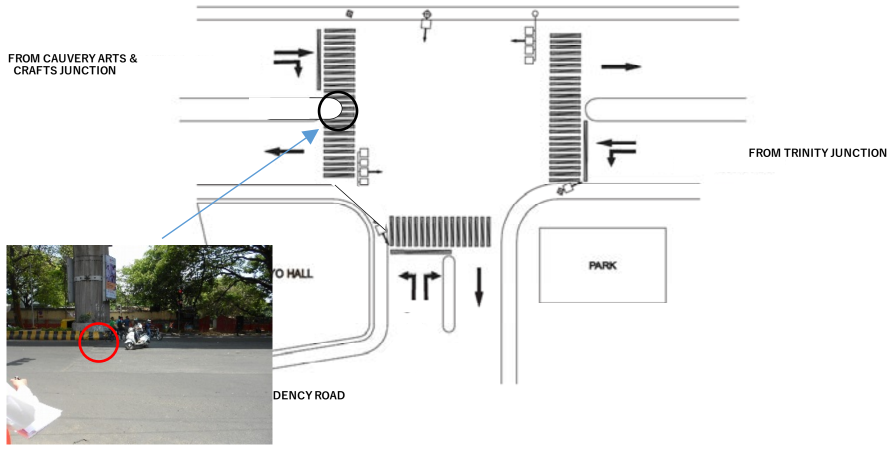
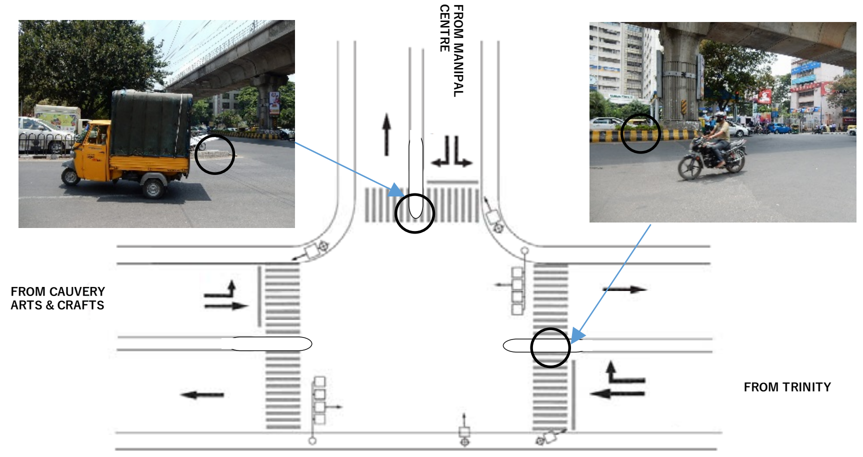
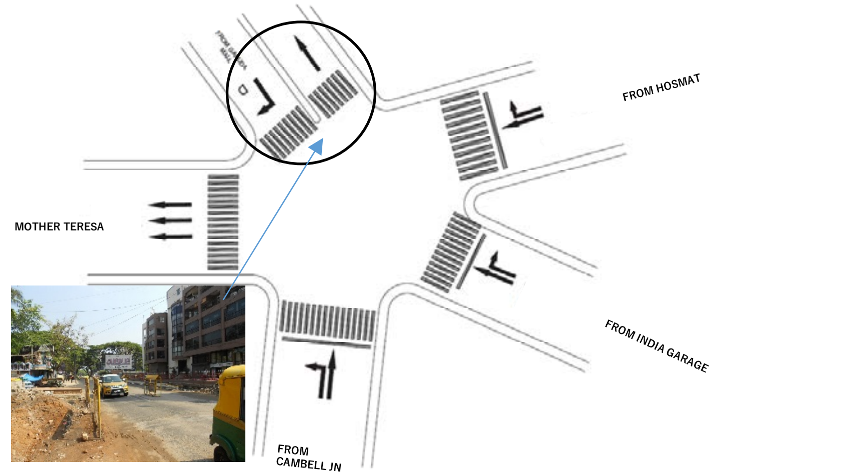
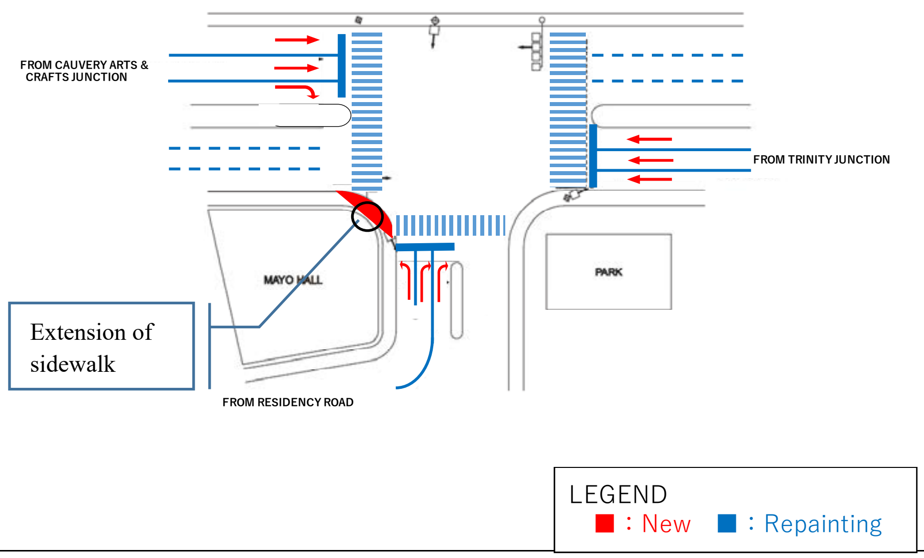
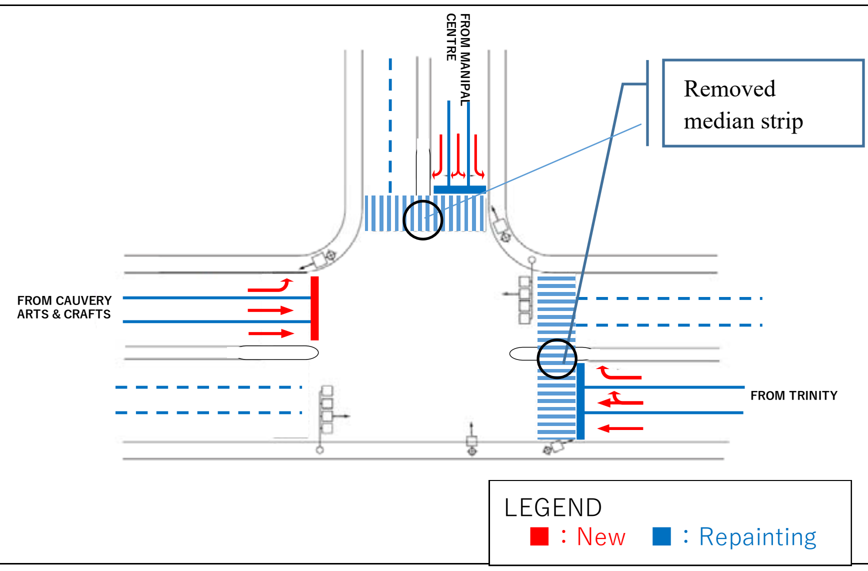
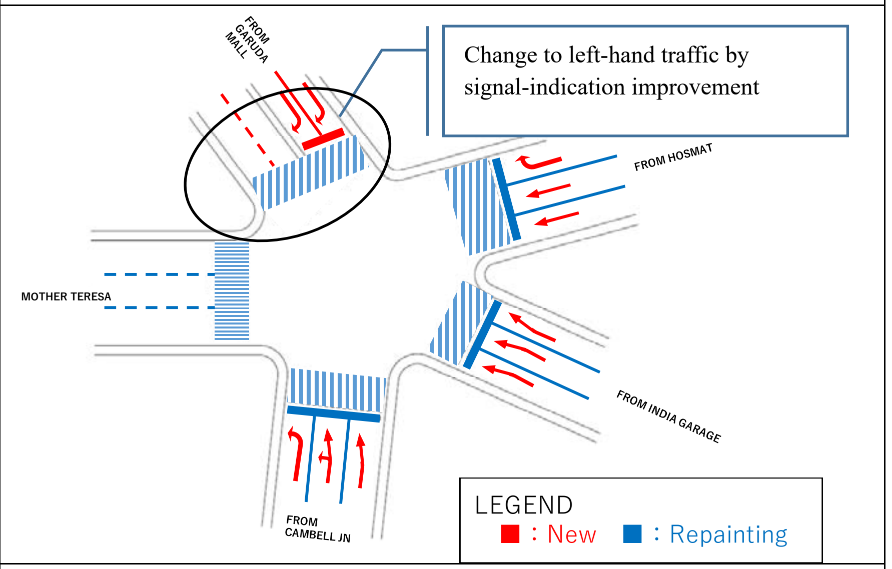
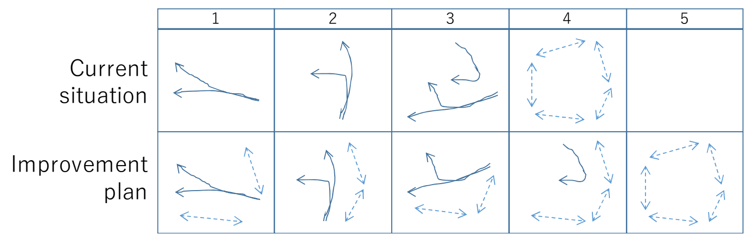
(1) Concept of Intersection Improvement

The intersection improvement consists of the signal improvement and the intersection improvement. The component of the intersection improvement is shown in Table 2-8. The intersection improvement policy and method is shown in Table 2-9.

Table 2-8 Component of the Intersection Improvement

Item	Concept of the Improvement
Signal Improvement	(1) Improvement by cycle length change and signal phase combination, (2) Ensuring safety, (3) Ensuring sufficient time for pedestrian to cross
Intersection Improvement (To enhance the signal-improving effect)	(1) Improving markings (e.g., zebra crossing, lane, direction arrow) (2) Splitting lane, (3) Extending sidewalk space, (4) Removing obstacles, (5) Other minor improvements

Table 2-9 Intersection Improvement Policy and Improvement Method (Examples)

	No. 4 MG Road- Commissariat Road-Residency Road	No.5 MG Road-Dickenson Road	No. 20 Victoria Rd-General KS Thimayya Rd-St Philomena
Current Situation			
Improvement Plan			
Issue	Pedestrian crossing is blocked by obstacles Crossing time is too short for pedestrian Pedestrian signal is invisible	Pedestrian crossing is blocked by obstacles Crossing time is too short for pedestrian Pedestrian signal is invisible	There is a section where right-hand traffic is applied Crossing time is too short for pedestrian
Content	To change the pedestrian crosswalk location by sidewalk extension To make road markings including pedestrian crossing, lane, stop line and direction arrow	To remove median To make road markings including pedestrian crossing, lane, stop line and direction arrow	To change to the left-hand traffic by signal phase improvement as shown below  To make road markings

(Source: JICA Study Team)

(2) Summary of Intersection Improvement

The road marking works will be carried out at all 29 intersections. As well as, sidewalk maintenance work by curbing stone and the removing of median strip that will be carried out at some intersections. The summary of intersection improvement is listed in Table 2-10.

Table 2-10 Summary of Intersection Improvement

	Road Marking Work								Subtotal (m2)	Sidewalk Construction (Curb block is included) (m3)	Removal of Sidewalks (m3)
	Crosswalk (*1) (m2)		Stop Line (*2) (m2)		Traffic Lane (*3) (m2)		Direction Arrow (*4) (m2)				
Basic width (m)	4.00		0.45		0.15	20.00	0.15	5.00			
Intersection No.	Full Length (m)	Q'ty (m2)	Full Length (m)	Q'ty (m2)	Number	Q'ty (m2)	Number	Q'ty (m2)			
1	101.8	203.6	37.9	17.1	13.0	39.0	20.0	15.0	274.7	17.0	-
2	101.6	203.2	50.2	22.6	13.0	39.0	24.0	18.0	282.8	-	-
3	107.0	214.0	47.0	21.2	12.0	36.0	20.0	15.0	286.2	6.4	-
4	64.0	128.0	31.1	14.0	10.0	30.0	18.0	13.5	185.5	13.1	-
5	46.3	92.5	29.9	13.5	10.0	30.0	16.0	12.0	148.0	-	5.3
6	75.5	151.0	60.7	27.3	16.0	48.0	28.0	21.0	247.3	-	-
7	0.0	0.0	30.0	13.5	9.0	27.0	15.0	11.3	51.8	6.8	-
8	45.7	91.4	17.4	7.8	7.0	21.0	10.0	7.5	127.7	-	-
9	42.9	85.8	21.0	9.5	6.0	18.0	12.0	9.0	122.3	-	-
10	60.4	120.8	28.2	12.7	9.0	27.0	14.0	10.5	171.0	-	-
11	83.4	166.8	42.5	19.1	15.0	45.0	24.0	18.0	248.9	-	-
12	76.1	152.2	32.1	14.4	13.0	39.0	18.0	13.5	219.1	-	-
13	66.4	132.8	42.6	19.2	6.0	18.0	12.0	9.0	179.0	-	-
14	57.5	115.0	28.6	12.9	9.0	27.0	14.0	10.5	165.4	-	-
15	88.6	177.2	44.4	20.0	9.0	27.0	18.0	13.5	237.7	-	-
16	77.7	155.4	36.0	16.2	13.0	39.0	19.0	14.3	224.9	-	-
17	18.0	36.0	19.8	8.9	7.0	21.0	10.0	7.5	73.4	-	-
18	36.5	73.0	29.6	13.3	8.0	24.0	14.0	10.5	120.8	-	-
19	47.0	94.0	24.9	11.2	5.0	15.0	12.0	9.0	129.2	-	-
20	52.9	105.8	36.3	16.3	8.0	24.0	20.0	15.0	161.1	-	-
21	52.7	105.4	24.2	10.9	8.0	24.0	15.0	11.3	151.5	2.6	-
22	0.0	0.0	15.7	7.1	5.0	15.0	9.0	6.8	28.8	9.3	-
23	39.2	78.4	24.6	11.1	6.0	18.0	12.0	9.0	116.5	2.0	-
24	20.7	41.4	21.6	9.7	6.0	18.0	10.0	7.5	76.6	-	-
25	64.4	128.8	31.0	14.0	9.0	27.0	15.0	11.3	181.0	28.4	-
26	21.0	42.0	15.8	7.1	3.0	9.0	10.0	7.5	65.6	8.3	-
27	31.2	62.4	30.6	13.8	6.0	18.0	15.0	11.3	105.4	-	-
28	30.4	60.8	22.9	10.3	10.0	30.0	16.0	12.0	113.1	-	-
29	50.6	101.2	27.5	12.4	3.0	9.0	10.0	7.5	130.1	-	-
Total		3118.9		406.8		762.0		337.5	4625.2	93.8	5.3

(Source: JICA Study Team)

<u>Condition of Above Calculation</u>:

*1. Crosswalk paint = 4 m in width × road cross in length × ratio 0.50

*2. Stop line paint = 0.45 min width × road cross in length of approaching side

*3. Lane paint = 15 cm in width, and applying at 50 m from the intersection

*4. Direction arrows = Painted at two places, 1st near the intersection, 2nd 30.0 m to 40.0 m from the intersection for each approach route. Direction arrows size: 0.15 m in width × 5 m in length

2-2-2-6 Equipment Plan

The equipment name, country to procure, specification and quantity by system are shown in tables (from Table 2-11 to Table 2-18).

Table 2-11 Equipment List (Centre System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
1	Center System				
1-1	B-TIC Server	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash 15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 6 or more、Interface：1000/100BASE-TX, USB3.0、Software：DBMS etc.	High Class	2
1-2	Video Wall	Japan	Display：Color TFT LCD、Display Size：55inch、Resolution：1920 × 1080、Bezel Width 3mm or less	High Class	6
1-3	Video Switcher	Japan	Input：RGB Analogue, DVI-D, HDMI (Compatible with PC Video Output Interface) 、Output：RGB Analogue, DVI-D, HDMI (Compatible with the Interface of Operator Console and Monitor)	High Class	1
1-4	Operator Console	Japan	CPU：Intel i7 Cash 30MB or more、Memory：4GB ECC DDR2 or more、HDD：250GB SATA or more、Monitor：22inch LCD Wide type	High Class	2
1-5	Call Recording Device	Japan	Connection type:Receiver modular terminal、Recording type：Automatic / Manual Recording、Maximum Recording time：2000hours or more	High Class	1
1-6	Color Laser Printer	Japan	Printing method：Xerographic (Laser) 、Print size：A3 and A4、Printing speed：30 pages／min or more	High Class	1
1-7	Black Laser Printer	Japan	Printing method：Xerographic (Laser) 、Print size：A3 and A4、Printing speed：35 pages／min or more	High Class	1
1-8	Network Control Program	Japan	Control capacity：1,000 nodes、Control method：SNMP、Configuration：Server and Client、Duplexing	High Class	1
1-9	Storage Device	Japan	CPU：Intel Xeon Processor(4core)3.4GHz Cash 8MB or more、Memory：8GB(4GB×2(DDR3 SDRAM) or more、HDD：48TB or more RAID5	High Class	1

(Source: JICA Study Team)

Table 2-12 Equipment List (Probe System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
2	Probe System				
2-1	Probe Server	Japan	CPU：Intel Xeon Processor(18core) 2.3GHz Cash 45MB or more、Memory：512GB (32GB DDR4) or more、HDD：1TB (2.5inch, SATA) x 12 or more	High Class	2

(Source: JICA Study Team)

Table 2-13 Equipment List (Queue Length Measurement System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
3	Queue Length Measurment System				
3-1	Queue Length Measurment Srver	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash 15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 2 or more	High Class	2
3-2	Vehiclel Detector (Ultra Sonic Type)	Japan	Detector type：Ultra Sonic、Resonance frequency：18 - 27KHz、Detectable speed：1 - 100 km/h	High Class	72
3-3	Local Controller	Japan	Local controller is used in the case that process unint is seperated from vhicle detector. It must meet the specification of vhicle detector.	High Class	72
3-4	Media Converter	Japan	LAN Interface：10 BASE-T/100BASE-TX (RJ-45) x 1 port、Network Interface：100BASE-FX (SC) x 1port、Transmission speed：100Mbps	High Class	12
3-5	Cabinet	Japan	Cabinet is used in the case that process unint is seperated from vhicle detector. Local controller is housed in the cabinet.	High Class	72

(Source: JICA Study Team)

Table 2-14 Equipment List (ATCC System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
4	Automatic Traffic Counter-cum-Classifier System (ATCC System)				
4-1	ATCC Server	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash 15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 2 or more	High Class	2
4-2	Vehicle Detector(Image Processing Type)	Japan	Image processing device：1/3 inch CCD、Effective pixels：659(H) X 494(V)、Resolution：VGA :640 x 480, QVGA :320 x 240	High Class	16
4-3	Local Controller	Japan	Local controller is used in the case that process unint is seperated from vhicle detector. It must meet the specification of vhicle detector.	High Class	16
4-4	Media Converter	Japan	LAN Interface：10 BASE-T/100BASE-TX (RJ-45) x 1 port、Network Interface：100BASE-FX (SC) x 1port、Transmission speed：100Mbps	Middle Class	8
4-5	Cabinet	Japan	Cabinet is used in the case that process unint is seperated from vhicle detector. Local controller is housed in the cabinet.	High Class	16

(Source: JICA Study Team)

Table 2-15 Equipment List (VMS System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
5	Variable Message System (VMS)				
5-1	VMS Server	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 6 or more	High Class	2
5-2	Operator Console for VMS	Japan	CPU：Intel i7 Cash 30MB or more、Memory：4GB ECC DDR2 or more、HDD：250GB SATA or more、Monitor：22inch LCD wide type	High Class	1
5-3	VMS Board	Japan	Board Size：5,000mm(W) x 3,000mm(H)、Height of Character：300mm or more、Element pitch：15mm、Light emitter：LED (Blue、Red、Green)	High Class	3
5-4	Local Controller	Japan	Local controller is used in the case that control uint is seperated from VMS Board. It must meet the specification of VMS Board.	High Class	3
5-5	Media Converter	Japan	LAN Interface：10 BASE-T/100BASE-TX (RJ-45) x 1 port、Network Interface：100BASE-FX (SC) x 1port、Transmission speed：100Mbps	Middle Class	3
5-6	Cabinet	Japan	Cabinet is used in the case that process unint is seperated from VMS Board. Local controller is housed in the cabinet.	High Class	3

(Source: JICA Study Team)

Table 2-16 Equipment List (Internet System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
6	Internet System				
6-1	Internet Server	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash 15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 2 or more	High Class	2

(Source: JICA Study Team)

Table 2-17 Equipment List (Signal System)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
7	Area Traffic Signal Control System(ATCS)				
7-1	ATCS Server	Japan	CPU：Intel Xeon Processor(4core) 3.5GHz Cash15MB or more、Memory：64GB (8GB DDR4) or more、HDD：1TB(2.5inch, SATA) x 6 or more、Interface：1000/100BASE-TX, USB3.0、Software：DBMS etc.	High Class	2
7-2	Operator Console for Signal	Japan	CPU：Intel i7 Cash 30MB or more、Memory：4GB ECC DDR2 or more、HDD：250GB SATA or more、Monitor：22inch LCD wide type	High Class	1
7-3	Local Controller	Japan	Protocol：UDP/IP DATEX (to Signal System Server) 、Clock：Synchronized to GPS、Cabinet：Dust control、Waterproof(IP55 and its equivalent)、Operating temperature・humidity：+15℃-+40℃、20-95％	High Class	29
7-4	UPS	Japan	Type：On-line type UPS、Input voltage：AC230V±15%, 60Hz Single-phase two-wire system、Output voltage：AC230V±2%, 60Hz Single-phase two-wire system、Capacity：more than 4hours backup time	High Class	29
7-5	Lantern for Vehicle (Red,Amber,Green)	Japan	Display surface：Red,Amber,Green、Figure／Size：Circle／φ300mm、Illuminant：LED、Color：Red (Wave length 625nm) 、Yellow (Wave length 590nm) 、Green (Wave length 500nm) 、Brightness：＞365ｃｄ (Red) 、＞910ｃｄ (Yellow) 、＞475ｃｄ (Green)	High Class	130
7-6	Lantern for Vehicle (Arrow for three directions)	Japan	Display surface：Arrow for three direction、Figure／Size：Circle／φ300mm、Illuminant：LED、Color：Red (Wavelength 625nm) 、Yellow (Wavelength 590nm) 、Green (Wavelength 500nm) 、Brightness：＞365ｃｄ (Red) 、＞910ｃｄ (Yellow) 、＞475ｃｄ (Green)	High Class	8
7-7	Lantern for Vehicle (Arrow for one direction)	Japan	Display surface：Arrow for one direction、Figure／Size：Circle／φ300mm、Illuminant：LED、Color：Red (Wavelength 625nm) 、Yellow (Wavelength 590nm) 、Green (Wavelength 500nm) 、Brightness：＞365ｃｄ (Red) 、＞910ｃｄ (Yellow) 、＞475ｃｄ (Green)	High Class	87
7-8	Lantern for Pedestrian (pole side/standard type)	Japan	Display surface：Red、Green、Figure／Size：Square／250mm×250mm、Illuminant：LED、Color：Red (Wavelength 625nm) 、Green (Wavelength 500nm) 、Brightness：365ｃｄ (Red) 、475ｃｄ (Green) 、	High Class	72
7-9	Lantern for Pedestrian (pole side/elapsed time presentation type)	Japan	Lantern for Pedestrian(7-8) with elapsed time presentation function	High Class	16
7-10	Lantern for Pedestrian (pole top/one unit)	Japan	Display surface：Red、Green、Shape／Size：Square／250mm×250mm、Illuminant：LED、Color：Red (Wavelength 625nm) 、Green (Wavelength 500nm) 、Brightness：365ｃｄ (Red) 、475ｃｄ (Green) 、Installed at top of the pole(one unit type)	High Class	42
7-11	Lantern for Pedestrian (pole top/two units)	Japan	Display surface：Red、Green、Shape／Size：Square／250mm×250mm、Illuminant：LED、Color：Red (Wavelength 625nm) 、Green (Wavelength 500nm) 、Brightness：365ｃｄ (Red) 、475ｃｄ (Green) 、Installed at top of the pole(two units type)	High Class	16
7-12	Lantern for Pedestrian (pole top/one unit/elapsed time presentation type)	Japan	Lantern for Pedestrian(7-10) with elapsed time presentation function	High Class	15
7-13	Lantern for Pedestrian (pole top/two units/elapsed time presentation type)	Japan	Lantern for Pedestrian(7-11) with elapsed time presentation function	High Class	5
7-14	Vehicle Detector(Ultra Sonic Type)	Japan	Detector：Ultrasonic type、Resonant frequency：18 - 27KHz、Detectable speed：1 - 100 km/h	High Class	47
7-15	Vehicle Detector(Image Processing Type)	Japan	Image processing device：1/3 inch CCD、Effective pixels：659(H) X 494(V)、Resolution：VGA :640 x 480, QVGA :320 x 240	High Class	18
7-16	Communication Device	Japan	IEEE802.15.4, 2.4GHz Band, 16 Channels	High Class	53
7-17	Media Converter	Japan	LAN Interface：10 BASE-T/100BASE-TX (RJ-45) x 1 port、Network Interface：100BASE-FX (SC) x 1port、Transmission speed：100Mbps	High Class	29

(Source: JICA Study Team)

Table 2-18 Equipment List (Common Equipment)

No	Name of equipment	Country	Supecification and Configuration	Level	Amount
8	Others (Common Equipments)				
8-1	L2-SW	Japan	Interface：10/100BASE-TX×16port or more、LAN Protocol：TCP/Ip etc.、MaximumVLAN：200	High Class	4
8-2	L3-SW	Japan	Swithcing speed：40Gbps and its equivalent、WAN Interface：10/100BASE-TX×4 or more Optical fiber port (media converter) ×2 or more、LAN Interface：10/100BASE-TX×16 port or more	High Class	4
8-3	19inch rack	Japan	Structure：Inside self standing、Material：Steel board、Dimension：W600 x D600xH2000ｍｍand its equivalent、Board thickness： t =1.6mm or more	Middle Class	3
8-4	Fire Wall	Japan	Throughput：800Mbps or more、New session：3,500 or more、Policy：4,000 or more、IP Sec VPN Throughput：350Mbps or more	Middle Class	3
8-5	SAN-SW	Japan	Port speed：16Gbps Fiber channel、Number of port：24、Switch band width：1536Gbps	Middle Class	4

(Source: JICA Study Team)

2-2-3 Outline Design Drawing

The outline design drawings are listed below. The drawings are attached in Appendix 6.

1)Location of Roadside Equipment
2)Detailed Location of Traffic Signal
3)Typical Drawing of VMS Type 1
4)Typical Drawing of VMS Type 2
5)Typical Drawing of VMS Type 3
6)Pole of Sensor

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Installation of Equipment

Installation of equipment is conducted after the completion of civil engineering works (pole installation, gantry foundation work e.g.), installation of pull box and installation of conduit and arriving of equipment from Japan. Installation of equipment is consisting of the installation (the bringing the equipment, mounting and fixing) and the test. After the completion of installation, the unit test and counter test are conducted and finally the comprehensive performance test is conducted.

(2) Installation of Roadside Equipment

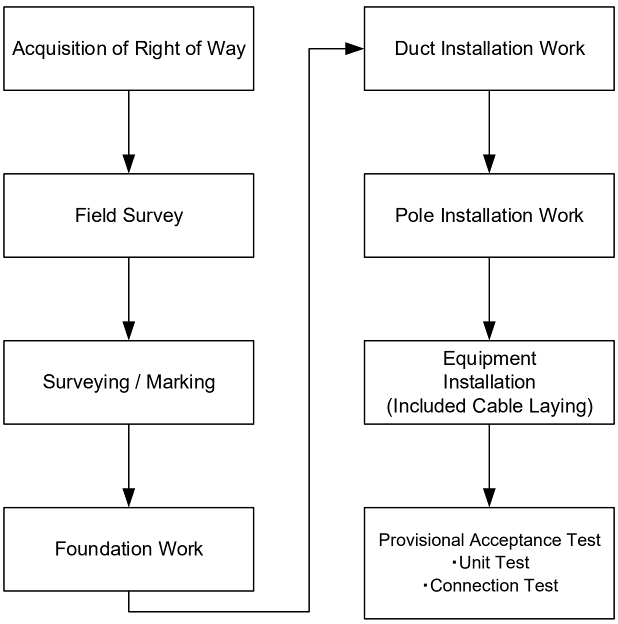
Installation of roadside equipment includes equipment of the traffic information system and the signal system.

1) Roadside Equipment of the Traffic Information System

The roadside equipment of the traffic information system includes the equipment of the following subsystems:

- ATCC system
- Queue length measurement system
- VMS system

The installation flow of the roadside equipment of the traffic information system is shown in Figure 2-26.



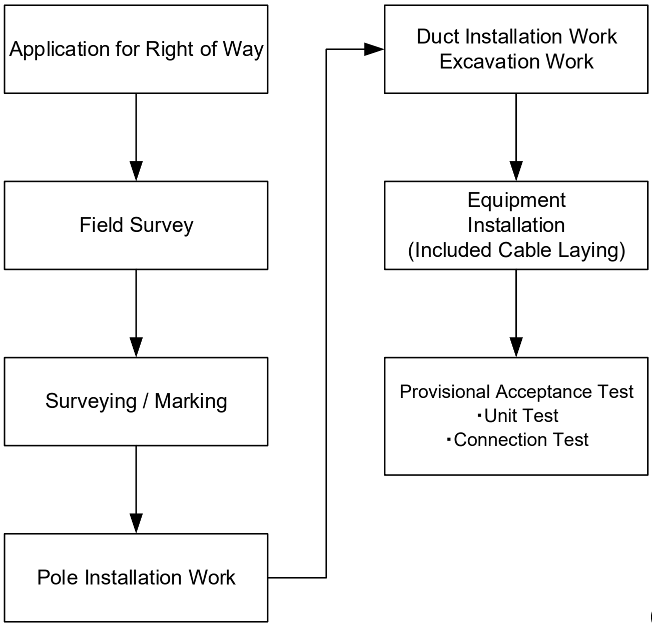
(Source: JICA Study Team)

※The connection test will be conducted after completing the installation and unit test of the road side equipment.

Figure 2-26 Installation Flow of the Roadside Equipment of the Traffic Information System

2) Roadside Equipment of the Signal System

The roadside equipment of the signal system includes the signal lights and vehicle detectors. The installation flow of the roadside equipment of the signal system is shown in Figure 2-27.



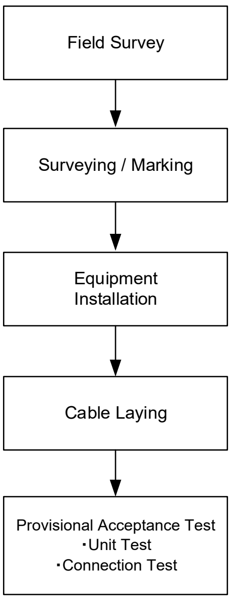
(Source: JICA Study Team)

※The connection test will be conducted after completing the installation and unit test of the road side equipment.

Figure 2-27 Installation Flow of the Roadside Equipment of the Signal System

(3) Installation of Centre System Equipment

The installation flow of the centre system equipment is shown in Figure 2-28.



(Source: JICA Study Team)

Figure 2-28 Installation Flow of the Centre System Equipment

1) Centre Equipment to be Installed at KSDC

BTIC server, probe server, queue length measurement server, ATCC server, internet server, VMS server, and the signal system server will be installed at KSDC with the following works:

A) **BTIC Server**

- Installation of application software
- Unit test of the BTIC server
- Connection test to the operator console ofthe traffic information system installed at DULT

B) **Probe Server**

- Installation of application software
- Unit test of probe server
- Connection test to BMTC prove server to confirm that the probe data can be acquired properly
- Connection test to the queue length measurement server to confirm that the queue length data can be acquired properly

C) **Queue Length Measurement Server**

- Unit test of the queue length measurement server
- Connection test to the roadside equipment

D) **ATCC Server**

- Unit test of the ATCC server
- Connection test to the roadside equipment

E) **Internet Server**

- Unit test of internet server
- Connecting test to the probe server

F) **VMS Server**

- Unit test of VMS server
- Connection test with VMS board and BTIC server

G) **Signal System Server**

- Unit test of the signal system server
- Connection test with roadside equipment of the signal system

2) Centre Equipment to be Installed at DULT

A video wall and an operator console for centre system will be installed at DULT with the following works.

- Unit test of video wall and operator console
- Connection test with BTIC server installed at KSDC

3) Centre System Equipment to be Installed at BTP

Operator consoles for the signal system and the VMS system will be installed at BTP with the following works.

- Unit test of operator console
- Connection test to the signal system and VMS system

(4) Others

Other construction works include foundation works, pole installations, duct installations, and cable laying. For the foundation works, the duct installations, and cable laying, it must be carefully carried out not to damage the installed objects underground.

1) VMS Gantry to be Installed on MG Road

For the work of foundation pile and pole installation for VMS gantry and VMS board installation at MG Road, careful attention shall be paid to the metro railway which runs above at the site.

2) VMS Gantry to be Installed at Silk Board

VMS gantry shall be installed behind the existing gantry of the road sign. The existing gantry shall be removed after the unit test and connection test of the VMS board.

2-2-4-2 Implementation Conditions

(1) Overall Work

The Project includes a wide range of engineering works such as civil works and installations of various type of equipment (the centre system, the probe system, the queue length measurement system, the ATCC system, the VMS system, the internet system, and the signal system), and therefore, shall be carried out with close cooperation in detail for scheduled completion. The major focus points in planning the implementation are as follows:

- The civil works will be carried out, avoiding the rainy season from June to October in consideration of workability and safety. Particularly during the period when it heavily rains i.e., from September to October, the indoor installation works will be mainly carried out.
- Minimizing the stopping time of the systems currently in operation is important, and system suspension shall be avoided particularly during the rainy season.
- Safety management shall be ensured because of heavy traffic in the Project area.

(2) Installation in Related Organization

The Project will also provide a number of different kinds of equipment and facilities to related organizations including DULT, KSDC, and BTP. The following are the focus points of concern for the implementation of the Project.

1) Items to be taken cared by the Recipient Side before Construction and Procurement

- To secure the budget for tax exemption;
- To allocate appropriate personnel, e.g., engineers;
- To provide necessary support for the construction and procurement e.g., providing

necessary information and acquiring permission for roadwork; and

- To make ready the space for the equipment to be installed at DULT, KSDC, and control centre of BTP, and all necessary related works.

2) Items to be taken cared by the Recipient Side during Construction and Procurement

- To provide necessary telecommunication cable (optical fibre cable) and electricity (supply of power cable);
- To provide a space required for construction and installation work;
- To provide necessary support for the construction and procurement, e.g., providing necessary information, permission, and safety measure; and
- To allocate relevant personnel for attending the training course for the soft component program.

2-2-4-3 Scope of Works

The Project includes various works such as installation of the centre system, the probe system, the queue length measurement system, the ATCC system, the VMS system, the internet system and the signal system, civil works including constructions of signal pole, VMS foundations, pull boxes, conduits, horizontal directional drilling, road marking, removal/renovation of sidewalk and others that will be simultaneously carried out.

The Government of India and the Contractors must clearly recognize the demarcation of the scope of works (hereinafter referred to as “SOW”) and work in close cooperation in the process of the Project.

The demarcation of the SOW in the Project is shown in Table 2-19.

Table 2-19 Demarcation List of the SOW

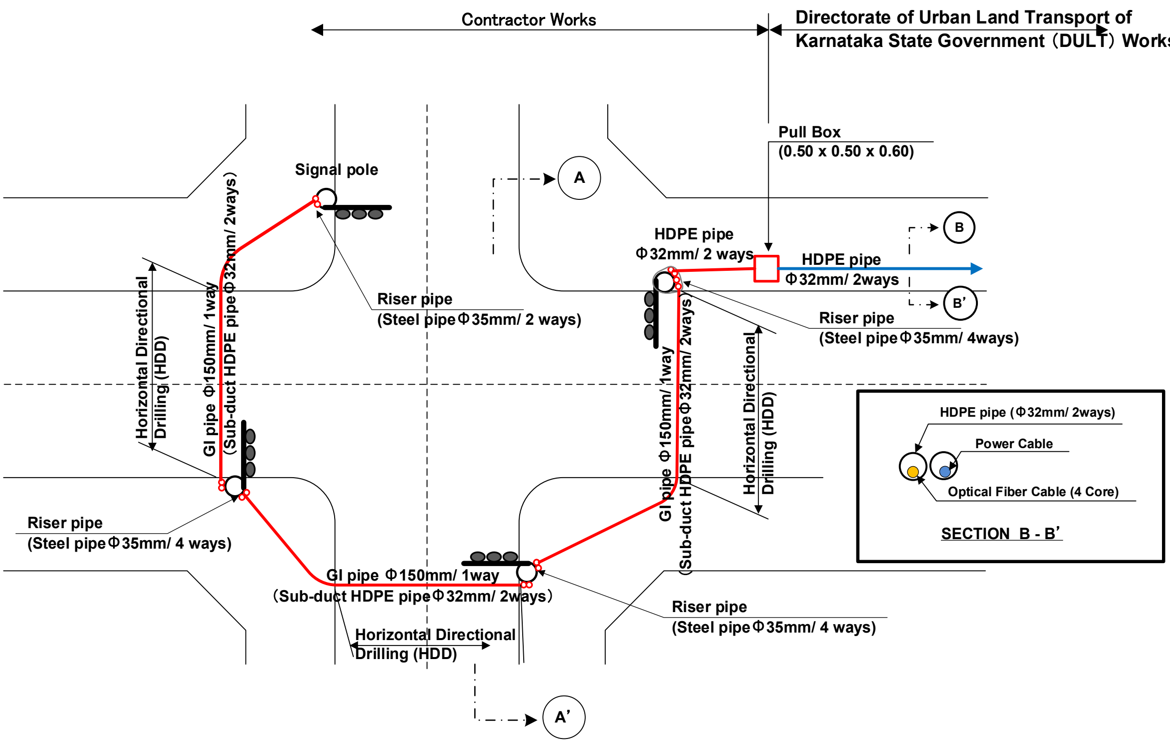
Japan Side	India Side
1. Centre System (1 set)	1. Refurnished the existing room including cleaning, painting, electrification, air conditioning, etc. of the equipment room
2. Probe System (1 set)	2. Coordination with various relevant agencies and processing following these applications: - Tax exemption and customs clearance - Acquisition for any right-of-way permission - Other necessary permission (gas, water, electricity, and etc.) - Other necessary coordination and application procedures
3. ATCC System (8 locations)	3. Replacement of existing equipment (signal pole, signal lamp device, equipment, gantry, and etc.)
4.Queue Length Measurement System (12 locations)	4. Internal writing works for equipment room
5. VMS (3 units)	5. Remove obstacles from the Project sites
6.Internet System (1 set)	6. Maintenance of spare parts
7.Signal system (29 intersections)	7. Installation of telecommunication cable, electricity (power cable), and conduit
8. Civil Work (construction of signal pole, VMS foundation, pull box, conduit, horizontal directional drilling, road marking, removal of sidewalk, and	8. Witness of equipment installation and adjustment work (trial operation)

Japan Side	India Side
renovation work on the sidewalk)	
	9. Witness of provisional acceptance test
	10. Witness of final acceptance test (completion test)
	11. Provision of counterpart
	12. Obtaining GST budget and payments

(Source: JICA Study Team)

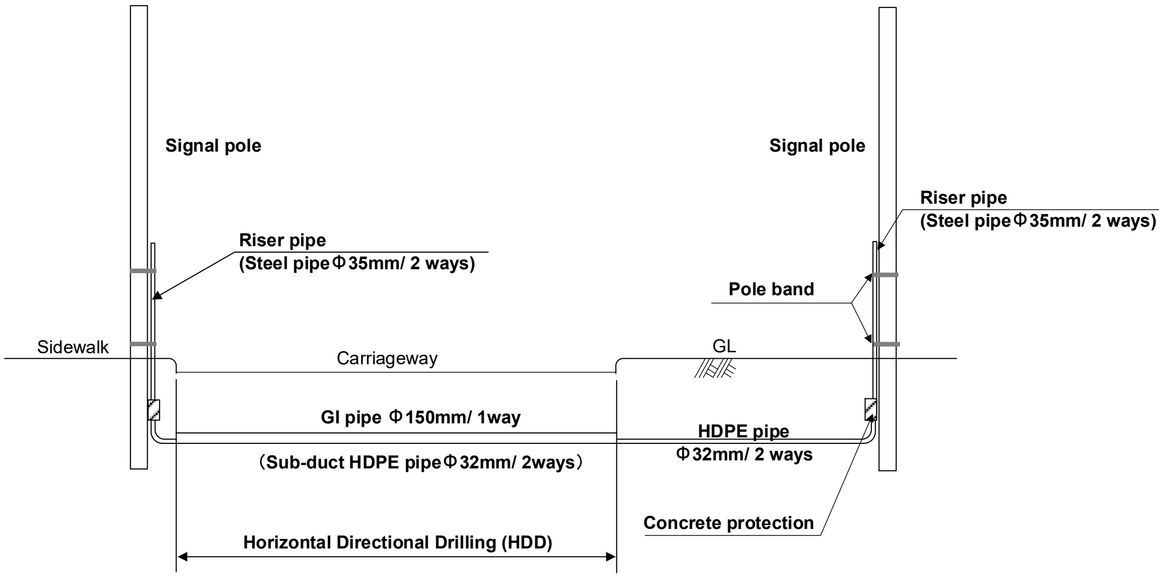
The Contractor will undertake the civil works, material and equipment design, production, factory test, export packing, transportation to the sites and construction of facilities in the plan according to the specifications prepared by the Consultants and verify the status of construction and performance of each equipment and system after production through field tests, upon which the resulting products will be delivered to corresponding parties. In addition, the staff will be trained as necessary during the period of construction and field tests for the technology transfer to India.

The demarcation of the construction in the Project is shown in Figure 2-29.



(Source: JICA Study Team)

Figure 2-29 Demarcation of the Construction



(Source: JICA Study Team)

Figure 2-30 Section A – A'

The construction and cable laying work conditions are shown below.

- Road crossing including HDD and horizontal boring or pipe jacking.
- HDPE pipe (sub-duct) shall be pulled into already installed 150 mm galvanized steel pipe (GI pipe) for the accommodation of optical fibre cable and power cable.
- The nylon rope will be into the HDPE pipe (sub-duct).
- Laying of cable or blow-in into HDPE pipe.
- The optical fibre cable and power cable will be into the HDPE pipe for cable section.

Tasks assigned to the Indian side shall be carried out in a timely manner without delay while coordinating with relevant construction process. Both the Indian and Japanese sides must collaborate with each other to facilitate the progress of the Project and to complete it within the scheduled period.

2-2-4-4 Consultant Supervision

(1) Detailed Design for the Consultants

A consultancy services agreement will be signed between DULT, a counterpart agency of the Indian side, and the Consultants from Japan. Detailed design included in the consultancy agreement is as follows:

1) Detailed Design

Confirm the cost of construction and define the construction works undertaken by DULT through field studies and consultation with the Indian side in view of the results of the preparatory survey study.

2) Preparation of Tender Documents

Prepare the tender documents according to the detailed design, construction plan, and provisions of the grant system.

The following personnel are required for the preparation of the detailed design and document by the Consultants. Personnel and tasks required for the detailed design are shown in Table 2-20.

Table 2-20 Personnel and Tasks Required for the Detailed Design

Position	Task
Chief Consultant	Review of equipment specifications, preparation of tender documents (general conditions), and final confirmation of scope of works.
Traffic Information System Design-1	Final confirmation of technical specification and preparation of tender documents (technical specifications).
Traffic Information System Design-2	Final confirmation of technical specification and preparation of tender documents (technical specifications).
Signal System Design	Final confirmation of technical specification and preparation of tender documents (technical specifications).

(Source: JICA Study Team)

(2) Procurement Supervision System

Procurement supervision included in the consultancy agreement is as follows:

1) Tender Assistance

The Consultants will publicly announce the tender, answer to questions, attend the tender, evaluate the tender result, assist in contract negotiations, and attend the signing of the Contractor's agreement.

2) Construction Supervision

The Consultants will a) hold a meeting with the concerned parties involved before the start; b) approve the design drawings; c) inspect the equipment before the shipment; d) supervise the installation at the sites; e) prepare reports during the construction period; f) issue interim result certificates, and g) inspect and take necessary procedures upon completion.

3) Supervision Operations after the Completion of the Implementation

The supervision operations include the issuance of certificate of completion of construction, procedures for handing over the completed construction, and preparation of the final operational report.

The personnel required for these supervision operations will be the local staff employed by the Project, who will assist the procurement and supervision to allow the construction to be carried out simultaneously at multiple locations in an effort to reduce the construction period.

Table 2-21 Consultants Personnel

Position	Task
Chief Consultant	- Presence of handover
Resident Procurement Supervising Engineer	- Stations at the site throughout the construction period and performs procurement and supervision for the entire project. - Manages quality, progress, payments and safety, holds consultations and negotiations with the Indian side and makes reports. - Construction supervision of traffic control system (Centre system, probe system and internet system).
Procurement Supervising Engineer – 1 (Advance arrangement, inspection and acceptance, delivery, etc.)	- Discusses and arranges equipment transportation in advance. - Attends to the inspection, acceptance, and delivery. - Witness to the manufacturer's warranty period before inspection
Procurement Supervising Engineer –2	- Manages the progress, quality and safety of the construction. - Construction supervision of the traffic control system (queue length measurement system, traffic counter and VMS system).
Procurement Supervising Engineer – 3	- Manages the progress, quality and safety of the construction. - Construction supervision of the signal system.
Inspection Engineer –1	- Confirms and verifies the drawings of ITS systems and attends the inspections at the factory before shipment.
Inspection Engineer –2	- Pre-shipment inspection witness

(Source: JICA Study Team)

Table 2-22 Local Consultants Personnel

Position	Task
Assistant procurement supervisor	- Organizes the support operations in the overall procurement supervision

(Source: JICA Study Team)

2-2-4-5 Quality Control Plan

Quality of the equipment and materials procured for the Project and the implementation will be managed as follows:

(1) Review of Drawings

Mandate the Contractors to submit the drawings of all equipment, materials and construction plans, and the Consultants will verify that the specifications and quality shown in such drawings conform to the contract.

(2) Participation in the Inspection at the Factory

When the suppliers have completed the equipment and material purchases and confirmed the overall operation of the systems and conform to the performance and quantities specified in the specifications, attend to the inspections at the factory to verify the performance and quantities.

(3) Inspection Before Shipment

When the inspections at the factory have been completed and the suppliers have packed all equipment and materials to complete the shipment preparation, inspect the goods before the shipment, check the quantity of packages, type of packing, case marks and other details against the packing list and other documents and ensure that the packages, are durable enough for the sea transportation and inland transportation in India.

(4) Pre-shipment Inspection by Third-Party Agency

Upon the completion of package inspection, a third-party agency will inspect the freight before loading and ensures that the goods have been loaded properly.

(5) Field Testing

The installation works at the sites will be inspected and field-tested (Post Construction Tests) to confirm results. The field tests will consist of single testing (Provisional Acceptance Test) to ensure the functionality of each unit of the equipment and comprehensive testing (Final Acceptance Test) to confirm the overall system functions. The field tests will be led by the Contractor in the presence of the Consultants and DULT personnel. Following the comprehensive testing (Final Acceptance Test), submit a report on the completion of the inspections to JICA and the Government of India.

(6) Warranty

The suppliers will guarantee the quality of the equipment and materials for one year after taking over the equipment, and will restore the products to their original conditions without delay should failure occurs.

2-2-4-6 Procurement Plan

(1) Procurement Policy

The Project is positioned as the establishment of ITS system, which shall be highly reliable. Since such ITS equipment is not distributed and manufactured in India, all sets of ITS equipment (traffic control system and the signal system) are procured from Japan.

The list of procurement of main equipment is shown in Table 2-23.

Table 2-23 Main Equipment Suppliers

No.	Item	Local	Japan
1	Centre System		○
2	Probe System		○
3	ATCC System		○
4	Queue Length Measurement System		○
5	VMS		○
6	Internet System		○
7	Signal System		○
8	Signal Pole	○	
9	Control Strut pole	○	
10	Camera Pole	○	
11	Gantry (Type-1, Type-2 and Type-3)	○	
12	Ready-Mix Concrete	○	
13	Reinforcing Steel (Deformed bar), Cement, Sand and Crushed Stone	○	
14	PVC Pipe, GI Pipe and HDPE Pipe	○	
15	Electricity (power cable)	○	
16	Telecommunication Cable	○	
17	Concrete Curb Materials and Concrete Tile, Road Marking Materials	○	

(Source: JICA Study Team)

(2) Transportation Plan

The equipment acquired in Japan will be shipped by sea, departing from the Japanese port and will arrive at the Port of Chennai. The equipment and materials will be transported by land from a landed port to a warehouse in Bengaluru and will be stored there. They will subsequently be delivered to the construction plan.

The equipment acquired in Japan will be packed for export and delivered to the Yokohama Port or an equivalent location by the Contractor, and be shipped to India thereafter.

Upon the arrival at the Port of Chennai, personnel in India will complete the customs clearance and the contracted inland carrier will transport the goods from the port to Bengaluru warehouse. Subsequently, the goods are delivered from the warehouse in small lots according to the Project process.

The main warehouse and site depot shall be borne by the Contractor.

2-2-4-7 Operational Guidance Plan

(1) Instruction for Initial O&M

The instruction for initial O&M will be conducted at each place (BTIC, TMC, KSDC, Roadside) by the Contractor. The Japanese engineers will provide instruction to the equipment operators in India as soon as the unit and connection test of each system is completed, which requires 2.5 months for the traffic information system and 2.5 months for the signal system.

(2) Instruction Contents

The instruction contents for initial O&M are shown below.

Table 2-24 Instruction Contents for Initial O&M

No.	Item
1	Basic technology on electricity, communication, ITS technology related to the Project
2	Operation method and technology
3	Inspection method and technology
4	Countermeasure for system failure
5	Method for identifying system failure
6	Recording management for O&M

(Source: JICA Study Team)

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Aim of Soft Component

Soft component will be implemented with the following purposes:

1) BTIC System

DULT has no experience in the operation and management of BTIC System. Therefore, smooth commencement will be difficult in the initial stage just with the guidance in system operation/maintenance provided by the Contractor. Furthermore, sustainable and constructive usage of traffic information will also be difficult because of inadequate knowledge in method of analysis for traffic information.

Hence, assistance to acquire sufficient skills required for O&M is necessarily important to be provided, preparing an operation/maintenance manual for the traffic information system, for smooth commencement. Acquiring knowledge on methods of analysis for traffic information, utilization for transport planning and appropriate information management also need to be assisted by the soft component.

2) Signal System

The signal system to be developed in the Project requires to review parameters according to the changes in traffic condition. The traffic signals have already been operated by BTP. However, BTP does not have enough experience or skills to properly grasp the traffic condition and continuously maintain control function of the signal system such as setting parameters responding to the changes of traffic condition. There are also issues on the capability for proper improvement/maintenance of the intersections, where traffic signals will be installed to exert the effect of signal function and proper method for educational activities on traffic safety provided by police officers.

Therefore, technical assistance by soft component is required mainly for methods of traffic survey to review parameters, parameter setting and management of traffic information including amendment of the current operation/maintenance manual. Method of improving road intersections to enhance the effect of signal control and educational activities to raise awareness of drivers and residents on traffic safety conducted by police officers also need to be assisted by the soft component.

3) VMS System

VMS has already been operated by BTP. However, BTP has no experience to comprehend traffic information obtained from the traffic information system and accordingly set the necessary information to VMS system.

Therefore, training by soft component is required mainly for methods of comprehending traffic information obtained from the traffic information system, collecting/managing information to be provided such as traffic accidents, and deciding necessary information.

As for methods of O&M for system and device, the manual and training will be separately given by the Contractor.

(2) Contents and Activities for Soft Component Training

The soft component training will be conducted for the following items:

- Integrated and efficient operation / management of each system;
- Management and analysis of traffic information of BTIC System;
- Operation / management of area traffic signal system, including setting various parameters and methods of traffic survey, improvement of intersection and educational activities for traffic safety; and
- Operation / Management for information provision method for VMS.

【Training Period】From January to February 2019

(3) Target Members of Soft Component and Contents of Activities for Technical Support

1) Target Members of Soft Component

The Soft Component Training will be conducted mainly to engineers of DULT and BTP but engineers of BBMP (Bengaluru City Government) will also be included. Number of target members for technical support and groups divided by specialty are shown in Table 2-25.

Table 2-25 Number of Target Members for Technical Support and Group According to Specialty

Agency	Duties	Number of People		Group
		Responsible Person	Person in-charge	
DULT	Operation	1	2	A
	Transport Planning	1	6	B
BTP	Operation	1	6	C
	Parameter Setting	1	6	D
	Intersection Designing	1	6	E
BBMP (Bengaluru City Government)	Transport Planning	1	4	F
	Intersection Designing	1	4	G

(Source: JICA Study Team)

2) Contents of Activities for Technical Support

Contents of activities for technical support are shown in Table 2-26.

Table 2-26 Contents of Activities for Technical Support

<u>DULT：BTIC System（1 month）</u>

Contents of Activities	Group	Period Required (Week)
1.Demarcation of roles among related agencies and method of cooperation / coordination with each agency	A- F（Responsible Person）	0.5
2. Preparation of system operation / maintenance manual	A	1.5
3. Method of information management	A	0.5
4. Methods for analysis and utilization of information	B, F	1.0
5.Explanation of required organization structure for	A, B, F	0.5

information management and BTIC System in the future		
6. Assessment	A, B, F	-

BTP: Signal System・VMS System (1 month)

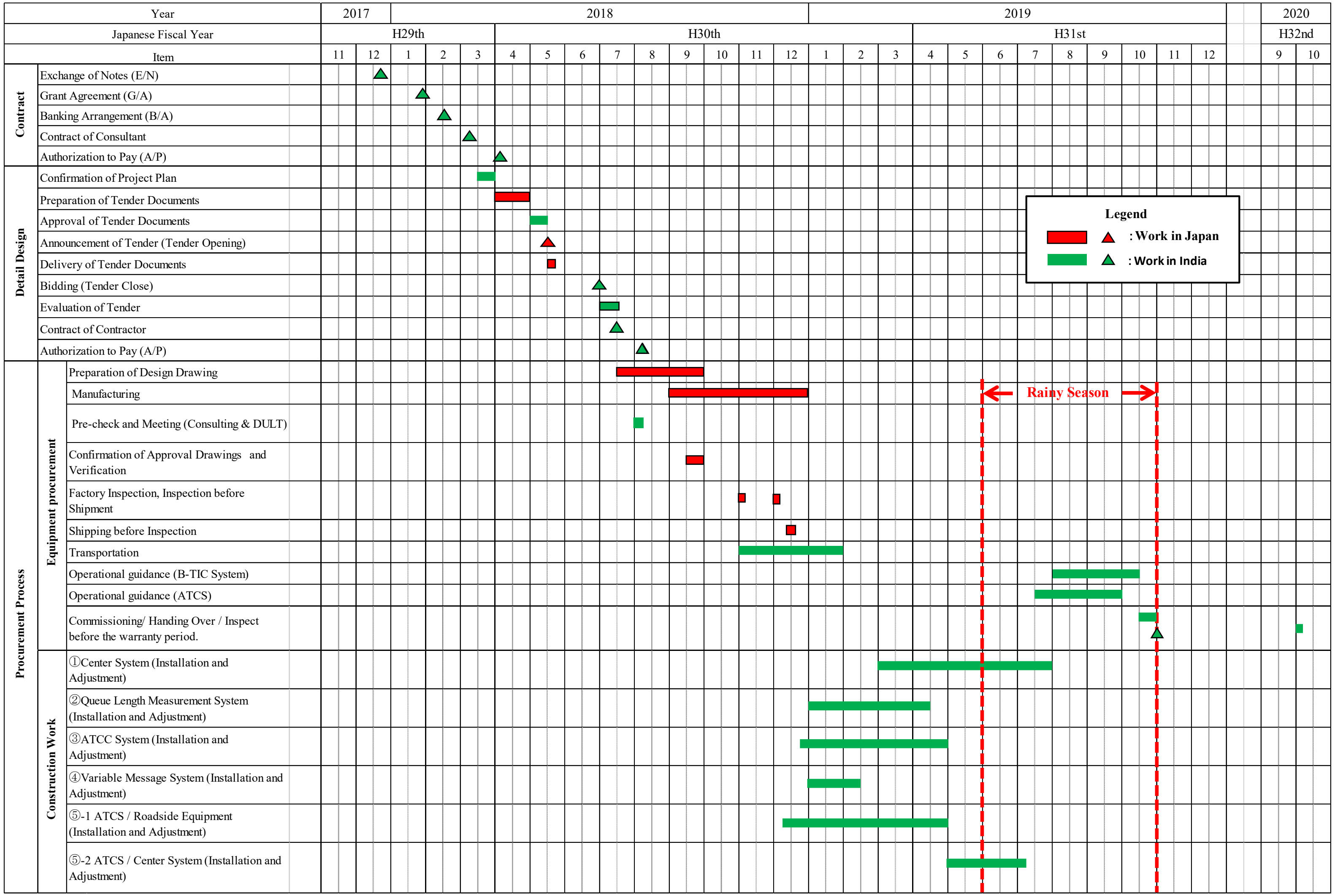
Contents of Activities	Group	Period Required (Week)
1. Amendment of operation / maintenance manual for system	C	1.5
2. Method of information management	D	0.5
3. Method / Analysis of traffic survey and method of applying to signal designing	D	0.5
4. Method to review parameters for traffic signal operation	D	0.5
5. Method of intersection designing / maintenance	E, G	0.5
6. Explanation of fundamentals and method of educational activities and raising awareness of traffic safety	C, D, E	0.5
7. Assessment	C, D, E, G	-

(Source: JICA Study Team)

2-2-4-9 Implementation Schedule

The implementation schedule for the Project is shown in Table 2-27.

Table 2-27 Implementation Schedule



(Source: JICA Study Team)

2-3 Obligations of Recipient Country

2-3-1 Responsibility of Recipient Country

Items to be arranged by the Indian side for the implementation of the grant aid project from Japan are shown in Table 2-28.

Table 2-28 Implementation of Grant Aid Project by the Japanese and Indian Sides

No.	Item	Japan	India	Remark
1	Center System (1 set)	○		During the Project implementation
2	Probe System (1 set)	○		
3	ATCC System (8 locations)	○		
4	Queue Length Measurement System (12 locations)	○		
5	VMS System (3 units)	○		
6	Internet System (1 set)	○		
7	Signal System (29 intersections)	○		
8	Civil Work (construction of signal pole, VMS foundation, pull box, conduit, horizontal directional drilling, road markings, removal of sidewalk, and renovation work on the sidewalk)	○		
9	Equipment procurement, installation, and adjustment	○		
10	Marine transport, inland transport, and transport to construction site	○		
11	Provisional acceptance test, acceptance test and final acceptance test	○		
12	Investigation of underground facility by test pit	○		
13	Banking arrangement (B/A)		○	Before bidding
14	Issuing A/P to a bank in Japan (the Agent Bank) for the payment to the Consultant		○	
15	Road administrators' (NHAI and Municipal) acceptance for improvement of intersection and construction drawing of roadside installation		○	
16	Application for the Project site and cleaning		○	
17	Payment for A/P Contractor		○	During the Project implementation
18	Counterpart for coordination of the Project (DULT/BTP)		○	
19	Customs clearance in India and support with internal transportation therein		○	
20	Support for working permit of Japanese engineer and third country's engineer		○	
21	Tax exemptions for custom duties, internal taxes, corporation tax, income tax and other fiscal levies which may be imposed in India		○	

No.	Item	Japan	India	Remark
	with respect to the purchase of the products and services			
22	Renovation of installation site (BTIC, KSDC, and BTP) including air conditioning, electronic devices, and lightning equipment, if necessary		○	During the Project implementation
23	Modification of the existing probe system of BMTC		○	
24	Acquisition of approval for use of road and other approvals (water, gas, electronic, and so on)		○	
25	Acquisition of site access and inside access		○	
26	Installation of HDPE pipe (32 mm, 2 ways), and installation and operation of power cable		○	
27	Internal wiring works for equipment room		○	
28	Removal of obstacles from the Project site		○	
29	Preparation and submission for status reports after the work (Check the number of goods, supervision for construction, operation training and other project works)		○	
30	Preparation and submission for project monitoring report		○	
31	Preparation and submission for the report concerning completion of the Project		○	
32	Preparation for O&M personnel		○	Before completion of construction
33	Replacement of existing traffic sign and gantry		○	On commission of operation
34	Replacement of existing lightning equipment and signal pole		○	
35	Prepare for the cost of O&M		○	After taking over
36	Maintenance spare parts (signal pole and sensor pole)		○	
37	O&M (including telecommunication cable)		○	
38	Daily and regular check		○	

(Source: JICA Study Team)

2-3-2 Undertaking of the Recipient Country

In relation to the implementation of the Project, the following services and works are to be executed by the Indian side.

2-3-2-1 Execution before Tender

- To get the approval of installation drawings by related agencies such as (Bengaluru City government (BBMP), BTP, National Highway Authority of India (hereinafter referred to as "NHAI") and DULT.
- Site acquisition for BTIC, TMC and KSDC, and all necessary works and permissions related to its acquisition.

2-3-2-2 Execution before Project Starts

- Acquisition for any right-of-way permission.
- Site acquisition for BTIC (DULT), TMC (BTP) and KSDC, and all necessary works and permissions related to its acquisition.

2-3-2-3 Execution during Installation

- Providing power supply necessary for the provided equipment at the BTIC (DULT), TMC (BTP) and KSDC; Installation of telecommunication cable (Optical fibre cable and etc.)
- Renovating centres to accommodate the provided equipment, which includes upgrading of air-conditioning system, replacement of electrical fittings and lighting fixtures, refurbishing of interior finishes, if necessary.
- Providing power supply necessary for the provided equipment at the site to coordinate with the power company.
- Providing reliable communication network necessary for the provided equipment at the site to coordinate with the telecommunications company.
- Removal of existing facilities after the start of operation
  - Signal poles
  - Signal lamp device
  - Gantry

2-3-2-4 Execution after Completion

To maintain and use properly and effectively the facilities constructed and equipment provided under the grant aid

- Allocation of maintenance cost
- O&M structure
- Routine check/periodical inspection
- Management of spare parts

2-4 O&M Plan

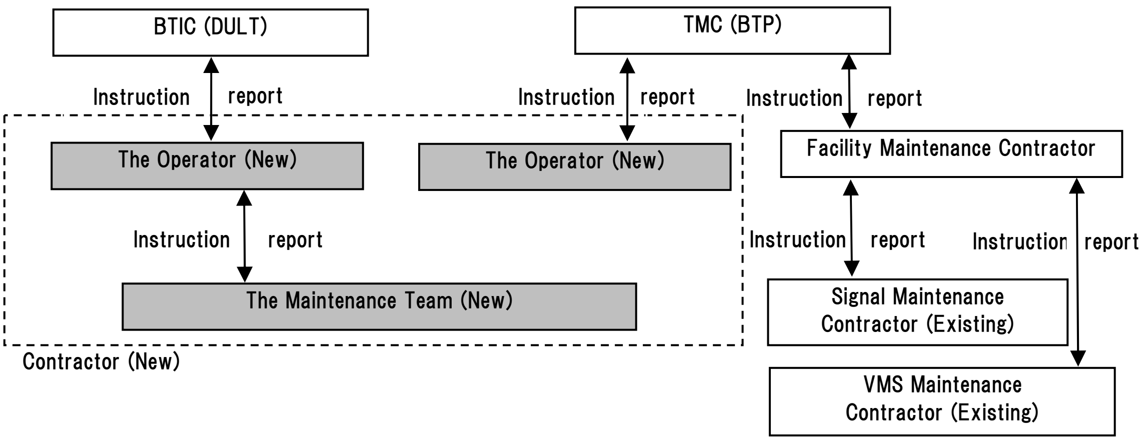
2-4-1 Purpose and Outline of the O&M

After completion of the implementation of the system by the Project, the O&M of the system will be commenced by Indian side for five (5) years.

BTP has been outsourcing the maintenance for the existing facilities such as the existing signal system, the existing CCTV and etc. to the Facility Maintenance Contractor (hereinafter referred to as "FMC"). In case of occurrence of incidents, the FMC identifies the cause and instructs the maintenance Contractors.

The Contractor shall station the Operator to both BTIC and TMC and also the Contractor shall prepare the Maintenance Team and local office in Bengaluru for maintaining the system/equipment of the Project, in order to respond on a round-the-clock basis for any failure of system/equipment. The support team shall compose of local maintenance team and backup team from Japan. When the failure is beyond the capacity of the local maintenance team, the local maintenance team requests the chief engineer (Contractor) to dispatch another engineer to the site for resolving any failure of system/equipment. Local office staff shall oversee both BTIC and TMC. Staffs of local office except call operators shall be prepared for immediate response at any time for failure of system/equipment.

Figure 2-31 summarizes the organization structure for the O&M.



(Source: JICA Study Team)

Figure 2-31 Organization Structure for the O&M

The BTIC System shall be managed by DULT and the TMC System shall be managed by BTP. The category of the system and the demarcation of the O&M are shown in Table 2-29.

Table 2-29 Category of the System and Demarcation of the O&M

System	*Sub system*	*Server Equipment* (at KSDC)	*Centre Equipment*		*Roadside Equipment*	*System Name for each Centre*	*O/M by*
Traffic Information System	***Centre System***	BTIC Server	Operator Console Video Wall	***at BTIC***		***BTIC System***	***DULT***
	ATCC System	ATCC Server			ATCC Sensor Controller		
	Que Length Measurement System	Que Length Measurement Server			Que length Sensor Controller		
	Probe System	Probe Server					
	Internet System	Internet Server					
	VMS System	VMS System Server	Operator Console	***at TMC***	VMS Controller	***TMC System***	***BTP***
Signal System	***Signal System***	Signal System Server	Operator Console		Signal/Sensor Controller		

(Source: JICA Study Team)

2-4-2 BTIC Organization Structure for the O&M

The Director of BTIC will be assigned from DULT and the Operator will be assigned from the Contractor under the Director. Also, the Maintenance Team is organized from the Contractor. The role of the employer and the Contractor for BTIC is described in Table 2-30.

Table 2-30 Role of Employer and the Contractor for BTIC

Position	Roles and Responsibilities	Contents
Director and his/her staff @ BTIC	Director: is responsibe for supervising and controlling all activities of BTIC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between BTIC and other related Gov. agencies especially Traffic Police. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for BTIC if necessary. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @ BTIC)	Operation ***-Lump Sum basis-***	- Responding to enquiries from general public. - Observing operating status of ATCC and Queue Length Measurement System. - Observing traffic status on schematic map of video wall. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version - Annual Updating of Digital Road Map
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for DULT officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Evaluation and Adjustment of Equipment/System ***-Lump Sum basis-***	- Detecting actual travel time along major roads by probe cars and evaluating the reliability of the probe system - Revise software and/or parameter of the probe system according to results of incorporate the latest digital road maps into the probe system annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from BTIC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Quotation basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired

Role of Operator

Role of Maintenance Team of the Contractor

(Source: JICA Study Team)

2-4-3 TMC Organization Structure for the O&M

The Director of TMC will be assigned from BTP and the Operator will be assigned by the Contractor under the Director. Also, the Maintenance Team is organized from the Contractor. The role of the Employer and the Contractor for TMC is described in Table 2-31.

Table 2-31 Role of Employer and the Contractor for TMC

Position	Roles and Responsibilities	Contents
Traffic Police Director and his/her staff @ Traffic Management Centre (TMC)	Director: is responsibe for supervising and controlling all activities of TMC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between TMC and other related Gov. agencies especially BTIC. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for TMC if necessary. - Instructing to the operator to revise signal parameter (cycle, split, offset) according to monitoring results and requests from local residents. - Instructing manual operations to the operator as required - Inputting necessary messages on VMSs if necessary. - Instructing to the Contractor response and resolution during off-time in case of incidents during off-time. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @TMC)	Operation ***-Lump Sum basis-***	- Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at Fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the representative of the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for BTP officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Evaluation and Adjustment of Equipment/System ***-Lump Sum basis-***	- Review the current traffic condition and adjust each equipment/system accordingly by revising control parameter annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from TMC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Unit Price basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaire.

(grey)	Role of Operator
(blue)	Role of Maintenance Team of the Contractor

(Source: JICA Study Team)

2-4-4 Contractor Organization Structure for the O&M Service

The organization structure of the Contractor for the O&M Service consists of the Operators stationed at BTIC and TMC and the Maintenance Team. The Maintenance Team composes of local maintenance team at the local office and the backup team from Japan. When the failure is beyond the capacity of the local maintenance team, the local maintenance team requests the Chief Engineer (Contractor) to deploy another engineer to the site for resolving any failure of system/equipment. Local office staff shall oversee both BTIC and TMC. Staffs of local office except call operators shall be prepared for immediate response at any time for failure of system/equipment.

The description of the role of the Contractor is shown in Table 2-32.

Table 2-32 Role of the Contractor for the O&M

No.	Position	Main functions	Remarks
1	Contractor's Representative	-Communication with Employer and Employer's representative -Decision and Direction to key stuff of O&M Contractor -Receive report from key stuff of O&M Contractor	1 Person
2	Operator at BTIC (10:00-17:30 on weekdays and Saturday except for the 2nd Saturday with 1 Shift)	(Operation) -Responding to enquiries from general public. -Observing operating status of ATCC and Queue Length Measurement System. -Observing traffic status on schematic map of video wall. -Observing operation status of server installed at KSDC from operator console. -Checking the error log of each server and ask according to the instruction of the representative of the Contractor -Comparing the inventory and spare parts periodically. -Establishing supplementary plan for spare part -Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. -Calculation of Availability quarterly based on incident reports.	1 Person 1 shift
		(Primary Response; when incident occurs) -Identifying situations and causes of system malfunctions. -Requesting Maintenance Team of O&M Contractor for response, in case of failure and incident. -Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. -Preparing and submitting incident reports to the Employer.	

No.	Position	Main functions	Remarks
3	Operator at TMC (8:00-20:00 including Saturday, Sunday, Holiday with 2 shift)	(Operation) - Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Calculation of Availability quarterly based on incident reports.	Two (2) Person Two (2) Shift
		(Primary Response; when incident occurs) -Identifying situations and causes of system malfunctions. -Requesting Maintenance Team of O&M Contractor for response, in case of failure and incident. -Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. -Preparing and submitting incident reports to the representative of the Employer.	
4	Call Center Operator at Contractor's local office	-Receiving phone call information/data from the Operator and related party at O&M local office -Record the call information/data -Providing necessary information/data to related party	1 Person
5	Chief Engineer for Periodic Inspection & Preventive Maintenance	-Lead the Periodic Inspection & Preventive Maintenance activity and Team	1 Person each for BTIC & TMC Systems
6	Maintenance Team for Periodic Inspection & Preventive Maintenance	-Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer -Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. -Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version	Routine Operation

No.	Position	Main functions	Remarks
7	Local Staff (Remote service from O&M local office)	(Routine Operation) -Remote diagnostics periodically for confirming operation status of server at KSDC from PC at Contractor's office. (Emergency) -Identifying situations and causes of system malfunctions. -Rectifying malfunction remotely. -Providing necessary information about incidents as per request from TMC operators.	Routine Operation and Emergency
8	Supporting Japanese Staff (Remote service from Japan HQ)	-Remote service from O&M local office to inspect the system -Remote service from Japan HQ to resolve the problem -Support to Local stuff (Remote service from O&M local office)	If necessary
9	Team Leader for road side service	-Oversight and management of the on-site service team	1 Person each for BTIC & TMC Systems
10	Local Engineer for road side service	-Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts -Replacement and resolution of damaged facility -Repairing retrieved defective/damaged parts if repairing is possible.	When failure occurs

(Source: JICA Study Team)

Table 2-33 Minimum Experience of Major Positions of the Contractor

Position	Minimum Experience
Contractor's Representative	■ Work Experience of ITS:10 years ■ Work Experience of Maintenance of ITS: 5 years
Operator	■ Work Experience of IT: 8 years ■ Language: Fluent in English and local language
Call Centre Operator	■ Language: Fluent in English, Kannada, and Hindi
Chief Engineer for Periodic Inspection and Preventive Maintenance	■ Work Experience of ITS: 10 years ■ Maintenance Work Experience of Similar Works as Project Manager, Chief Engineer or Equivalent Position: 5 years
Team Leader for On-site Service	■ Work Experience of IT: 10 years

(Source: JICA Study Team)

2-4-5 Performance Target and Payment Reduction for O&M Service

2-4-5-1 Performance Target

The Contractor shall endeavour to attain the performance target according to severity levels by risks of incidents which are described in the following Table 2-34. Severity (Critical, Major, Minor) of incidents are defined according to risks to road users while required response time and resolution time are defined according to severity. In case of occurrence of incidents, the Contractor shall perform less than the indicated response and resolution time as shown in Table 2-34.

Table 2-34 Definition by Severity of Incidents

<table>
<tr><th rowspan="2">Severity of Incidents</th><th rowspan="2">Definitions</th><th rowspan="2">Response Time</th><th colspan="2">Resolution Time</th></tr>
<tr><th>System Failure</th><th>Facility Incident at Site</th></tr>
<tr><td>Critical</td><td>Incidents which have high possibility of immediately impairing road user's safety.</td><td>< 1 hour</td><td>< 6 hours</td><td rowspan="3">< 24 hours</td></tr>
<tr><td>Major</td><td>Incidents which may impair road user's safety.</td><td>< 1 hour</td><td>< 12 hours</td></tr>
<tr><td>Minor</td><td>Failures of control system that does not have any possibility to impair road users' safety</td><td>< 2 hours</td><td>< 24 hours</td></tr>
</table>

(Source: JICA Study Team)

2-4-5-2 Categorize of Severity

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to determine it.

Examples of the incidents of each severity for BTIC and TMC are shown in Table 2-35.

Table 2-35 Examples of Incidents by Severity for BTIC

Severity	Example
Critical Incident	■ Seriously damaged ATCC / Que length pole(s) by traffic accident, which has already collapsed and/or will probably collapse.
Major Incident	■ Damaged ATCC / Que length pole(s) by traffic accident, which will not probably collapse immediately.
Minor Incident	■ Slight damage on ATCC/Que length pole(s) by traffic accident, which will not collapse; ■ Miscommunication among BMTC System/BTIC/Sensors; and ■ Sending abnormal data from BTIC to TMC/Internet.

(Source: JICA Study Team)

Table 2-36 Examples of Incidents by Severity for TMC

Severity	Examples
Critical Incident	■ Green-Green conflict of signal; ■ Red and yellow blinking of signal; ■ Light out of signal lamp; ■ Lighting plural number of signal lamp simultaneously; and ■ Seriously damaged signal pole(s) and/or VMS gantry by traffic accident, which has already collapsed and/or will probably collapse.
Major Incident	■ Damaged signal pole(s) and/or VMS gantry by traffic accident, which will not probably collapse immediately; and ■ Light out of some signal ramps due to halt of the signal system, which makes road users have difficulties to identify the signal phase.
Minor Incident	■ Slight damage on pole(s) or gantry(s) by traffic accident, which will not collapse; ■ Miscommunication among BTIC/TMC/controller/signal/VMS; ■ Sending abnormal data from TMC to signal/VMS; ■ Insufficient illuminance of signal ramp/VMS; and ■ Light out of VMS screen.

(Source: JICA Study Team)

2-4-5-3 Performance Target of Availability

(1) Performance Target

Availability of the System is evaluated quarterly and its Performance Target is 99%.

(2) Evaluation Method

System availability is calculated according to down time responsible for the Contractor. The formula of calculation of availability is shown as follows:

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): "Total time during the System are not available.
Downtime is calculated based on the following unit; when some signals are not available at one junction, the Down time is not calculated to each signal but to one junction.

Downtime is calculated based on the following units;

BTIC

(1) ATCC/Que length sensors: Site basis;
(2) Operator consoles: Console basis; and
(3) Servers: Server basis:

TMC

(1) Signals: Junction basis;
(2) VMSs: Site basis;
(3) Operator consoles: Console basis; and
(4) Servers: Server basis:

Total time (hours): Total time of evaluation period (3 months; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g., traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, and vandalism) and works instructed by the employer.

The permissive downtime of emergency response that is not attributable to the Contractor will be determined by mutual negotiation. The Contractor shall report unavoidable downtime including response time and resolution time, and the Employer shall assess the downtime and permit the Contractor to consider the downtime for the calculation of the availability. Failure to meet the Target Availability requirements by the Contractor shall be a sufficient cause for the Employer to authorize repairs to be completed by others and reduce the costs of such repair from payments due the Contractor. Repetitive failure shall be a sufficient cause for The Employer to terminate the Contract.

2-4-5-4 Payment Reduction

The Contractor's performance is evaluated based on the difference between target availability and actual availability. When the availability does not reach the target availability, the Employer can deduct the calculated amount from O&M payment according to the following formula.

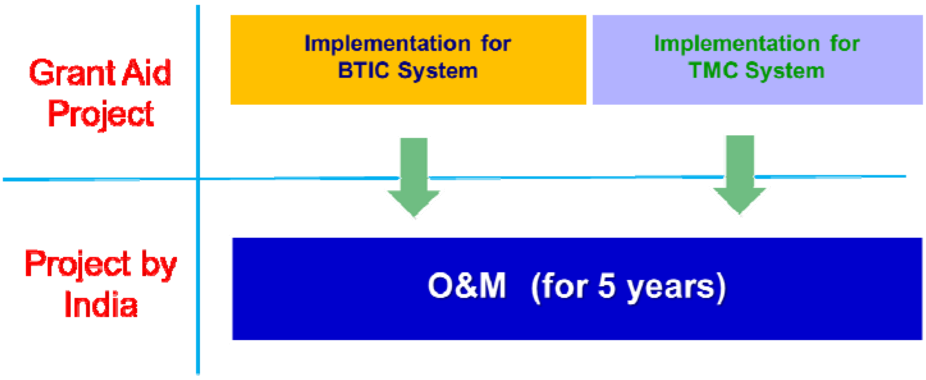
Payment Reduction =
Lump sum portion of O&M payment(Target availability (%) – Availability (%))/50*

E.g.,) Downtime: 110 hr, Total time: 2160 hr (24 * 90), Permissive Downtime: 60 hr, Target availability: 99%, O&M payment for 3 months: INR 0.8 Crores
Availability = (1 - ((110 - 60) / (2160 - 60))) * 100, Availability = 97.62%
Payment Reduction = 80 * (99 - 97.62) / 50

2-4-6 O&M Contract

2-4-6-1 Scheme of the Project

After completion of the implementation for the BTIC System and TMC System in the grant aid project, the O&M of these systems will be conducted by the Indian side for five (5) years. Figure 2-32 summarizes the scheme of the Project.

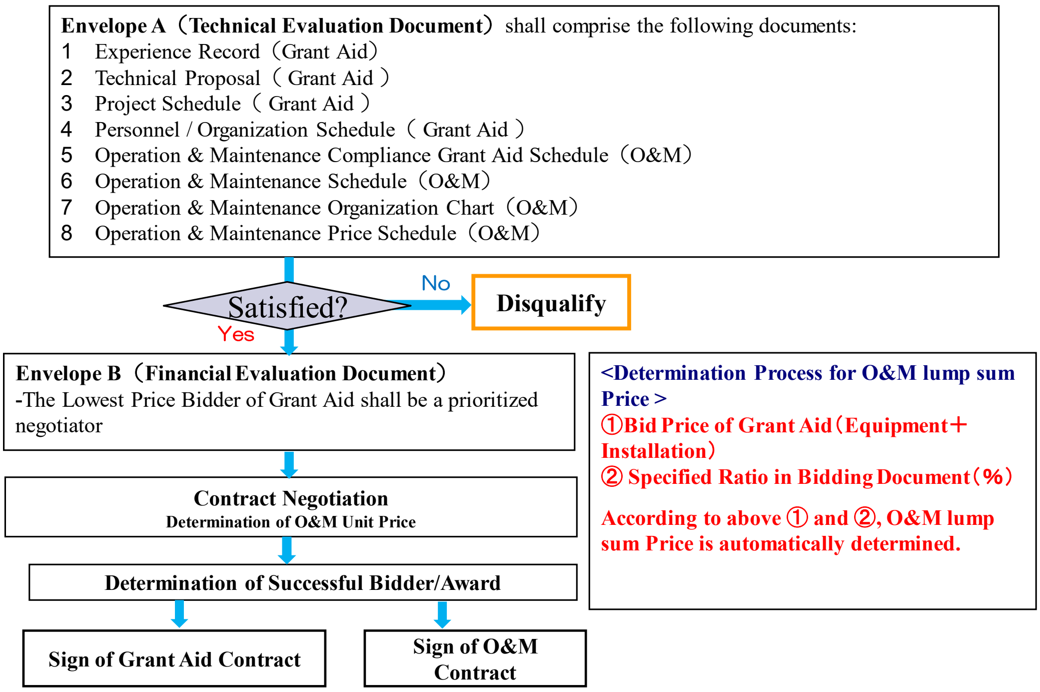


(Source: JICA Study Team)

Figure 2-32 Scheme of the Project

2-4-6-2 Bidding Method

The contract for the grant aid project and the contract for the O&M Service are necessary for the bidding according to Figure 2-33.



(Source: JICA Study Team)

Figure 2-33 Bidding Flow of the Project

2-4-6-3 Study of Related Existing Contract

In order to prepare an appropriate O&M contract for the Project, the related existing contracts have been collected and examined as follows:

(1) FIDIC Gold Book (Conditions of Contract for Design, Build and Operate Projects)

- This form is for large-scale and long-term projects.
- The clauses related to operation would be for reference of the O&M contract.
- Performance damages for production outputs are stipulated.

(2) BTP Contracts

- There are existing contracts for supply, installation, commissioning and maintenance of IT equipment.
- Those contracts are based on the form of contract for small works used by multilateral development banks (hereinafter referred to as "MDBs") such as the World Bank (hereinafter referred to as "WB"), Asian Development Bank (hereinafter referred to as "ADB"), and JICA, with modifications of the General Conditions.
- "Penalty" for maintenance service is additionally stipulated.

(3) DULT Contracts

- There are existing contracts for supply, installation, commissioning and maintenance of IT equipment.
- The contract for Mysore ITS Project funded by WB (Global Environment Facility) is based on WB's form of contract for information system (Design, Supply and Installation), and there is no clause for "Penalty" for maintenance.
- The contract for Karnataka State Road Transport Corporation (hereinafter referred to as "KSRTC") ITS Project seems to be an original form and stipulates "Penalty" for maintenance service.

(4) MDBs Small Works Contract

- The form of contract is simple and BTP uses this form (with modifications).
- This is for construction works and not suitable for contracts only for maintenance service.

(5) WB Management Service Contract

- This is dedicated for facility management services, that is, O&M Services.
- Basic concept is no "Penalty" as below.
- Clause 7. Performance Targets: Failure to achieve the performance targets will not result in any penalty, or create grounds for termination of the contract, except to the extent specified in Schedule C or Schedule G.

(6) WB Output and Performance-based Road Contract

- There are clauses related to payment reductions due to failure to meet the performance targets.

(7) Others

- Repair and Maintenance Contract (Joint Contracts Tribunal, UK)

2-4-6-4 Preparation of Form of the O&M Contract (Draft)

Based on the examinations of related existing contracts mentioned in「2-4-6-3 Related Existing Contract」, the General Conditions of WB Management Services Contract has been concluded to be the most appropriate for the O&M contract of the Project.

This contract is originally a part of the contract for large-scale and long-term PPP project that has constant revenue and therefore some complicated clauses are included.

Meanwhile, the O&M Services of the Project are simply a kind of after-sales service for equipment.

Therefore, unnecessary definitions and clauses in WB Management Services Contract such as “Utility”, “Account”, and “Management Authority” should be excluded.

In addition, the WB Management Services Contract is subject to copyright.

Table 2-37 Summary of O&M Contract

Item	Summary
(1) General Conditions	■ World Bank Management Service Contract is used.
(2) Particular Conditions	■ The employer is DULT. ■ DULT will issue power of attorney to BTP as Employer’s Representative for O&M Service within BTP. ■ Payment reductions due to failure to meet the requirements are additionally stipulated. ■ Independent expert for dispute resolution who is stipulated in the above general conditions remained. Remunerations for the independent expert will be borne by the employer and the Contractor on halves.

(Source: JICA Study Team)

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

2-5-1-1 Estimation Conditions

- Date of Estimation: July 2016
- Foreign Exchange Rate: USD 1 = JPY 109.04
- Foreign Exchange Rate: INR 1 = JPY 1.47
- Others: The Project will be implemented in accordance with the Guidelines for Japan’s Grant Aid

2-5-1-2 Japanese Portion

This section is closed due to confidentiality.

2-5-1-3 Indian Portion

Estimated cost of the Indian portion is shown in Table 2-38.

Table 2-38 Estimated Cost of India Portion

Item	Unit	Amount (INR)	Japanese Yen (JPY)
1) Replacement of signal pole	Lot	1,345,000	1,977,150
2) Installation of HDPE pipe (32 mm/ 2 ways) and installation of electricity (power cable) and telecommunication cable (Optical fibre cable)	Lot	3,612,000	5,309,640
3) Wiring work for power cable and optical fibre cable (DULT Building, Data Centre and BTP)	Lot	126,000	185,220
4) Replacement of gantry and etc.	Lot	349,000	513,030
5) Maintenance spare parts (Signal pole and sensor pole)	Lot	1,013,000	1,489,110
Total		6,445,000	9,474,150

(Source: JICA Study Team)

In addition to the above expenses, there are banking arrangement (hereinafter referred to as “B/A”), procedure fee, authorization to pay (hereinafter referred to as “A/P”), issuance fee, import permit to India and import tax and other tax burden. In order to smoothly implement the plan, it is necessary to secure these budgets in advance. The budget request should be done on April 2018.

2-5-2 O&M Cost

This section is closed due to confidentiality.

2-6 Tax Exemption

Basically, tax exemption should be adopted in the grant aid project, the survey team researched the procedures and stakeholders of tax matters in the actual implementation stage.

The result of the survey should be listed and described in minutes as evidences of undertakings of the recipient country with their schedule and project cost estimation.

And it should be noted that this information should be confirmed in the detailed design stage.

Furthermore, the team also researched the new tax law, "The Goods and Services Tax (hereinafter referred to as "GST")" has revolutionized the Indian taxation system. The GST Act was passed in and came into effect from 1st July 2017.

2-6-1 Contents of the Research

The survey team researched the application process for claiming such tax exemption or refund as follows:

- Required procedure for application of tax exemption and refund.
- Required Tax Items
- The application reception window
- Procedure of getting permission.
- Estimated time for getting approval of tax exemption and refund.
  etc.

2-6-2 Outsourcing

The JICA Study Team outsourced tax research to "Price Water House Coopers Pvt. Ltd" which is a specialized company for accountants.

2-6-3 New Taxation System GST

The new tax law "The Goods and Services Tax" has enforced as the Indian taxation system. The GST Act was passed in and came into effect from 1st July 2017.

Basic conception of GST is as follows:

1) GST is the indirect tax for the whole nation, which will make India one unified common market.
2) Simple application with online system. The applicant needs only one-time operation.

GST is incorporated from: Value Added Tax (VAT), Central Sales Tax, Excise Duty, Custom Duty, and Service Tax. Income Tax (corporate, personal) and Basic Custom Duty are excluded from GST.

GST consists of Central GST (CGST), State GST (SGST), Integrated GST (IGST) : beyond states and countries.

2-6-4 Tax Items

Outline of tax items in the project is shown in table below. Whether each tax item subject to exemption or refund is described from past records in India. Whether each tax of this project will be exempted or not will be confirmed through further survey.

Table 2-39 Outline of Tax Items

No.	Type	Items	Rate (%)	Exempt (Advanced / Reimbursed)	Contents
1	Indirect Tax	GST (CGST, SGST, IGST)	5,12,18,28	Exempt (Reimbursed)	No record. Announce from GOI
2		Basic Custom Duty	10	Exempt (Advanced)	From precedent
3		Education Cess	3	Exempt (Advanced)	From precedent
4	Direct Tax	Personal Income Tax	0,5,20,30,40,45	Exempt (Advanced / Reimbursed)	From precedent
5		Corporate Tax	40	Exempt (Reimbursed)	From precedent

(Source: JICA Study Team)

2-6-5 Outline of Procedure of Tax Exemption

(1) Requirements for Application

For making application of tax exemption and refund, it should be required to get PIN from central government and TIN from state government.

According to past results, it takes about two weeks to get PIN and TIN.

(2) Application of Tax Exemption

Basic custom duty, personal income tax, and corporate income tax are subject to the tax exemption. DULT will issue a letter based on the description of Exchange of Notes (E/N) and Grant Agreement (G/A) regarding the tax exemption to the Department of Finance (DOF) in the state government.

(3) Approval of Tax Exemption and Refund

Regarding approval of tax exemption, GOI indicated as below:

- GST is decided at ‘GST Council’ shall be held two times a month
- GST consists of the Finance Ministry officers if central and state government.
- The Contractor shall go through the same procedure as old tax system.
- Regarding GST, approximately 90% of the amount of applicated tax shall be refunded in a week, the rest will be refunded after the evaluation by certification authority. It takes about one year.

(4) Required Documents

For all tax items, the applicant shall submit documents about applicability of refund and discuss with certification authority. The minimum required documents for application are as follows:

- Exchange of notes (E/N) document
- Project outline document
- Documents to explain to certify the communality and usability of the Project.

Regarding required documents, the Contractor shall refer and research in each case.

2-6-6 Others

(1) Refund for Subcontractor

The refund for subcontractor is not applicable. It applies only to the main Contractor.

(2) Range of Application of Bilateral Tax Treaty between Japan and India

The Project is based on the premise covered by a bilateral tax treaty. The Contractor shall be applicable for all tax exemptions.

The rules of tax exemption between Japan and India are based on the treaty "Desiring to Amend the Convention between the Government of Japan and the Government of the Republic of India for the Avoidance of Double Taxation and the Prevention of Fiscal Evasion with respect to Taxes on Income"

However, this treaty covers only three items (interest of fund, income tax for a project of cultural exchange, and educational training fee). So, there is no item for this Project.

(3) Consideration

Although the new GST law has started, operation of this law is not working adequately because it is only few months passed since it enforced.

GOI announced that approximately 90% of the amount of applicated tax shall be refunded within 7 days, but the refund system has not prepared yet.

Therefore, the contents of this survey shall be updated and examined accordingly with paying attention to future progress of GOI.

Chapter 3 Project Evaluation

3-1 Preconditions

1) Permission for Construction

Receive the permission for the construction from related organizations of the city and country, when various equipment is installed on the city road, state highway, or national highway.

2) Budget and Tax Exemption for the Project

Be ready for the bank procedure and tax exemption, and to precede the budget.

3) BTIC Centre Maintenance

Maintain the air-conditioning, lightning, electrical and wiring facility of the BTIC at the second floor of DULT Building.

4) Coordination with KSDC

Coordinate with KSDC to install a server.

5) Assignment of the Person In-charge for Implementation

Assign the person in-charge for implementation from DULT and BTP, before project commencement.

Table 3-1 Project Content, Deadline and Charge

No.	Items	Deadline	In charge
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	DULT
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT

(Source: JICA Study Team)

3-2 Necessary Inputs by Recipient Country

Necessary inputs by recipient country is described separately; divided into the middle of the Project and after the Project as follows:

(1) Organization for the O&M

Assign the Employer Representatives for the O&M and supervision and coordination of the O&M Service so that the O&M is conducted suitably and effectively.

(2) Budget for the O&M

Approve the budget for the cost of conducting the O&M including the telecom and electronic companies.

3-3 Project Evaluation

3-3-1 Relevance

In order to keep pace with the increase of the traffic demand at Bengaluru Metropolitan Area, the development of road infrastructure is underway as the structural measure. But the core area in Bengaluru which has a serious traffic congestion has not enough space to expand the roads. Therefore, the urgent non-structural measure is required.

The target area of the Project is the central commercial area which has a serious traffic congestion around the MG Road. The mitigation of the traffic condition in the area greatly contributes to the economic development of the Bengaluru.

DULT is now engaged in the reinforcement of its personnel capable of planning the future road transportation plan including the ITS and BTP already has experience in operating the existing signal system, the existing Variable Message Sign system and etc. With these backgrounds, both DULT and BTP have enough personnel organizations and finance to operate and maintain the introduced system on the Project.

Considering the emergency of the Project, the effect to the economy and the operation and maintenance, the relevance of the Project is greatly expected.

3-3-2 Effectiveness

3-3-2-1 Direct Effects

The following direct effects are expected by the Project.

Table 3-2 Queue Length and Average Travel Speed

Index	Base Line (Measured Value in 2016)	Target Value (2022) <3 years after the completion of the Project>
Queue Length (Peak Hours 9:00-10:00)	Total of the longest queue length among all approaching roads at each junction (*1): 844.8 m	590 m (-30%)
	Total of the longest queue lengt h of all approaching roads at e ach junction (*1): 1576.9 m	970 m (-40%) (*2)
Average Travel Speed (*3) (Peak Hours 9:00-10:00)	13 Km/h	15 Km/h

(*1) 7 key junctions among all 29 junctions
(*2) Estimated value based on the reduction rate of 30% for the maximum length at each junction, also considering the reduction rate of approaching roads
(*3) Major arterial roads in the central area of the city

(Source: JICA Study Team)

Table 3-3 Wasted Green Time at Key Junction

	Junction Name	Operating Hours of Traffic Signal Per Day (Minutes)	Wasted Green Time Per Day (*1)	
			Minutes	Percentage
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*2)	81	34%
07	Vivekananda / Bhaskaran Junction	900	510	57%

(*1) The wasted green time: If there is no vehicle passing through the junction during green signal indication due to absence of traffic, it shall be recorded with time as Wasted Green Time. Measured value in 2017.
(*2) The survey time at this junction was limited to the above indicated duration.
The reduction of the wasted green time will be expected by introducing the ITS systems on the Project.

(Source: JICA Study Team)

3-3-2-2 Indirect Effect

Mitigation of traffic congestion, enhancement of convenience through improved punctuality of travel time and consequently development of local economy is expected in Bengaluru metropolitan area.

3-4 Evaluation of the Effect of the Introduced System

3-4-1 Traffic Information System

3-4-1-1 Purpose

The evaluation of the traffic information system shall be conducted to confirm whether there is a large discrepancy between the actual travel time and estimated travel time shown on VMS (at 3 locations). If it is observed, the system shall be adjusted.

3-4-1-2 Parties to Carry Out Verification/Adjustment and Their Roles

The following evaluations shall be conducted under the responsibility of the Contractor. (The local survey described below may be outsourced to the local survey Consultant by the Contractor as necessary.)

3-4-1-3 Methodology

The following survey and verification shall be conducted by the Contractor once a year.

(1) Local Survey

Actual travel time required from the location of VMS installed to main destinations displayed on VMS by alternative routes (about 3 routes) shall be measured by running vehicles. The estimated travel time for each route shown on VMS shall be recorded when they start. The conditions of the routes to the direction of travel shall also be recorded by a driving recorder during running.

The above survey shall be conducted for two days of weekdays and one day of holidays at morning peak hours, evening peak hours and other off-peak hours at three locations of VMS.

(2) Evaluation

Based on the above site survey results, compare the estimated travel time calculated by the system and actual required travel time, and confirm whether they are boldly separated. If boldly separated, inspect the cause, and conduct system adjustment as necessary.

3-4-2 Signal System

3-4-2-1 Purpose

The evaluation of the signal system shall be performed basically once a year for two purposes, i.e. evaluation of the short-term index for the effect of the introduced system and adjustment of the system.

3-4-2-2 Parties to Carry Out Evaluation/Adjustment and Their Roles

The evaluation of the short-term index shall be performed by the Consultant, that will be contracted with the Indian authority, as a third-party and the adjustment of the system shall be carried out by the Contractor.

3-4-2-3 Consultant's Work

Indian side will make a contract with the Consultant apart from the Consultant being engaged in the grant aid project for the evaluation of the system.

The site surveys for the purposes of the evaluation of the short-term index and adjustment of the system shall be conducted. The short-term index shall be verified to assess the effect of the introduced system based on the result of the site survey and the system history information.

(1) Site Survey

The site surveys shown in Table 3-4 shall be conducted. The results of these surveys shall be further provided to the Contractor to utilize for the system adjustment.

Table 3-4 List of Site Survey to be Conducted by the Consultant

Survey Item	Survey Content
Travel Time /Delay Time Survey	Measuring travel time and delay time (stop time at junctions) on the target routes for introduction of Signal System
Junction Traffic Volume Survey in Each Direction	Counting traffic volume of approaching roads at the key j unctions (7 junctions)
Passing Traffic Volume Survey	Counting passing traffic volume per unit of time during gr een indication at the key junctions (7 junctions)

(Source: JICA Study Team)

(2) Evaluation Item

The short-term indexes for the system introduction effect are shown in Table 3-4-2. The Consultant evaluates the system introduction effects by verifying each short-term index.

Table 3-5 Queue length and Average Overall Travel Speed Reference value

Index	Base Line Value (Measured Value in 2016)
Queue Length (Peak Hour: 9:00-10:00)	Total of the longest queue length among all approaching roads at each junction (*1): 844.8 m
	Total of the longest queue length of all approaching roads at each junction (*1): 1576.9 m
Average Travel Speed (*2) (Peak Hour: 9:00-10:00)	13 km/h

(Source: JICA Study Team)

(*1) For 7 key junctions among 29 junctions (*2) Major arterial roads in the central area of the city

Table 3-6 Wasted Green Time at Key Junction – Base Line Value

	Junction Name	Operating Hours of Traffic Signal Per Day (Minutes)	Base Line Value of Wasted Green Time Per Day (*1)	
			Minutes	Percentage
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*2)	81	34%
07	Vivekananda / Bhaskaran Junction	900	510	57%

(Source: JICA Study Team)

(*1) Measured value in 2017, (*2) The survey time at this junction was limited to the above indicated duration.

(3) Evaluation Policy for Short-term Index

The following items shown in Table 3-7 shall be evaluated to confirm whether the base line values of the short-term index are improved as the system introduction effect.

Table 3-7 Evaluation Items by Confirmation Purpose

Confirmation Purpose	Evaluation Item	Data Source
Improvement of Average Travel Speed	Travel Time / Delay Time	(Site Survey)
Reduction of Wasted Green Time	Passing Traffic Volume	(Site Survey)
Improvement of Queue Length	Queue Length (*1)	O&M Contractor (*2)

(Source: JICA Study Team)

(*1) Key intersections（7 intersections）in each direction, (*2) Data to be acquired from the system log

(4) Contractor's Work

The Contractor shall adjust the signal control parameter for cycle, split and off-set based on the results of the local surveys conducted by the Consultant and the information of the system logs.

1) System Adjustment Method

The following items shown in Table 3-8 shall be evaluated for adjustment of signal control parameters for cycle, split and off-set.

Table 3-8 Confirmation Item for System Adjustment

System Adjustment Purpose	Evaluation Item	Data Source
Improvement of changes in traffic flow	Travel Time/Delay Time	(Site Survey)
Improvement of changes in green time	Passing Traffic Volume	(Site Survey)
Reduction of wasted green time	Passing Traffic Volume	(Site Survey)
Reduction of dead green time	Passing Traffic Volume	(Site Survey)
Improvement of handling traffic at junctions	Passing Traffic Volume	(Site Survey)
Increase/decrease in congestion and Improvement of disproportionate degree of congestion	Queue Length (*1)	O&M Contractor (*2)

(*1) Key junctions (7 junctions) in each direction, (*2) Data to be acquired from system log

(Source: JICA Study Team)

2) Data Provision to the Consultant for Evaluation of Short-term Index for System Introduction Effect

The data of queue length by direction at the key junctions (7 junctions) acquired from Signal System shall be provided to the Consultant by the Contractor. The data will be used for evaluation of the short-term index for the effect of the introduced system. The data should be summarized in such forms as hourly queue length by direction at each junction, etc. It should also be prepared in a way that it is sufficiently easy to understand for a third party.

= End of Document =

Appendix-1

Member List of the Study Team

Member List of the Study Team

No.	Title	Name	Organization
1	Team Leader	Shuntaro KAWAHARA	Infrastructure and Peacebuilding Department, JICA
2	Project Planning	Yoshihiro KAWASAKI	Team 1, Transportation and ICT Group, Infrastructure and Peacebuilding Department, JICA
3	Project Planning	Hidetaka SAKABE	Team 1, Transportation and ICT Group, Infrastructure and Peacebuilding Department, JICA
4	Project Planning	Yuichi ICHIKAWA	Grant Aid Project Management Division 1, Financial Cooperation Implementation Department , JICA
5	Chief Consultant/Traffic Plan1	Masato OKUDA	Nippon Koei Co., Ltd.
6	Deputy Chief Consultant/Traffic Plan 2	Hiroya TOTANI	Nippon Koei Co., Ltd.
7	Traffic control system Plan	Noboru KONDO	East Nippon Expressway Co., Ltd.
8	Signal system Design	Motoyoshi NODA	Nippon Koei Co., Ltd.
9	Control sytem Design	Eiji WAKATSUKI	East Nippon Expressway Co., Ltd.
10	Road side system Design	Masahito TAKAHASHI	Nippon Koei Co., Ltd.
11	Intersection improvement Plan	Michio ISEKI	Nippon Koei Co., Ltd.
12	Procurement Plan/Cost Estimate	Yuichiro OTSUKA	Nippon Koei Co., Ltd.
13	Implementation Plan/Cost Estimate	Teruhiro TAHARA	Nippon Koei Co., Ltd.

Appendix-2

Study Schedule

Schedule of the First Field Survey

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Feb	27	Sat				***Arrival at Bengalure***	***Arrival at Bengalure***						
	28	Sun			***Arrival at Bengalure*** AM Internal Meeting PM Site survey for signal	AM Internal Meeting PM Site survey for signal	AM Internal Meeting PM Site survey for signal						
	29	Mon			AM Internal Meeting with Local engineer PM Meeting with DULT	AM Internal Meeting with Local engineer PM Meeting with DULT	AM Internal Meeting with Local engineer PM Meeting with DULT						
Mar	1	Tue			AM Site survey for VMS PM Meeting with BMTC at BMTC	AM Site survey for VMS PM Meeting with BMTC at BMTC	AM Site survey for VMS PM Meeting with BMTC at BMTC						
	2	Wed			AM Site survey for VMS PM Meeting with BTRAC at BTRAC	AM Site survey for VMS PM Meeting with BTRAC at BTRAC	AM Site survey for VMS PM Meeting with BTRAC at BTRAC						
	3	Thu	***Arrival at Bengalure***		AM Preparation for Traffic survey	AM Preparation for Traffic survey	AM Preparation for Traffic survey						
	4	Fri	AM Internal Meeting PM Data Centre (KDSC)		AM Internal Meeting PM Data Centre (KDSC)	AM Internal Meeting PM Data Centre (KDSC)	AM Internal Meeting PM Data Centre (KDSC)						
	5	Sat	PM Meeting with DULT at DULT		PM Meeting with DULT at DULT	PM Meeting with DULT at DULT	PM Meeting with DULT at DULT						
	6	Sun	Documentation		Documentation	***Departure from Bengalure***	Documentation						
	7	Mon	Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)		Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)		Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)						
	8	Tue	AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC		AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC		AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC						
	9	Wed	PM Discussion with DULT, BMTC BTRAC and BBMP on M/D		PM Discussion with DULT, BMTC BTRAC and BBMP on M/D		PM Discussion with DULT, BMTC BTRAC and BBMP on M/D						
	10	Thu	***Departure from Bengalure***		AM Discussion with Trimax and PWC on BMTC existing system PM Finalization of M/D with DULT		AM Discussion with Trimax and PWC on BMTC existing system PM Finalization of M/D with DULT						
	11	Fri			***Departure from Bengalure***		***Departure from Bengalure***						

Schedule of the Second Field Survey

Day		JICA		Consultant								
		Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
	1 Fri					***Arrival at Bengalure***		***Arrival at Bengalure***	***Arrival at Bengalure***			
	2 Sat					Internal Meeting Meeting with DULT		Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT			
	3 Sun											
	4 Mon			***Arrival at Bengalure***	***Arrival at Bengalure***	I/F&Analyze of Probe data		Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	***Arrival at Bengalure***		
	5 Tue			I/F&Analyze of Probe data	Traffic Survey Review	I/F&Analyze of Probe data		Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	6 Wed			I/F&Analyze of Probe data	Traffic Survey Review	I/F&Analyze of Probe data	***Arrival at Bengalure***	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	7 Thu			Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx3)	Equipment location & Pow/Com (BTRAC)	Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	8 Fri			Equipment location & Pow/Com (BTIC)	Equipment location (Signalx3)	Equipment location & Pow/Com (BTIC)	Equipment location & Pow/Com (BTIC)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	9 Sat			Equipment Location (VMSx3)	Equipment location (Signalx3)	Equipment Location (VMS)	Equipment Location (VMS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	10 Sun											
	11 Mon			I/F&Analyze of Probe data	Equipment location (Signalx3)	I/F&Analyze of Probe data	I/F&Analyze of Probe data	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	12 Tue			Equipment Location (VMSx3)	Equipment location (Signalx3)	Equipment Location (VMS)	Equipment Location (VMS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	13 Wed			Equipment location & Pow/Com (KSDS)	Equipment location (Signalx3)	Equipment location & Pow/Com (KSDS)	Equipment location & Pow/Com (KSDS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
April	14 Thu			Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx2)	Equipment location & Pow/Com (BTRAC)	Equipment location & Pow/Com (BRTC)	Equipment location (Signalx2)	Pow/Com & Buried material (Signalx2)	IS Improvement Concept (Signalx2)		
	15 Fri			Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)	***Departure from Bengalure***	Equipment location & Pow/Com (BTIC)	***Departure from Bengalure***	Buried Material Spare (Signalx3)	IS Improvement Concept (Signalx3)		
	16 Sat			Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		Equipment location & Pow/Com (BRTC)		Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		
	17 Sun				***Departure from Bengalure***							
	18 Mon			***Departure from Bengalure***			I/F&Analyze of Probe data		Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		
	19 Tue						Pow/Com & Buried material (VMSx2)		Pow/Com & Buried material (VMSx2)	IS Improvement Drawing (signalx3)		
	20 Wed						Pow/Com & Buried material (VMSx1)		Pow/Com & Buried material (VMSx1)	IS Improvement Drawing (signalx3)		
	21 Thu						location/Cable Drawing (BTIC)		Select Trial Digging location	IS Improvement Drawing (signalx3)		
	22 Fri						location/Cable Drawing (BTRAC)		location/Cable Drawing (VMS)	IS Improvement Drawing (signalx3)		
	23 Sat						location/Cable Drawing (KSDS)		Contract of Trial Digging	IS Improvement Drawing (signalx3)		
	24 Sun						***Departure from Bengalure***					
	25 Mon								Trial Digging Test (VMS)	IS Improvement Drawing (signalx3)		
	26 Tue								Trial Digging Test (Signal)	IS Improvement Drawing (signalx3)		
	27 Wed								***Departure from Bengalure***	***Departure from Bengalure***		
	23 Thu				***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***		***Arrival at Bengalure***	***Arrival at Bengalure***
	24 Fri				Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT		Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT
	25 Sat				Basical Concept of OM (BTIC/KSDS)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Centre Equipment & Installation (TMC/KSDS)	Centre Equipment & Installation (TMC/KSDS)
	26 Sun											
Jun	27 Mon				Basical Concept of OM (BTRAC)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (VMSx1)	Equipment location & Pow/Com (VMSx1)
	28 Tue				Basical Concept of OM (BTIC/KSDS)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (VMSx2)	Equipment location & Pow/Com (VMSx2)
	29 Wed			***Arrival at Bengalure***	Basical Concept of OM (BTRAC)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Gathering information of the Sub Contractor	Gathering information of the Sub Contractor
	30 Thu			***Meeting with DULT***	***Meeting with DULT***	***Meeting with DULT***	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx4)	Equipment location & Pow/Com (Signalx4)
	1 Fri			***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTIC/KSDS)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTIC/KSDS)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)		***Meeting with Commissioner DULT*** Equipment location & Pow/Com (Signalx5)	***Meeting with Commissioner DULT*** Equipment location & Pow/Com (Signalx6)
	2 Sat			***Meeting with DULT on OM***	***Meeting with DULT on OM***	Basical Concept of OM &TS (BTIC/KSDS)	Basical Concept of OM &TS (BTIC/KSDS)	Basical Concept of OM & TS(BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	3 Sun											
	4 Mon			***Meeting with BRTC on OM***	***Meeting with BRTC on OM***	***Meeting with Trimax on BMTC I/F***	***Meeting with Trimax on BMTC I/F***	***Meeting with BRTC on OM***	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	5 Tue			***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***		***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***
	6 Wed			Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)		Meeting on Basic Concept of TS &OM (DULT)	Meeting on Basic Concept of TS &OM (DULT)
	7 Thu			***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Departure from Bengalure***	***Meeting with Commissioner DULT***		***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***
	8 Fri			***Sign of Comissioner DULT***	***Sign of Comissioner DULT***	***Departure from Bengalure***	***Departure from Bengalure***		Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	9 Sat			***Departure from Bengalure***	***Departure from Bengalure***				Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Quex1)	Equipment location & Pow/Com (Quex1)
July	10 Sun											
	11 Mon								Gathering information of the Sub Contractor		Gathering information of the Sub Contractor	Gathering information of the Sub Contractor
	12 Tue								Equipment location & Pow/Com (Quex1)		Equipment location & Pow/Com (Quex1)	Equipment location & Pow/Com (Quex1)
	13 Wed								Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	14 Thu								***Departure from Bengalure***		Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	15 Fri										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	16 Sat										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	17 Sun										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	18 Mon										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	19 Tue										Equipment location & Pow/Com (ATCCx2)	Equipment location & Pow/Com (ATCCx2)
	20 Wed										Equipment location & Pow/Com (ATCCx3)	Equipment location & Pow/Com (ATCCx3)
	21 Thu										Equipment location & Pow/Com (ATCCx3)	Equipment location & Pow/Com (ATCCx3)
	22 Fri										***Departure from Bengalure***	***Departure from Bengalure***

Schedule of the Third Field Survey

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Dec	7	Wed			***Arrival at Bengalure***					***Arrival at Bengalure***			
	8	Thu			Internal Meeting with Counterpart Meeting with Commercial Tax Department					Internal Meeting with Counterpart Meeting with Commercial Tax Department			
	9	Fri			Meeting with DULT ITS Special Officer					Meeting with DULT ITS Special Officer			
	10	Sat			Documentation					Documentation			
	11	Sun			Documentation					Documentation			
	12	Mon			Meeting with Mr.P.N.Karanth Meeting with Shimizu Corp. India					Meeting with Mr.P.N.Karanth Meeting with Shimizu Corp. India			
	13	Tue			Discussion with Bharat Sanchar Nigam Ltd					Discussion with Bharat Sanchar Nigam Ltd.			
	14	Wed			Meeting with DULT Commissioner Meeting with PWC					Meeting with DULT Commissioner Meeting with PWC			
	15	Thu			***Departure from Bengalure***					***Departure from Bengalure***			

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Jun	7	Sat			***Arrival at Bengalure***	***Arrival at Bengalure***				***Arrival at Bengalure***			
	8	Sun			Documentation	Documentation				Documentation			
	9	Mon			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	10	Tue			Documentation	Documentation				Documentation			
	11	Wed			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	12	Thu			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	13	Fri			Meeting with DULT Commissioner	Meeting with DULT Commissioner				Meeting with DULT Commissioner			
	14	Sat			Documentation	Documentation				Documentation			
	15	Sun			Meeting with Commercial Tax Department	Meeting with Commercial Tax Department				Meeting with Commercial Tax Department			
	16	Mon			Discussion with Bharat Sanchar Nigam Ltd.	Discussion with Bharat Sanchar Nigam Ltd.				Discussion with Bharat Sanchar Nigam Ltd.			
	17	Tue			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	18	Wed			***Departure from Bengalure***	***Departure from Bengalure***				***Departure from Bengalure***			

Schedule of the Fourth Field Survey

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Apr	20	Thu		***Arrival at Delhi***									
	21	Fri		Meeting with JICA Office Meeting with JICA Experts	***Arrival at Bengalure***	***Arrival at Bengalure***							
	22	Sat		***Arrival at Bengalure***									
	23	Sun	***Arrival at Bengalure***	Site Survey						***Arrival at Bengalure***			***Arrival at Bengalure***
	24	Mon	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	25	Tue	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	26	Wed	Meeting with Karnataka State PM:***Departure from Bengalure***	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	27	Thu		AM:Leaving to Delhi PM:Meeting with MoUD	AM:Leaving to Delhi PM:Meeting with MoUD ***Departure from Delhi***	Meeting with Karnataka State	Meeting with Karnataka State ***Departure from Bengalure***			Meeting with Karnataka State			Meeting with Karnataka State
	28	Fri		***Departure from Delhi***		other duty				Meeting with Karnataka State ***Departure from Bengaluru***			Meeting with Karnataka State ***Departure from Bengaluru***
	29	Sat				Follow up work for Sub Contractor ***Departure from Bengaluru***							
	30	Sun											

Schedule of the Fifth Field Survey

Day			JICA		Consultant								
			Kawahara	**Sakabe**	**Okuda**	**Totani**	**Kondo**	**Wakatsuki**	**Noda**	**Takahashi**	**Iseki**	**Otsuka**	**Tahara**
Jun	28	Wed			***Arrival at Bengalure***	***Arrival at Bengalure***			***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***		***Arrival at Bengalure***
	29	Thu			Metting with DULT	Metting with DULT			Metting with DULT	Metting with DULT	Metting with DULT		Metting with DULT
	30	Fri			Metting with DULT	Metting with DULT			Metting with DULT	Metting with DULT	Metting with DULT		Metting with DULT
Jul	1	Sat			Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)			Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)		Metting with DULT(ITS Officer)
	2	Sun			Documantation	Documantation	***Arrival at Bengalure***	***Arrival at Bengalure***	Documantation	Documantation	Documantation		Documantation
	3	Mon			Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	***Arrival at Bengalure***	Meeting with BTP(Facility Management Contractor)
	4	Tue			Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP
	5	Wed	***Arrival at Delhi***	***Arrival at Delhi***	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)
	6	Thu	Meeting with JICA Meeting with MoUD	Meeting with JICA Meeting with MoUD	Meeting with JICA Meeting with MoUD	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP
	7	Fri	AM:Meeting with MoUD PM: DEL->BLR	AM:Meeting with MoUD PM: DEL->BLR	AM:Meeting with MoUD PM: DEL->BLR	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP
	8	Sat	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT
	9	Sun	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation
	10	Mon	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT
	11	Tue	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT
	12	Wed	Signing of M/D PM: BLR->DEL	Signing of M/D PM: BLR->DEL	Signing of M/D PM: BLR->DEL	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works
	13	Thu	Report to JICA Office (Follow up on MoUD)	Report to JICA Office (Follow up on MoUD)	Report to JICA Office (Follow up on MoUD)	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works
	14	Fri	***Departure from Delhi***	***Departure from Delhi***	***Departure from Delhi***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***

Appendix-3

List of Parties Concerned in the Recipient Country

List of Parties Concerned in the Recipient Coutry

Directorate of Urban Land Transport (DULT)	
Ms. Majula IAS	Commissioner, DULT
Mr. Darpan Jain IAS	Commissioner, DULT
Mr. N.Murali Krishna	ITS Special Officer
Mr. Shamanth.P.K	Head of TETC (Traffic Engineering Transportation Cell)
Mr. Siva Subramaniam.J	Transport Planner
Mr. Manohar Meena	ITS Specialist
Bengaluru Traffic Police (BTP)	
Mr. RI Kasim	Assistant Commissioner of Police (Traffic & Planning)
Mr. Diwakar	Traffic Police
Mr. Malikarjuna	Project Manager, CMS
Bengaluru Metropolitan Transport Corporation (BMTC)	
Mr. Bishwajit Mishra	Director (Information Technology)
Mr. Nagendra	Chief Manager
Bruhat Bengaluru Mahanagara Palike (BBMP)	
Mr. Basvaraj R Kabade	Executive Engineer, Traffic Cell

Appendix-4

Minutes of Discussions

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India headed by Mr. Shuntaro KAWAHARA, Senior Advisor, JICA, and is scheduled to stay in India from February 27 to March 11, 2016.

The Team held a series of discussions with the officials concerned of the Indian side and conducted a field survey in the Project area. In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works and prepare the Interim Report.

Bengaluru, March 10, 2016

川原 俊太郎

Shuntaro KAWAHARA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Dr. M. A. Saleem, IPS
Additional Commissioner
Bengaluru Traffic Police
Karnataka State Police
India

ATTACHMENT

1. Objective of the Project

The Objective of the project is to establish a new traffic control system through introduction of ITS equipment to the Karnataka Government, thereby contributing to relieving traffic congestion and environmental conservation in Bengaluru City Area.

2. Project Sites

Both sides confirmed that the sites of the Project are Bengaluru, which are shown in Annex-1-1 and Annex-1-2.

3. Executing Agency

Both sides confirmed the executing agency is Directorate of Urban Land Transport (hereinafter referred to as "DULT") : which is under the Department of Urban Development, Government of Karnataka. The executing agency shall coordinate with all the relevant agencies to ensure smooth implementation of the Project and ensure that the Undertakings are taken by relevant agencies properly and on time. The organization charts including relevant agencies are shown in Annex-2.

4. Items requested by the India side

4-1 As a result of discussions, both sides confirmed that the items requested by the India side are as follows:

Both sides reviewed the request contents and confirmed that request should be based on the Technical Review Report for Loan Assistance completed after the request for the Grant aid.

Request		Technical Review Report	
ITS Component	Quantity	ITS Component	Quantity
Traffic Information Centre	1 set	Center System	1 set
Probe Data Systems	6700 units	Probe System	1 set
Vehicle Detectors	5,000 units	Queue Length Measurement System	13 locations (100 units)
Traffic Counters	56 units	Automatic Traffic Counter-Com Classifier (ATCC)	8 locations (16 units)
VMS systems	6 units	Variable Message Sign System (VMS System)	3 units
-	-	Internet System	1 set
Advanced Signal Controllers	20 intersections	Signal Control System	20 intersections

AK

The both side agreed regarding the probe system of the Project as follows:

(1) The probe system would utilize GPS data generated by the bus-tracking system introduced by Bengaluru Metropolitan Transport Corporation (BMTC) although the availability of the GPS data must be verified by the Team during the second mission around April 2016;

(2) The India side would submit the GPS data set of bus-tracking system as early as possible; and

(3) The Project would not cover GPS devices attached to buses owed by the Corporation.

The Team requested India side that the bus tracking system of BMTC must be properly operated and maintain even after the end of five years BOT contract with TRIMAX in order to secure sustainability of the probe system of the Project.

4-2 JICA will assess the appropriateness of the above requested items through the survey and will report findings to the Government of Japan. The final components of the Project would be decided by the Government of Japan.

5. Japanese Grant Scheme

5-1 The India side understands the Japanese Grant Scheme and its procedures as described in Annex-3, Annex-4 and Annex-5, and necessary measures to be taken by the India side. A template of the Project Monitoring Report to be submitted by the executing agency is as attached in Annex 6.

5-2 The India side understands to take the necessary measures, as described in Annex 7, for smooth implementation of the Project, as a condition for the Japanese Grant to be implemented. The detailed contents of the Annex-7 will be worked out during the survey and shall be agreed no later than by the Explanation of the Draft Preparatory Survey Report.

The contents of Annex-7 will be used to determine the following:

(1) The scope of the Project.

(2) The timing of the Project implementation.

(3) Timing and possibility of budget allocation.

Contents of Annex-7 will be updated as the Preparatory Survey progresses, and will finally be the Attachment to the Grant Agreement.

5-3 To respond questions of Indian side, the Team explained as follows.

(1)Ex-Post Evaluation

JICA will conduct ex-post evaluation three (3) years after the project completion with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability) of the Project. Result of the evaluation will be publicized. The Indian side is required to provide necessary support for them.

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(2)Source country and specification of products and services

The Grant Aid may be used for the purchase of the products or services of a third country other than Japan and India, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project. The functions and specifications of products procured by the Project will be carefully considered during the preparatory survey consulting the Indian relevant agencies, and finalized in the tender document approved by the Executing Agency.

6. Schedule of the Survey

6-1 The Team will proceed with further survey in India until March 11, 2016.

6-2 JICA will prepare an Interim Report in English and dispatch a mission around April 2016 to explain the result of scoping the project site for installation of equipment. And the Team proceeds to collect information to design specifications of equipment.

6-3 The Team will prepare a draft Preparatory Survey Report in English and dispatch a mission to India in order to explain its contents around July 2016.

6-4 If the contents of the draft Preparatory Survey Report is accepted in principle and the Undertakings are fully agreed by the India side, JICA will complete the final report in English and send it to India around October, 2016.

6-5 The above schedule is tentative and subject to change.

7. Environmental and Social Considerations

7-1 The India side confirmed to give due environmental and social considerations during implementation of the Project, and after completion of the Project, in accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010).

7-2 The Project is categorized as Category C because the scope of the Project is limited to installation of equipment, and its potential adverse impacts on the environment are not likely to be significant. The India side confirmed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Environmental Impact Assessment (EIA) /Initial Environmental Examination (IEE) and information disclosure, etc.) and make EIA/IEE report of the Project as needed. The EIA/IEE approval shall be received from the responsible authorities and submitted to JICA before the Cabinet approval of the Project by the Government of Japan.

7-3 The India side confirmed the Project would not need EIA/IEE approval by the Indian relevant agencies.

8. Other Relevant Issues

8-1 Provision of Conveniences to the Team by the India Side

The India side shall, at its own expenses, provide the Team with the following items in cooperation with DULT and other organizations concerned.

(1) Security-related information as well as measures to ensure the safety of the Team members;
(2) Data and information necessary for the Survey.
(3) Counterpart personnel;
(4) Suitable office space with necessary equipment and services;
(5) Credentials or identification cards;
(6) Appointments arrangement;
(7) Entry permits necessary for the Team members to conduct field surveys; and
(8) Support in obtaining other privileges and benefits if necessary including:
   1) Permission to photograph and to enter into private properties and restricted areas for the Team for proper execution of the Survey, if necessary, and
   2) Arrangement to allow the Team to bring back to Japan any necessary data, maps and materials related to the survey, subject to approval by the Government of India, in order to analyze the Project and prepare the reports.

8-2 Responsible organizations for ITS introduction and operation

As a result of discussions, both sides confirmed In-charge organizations of ITS by the India side are as follows:

ITS Component		Implementation (Procurement)	Operation & Maintenance	Ownership
Bengaluru Traffic Information System	Centre System Probe System Queue Length Measurement System Automatic Traffic Counter-Com Classifier Internet System	DULT, Government of Karnataka	DULT, Government of Karnataka	DULT, Government of Karnataka
	Variable Message Sign System	DULT, Government of Karnataka	Bengaluru Traffic Police	Bengaluru Traffic Police
Signal Control System		DULT, Government of Karnataka	Bengaluru Traffic Police	Bengaluru Traffic Police

8-3 The Project owner

The Indian side stated that DULT would be the owner of the Project and enter in to contract with a Japanese contractor.

8-4 Selection of location for ITS

The both sides agreed the locations of ITS equipment shown in Annex-1-1 and Annex-1-2.

(1) Intersection of Signal Control

Target intersections of signal control system are 29 ones along MG Road zone shown in Annex-1-2 combined with parts of both Old Madras Road and Hosur

Road.

(2) VMS

The proposed VMS will display the information on the traffic congestion status, time to major destinations and other messages as necessary. They will be installed at three locations, MG Road, in the vicinity of Hanging Bridge and in the vicinity of Silk Board Junction shown in Annex-1-1.

(3) ATCC

8 locations (16units) of ATCCs will be installed at middle point between major intersections shown in Annex-1-1.

(4) Queue Length Measurement

13 locations (100units) of Queue Length Measurement System will be installed at the intersections shown in Annex-1-1.

(5) Data Server

From the point of view of the maintenance and security, installation of servers necessary for the Project in Karnataka State Data Center (KSDC) is rational selection.

8-5 Installation of signal control

The Traffic Police stated that:

(1) New signals procured by Project should be, firstly, installed at proper positions, secondly the Traffic Police will confirm the operation of them, thirdly the Traffic Police will relocate previous signals by their own expense;

(2) Preferable signal controlling data transmission device is Wi-Fi, and aerial cable is not applicable.

8-6 Confirmation of necessary procedure for approving on road works of the contractor on roads

The Team requested DULT to confirm followings:

(1) The necessary approvals by relevant agencies and their procedure for the Japanese contractor to conduct on-site installation works on roads;

(2) Who owes costs of utility relocation; and

(3) What kind of safety measures for works on roads should be taken by Japanese contractor and relevant agencies.

8-7 Acceleration of the Project progress

Indian side requested that the Preparatory Survey would include preparing detailed design and draft tendering document so as to accelerate the Project progress.

As a response to its request, the Team explained followings:

(1) Tendering document and Detailed Design of the Project must be approved by both the Executing Agency and JICA according to administrative due process after signing E/N and G/A;

(2) In order to accelerate the Project, JICA would prepare the Final Preparatory Survey

Report describing, as clearly and in detail as possible, quantities, functions and specification of the equipment procured by the grant; and

(3) Crucial issues on accelerating the Project are for relevant agencies,
   1) To present prompt decision on the Project content such as functions and installation locations of ITS equipment;
   2) To avert modification of decision in later process; and
   3) To submit the Team necessary materials such as:
      - Drawings of target roads and intersections including buried utility ducts and location of the existing power and communication cable to connect the equipment;
      - Design standards of structure (pole and gantry etc);
      - Data format of Bus-tracking system;
      - Drawings of traffic information center and traffic management center, and related equipment;
      - Building Permission of traffic information center, traffic management center and KSDC; and
      - Frequency of power failure and total time of every area where equipment will be installed.

8-8 Tax Exemption

The Indian side stated that the Government of Karnataka had implemented a World Bank assisted project of which loan agreement described tax exemption, and that the India side would review it and explain possible tax treatment and necessary procedure during the second mission of the Team around April 2016.

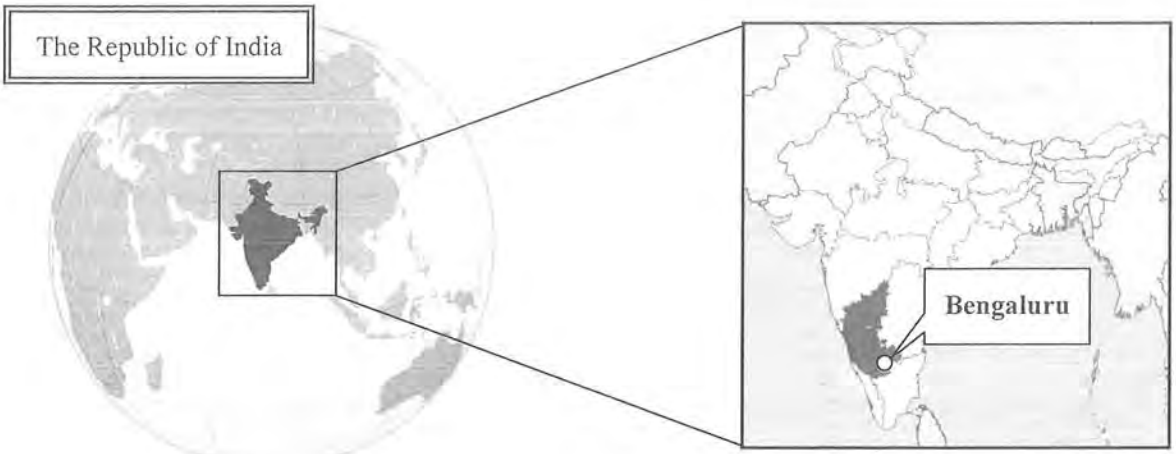
8-9 Defect liability period

The Team stated that the defect liability period of the Project is expected to be (1) year according to Japanese convention while Indian side explained a defect liability period in India varies from (1) to (3) years depending on a project peculiarity. The defect liability period of the Project should be further discussed in later process.

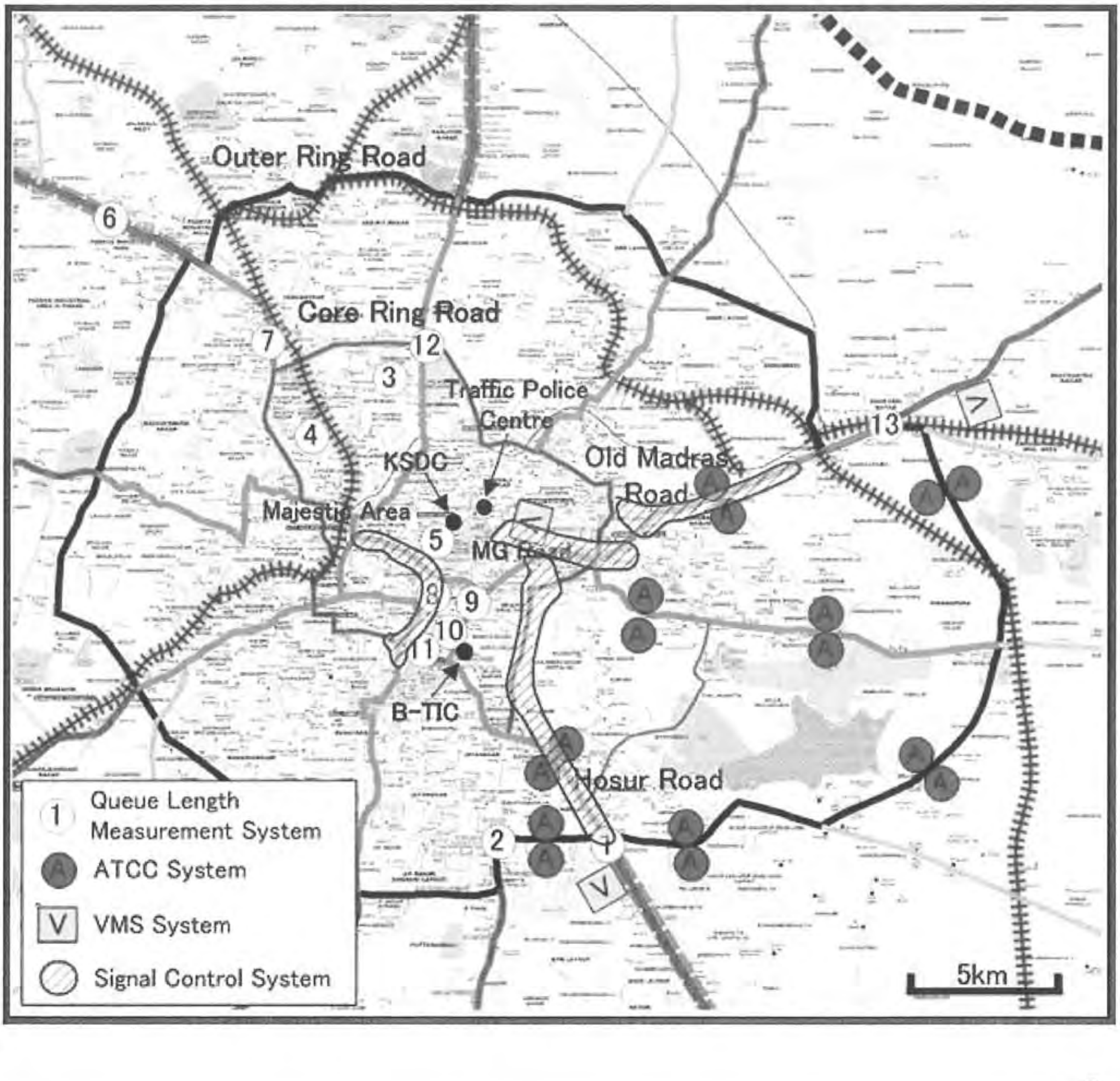
Annex-1-1 Project Sites
Annex-1-2 Target Intersections
Annex-2 Organization Chart
Annex-3 Japanese Grant
Annex-4 Flow Chart of Japanese Grant Procedures
Annex-5 Financial Flow of Japanese Grant
Annex-6 Project Monitoring Report (template)
Annex-7 Major Undertakings to be taken by Each Government

SK

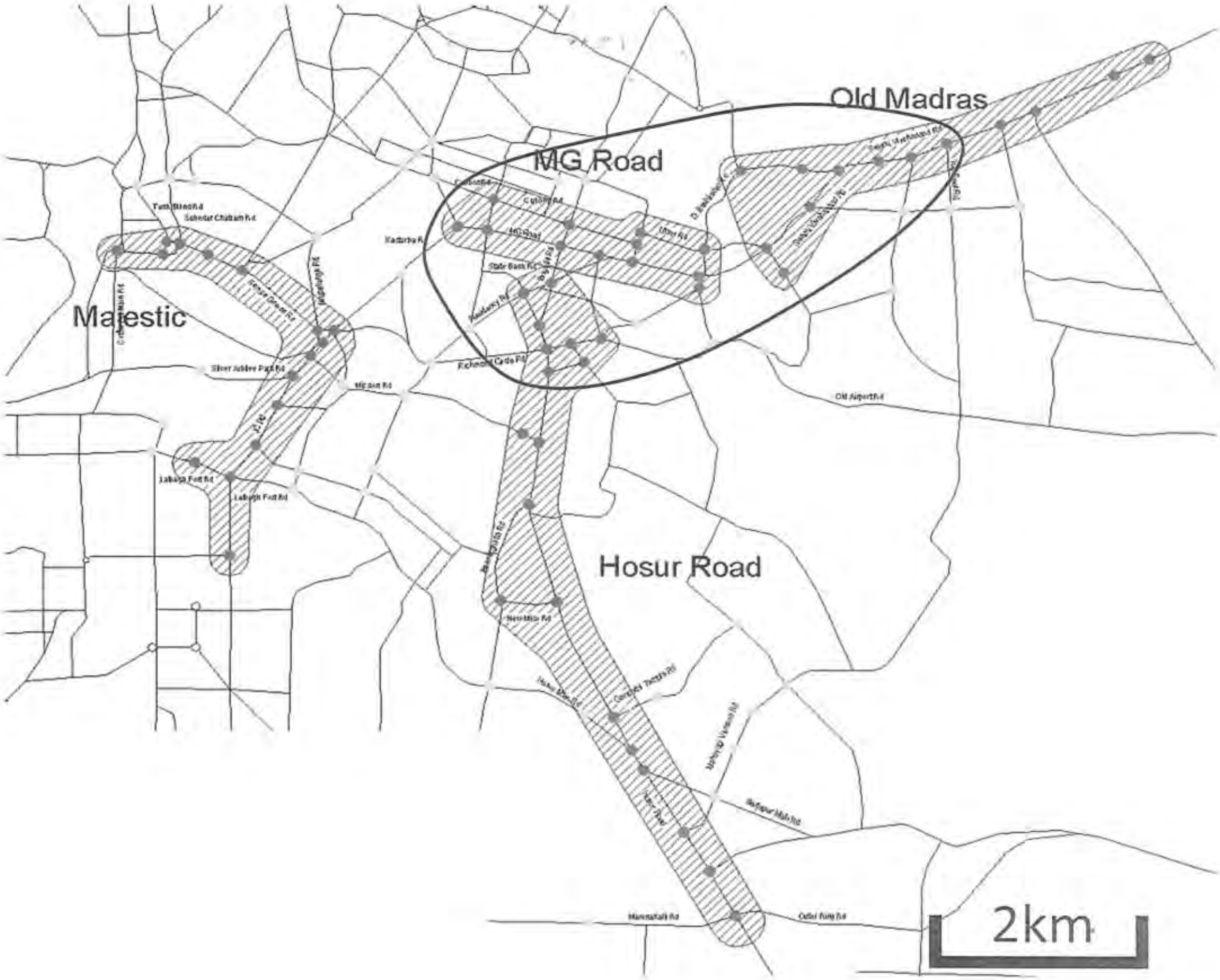
Annex-1-1: Project Sites



Source: Wikipedia

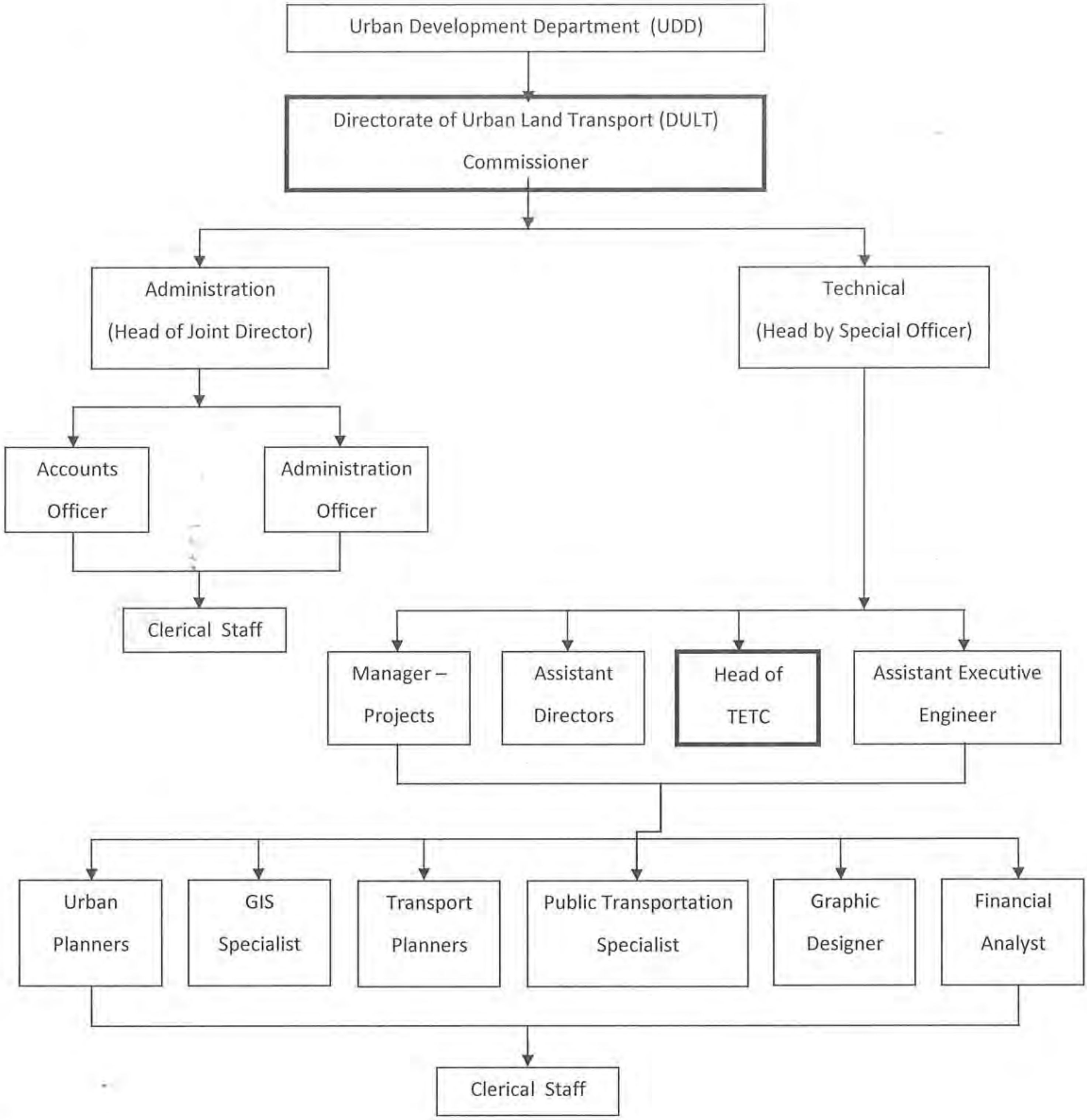


Annex-1-2: Target Intersections

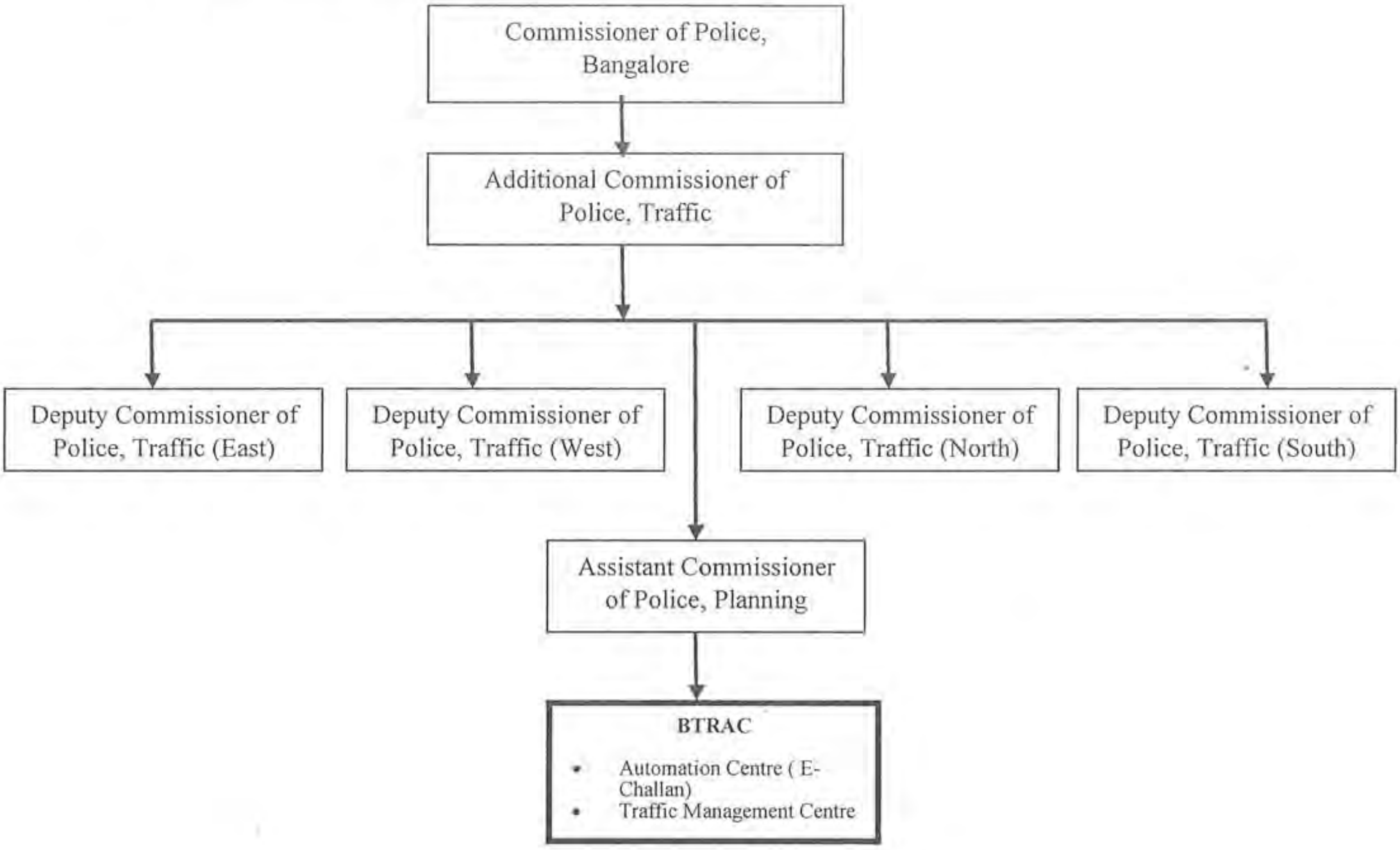


Annex-2: Organization Chart

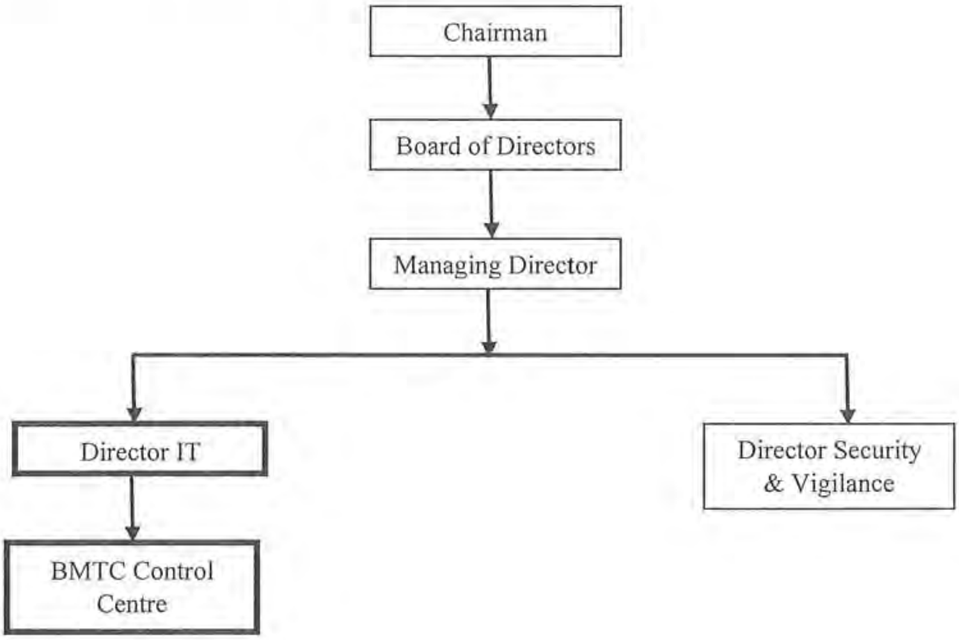
DULT Organization Structure:



Bangalore Traffic Police Organization Structure:



BMTC Organization Structure:

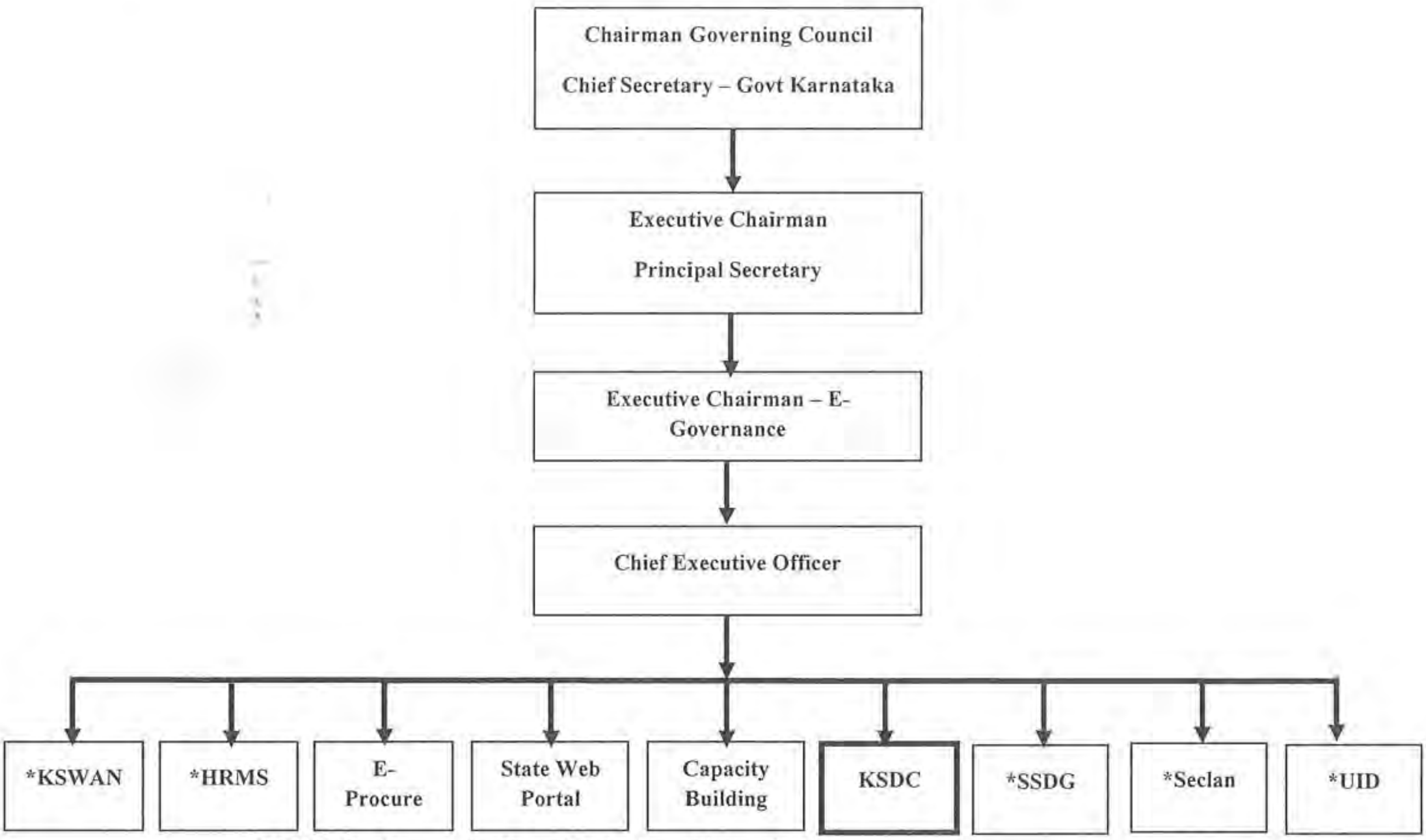


KSDC (Karnataka State Data Centre) Activities and Organization Structure:

Key activities of KSDC are explained below:

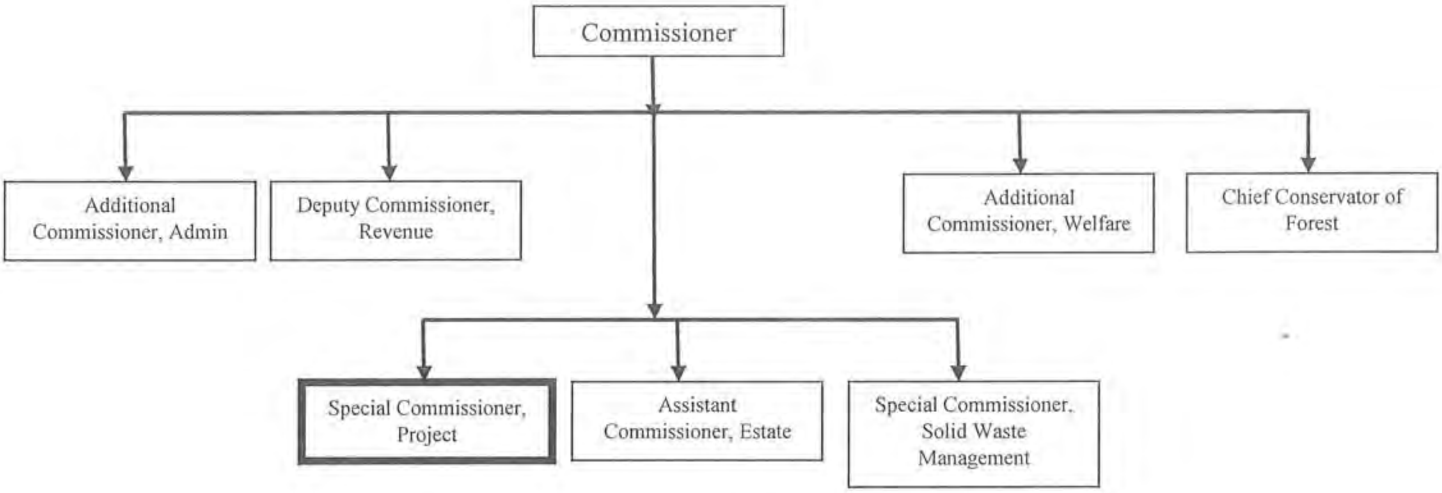
- Installation and upgradeof Servers, Storage and other necessary infrastructure to meet the department requirement for hosting their applications, websites and Databases.
- Virtualized more than 500 numbers of servers.
- Technical Upgrades.
- Implementation of Cloud services for KSDC.
- Procurement of Servers and Storage for Departments.
- Data Management System for Services to Government Department Applications

Organisation Structure of KSDC and Related Departments Under Karnataka State Government E-Governance Project:



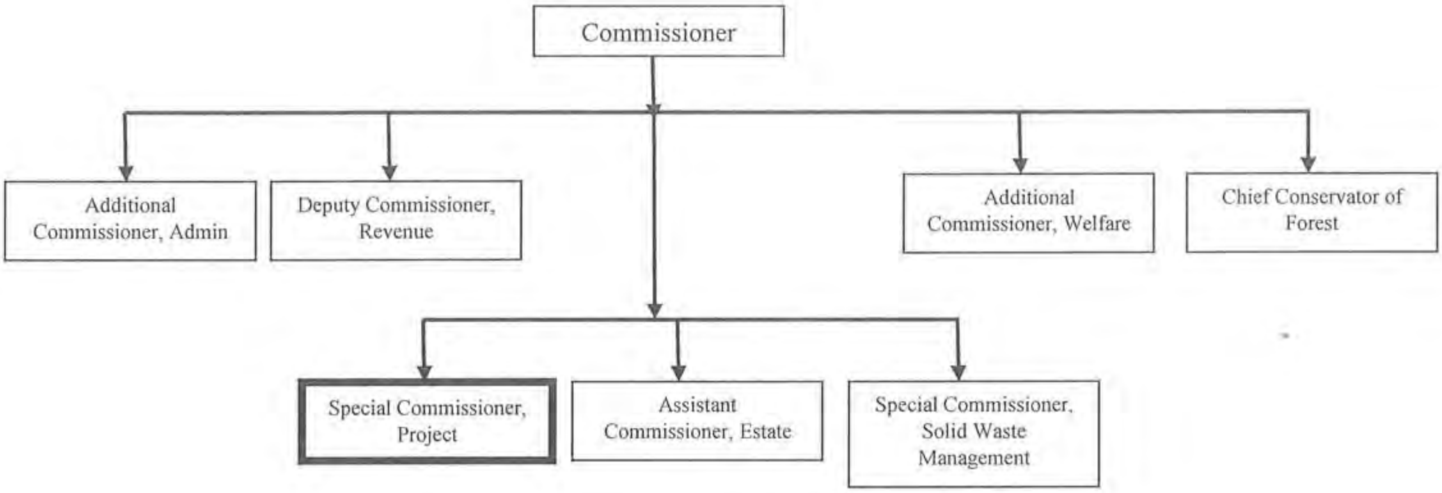
* KSWAN - Karnataka State Wide Area Network
* HTMS - Human Resource Management System
* SSDG – State Secure Delivery Gateway
* Seclan – Secretariat Local Area Network
* UID - Unique Identification Authority

BBMP Organization Structure:



Annex-2

BBMP Organization Structure:



Annex-3: Japan's Grant Aid Scheme

JAPAN'S GRANT AID

Based on a JICA law which was entered into effect on October 1, 2008 and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for Projects for construction of facilities, purchase of equipment, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

· Preparatory Survey

- The Survey conducted by JICA

· Appraisal &Approval

-Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet

· Authority for Determining Implementation

-The Notes exchanged between the GOJ and a recipient country

· Grant Agreement (hereinafter referred to as "the G/A")

-Agreement concluded between JICA and a recipient country

· Implementation

-Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.

- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles, in accordance with the E/N, to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. The Grant Aid may be used for the purchase of the products or services of a third country, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals", in principle.

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals, in principle. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-6. The Japanese Government requests the Government of the recipient country to exempt all customs duties, internal taxes and other fiscal levies such as VAT, commercial tax, income tax, corporate tax, resident tax, fuel tax which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract, since the Grant Aid fund comes from the Japanese taxpayers.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"), in principle. JICA will execute the Grant Aid by making payments in Japanese yen, in principle, to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

The Government of the recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

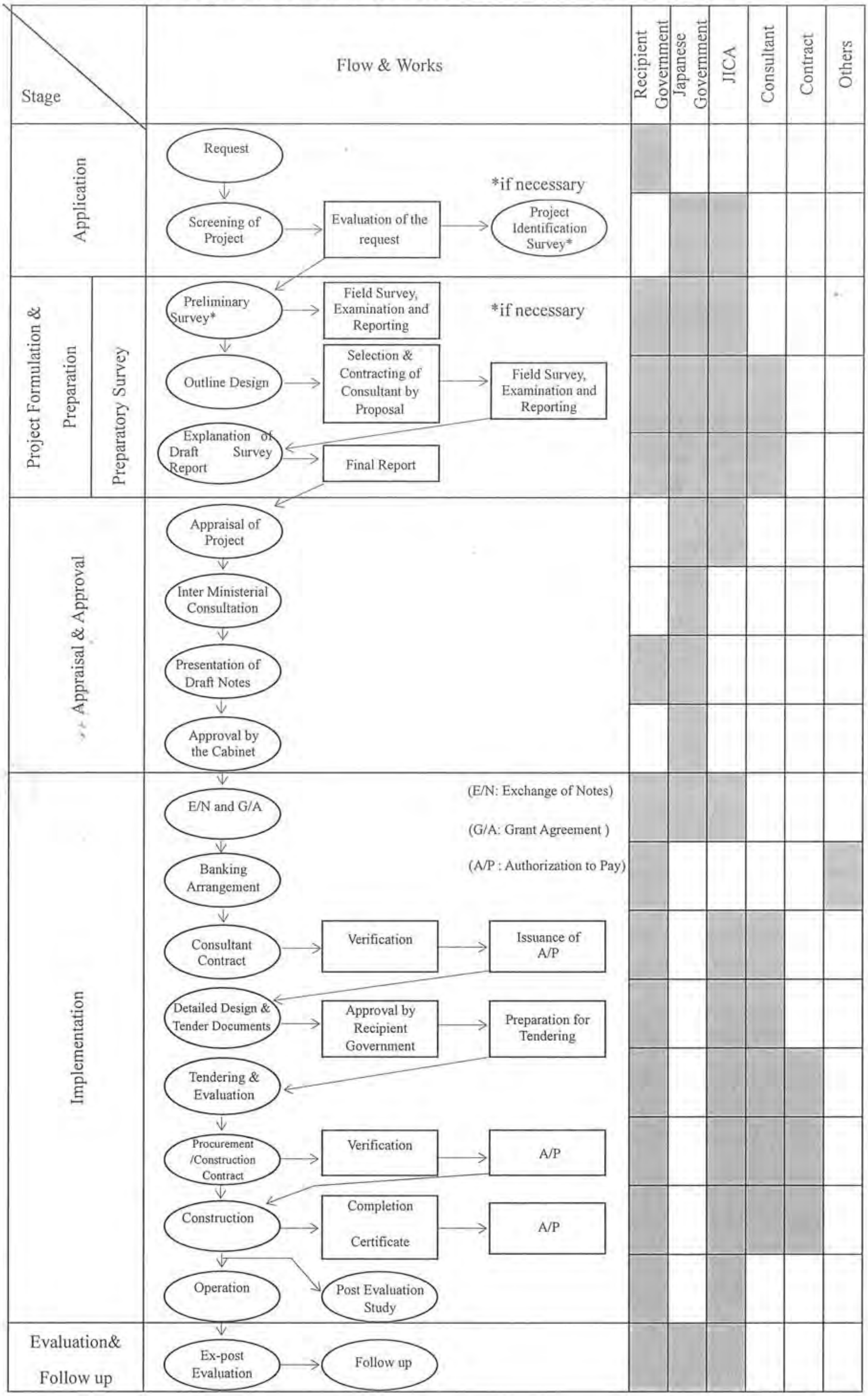
(11) Monitoring

The Government of the recipient country must take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and must regularly report to JICA about its status by using the Project Monitoring Report (PMR).

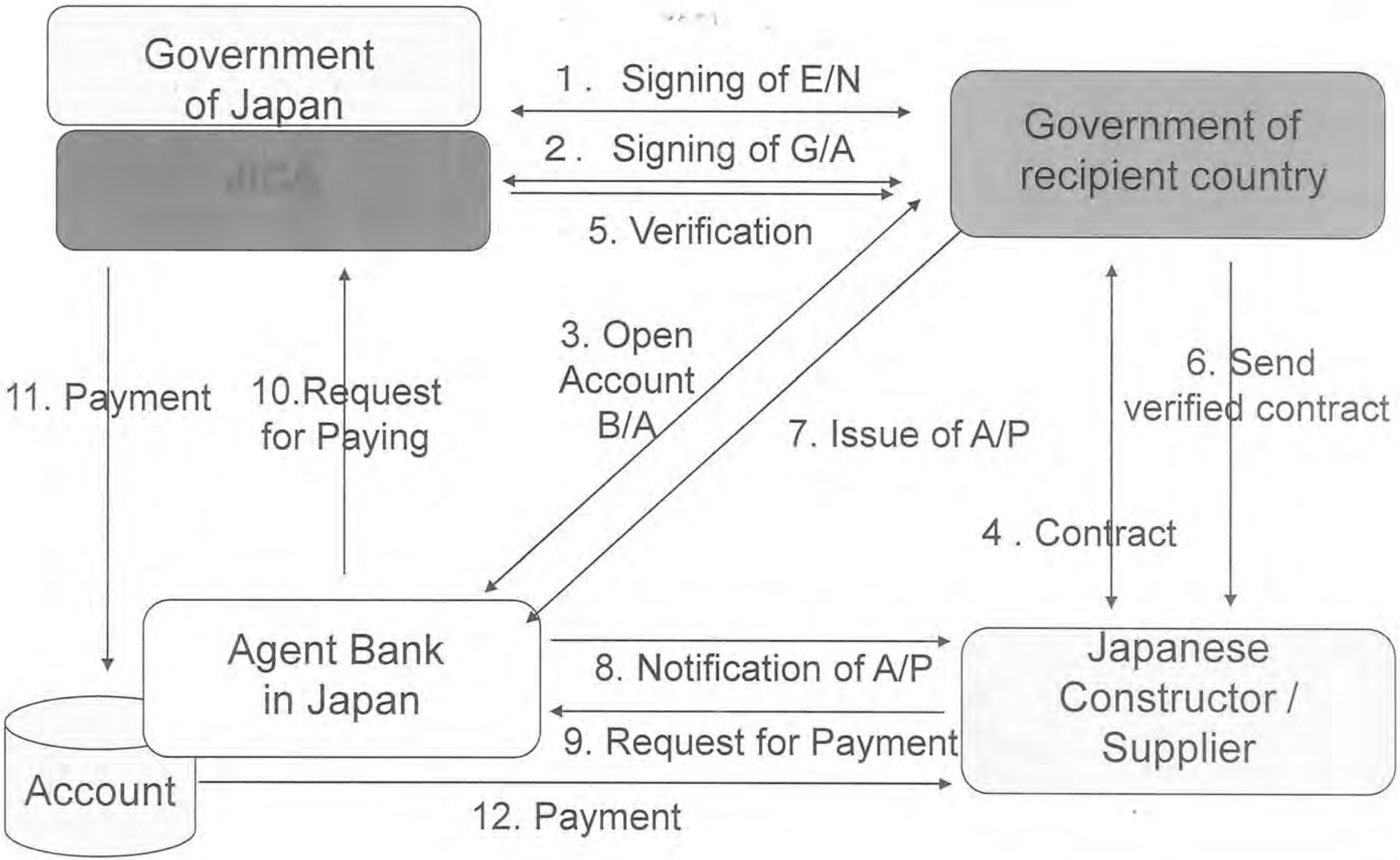
(12) Safety Measures

The Government of the recipient country must ensure that the safety is highly observed during the implementation of the Project.

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Financial Flow of Grant Aid



Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX

Organization Information

Authority (Signer of the G/A)	____________ Person in Charge ____________ (Division) ____________ Contacts Address: ____________ Phone/FAX: ____________ Email: ____________
Executing Agency	____________ Person in Charge ____________ (Division) ____________ Contacts Address: ____________ Phone/FAX: ____________ Email: ____________
Line Ministry	____________ Person in Charge ____________ (Division) ____________ Contacts Address: ____________ Phone/FAX: ____________ Email: ____________

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY ______ mil. Government of (________): ____________
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

Location	**Original:** *(M/D)* **Attachment(s):Map**	**Actual:** *(P/Rand PCR)* **Attachment(s):Map**

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual
(M/D)	*(M/D)*	*(P/R and PCR)*

2-1-2 Reason(s) for the modification if there have been any.

(P/R and PCR)

2-2 Implementation Schedule

2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
[M/D] Project Completion Date*	*(M/D)*		*(P/R,PCR)* As of (Date of Revision) Please state not only the most updated schedule but also other past revisions chronologically.

*Project Completion was defined as ______________________ at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

(P/R and PCR)

2-3 Undertakings by each Government

2-3-1 Major Undertakings

See Attachment 2.

2-3-2 Activities

See Attachment 3.

2-4 Project Cost

2-4-1 Project Cost

Table 2-3-1 Comparison of Original and Actual Cost by the Government of Japan (Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction Facilities (or Equipment)				
Consulting Services	- Detailed design -Procurement Management -Construction Supervision			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

Table 2-3-2 Comparison of Original and Actual Cost by the Government of XX

Items			Cost (Million USD)	
	Original	Actual	Original	Actual
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = (local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

(P/R, PCR)

2-5 Organizations for Implementation

2-5-1 Executing Agency:

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*
Actual, if changed: *(P/R and PCR)*

2-6 Environmental and Social Impacts

Report based on the agreed environmental checklist and monitoring form (See Attachment 4)

3: Operation and Maintenance (O&M)

3-1 O&M and Management

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: *(PCR)*

3-2 **O&M Cost and Budget**

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s): *(M/D)*	
Potential Project Risks	Assessment
1.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L

(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	
(P/R and PCR)	

5: Evaluation

5-1 Overall evaluation

Please describe your evaluation on the overall outcome of the project.

(PCR)

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

(PCR)

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Monitoring report on environmental and social considerations

Annex-7 Major Undertakings to be taken by Each Government

I. Major Undertakings to be taken by the India Side

1. Before the Tender

No.	Items	Deadline	In charge	Cost	Ref.
1	To open Bank Account (Banking Arrangement (B/A))	within 1 month after G/A	DULT		

2. During the Project Implementation

No.	Items	Deadline	In charge	Cost	Ref.
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A	-	-	-	-
	1) Advising commission of A/P	within 1 month after the singing of the contract	DULT		
	2) Payment commission for A/P	every payment	DULT		
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	-	-	-	-
	1) Tax exemption and customs clearance of the products at the port of disembarkation	during the Project	DULT		
3	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work	during the Project	DULT		
4	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the Products and/or the Services be exempted and/or borne by its designated authority without using the Grant; Such customs duties, internal taxes and other fiscal levies mentioned above include VAT, commercial tax, income tax and corporate tax of Japanese nationals, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract	during the Project	DULT ???		
5	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment	during the Project	DULT		
6	Equipment procurement and construction work	-	-	-	-
	1) Providing power supply necessary for the provided equipment at Traffic Information Center(DULT) and Traffic Control Center(BTP)	before equipment at the sites	DULT BTP		
	2) Renovating Centers to accommodate the provided equipment, which includes upgrading of air-conditioning system, replacement of electrical fittings and lighting fixtures, refurbishing of interior finishes, if necessary.	before equipment at the sites	DULT BTP		

3. After the Project

No.	Items	Deadline	In charge	Cost	Ref.
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodical inspection	After completion of the construction	DULT BTP		

(B/A: Banking Arrangement, A/P: Authorization to Pay)

II. Major Undertakings to be Covered by the Japanese Grant

No.	Items	Deadline	Cost Estimated (Million Japanese Yen)*
1	To provide equipment	-	-
	1) To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	-	-
	a) Marine(Air) transportation of the products from Japan to the recipient country	during the Project	
	b) Internal transportation from the port of disembarkation to the project site	during the Project	
	2) To install the equipment including testing, training, and commissioning	during the Project	
	Total		

*: The cost estimates are provisional. This is subject to the approval of the Government of Japan.

III. Major Undertakings to be covered by either side (to be discussed)

No.	Items	Deadline	Cost Estimated (Million Japanese Yen)*
1	1) To improve intersections	during the Project	
2	1) Securing space for unpacking work and installation of the equipment, material storing yard, temporary construction yard and waste disposal	before equipment at the sites	
3	1) Removing designated equipment and obstacles from the Project site	-	-
	a) Relocation of existing traffic signal of target sections		
	b) Relocation of existing utility of target roads and intersections		
	Total		

TECHNICAL NOTE – TRAFFIC POLICE
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Bengaluru Traffic Police. In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

奥田真人

Masato OKUDA
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Maintenance part in pending.

R. HITHENDRA, IPS
Additional Commissioner
Bengaluru Traffic Police
Karnataka State Police
India

ATTACHEMENT

1. Objective

The objective of meeting with new Additional Commissioner of Traffic Police, Bengaluru is to explain and confirm the Area Traffic Signal Control System and Variable Message Sign System proposed by Grant project.

2. Agenda

- To explain about the items which were already confirmed with the previous Additional Commissioner
- To explain and confirm on the proposed Area Traffic Control System, concept/function of MODERATO, other required improvement e.g. signal phase, pedestrian signals and etc.

3. Discussed and Confirmed Items

a) Item discussed and confirmed/re-confirmed with Traffic Police
  - VMS system and Signal system will be implemented by DULT but operation and maintenance will be carried out by Bengaluru Traffic police.
  - The new signal will be installed by the grant project. The existing signal will be relocated by Traffic police at their own expense.

4. VMS

- The location of VMS was re-confirmed with Traffic Police. The Traffic Police re-confirmed the location of VMS at MG Road, Hanging Bridge and Silk Board. The approval process from road agencies such as BBMP and NHAI will be initiated by DULT.
- The traffic information will be generated by BTIC and transmitted to BTRAC. The messages such as incident and event will be inputted by Traffic Police as necessary.
- At Silk Board, the existing gantry and sign board will be replaced with new VMS gantry and VMS board. DULT will take care of obtaining approval from NHAI.
- The server equipment of VMS and traffic signal will be installed at Traffic Management Centre of Traffic Police.

5. ATCS

- Twenty nine (29) locations of signal were re-confirmed and approved.
- MODERATO will be introduced with focus on area control and reduction of congestion length.
- Fixed line communication between controller and signals at intersection will be adopted.

6. Other Proposed Improvements Explained to Traffic Police

a) By Grant Project
  - Signal phase improvement will be done for smooth and safety traffic.
  - Pedestrian signal improvement will be done for safe crossing with the introduction of separate display type of pedestrian signal.
  - Intersection improvement such as extending sidewalk, moving the cross location and remove the median strip will be done at 29 intersections where new signal will be installed.

- Change to left-hand traffic by signal indication improvement will be done at Victoria Rd-General KS Thimayya Rd-St Philomena.

b) By Traffic Police

- Publication to notify and let people understand and accustomed to the above improvements will be done by Traffic Police.

7. Others

Maintenance plan for maintenance of system shall be proposed by study team. The maintenance plan shall include aspects such as procuring maintenance contractor, availability of spare parts with local suppliers for all the systems installed by the grant project, cost plan and etc,.

Annex-1 Items Discussed and Confirmed with traffic police in the Past

Annex-2 Area Traffic Control System

Annex-3 Signal Phase Improvement

Annex-4 Pedestrian Signal Improvement

Annex-5 Improvement of Intersections.

Annex-6 Required Organization Structure

Attachment-1

Items Discussed and Confirmed with Traffic Police in the Past

- Area Traffic Signal Control System (ATCS) at selected intersections will be introduced by Japanese Grant Project.
- Variable Message Sing Board at selected locations will be introduced by Japanese Grant Project.

The details are explained hereinafter.

1.1 Area Traffic Signal Control System (ATCS)

The traffic signal which automatically controls optimal signal timing according to the traffic volume measured by roadside sensors will be introduced.

(1) Candidate Corridors Recommended by Traffic Police

The following four candidate corridors were recommended by Traffic Police.

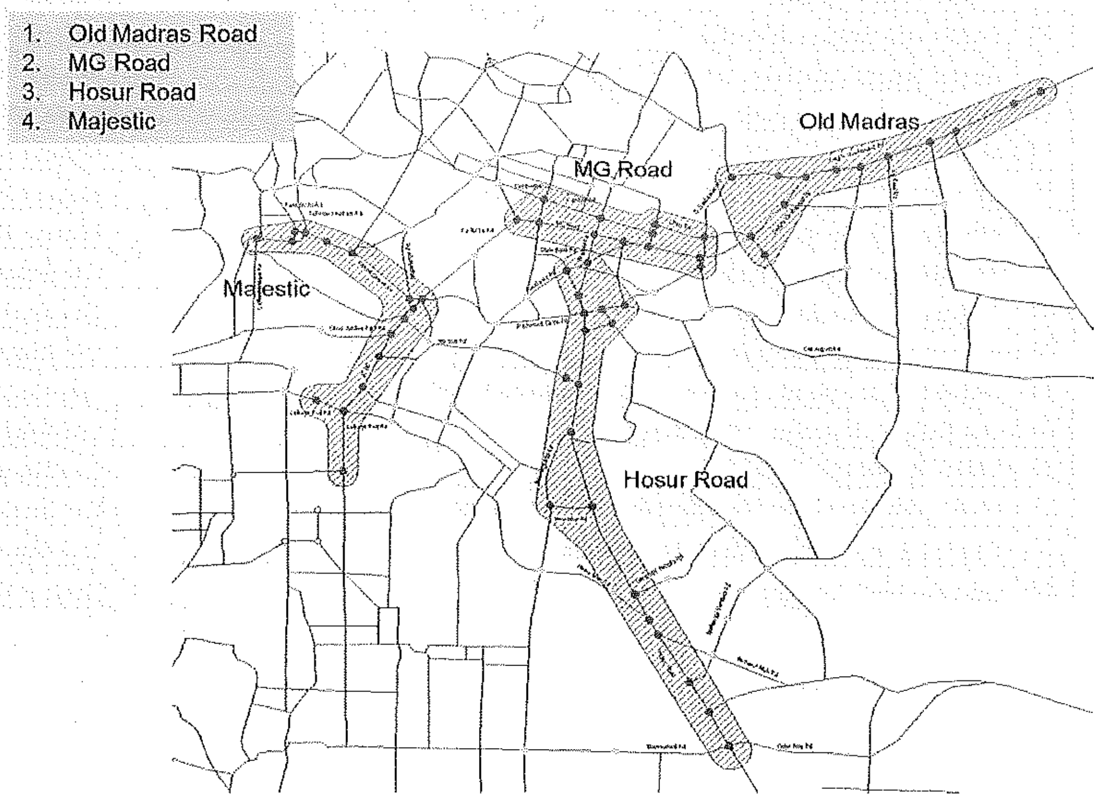


Figure 0-1 Candidate Corridors Recommended by Traffic Police

(2) Intersections Identified by JICA Survey Team

Based on the corridors recommended by Traffic Police, JICA Survey Team selected the following 29 intersections for Traffic Signal Control System.

Table 0-1 Identified Intersection for Traffic Signal Control System

	Intersection Name	Area
1	Queens Statue Circle Junction (Jewels De Paragon)	MG Road
2	Anil Kumble Circle Junction	MG Road
3	Arts & Craft Circle Junction	MG Road
4	Mayo Hall Junction	MG Road
5	Webbs Circle Junction	MG Road
6	Trinity Circle Junction	MG Road
7	General KS Thimayya Road-Trinity-Church Road	MG Road
8	Begum Mahal Junction	MG Road
9	Adigas Junction (Ulsoor Rd Dickenson Rd)	MG Road
10	Manipal Centre Junction	MG Road
11	Kamraj Road Junction	MG Road
12	Shivaji Nagar Intersection Junction (BRV)	MG Road
13	OPERA Junction	Hossur Road
14	Ashirwadam Junction	Hossur Road
15	Old Police Station Junction	Hossur Road
16	Ashok Nagar Junction (Shoolay circle)	Hossur Road
17	Johnson Market Junction	Hossur Road
18	Mother Theresa Junction	Hossur Road
19	Campbell Road Junction	Hossur Road
20	D'Souza Circle Junction	Hossur Road
21	Kensington Oval Junction	Old Madras Road
22	Tamari kannan Junction	Old Madras Road
23	Anjeneya temple Junction	Old Madras Road
24	OM Rd & Double rd Junction (Police Station Junction)	Old Madras Road
25	OM Rd & Indiranagar 100ft Junction	Old Madras Road
26	CMH Rd Adarsh Theater Jn	Old Madras Road
27	Swami Vivekananda Rd-Cambridge Road-Bazaar st	Old Madras Road
28	OM Rd & Indiranagar 80 Ft. Rd. Junction	Old Madras Road
29	Garudal Mall Junction	Hossur Road

The locations of the 29 intersection are shown on the map in the figures below.

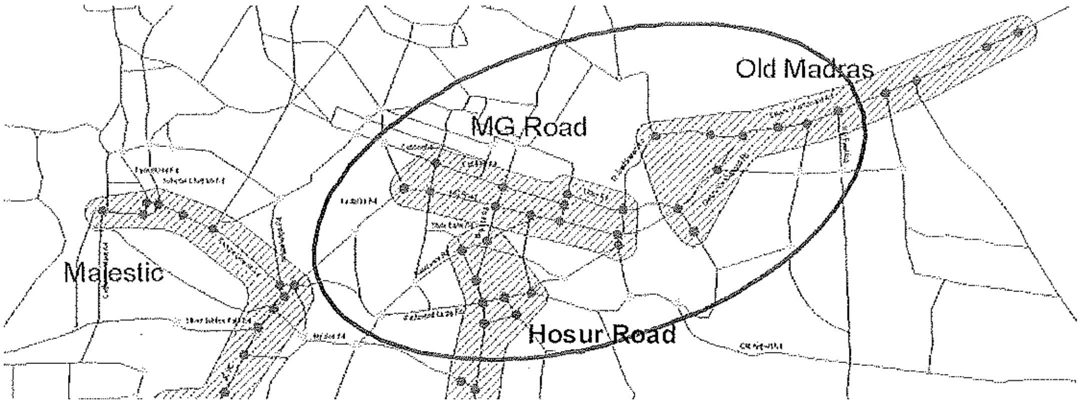


Figure 0-2 Identified 29 Intersections

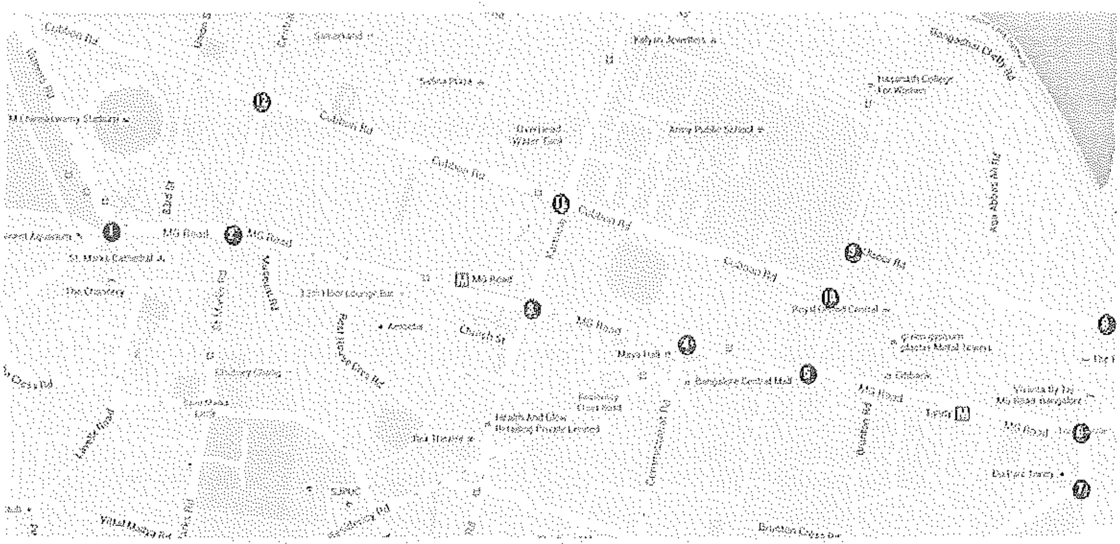


Figure 0-3 Identified Intersections in MG Road Area

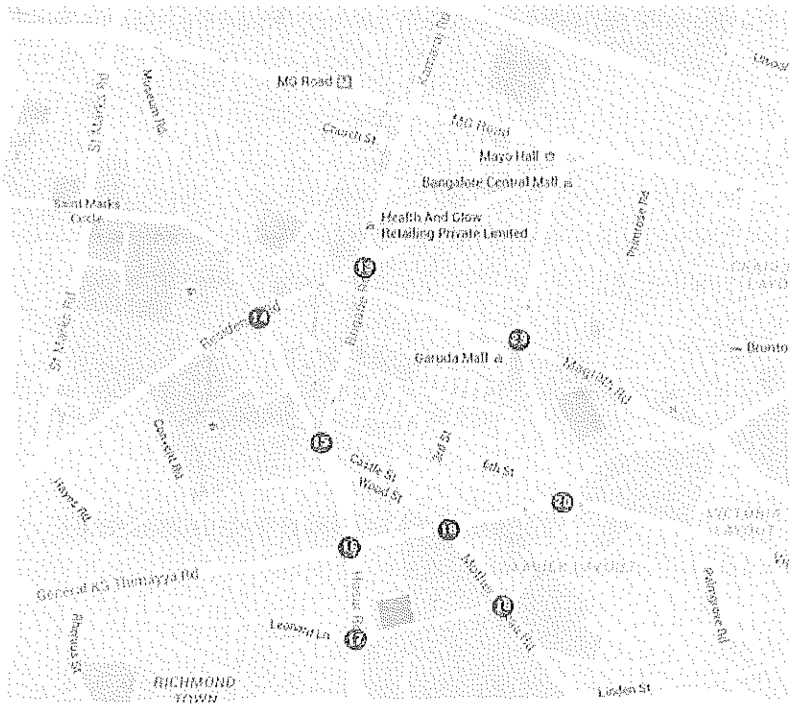


Figure 0-4 Identified Intersections in Hosur Road Area

Figure 0-5 Identified Intersections in Old Madras Road Area

(3) Agreed Items of Traffic Signal with Traffic Police

The following items have been agreed with Traffic Police

- New traffic signals at the target intersection will be installed by the vendors procured in grant project.
- The existing traffic signals at the above intersection will be relocated by Traffic Police at their own expense.
- The operation and maintenance of the new traffic signals will be handled by Traffic Police after handover.

1.2 Variable Message Sign Board (VMS)

(1) Purpose and Function of VMS

- The expected travel time from the location of VMS to the major landmark ahead and congestion level will be displayed.
- The expected travel time and congestion level will be calculated at Bengaluru Traffic Information Centre (B-TIC) and automatically shown on VMS.
- The necessary information e.g. traffic accident, traffic regulation and others will also be manually input by Traffic Police on their own decision as necessary and displayed by the same VMS.

(2) Number and Selected Location of VMS

Three (3) VMS will be installed by the grant project. The following locations were selected by JICA Survey Team:

1) MG Road at Trinity Metro Station

2) KR Puram Junction at Hanging Bridge

3) Silk Board Junction at Silk Board

The locations are mapped in the figure below.

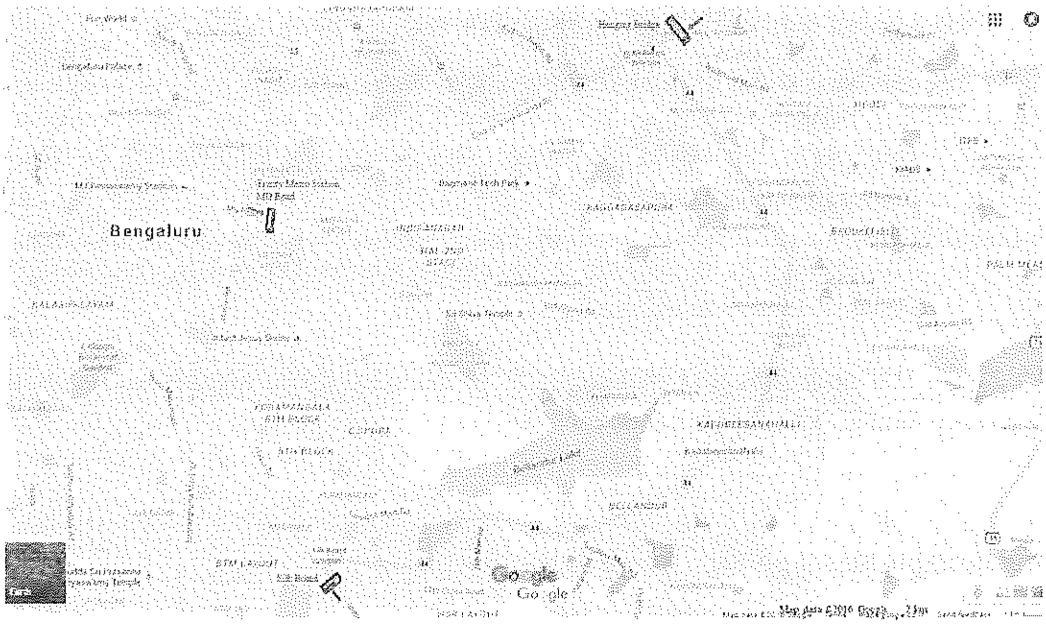


Figure 0-6 Selected Locations of VMS

(3) Image of VMS

The figures below show the images of VMS.

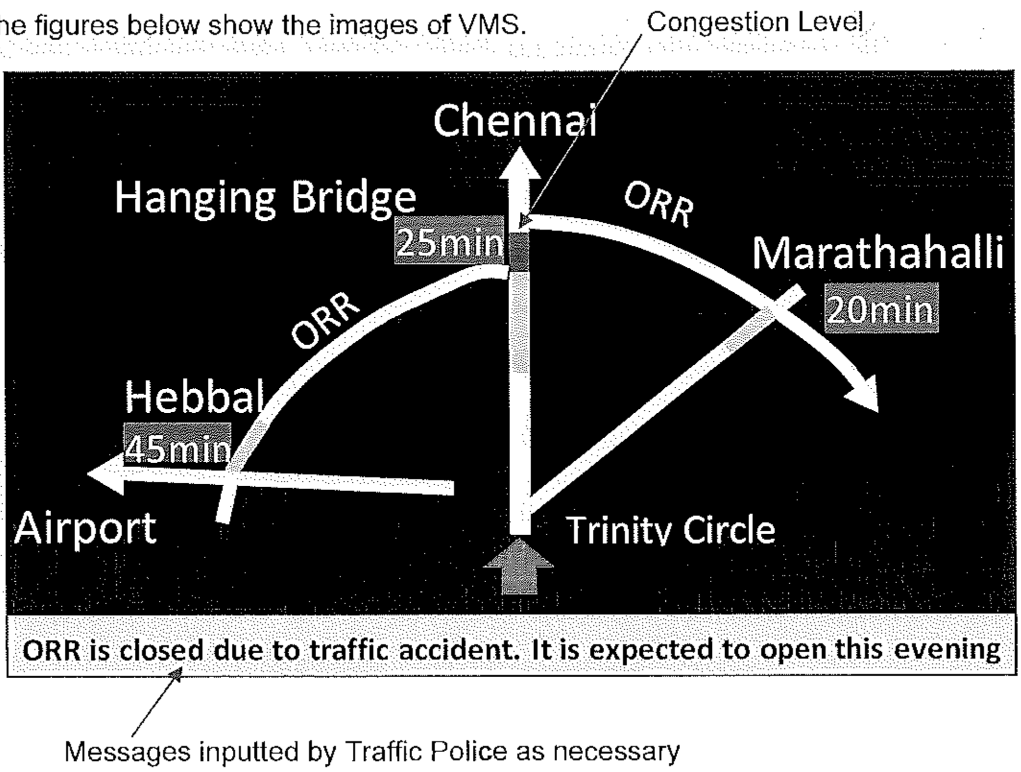


Figure 0-7 Example of VMS (MG Road at Trinity Metro Station)

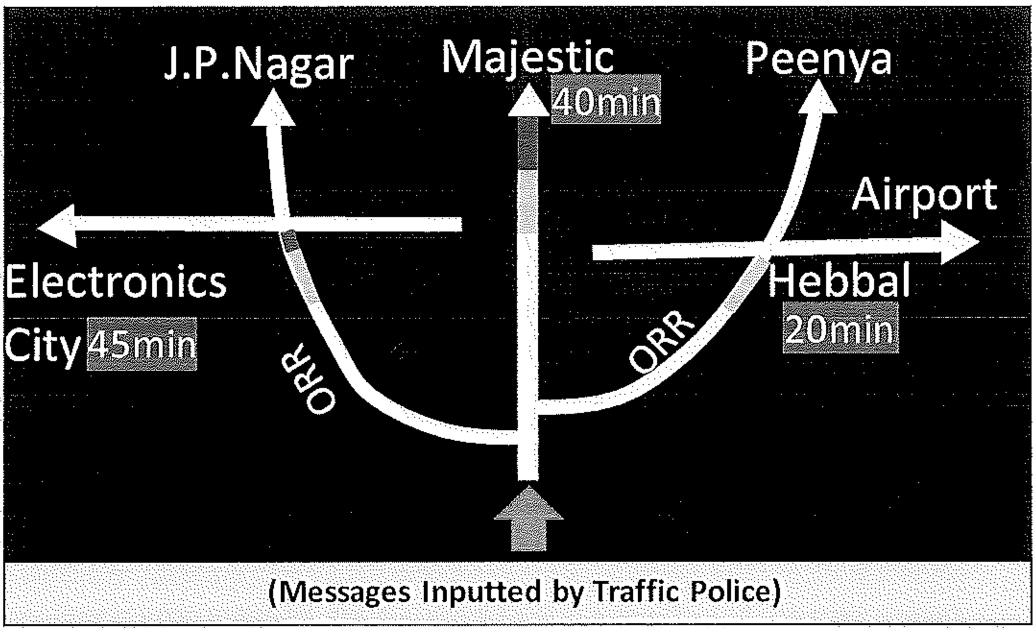


Figure 0-8 Example of VMS (KR Puram Junction at Hanging Bridge)

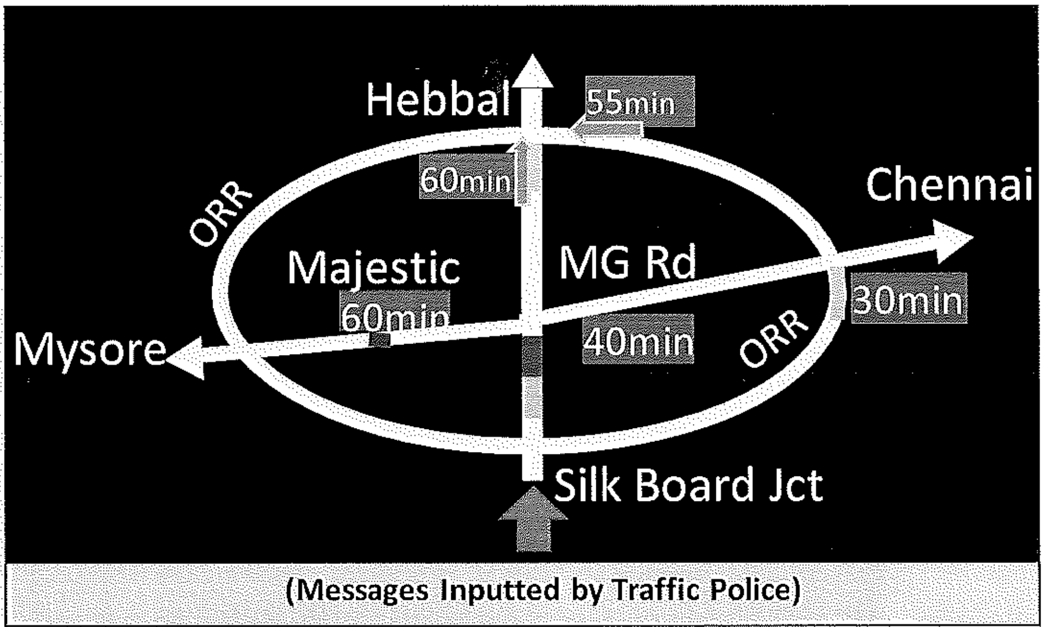


Figure 0-9 Example of VMS (Silk Board Junction at Silk Board)

2 Items to Be Confirmed with Traffic Police

2.1 Installation Location of ATC and VMS Server

Different servers will be installed for various systems prepared by Grant project. It is proposed that ATC and VMS servers are prepared under BTRAC and all other servers are prepared under B-TIC. Based on the discussions with KSDC, it is proposed to install servers in KSDC.

Therefore, Traffic Police require to confirm their acceptance to install ATC and VMS servers in KSDC premises and connect the servers in KSDC to BTRAC control centre through a secure point to point network connection.

2.2 Installation of VMS (MG Road at Trinity Metro Station and Silk Board Junction)

(1) MG Road at Trinity Metro Station

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Trinity Circle which is a major diverting point ahead, and etc.

The field survey found that there is no other appropriate location other than below.

It will be installed closed to the Trinity Metro Station building structure.

JICA Survey Team would like to confirm whether there is no particular problems in view of Traffic Police.

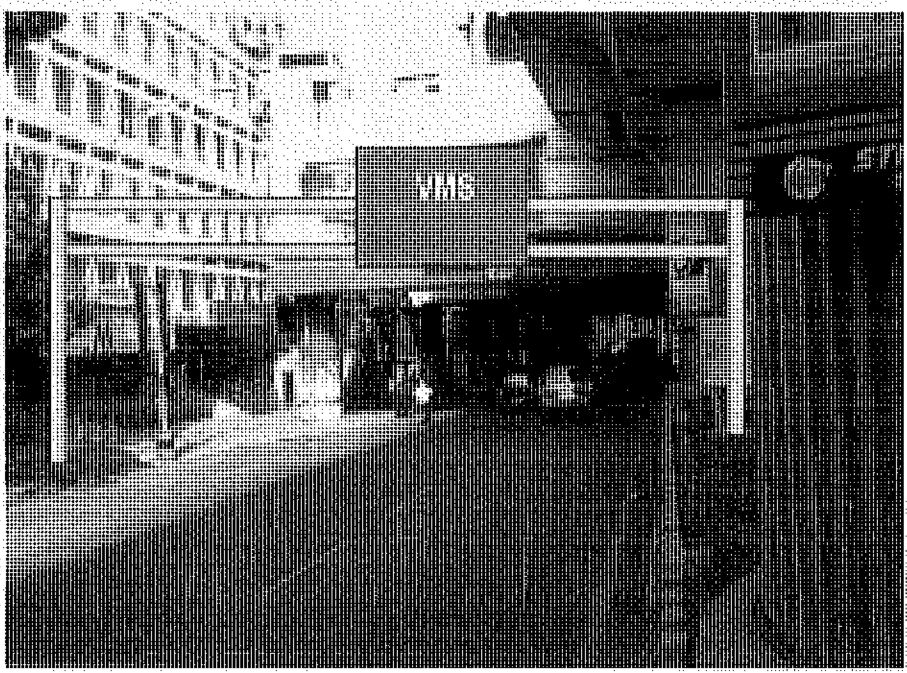


Figure 2-1 Proposed Location of VMS on MG Road at Trinity Metro Station

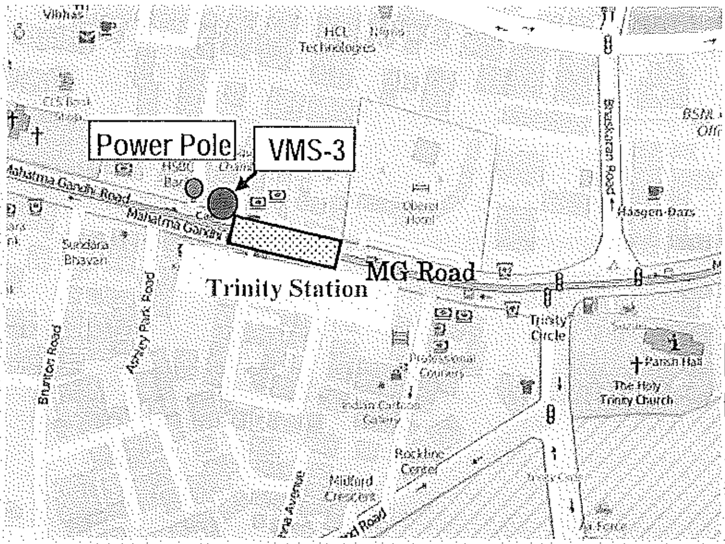


Figure 2-2 Proposed Location on the Map

(2) Silk Board Junction

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Silk Board Junction which is a major diverting point ahead, and etc.The field survey found that there is no other appropriate location other than below.

There are existing sign boards on the gantry. However the field survey found that there is no other appropriate location other than here. Thus, it is proposed that

- To remove the existing gantry by the grant project,
- To install new gantry by the grant project,
- To place VMS on the new gantry, and
- To place the existing sign boards on the new gantry as shown below.

<u>JICA Survey Team would like to confirm whether this proposal is acceptable.</u>

Figure 2-3 Existing Sign Boards and Gantry at Silk Board Junction

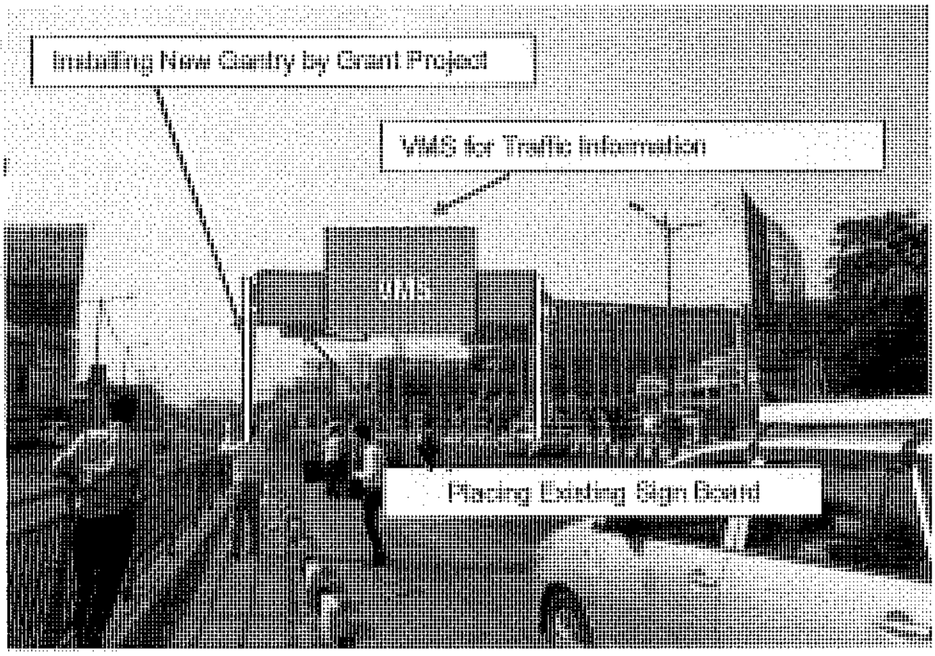


Figure 2-4 Proposed Installation and Arrangement at Silk Board Junction

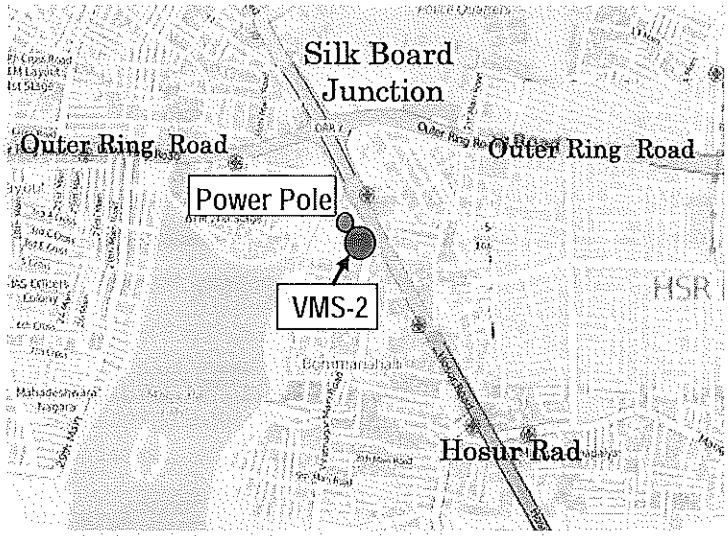


Figure 2-5 Proposed Location on the Map

(3) Hanging Bridge

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Hanging Bridge which is a major diverting point ahead, and etc.

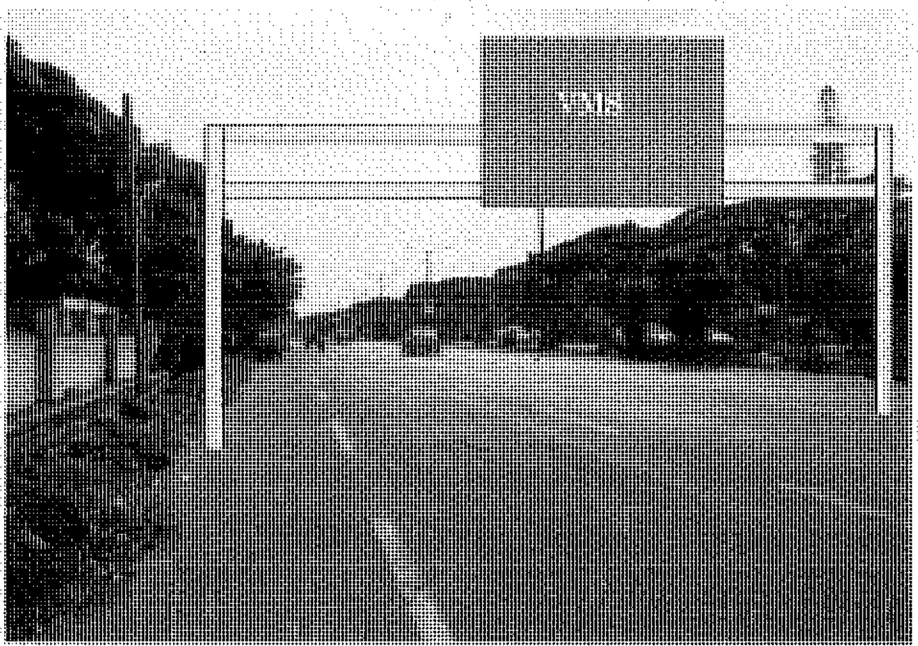


Figure 2-6 Proposed Location of VMS at Hanging Bridge

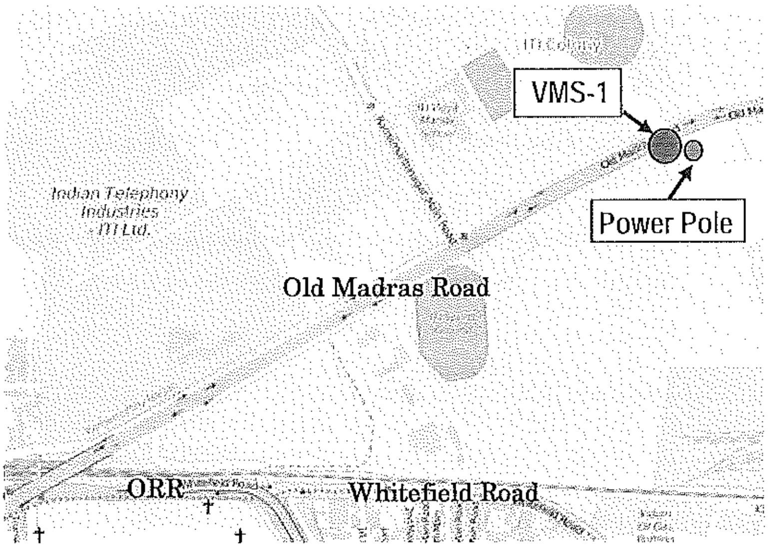


Figure 2-7 Proposed Location on the Map

2.3 B-TIC: Bengaluru Traffic Information Centre

Bengaluru Traffic Information Centre (B-TIC) will be developed by the grant project for the purpose of dynamic traffic information provision and utilization of quantitatively measured data on traffic.

- Major input data: BMTC Bus Probe Data
- Major output information: Congestion information on major road to be provided from VMS and Internet

B-TIC will generate the dynamic traffic information based on the major input data. The generated dynamic traffic information will be provided through VMS and Internet.

<u>B-TIC will be developed and operated under jurisdiction of DULT. VMS will be prepared as one component of B-TIC. VMS will be operated and maintained by **Traffic Police.**</u>

The basic configuration of B-TIC is shown in the figure on the next page.

Basic Configuration of Proposed ITS System

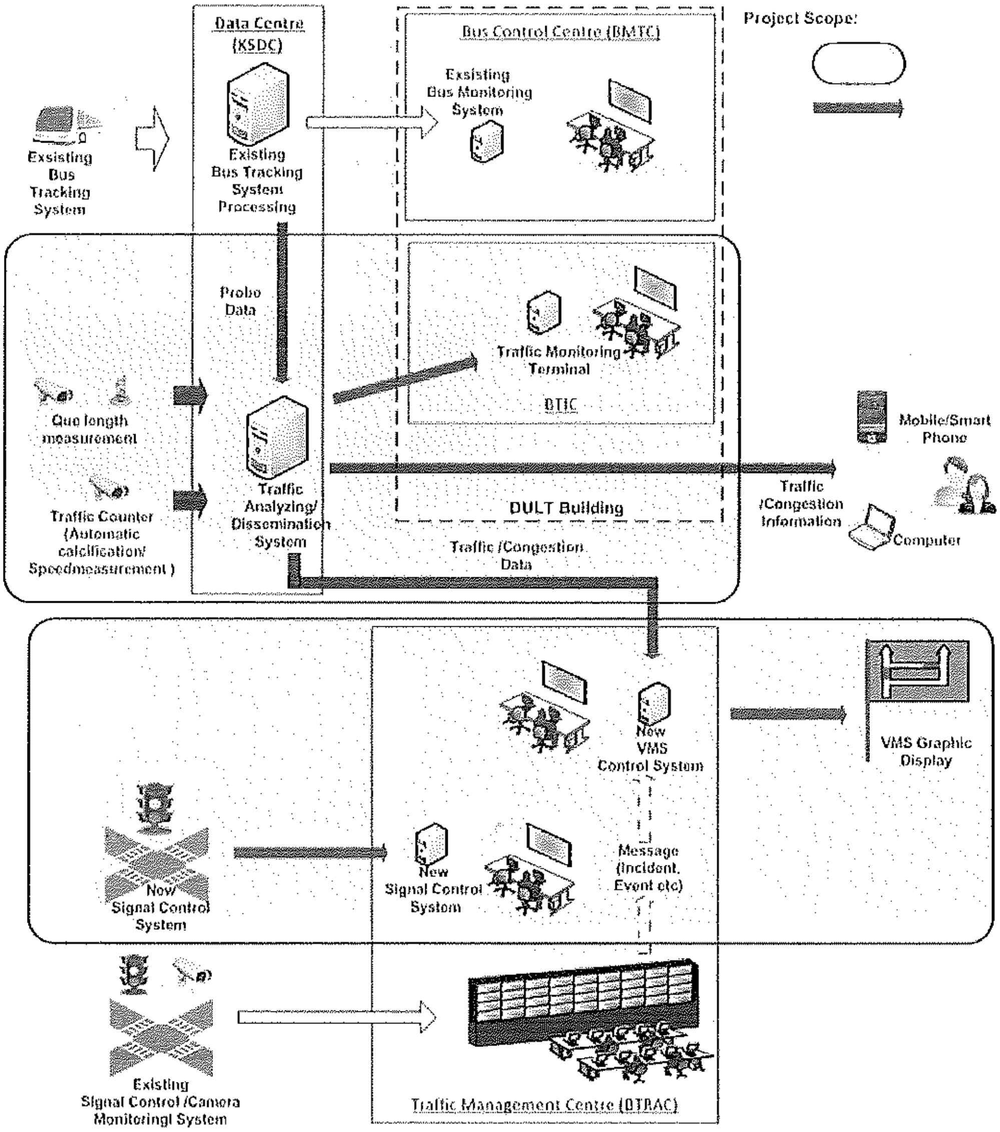


Figure 2-8 Basic Configuration of B-TIC

2.4 Demarcation of Related Agency: Traffic Police and DULT

The demarcation of the related agencies of ITS is summarized below.

Table 2-1 Demarcation of Related Agency for ITS

ITS Component		Implementation (Procurement)	Operation & Maintenance	Equipment Ownership
B-TIC	Centre Other Roadside Equipment	DULT	DULT	DULT
B-TIC	VMS (*1)	DULT	**Bengaluru Traffic Police**	**Bengaluru Traffic Police**
ATCS (*2)		DULT	**Bengaluru Traffic Police**	**Bengaluru Traffic Police**

*1: Variable Message Sign Board, *2: Area Traffic Control System

Annex-2

Area Traffic Control System

1. Basic Concept of Signal Control

1.1. Basic System Configuration

The traffic condition varies depending on various factors such as time or day (rush-hour, normal-hour, off-hour, holiday, weekday, etc.). In order to alleviate traffic congestion and reduce the number of traffic accidents it is important to optimize the signal control based on the current traffic condition.

The traffic control center gathers the real-time traffic data from the vehicle detectors on the road. Then the central computer analyzes the data and gives the appropriate signal parameters to each signal. There are 3 fundamental parameters of traffic signal: Cycle, Split and Offset shown in Table 1.

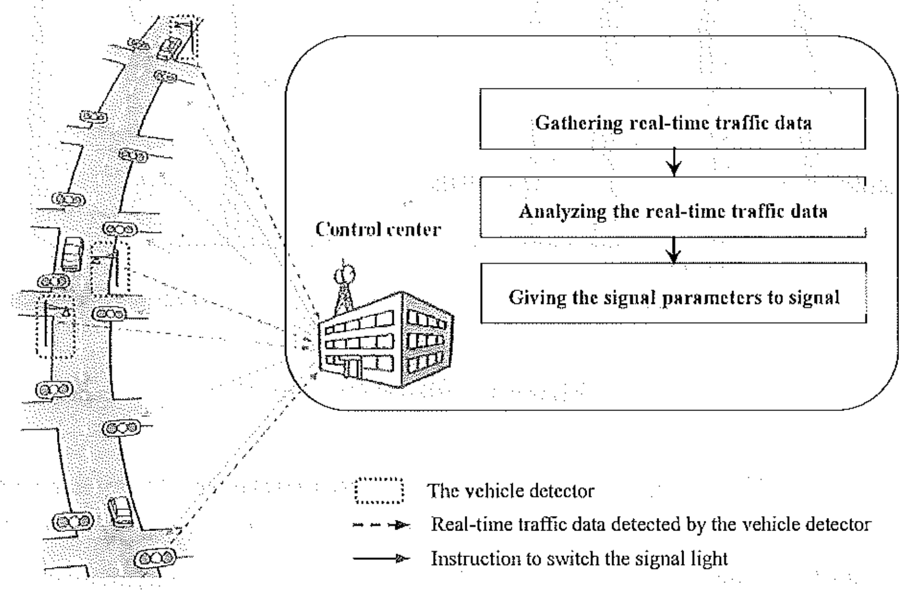
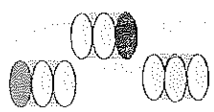
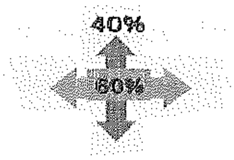
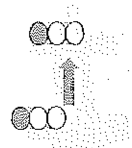


Figure 1 Basic System Configuration

Table 1 Fundamental Signal Parameters

Cycle	Split	Offset
		
Time required for a complete sequence of indications e.g. from green indication to next green indication.	Portion of time allocated to each phase within a cycle at an intersection.	Time difference of coordinated phases between two traffic signals.

1.2. Signal Coordination

Signals installed at short distance need to be coordinated to offer green wave, in which vehicle that has passed an intersection during green will be given green at next signal to allow the vehicle to pass through next intersection without stopping. The reduction of waiting time at signals is illustrated in Figure 2 . To provide green wave, neighboring two signals must operate with the same cycle length and they must be coordinated.

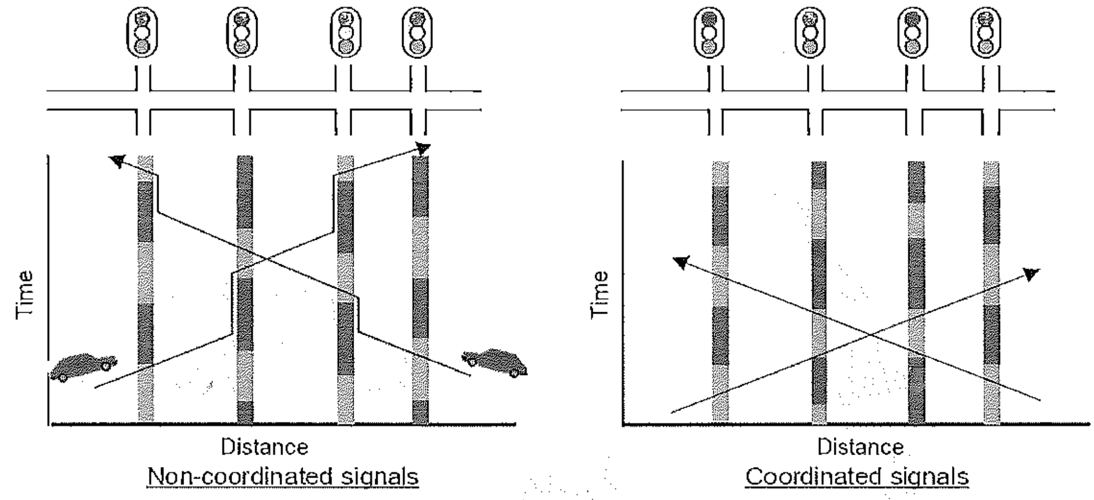


Figure 2 Signal Coordination

2. Required Measures: Reduction of Congestion Length and Area-wise Control

As shown in the previous chapter of technical note, the sections of MG road, Old Madras road and Hosur road in the core area of the city and adjacent areas of these sections are selected as the target area of the traffic single of the grant project.

These roads, MG road, Old Madras road and Hosur road, are major trunk roads in Bengaluru. In particular, the congestion is severe on the sections of these roads in the core area of the city.

It was found by the previously conducted traffic surveys and related existing studies in Bengaluru that it is critical to reduce the congestion length on this target areas.

It is also important that the traffic flow in the adjacent areas with chronic congestion shall be smoothened, synchronizing with these trunk roads by 'area-wise control'. For example, it will be more effective to synchronize the signals on

Gabon road running in parallel with MG road and in the areas in the vicinity of Brigade road.

Therefore, reducing congestion length on these target areas by area-wise control is important.

2.1. Area-wide Signal Control

2.1.1. Area Segmentation

Regarding the wide area (e.g. Bengaluru city), it includes various areas which are in different traffic conditions. For the area-wide signal control it is essential that the signal control is conducted by small area in an analogous the feature of traffic.

The system makes a sub-area and conducts the signal control by the sub-area adapting to the feature of the traffic condition of each area. Figure 3 shows the example of the sub-area (sub-area1~3). The sub-area is composed of key intersections which is on an arterial road and other normal intersections.

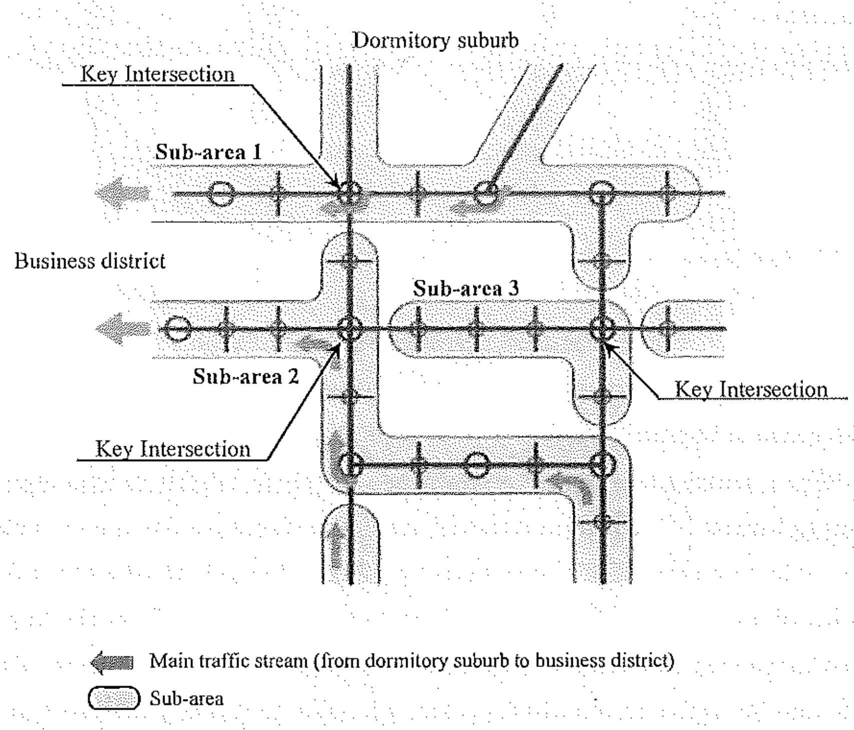


Figure 3 Example of Sub-areas

2.1.2. Dynamic Transition of Sub-area

The traffic condition varies depending on even a period of time in a day. In order to adapt to the temporal variation of traffic condition, the system dynamically changes the conformation of the sub-area by integrating and cutting off sub-areas.

The example of the dynamic transition of the sub-area is shown in Figure 4. Type A is the conformation in a rush hour. In the rush hour neighboring sub-areas are connecting along the main traffic stream (from dormitory suburb to business district). On the other hand, in holiday they are connecting along the main traffic stream (from dormitory suburb to resort area).

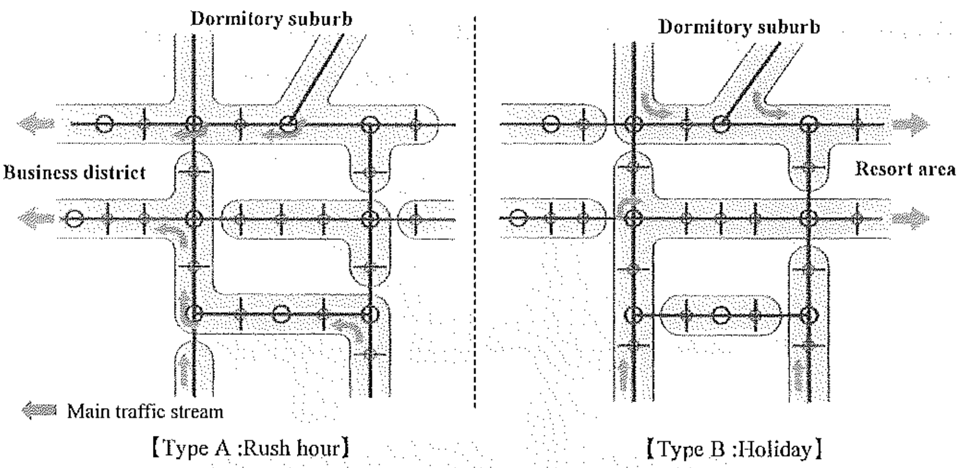


Figure 4 Transition of Sub-area

2.2. Decrease of Queue Length

When congestion occurs the decrease of queue length is also essential for the signal control. The system controls signals to decrease the queue length based on the detection of it. The vehicle detector (Queue Length Measure) is installed at the point of about 150m, 300m, and 500m (maximum) away from the key intersection and measures how long the queue is running. The vehicle detector (Inflow Traffic Volume Measure) is installed at close roadside to the key intersection and detects the inflow volume around the traffic lane 50m away from the key intersection. Figure 5 shows the configuration of queue length measurement.

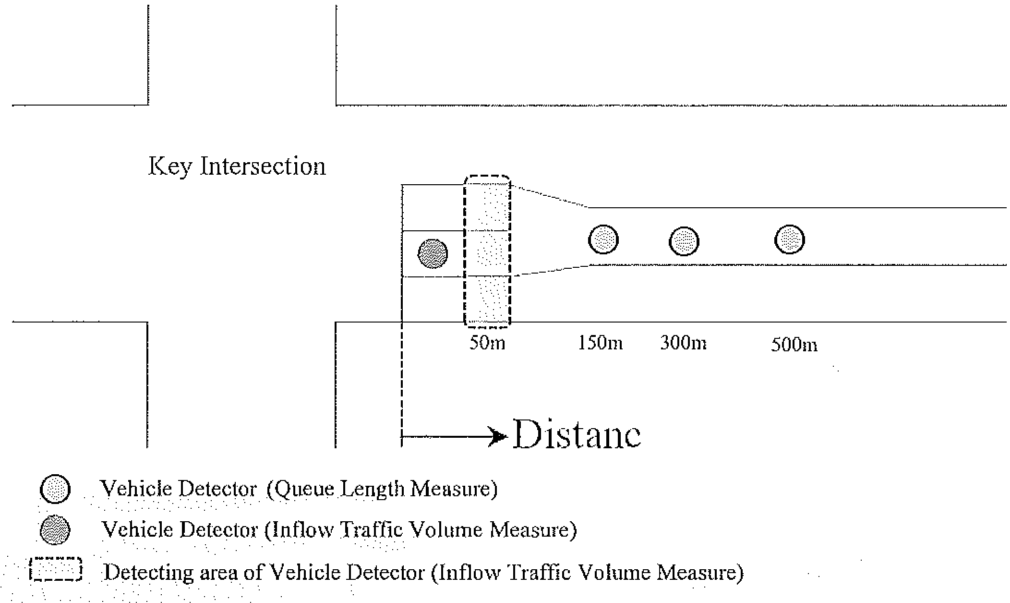


Figure 5 Configuration of Queue Length Measurement

3. Vehicle Detector

3.1. Type of Vehicle Detector

The type of vehicle detector for the real-time vehicle detection is shown in Table 2.

Table 2 The list of Vehicle Detector

Type	Function and Installation
Vehicle Detector (Queue Length Measure)	It measures the queue length heading to the key intersection. It is installed roadside at the point of about 150m, 300m, and 500m (maximum) away from the key intersection.
Vehicle Detector (Inflow Traffic Volume Measure)	It measures the inflow traffic volume at the close roadside to key intersection. It is installed adjacent roadside of Key intersection.
Vehicle Detector (Traffic Volume Measure for Offset)	It measures the traffic volume for the setting of offset time. It is installed at the middle point between two key intersections.

3.2. Configuration

The configuration of vehicle detectors is shown in Figure 6.

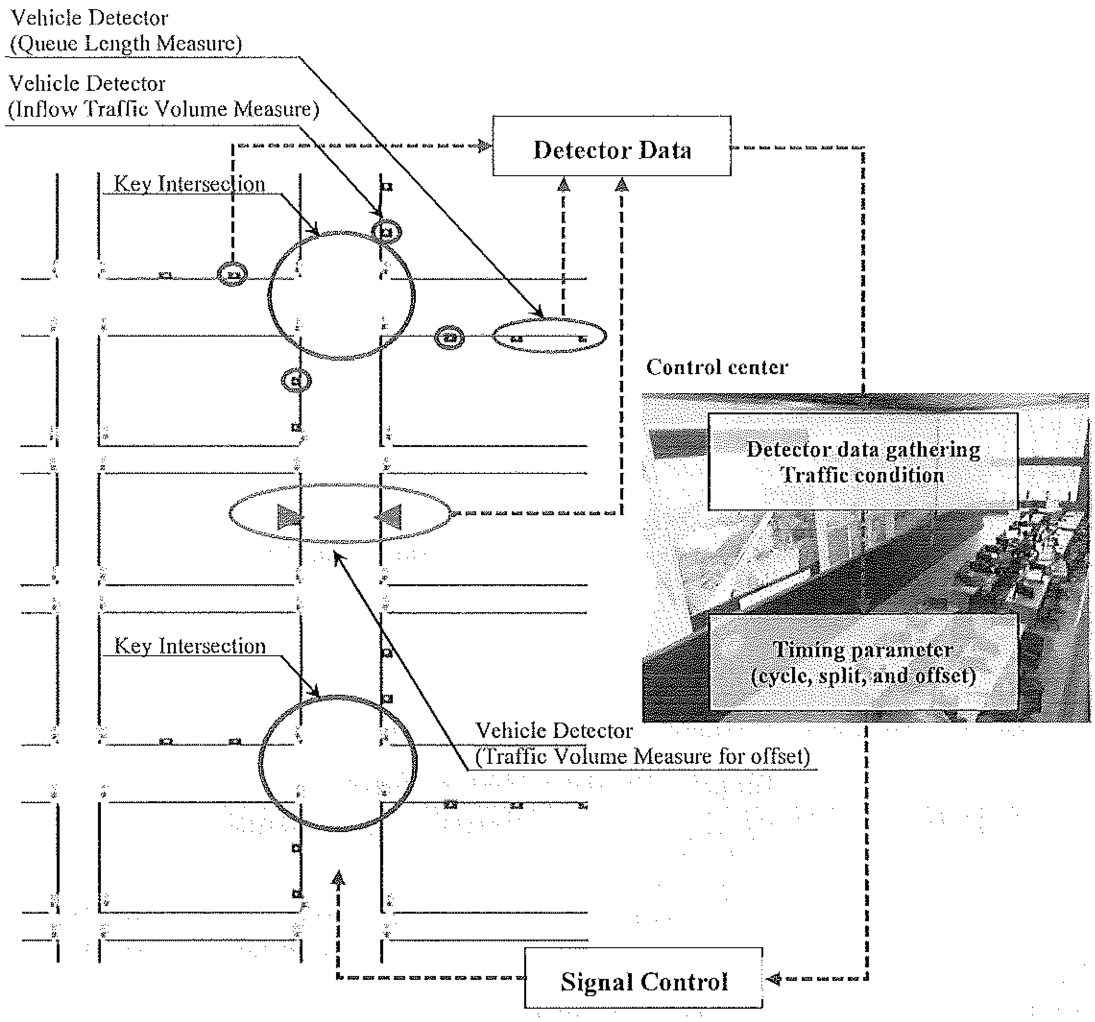
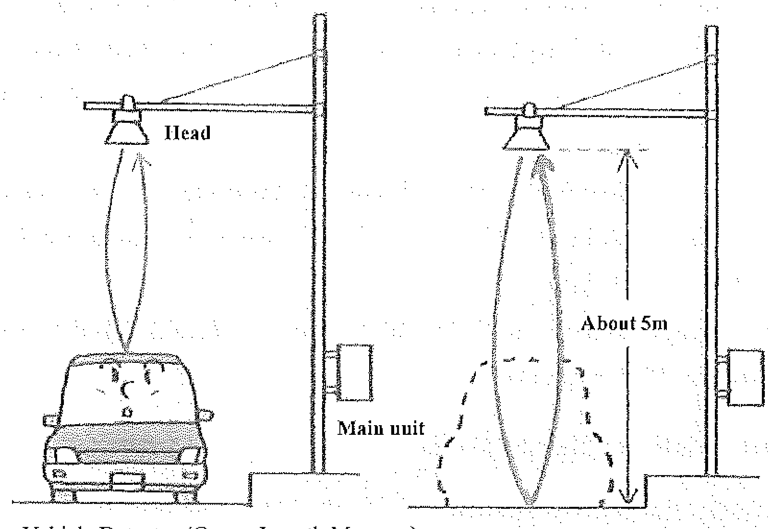


Figure 6 Configuration of vehicle detectors

3.3. Equipment

The ultrasonic sensor shown in Figure 7 is used for the vehicle detector (Queue Length Measure) and the vehicle detector (Traffic Volume Measure for offset). It detects the vehicle by calculating the reflecting time of ultrasonic.

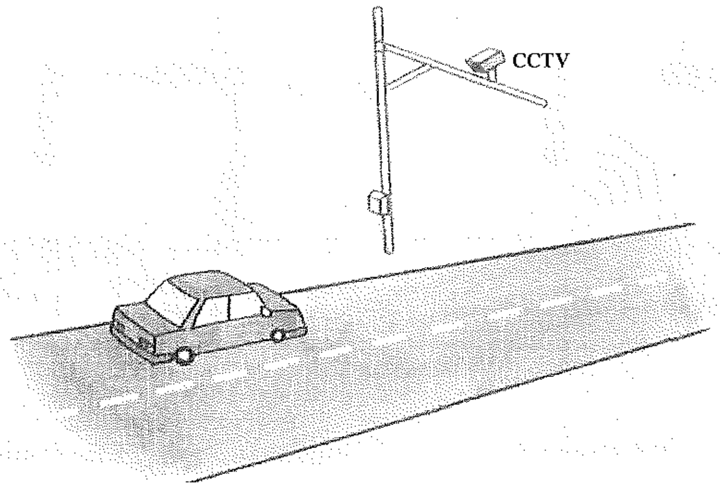
The CCTV sensor shown in Figure 8 is used for the vehicle detector (Inflow Traffic Volume Measure). It detects vehicles flowing at intersection by image processing.



・Vehicle Detector (Queue Length Measure)

・Vehicle Detector (Traffic Volume Measure for offset)

Figure 7 Image of Ultrasonic Sensor



・Vehicle Detector (Inflow Traffic Volume Measure)

Figure 8 Image of CCTV Sensor

3.4. Communication Method of Traffic Signal at Intersection

(1) Wifi Communication or Fixed Line Communication

There is a discussion as to which type of communication method, either Wifi connection or fixed line connection, shall be applied to traffic signal at intersection. The fixed line connection needs to be applied due to the following reasons;

- Critically high reliability and instantaneousness are required for communication between controller and signals at intersection.
- All signals need to be synchronized (Green, Yellow, Red). There is a chance that the delay occurs at any of the signals due to transmission delay by Wifi communication.
- There is a possibility that Green is indicated by all signals due to transmission delay by Wifi connection. (Green will be blinked by fail-safe function in this case)
- The signal is usually controlled by one second. It is difficult to control by one second by Wifi connection.

(2) Aerial Cable or Buried Cable

The buried cable is recommended due to the following reason:

- The aerial cable spoils sight view.
- The aerial cable is exposed to danger of being disconnected.

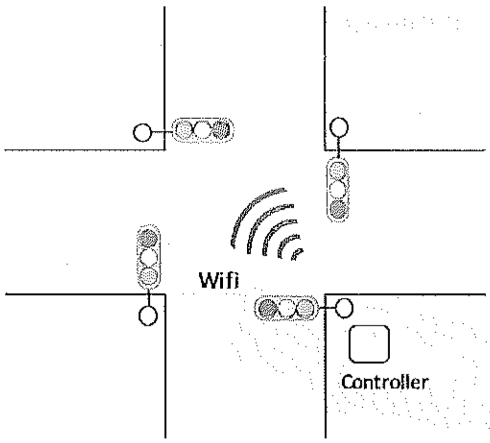


Figure 9 Wifi Connection

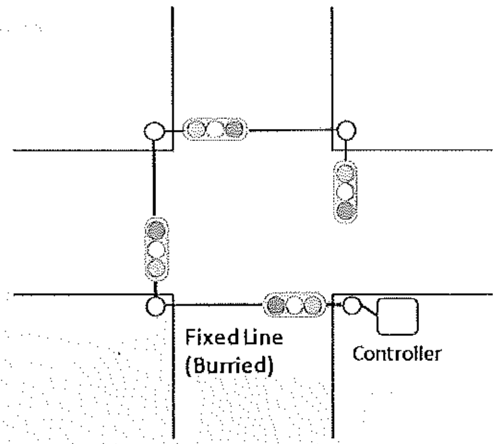
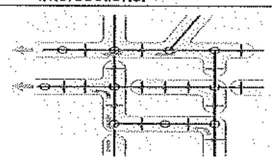
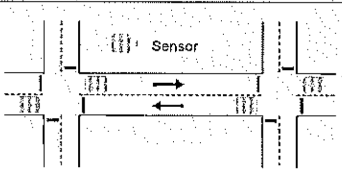
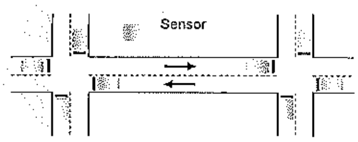


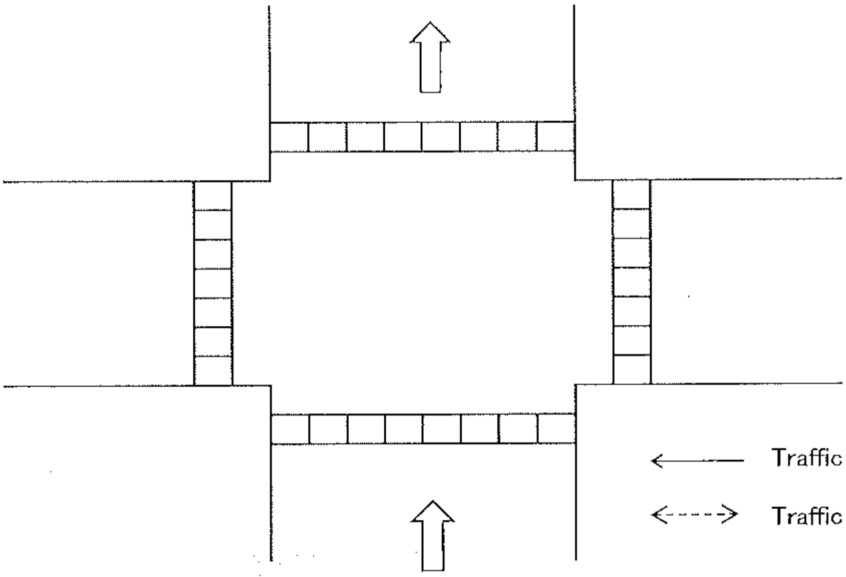
Figure 10 Fixed Line Connection

4. Comparison of Signal Control Method

Table 3 Comparison of Signal Control Method

Method	MODERATO	SCOOT	SCATS
Meaning	Management by Origin-DEstination Related Adaptation for Traffic Optimization	Split Cycle Offset Optimization Technique	Sydney Coordinated Adaptive Traffic Systems
Developed Country	Japan	United King dam	Australia
Purpose	1. Decrease of congestion volume and Que length 2. Area wise control based on key intersections.	1. Adjustment of green signal timing by forecasting arrival time of cluster of vehicle. 2. Line wise traffic control	1. Optimize split by degree of saturation and control offset by the pattern depends on the traffic volume 2. Point wise and line wise control
			
Sensor location	1. At entrance of key Intersection 2. Traffic volume sensor at entrance 3. Que length sensor at 150m, 300m and 500m from Intersection	1. At exit of Intersection 2. Traffic volume sensor at 150/200m from Intersection	1. At entrance of intersection 2. Traffic volume sensor at entrance of intersection
Control Index	1. Traffic Volume 2. Que length 3. Travel time	1. Arrival time forecast 2. Congestion or not 3. Traffic volume/duration of Green signal rate	1.Traffic volume/duration of Green signal rate
Sub Area	Subarea is combined and separated automatically based on traffic situation	Fixed	Non
Evaluation	Target area is congested area wise based on MG Road. Area wise control and reducing the que length by MODERAT is most effective for the target area.		

Signal Phase Improvement



⟵ Traffic stream (Vehicle)

⟵ - - - ⟶ Traffic stream (Pedestrian)

Signal indication flow	①	⇒	②	⇒	③	⇒	④		now
	①	⇒	②	⇒	③	⇒	④		new

【Basic approach for the signal indication】

1. Simplify the signal indication
2. Same signal indication to the same directional road
3. Keep the sequency of the vehicle stream
4. Keep the sequency of the pedestrian stream
5. Eliminate the danger order of the signal indications

Besides, if necessary improvement of intersection (extension/relocation of sidewalk and signals, road marking, etc,.) shall be done.

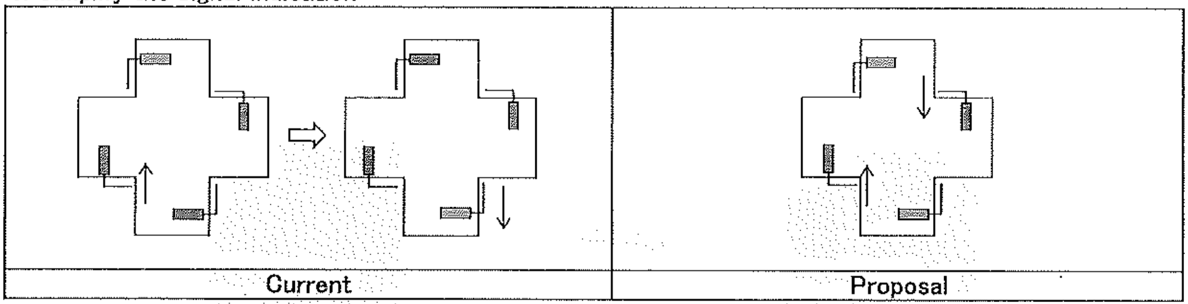
【Proposal signal indication for Anil Kumble Circle Junction】

<u>In order to decrease the following potential dangers in the current signal indication flow, the indication order of ② and ③ is switched in the new flow.</u>

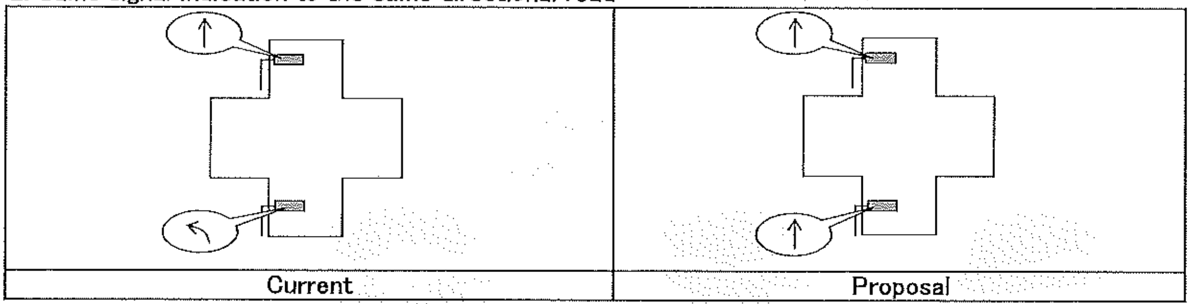
1. In the current flow (②⇒③), right turning vehicle could ignore the signal light induced by the traffic stream of lane for through traffic.
2. If this is the case mentioned above, head on crash could happen between the right turning vehicle and the vehicle coming from opposite side.
3. In order to decrease the danger under the current signal indication flow, Longer cycle time have to be set to keep the clearance between the right turning vehicle and the opposite side vehicle. But, longer cycle time leads to the increase of a waiting time, which could cause further congestion and red light running.

The images of the basic approach for signal indication are shown below.

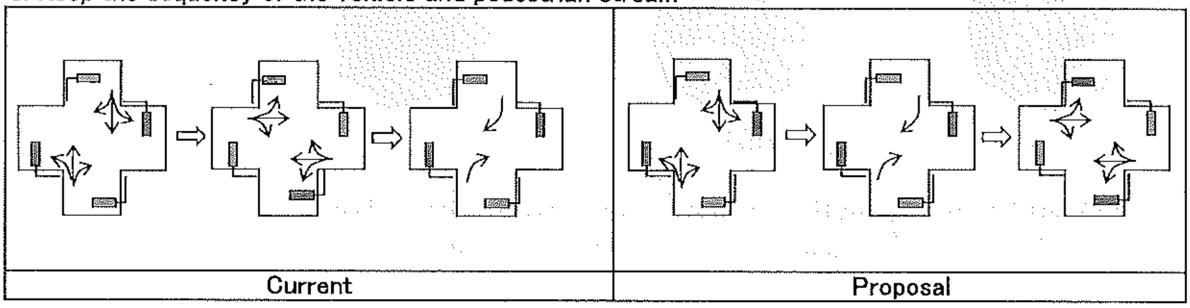
1. Simplify the signal indication



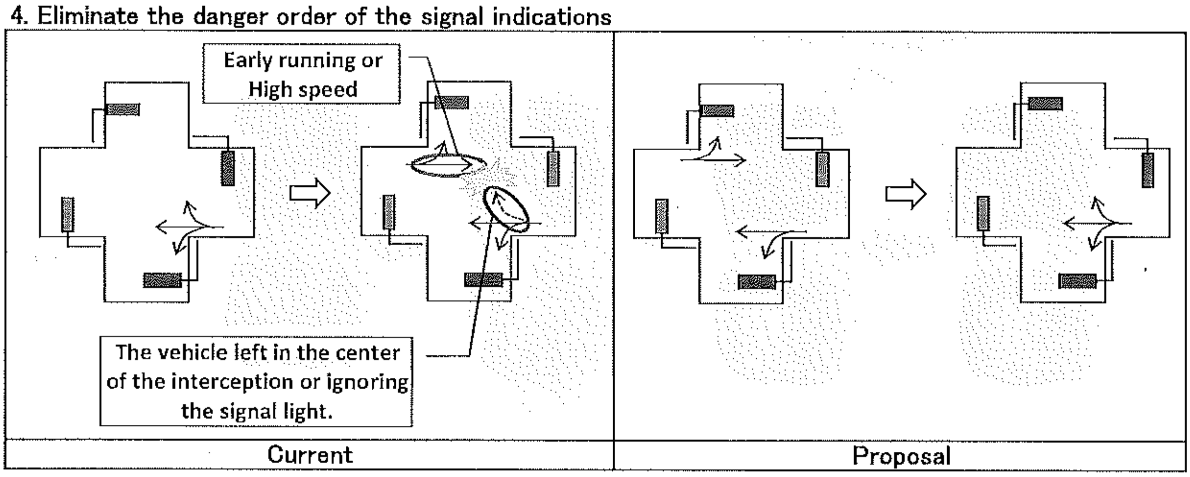
2. Same signal indication to the same directional road



3. Keep the sequency of the vehicle and pedestrian stream



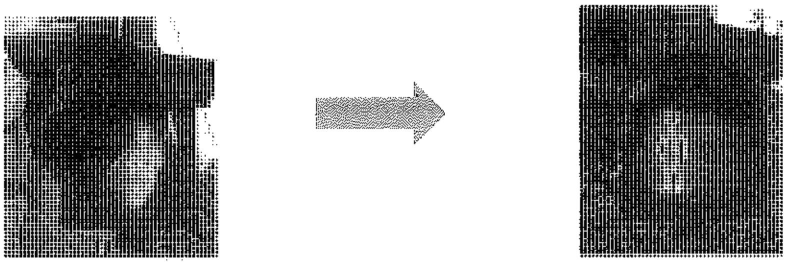
4. Eliminate the danger order of the signal indications



←—— Traffic stream (Vehicle)

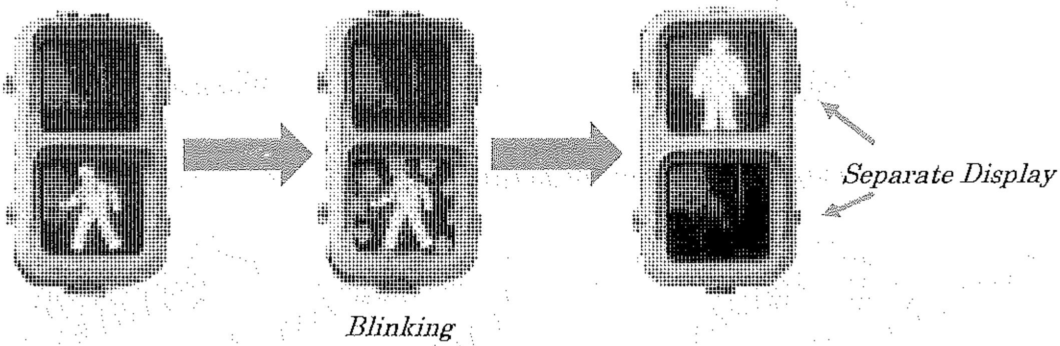
Pedestrian Signal Improvement

<Current Pedestrian Signal>



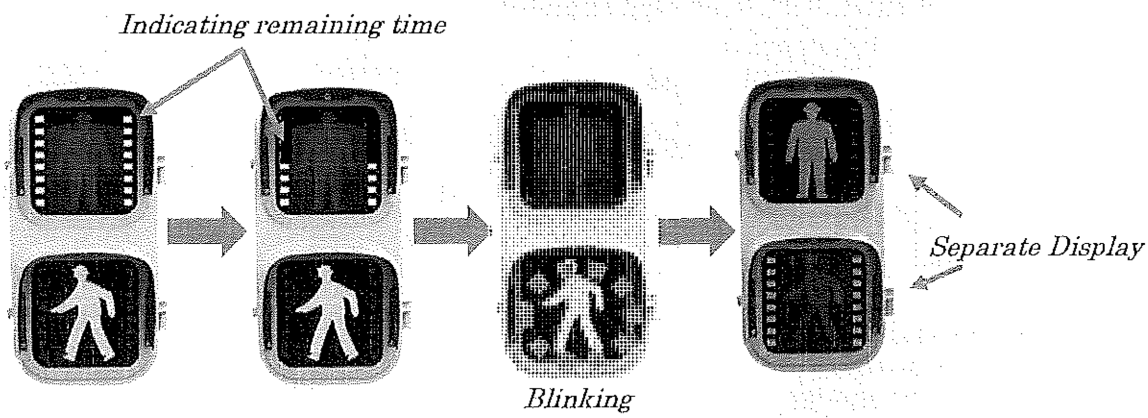
<Proposed Pedestrian Signal>

(Standard Type)



It blinks for duration of time for pedestrian to cross before it becomes red.
Green and red are indicated by separated display for clear recognition.

(Remaining Time Display Type)



It blinks for duration of time for pedestrian to cross before it becomes red.
Green and red are indicated by separated display for clear recognition.
It indicates remaining time for both green and red.

Pedestrian Signal Improvement

Item	Current Pedestrian Signal	Proposed Pedestrian Signal
Light Emitting Device	LED or Light Bulb	LED
Lamp Unit	Single display for green and red	Two separated displays for green and red
Displaying Method	Green → Red (Most signals do not have green blinking function before changing to red.)	Green → Green Blink → Red
Concern/Advantage	<Concern> · Perceptibility of signal indication is limited because both green and red are displayed on single display unit. · Pedestrian does not know when it becomes red due to absence of blinking time resulting in greater danger such as pedestrians being left in the middle of crossing when it becomes red, and etc.	<Advantage> · Green and red are more easily and clearly recognized by pedestrian because they are separately indicated. · Pedestrian knows remaining time before it becomes red so that they can take necessary action such as not start crossing, hurrying up completing crossing and etc. resulting in reduced probability of being left in the middle of crossing and so on. · Long life time of signal (LED)
Remark	In most cases, the green time is set at approx. 10 seconds which is too short to cross. This is considered one of the factors which induce pedestrians to ignore signal.	The required green time will be set according to the distance of pedestrian crossing.
Others		Publication of new display method is necessary.

Pedestrian Signal Improvement

Necessity of Publication of Pedestrian Signal

The indication of the recommended pedestrian signal will be different from the ones which are applied to the current pedestrian signals in Bengaluru.
People are not used to the new one. Thus publication to notify and let people accustomed to is required under the responsibility of Traffic Police.

Annex-5

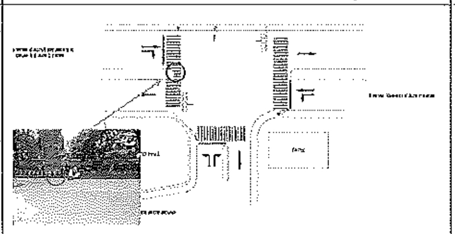
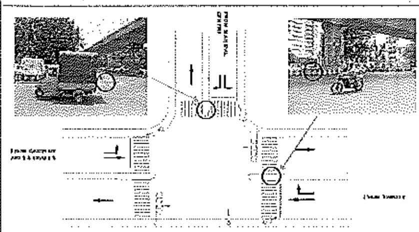
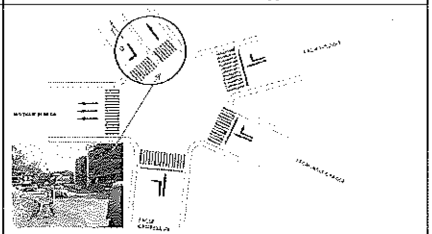
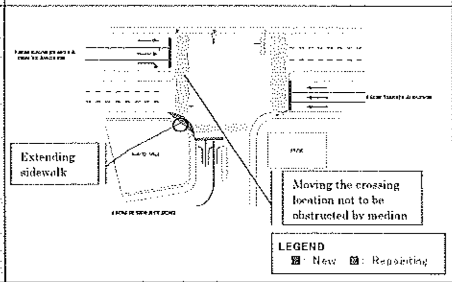
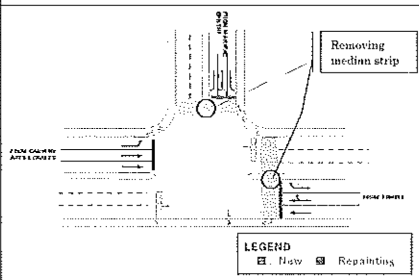
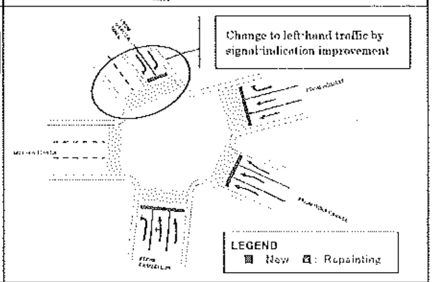
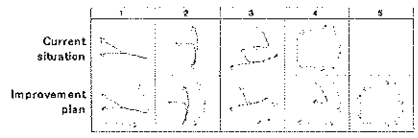
Improvement of Intersection together with Installation of Traffic Signal and Pedestrian Signal (Examples)

<Reason: Improving Intersection together with Installation of Traffic Signal and Pedestrian Signal>

1. To maximize effect of new signals, 2. To assure safety of pedestrian

<Major Improvement Items>

1. Road Marking (Pedestrian Crossing, Lane, Direction Arrow, etc.) 2. Splitting lane, 3. Extending sidewalk, 4. Removing obstacles, 5. Other minor improvements

	No4 MG Road- Commissariat Road-Residency Road	No.5 MG Road-Dickenson Road	No20 Victoria Rd-General KS Thimayya Rd-St Philomena
Current Situation			
Improvement Plan			
Issue	· The pedestrian crossing is blocked by obstacles. · The crossing time of pedestrial signal is too short to cross. · The pedestrian signal is almost invisible.	· The pedestrian crossing is blocked by obstacles. · The crossing time of pedestrial signal is too short to cross. · The pedestrian signal is almost invisible.	Right-hand traffic causing confustion of driver, thereby higher possibility of accident
Improved Items	· Moved crossing: (1) Cleared obstacles to cross (2) Increased intersection capacity by increased road space (compact-sized intersection) · Extended sidewalk: (1) Assured space for pedestrian (2) Shortened length of pedestrian crossing · Road marking (Pedestrian crossing, Lane, Stop line, Direction arrow) · Increased pedestrian crossing time	· Removed median: Cleared obstacles to cross · Road marking (Pedestrian crossing, Lane, Stop line, Direction arrow) · Increased pedestrian crossing time	Changed to the left-hand traffic by signal indication improvement (as shown below) 

TECHNICAL NOTE – B-TIC
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

奥田真人	
Masato OKUDA	**V. MANJULA, IAS**
Chief Consultant	Commissioner
Preparatory Survey Team	Directorate of Urban Land Transport
Japan International Cooperation Agency	Government of Karnataka
Japan	India

ATTACHEMENT

1 Objective

The objective of meeting with Commissioner of DULT is to discuss and confirm the details of B-TIC to be developed by grant project.

2 Confirmed and Agreed Items by DULT

2.1 Items Confirmed and Agreed with BMTC

There are several aspects of B-TIC which need to be confirmed and agreed with BMTC because the major input data of B-TIC is bus probe data and it will be provided by BMTC. The items described below are agreed with BMTC and they were reported to Commissioner of DULT and confirmed.

a) It was confirmed that B-TIC Probe Server will receive 10 sec probe data from BMTC.

b) It was confirmed that BMTC will push the probe data at every 60 sec interval to B-TIC Probe Server. It means that BMTC will push the last 6 records of probe data at a time every 60 second, which are collected by BMTC server at an interval of 10 sec from GPS devices installed on their city buses.

c) It was agreed that BMTC will provide the bus probe data to B-TIC free of cost.

d) It was also agreed that BMTC will make necessary modification of their systems at their own cost.

e) It was agreed that the communication line between BMTC Server and B-TIC server will be prepared by the grant project. B-TIC will be responsible for the cost of the maintenance of the communication line.

2.2 Items Confirmed and Agreed on B-TIC Function

a) Information Dissemination with VMS and Internet

The following explanations were given to Commissioner of DULT by JICA Survey Team and agreed.

・VMS;

VMS will comprise multi-coloured display panel which shows schematic road map and message display line. The real time congestion status and expected travel time to the major destinations ahead will be displayed on the schematic road map in the multi-coloured display panel. This information will be automatically generated by B-TIC server. The messages on the traffic event such as accident will be displayed on the message display line. The messages will be manually inputted by Traffic Police at B-TRAC centre as necessary.

・Internet;

It displays congestion status with different colours according to the level of congestion. The congestion status will be shown on the road network of major arterial roads in Bengaluru metropolitan area.

b) Functions of Roadside Equipment

The details of functions of roadside equipment such as ATCC and Que Length measurement to be installed under B-TIC were explained by JICA Survey Team and they were agreed.

c) Stored Data in B-TIC server
The followings were agreed with Commissioner of DULT.
The probe data collected from BMTC will be saved for 10 years, categorised by road section. The section will comprise group of links (apporx.100m per link) and will be defined as distance between certain points for analysing of traffic data.
ATCC and Queue Length data collected from the roadside equipment will be saved for 10 years.
The saved data in BTIC will be utilised for the purpose of reporting and evaluation by importing into Microsoft excel file and MS-Access file formats.

d) Operation and Maintenance organization
JICA Survey Team proposed the required organisation structure which consists of one director and two operators. The director will be assigned from DULT and the operators will be outsourced.

3 Items Requested by DULT

a) Required Expertise of Staff for Operation and Maintenance of B-TIC
Commissioner of DULT requested JICA Survey Team to mention on the report about the required expertise of staff of each position for operation and maintenance of B-TIC. It was agreed that JICA Survey Team will mention on the report.

b) Required Method for Integration of B-TIC with Other Systems in the Future
B-TIC is intended to play a central role as information centre in Bengaluru metropolitan area in the future as envisaged by ITS Master Plan. Commissioner of DULT requested JICA Survey Team to mention on the report about the required method on how to integrate the systems of the third party agencies with B-TIC. It was agreed that JICA Survey Team will mention on the report.

1 Role and Function of B-TIC

1.1 Objectives of B-TIC

B-TIC will be established to achieve three objectives as described below.

- To disseminate the processed road/traffic information to users on a real-time basis.
- To use stored quantitative data for effective road planning, operation and maintenance.
- To share the information amongst related Gov. agencies.

Each equipment to be developed and their quantity, the following contents will be installed.

Table1 Quantity of ITS Components

ITS Component		Quantity
B-TIC System	Center System	1 set
	Probe Data System	1 set
	Que Length Measurement System	12 locations (72 units)
	Automatic Traffic Counter and Classifier	8 locations (16 units)
	Variable Message Sign	3 units
	Internet System	1 set

1.2 Data Collection and Storage

The B-TIC collects necessary data from the following sub-system components.

1) Automatic Traffic Counter-cum-Classifier System (ATCC):

① ATCC installed at the middle point of major intersections on arterial roads. It collects and process the following data to ATCC server of B-TIC at one-minute interval.

- Traffic volume of large sized/small sized vehicle
- Average speed
- Equipment status

② The ATCC server process the one-minute traffic data collected into five-minute data. Traffic volume will be sum of the latest five one-minute data and speed data will be the arithmetic average of the latest five one-minute data.

Five-minute traffic volume data will be accumulated into one-hour data and one-hour data will be accumulated 24-hour data.

L All processed data will be stored in the ATCC server and the data will be transferred to B-TIC server. B-TIC server stores data for ten years to analyse for future usage.

2) ***Queue Length Measurement System:***

① The Queue Length Measurement System installed distance of 300m, 600m and 900m in principal from the stop line of the chronically congested intersection. It judges the congestion level and determine whether queue has extended to the detector location or not. Measurement duration will be one-minute interval. Following data will be transmitted to the Queue Length Measurement Server one minute interval.

- Vehicle count
- Time occupancy rate
- Equipment status

② The Queue Length Measurement Server estimates the queue length of all approaches where vehicle detectors are installed. The estimation processes are described below.

- Starting from the vehicle detector nearest to the occupancy data needs to be compared against lower and upper limits which have to be settled at each detector location.
- If the occupancy is lower than lower limit, the system judges that no queue exists.
- If occupancy is higher than higher limit, the system judges that queue extends beyond the detector location and the data from the next detector will be processed.
- If the occupancy is between lower and upper limits, queue length needs to be calculated as proportionally.

The Queue Length Measurement Server process the one-minute average occupancy data collected into five-minute data. The Processed five-minute data will be transferred to Probe Server at every five minute interval.

③ All processed data will be stored in the Queue Length Measurement Server and the data will be transferred to B-TIC server. B-TIC server stores data for ten years to analyse for future usage.

④ B-TIC server will have the reporting function which will be generated as a file in portable document file format as per the system operator's request.

3) Probe Car System:

① Probe Car System collects the location data from BMTC buses equipped GPS devices to grasp travel speed of each link※. GPS devices of BMTC buses transmits bus location data, device ID, time, bus route number and etc. to BMTC server every ten seconds. Probe car server of B-TIC receives bus location data from BMTC server at every one-minute interval which composes of six ten-second data.

※Each link: The distance of each link is considered approximately 100 meters. Actually it will be determined by Digital Road Map to use.

② The probe car server process following processes and calculation cycle will be every five minute. Therefore, information will be updated every five minute.

- Data validation
- Map matching
- Determination of moving direction
- Link speed calculation
- Mean link speed and link average travel time
- Congestion level of link
- Section※ travel time

※Section: Section composes of links. It is defined as distance between certain point to major destinations for displaying travel time in sketch map of VMS.

The probe server receives processed data received from the queue length measurement server and combine with processed data of probe server at every five minute.

Although updating time of information is at every five minute, calculation time can be considered utmost fifteen minutes for executing all above processes. Therefore, information provided users is utmost fifteen minutes past information.

③ All data transmitted from BMTC server and processed data of the B-TIC will be transferred to B-TIC server. B-TIC server stored processed location data after map matching for three months, while five-minute link speed, section congestion level and section travel time data will be kept for ten years.

④ B-TIC server will have the reporting function which will be generated as a file in portable document file format as per the system operator's request.

1.3 ITS Components and Information for Dissemination to Users

The B-TIC disseminates necessary traffic information to users by VMS and Internet.

1) VMS:

It composes of both multi display type of sketch map and message display line. In the sketch map, displaying information is real time traffic status and time to major destination. The displayed information on sketch map will be processed by Probe server of B-TIC and transferred to VMS server in Traffic Police. Operator of Traffic Police enable to display both displayed information on sketch map and any messages on message line in normal usage. If Traffic Police consider to display higher priority information on sketch map such as incident information, operator of Traffic Police enables to add on displayed information on sketch map.

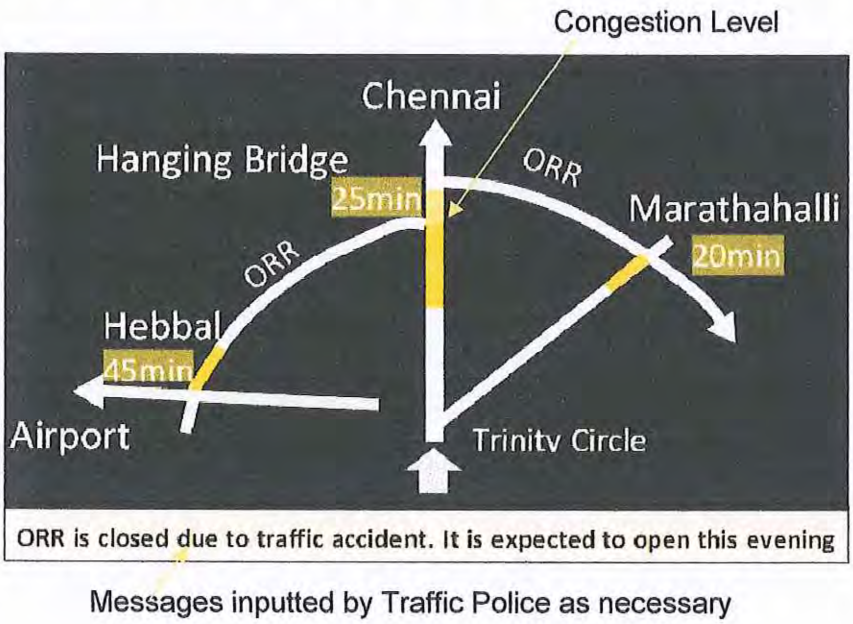


Figure1 Example of VMS (MG Road at Trinity Metro Station)

2) Internet:

It displays traffic status of all arterial roads network in Bengaluru Metropolitan. It also displays incident and event information which may be considered big impact to traffic status such as big accident, road closure etc.

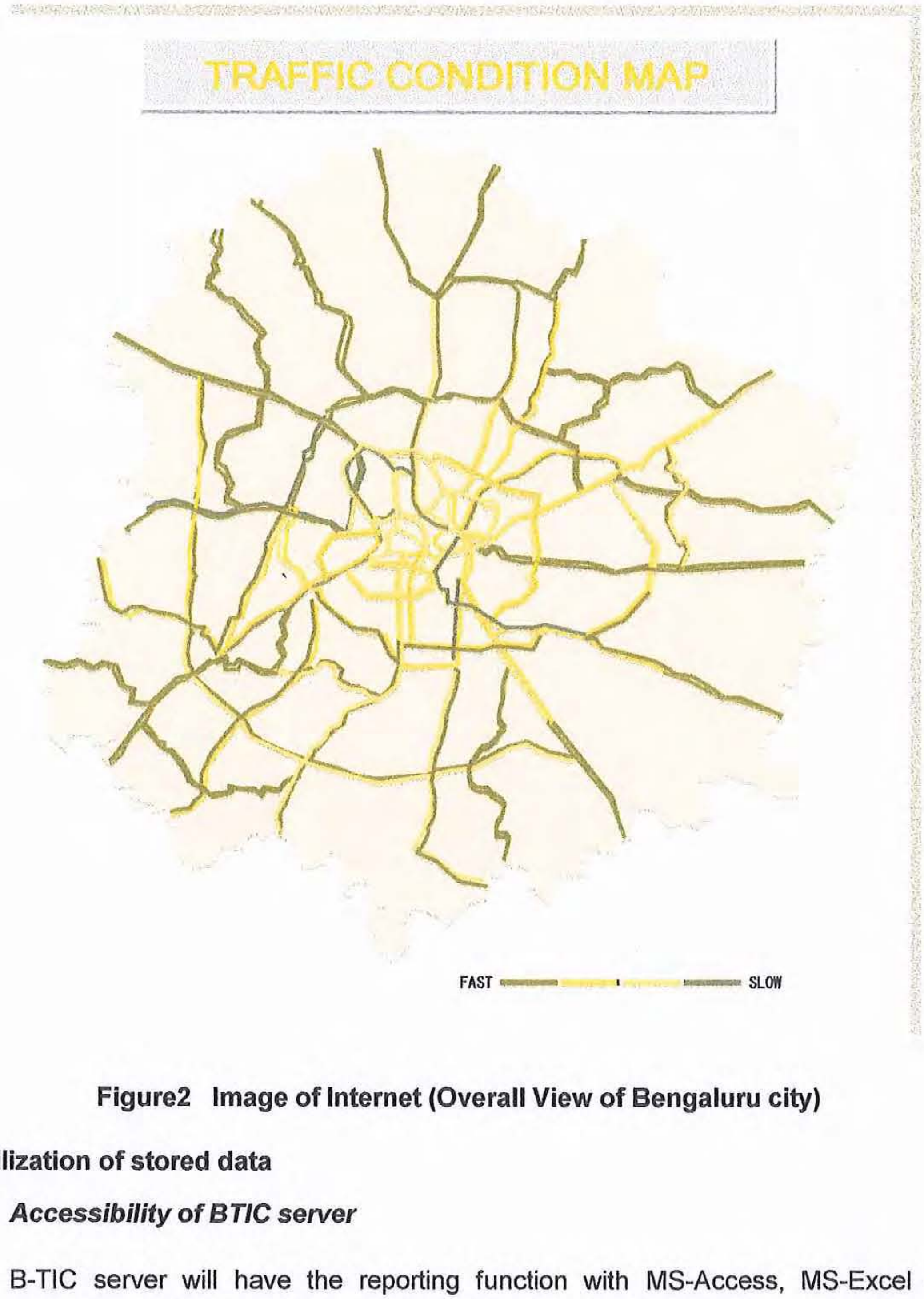


Figure2 Image of Internet (Overall View of Bengaluru city)

1.4 Utilization of stored data

1) Accessibility of BTIC server

B-TIC server will have the reporting function with MS-Access, MS-Excel or equivalent friendly software which will be generated as a file in portable document file format as per the system operator's request.

2) Utilization of store data

The stored data in storage device is used for road planning, operation and maintenance. Proceeded data are stored certain period and these data are compiled in accordance with request of related Gov. agencies. Followings are possible utilization of stored data.

- Finding cause of bottleneck by Identifying starting point of congestion.
- Finding redundancy route by identifying peak hours and transition of queue length of road which is parallel to another route.
- Prospecting the congestion status of arterial road of Bengaluru Metropolitan to encourage users to utilize redundancy route by pre-notice.
- Grasping effectiveness to traffic flow by road/lane closure of road work or adverse weather.
- Grasping correlation between contribution ratio of large sized vehicles and pavement damage.
- Compiling transition and tendency of congestion status by elapsed time.
- Compiling average travel speed and travel time by hourly, daily monthly and seasonal to understand the tendency of changes of peak hours, weekday, holiday and festival season.
- Grasping the effect of construction or extension of road, metro, flyover, etc. by comparing traffic status between before and after.

1.5 Information Sharing among Related Gov. Agencies

Any processed and compiled data/information including above can be provided to related Gov. agencies.

- Traffic Police, Road Administrators (BBMP, PWD, NHAI and BDA) can utilize their traffic/road management and planning.
- Shared information with Traffic Control Centre of BPRR in the case of happening of big incident which may affect each other such as big accident, road closure of BPRR, etc. (In future)
- Provision of parking availability information of off road public parking lot to users. (In future)

1.6 Location of Roadside Equipment

The installation locations of roadside equipment is determined in accordance with the basic policy for installation location selection given below.

Table 2 Installation location selection policy: B-TIC

Roadside unit	Installation location selection policy
Que Length Measurement System Equipment	▪ For measurement of congestion length, vehicle sensors will be installed at 300m, 600m and 900m* from the intersection having significant congestion. ▪ Vehicle sensors will be installed on overtaking lane considering that many obstacles exist on lane on sidewalk side.
Automatic Traffic Counter and Classifier	▪ The installation location will be selected from where the measurement area can be secured using image processing method taking into consideration the traffic situation in India where the trend is not to follow the lane.

(*900m will installed as necessity ; intersection with so heavy traffic.)

1) Que Length Measurement System

Roadside Equipment will be installed on overtaking lane considering that many obstacles exist on lane on sidewalk side.

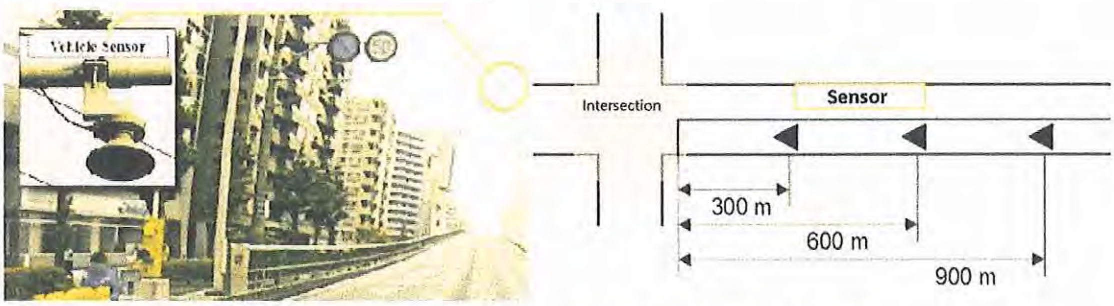


Figure3 Installation image of roadside units (Que Length)

2) Automatic Traffic Counter and Classifier

The installation location will be selected from where the measurement area can be secured using image processing method taking into consideration the traffic situation in site where the trend is not to follow the lane.

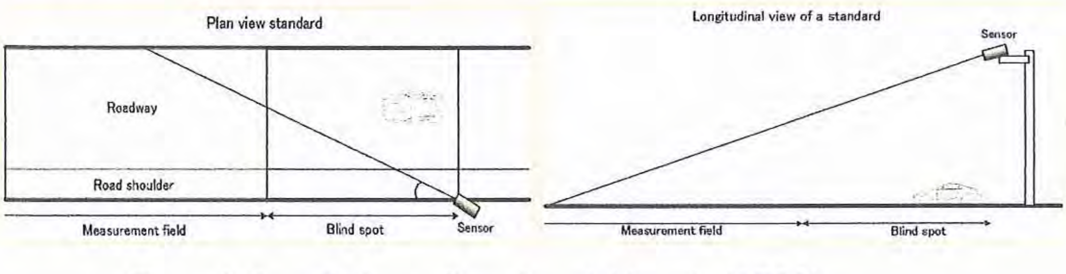


Figure4 Installation policy of roadside units(ATCC)

1.7 System Configuration

System Configuration of all ITS system is shown in below.

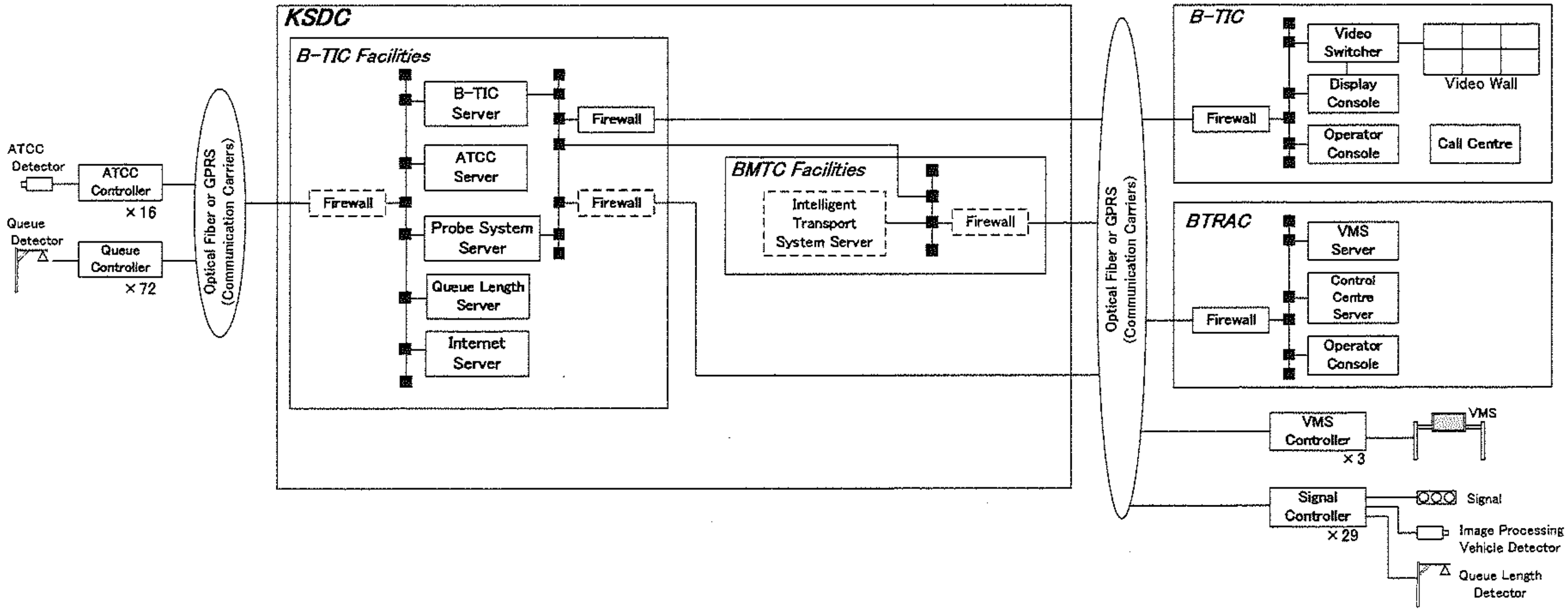


Figure5 System Configuration of all ITS System

2 Required Organization Structure for ITS Pilot Project

In order to sustain the pilot project, posting adequate employee for managing system is required. B-TIC is an organization needs to be newly set up the organization.

2.1 Organization Structure for Operation and Maintenance of B-TIC

B-TIC will be operated and maintained under supervision of DULT. Therefore, one Project Director needs to be posted from DULT. Operators need to be employed under Project Director. As for the maintenance, there is a option for DULT to outsource the maintenance work to the contractor or sub-contraoctor, a company which installs the system. The roles and responsibilities of staff for operation and maintenance of B-TIC are as follows.

Table 3 Roles and Responsibilities

Position	Roles and Responsibilities	Working Hours
Project Director (This position can combine with routine work of DULT)	• Responsible for supervising and controlling all activities of B-TIC • Coordination of all activities between B-TIC and other related Gov. agencies especially Traffic Police. • Checking the report issued by the systems. • Compiling, analysis and providing the processed data/information as per request of related Gov. agencies. • Informing malfunction of ATCC system, Queue Length Measurement system and Prove system to the maintenance company. • Informing the necessity of updating system such as Digital Road Map.to the maintenance company • Checking the spare parts inventory	Daytime only
Operator-1	• Receiving and answering enquiries from general public and the related Gov. agencies • Informing necessary information to the related Gov. agencies. • Request the related Gov. agencies to provide related information if necessary.	Daytime only

	• Checking the storage condition of spare parts. • Taking charge of operator-2's work in his absence.	
Operator-2	• Checking the status of ATCC system and Queue Length Measurement System • Monitoring traffic condition on schematic map of video wall • Informing the malfunction of any systems to Project Director • Carrying out Update or maintenance of the server in KSDC from console. • Checking any discrepancy between the information displaying on VMS by Traffic Police and probe server. • Taking charge of operator-1's work in his absence.	Daytime only

The minimum experience of each position is shown as follows;

Position	Minimum Experience
Project Director (This position can combine with routine work of DULT)	• Education: University graduate • Total Work Experience: 10 years. • As manager of work: three years • Language: Fluent in English
Operator-1	• Education: College graduate or similar • Total Work Experience: 5 years. • In similar size of work: three years • Language: Fluent in English and Local Language
Operator-2	• Education: College graduate or similar • Total Work Experience: 5 years. • In similar size of work: three years • Language: Fluent in English and Local Language

Contracted maintenance company is required following works described below to sustain the B-TIC system.

- Submission of preventive work plan and carrying out it as per plan
- Submission of necessary report after checking or repairing the system
- Carrying out repair works for equipment and retrieving system
- Maintaining spare parts
- Time from receiving notification of failure to completing the permanent or temporary remedial measure for all B-TIC system※ shall be less than 24 hours.

※ B-TIC system: Centre System, ATCC system, Queue Length Measurement system, and Probe system

TECHNICAL NOTE – BMTC
ON THEPREPARATORY SURVEY FOR
THEPROJECTFORBENGALURUMETROPOLITANREGION ITS
INTHE REPUBLIC OF INDIA

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JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India.The Team held a series of discussions with the officials of Bengaluru Metropolitan Transport Corporation (BMTC). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July05,2016

奥田真人

MasatoOKUDA
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency
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V.MANJULA,IAS
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Directorate of Urban Land Transport
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Ekroop Caur

Dr. EkroopCaur, IAS
Managing Director
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Corporation
Government of Karnataka
India

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1 Items Discussed and Confirmed with BMTC in the Past

- Probe Data transmission by GPS Devices installed on approximately 6400 BMTC city buses at 10 sec interval and collection of probe data by BMTC Server
- BMTC Probe system server configuration setup in KSDC
- Preparation of B-TIC by Japanese Grant Project
- The real time probe data transmission from BMTC to B-TIC
- Sample Probe data provided by BMTC to grant project study team

The details are explained hereinafter.

1.1 Probe Data Transmission by GPS Devices

- The GPS Devices installed on BMTC buses collect and transmit GPS data at every 10 sec interval to the servers.
- The probe data transmitted by GPS devices is collected by the BMTC server
- The BMTC servers are installed in KSDC Data centre

1.2 B-TIC: Bengaluru Traffic Information Centre

Bengaluru Traffic Information Centre (B-TIC) will be developed by the grant project for the purpose of dynamic traffic information provision and utilization of quantitatively measured data on traffic.

- B-TIC will be developed and operated under jurisdiction of DULT.
- Major input data: BMTC Bus Probe Data
- Major output information: Congestion information on major road to be provided from VMS and Internet
- It is proposed to install the B-TIC servers in KSDC

1.3 Transmission of Probe Data from BMTC to B-TIC

BMTC has agreed to provide the real time probe data to B-TIC in a format and at an interval proposed by DULT. The format and interval of probe data requirement by B-TIC is provided in table below.

Table 1-1 Probe Data Transmission from BMTC to B-TIC

Probe Data Transmitting Server	Probe Data Receiving Server	Data Interval of Transmission	Format of Data
BMTC	B-TIC	***At every 60 Sec, 6 packets of real time Probe Data**	GTFS

* The details are elaborated in section 2 below.

1.4 Demarcation of Responsibility for Communication Line Between BMTC and B-TIC

The demarcation of responsibilities for preparation and maintenance of communication line between BMTC and B-TIC for real time probe data transmission is provided in table below.

Table 1-2 Communication Line Between BMTC to B-TIC

Communication Line Preparation	Communication Line Operation & Maintenance	Making the Probe Data available for B-TIC
Grant Project	DULT	**BMTC**

2 Network Communication from BMTC to B-TIC

The network communication configuration for transmission of probe data from BMTC to B-TIC is provided in the figure 2-1 below.

The required probe data transmission related aspects from BMTC to B-TIC are described below.

- B-TIC will prepare the communication line from BMTC to B-TIC.
- BMTC will be responsible to provide the last 6 probe data records to B-TIC at every 60 seconds interval. B-TIC would be responsible to pull the probe data through API or other ways.
- BMTC agreed to provide the probe data to B-TIC free of cost.

3 Probe Data Collection Internal required for B-TIC

BMTC currently collects the data from Buses on every 10 seconds. B-TIC requires the 6 packets of real time data on every 60 Seconds.

4. Confirmation Items Required From BMTC

The following items require confirmation from BMTC to ensure reliable transmission of probe data from BMTC to B-TIC.

- B-TIC would coordinate with BMTC regarding data format to ensure smooth and uninterrupted data transmission flow.
- Based on the sample probe data provided by BMTC to grant study team, data fields mentioned in table below is identified. BMTC need to confirm the data field of probe data.

4.1 Data Format for the Probe Data Provided By BMTC: BMTC will decide the data format for the packet transfer. B-TIC request to include at least below mentioned fields in the data format:

1	Device Serial Number
2	Packet Code
3	GPS Device Date & Time (Time shall be in HH:MM:SS format)
4	Long Lat Information
5	Server Date & Time (Time shall be in HH:MM:SS format)

TECHNICAL NOTE – KSDC
ON THE PREPARATORY SURVEY FOR
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JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Karnataka State Data Centre (KSDC). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

奥田真人

Masato OKUDA
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Project Director, KSWAN
Centre for e-Governance
Karnataka State Data Centre
Government of Karnataka
India

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1 Items Discussed and Confirmed with KSDC

- Installation of B-TIC Servers in KSDC
- KSDC provide two types of services: Co-Location and Management Services. Clients can choose one of the services as per their requirement
- Cost of Electricity and Space provision for two types of services provided by KSDC
- Communication network connection from KSDC to B-TIC
- Operation and Maintenance of B-TIC Servers installed in KSDC

The details are explained hereinafter.

1.1 Space for B-TIC Servers in KSDC

- JICA Survey Team discussed with KSDC officials regarding installation of B-TIC Servers in KSDC.
- KSDC agreed to provide required space in their Data Centre.

1.2 Types of Service Offered By KSDC

KSDC offers two types of service for servers in KSDC.They are:

a) Co-Location: KSDC provides space in their data centre for customers to install their hardware (servers) and software (application, database etc). KSDC do not charge. KSDC also provides uninterrupted power supply to the customers'equipment free of charge.

b) Management Services: KSDC preparesall required hardware and software such as servers, database and etc. and installs them in their data centre. The customer develops their own applications and host on the servers prepared by KSDC. KSDC charges the customer. The fee is based on the hardware and software which are prepared by KSDC.

1.3 Type of Service for B-TIC Servers

- It was proposed to install the B-TIC Servers by Co-Location type.
- The grant project will prepare B-TIC Servers, the related hardware and

software in the KSDC premises.

- KSDC will provide the space and the power supply arrangement to the servers free of cost.

1.4 Communication Network from KSDC to B-TIC

- Service providers, BSNL, Reliance and Sify, are providing communication connections between KSDCand customer locations.
- Likewise, the communication connection between KSDC and B-TIC is required to prepare.
- The communication connection between KSDC and B-TIC will be prepared by B-TIC.
- The communication cost and maintenance cost of the communication connection will be responsibility of B-TIC.

1.5 Operation and Maintenance of Servers Installed in KSDC

- B-TIC will be responsible for the operation and maintenance of the servers installed in KSDC.
- B-TIC will prepare the network configuration in B-TIC for remote monitoring, operation and maintenance of the servers installed in KSDC.

1.6 Power Backup in KSDC

- KSDC installedthree Diesel generator sets (total 2000 KVA) to provide power backup in case of primary power failure.
- As a precautionary measure, KSDC installed two separate power connections from two different sub-stations of the power supplier company as primary power supply arrangement.
- The Diesel generator sets can provide continuous power supply for around 18 hours in case of emergency requirement.
- KSDC also installed UPS for secondary backup.
- KSDC will prepare power and UPS sockets to connect B-TIC server.

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JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 12, 2016

FOR 高橋 雅人	
Masato OKUDA	**V. MANJULA, IAS**
Chief Consultant	Commissioner
Preparatory Survey Team	Directorate of Urban Land Transport
Japan International Cooperation Agency	Government of Karnataka
Japan	India

Meeting Record

Topic	Meeting with DULT
Date	07 Jul, 2016
Time	10:30 – 11:30
Venue	DULT Office
Attendees	From DULT: 1. Ms. Manjula IAS - Commissioner - DULT From JICA Survey Team: 1. Mr. Okuda 2. Mr. Totani 3. Mr. Takashi 4. Mr.Narayan 5. Mr. Manohar 6. Mr. Varun

Meeting Record

1. Purpose:

The purposes of the meeting are:

- To explain to the Commissioner of DUT about the conclusion of the discussions held with the related agencies (Traffic Police, BMTC and KSDC), and
- To discuss and confirm on the details of the proposal of B-TIC based on the Technical Note prepared by JICA Survey Team.

2. Traffic Police

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with new Additional Commissioner of Traffic Police on the proposed ATCS (Area Traffic Control System) and VMS and discussed as follows:

2.1 Items Agreed by Additional Commissioner of Traffic Police:

- **Locations of ATCS and VMS:** JICA Survey Team carried out the site survey and identified 29 intersections of ATCS and three (3) locations of VMS. All locations were agreed by the Additional Commissioner of Traffic Police.
- **Method of ATCS:** JICA Survey Team explained about MODERATO as the method of ATCS and it was agreed that MODERATO will be introduced by the grant project.
- **Other improvement:** JICA Survey Team explained about the necessity of the following improvement to be carried out together with introduction of ATCS to maximize the effect.
  - ✓ Improvement of signal phase,
  - ✓ Improvement of pedestrian signals, and
  - ✓ Improvement of intersection.

  Additional Commissioner of Traffic Police agreed the proposals of all above improvement to be carried out.

2.2 Items Raised by Additional Commissioner of Traffic Police:

The following items were raised by Additional Commissioner of Traffic Police:

- **Budget for Maintenance of ATCS and VMS**
  The Traffic Police are responsible for maintenance of ATCS and VMS after handover. Additional Commissioner of Traffic Police requested DULT to explain how the funds will be allocated from State Government budget to Traffic Police for the maintenance costs of the ATCS and VMS systems.
- **Details of Maintenance**
  Additional Commissioner of Traffic Police wished to know how ATCS which is new to them can be sustainably maintained. He requested JICA Survey Team to provide the details of maintenance (called maintenance plan).
  JICA Survey Team agreed that it will be provided. (Question has been submitted to [illegible] and operation plan)
- **Permission of Relocation of Existing Gantry and Sign Board at Silk Board Junction**
  JICA Survey Team proposed the arrangement of relocation of the existing gantry and sign board for installation of VMS at Silk Board Junction, as detailed on the Technical Note.
  Additional Commissioner of Traffic Police mentioned that the permission of the proposed relocation arrangement needs to be taken from NHAI through DULT.
- **Permission of Installation of Roadside Equipment**
  Additional Commissioner of Traffic Police mentioned that the permission of installation of other roadside equipment needs to be taken from the related road administrators through DULT.
- **Location of Servers of ATCS and VMS**
  JICA Survey Team proposed to install the servers of ATCS and VMS in KSDC (Karnataka State Data Centre), instead of in the centre of B-TRAC, due to such reasons as availability of power supply, assurance of data security and etc.
  Additional Commissioner of Traffic Police mentioned that all components which belong to Traffic Police shall be under direct control of Traffic Police and thus the servers of ATCS and VMS shall be installed in the centre of B-TRAC.

2.3 Items Confirmed with Commissioner of DULT

The items which were raised by Additional Commissioner of Traffic Police mentioned above were confirmed with Commissioner of DULT as follows:

- **Budget for Maintenance of ATCS and VMS**
  Commissioner of DULT confirmed that it will be explained to Traffic Police by DULT.
- **Permission of Relocation of Existing Gantry and Sign Board at Silk Board Junction**
  Commissioner of DULT confirmed that DULT will take care of obtaining approval.
- **Permission of Installation of Roadside Equipment**
  Commissioner of DULT mentioned that the permissions for installation of the roadside equipment from the road administrators shall be taken just prior to tender process due to likeliness that such factors as road conditions at site, officials in charge and etc. will be altered. It was confirmed that the permission will be obtained through DULT.
  It was also confirmed that the design drawings of the roadside equipment will be submitted to BBMP through DULT after completion of the design drawings to be prepared by JICA Survey Team.
- **Location of Servers of ATCS and VMS**

Commissioner of DULT confirmed that she will discuss with Additional Commissioner of Traffic Police.

JICA Survey Team will prepare advantages and disadvantages of installing servers in the centre of B-TRAC and KSDC.

3. B-TIC

JICA Survey Team explained about the proposals of B-TIC as detailed on the Technical Note to Commissioner of DULT. They were conformed and requests were made by Commissioner of DULT as follows:

3.1 Items Agreed with Commissioner of DULT

- **Probe Data Transmission from BMTC to B-TIC**
  It was confirmed that B-TIC will receive 6 records of GPS probe data at a time every 60 seconds from BMTC.
- **Details of Functions of Roadside Equipment**
  The details of functions of roadside equipment to be installed under B-TIC were explained by JICA Survey Team and they were agreed. (ATCC, queue detection, ACTS)
- **Period of Data Storage**
  The period of storage of collected and processed data was discussed and it was agreed as ten (10) years. (100 GB per day)
- **Information to Be Provided from VMS**
  The details of information to be provided from VMS were explained by JICA Survey Team and they were agreed.
- **Operation and Maintenance**
  The organization structure and roles of each position were explained by JICA Survey Team and they were agreed.
- **Permission of Installation of Roadside Equipment**
  Commissioner of DULT mentioned that the permissions for installation of the roadside equipment under B-TIC from the road administrators shall be taken just prior to tender process due to likeliness that such factors as road conditions at site, officials in charge and etc. will be altered. It was confirmed that the permission will be obtained through DULT.
  It was also confirmed that the design drawings of the roadside equipment will be submitted to BBMP through DULT after completion of the design drawings to be prepared by JICA Survey Team.

3.2 Items Requested by Commissioner of DULT

- **Required Expertise of Staff for Operation and Maintenauce of B-TIC**
  Commissioner of DULT requested JICA Survey Team to mention on the report about the required expertise of staff of each position for operation and maintenance of B-TIC.
  It was agreed that JICA Survey Team will mention on the report.
- **Required Method for Integration of B-TIC with Other Systems in the Future**
  B-TIC is intended to play a central role as information centre in Bengaluru metropolitan area in the future as envisaged by ITS Master Plan. Commissioner of DULT requested JICA Survey Team to mention on the report about the required method on how to integrate the systems of the third party agencies with B-TIC.
  JICA Survey Team agreed that it will be mentioned on the report.

4. Karnataka State Data Centre (KSDC):

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with the officials of KSDC and items agreed with KSDC as follows:

4.1 Items Agreed with KSDC

- **B-TIC Server and Services to Be Provided by KSDC**
  It was agreed that B-TIC servers will be installed in KSDC by 'Co-Location Method'. The Co-Location Method is a type of service offered by KSDC in which all hardware and software will be prepared by the grant project and spaces of the hardware and power supply will be provided by KSDC.
- **Cost for the Space and Power Supply**
  It was confirmed that the spaces and power supply will be provided free of charge under the co-location method.
- **Communication Line between KSDC and B-TIC**
  It was confirmed that the communication line between KSDC and B-TIC will be prepared by the grant project.

4.2 Comments of Commissioner of DULT

- **Budget for Communication Line**
  Commissioner of DULT mentioned that the budget for the communication line between KSDC and B-TIC will be assured based on the cost provided by JICA Survey Team. She also mentioned that KSWAN could be used for secondary communication line as backup.

5. Bangalore Metropolitan Transport Corporation (BMTC):

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with the officials of BMTC and items agreed with BMTC as follows:

5.1 Items Agreed with BMTC

- **Cost for Providing Probe Data to B-TIC**
  It was agreed that BMTC will provide the bus probe data which they collect to B-TIC free of cost.
- **Communication Line between BMTC Server and B-TIC Server**
  It was agreed that the communication line between BMTC Server and B-TIC server will be prepared by the grant project. B-TIC will be responsible for the cost of the maintenance of the communication line.
- **Probe Data Transmission from BMTC Server to B-TIC Server**
  It was agreed that the probe data will be pushed from BMTC server to B-TIC server. It was also agreed that BMTC will make necessary modification of their systems at their own cost.

6. Action Items by DULT

It was confirmed that the following items will be taken care by DULT.

- **Information about Current Organization of Traffic Police**
  DULT will obtain the information of the current organisation of Traffic Police with number of staff in each section and will share with JICA Survey Team.

- **Information about Budget of Traffic Police**
  DULT will obtain the information of the budget allocated to Traffic Police for the last four (4) years. It will include the cost spent for operation and maintenance of their current system of B-TRAC.
- **Information about Tax Exemption**
  DULT will share the information about tax exemption applied to the projects of World Bank executed in Karnataka State.
- **Obtaining Approval on Trial Digging from BBMP**
  DULT will obtain approval on the trial digging from BBMP as soon as possible.
- **Obtaining Signatures from Related Agencies on Technical Notes**
  DULT will obtain the signatures from Traffic Police, KSDC and BMTC on the technical notes submitted by JICA Survey Team.

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Bengaluru, July 12, 2016

高橋 雅人

Masahito TAKAHASHI
Roadside Equipment Design Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

SHAMANTH P KUCHANGI
Head Of TETC
Directorate of Urban Land Transport
Government of Karnataka
India

Meeting Record

Topic	Meeting with DULT
Date	12 July,2016
Time	15:30
Venue	DULT Office
Attendees	Representative from DULT: 1. Mr. Shamanth 2. Mr. Siva Representative from JICA Team: 1. Mr. Takahashi 2. Mr. Manohar 3. Mr. Varun

Meeting Record

Agenda:

- Meeting with DULT team to discuss on status update and queries of Study team.

Discussed Items are as below:

1. Explanation of ATCS sensors locations by study team.

DULT team asked for the explanation on the rationale behind selection of the Vehicle Detector locations. Some on the intersections which are part of the ATCS sub-area but does not have any Vehicle detection sensors installed.

Study team has provided the required explanation. Vehicle Detectors (Inflow traffic volume measure) & Vehicle Detectors (Queue Length Measure) are installed only at the key intersections to measure the inflow traffic volume at the close roadside to key intersection and to measure the queue length heading to the key intersection respectively.

Vehicle Detector (Traffic Volume Measure for Offset) are installed at the middle point between two key intersections to measure the traffic volume for calculating/setting the offset time.

The traffic control center will collect all the traffic data in real time from these sensors installed at the key intersections. The central controller will analyze the collected traffic data and send signal parameters (Cycle, Split and offset) to each signal in order to de-congest the key intersections and provide smooth follow in the sub-area. The signal parameters of non-key intersections are changed regularly on the bases of real time traffic data to control the traffic flow towards the key intersection to reduce congestion.

2. QMS & ATCC detailed Location.

The locations finalized for QMS & ATCC were briefed and were accepted by DULT team.

3. Which agency will bear the Cost for relocation of the existing sign board gantry at Silk Board Junction?

According to DULT team, the cost will be bear by either DULT or NHAI. This decision will be taken up during the execution phase only.

4. Languages to be displayed on VMS & Internet.
    - **Internet Website**: Two Languages- Kannada and English. Default Language shall be English.
    - **VMS:** Two languages (Kanada and English) on the VMS proposed on MG Road & Hanging Bridge which are under State Govt (agency) Jurisdiction.
      Three languages (Kanada, Hindi and English) on the VMS proposed on Silk Road which is on National Highway and is under NHAI.

5. Trial digging approval.

DULT has already requested to approving authority (BBMP), the same is in process, DULT team is doing regular follow up with BBMP.

6. Confirming the required process for approval on construction & installation of the roadside equipment.

DULT is responsible for the execution of such projects under the Grant, hence DULT will get all required approvals for construction and installation works.
DULT will obtain the NOCs for concerned agencies once implementation plan is finalized. The tentative time required to obtain all required clearances and approvals is 3 to 4 weeks.

7. Obtaining Signature on technical notes.

The technical notes submitted by the study team are under review by DULT team. Same will be provided latest by mid-next week.

8. Traffic Police questionnaire.

Meeting with the B-TRAC officials is being scheduled for discussion and obtaining required information from Traffic Police. DULT team is doing daily follow up with B-TRAC officials for the meeting schedule.

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, August 27, 2016

奥田真人	
Masato OKUDA	**V. MANJULA, IAS**
Chief Consultant	Commissioner
Preparatory Survey Team	Directorate of Urban Land Transport
Japan International Cooperation Agency	Government of Karnataka
Japan	India

ATTACHEMENT

The following items were confirmed between DULT and the Team:

1 Installation of Servers of VMS and Traffic Signal

The Team proposed that the servers of VMS and Traffic Signal be installed in Karnataka State Data Centre (KSDC) because of advantages such as secured environment, continuous power supply and etc.

The Commissioner of DULT tentatively agreed with this idea and will discuss with the Traffic Police.

2 Removal/Relocation of Existing Gantry at Silkboad Junction

The removal/relocation of the existing gantry including information board at Silkboard Junction will be responsible of Indian side (DULT or NHA), including the work and cost.

Minutes of Discussions
on the Preparatory Survey for the Project for
Implementation of Advanced Traffic Information and Management System
In Core Bengaluru
(Explanation on Draft Preparatory Survey Report)

With reference to the minutes of discussions signed between Directorate of Urban Land Transport (hereinafter referred to as "DULT"), Government of Karnataka (hereinafter referred to as " GOK"), Bangalore Traffic Police (hereinafter referred to as "BTP") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on March 10, 2016 and in response to the request from the Government of India (hereinafter referred to as "GOI") dated November 18, 2015 JICA dispatched the Preparatory Survey Team (hereinafter referred to as “the Team”) for the explanation of Draft Preparatory Survey Report (hereinafter referred to as “the Draft Report”) for the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as “the Project”), headed by Shuntaro kawahara, Senior Advisor, JICA from January 8 to 13, 2017.

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Bengaluru, January 16, 2017

Shuntaro Kawahara
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Darpan Jain, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Hitendra, IPS
Additional Commissioner
Bangalore Traffic Police
Karnataka State Police
India

ममता बत्रा/MAMTA BATRA
अवर सचिव/Under Secretary
आवासन और शहरी कार्य मंत्रालय
Ministry of Housing And Urban Affairs
भारत सरकार/Govt. of India
नई दिल्ली/ New Delhi

Ministry of Urban Development
India

Department of Economic Affairs

Ministry of Finance

India

के. ए. सिवदास/K. A. SIVADAS
अवर सचिव/Under Secretary
आर्थिक कार्य विभाग/Deptt. of Eco. Affairs
वित्त मंत्रालय/Ministry of Finance
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

ATTACHEMENT

1. Project Name

   Both sides confirmed that the Project title would be changed to "the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru".

2. Contents of the Draft Report

   After the explanation of the contents of the Draft Report by the Team, the India side agreed to its contents.

3. Cost Estimate

   Both sides confirmed that project cost estimation described in Annex 1 is provisional, and will be examined further by the Government of Japan for its approval.

4. Confidentiality of the Cost Estimate and Technical Specifications

   Both sides confirmed that the cost estimateand technical specifications in the Draft Report should never be duplicated or disclosed to any third parties until all the contractsunderthe Project are awarded.

5. Timeline for the Project Implementation

   The Team explained to theIndia side that the expected timeline for the project implementation is as attached in Annex 2.

6. Expected Outcomes and Indicators

   Both sides agreed that key indicators for expected outcomes and key indicators targeted in year 2022, in which ex-post evaluation by JICA is planned, are as follows. TheIndiasideshall monitor the progress based on those indicators.

   [Quantitative indicators]

   (1) 13% improvement of the average travel speed along trunk roads where signals will be installed by the Grant; and

   (2) 30% reduction of queuelength of main intersections where signals will be installed by the Grant.

[Qualitative indicators]
(1) Long-term vitality of Bengaluru city's regional economy;
(2) Reduction of global warming; and
(3) Reduction of the traffic accidents.

7. Technical Assistance ("Soft Component" of the Project)
   Considering the sustainable operation and maintenance of the products and services granted through the Project, technical assistance to instruct initial operation and maintenance is planned under the Project. The India side confirmed to deploy necessary operation and maintenance personnel as described in the Draft Report to effectively acquire benefit from the technical assistance.

8. Undertakings of the Project
   Both sides confirmed the undertakings of the Project as described in Annex 3.The India side assured to take the necessary measures and coordination including allocation of the necessary budgetwhich are preconditions of implementation of the Project.
   It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs including those to be borne by India side will be calculated at the Detailed Design (D/D) stage. In this connection, cost for "Internal wiring works in the building for the Bnegaluru Traffic Information Center" described in the item 8 of 1. (2) Of Annex 3 will be finalized and confirmed at the stage of D/D.
   Both sides also confirmed that necessary expenses will be discussed and confirmed when issues and/or necessity arise regarding "To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project" described in the item 10 of 1.(2) of Annex 3.
   India side also explained that budget allocation is subject to budget approval of the Cabinet.
   Both sides also confirmed that the Annex 3 will be used as an attachment of Grant Agreement (G/A).

8-1 Tax Exemption
   With respect to exemption of customs duties, internal taxes and other fiscal levies as stipulated in Annex 3, both sides confirmed as follows in principle:
   - Exemption from Custom Duties imposed by GOI ;
   - Reimbursement of Service Tax and Excise Tax imposed by GOI;
   - Reimbursement of Value Added Tax imposed by GOK; and
   - Budget for reimbursement of the taxes imposed by GOI and GOK shall be secured by DULT and/or GOI according to procurement plan of the Project

prepared by the contractor/supplier.

The procedure for reimbursement of Value Added Tax is described in Annex 4.Procedures for other tax treatment including sharing of expenses on tax reimbursement between GOI and GOK shall be clarified byDULT by finalizing Detail Design of the Project. In case of enactmentof new taxation, both sides will consult each other to ensure exemption from new taxes imposed on Japanese nationals engaged in the Project.

8-2Opening B/A and Issuing A/P

(1) The Implementing Agency, Directorate of Urban Land Transport (DULT) of GOK, is expected to open Bank Account (B/A) just after the signing of Grant Agreement (G/A), according to the G/A (Schedule 3). Any other process must follow the completion of B/A (See"Annex 2 Progress Chart"). DULT is expected to clarify necessary procedures of B/a consulting with Department of Finance, GOK and Department of Economic Affairs, Ministry of Finance, GOI in advance, and will take prompt actions accordingly.

(2) After making the Contract with Consultant/Supplier, DULT is expected to issue Authorization to Pay (A/P) under the B/A in order to facilitate payment to Consultant/Supplier based on the Contract.

9. Monitoring during the Implementation

The Project will be monitored by the Executing Agency andreported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 5.The timing of submission of the PMR is described in Annex 2.

10. Project Completion

Both sides confirmed that the project completes when all the facilities constructed and equipment procured by the grant are in operation. The completion of the Project will be reported to JICA promptly, but in any event not later than six months after completion of the Project.

11. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, and Sustainability). The result of the evaluation will be publicized. TheIndia side is required to provide necessary support for the data collection.

12. Items and measures to be considered for the smooth implementation of the Project

Both sides confirmed the items and measures to be considered for the smooth implementation of the Project asdescribed in Annex 6.

13. Schedule of the Study

JICA will finalize the Preparatory Survey Report based on the confirmed items.Although the Report excluding the additional study namely drafting contract and specifications for O&M described in "15-4 Issues on Operation and Maintenance" will be finalized around April 2017, it will possibly take a few months in addition for JICA to finalize the additional study. The Team explained that JICA will inform DULT of schedule of the Report delivery as early as possible.

14. Environmental and Social Considerations

The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as C because the Project is likely to have minimal adverse impact on the environment under the Guidelines.

15. Other Relevant Issues

15-1. Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

15-2. Short-term outcomes and indicators

India side requested to set short-term outcomes and indicators to enhance public relations. The Team explained that it will consider proper short-term outcomes and include them into the final Preparatory Survey Report.

15-3. Location of the signal control server

DULT and BTPwill decide location of the signal control server (Traffic Center of BTP or KSDC) by the end of February to be incorporated into the final report of preparatory survey.

15-4. Issues on Operation and Maintenance (O&M)

BTP agreed the O&M structure (see Annex 6) and the 10 Year Maintenance Schedule proposed by the Team in principle.

DULT stated that they would like to go for a single bid (means "*single procurement process but two separate contract will be signed with the same contractor for Implementation and O&M*") where the same contractor shall be incharge for implementation as well as O&M. The funding can be arranged in such a way that implementation is funded through the Japanese grant and O&M shall be borne by GoK and it is requested that the O&M contractor should take care of the system for 5 years so as to secure proper O&M of the equipment and technology transfer including consulting, commissioning, troubleshooting and so on.

The Team stated as follows:

- JICA agreed to the proposed procurement policy for implementation and O&M in principle. The details of the tendering procedures would be discussed and confirmed through the detailed design stage by both sides.
- JICA survey team would prepare a draft of contract and specifications for O&M.

15-5. Interoperability

DULT requested JICA to extend support for interoperability of the system to work with other systems when the India decides to expand ITS services in Bengaluru.

The team replied that JICA will consider possibility of the support according to contents of the request, necessity of support, technical possibility including consent of the systems' manufacturers to open their intellectual properties regarding the systems and so on.

Annex 1 Cost Estimate
Annex 2 Project Implementation Schedule
Annex 3 Major Undertakings to be taken by India side
Annex 4 Procedure for tax exemption and reimbursement
Annex 5 Project Monitoring Report (template)
Annex 6 Maintenance Plan

Annex 1 Cost Estimation

Confidential

1. Japaneseside

This Part is closed due to the confidenciality.

2. Indian side

Item	Unit	Amount	
		Indian Rupee	Japanese yen
Installation of HDPE pipe (32mm/ 2ways) , electricity (power cable) and telecommunication cable (Optical fiber cable)	49 place	3,612,000	5,309,640
Internal wiring works in the building for the Bnegaluru Traffic Information Center	1 place	126,000	185,220
Initial maintenance spare parts (signal pole &sensor pole)	30 pcs	1,013,000	1,489,110
Replacement of existingantry of traffic sign boards	1 place	349,000	513,030
Replacement of existing signal pole	149 pcs	1,345,000	1,977,150
Total		6,445,000	9,474,150

3.Estimation Conditions

(1)Date of Estimation: July 2016

(2)Foreign Exchange Rate: US$1 = JPY 109.04

INR1 = JPY 1.47

(3) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost (Thousand India Rupee)	Ref.
1	To issue A/P to a bank in Japan(the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	DULT		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	DULT		
	2) Payment commission for A/P	every payment	DULT		
3	To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	during the Project	DULT		
4	To facilitate Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	DULT		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in India with respect to the purchase of the products and the services be exempted	during the Project	DULT DOF MOF		
6	To renovate DULTCenter, BTPTraffic Management Center and KSDCincluding air conditioning, replacement electrical fittings, lighting fixture and refurbishing if necessary, to accommodate the equipment	before installation of the equipment	DULT BTP		
7	To acquire site access and work permission for the centers	before installation of the equipment	DULT		
8	1) To install HDPE pipe (32mm/ 2ways), electricity (power cable) and telecommunication cable (Optical fiber cable)	before installation of the equipment	DULT	3,612	
	2) To implement internal wiring works in the building for for the Bnegaluru Traffic Information Center	before installation of the equipment	DULT	126	
9	To remove obstacles from the Project sites	before installation of the equipment	DULT BTP		
10	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	DULT		
11	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within one month after completion of each work	DULT		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	DULT		
12	To submit a report concerning completion of the Project	within six months after completion of the Project	DULT		
13	To procure initial maintenance spare parts (signal pole & sensor pole)	Before completion of the equipment installation	DULT,	1,013	

Annex 2 Progress Chart for the Undertakings by the DULT side

	Year	2017										2018												2019				
	Item	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Before the Tender	E/N (Exchange of Notes)	△																										
	G/A (Grant Agreement)		△																									
	B/A (Banking Arrangement)		△																									
	Contract of Consultant		△																									
	A/P (Authorization to Pay for Consultant)			△																								
	Acquisition of approval of intersection improvement & installation drawing		■																									
	Detailed Design and prepare Tender Document			■	■																							
	PMP(Project Monitoring Report)					△							△	△ Shipping							△ Installation		△ Training		△ Hand Over	△ Final		
	Secure and clear the location where the equipment would be installed				■																							
	Announcement of Tender (Tender Opening)					△																						
	Evaluation of Tender (Technical)							■																				
	Evaluation of Tender (Financial)							■																				
	Contract of Contractor								△																			
	A/P (Authorization to Pay for Contractor)									△																		
										Design &Manufacturing				Shipping&				Installation &Test					Operational					
	Ensure and support prompt custom clearance													■	■													
	Acquisition of site access and work permission for the centres													■	■													
	Renovate DULT Centre, BTP Traffic Management Centre and KSDC												■	■	■													
	Internal wiring work in the building for the Control Centre (B-TIC)												■	■	■													
	To remove obstacles from the Project sites												■	■	■													
	Replace existing signal poles																			■	■							
	Secure operation and maintenance personnel																					■	■	■				
	Replace existing gantry of message boards																					■	■					
	Procure initial spare parts (signal & sensor pole)																						■	■				
	Final Commissioning and Hand Over																									△		
Execution after Completion	Allocation of Operation and Maintenance Cost																									■	■	■
	Operation and maintenance including power supply and communication network																									■	■	■
	Routine check and Periodic inspection																									■	■	■

Annex 3 Major Undertakings to be taken by India side

B/A: Banking Arrangement

A/P: Authorization to pay, N/A: Not Applicable

DULT: Directorate of Urban Land Transportation, State Government of Karnataka

BTP: Bengaluru Traffic Police

KSDC: Karnataka State Data Center

DOF : Department of Finance, State Government of Karnataka

MOF: Ministry of Finance, Government of India

1. Specific obligations of the Government of India and the Implementing Agency which will not be funded with the Grant

(1) Before the signing of Grant Agreement

NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
1	Budget Approval by the Parliament/Cabinet	2 weeks before the signing of Grant Agreement	DULT		

(2) Before the Tender

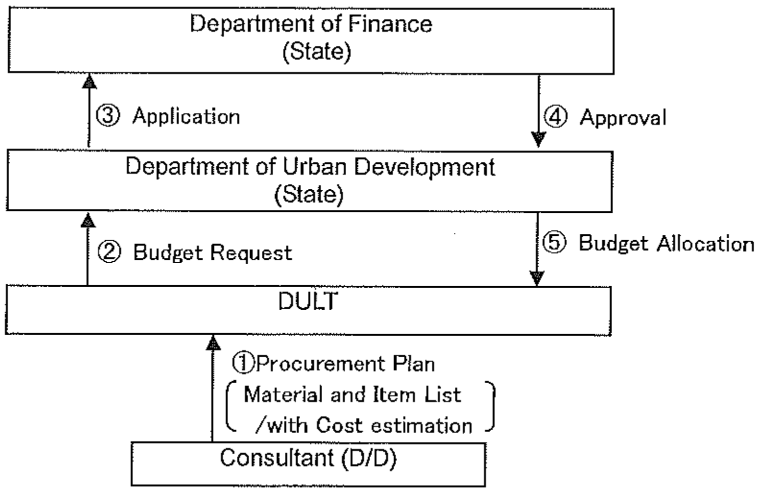
NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT		
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	DULT		
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT		
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT		
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT		

NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
14	To secure operation and maintenance personnel	Before completion of the equipment installation	DULT, BTP		
15	To replace existing gantries oftraffic sign boards	Just after commencement of operational guidance	DULT	349	-
16	To replace existing signal poles	Just after commencement of operational guidance	BTP	1,345	

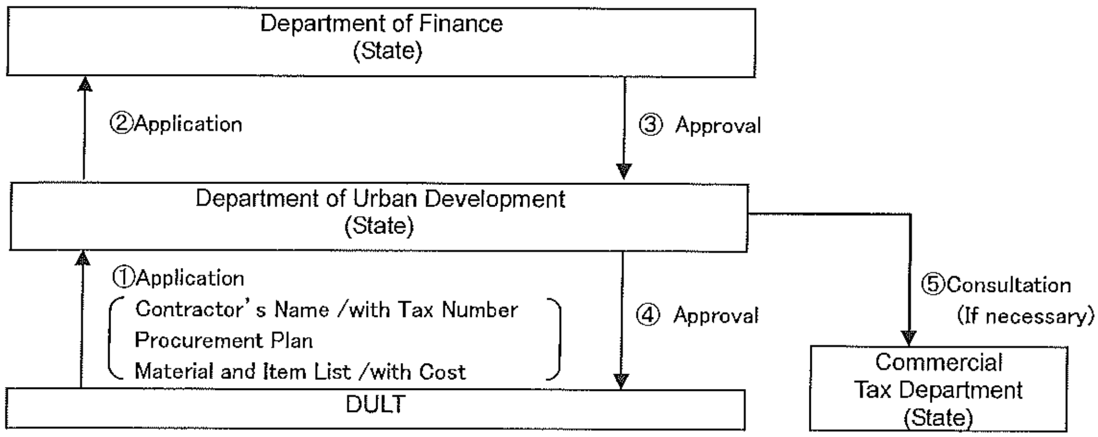
This Part is closed due to the confidenciality.

Annex 4 Basic Procedure for Tax Exemption and Reimbursement (State Tax -VAT-)

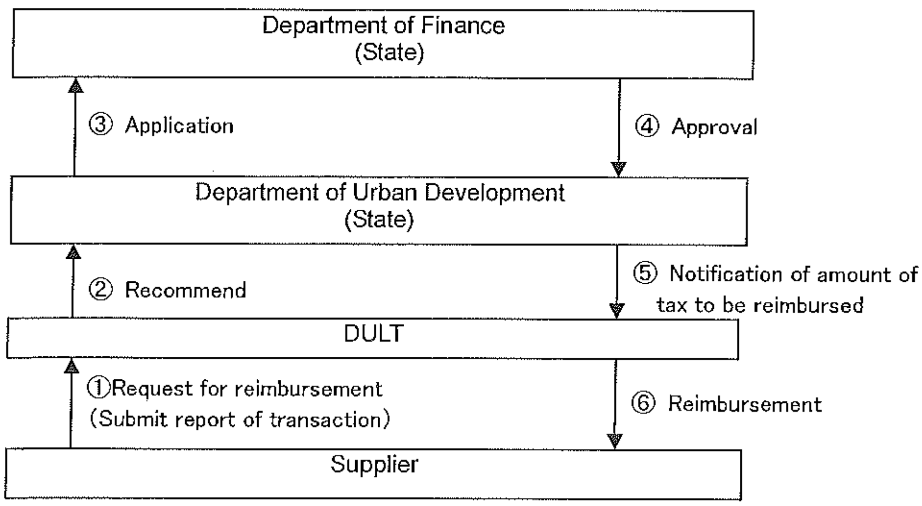
Flow 1 Allocation of Budget for Tax Reimbursement (one time)



Flow 2 Concurrence Procedure for Tax Reimbursement (one time)



Flow 3 Procedure for Tax Reimbursement (quarterly)



Annex 5
G/A NO. XXXXXXX
PMR prepared on DD/MM/YY

Project Monitoring Report
on
____
Grant Agreement No. XXXXXXX
20XX, Month

Organizational Information

Signer of the G/A (Recipient)	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:
Executing Agency	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:
Line Ministry	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:

General Information:

Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY ________ mil. Government of (__________): ______________

1: Project Description

1-1 Project Objective

1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr)	Target (Yr)
Qualitative indicators to measure the attainment of project objectives		

2: Details of the Project

2-1 Location

Components	Original *(proposed in the outline design)*	Actual
1.		

2-2 Scope of the work

Components	Original* *(proposed in the outline design)*	Actual*
1.		

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original		Actual
	(proposed in the outline design)	*(at the time of signing the Grant Agreement)*	

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations

See Attachment 2.

2-4-2 Activities

See Attachment 3.

2-4-3 Report on RD

See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant(<u>Confidential until the Bidding</u>)

Components			Cost (Million Yen)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

2-5-2 Cost borne by the Recipient

Components			Cost (1,000 Taka)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)* name: role: financial situation: institutional and organizational arrangement (organogram): human resources (number and ability of staff):
Actual *(PMR)*

2-7 Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)*
Actual *(PMR)*

3-2 Budgetary Arrangement

- Required O&M cost and actual budget allocation for O&M

Original *(at the time of outline design)*

- **Actual** *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks *(at the time of outline design)*

Potential Risks	Assessment
1. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:

	Contingency Plan (if applicable):
Actual Situation and Countermeasures	
(PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
						Price (Decreased) E=C−D	Price (Increased) F=C+D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ●month, 2015	2nd ●month, 2015	3rd ●month, 2015	4th	5th	6th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)

-
-
-

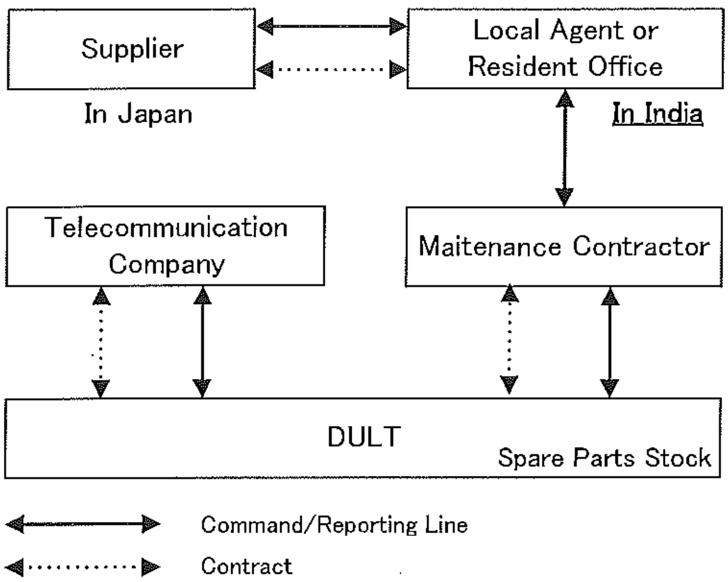
Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

	Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost	(A/D%)	(B/D%)	(C/D%)	
Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost	(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost	(A/D%)	(B/D%)	(C/D%)	
Total	(A/D%)	(B/D%)	(C/D%)	

Annex-6 Maintenance Plan

1) DULT : B-TIC

<Maintenance Structure>



- Technical support/technical consulting
- Purchasing new parts from supplier
- Ordering repair to supplier

- Identifying cause of failure
- System recovery
- Regular inspection

- Daily operation (during normal time)
- Judging origin of failure (Communication/B-TIC/BMTC/BRTRAC)
  → Coordinating with relevant authority

<Assurance of Availability of Spare Parts>

- Stocked spare parts will be used on the occasion of failure or for replacement due to life cycle.
- New spare parts will be purchased before they become out of stock according to spare parts procurement plan under above maintenance structure.
- Broken parts will be repaired by supplier under above maintenance structure.

<Local Agent/Resident Office>

- Supplier must be capable to supply equipment continuously e.g. for 10 years through his resident office or local agent
- Local agent must have experience of handling similar product of the supplier
- Above conditions will be specified in the tender document
- Items to be supplied: All items that are purchased from Japan

<Selection of Maintenance Contractor>

- Timing: Before operation and maintenance guidance to be provided by supplier
- Condition : Contractor must have maintenance experiences of the systems described below.

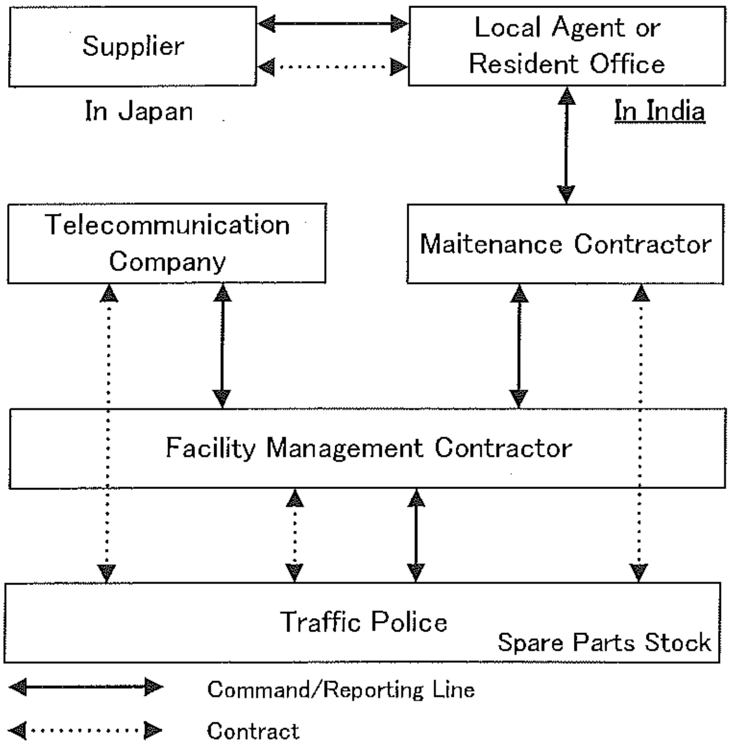
<Requirement of Maintenance Contractor: Maintenance Experience>

(1) Probe System (generating traffic congestion information from probe data) and Internet (providing traffic congestion information)
(2) ATCC System
(3) Queue Length System

Annex-6 Maintenance Plan

2) Traffic Police: ATCS and VMS System

<Maintenance Structure>



- Technical support/technical consulting
- Purchasing new parts from supplier
- Ordering repair to supplier

- Identifying cause of failure
- System recovery
- Regular inspection

- Coordinating with relevant authority (e.g. each maintenance contractor, telecommunication company)
- Keeping record of system recovery
- Reporting to Traffic Police

- Daily operation (during normal time)
- Judging origin of failure (Communication/BTRAC/B-TIC) → Coordinating with relevant authority

<Assurance of Availability of Spare Parts>

- Stocked spare parts will be used on the occasion of failure or for replacement due to life cycle.
- New spare parts will be purchased before they become out of stock according to spare parts procurement plan under above maintenance structure.
- Broken parts will be repaired by supplier under above maintenance structure.

<Local Agent/Resident Office>

- Supplier must be capable to supply equipment continuously e.g. for 10 years through his resident office or local agent
- Local agent must have experience of handling similar product of the supplier
- Above conditions will be specified in the tender document
- Items to be supplied: All items that are purchased from Japan

<Selection of Maintenance Contractor>

- Timing: Before operation and maintenance guidance to be provided by supplier
- Condition : Contractor must have maintenance experiences of the systems described below.

<Requirement of Maintenance Contractor: Maintenance Experience>

(1) VMS System
(2) Signal System (Dynamic traffic signal control according to traffic condition)

Minutes of Discussions
on the Preparatory Survey for the Project for
Implementation of Advanced Traffic Information and Management System
in Core Bengaluru
(the 5th Site Survey)

With reference to the minutes of discussions signed between Directorate of Urban Land Transport (hereinafter referred to as " DULT "), Government of Karnataka (hereinafter referred to as " GOK"), Bangalore Traffic Police (hereinafter referred to as "BTP") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on March 10, 2016 and in response to the request from the Government of India (hereinafter referred to as "GOI") dated November 18, 2015 JICA dispatched the Preparatory Survey Team (hereinafter referred to as “the Team”) for the explanation of the result of the additional survey on the project for the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as “the Project”), headed by Shuntaro KAWAHARA, Senior Advisor, JICA from June 28 to July 14, 2017.

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Bengaluru, July 12, 2017

fr

Shuntaro Kawahara
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Darpan Jain, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

ममता बत्रा/MAMTA BATRA
अवर सचिव/Under Secretary
आवासन और शहरी कार्य मंत्रालय
Ministry of Housing And Urban Affairs
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

Ministry of Urban Development
India

के. ए. सिवदास/K. A. SIVADAS
अवर सचिव/Under Secretary
आर्थिक कार्य विभाग/Deptt. of Eco. Affairs
वित्त मंत्रालय/Ministry of Finance
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

Department of Economic Affairs
Ministry of Finance
India

Concerns of MOHUA & the reply of GoK thereto has been made part of this document as Annexure-7

ATTACHMENT

1. Items to be Confirmed in the Additional Survey

After the explanation of the contents of the additional survey by the Team, the India side agreed to its contents. Based on the main points confirmed and the Final Preparatory Survey Report, conditions of contract and specifications for the Project and the Operation and Maintenance (hereinafter referred as "O&M") of it will be prepared at the stage of Detailed Design.

The main points confirmed between both sides are followings:

1-1 Main Points of O&M Specification

The Team submitted the O&M Specification (draft) to DULT. The major conformed items are agreed as follows. The main points of O&M Specification for Bengaluru Traffic Information Center (hereinafter referred to as "BTIC") and those for BTP are shown in Annex 1-1 and Annex 1-2 respectively. And also both sides confirmed about basic concept of service level as shown in Annex 1-3.

(1) Role of the Contractor

Role of the Contractor is shown in Annex 2.

(2) Service Level (DULT and BTP)

- Severity (Critical, Major, Minor) of incidents are defined according to risks to road user.
- Required Response Time and Resolution Time are defined according to the severity.
- System availability is calculated according to down time responsible for the Contractor.
- The Contractor's performance is evaluated based on the difference between target availability and actual availability.
- Payment will be possibly deducted according to the Contractor's performances.

1-2 Form of O&M Contract

The Team submitted the Draft Form of O&M Contract to DULT. The major conformed items are agreed as follows.

(1) General Conditions

- World Bank Management Service Contract is used.

(2) Particular Conditions

- The Employer is DULT.
- DULT will authorize to BTP as Employer's Representative for O&M service within BTP.
- Payment reductions due to failure to meet the requirements are additionally stipulated.
- Independent Expert for dispute resolution who is stipulated in the above general conditions is remained. Remunerations for the Independent Expert will be borne by the Employer and the Contractor on halves.

1-3 O&M Price

The Team submitted the O&M price to DULT. The major conformed items are agreed as follows.

(1) Composition of the O&M Price

O&M price consists of Lump-sum portion and Unit Price portion.

- Lump-sum Portion
  - Operation
  - Primary Response
  - Emergency Response (including resolution cost for damaged facilities)
  - Periodic Inspection and Preventive Maintenance including Update and Debugs of the Installed Software
  - Local Training and Seminar
  - Annual Adjustment of equipment/system including adjustment of parameters of the signal system and necessary survey
  - Minor modifications of the system software (e.g. Improvement of visibilities of system console, web site design of traffic condition information of internet system, etc.) within one (1) year after the completion of the Project according to bilateral negotiations to avoid impartial and excessive burden of the Contractor
- Unit Price Portion

The Contractor can claim invoice of following items according to the unit price prescribed in the O&M Contract

  - Purchasing additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer
  - Purchasing new equipment and parts if retrieved defective/damaged equipment

and parts is impossible to be repaired

- Notes
  - In case the Employer requests to upgrade software by adding new function, the price for the upgrading is subject to negotiation.

(2) Methodology to Determine the O&M Price

- Both sides confirmed that lump sum portion of O&M price shall be calculated by "Fixed Rate" prescribed in the instructions to bidders. The Team proposed methodology to set the rates as follows;

This Part is closed due to the confidenciality.

- The unit price prescribed in the O&M Contract shall be determined according to the result of the contract negotiation although it should basically meet the unit prices shown in the Bill of Quantities submitted as a bid document by the Contractor.

1-4 Procedures and Evaluation Criteria of the Bidding

The Team explained to DULT procedures and evaluation criteria of the bidding, of which flowchart is shown in Annex-3. The major conformed items are agreed as follows.

1-5 Amount of the Performance Security for the O&M Contract

DULT insisted that sufficient amount of Performance Security should be delivered by the Contractor to ensure proper performance of the Contractor. Both sides agreed that amount of the Performance Security for the O&M Contract would be equal to the amount of 10 percent of the O&M Contract Price in India Rupee.

1-6 Monitoring the Impact of the Project

Both sides agreed that DULT would employ a consulting firm to annually monitor short term impact of the Project, namely reduction of queue length, vehicle stop frequency, travel time and wasted green signal time, and that terms of reference of the consulting firm would be described in the Final Preparatory Survey Report. Both sides also confirmed that the first monitoring shall be conducted between three to six months after the commencement of the system operation.

2. Respond to the Inquiries from MoUD.

(1) Letter to MoUD by DULT

Both sides confirmed that DULT had replied to the letter from Ministry of Urban Development, the Government of India (hereinafter referred to as "MoUD") dated on May 18, 2017, as shown in Annex-4.

(2) Provision of Necessary Data for DULT Reference

The Team presented an additional explanation to DULT as follows;.

- Interoperability of BTIC and Signal System (Annex 5-1);
  The Team explained that UTMS standard of signal systems has already been incorporated into ISO (International Standard Organization). Communication protocol used internationally, also in India, will be also applied to the BTIC system under the Project; and
- Project Impact (Annex 5-2).

3. Schedule of the Preparatory Survey

JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the India side around September 2017.

4. Major Undertakings to be Taken by the India side

The Team explained that major undertakings to be taken by the India side which are discussed in January 2017 has been revised based on the additional survey results as shown in Annex 6.

5. Public Relations for the Project

DULT requested the Japanese side to support public relations during and after the Project to notify local residents, road users and Government entities across the country of new services provided by the Project.

Annex 1-1: Main Points of O&M Specification for BTIC
Annex 1-2: Main Points of O&M Specification for BTP

Annex 1-3: Basic Concept of Service Level

Annex 2: Role of the Contractor

Annex 3: The Procedures and Evaluation Criteria of the Bidding

Annex 4 : A copy of the Letter from DULT to MoUD (dated on July 10, 2017)

Annex 5-1: Interoperability of BTIC and Signal System

Annex 5-2: Project Impact

Annex 6: Major Undertakings to be taken by India side (Revised Information based on the Results of the Additional Survey)

Annex 1-1

Main Points of O&M Specification for BTIC

I. Working Shift and Role of the Contractor

1. The working shift for the Contractor's staffs who will be posted at DULT

- Working hours : 10:00 to 17:30 on weekdays and Saturday except for the 2nd Saturday with 1 shift
- During non-working hours, the Contractor has to respond to accident and/or system failure when the Employer instructs.

2. Reporting

The Contractor submits daily, monthly, quarterly and incident reports of the Contractor's activity to the Employer, who determines reduction amount for payment according to the availability described in a quarterly report.

II. Primary Response and Emergency Response

1. Response and Resolution Time for Incidents

Response and Resolution Time in case of incidents, the Contractor shall perform less than the indicated time period in the table below.

<table>
<tr><th rowspan="2">Severity of Incidents</th><th rowspan="2">Definitions</th><th rowspan="2">Response Time</th><th colspan="2">Resolution Time</th></tr>
<tr><th>System Failures</th><th>Facility Incident at Site</th></tr>
<tr><td>Critical</td><td>Incidents which have high possibility of immediate danger to road users.</td><td>< 1 hour</td><td>< 6 hours</td><td rowspan="3">24 hours</td></tr>
<tr><td>Major</td><td>Incidents which may cause danger to road users.</td><td>< 1 hour</td><td>< 12 hours</td></tr>
<tr><td>Minor</td><td>Failures of control system that does not have any possibility to damage road users' safety</td><td>< 2 hours</td><td>< 24 hours</td></tr>
</table>

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

Examples of the incidents of each severity are shown in the below table.

Severity	Kinds of Failure
Critical Incident	① Seriously damaged ATCC (Automatic Traffic Counter Classifier) / Que length pole(s) by traffic accident, which has already collapse and/or will probably collapse
Major Incident	② Damaged ATCC / Que length pole(s) by traffic accident, which will not probably collapse immediately
Minor Incident	③ Slight damage on ATCC/Que length pole(s) by traffic accident, which will not collapse; ④ Discommunication among BMTC System/BTIC/Sensors; and ⑤ Sending abnormal data from BTIC to TMC/Internet;.

2. Service Level

Service level is evaluated quarterly based on the availability.

2.1 The Formula of Calculation of Availability

The formula of calculation of availability is shown as follows

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): "Total time during which the specified services/components with specified technical and service standards are not available.
Downtime is calculated based on the following unit;
(1) ATCC/Que length sensors: Site basis;
(2) Operator consoles: Console basis; and
(3) Servers: Server basis:

Totaltime (hours): Total time of evaluation period (3 month; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

2.2 Target Availability

Target availability is 99.00%.

2.3 Payment Reduction

When the availability does not reach the target availability, the Employer can deduct calculated amount from O&M payment. Following is the formula for calculation of the amount for payment reduction.

Payment Reduction = Lump sum portion of O&M payment*(Target availability (%) - Availability (%))/50

This Part is closed due to the confidenciality.

Eg.) Downtime: 110hr, Totaltime: 2160hr (24*90), PermissiveDowntime: 60hr, Target availability: 99%, O&M payment for 3months: INR 80 Lakh

Availability= (1-((110-60)/(2160-60)))*100, Availability = 97.62%

Payment Reduction = 80*(99-97.62)/50,

Payment Reduction = INR 2,88,000

III. Periodic Activities

Periodical Activities by the Contractor is shown in the followings:

1. Periodic Inspection and Preventive Maintenance

Periodic Inspection and Preventive Maintenance shall be carried out by the Contractor.

Frequency	BTIC Server	Roadside Equipment	Participants
Monthly	Visual Check	Visual check from vehicles	Local
Semiannual	Detail Check + Cleaning	Detail Check + Cleaning	Local
Annual	Adjustment of Equipment/System	Adjustment of Equipment/System	Local

<Note>

Preventive Maintenance: Necessary works for preventing system/equipment failures including cleaning, replacing damaged parts, and adjusting position of detecting equipment.

Detail Check: Visual inspection and contact diagnostics.

The Contractor will submit a plan and check sheets for the Periodic Inspection on each equipment and system.

Adjustment of Equipment/System: The Contractor will revise software and/or parameter of the probe system according to results of the monitoring, and incorporate the latest digital road maps into the probe system annually.

2. Seminar

Two days seminar will be hold once in a year by the Contractor. The purpose of seminar is to transfer the ITS technologies and know-how to Police officers, TMC employees, DULT employees, any other Government employees and local private companies of ITS sector including manufactures, operators and maintenance firms. The venue of the seminar shall be provided by DULT. Japanese engineers of the Contractor and knowledgeable local engineers will be lecturers for the seminar.

3. Adjustment of Equipment/System

The Contractor will adjust the probe system based on actual travel time along major roads detected by probe cars.

Annex 1-2

Main Points of O&M Specification for BTP

I. Working Shift and Reporting

1. The working shift for the Contractor's staffs who will be posted at TMC

- Working hours : 8 : 00 to 20:00 with 2 shifts.
- During non-working hours, the Traffic Police at TMC informs the Contractor of accidents and system failures, the Contractor shall respond to the information.

2. Reporting

The Contractor submits daily, monthly, quarterly and incident reports of the Contractor's activity to a representative of the Employer (Bengaluru Traffic Police). The Employer determines reduction amount for payment according to the availability described in a quarterly report.

II. Primary Response and Emergency Response

1. Response and Resolution Time for Incidents

Response and Resolution Time in case of incidents, the Contractor shall perform less than the indicated time period in the table below.

Severity of Incidents	Definitions	Response Time	Resolution Time	
			System Failures	Facility Incident at Site
Critical	Incidents which have high possibility of immediate danger to road users.	< 1 hour	< 6 hours	24 hours
Major	Incidents which may cause danger to road users.	< 1 hour	< 12 hours	
Minor	Failures of control system that does not have any possibility to damage road users' safety	< 2 hours	< 24 hours	

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

Examples of the incidents of each severity are shown in the below table.

Severity	Examples
Critical Incident	① Green-Green Conflict of signal ② Red and yellow blinking of signal ③ Light out of signal lamp ④ Lighting plural number of signal lamp simultaneously ⑤ Seriously damaged signal pole(s) and/or VMS gantry by traffic accident, which has already collapse and/or will probably collapse
Major Incident	⑥ Damaged signal pole(s) and/or VMS gantry by traffic accident, which will not probably collapse immediately ⑦ Light out of some signal ramp due to halt of signal system, which makes road users have difficulties to identify the signal phase
Minor Incident	⑧ Slight damage on pole(s) or gantry(s) by traffic accident, which will not collapse; ⑨ Discommunication among BTIC/TMC/controller/signal/VMS; ⑩ Sending abnormal data from TMC to signal/VMS; ⑪ Insufficient illuminance of signal ramp/VMS; and ⑫ Light out of VMS screen.

2. Service Level

Service level is evaluated quarterly based on the availability.

2.1 The formula of calculation of availability

The formula of calculation of availability is shown as follows

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): "Total time during which the specified services/components with specified technical and service standards are not available.

Downtime is calculated based on the following unit;

(1) Signals: Junction basis;
(2) VMSs: Site basis;
(3) Operator consoles: Console basis; and
(4) Servers: Server basis:

Totaltime (hours): Total time of evaluation period (3 month; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

2.2 Target Availability

Target availability is 99.00%.

2.3 Payment Reduction

When the availability does not reach the target availability, the Employer can deduct calculated amount from O&M payment. Following is the formula for calculation of the amount for payment reduction.

Payment Reduction = Lump sum portion of O&M payment*(Target availability (%) - Availability (%))/50

This Part is closed due to the confidenciality.

Eg.) Downtime: 110hr, Totaltime: 2160hr (24*90), PermissiveDowntime: 60hr, Target availability: 99%, O&M payment for 3months: INR 80 Lakh

Availability= (1-((110-60)/(2160-60)))*100, Availability = 97.62%

Payment Reduction = 80*(99-97.62)/50,

Payment Reduction = INR 2,88,000

III. Periodic Activities

1. Periodic Inspection and Preventive Maintenance

Periodic Inspection and Preventive Maintenance shall be carried out by the Contractor.

Frequency	TMC System	Roadside Equipment	Participants
Monthly	Visual Check	Visual check from vehicles	Local
Semiannual	Detail Check + Cleaning	Detail Check + Cleaning	Local
Annual	Adjustment of Equipment/System	Adjustment of Equipment/System	Japanese

<Note>

Preventive Maintenance: Necessary works for preventing system/equipment failures including cleaning, replacing damaged parts, and adjusting position of detecting equipment.

Detail Check: Visual inspection and contact diagnostics.

The Contractor will submit a plan and check sheets for the Periodic Inspection on each equipment and system.

Adjustment of Equipment/System: The Contractor will dispatch Japanese engineers annually to review the current traffic condition and adjust each equipment/system accordingly by revising control parameter.

2. Seminar

Two days seminar will be hold once in a year by the Contractor. The purpose of seminar is to transfer the ITS technologies and know-how to Police officers, TMC employees, DULT employees, any other Government employees and local private companies of ITS sector including manufactures, operators and maintenance firms. The venue of the seminar shall be provided by DULT. Japanese engineers of the Contractor and knowledgeable local engineers will be lecturers for the seminar.

3. Adjustment of Equipment/System

The Contractor will, once a year, review the current traffic condition and adjust each equipment/system accordingly by revising control parameter.

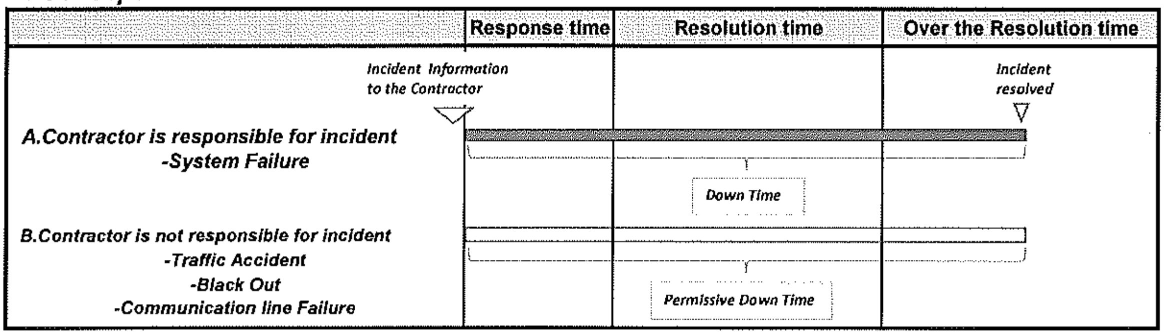
Annex 1-3

Basic Concept of Service Level and Payment Reduction

1. Contents of Service Level

Service Level	PerformanceTarget	Evaluation Method	Payment Reduction
1 Availability	; 99%	$\text{Availability} = (1 - \frac{\text{Downtime} - \text{Permissive Downtime}}{\text{Totaltime} - \text{Permissive Downtime}}) \times 100$	Payment Reduction = Lump sum portion of O&M payment $\times \frac{\text{Target availability(\%)} - \text{Availability (\%)}}{50}$
2.1 Response time	- Critical*;1 Hour - Major*; 1 Hour - Minor*; 2 Hours	Incident Report	NA
2.2 Resolution time	(System Failure) Critical*; 6 Hours Major*; 12 Hours Minor*; 24Hours (Facility Incident at site) ;24Hours	Incident Report	

2. Concept of Down time



Role of the Contractor

I. Role of the Contractor for BTIC

Position	Roles and Responsibilities	Contents
Director and his/her staff @ BTIC	Director: is responsibe for supervising and controlling all activities of BTIC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between BTIC and other related Gov. agencies especially Traffic Police. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide infomnation for BTIC if necessary. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @ BTIC)	Operation ***-Lump Sum basis-***	- Responding to enquiries from general public. - Observing operating status of ATCC and Queue Length Measurement System. - Observing traffic status on schematic map of video wall. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version - Annual Updating of Digital Road Map
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for DULT officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Adjustment of Equipment/System ***-Lump Sum basis-***	- Detecting actual travel time along major roads by probe cars and adjusting the probe system - Revise software and/or parameter of the probe system according to results of incorporate the latest digital road maps into the probe system annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from BTIC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Quotation basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired

Role of Operator

Role of Maintenance Team of the Contractor

II. Role of the Contractor for BTP

Position	Roles and Responsibilities	Contents
Traffic Police Director and his/her staff @ Traffic Management Centre (TMC)	Director: is responsibe for supervising and controlling all activities of TMC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between TMC and other related Gov. agencies especially BTIC. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for TMC if necessary. - Instructing to the operator to revise signal parameter (cycle, split, offset) according to monitoring results and requests from local residents. - Instructing manual operations to the operator as required - Inputting necessary messages on VMSs if necessary. - Instructing to the Contractor response and resolution during off-time in case of incidents during off-time. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @TMC)	Operation ***-Lump Sum basis-***	- Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at Fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the representative of the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for BTP officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Adjustment of Equipment/System ***-Lump Sum basis-***	- Review the current traffic condition and adjust each equipment/system accordingly by revising control parameter annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from TMC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Unit Price basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaire.

Role of Operator

Role of Maintenance Team of the Contractor

Annex 3

The Procedures and Evaluation Criteria of the Bidding

Note: One Stage / Two Envelope System

Envelope A (Technical Evaluation)

[Evaluation Criteria]

- Compliance for Requirements
- Validation of Service Proposal (Organization, Personnel)

[Bid Documents]

1) Experience
2) Technical Proposal
3) Project Schedule
4) Personnel / organization Schedule
5) Operation & Maintenance Compliance Schedule
6) Operation & Maintenance Service Proposal (Organization, Personnel)
7) Operation & Maintenance Schedule

Satisfied?

No → **Disqualified**

Yes ↓

Envelope B (Price Evaluation)

[Evaluation Criteria]

- Bidder who bids at the lowest price becomes ***prioritized negotiator.***

[Bid Documents]

1) Equipment and Installation Price Schedule (incl. Bill of Quantities)
2) Operation & Maintenance Price Schedule

↓

Contract Negotiation

- ***Check the price proposal***
- ***Determine unit prices for O&M based on Bill of Quantities of Price Schedule, etc.)***

↓

Determination of Successful Bidder/ Award

↓

Signing of Main Contract | **Signing of O&M Contract**

Annex 4

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MAHENDRA JAIN, *I.A.S.*
Additional Chief Secretary to Government
Urban Development Department

D.O.No: DULT/33/ITS-Grants/2014-15/1188 Date:10-07-2017

Dear Sir,

Sub: Requesting to reconsider the project for implementation of Advance Traffic Information and Management System in core Bengaluru

Ref-1: MoUD Letter K-14011/93/2014-UT-IV dated 17th June 2015

Ref-2: MoUD Letter K-14011/93/2014-UT-IV dated 20th October 2015

Ref-3: DULT Letter DULT/33/ITS-Grant/2014-15/2330 dated 07th February 2017

Ref-4: MoUD Letter K- 14011 / 93/2014-UT-IV/UT-V dated 18th May 2017

***

1. The Directorate of Urban Land Transport with technical assistance from JICA has prepared the ITS Master Plan for Bangalore and Mysore. The Master Plan intends to integrate various technology components that are being planned by different agencies of the state government, such that the traffic and transport issues in the city faced currently and issues expected in the future could be solved in coherent manner using technology interventions.
2. The implementation of the ITS Master Plan in Bengaluru was decided to be taken up with the Peripheral Ring Road project under the JICA ODA loan. A DPR for PRR was prepared, which included City ITS & PRR ITS components and was submitted to MoUD.
3. As City ITS implementation was one of the first city scale deployment being undertaken in India, it was decided to seek grant assistance from Government of Japan for demonstration of some of key components on a pilot basis in Bangalore. It was intended that learnings from the pilot implementation, could be useful for scaling up the ITS deployment to city wide. In this regard, DULT had submitted the grant application for Grant-in-Aid in October 2014 through MoUD. The grant proposal envisages establishing of:
   - Bengaluru Traffic Information Centre (B-TIC)
   - Advance Traffic Control System (ATCS) for 29 locations
   - Variable Message Signs (VMS) for 5 locations.
   - Automatic Traffic Counter and Classifier (ATCC)
   - Queue-length Measurement Sensor (QMS)

Annex 4

4. The application was recommended to DEA by MoUD (Ref 1&2) after obtaining clarification from DULT. Subsequently, after DEA's recommendation, JICA had dispatch a study team to carry out preparatory study for the ITS grant project in Bengaluru. The draft preparatory study includes finalization of location for ITS implementation, technology scooting keeping in view interoperability requirements, setting expected outcomes, preparation of operations and maintenance scope, stakeholder consultations, undertakings from both the governments on responsibilities, implementation plan, and cost estimation, etc.

5. The agreed Minutes of Discussion (M.D) between DULT and JICA was submitted to MoUD (Ref 3) for approval and recommending the ITS grant project for implementation. On 18th May 2017, DULT received official confirmation from MoUD (Ref 4) for not recommending the project for technical assistance and the following reasons were cited for the same:

    i. "The system over a small area compared to the entire city does not yield benefits as traffic moves in a continuum".

    ii. "Expansion of the system will entail the issues pertaining to propriety"

6. With regard to the above concerns, we would like to acknowledge that these were duly deliberated while preparing the grant proposal and also at various stages during the preparatory study.

7. With respect to the concern of MoUD regarding the anticipated benefits of the small scale pilot implementation, it may be noted that grant components of ITS implementation were carved out from the ITS Master Plan for Bengaluru, wherein ITS interventions were planned in a more holistic manner. The Directorate also intends to implement a city wide ITS, and a proposal for which was also put forth to MoUD as sizeable benefits in traffic improvement can be realized at city scale. However, ITS implementations are complex that requires involvement of multiple stakeholders and currently the expertise available within the country is also limited. Hence, it was decided that the pilot ITS implementation is very essential to be taken up, so that the learnings could be utilized before embarking on a city wide implementation.

8. We would like to clarify that in the pilot implementation certain components like establishment of B-TIC (which includes probe system, center console, video wall and servers) would be for city wide operations, and other field components like advance signals

systems (ATCS), ATCC, VMS, etc. are proposed for smaller scale at key locations in Bengaluru. Once the field systems are implemented, calibrated and demonstrated to work well in Indian conditions, these systems would be further scaled to other locations in Bengaluru.

9. The ITS systems that have been proposed for Bengaluru through the Japanese Government grant was considered after careful examination of the benefits that have been measured in implementation in Japan. For example, similar ATCS implementation in Tokyo Metropolitan Area (621 sq. kms.) has helped the city reduce total delays in the area by more than 23% and length of congestion (queuing) by 28%. In terms of economic benefits, the total savings in time and fuel consumptions has been determined as Rs. 5,500 crore per year.

10. Although, as rightly pointed by MoUD the economic benefits of the scale achieved in Tokyo Metropolitan Area would not occur with small scale (pilot) implementation in Bengaluru, localized benefits in traffic improvements is very much anticipated with the proposed pilot implementation. In this regard, JICA has established indicators to objectively measure the impact of pilot implementation. For example, the average queue length at junctions where ATCS would be implemented is anticipated to reduce by 30% post implementation and the average travel speed on the corridor is anticipated to increase by 13%.

11. In the preparatory study for the grant project, it has been measured in an initial survey that at key intersections where ATCS is proposed, that currently the underutilization of green time at signals is averaged for 7 junctions at about 236 minutes in 15 hours of operations and the maximum value of underutilized green time was measured to be 510 minutes, translates to about 57% of time the green time is underutilized. Thus, clearly an opportunity for adaptive traffic signals (ATCS) to minimize the underutilization of green time in real time operations, which would improve the overall operational efficiency at proposed junctions. Further as the proposed ATCS is also required to achieve synchronization of group of signals in the area, number of stops per vehicles is anticipated to reduce there by increasing average journey speeds

12. MoUD has raised concern that expansion of the system will entail the issues pertaining to propriety. DULT has in several occasions emphasized that interoperability and scalability of the system should be incorporated in the system design and specification. Japanese

Annex 4

counterpart has agreed to this and the same has been incorporated in the Minutes of Discussion (M/D) submitted to MoUD.

13. It may also be noted that DULT has examined the signal systems implemented in Japan and many cities their ATCS (MODERATO) has been implemented and in operation along with other stand-alone signal systems. For example, in the Tokyo Metropolitan Area MODERATO is operational at 49.8% signalized junctions and remaining junctions are operated by stand-alone signal systems. The proposed ATCS for Bengaluru has capacity to expand upto 128 signals and these ATCS signals can coexist with other ATCS or stand-alone signal systems.

14. DULT has further ensured that in the proposed grant project the contractor would also be responsible for carrying out the operations and maintenance (O&M) for 5 years after commissioning of the systems, so that the anticipated benefits can be demonstrated. DULT, in subsequent discussions with JICA has also laid conditions that in the course of O&M, local technology partners have to be enabled by the project contractor, so that continued spares and skilled manpower would be available locally.

15. Traffic congestion in Bangalore is one of the critical infrastructure bottlenecks and optimal utilisation of existing road infrastructure using intelligent transport system is a part of the strategy to remove these bottlenecks. This project is expected to help in mitigating the traffic issues and provide necessary learnings for further citywide expansion of ITS. Considering the readiness of the project and the leap of progress that has been made, including bringing various stakeholders on-board, securing of space for BTIC, and signals, etc. the proposal may kindly be re-examined by MoUD.

With regards,

Yours sincerely,

Mahendra

Sri Durga Shanker Mishra, IAS
Secretary,
Ministry of Urban Development,
Government of India,
New Delhi.

Copy

1. The Chief Representative, JICA India, New Delhi.

Expansion of Signal System

Annex 5-1

1. Connectivity and Procurement of Equipment for Expansion of Signal System

The signal system consists of a centre server and roadside modules, i.e. signals, controllers and sensors installed at each intersection. The centre server which will be procured by the grant project is capable of controlling a large number of signals. Thus, modification of the software of the centre server is not necessary even if the signals are additionally procured.

The parameter setting is required when the signals are added. Setting the parameter is to be done by operator console terminal. How to set the parameter will be explained by the operation manual which will be prepared under the grant project. A technical guidance on how to set the parameter will also be provided to Bengaluru Traffic Police under the grant project.

The intellectual property rights are not a factor which limits connectivity of the signal system because the communication standard and protocol which will be adopted to the system of the grant project is opened and they are international standard. (The details are explained below on the next page.)

Therefore, expansion of the signal system is possible by procuring and connecting the equipment which fulfils the technical requirement for connecting to the centre server. The functional requirement will be prepared as technical specification and will be attached to the bidding document for the grant project.

Since technical specification and communication protocol between the centre server and roadside modules are opened, additionally procured roadside modules which are compatible with the signal system can be manufactured by any manufactures that have sufficient technical capability. It is considered that technically simple modules, i.e. signal and roadside sensors, can be manufactured by Indian local companies even now. Technically sophisticated modules such as controllers can be locally produced in near future through research & development and/or collaboration with several experienced Japanese companies. For your reference, there is a case in Thailand that the controllers are locally manufactured by local companies through collaboration with a Japanese company.

Therefore, 'competitiveness' for procurement of additional equipment for expansion of the signal system is not impaired by the intellectual property rights.

Expansion of Signal System

The details are explained below.

1) Interface

The following interfaces which will be adopted to the signal system of the grant project are open as they conform to international standards.

- ✓ Centre to Centre
- ✓ Centre to Controller
- ✓ Controller to Signal and Sensor
  (Refer to Attachment for Detail)

2) Equipment Specification

The equipment specifications will be prepared under the grant project and will be disclosed. Therefore, the companies can manufacture the equipment by referring to them (as long as the conditions described on the previous page are met).

3) Centre System

It is possible to add a lot of signals only by changing the parameter setting. The software modification is not required for adding signals.

When adding a new center, it can be connected to the existing center if the interface of the new center conforms to the international standard.

4) Controller

The interface is open because it conforms to the international standard, and the functional requirement is specified by the specification. Therefore, it is possible for many companies to manufacture the controllers.

If additional procurement is necessary in the immediate term, the controllers can be purchased from several different Japanese companies. It is also possible that Japanese companies provide the main parts to the Indian local companies and the controllers will be locally manufactured by OEM (Original Equipment Manufacturing).

The additional controllers can be connected to the centre without modification of the centre system.

5) Signal and Sensor

Expansion of Signal System

The Indian local companies could manufacture the signals and sensors by themselves because the interface (controller to signals and sensor) conforms to the international standard, and the signals and sensors can be connected to the controllers.

2. Area of Signal System

The signal system to be introduced by the grant project realizes effective signal control by Area Control.

The area control is effective in the area of continuous signals having their interval of 300 meters to 400 meter or less. If the distance is more than these intervals, the effect will be reduced.

Therefore, standalone signals are sufficient and the area control is not required in these areas.

It is necessary to consider the area to be expanded once the effect is confirmed after introducing the area control signal system by the grant project.

Attachment-1 : "Relation of UTMS Standard and International Standard"
Attachment-2 : "ISO TC204 Working Group of Standardization of Traffic Management"

Attachment - 1 : "Relation of UTMS Standard and International Standard"

Layer of OSI Model	UTMS Standard	Applicable International Standard
(7) End Application Layer	Traffic Signal DATEX-ASN Message Standard	---
(7) Application Layer	DATEX-ASN Communication Application Standard	ISO 14827- 1,2 ISO 15784
(6) Presentation Layer	UD Type Encording Standard	ISO/IEC 8824-1, 8825-1, 10646-1, NTCIP1102v01.06
(4/3) Transport/Network Layer	UD Type Transporting Standard	IP : IAB, STD51, RFC791 UDP : RFC768
(2) Data Link Layer	UD Type Interface Standard	PPP : IAB, STD51, RFC1661
	S9 Interface Standard	PPP : IAB, STD51, RFC1661
(1) Physical Layer	UD Type Interface Standard	V.32
	S9 Interface Standard	EIA-422-A

UTMS	Universal Traffic Management Society of Japan
IEC	International Electrotechnical Commission
NTCIP	The National Transportation Communications for Intelligent Transportation Systems (ITS) Protocol
IAB STD	Interactive Advertising Bureau Standard
RFC	Request for Comments
V.32	Transfer protcol of ITU-T(Internationel Telecommunication Union Telecommunication Standardization Sector)
EIA	Electronic Industries Alliance

ISO/TC204 Working Group of Standardization of Traffic Management

WG 9 Integrated Transport Information, Management and Control

WG 9 is working on the standardization of traffic management (traffic information and control, etc.). Specifically, it is working on the systematization of information and standardization of communication systems between traffic management centers, between centers and roadside modules, and between roadside modules, to enable efficient data exchange and to provide information to outside organizations.

List of WG 9 work items

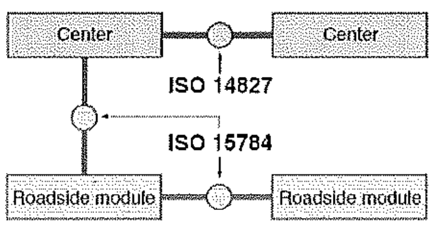
	Standardization themes	ISO number	Contents
1	Data interfaces between Centres for Transport Information and Control Systems - Part 1: Message Definition Requirement	ISO 14827-1	Definition of message forms between centers for transport information and control systems
2	Data interfaces between Centres for Transport Information and Control Systems - Part 2: DATEX-ASN Application	ISO 14827-2	Definition of a DATEX-ASN-based communication protocol between centers for transport information and control systems
3	Data interfaces between Centres for Transport Information and Control Systems Part 3 : Data interfaces between centres for Intelligent Transport Systems (ITS) using XML	DIS 14827-3	Definition of an XML-based communication protocol between centers for transport information and control systems
4	Data exchange involving roadside modules communication - Part 1: General principles and documentation framework of application profiles	ISO 15784-1	Principles underlying application profiles and framework for documentation regarding communication between centers and roadside modules
5	Data exchange involving roadside modules communication - Part 2: Application profile-data exchange (AP-DATEX)	ISO 15784-2	Application profile based on TMP of communication between roadside modules (NTCIP 1103)
6	Data exchange involving roadside modules communication- Part 3: Application profile-data exchange (AP-DATEX)	ISO 15784-3	Application profile based on DATEX-ASN (ISO 14827) for communication between centers and roadside modules
7	Integrated Transport Information, Management and Control - Data quality in ITS Systems	TR 21707	Definition of data quality for ITS
8	Interface Protocol and Message Set Definition between Traffic Signal Controllers and Detectors (IPMSTSCD)	NP 10711	Definition of interface and message set between vehicle detectors and traffic signal controllers
9	The use of simulation models for evalution of traffic management systems: Input parameters and reporting template for simulation of traffic signal control systems	TR 16786	Specification of input parameters and report templates in evaluating signal control systems through simulation
10	Definition of data elements and data frames between roadside units and signal controllers for cooperative signal control	WD 19082	The definition of a use-case, requirements and data concepts for traffic signal control, incorporating probe data
11	Data interfaces between centres for transport information and control systems — Platform independent model specifications for data exchange protocols for transport information and control systems	PWI 19468	Platform independent model specifications for data exchange protocols for transport information and control systems
12	Intelligent transport systems - Roadside modules data interface Part 1 - Generalized field device	PWI 20684-1	Definition of interface between general roadside modules and the center
13	Intelligent transport systems - Roadside modules data interface Part 2 - Variable message signs	WD 20684-2	Definition of interface between the information display board and the center

Activities

The scope (center-to-center, centers-to-roadside) of standardization being worked on by WG 9 is shown in the figure. Centers refer to transport management centers. Roadside modules include signal control devices, information boards and sensors installed along roads.

Ensuring interconnectivity is one advantage of promoting the standardization of information and communication between centers as well as centers and roadside modules. It also reduces the risks involved in purchasing modules for procurers, and in development for module suppliers.

Scope of standardization



Definition of data elements and data frames between roadside units and signal controllers for cooperative signal control (WD 19082)

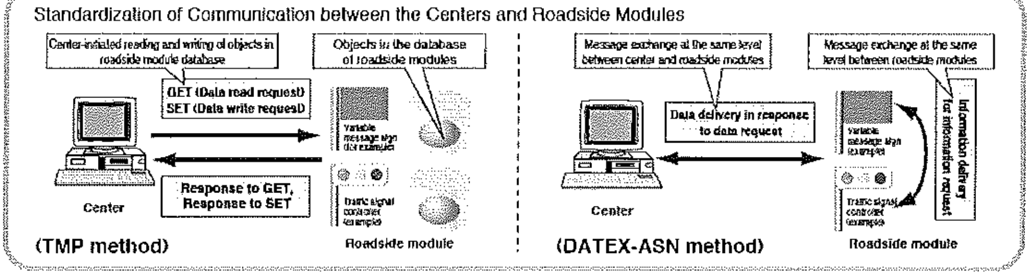
Recently, in addition to vehicle detectors, road-to-vehicle communications are making it possible to collect traffic information (probe data) directly. Therefore, through the presentation of a reference model, Japan made a new proposal to help develop a platform to utilize probe data for signal control. This item was approved as NP in 2016. Currently CD voting is being prepared.

Communication between Centers and Roadside Modules (ISO 15784)

Communication between centers and roadside modules refers to the exchange of information between the central modules of a transport management center and modules installed along roads, as well as between different roadside modules. WG 9 plans to prescribe this communication in the form of an application profile. The application profile will specify a set of base standards for the three upper OSI layers to meet the requirements for communication between centers and roadside modules. It will also prescribe how to use the base standards. As initial versions, the Transportation Management Protocol (TMP), from the U.S. National Transportation Communication for ITS Protocol (NTCIP), was adopted for Part 2, while DATEX-ASN from the ISO 14827-2 international standard for communications between transport management centers, was adopted as Part 3.

This item has been promoted under Japan's leadership. Part 1 and 3 were issued in October 2008 and Part 2 in November 2015 as ISO publications.

Standardization of Communication between the Centers and Roadside Modules



(Source: ITS Standardization Activities of ISO/TC 204, 2016)

Annex-5-2

■ Quantitative Effect

Indicator		Baseline Value in 2016	Estimated Value After Introducing ATCS (*3)
1. Queue Length			
	(1) Maximum Queue Length amongst Key Intersections (*1)	550 meters	385 meters (-30%)
	(2) Average Queue Length of Key Intersections (*1)	400 meters	280meters (-30%)
2. Average Travel Speed (*2)		13km/h	15km/h (+13%) (*4)

(*1) Key Intersections = 7 intersections where traffic congestion mostly occurs amongst 29 intersections

(*2) Average travel speed on target corridor in morning peak hour

(*3) For the period of 3 years after commencement of operation

(*4) It was found by traffic survey that the delay time waiting for signals is one of the causes of current travel speed on the target corridor. It was also observed that long cycle time is applied to many current signals.
Approximately 150 second is considered to be applied to the cycle time of the signal system which will be introduced in the project. Based on this, it is assumed that maximum waiting time for the signal is approximately 100 seconds (approx. 70% of 150 seconds). The average travel speed after the project was estimated by setting approx. 100 seconds for signal waiting time for the intersections currently taking more than 100 seconds.

Result of Signal Survey

Outline of carried out survey

- Surveyed Intersections: 7 Key Intersections
- Survey Contents: The following surveys for one cycle every half an hour for all day were carried out.
  - ✓ Signal Phase Time (to understand actual operation situation)
  - ✓ Passing Vehicle Counting by 10 Seconds During Green Time (to identify degree of inefficiencies if any)
  - ✓ Wasted Green/Dead Green Phenomena (supplementally carried out to confirm the situation)

Observations

- It was found that there are inefficiencies in signal operation at key intersections.
- The major inefficiencies are:
  - The signal cycle time is generally too long.
  - The time for pedestrian signal is generally too short.
  - The signal phase patterns at some intersections are not configured for traffic flow.
  - Thus, there are wasted green time during the traffic signal operation.

Quantified inefficiencies

The inefficiencies in terms of wasted green time are quantified by key intersection as follows:

	Junction Name	Signal Operating Time (Min.)	Wasted Green Time	
			Min.	Ratio
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*)	81	34%
07	Vivekananda/Bhaskaran Junction	900	510	57%

(*) Note: The survey time was limited to this time.

- **Improvement that can be made**
  - The optimal signal indications (i.e. green time, red time) according to traffic demand can be given.
  - The inefficiencies of signal operation can be more optimized.
  - The group of passing vehicles will be accordingly formed by optimizing signal time.
  - Then, the traffic flow will be more smoothened allowing the group of passing vehicles to pass next intersections by coordinating signals.

■ Example of Effect in Japan

The Advanced Traffic Control System (MODERATO) of Tokyo Metropolitan Police Department was completed and started operation in February, 1995. The following tables show the effect of MODERATO when it was implemented.

Table1: Results of Control

Index	Before Implementation (1994)	After Implementation (1995)	Effect in Ratio (%)
Total Travel Time [1,000 veh・hour]	1,194	1,086	9.1
Total Delay [1,000 veh・hour]	448	343	23.4
Congestion Length-time [km・hour]	8,423	6,066	28.0

Table1: Benefit in Economic Terms

Items	Benefit	
	(billion yen/year)	(crore INR/year)
Saving in Time (TM)	107.2	5,360
Saving in Fuel Consumption (FM)	2.9	1,450
Total	110.1	5,500

The conditions of above implementation are:

- Implemented Year: 1995
- Implemented Area: Tokyo Metropolitan Area (approx. 621km2)
- Implemented Road Length: 1,515km of Major Road
- Implemented Number of Key Intersection: 308
- Implemented Total Number of Intersection: 6,800

Annex-6

Annex 3 Major Undertakings to be taken by India side

(Revised Information based on the Results of the Additional Survey)

1. Specific obligations of the Government of India and the Implementing Agency which will not be funded with the Grant

(1) Before the Tender

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT		
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	DULT		
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT		
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT		
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT		

B/A: Banking Arrangement

A/P: Authorization to pay, N/A: Not Applicable

DULT: Directorate of Urban Land Transportation, State Government of Karnataka

BTP: Bengaluru Traffic Police

KSDC: Karnataka State Data Center

DOF : Department of Finance, State Government of Karnataka

MOF: Ministry of Finance, Government of India

(2) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	DULT		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	DULT		
	2) Payment commission for A/P	every payment	DULT		
3	To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	during the Project	DULT		
4	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	DULT		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in India with respect to the purchase of the products and the services be reimbursed	during the Project	DULT DOF MOF	**9,274**	
6	To renovate DULT Center, BTP Traffic Management Center and KSDC including air conditioning, replacement electrical fittings, lighting fixture and refurbishing if necessary, to accommodate the equipment	before installation of the equipment	DULT BTP		
7	To acquire site access and work permission for the centers	before installation of the equipment	DULT		
8	Internal wiring works in the building for the Control Center (B-TIC)	before installation of the equipment	DULT	3,738	-
9	To remove obstacles from the Project sites	before installation of the equipment	DULT BTP		
10	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	DULT		
11	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within one month after completion of each work	DULT		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	DULT		
12	To submit a report concerning completion of the Project	within six months after completion of the Project	DULT		
13	To procure initial spare parts (signal pole & sensor pole)	Before completion of the equipment installation	DULT,	1,013	

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
14	To secure operation and maintenance personnel	Before completion of the equipment installation	DULT, BTP		
15	To replace existing gantries of traffic sign boards	Just after commencement of operational guidance	DULT	349	-
16	To replace existing signal poles	Just after commencement of operational guidance	BTP	1,345	

This Part is closed due to the confidenciality.

This Page is closed due to the confidenciality.

Annex-7

K-14011/93/2014-UT-IV/UT-V
Government of India
Ministry of Urban Development
Urban Transport Wing

Nirman Bhawan, New Delhi
Dated: 18th May, 2017.

To,

The Commissioner and E/O Principal Secretary to Govt.,
Directorate of Urban Land Transport,
Urban Development Department,
Shanthinagar, Bangalore - 560027.

Subject: Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru.- reg.

Sir,

I am directed to refer to your letter No. DULT/33/ITS-GRANT/2014-15/2330 dated 07.02.2017 on the above cited subject vide which "Minutes of Discussion" was furnished to this Ministry. The proposal for implementation of Advanced Traffic Information and Management System in core Bengaluru was examined in detail. The system over a small area compared to the entire city does not yield benefits as traffic moves in a continuum. Also, any expansion of the system will entail the issues pertaining to propriety. Therefore, the same not recommended for Technical Assistance.

Yours faithfully,

(Mamta Batra)
Under Secretary to the Government of India
Telefax: 011-23062285

MAHENDRA JAIN, I.A.S.,
Additional Chief Secretary to Government
Urban Development Department

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Vikasa Soudha, Dr. Ambedkar Road
Bengaluru-560 001

GOVERNMENT OF KARNATAKA

D.O.No: DULT/33/ITS-Grants/2014-15/188 Date:10-07-2017

OFFICE OF SECRETARY (UD) 14 JUL 2017 Dy. No. 877196

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OSD (UT)

DS MRTS-UT

4. The application was recommended to DEA by MoUD (Ref 1&2) after obtaining clarification from DULT. Subsequently, after DEA's recommendation, JICA had dispatch a study team to carry out preparatory study for the ITS grant project in Bengaluru. The draft preparatory study includes finalization of location for ITS implementation, technology scooting keeping in view interoperability requirements, setting expected outcomes, preparation of operations and maintenance scope, stakeholder consultations, undertakings from both the governments on responsibilities, implementation plan, and cost estimation, etc.
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    ii. "Expansion of the system will entail the issues pertaining to propriety"
6. With regard to the above concerns, we would like to acknowledge that these were duly deliberated while preparing the grant proposal and also at various stages during the preparatory study.
7. With respect to the concern of MoUD regarding the anticipated benefits of the small scale pilot implementation, it may be noted that grant components of ITS implementation were carved out from the ITS Master Plan for Bengaluru, wherein ITS interventions were planned in a more holistic manner. The Directorate also intends to implement a city wide ITS, and a proposal for which was also put forth to MoUD as sizeable benefits in traffic improvement can be realized at city scale. However, ITS implementations are complex that requires involvement of multiple stakeholders and currently the expertise available within the country is also limited. Hence, it was decided that the pilot ITS implementation is very essential to be taken up, so that the learnings could be utilized before embarking on a city wide implementation.
8. We would like to clarify that in the pilot implementation certain components like establishment of B-TIC (which includes probe system, center console, video wall and servers) would be for city wide operations, and other field components like advance signals

systems (ATCS), ATCC, VMS, etc. are proposed for smaller scale at key locations in Bengaluru. Once the field systems are implemented, calibrated and demonstrated to work well in Indian conditions, these systems would be further scaled to other locations in Bengaluru.

9. The ITS systems that have been proposed for Bengaluru through the Japanese Government grant was considered after careful examination of the benefits that have been measured in implementation in Japan. For example, similar ATCS implementation in Tokyo Metropolitan Area (621 sq. kms.) has helped the city reduce total delays in the area by more than 23% and length of congestion (queuing) by 28%. In terms of economic benefits, the total savings in time and fuel consumptions has been determined as Rs. 5,500 crore per year.

10. Although, as rightly pointed by MoUD the economic benefits of the scale achieved in Tokyo Metropolitan Area would not occur with small scale (pilot) implementation in Bengaluru, localized benefits in traffic improvements is very much anticipated with the proposed pilot implementation. In this regard, JICA has established indicators to objectively measure the impact of pilot implementation. For example, the average queue length at junctions where ATCS would be implemented is anticipated to reduce by 30% post implementation and the average travel speed on the corridor is anticipated to increase by 13%.

11. In the preparatory study for the grant project, it has been measured in an initial survey that at key intersections where ATCS is proposed, that currently the underutilization of green time at signals is averaged for 7 junctions at about 236 minutes in 15 hours of operations and the maximum value of underutilized green time was measured to be 510 minutes, translates to about 57% of time the green time is underutilized. Thus, clearly an opportunity for adaptive traffic signals (ATCS) to minimize the underutilization of green time in real-time operations, which would improve the overall operational efficiency at proposed junctions. Further as the proposed ATCS is also required to achieve synchronization of group of signals in the area, number of stops per vehicles is anticipated to reduce there by increasing average journey speeds.

12. MoUD has raised concern that expansion of the system will entail the issues pertaining to propriety. DULT has in several occasions emphasized that interoperability and scalability of the system should be incorporated in the system design and specification. Japanese

counterpart has agreed to this and the same has been incorporated in the Minutes of Discussion (M/D) submitted to MoUD.

13. It may also be noted that DULT has examined the signal systems implemented in Japan and many cities their ATCS (MODERATO) has been implemented and in operation along with other stand-alone signal systems. For example, in the Tokyo Metropolitan Area MODERATO is operational at 49.8% signalized junctions and remaining junctions are operated by stand-alone signal systems. The proposed ATCS for Bengaluru has capacity to expand upto 128 signals and these ATCS signals can coexist with other ATCS or stand-alone signal systems.
14. DULT has further ensured that in the proposed grant project the contractor would also be responsible for carrying out the operations and maintenance (O&M) for 5 years after commissioning of the systems, so that the anticipated benefits can be demonstrated. DULT, in subsequent discussions with JICA has also laid conditions that in the course of O&M, local technology partners have to be enabled by the project contractor, so that continued spares and skilled manpower would be available locally.
15. Traffic congestion in Bangalore is one of the critical infrastructure bottlenecks and optimal utilisation of existing road infrastructure using intelligent transport system is a part of the strategy to remove these bottlenecks. This project is expected to help in mitigating the traffic issues and provide necessary learnings for further citywide expansion of ITS. Considering the readiness of the project and the leap of progress that has been made, including bringing various stakeholders on-board, securing of space for BTIC, and signals, etc. the proposal may kindly be re-examined by MoUD.

With regards,

Yours sincerely,

Sri Durga Shanker Mishra, IAS
Secretary,
Ministry of Urban Development,
Government of India,
New Delhi.

K-14011/93/2014-UT-IV/UT-V
Government of India
Ministry of Housing and Urban Affairs
Urban Transport Wing

Nirman Bhawan, New Delhi
Dated: 10th August, 2017.

To,
The Chief Secretary
Government of Karnataka,
Vidhan Soudha
Bangaluru - 560027.

Subject: Project for Implementation of Advance Traffic Information and Management System in Bengaluru- regarding

Sir,

I am directed to refer to your letter No. DULT/33/ITSGRANT/2014-15 dated 20.7.2017 on the above cited subject.

The above mentioned proposal has been re-examined in the light of clarifications received vide GoK's letter dated 10.7.2017. This Ministry supports the proposal for implementation of Intelligent Transport System (ITS) on pilot basis in Bangaluru with grant assistance from JICA. GoK may take further necessary action in this regard.

Yours faithfully

(Mamta Batra)
Under Secretary to the Government of India
Telefax: 011-23062285

Appendix-5

Soft Component (Technical Assistance) Plan

PREPARATORY SURVEY
ON THE PROJECT
FOR
BENGALURU METROPOLITAN REGION ITS
IN
THE REPUBLIC OF INDIA
Soft Component Plan

１．Background

(1) Background of the Project

"The Master Plan Study on the Introduction of Intelligent Transport Systems (ITS) in Bengaluru and Mysore in India (January 2014 to June 2015)" (hereinafter referred to as "the Master Plan Study") was conducted by the Japan International Cooperation Agency (JICA). The Master Plan Study proposes to develop various ITS in Bengaluru Metropolitan Area in phases: Short-term (Phase 1: 2015 to 2019), Mid-term (Phase 2: 2020 to 2024), and Long-term (2025 onwards).

After the Master Plan Study, the Technical Review for Bengaluru Peripheral Ring Road Construction Project (hereinafter referred to as “Technical Review Study”) was done from April to December 2015 by JICA and the top priority issues for ITS were identified as development of the "Bengaluru Traffic Information System" and "Signal System".

(2) Background of the Soft Component

The systems to be installed on this Project are as follows:

1) BTIC System

DULT has no experience in the operation and management of BTIC system. Therefore, smooth commencement will be difficult in the initial stage just with the guidance in system operation/maintenance provided by the contractor. Furthermore, sustainable and constructive usage of traffic information will also be difficult because of inadequate knowledge in method of analysis for traffic information.

Hence, assistance to acquire sufficient skills required for operation and maintenance (O&M) as well as preparing an operation/maintenance manual for the BTIC system for its smooth commencement is necessarily to be provided. Acquiring knowledge on methods of analysis for traffic information, utilization for transport planning, and appropriate information management also need to be assisted by the soft component.

2) TMC System

The signal system to be developed in this Project requires to review parameters according to the changes in traffic condition. The traffic signals have already been operated by the BTP. However, the BTP does not have enough experience or skills to properly grasp the traffic condition and continuously maintain control the functions of the signal system such as setting parameters responding to the changes of traffic condition. There are also issues on the capability for proper improvement/maintenance of the intersections where the traffic signals will be installed to exert the effect of the signal function and proper method for educational activities on traffic safety provided by police officers.

Therefore, technical assistance by soft component is required mainly for methods of traffic survey to review parameters, parameter setting, and management of traffic information including amendment of the current operation/maintenance manual. Method of improving road intersections to enhance the effect of signal control and educational activities to raise awareness of drivers and residents on traffic safety conducted by police officers also need to be assisted by the soft component.

VMS has already been operated by the BTP; however, the BTP has no experience to comprehend traffic information obtained from BTIC system and accordingly set the necessary information to VMS system.

Therefore, training through the soft component is required mainly for methods of comprehending traffic information obtained from BTIC system, collecting/managing information to be provided such as traffic accidents, and deciding necessary information to be shared.

As for the methods of O&M for system and device, the manual and training will be separately given by the contractor.

(3) Concept of the Soft Component

The following items from (a) to (g) shall be conducted properly for the efficient operation of the systems mentioned above:

(a) Basic operation / maintenance of each system;

(b) Integrated and efficient operation / management of each system;

(c) Management of the traffic information of BTIC system;

(d) Operation / management of the signal system including setting various parameters;

(e) Operation / management of VMS for the provision of the traffic information;

(f) Analysis of the traffic information of BTIC system and reflecting that to the road transport policy; and

(g) Conducting educational activities for the improvement of traffic safety.

２．Goals of the Soft Component

The goals of the soft component for each party are as follows:

Table-1 The Goals of the Soft Component

Name of Body	Object Person	Goal
DULT	Engineers responsible for the operation / maintenance of BTIC System and for planning the road transport policy.	Available to conduct a stable and sustainable provision of traffic information from the BTIC System. Available to utilize the collected / analyzed data efficiently.
BTP	Engineers responsible for the operation / maintenance of TMC System for conducting the design of intersections.	Available to conduct a stable and sustainable operation of TMC System. Available to conduct a sustainable adjustment of the parameters setting for signal system.
BBMP	Engineers responsible for planning of the road traffic policy and conducting the design of intersections.	Available to plan an efficient road transport policy and design intersections properly.

３．Effect of the Soft Component

(1) Effect of the Soft Component on BTIC System

- The role of each agency related to the city traffic can be clarified.
- The collaborative relationship of system operation, road traffic management, and road traffic planning among each related agency can be clarified.
- The technical capability for conducting basic O&M can be developed through preparing the O&M manuals in the soft component.
- The way to control and make efficient use of traffic information can be acquired.

(2) Effect of the Soft Component on TMC System (Signal System・VMS System)

- The technical capability for conducting basic O&M can be developed through preparing O&M manuals in the soft component.
- The skills to do research on traffic condition, properly grasp traffic condition, and reconfigure operation can be developed through continuously resetting the parameters responding to the changes of local facilities and traffic condition.
- The way to conduct O&M and improve the intersection for enhancing effect of the signal system can be acquired.
- The way of traffic control and enlightenment activity for improvement of traffic manners can be acquired.

４．Confirmation Method of the Outcome Achievement

During the technical support, it is necessary to grasp the value of the outcome achievement in each case. From a quantitative perspective, the person in-charge of the technical support arranges the expected outcome in the evaluation table and gathers the result. The Case of the Evaluation Table of the Outcome Achievement is indicated in Table-2.

Table-2 Case of the Evaluation Table of the Outcome Achievement

Evaluation Item	Grade
<u>From the technological aspect of conducting O&M in BTIC System</u> 1. Organizational structure ・Do you understand the role of each agency and activity? ・Is the way clarified to offer necessary information and to cooperate with each agency? 2. Planning O&M manual ・Do you understand the process in conducting O&M? 3. Information control technique ・Do you understand basic traffic information control technique? (include managing link and section) ・Do you understand the structure of database? 4. Methods on analysis and utilization of information ・Do you understand the methods on analysis of information? ・Do you understand the methods on utilization of information?	
<u>From the technological aspect of conducting O&M in the TMC System</u> 1. Revising the O&M manual ・Do you understand the process in conducting O&M? 2. Information control technique ・Do you understand traffic information control technique? ・Do you understand the structure of database? 3.Traffic survey and analysis/ application to signal system ・Do you understand the way of traffic survey? ・Do you understand the result of traffic survey and the analysis of traffic information? ・Do you understand the application to signal system? 4. The way to reset the signal system ・Do you understand the calculational procedure of proper parameter? (signal phase and timing) ・Do you understand the way to reset the design of sub-area? 5. Design of intersections/maintenance ・Do you understand the configuration design of intersections? ・Do you understand marking design of intersections? 6. Effective use of the signal system ・Do you understand the way of traffic control? ・Do you understand the way of enlightenment activity for the improvement of traffic manners?	

５． Action and Support Plan

(1) Target Members of Soft Component

The soft component training will be conducted mainly to the engineers of DULT and BTP; engineers of BBMP (Bengaluru City Government) will also be included. The number of target members for technical support and groups divided by specialty are shown in Table-3.

Table-3 Number of Target Members for Technical Support and Group According to Specialty

Agency	Duties	Number of People		Group
		Responsible Person	Person in-charge	
DULT	Operation	1	2	A
	Transport Planning	1	6	B
BTP	Operation	1	6	C
	Parameter Setting	1	6	D
	Intersection Designing	1	6	E
BBMP (Bengaluru City Government)	Transport Planning	1	4	F
	Intersection Designing	1	4	G

(2) Contents of Activities for Technical Support

The contents of activities for technical support are shown in Table-4.

Table-4 Contents of Activities for Technical Support

DULT：BTIC System （One Month）

Contents of Activities	Group	Period Required (Week)
1. Demarcation of roles among related agencies and method of cooperation/coordination with each agency	A- F（Responsible Person）	0.5
2. Preparation of system O&M manual	A	1.5
3. Method of information management	A	0.5
4. Methods for analysis and utilization of information	B, F	1.0
5.Explanation of required organization structure for information management and BTIC system in the future	A, B, F	0.5
6. Assessment	A, B, F	-

BTP: TMC System (One Month)

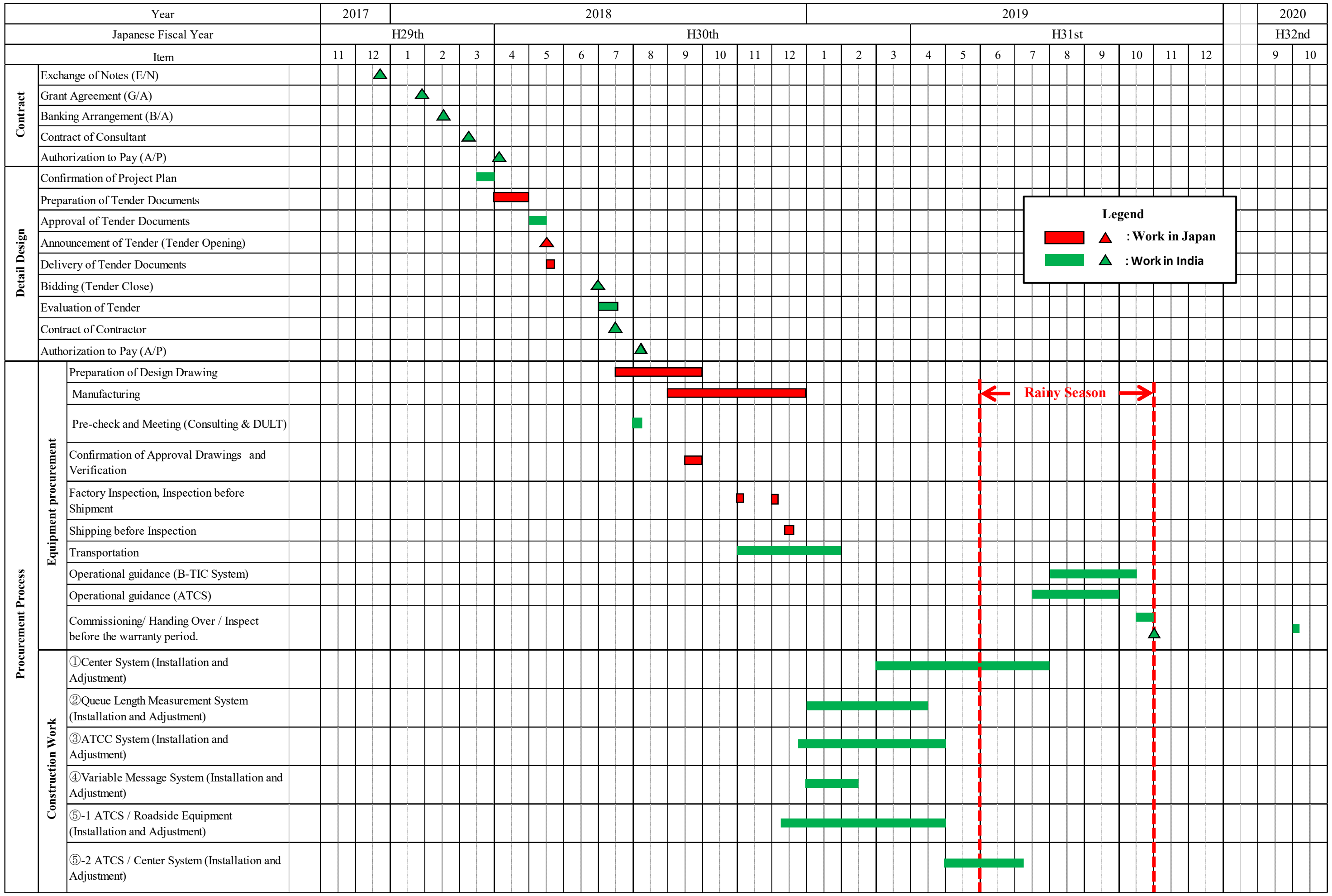
Contents of Activities	Group	Period Required (Week)
1. Amendment of O&M manual for system	C	1.5
2. Method of information management	D	0.5
3. Method/analysis of traffic survey and method of applying to signal designing	D	0.5
4. Method to review parameters for traffic signal operation	D	0.5
5. Method of intersection designing/maintenance	E, G	0.5
6. Explanation of fundamentals and method of educational activities and raising awareness of traffic safety	C, D, E	0.5
7. Assessment	C, D, E, G	-

(3) Support from Japan

The number of people in-charge of technical support from Japan is one engineer who advises the BTIC in great part (Japan: 0.5 months, Bengaluru: 1.0 month) and one engineer who advises the TMC in great part (Japan: 0.5 months, Bengaluru: 1.0 month)

７． Operating Schedule

Fieldwork period is from September 2019, after the operational explanation by supply traders, to October 2019.


Year
2017
2018
2019
2020
Japanese Fiscal Year
H29th
H30th
H31st
H32nd
Item
11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 9 10
Contract
Exchange of Notes (E/N)
Grant Agreement (G/A)
Banking Arrangement (B/A)
Contract of Consultant
Authorization to Pay (A/P)
Detail Design
Confirmation of Project Plan
Preparation of Tender Documents
Approval of Tender Documents
Announcement of Tender (Tender Opening)
Delivery of Tender Documents
Bidding (Tender Close)
Evaluation of Tender
Contract of Contractor
Authorization to Pay (A/P)
Procurement Process
Equipment procurement
Preparation of Design Drawing
Manufacturing
Pre-check and Meeting (Consulting & DULT)
Confirmation of Approval Drawings and Verification
Factory Inspection, Inspection before Shipment
Shipping before Inspection
Transportation
Operational guidance (B-TIC System)
Operational guidance (ATCS)
Commissioning/ Handing Over / Inspect before the warranty period.
Construction Work
①Center System (Installation and Adjustment)
②Queue Length Measurement System (Installation and Adjustment)
③ATCC System (Installation and Adjustment)
④Variable Message System (Installation and Adjustment)
⑤-1 ATCS / Roadside Equipment (Installation and Adjustment)
⑤-2 ATCS / Center System (Installation and Adjustment)
Rainy Season
Legend
: Work in Japan
: Work in India

８． Deliverables

The deliverables of the soft component are as follows:

(1) Final report for the Indian government

(2) Final report for JICA

(3) Manual of O&M

９． Primary Responsibility of the Other Country's Institute

The JICA Study Team would need for target achievement of the soft component not only the results of the soft component investment but also continually conducting the O&M by the country's institute and BTP. The primary responsibilities of the country's institute and BTP are as follows:

<u>Analysis of traffic conditions by using BTIC System and development of traffic plan</u>

・DULT analyses traffic condition based on the BTIC System and continually implement the traffic plan. In addition, DULT cooperates with each agency, shares the problem, and discusses preferential plan periodically and continually.

<u>Enlightenment activity for signal system to BTP, residents, and drivers</u>

・BTP teaches the way of traffic control continually to the local traffic office in order to use the signal system effectively at the intersection.

・BTP makes residents and drivers know pedestrian's manners, driver's manners, and so on, and move ahead on the enlightenment activity for improvement of traffic manners.

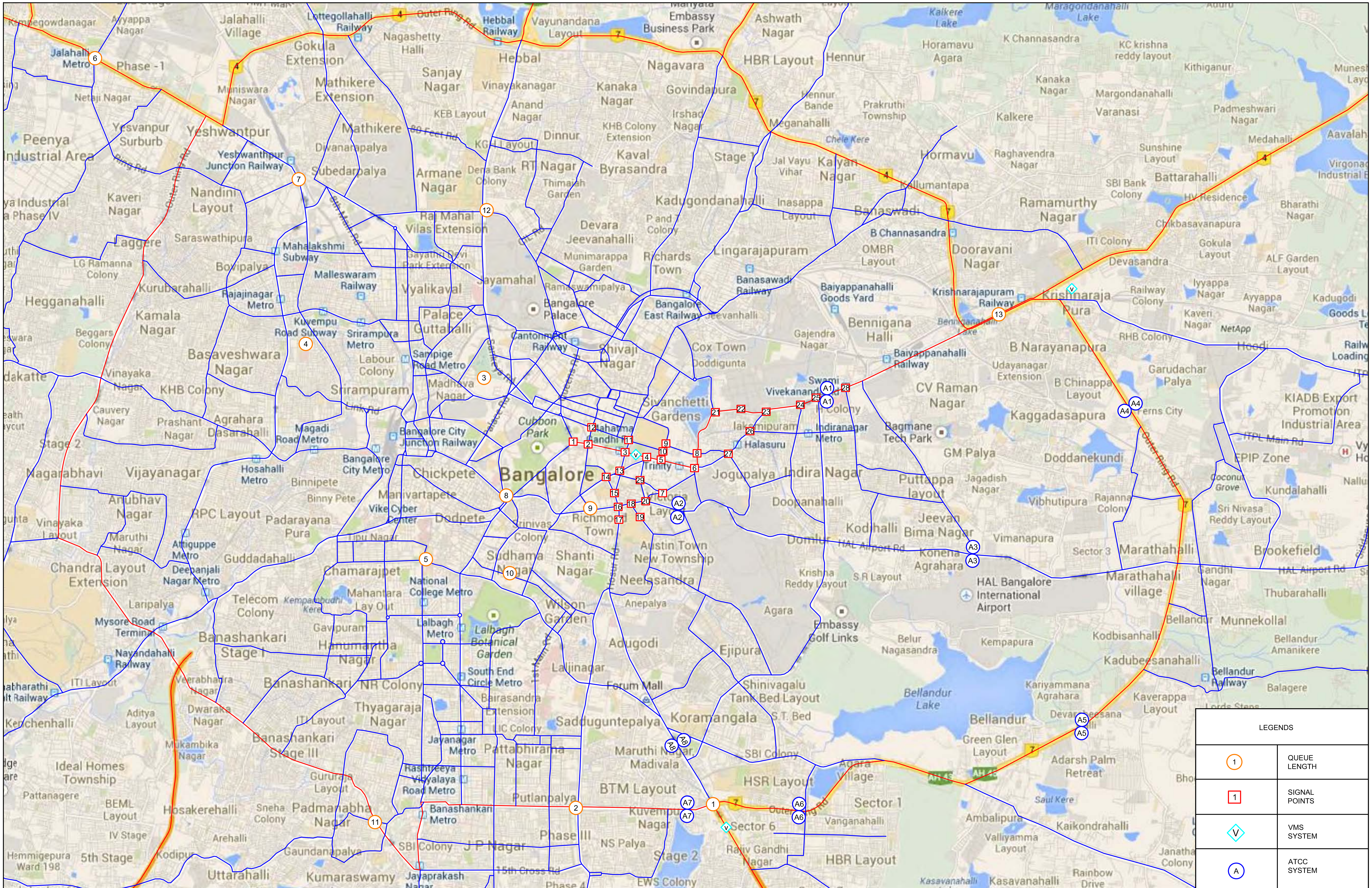
・DULT cooperates with BTP and move ahead on the enlightenment activity.

<u>Improvement of traffic information and the way to offer them by using the BTIC System</u>

・DULT discusses with each agency periodically and continually and is concerned in gathering necessary information to offer it to the BTIC System. In addition, DULT has to make a study on the ways to offer information and traffic information considering the needs and improvement from now on.

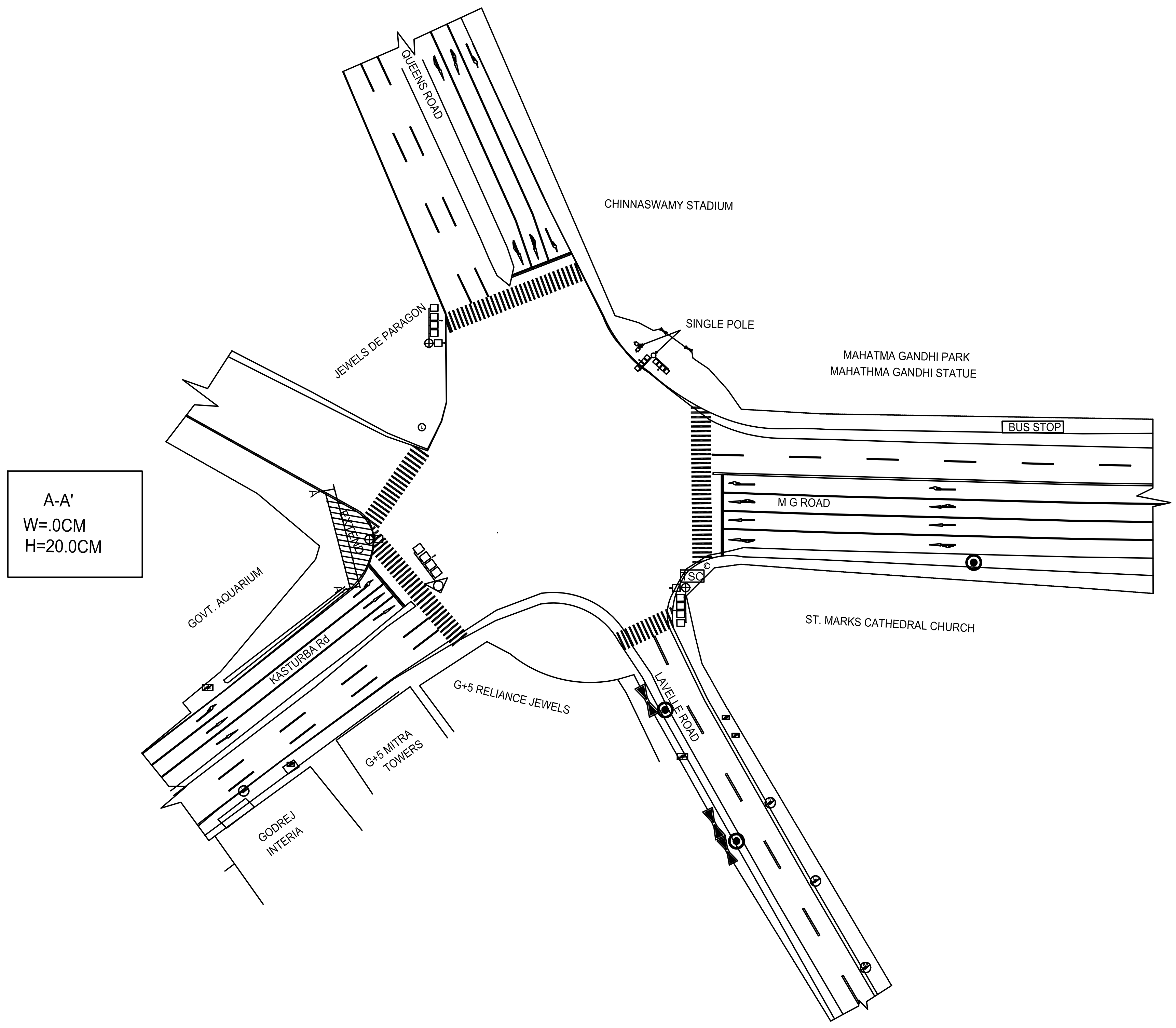
Appendix-6

Reference (Basic Drawings)



JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE LOCATION OF ROADSIDE EQUIPMENTS	DRAW. NO. CMM-2	NIPPON KOEI CO.,LTD EAST NIPPON EXPRESSWAY CO.,LTD

1 QUEENS Rd-KASTURBA Rd-M G Rd

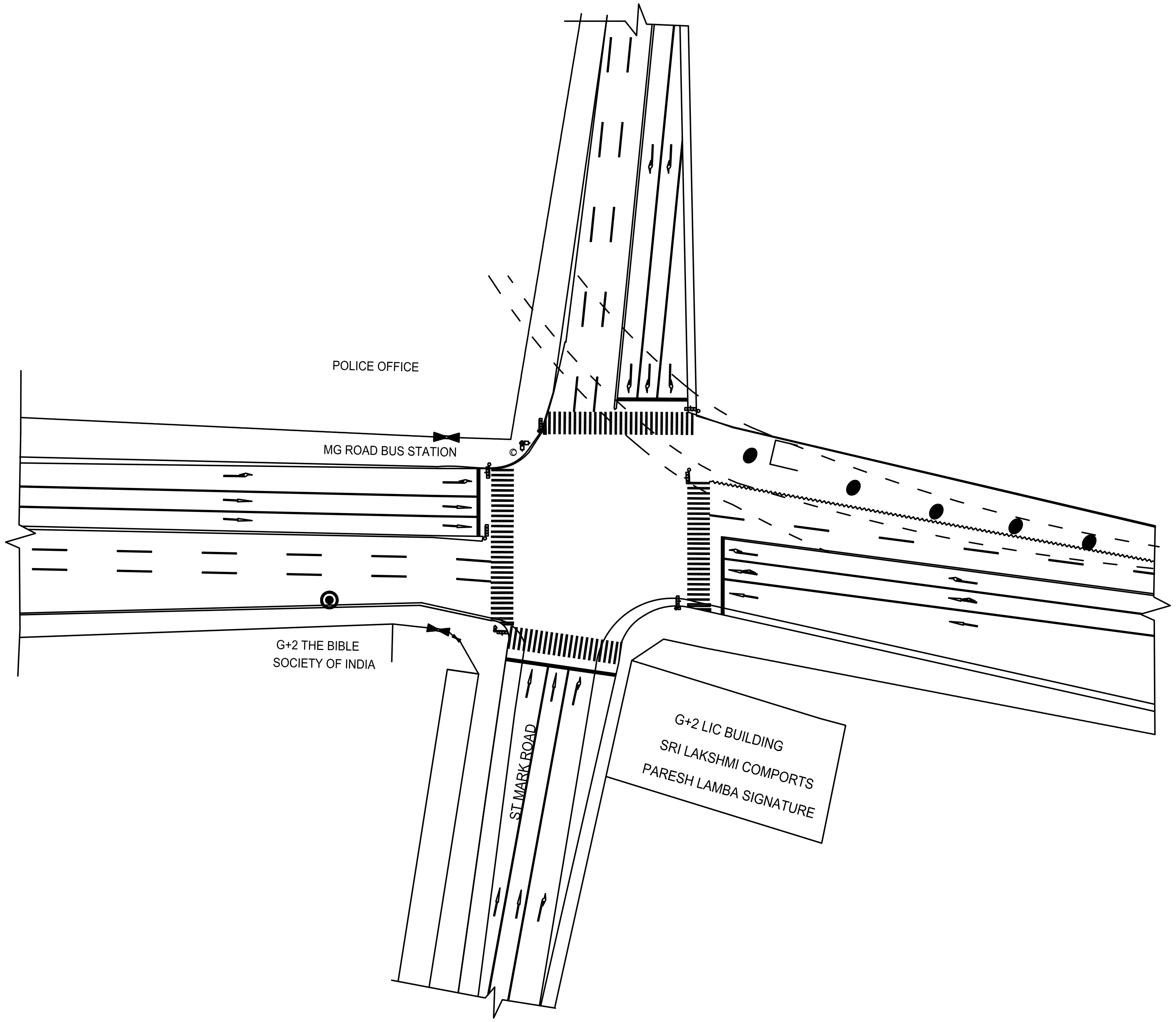


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 1	DRAW. NO. TS-1	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

2 Mg Road- St Marks Rd

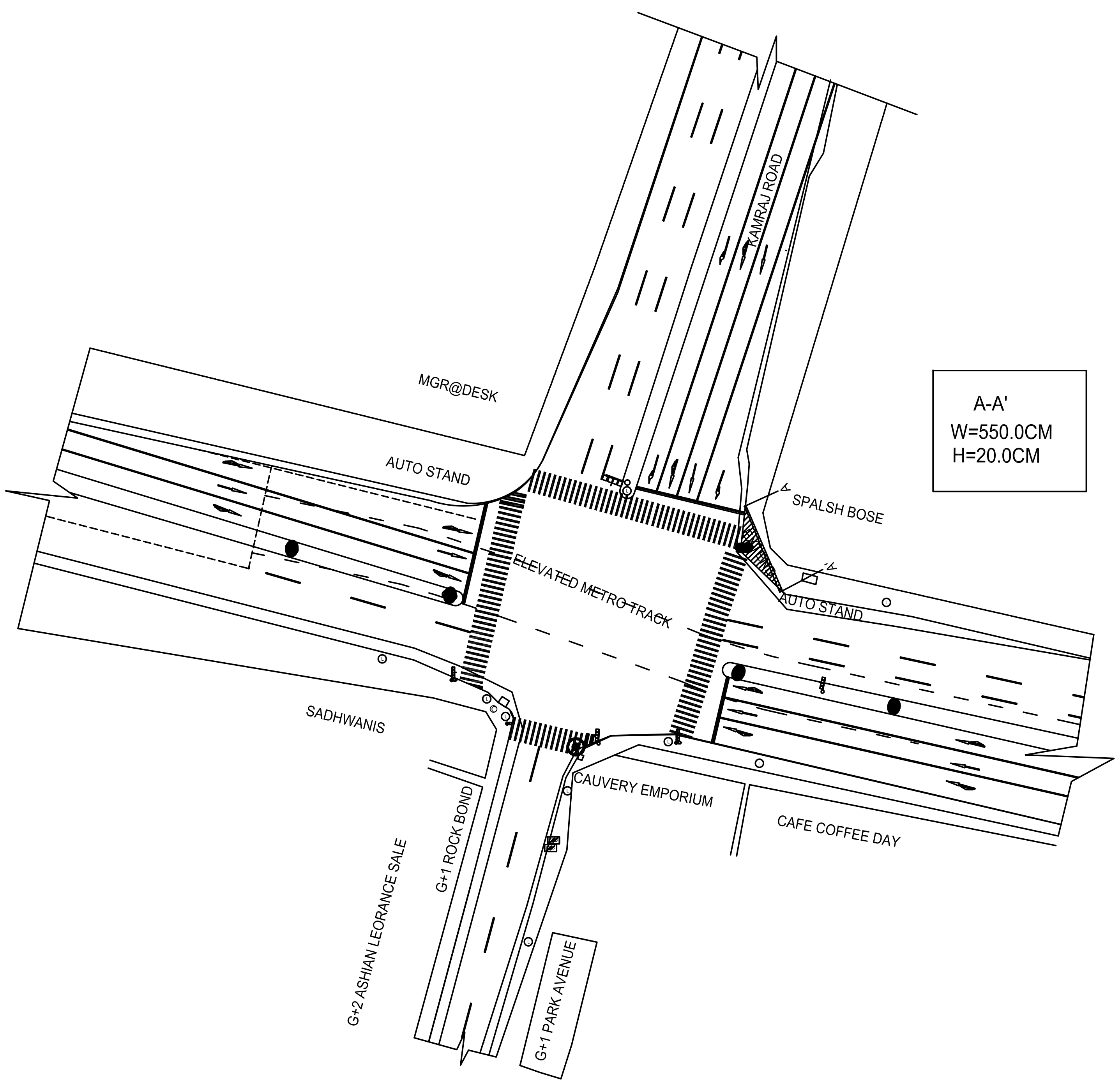


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 2	DRAW. NO. TS-2	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

3 Mg Road and Kamaraj Rd Jn



LEGENDS	
DISCRPITION	SYMBOL
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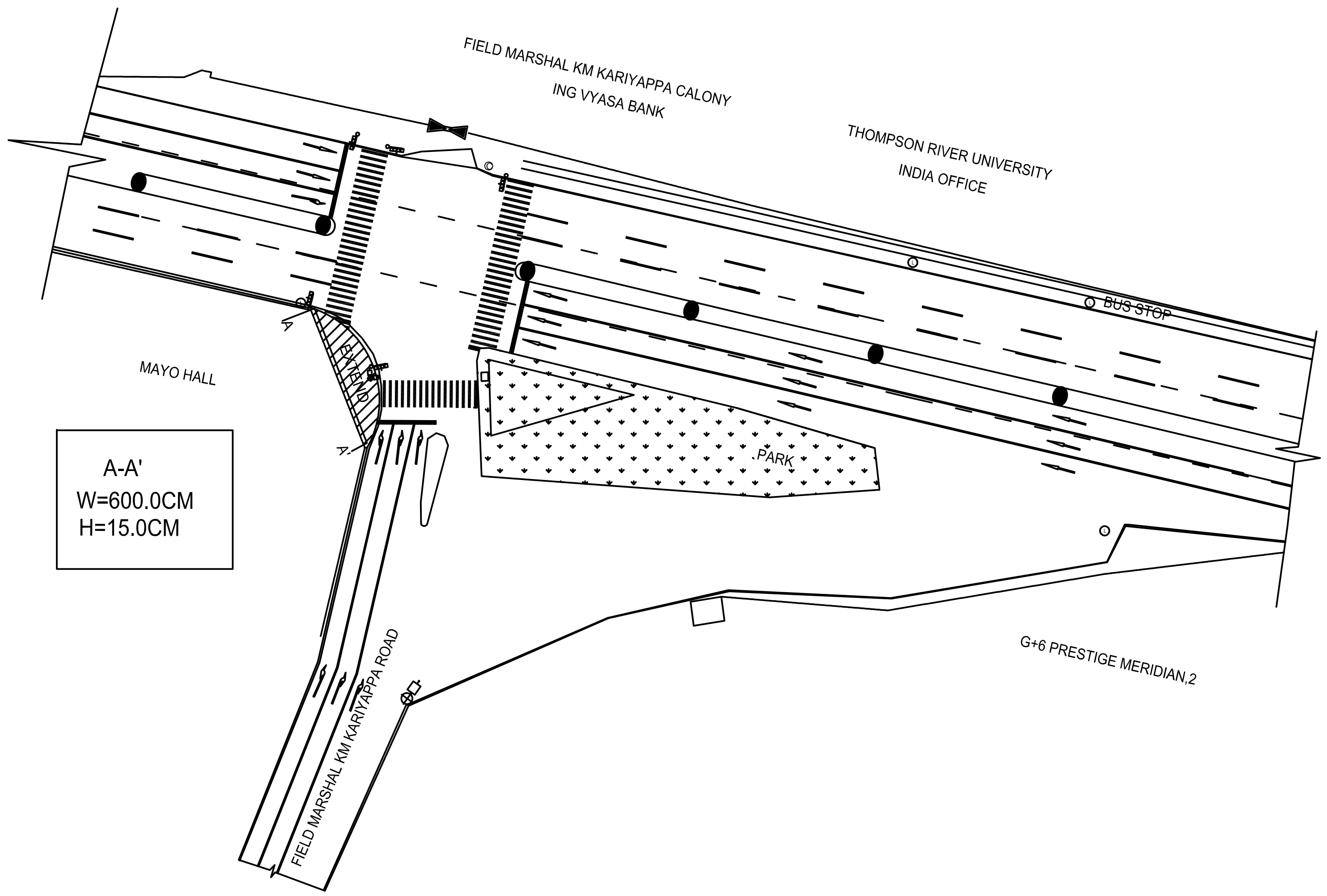
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

		DRAWING TITLE	DRAW. NO.	
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DETAIL LOCATION OF TRAFFIC SIGNAL 3	TS-3	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

4 MG Rd and Residency Rd



A-A'
W=600.0CM
H=15.0CM

LEGENDS	
DISCRPITION	SYMBOL
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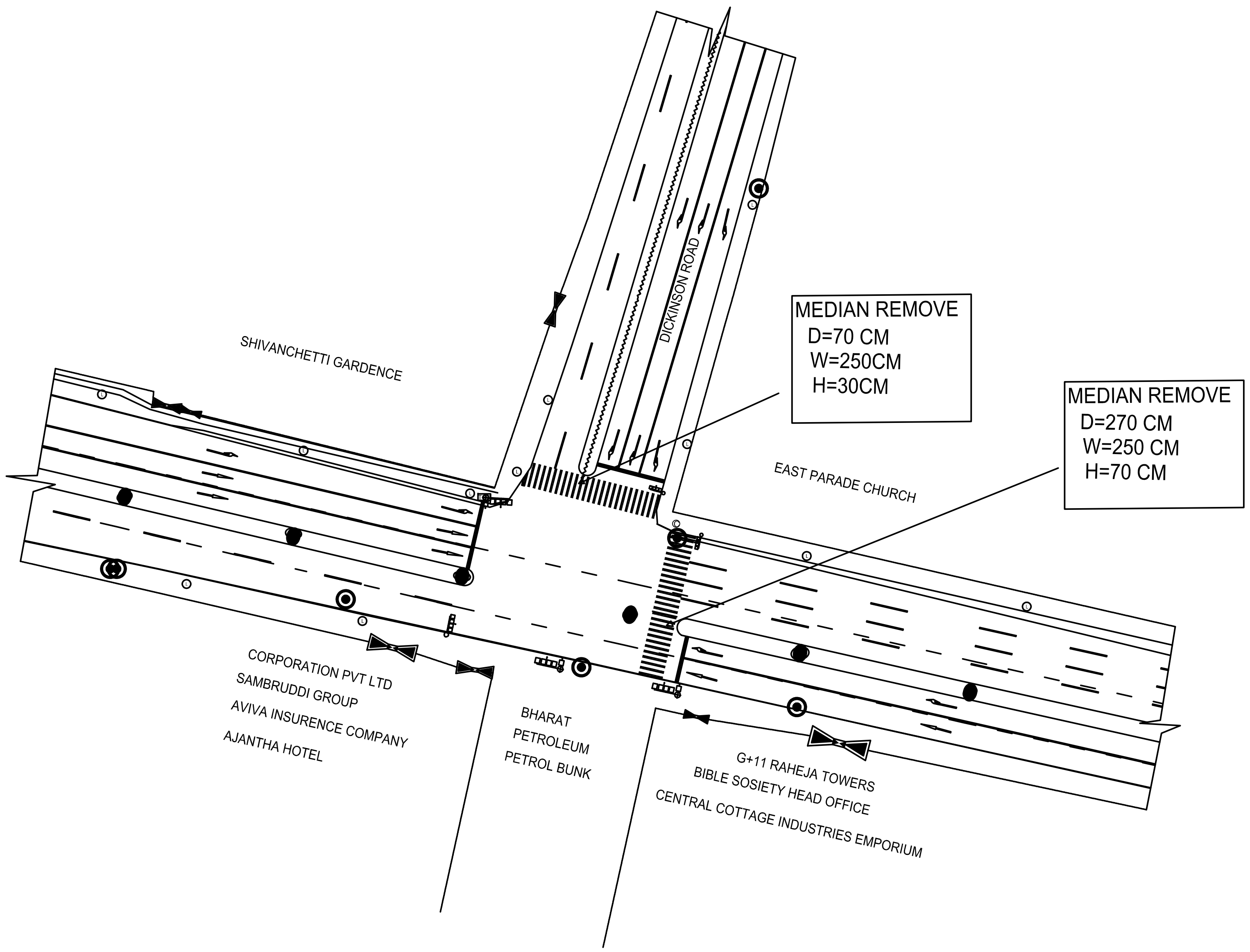
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 4	DRAW. NO.: TS-4	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

5 MG Road and Dickenson Rd Jn

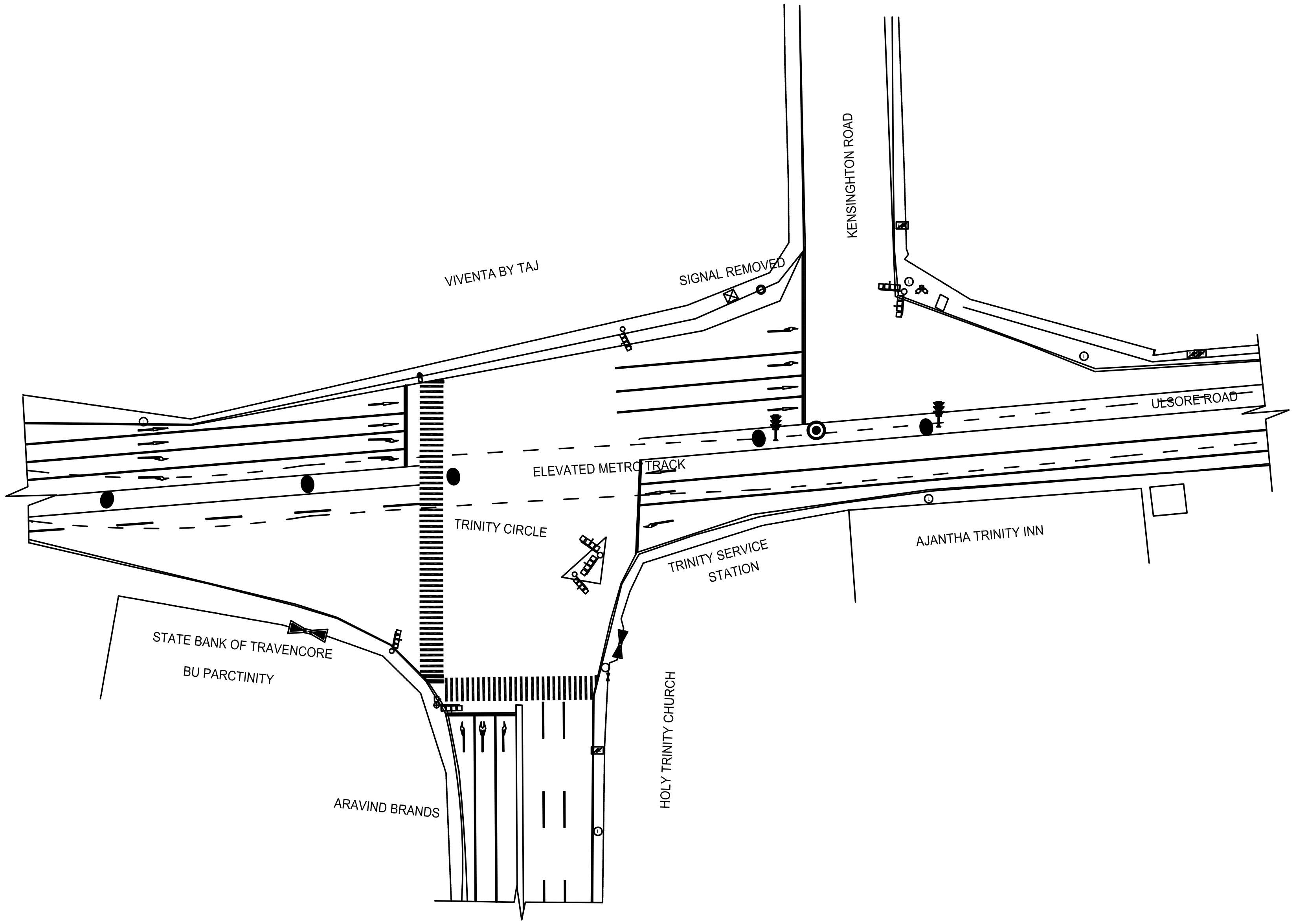


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 5	DRAW. NO.: TS-5	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

6 Trinity Circle



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DISCRPITION	SYMBOL
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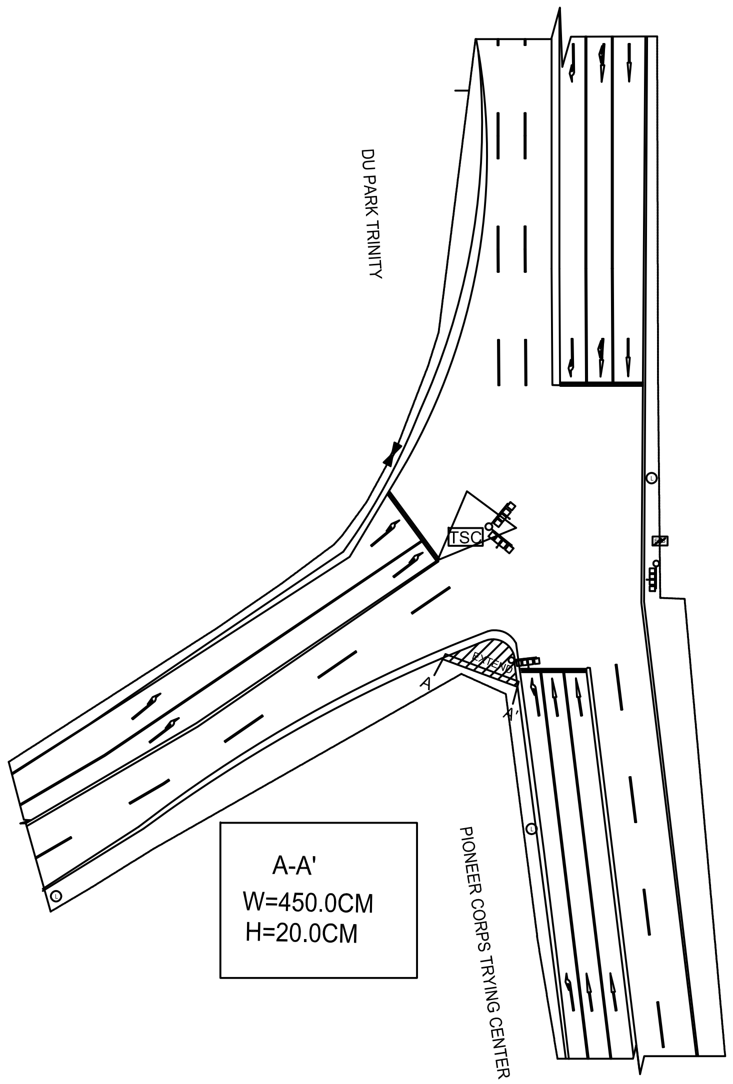
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 6	DRAW. NO. TS-6	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

7 Trinity Bus Stop



A-A'
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LEGENDS	
DISCRPITION	SYMBOL
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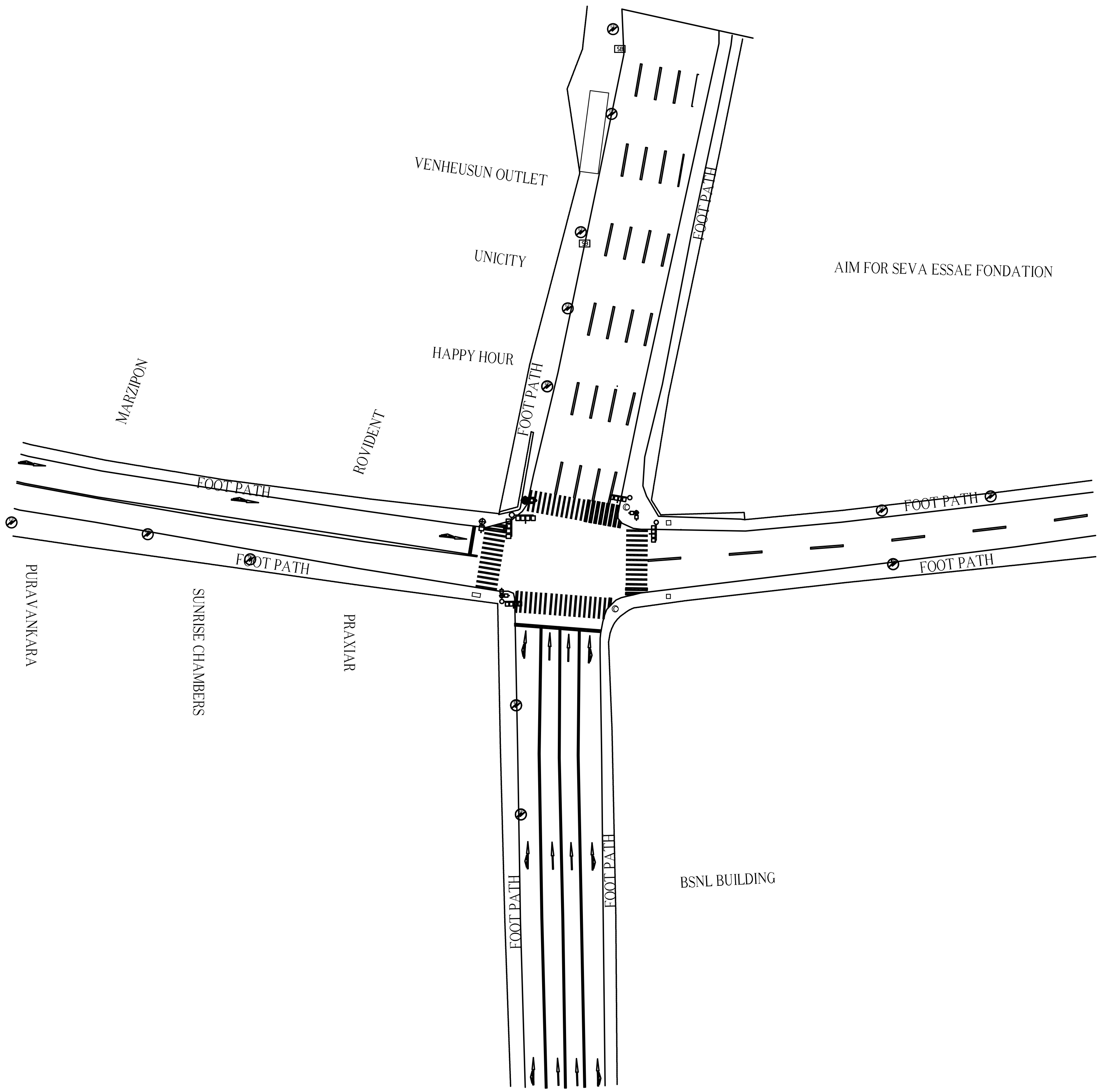
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 7	DRAW. NO. TS-7	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

8 Ulsoor Rd Kensington Rd Jn

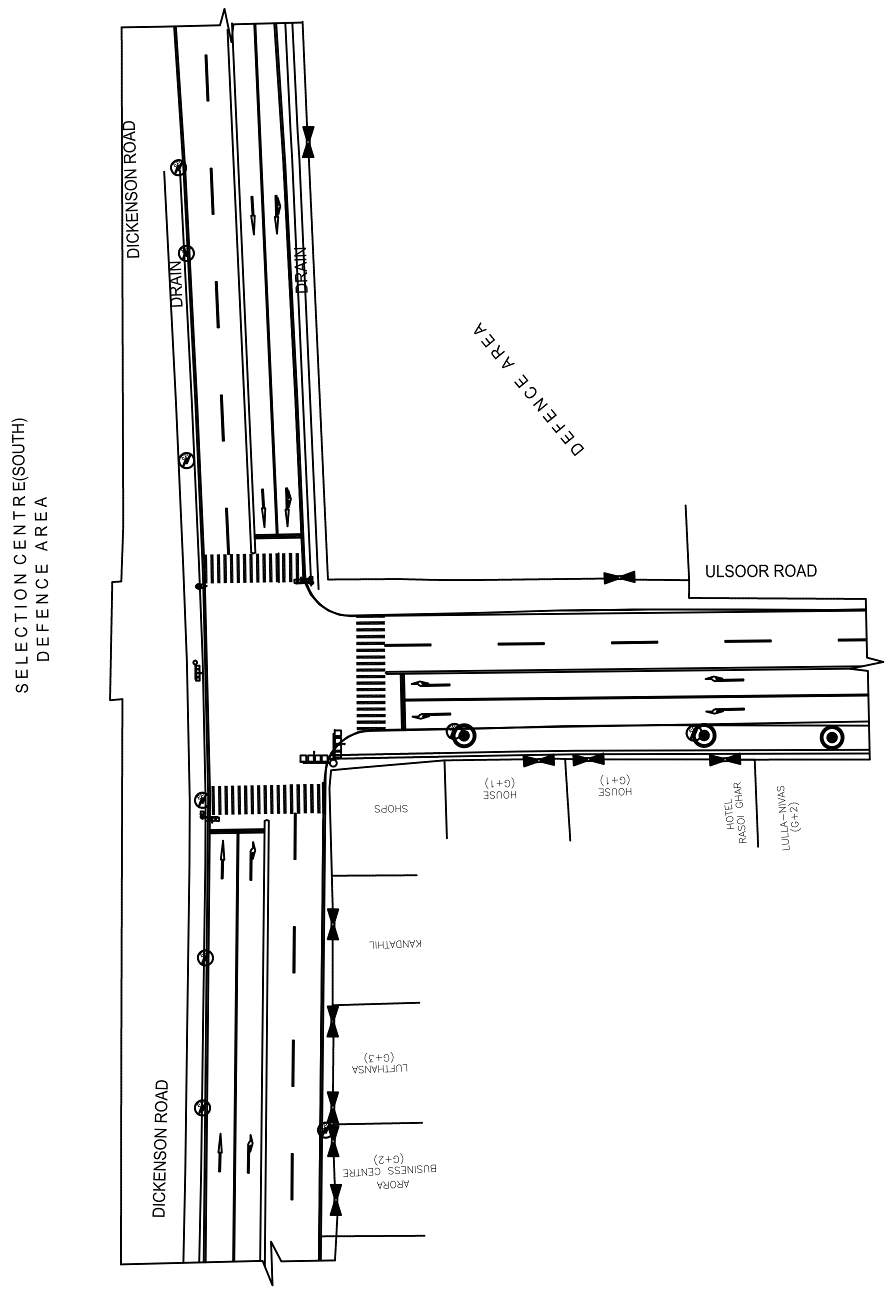


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD.
		DETAIL LOCATION OF TRAFFIC SIGNAL 8	TS-8	EAST NIPPON EXPRESSWAY CO.,LTD

9 Ulsoor Road Dickenson Rd Jn

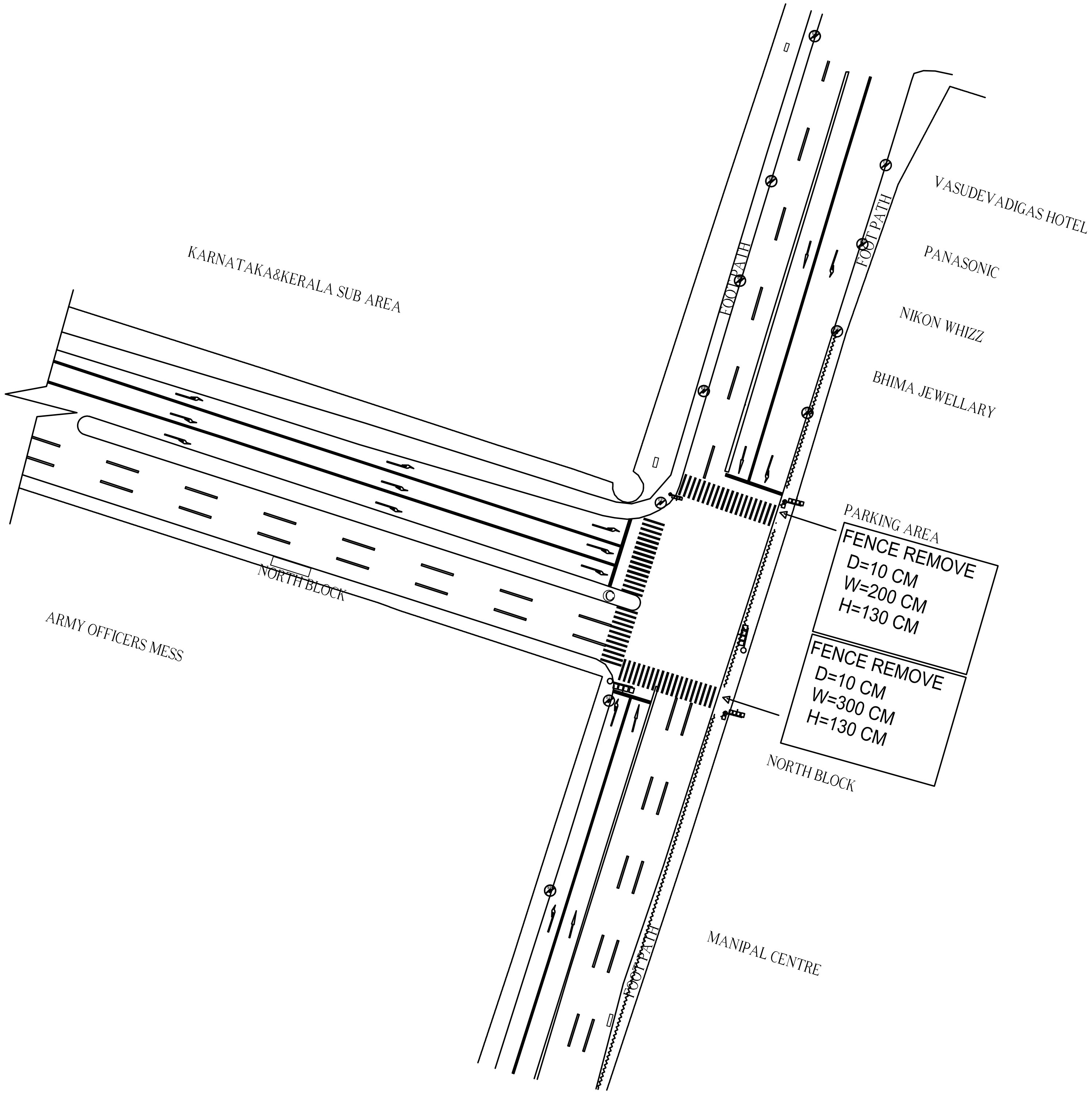


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 9	DRAW. NO.: TS-9	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

10 Cubbon Rd Dickenson Rd Jn

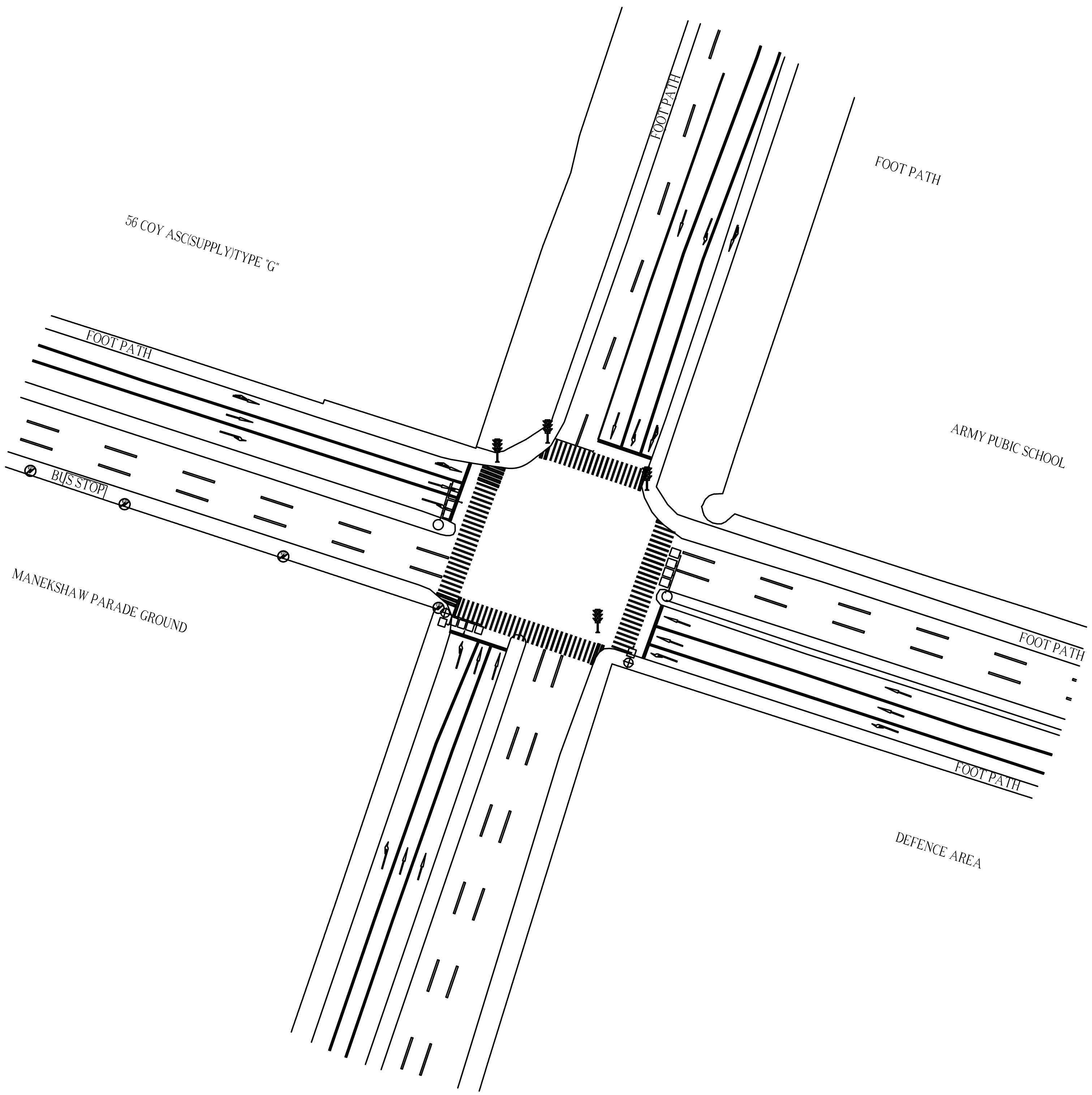


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 10	DRAW. NO. TS-10	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

11 Cubbon Rd Kamaraj Rd Jn

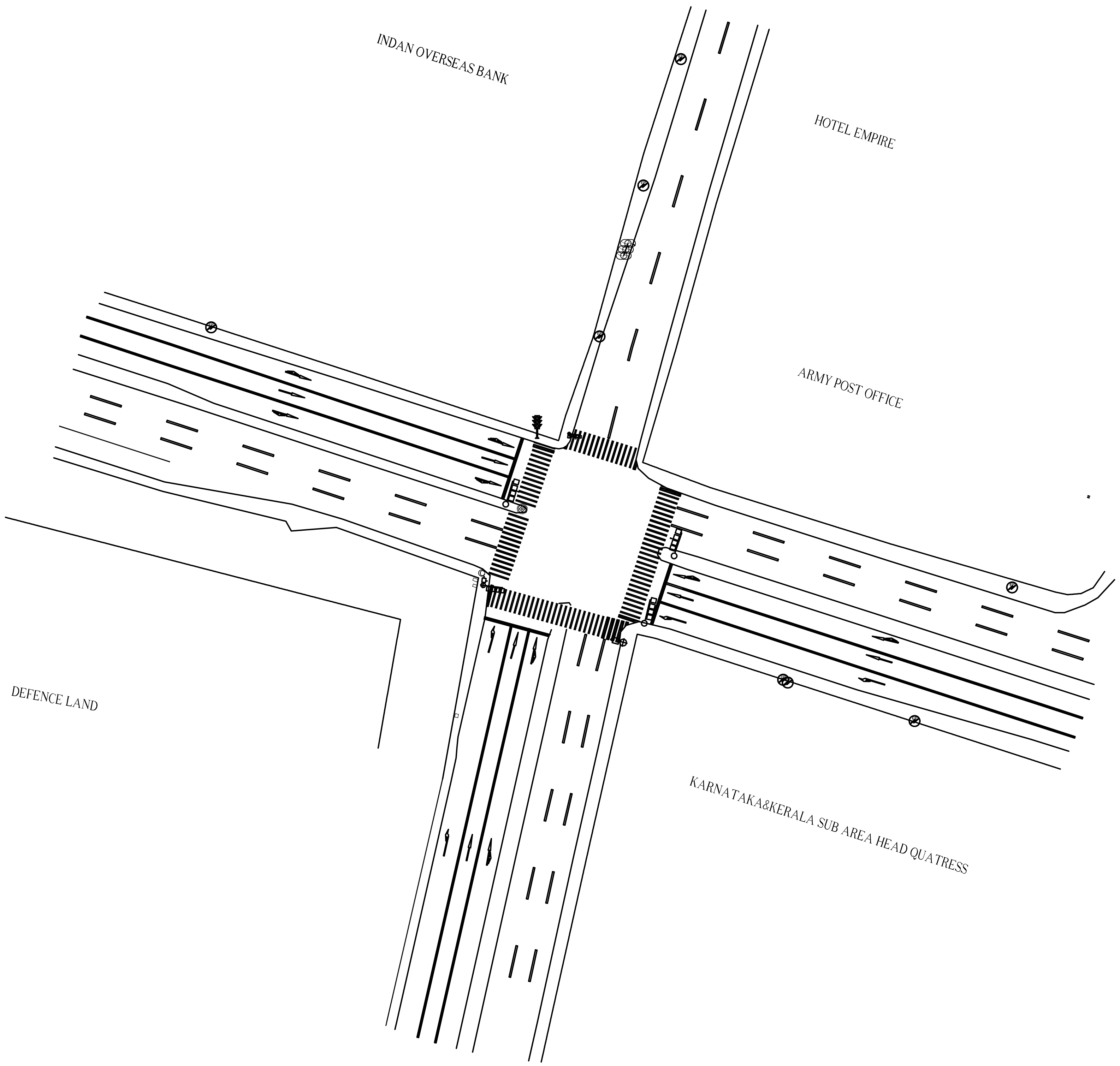


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

		DRAWING TITLE	DRAW. NO.	
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DETAIL LOCATION OF TRAFFIC SIGNAL 11	TS-11	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

12Cubbon Rd St Marks Rd Jn

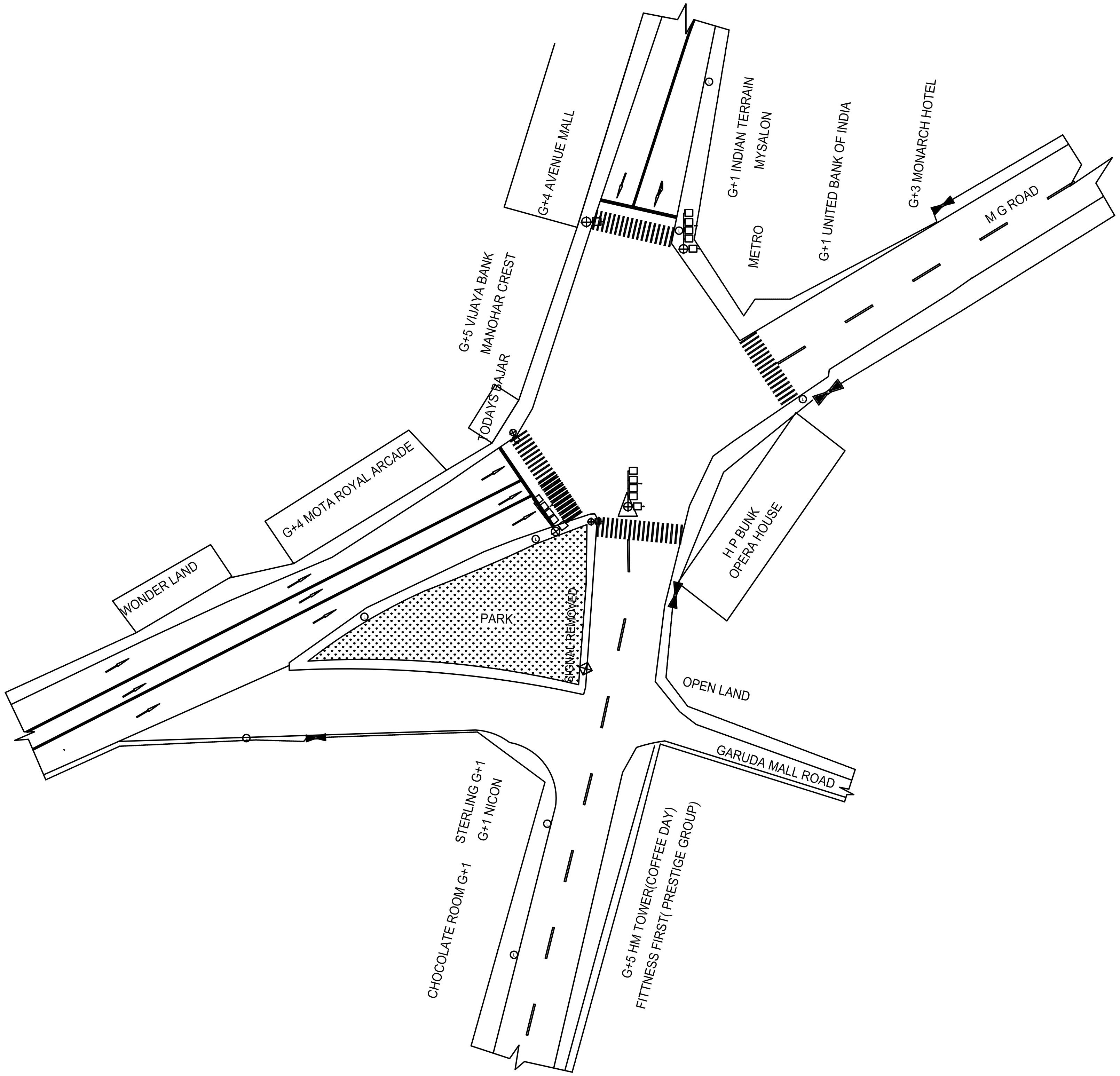


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 12	TS-12	

13 Recidency Rd Brigade Rd Jn

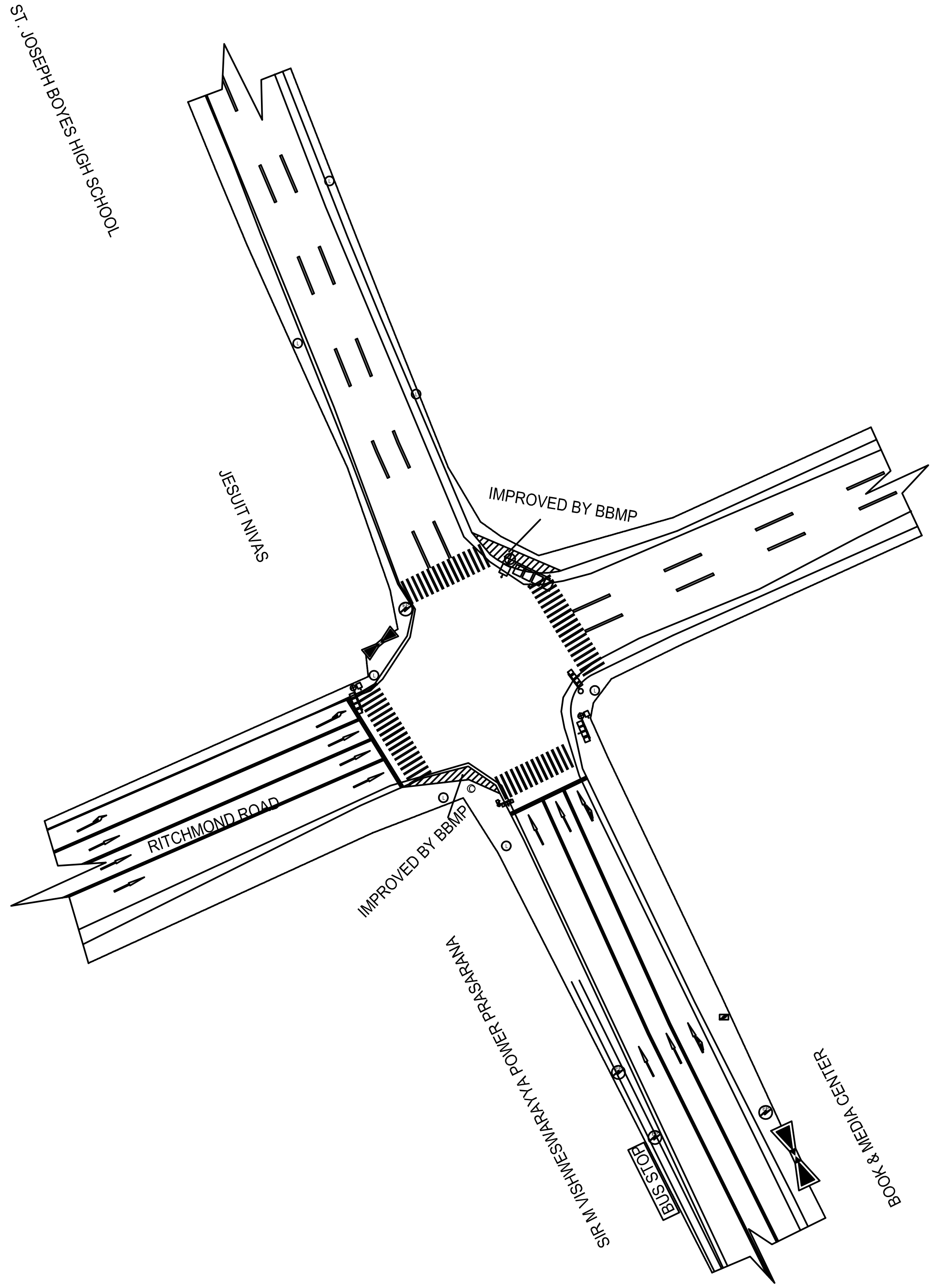


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 13	DRAW. NO. TS-13	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

14 Residency Rd Museum Rd Jn

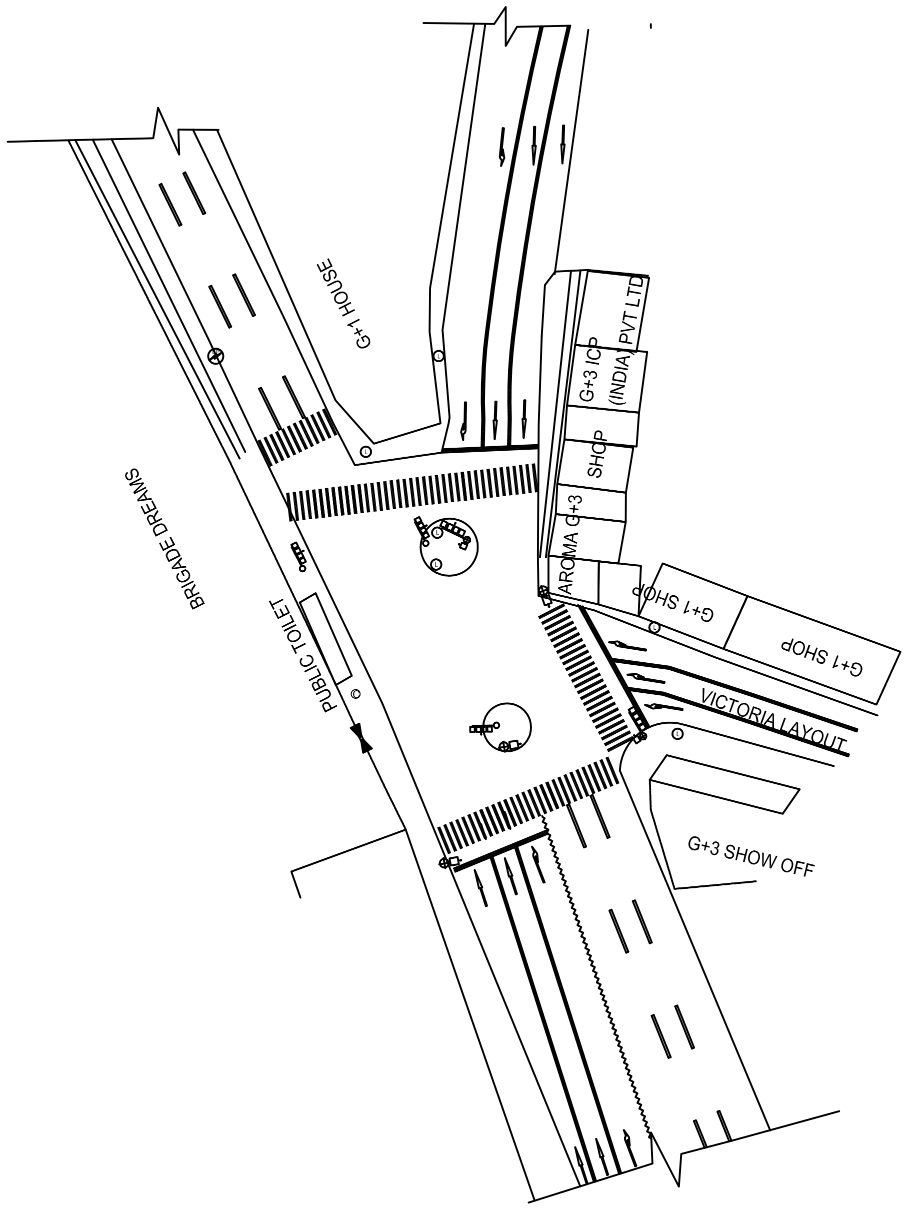


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 14	DRAW. NO.: TS-14	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

15 Museum Rd Castle Rd Jn

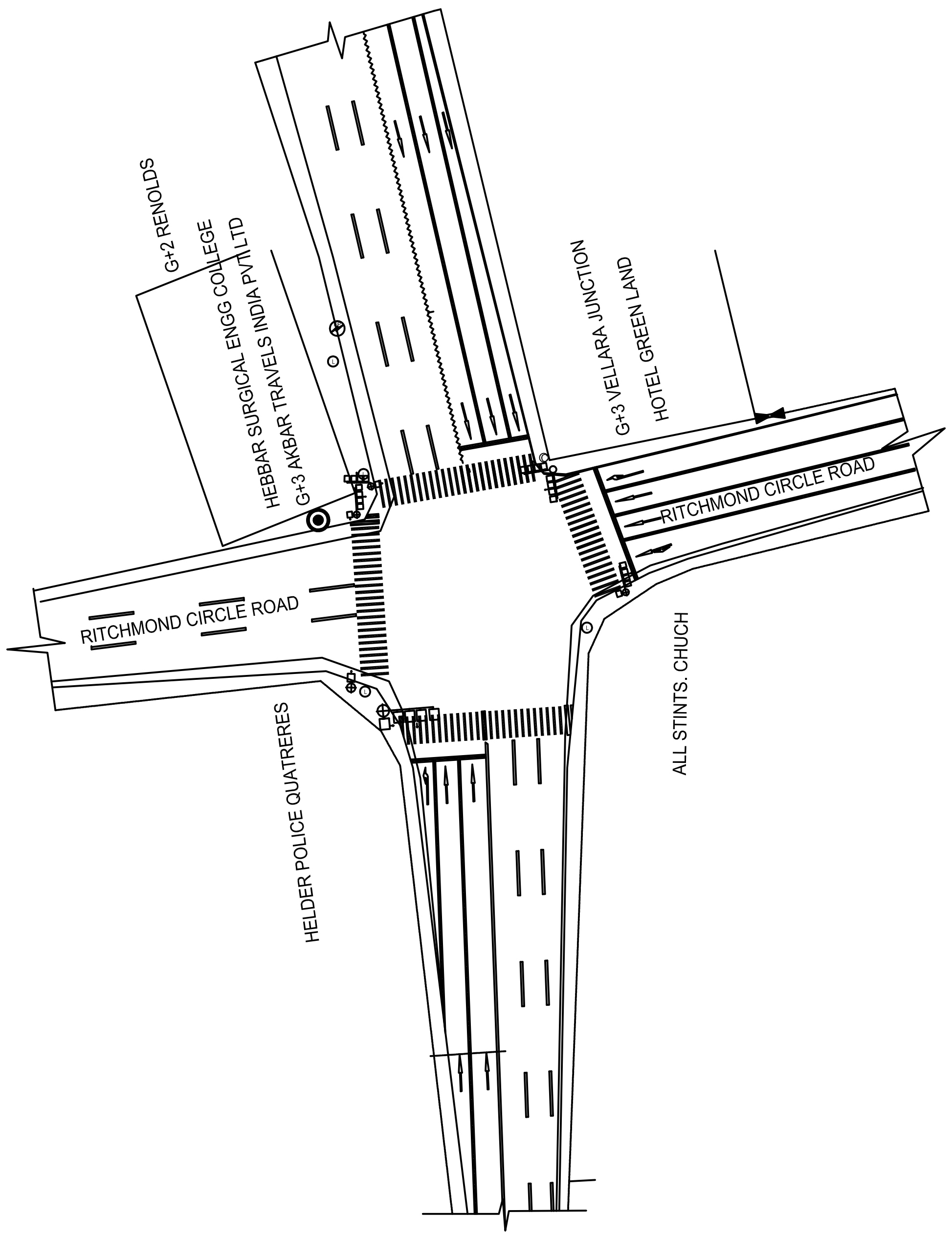


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 15	DRAW. NO. TS-15	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

16 General KS Thimaya Rd Hosur Rd Jn

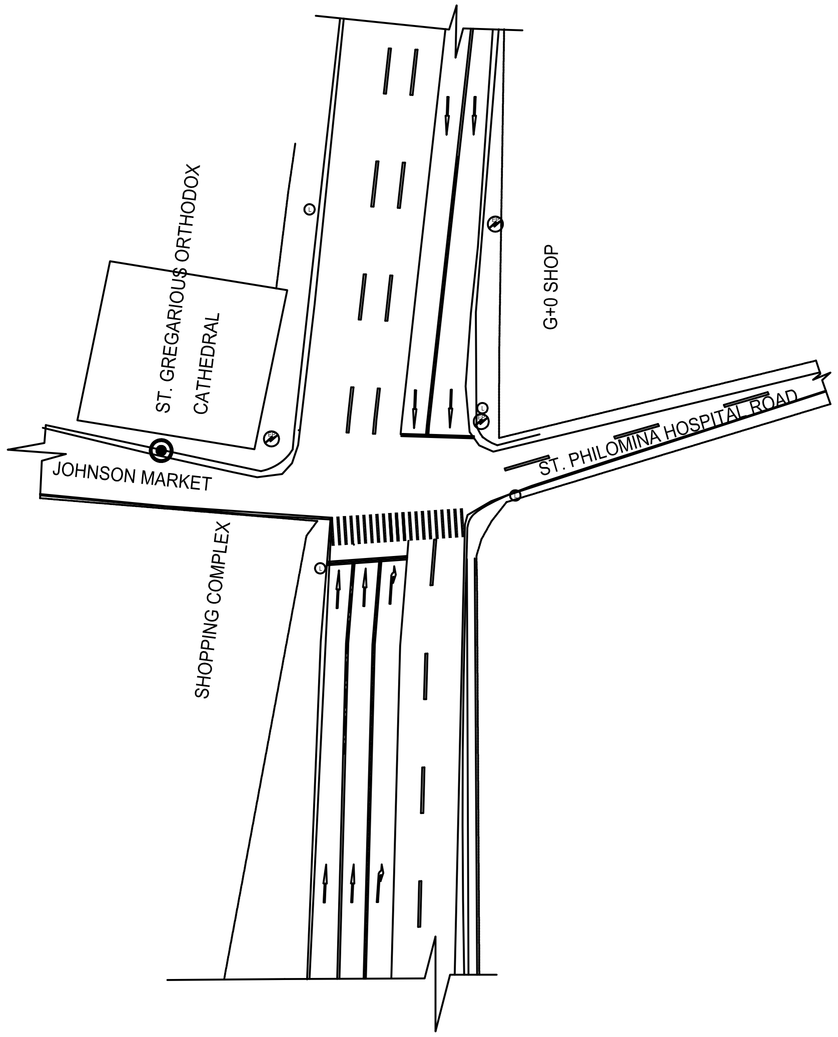


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 16	DRAW. NO. TS-16	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

17 Campbell Rd Hosur Rd Jn

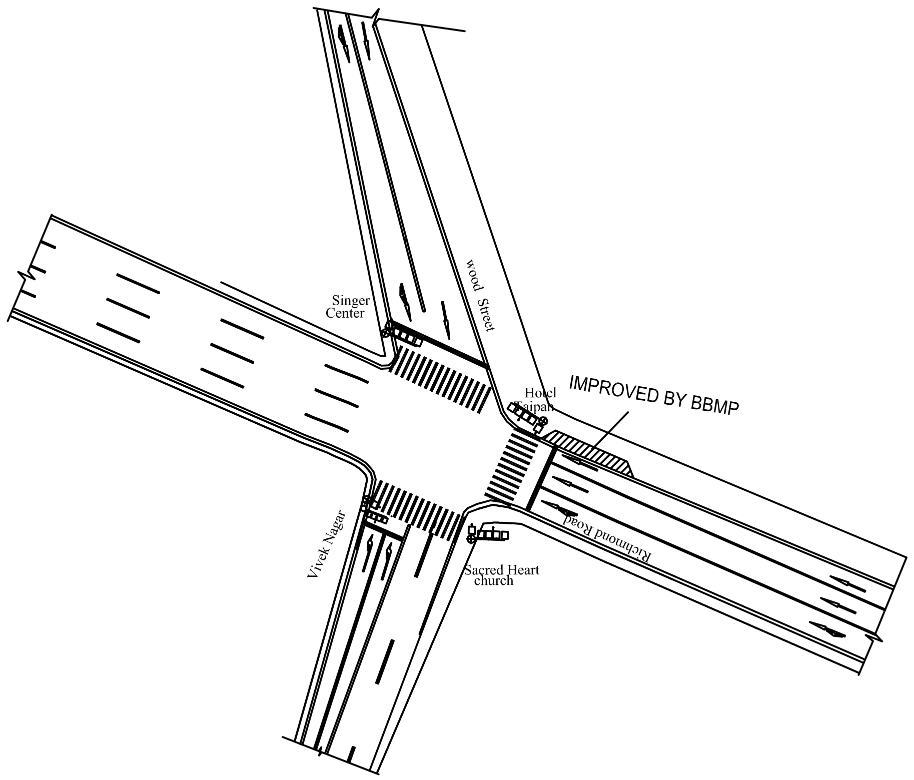


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 17	DRAW. NO. TS-17	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

18 General K S Thimayya Rd Mother Teresa Rd Jn

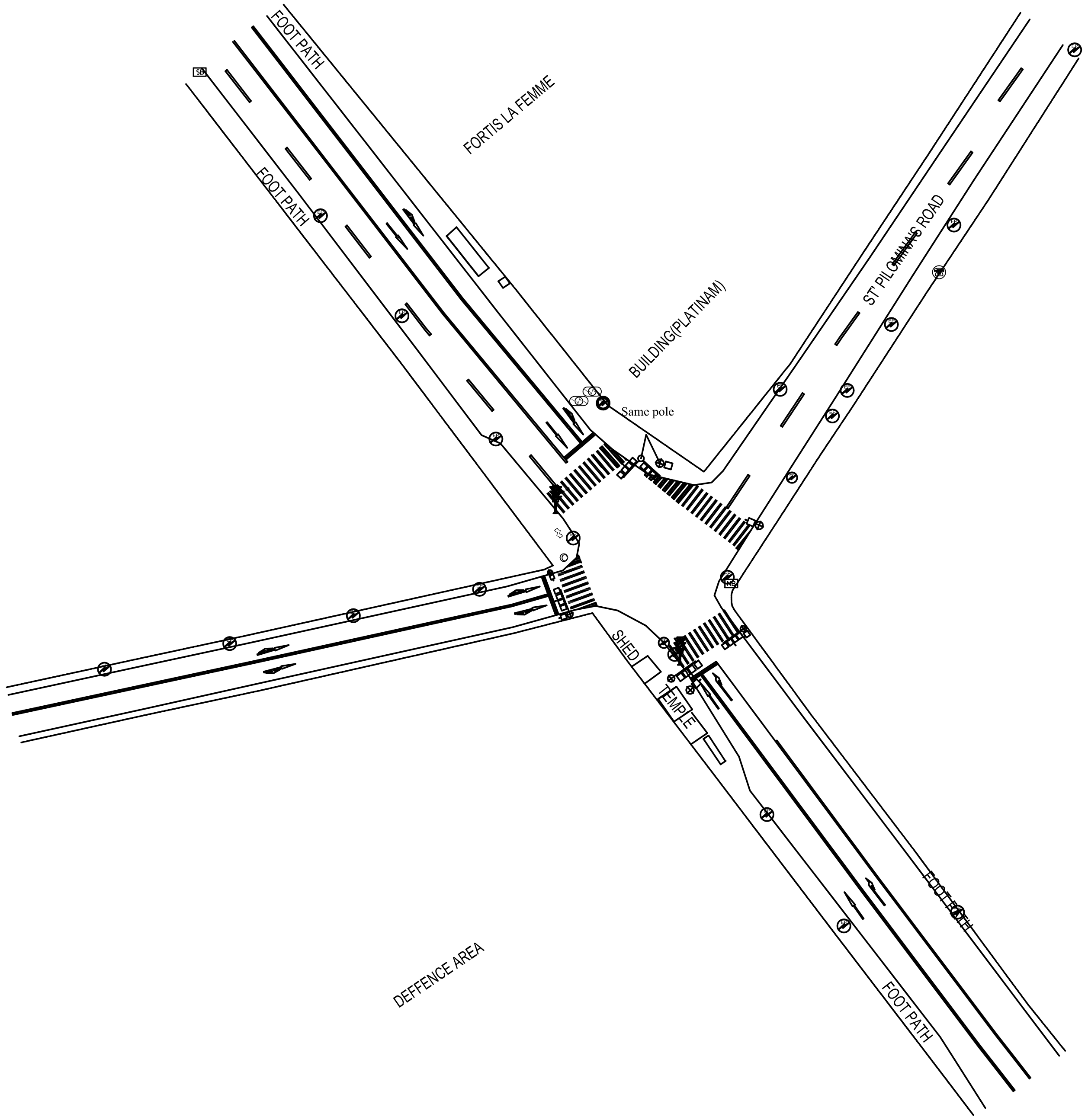


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 18	DRAW. NO. TS-18	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

19 St Philomena Rd Mother Teresa Rd Jn

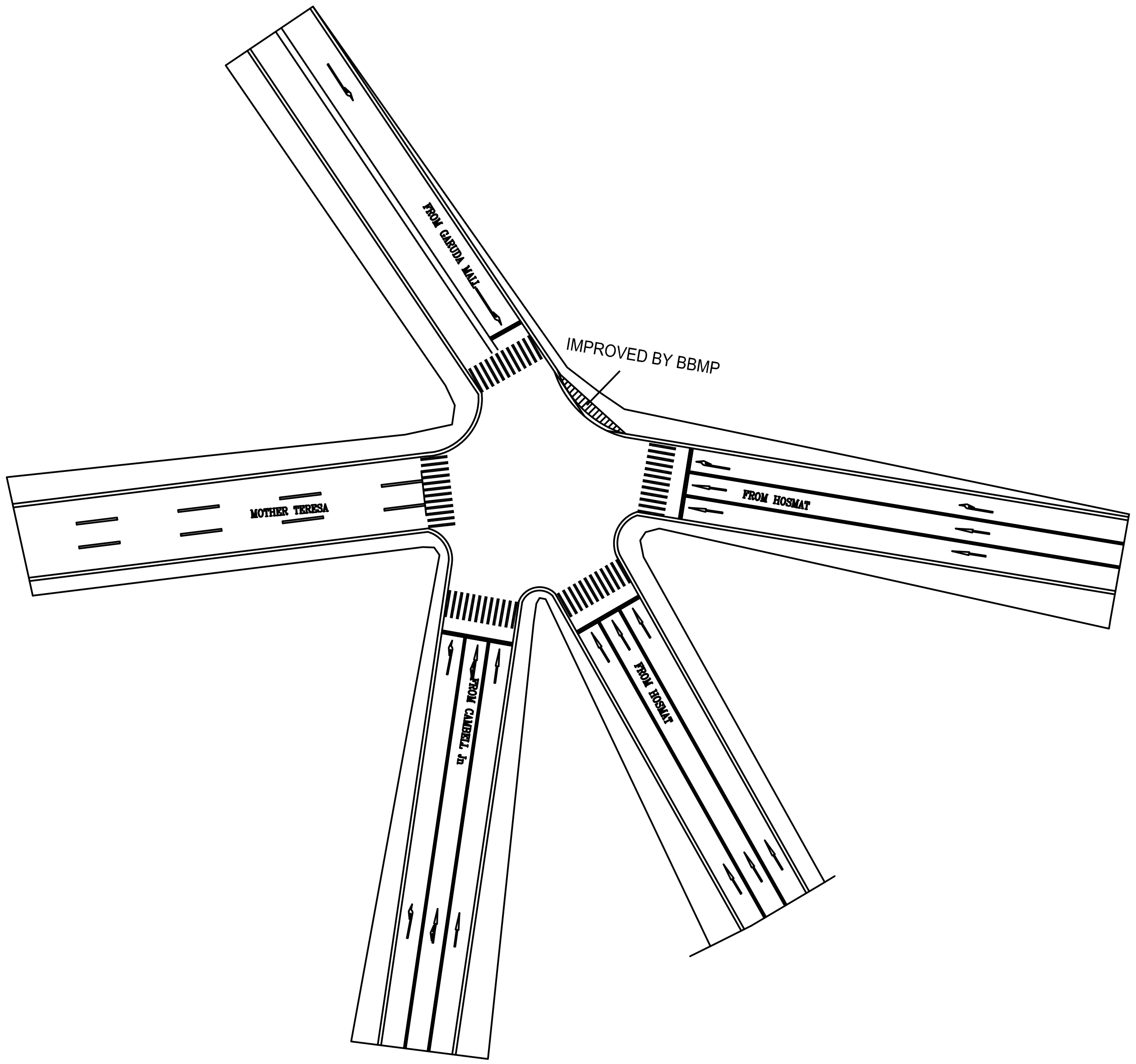


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 19	DRAW. NO. TS-19	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

20 Victoria Rd General K S Thimayya Rd

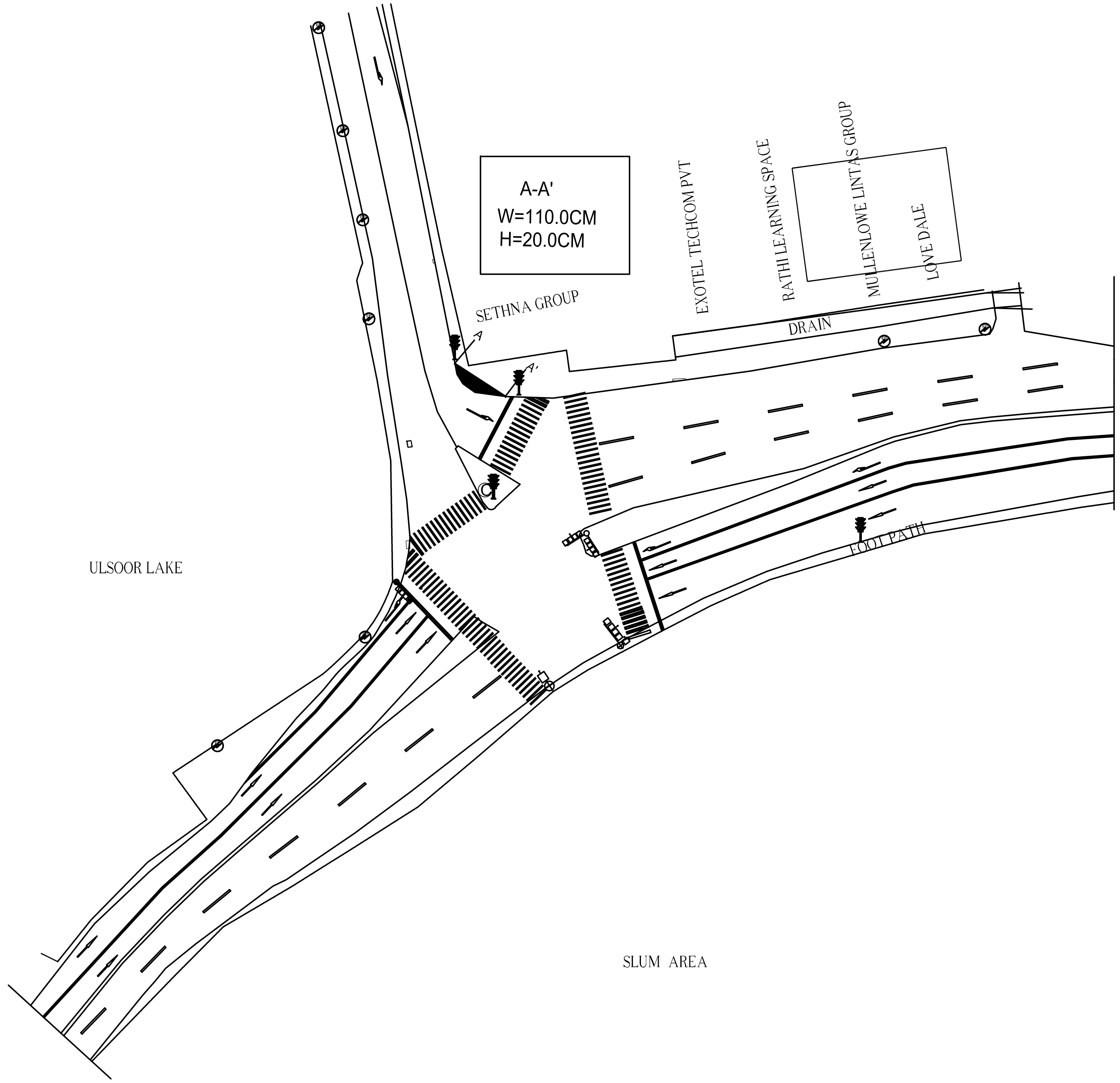


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 20	TS-20	

21 Kensigton &Oval Junction

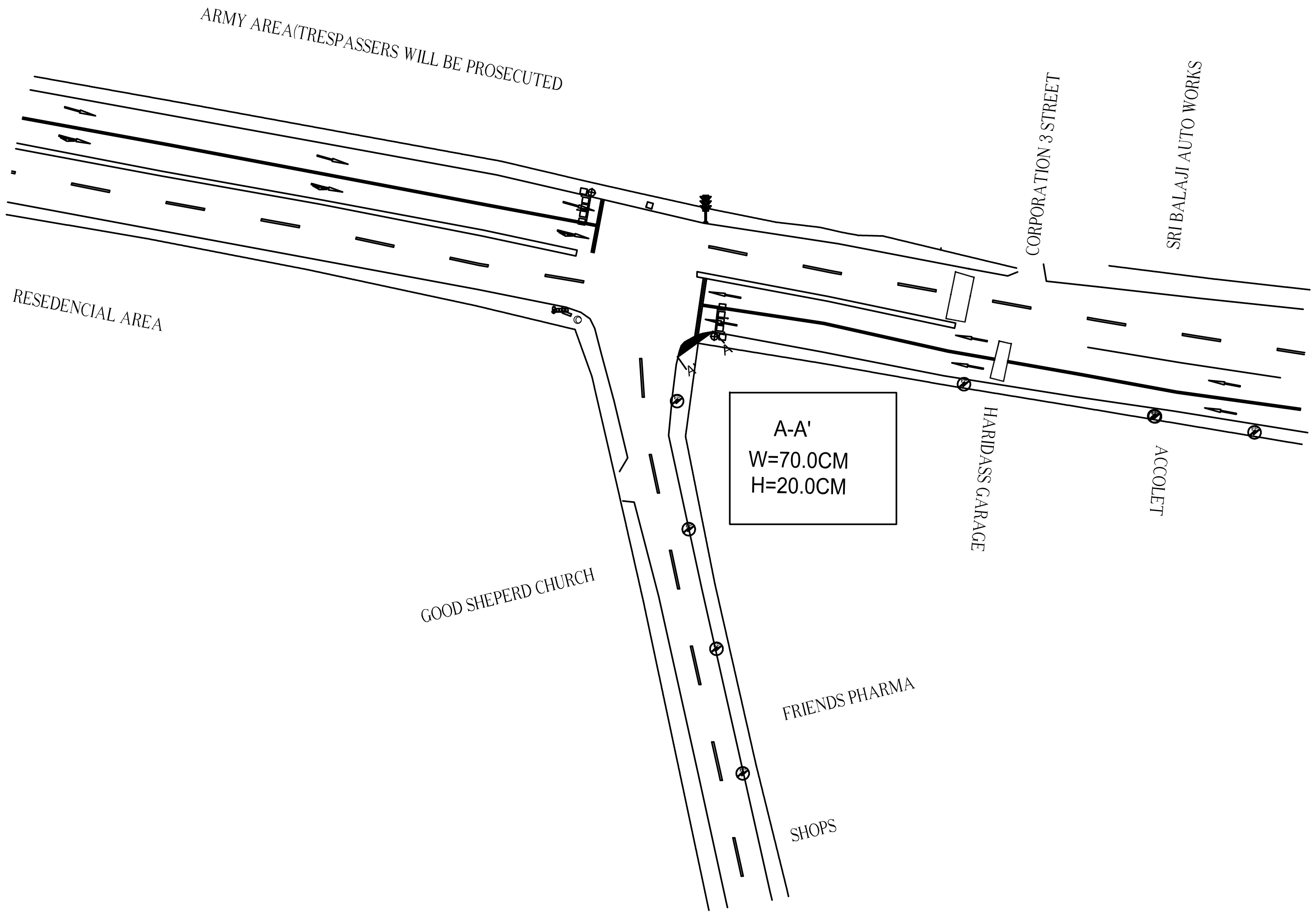


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 21	DRAW. NO. TS-21	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

22 Murphy Rd Corp colony Rd Jn

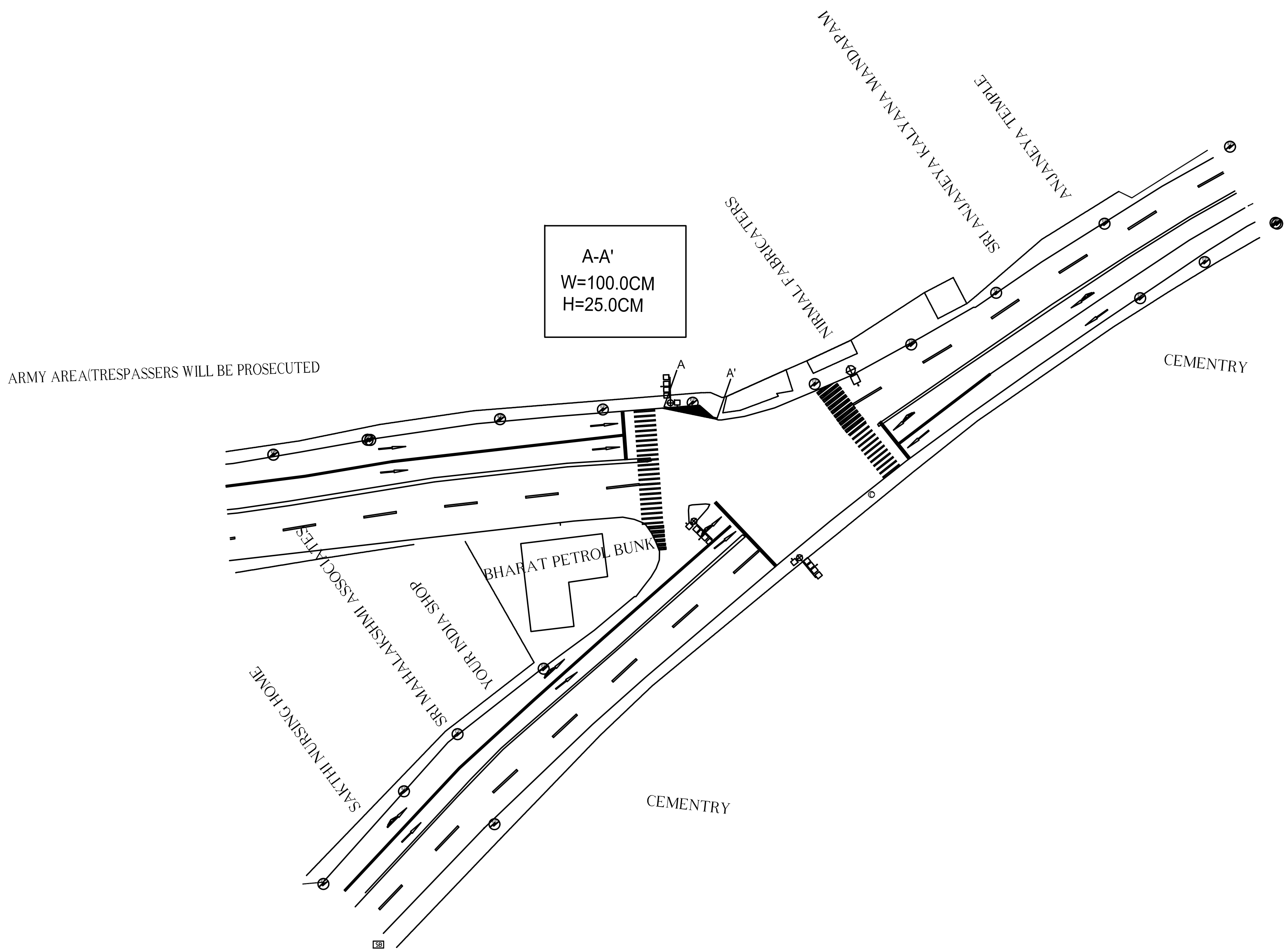


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 22	DRAW. NO. TS-22	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

23 Murphy Rd and Swami Vivekananda Rd Jn

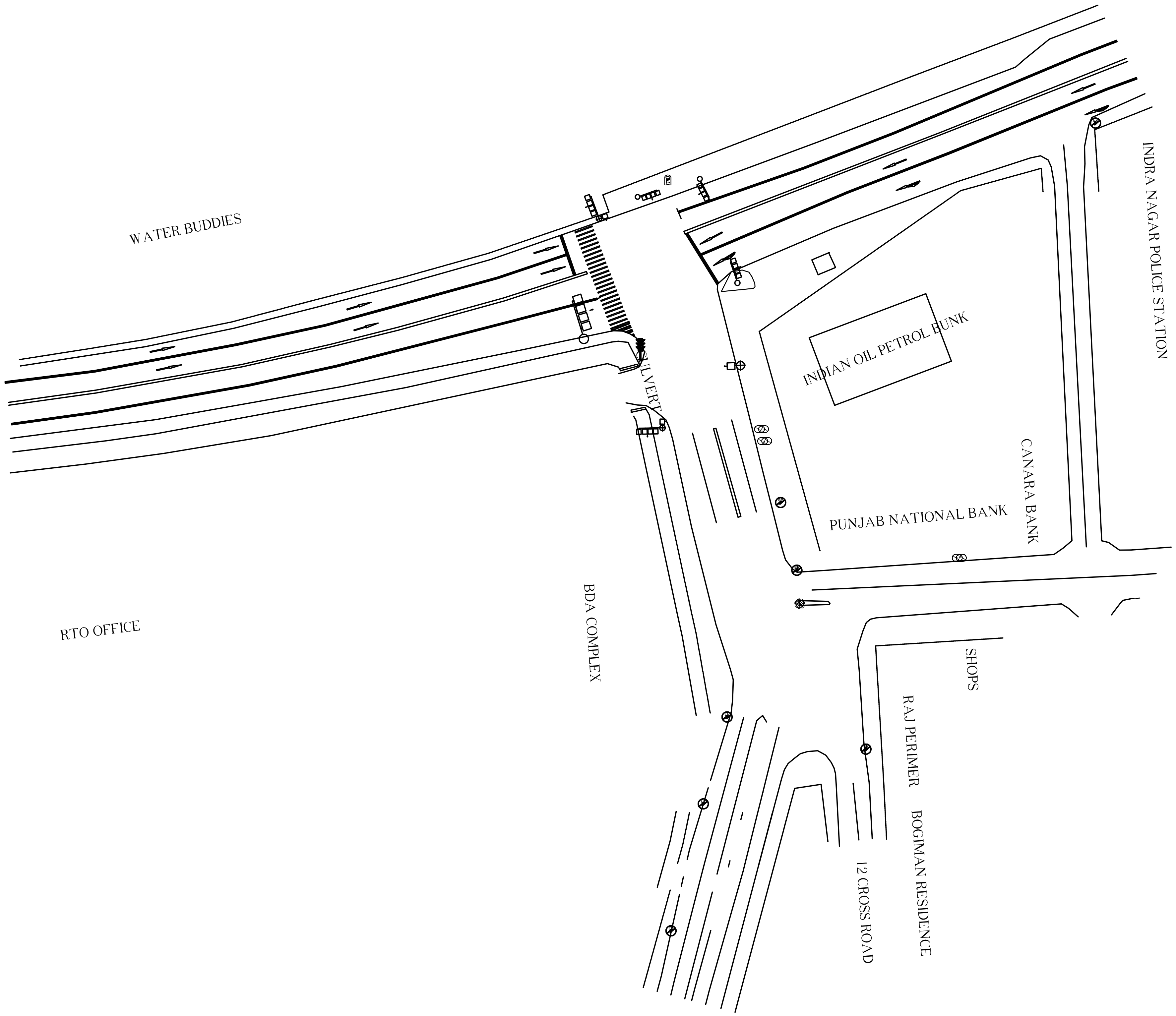


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 23	DRAW. NO. TS-23	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

24 Swami Vivekananda Rd and Indiranagar Double Rd Jn

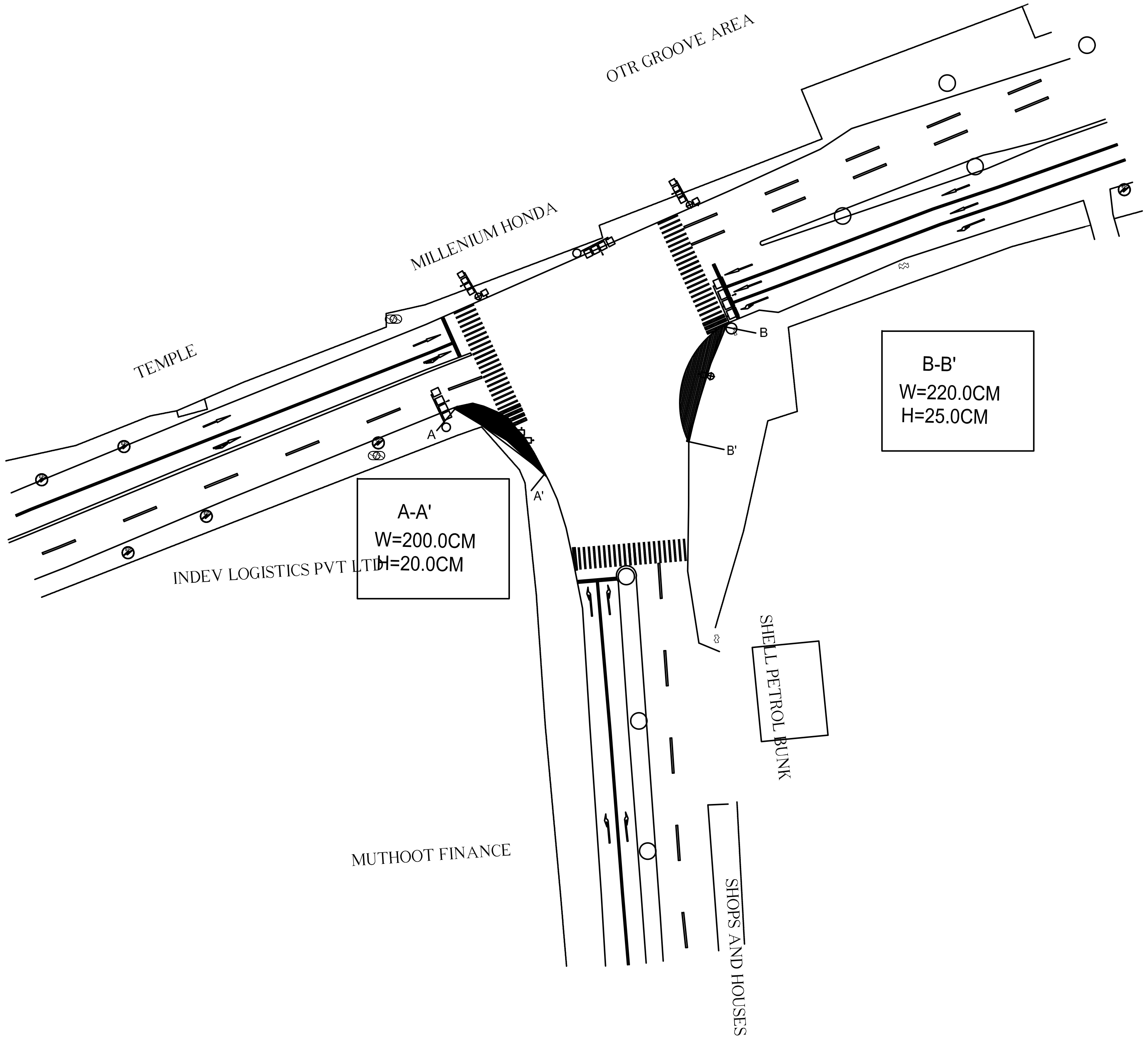


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 24	DRAW. NO. TS-24	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

25 Swami Vivekananda Rd and Indiranagar 100 ft Rd Jn

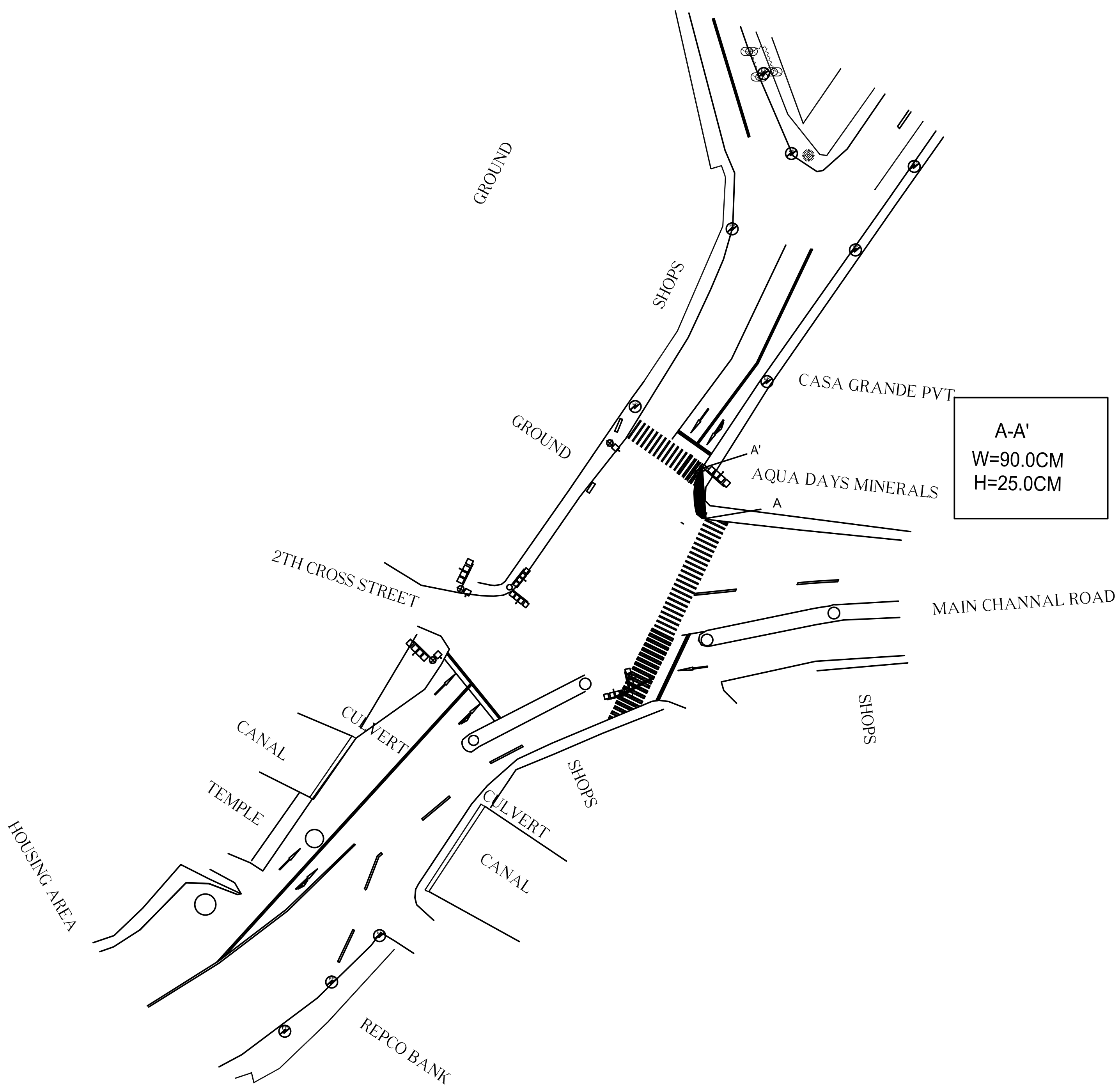


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

		DRAWING TITLE	DRAW. NO.	
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DETAIL LOCATION OF TRAFFIC SIGNAL 25	TS-25	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

26 A Nanjappa Circle

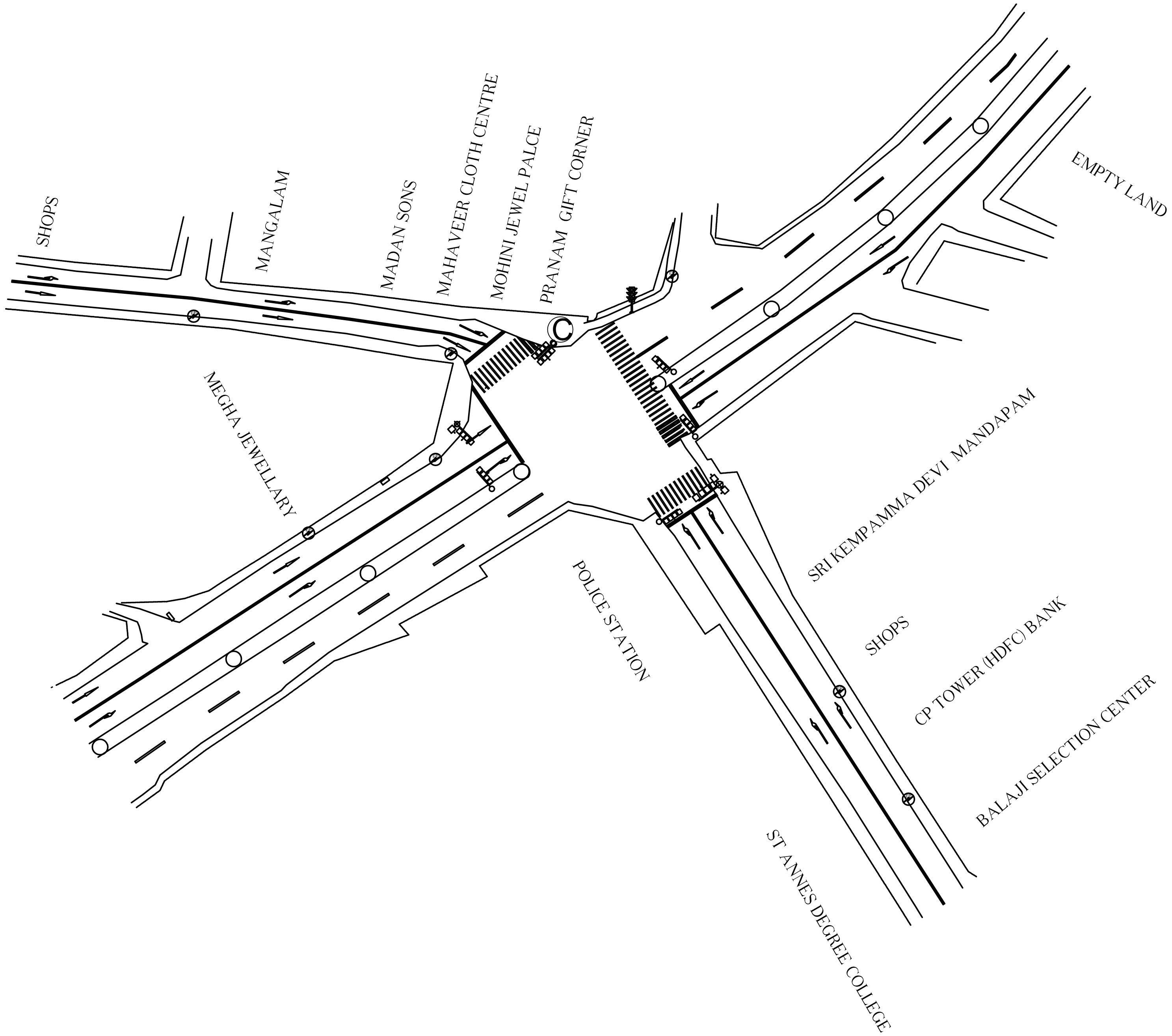


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 26	DRAW. NO. TS-26	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

27 Swami vivekanand Rd -Cambridge Rd-Bazaar st

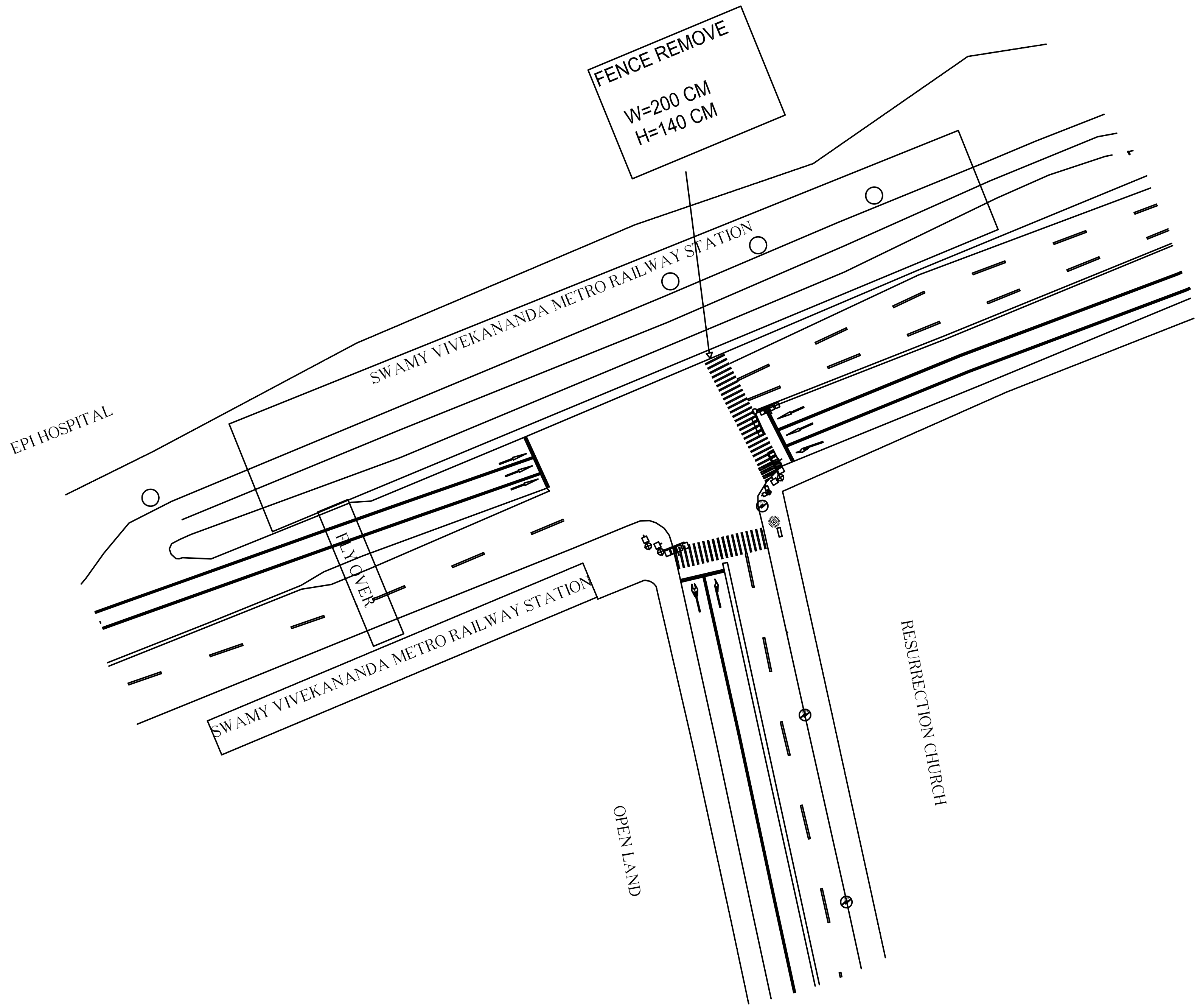


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 27	DRAW. NO. TS-27	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

28 Swami vivekanand Station

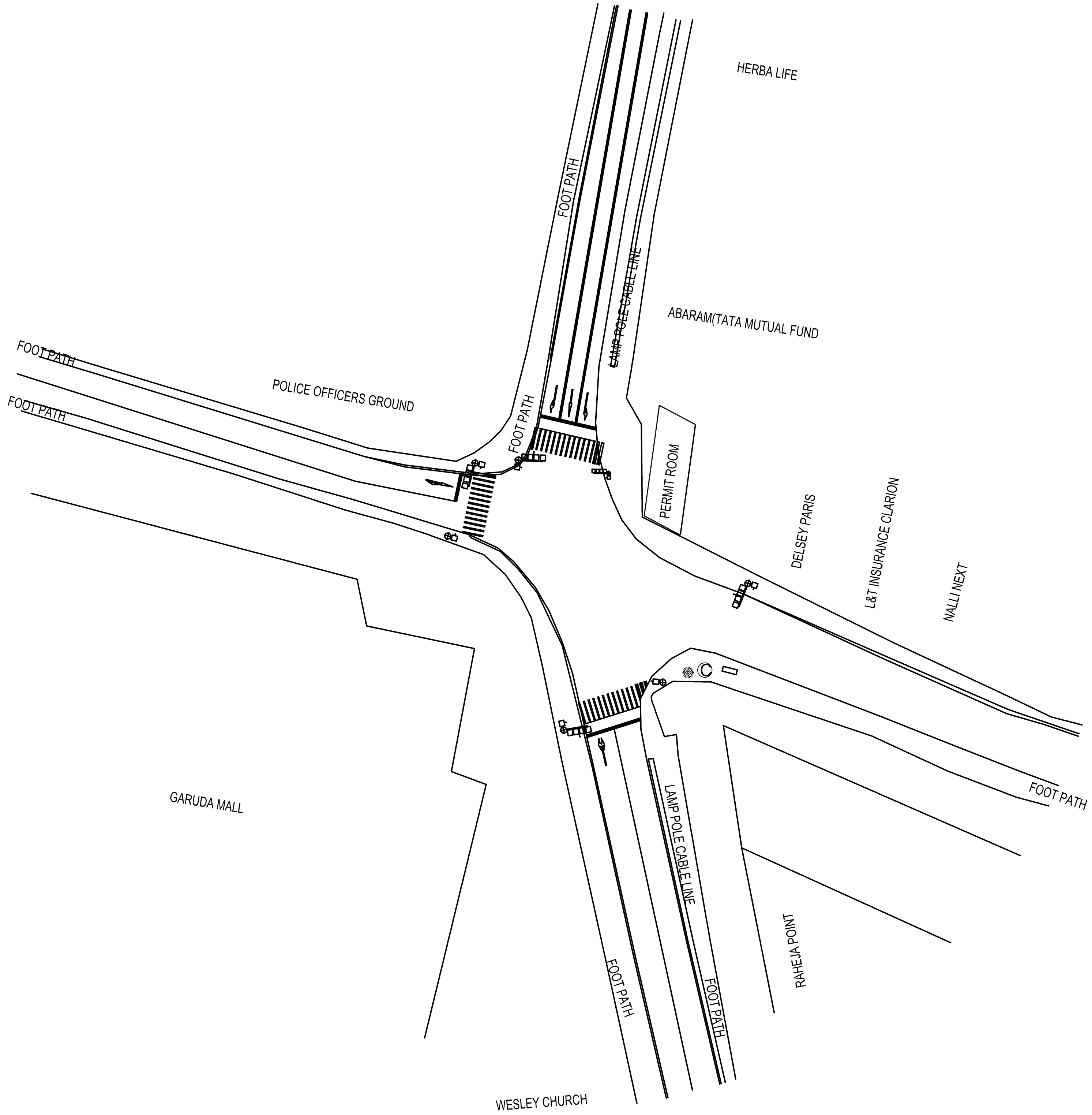


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 28	DRAW. NO. TS-28	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

29 Garuda Mall Jn

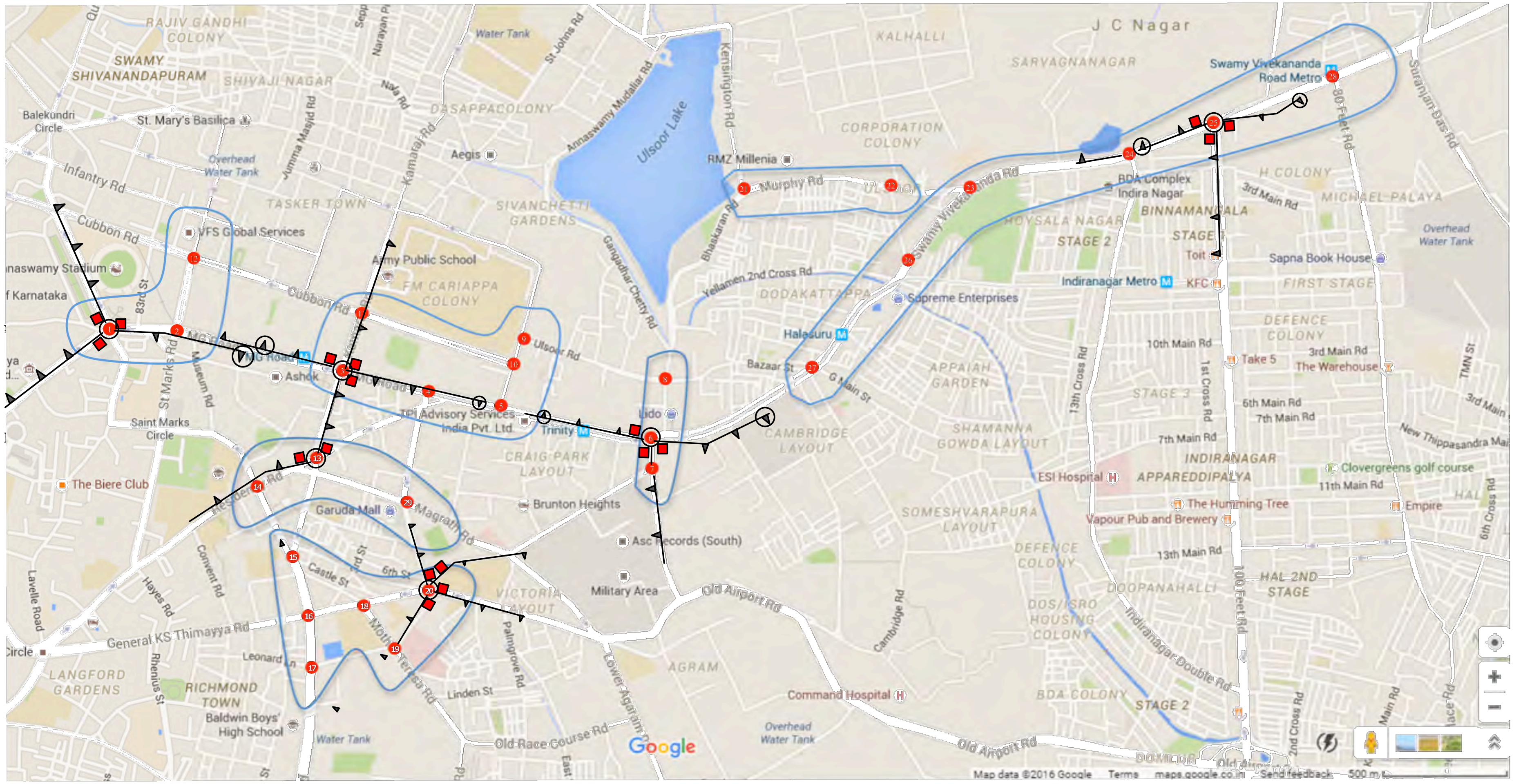


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE DETAIL LOCATION OF TRAFFIC SIGNAL 29	DRAW. NO. TS-29	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

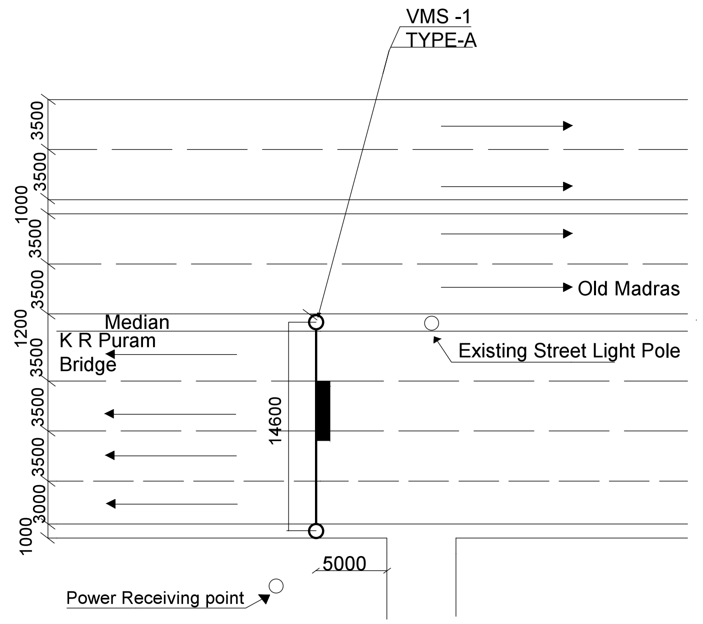
SUB AREA AND VEHICLE DETECTOR LAYOUT



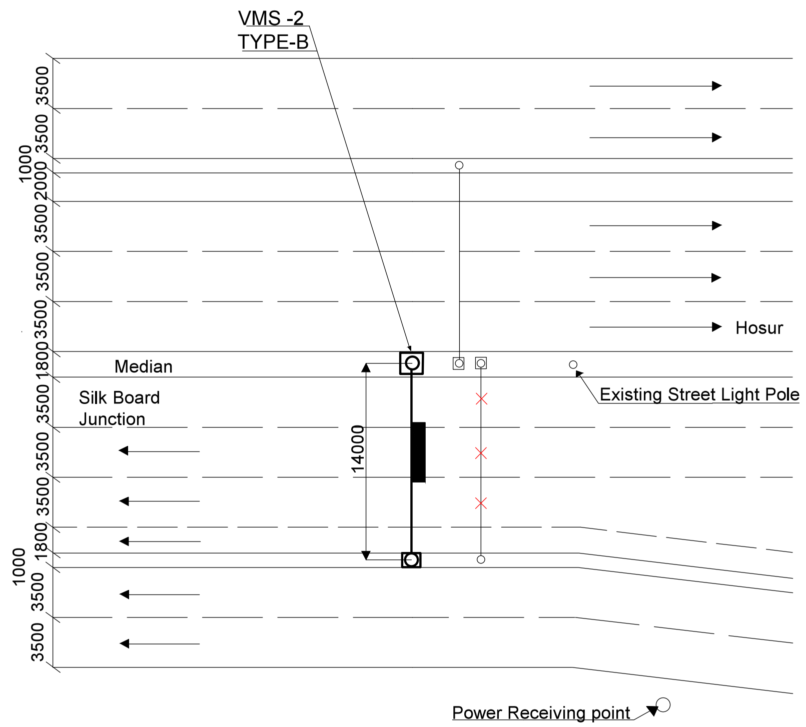
500 m

LEGENDS

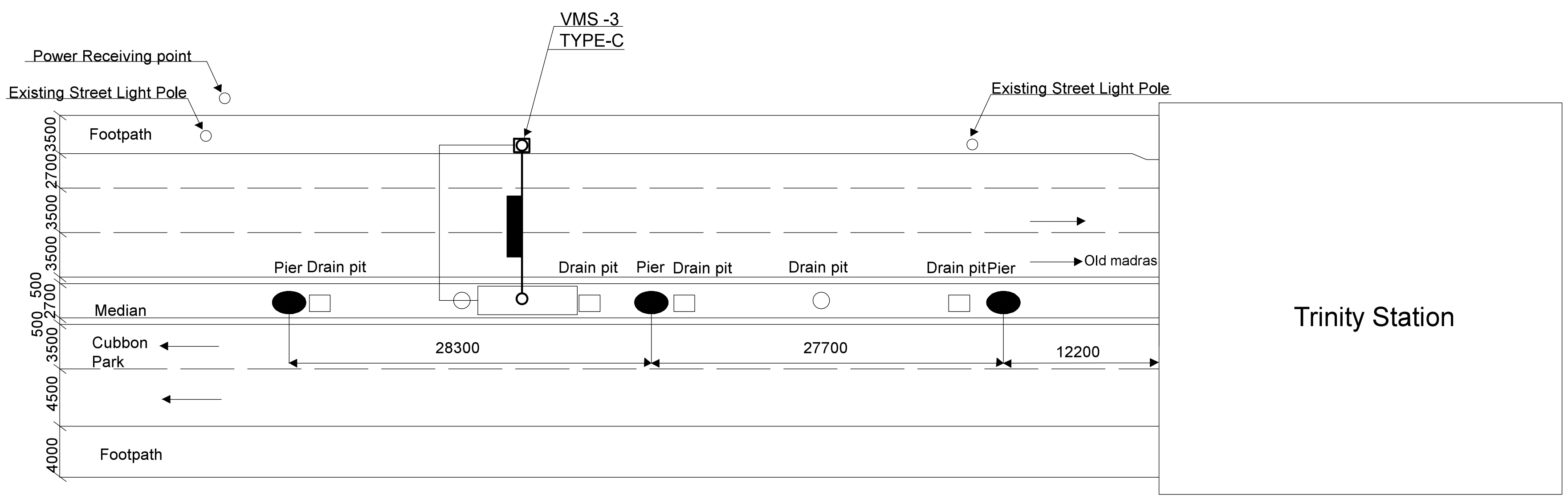
	SUB AREA		VEHICLE DETECTOR (QUEUE LENGTH MEASUREMENT
			VEHICLE DETECTOR (INFLOW TRAFFIC VOLUME MEASUREMENT)
	KEY INTERSECTION		VEHICLE DETECTOR (TRAFFIC VOLUME MEASURE FOR OFFSET)



VMS -1

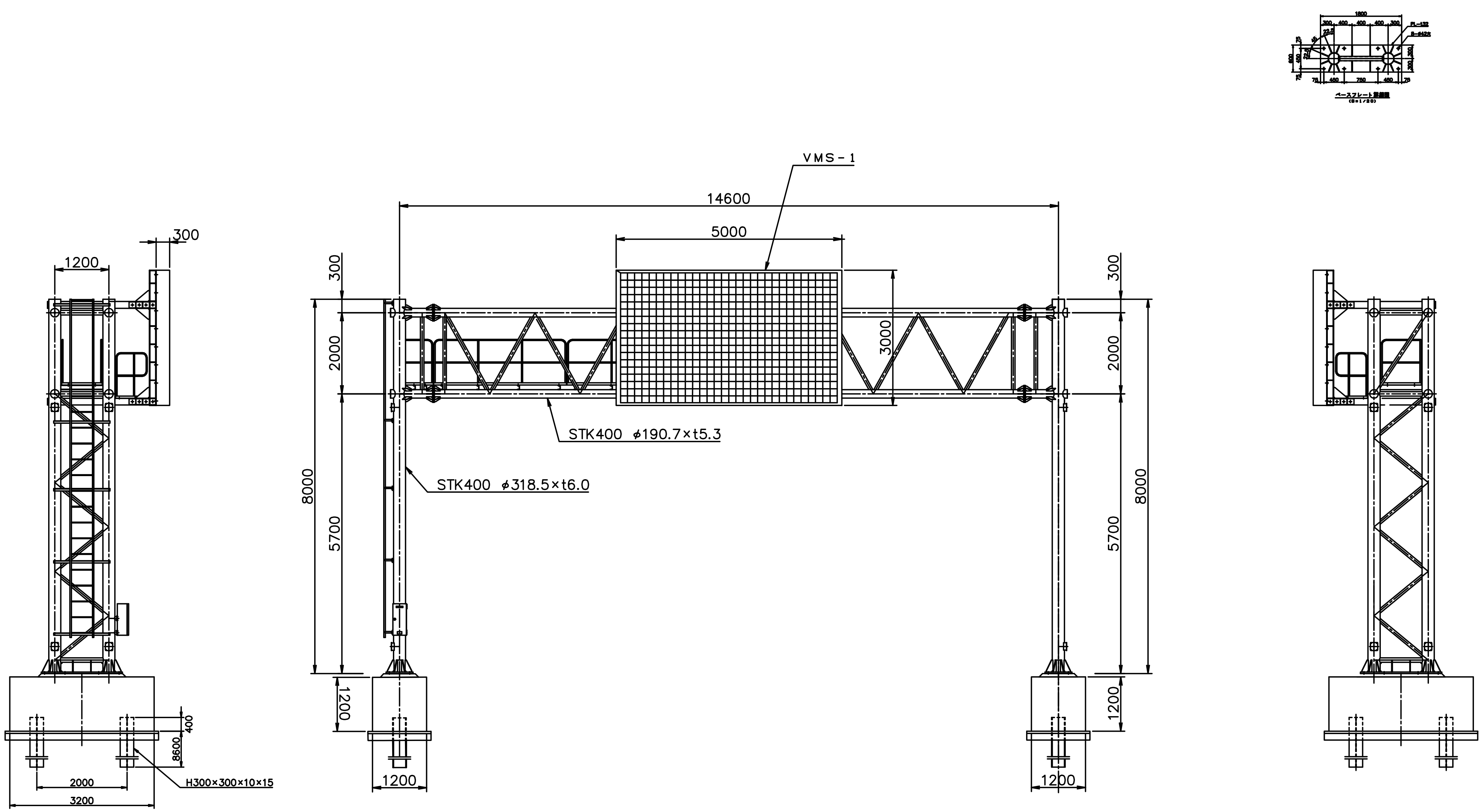


VMS -2

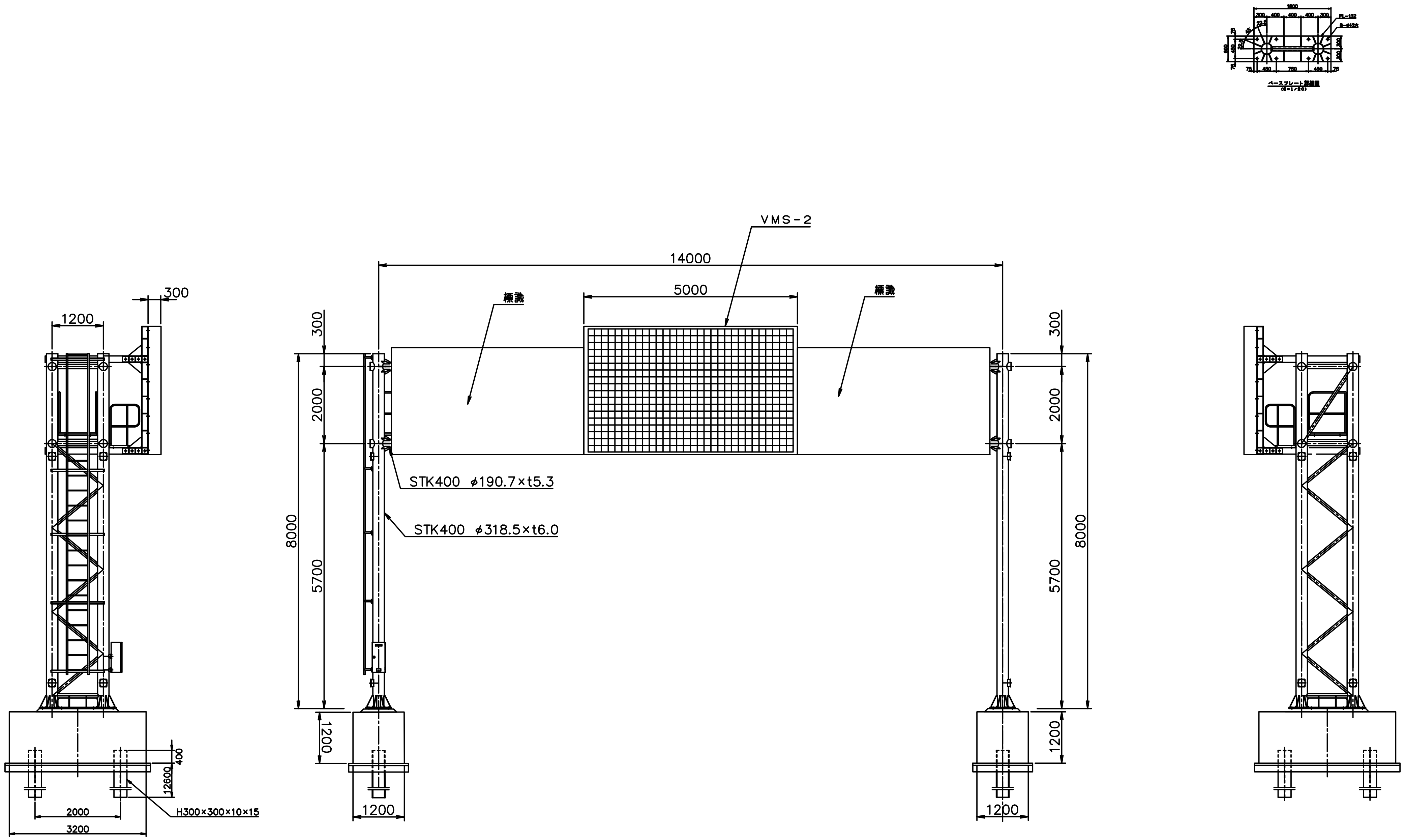


VMS -3

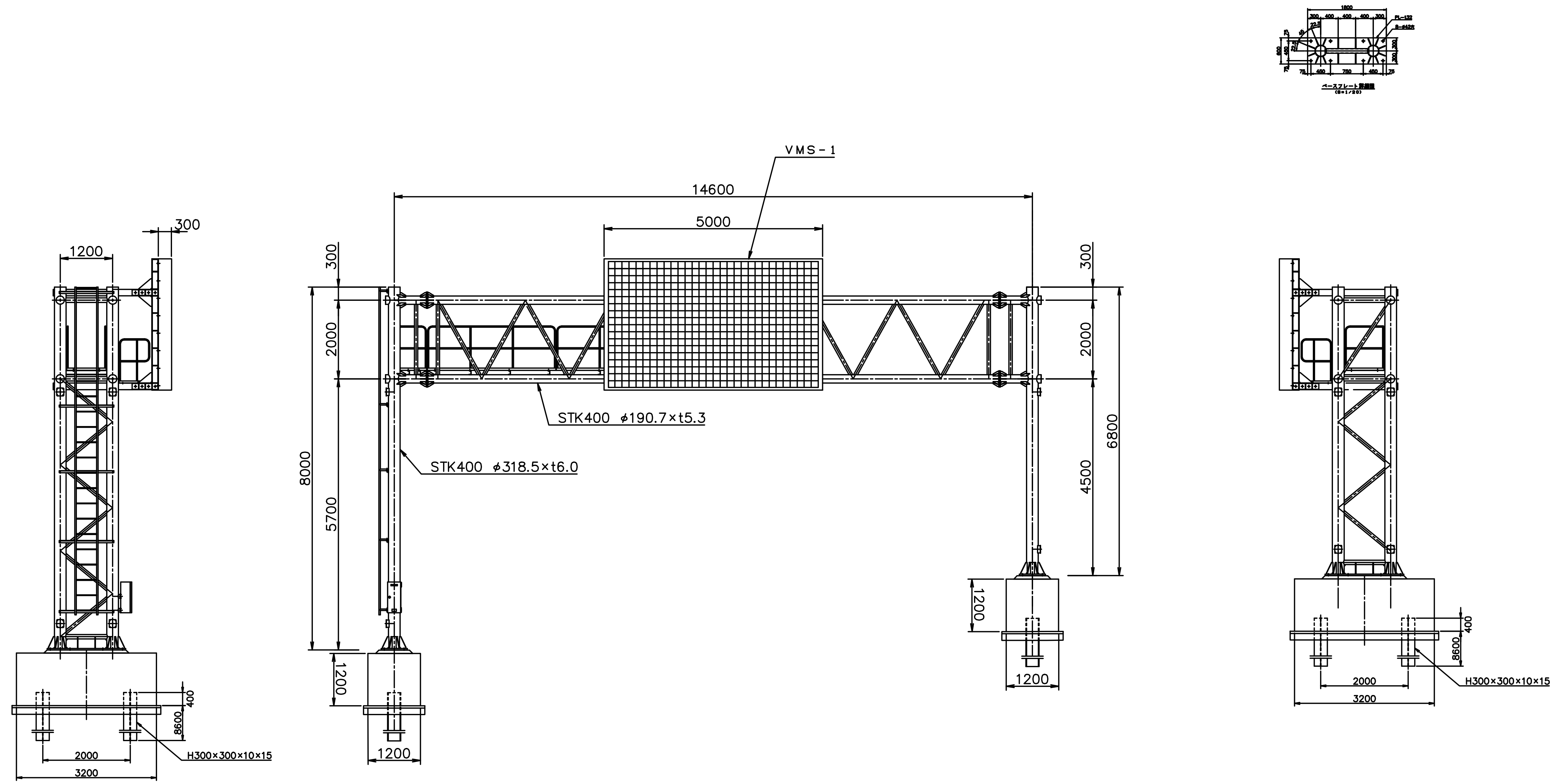
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARTORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE LAYOUT OF PLAN VMS	DRAW.NO.	NIPPON KOEI CO.,LTD.



JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE VARIABLE MESSAGE SIGN	DRAW. NO. VMS-1	NIPPON KOEI CO.,LTD EAST NIPPON EXRESSWAY CO.,LTD

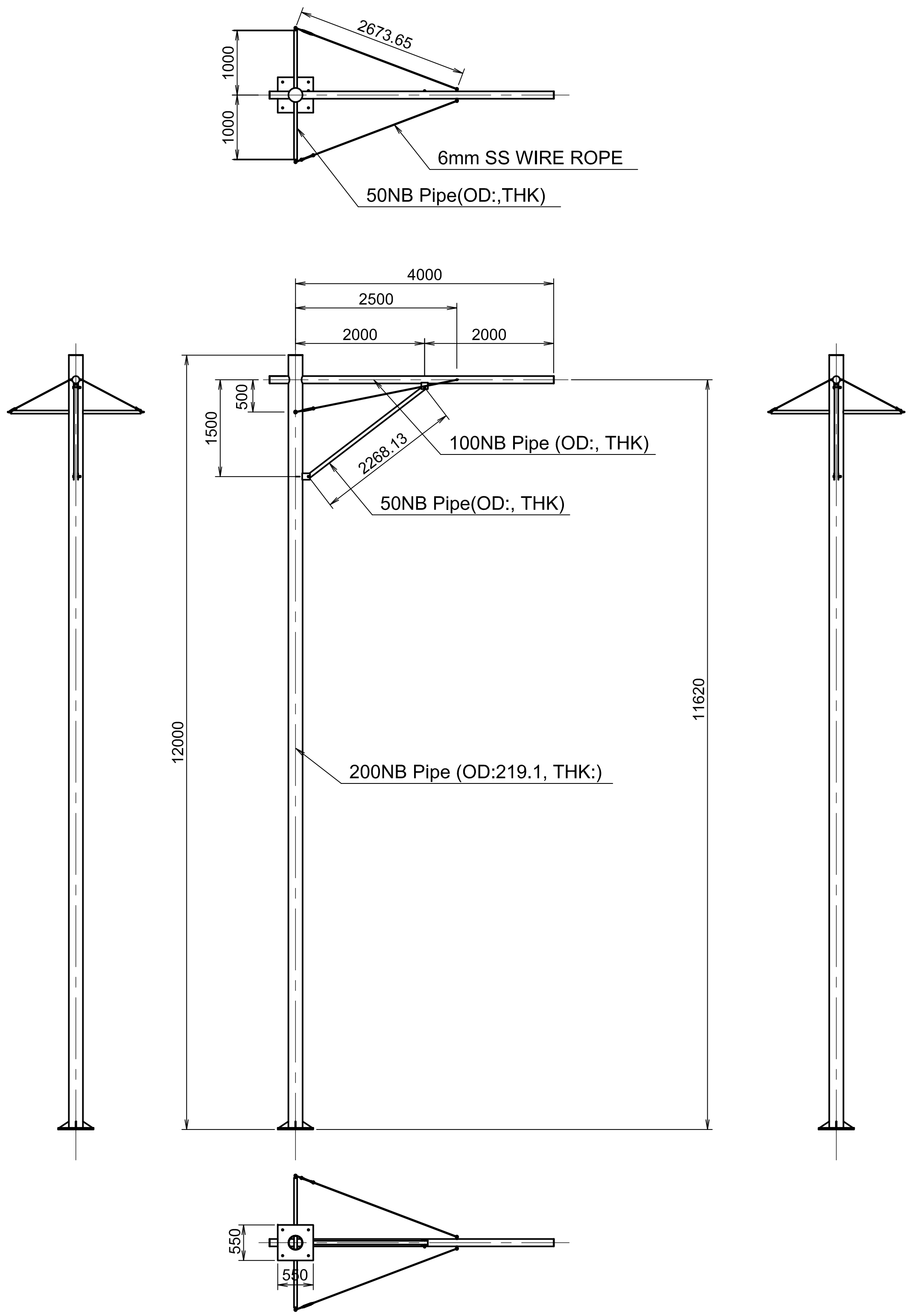


JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE VARIABLE MESSAGE SIGN	DRAW. NO. VMS-2	NIPPON KOEI CO.,LTD EAST NIPPON EXRESSWAY CO.,LTD



JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD EAST NIPPON EXRESSWAY CO.,LTD
		VARIABLE MESSAGE SIGN	VMS-3	

POLE OF SENSOR (S=1/50)
For Referrence）



JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE POLE OF SENSOR For Referrence）	DRAW. NO. SSP-1	NIPPON KOEI CO.,LTD EAST NIPPON EXPRESSWAY CO.,LTD