CHAPTER 2 CONTENTS OF THE PROJECT

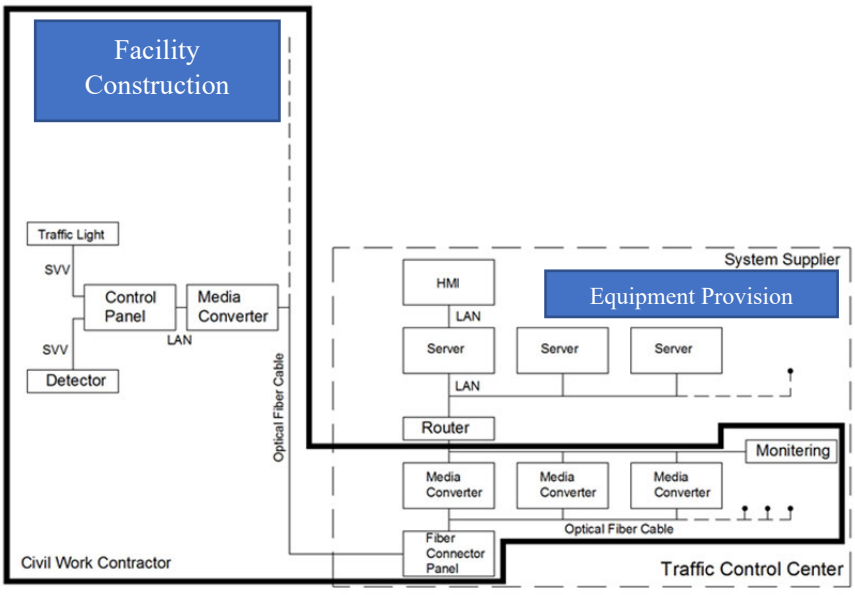
2.1 Project Components

This project aims to install traffic signals to 30 junctions in the CBD for the purpose of easing traffic congestion in Kampala City. Junctions with installed traffic signals are controlled by the traffic control centre, which is to be newly established at KCCA (reinforced concrete construction; semi-basement and three floors above ground). The Japanese traffic control system MODERATO is to be applied. Signal split will fluctuate according to traffic demands to optimize green lights. Connections between the junctions and the traffic control centre will be made over dedicated optical fiber laid for this project.

Table 2.1 Project Overview

Component (Package)	Particulars	Details
Facility construction	Junction improvement (civil engineering)	Improvements of 30 junctions (A=34,200m^2, Overlay A=14,600 m^2, 321 lanterns for vehicles, 220 lanterns for sidewalks, 28 controllers, 37 image detectors, ultrasonic detector, ducting and wiring work)
	Construction of traffic control centre (architecture)	Reinforced concrete construction. Semi-basement and three floors above ground (A=2,390.8m^2) Internal/external finish, outer walls: mortar bed, coating finish (wall coat); floors: porcelain tile, coating finish (urethane coating), etc. Inner walls: mortar bed, coating finish Ceiling: rock wool acoustic boards (T-frames, system ceiling)
	Development of information infrastructure	Laying flexible fiber optic cable (12C:6,640 m, 60C:9,790 m) Flexible Conduit: 12,654 m; Concrete pipes:1,650 m
Equipment provision	Traffic control equipment	One signal control block, one system management block, one signal control subordinate device, central display boards (twenty 55-inch monitors), one controller for the central display boards, one central display board HMI, seven HMI units

Source: JICA Study Team



Traffic Control System Diagram

Source: JICA Study Team

Figure 2.1 Traffic Control System Diagram

2.2 Preliminary Design

JICA is deeply involved in improving the traffic conditions in Kampala City. This junction improvement will be positioned as part of the city junction improvement programme utilizing grant aid from Japan, continuing since 1999.

Therefore, junction improvement must not only deliver a positive impact to the local economy and traffic safety but also must have added value reflecting the rationality and advantages of the specific technology in Japan's planning design approach in this field, as well as have a strong presence.

Also, because junction improvement construction work by Japan and the World Bank are scheduled to take place at the same time in the city, the design and construction plans are to minimize the impact on current traffic in the area of construction for this project and are to ensure the safety of pedestrians and other road users. In addition, the design policy is to be one that works on junction improvement without land acquisition and with consideration toward the impact on society and the natural environment.

2.2.1 Traffic Control System

The traffic control area shall be the entire city.

The Urban Transport Master Plan (UTMP) proposes the installation of traffic signals at about 200 junctions, vehicle detectors at about 2,000 points on single roads sections and installation of VMS boards at about 20 of the most important points in the city. The traffic control system to be introduced under this project will have the functions to ensure future expansion of the above-mentioned work and also being able to control all the target junctions.

(1) Traffic Control System.

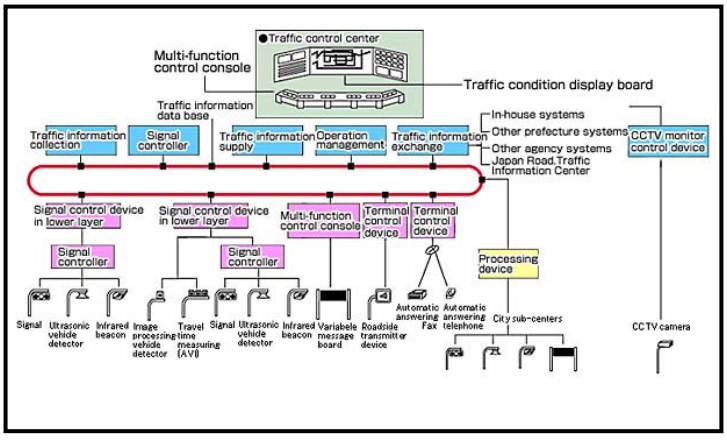
The traffic control system consists of the following three functions.

1) Traffic Information Processing Functions.

The data collected from the vehicle detectors placed at the in-flow points of the major junctions and each of the roads sections is processed by a subordinate signal control device to generate junction and route information, traffic volume, saturation traffic flow rate, queue length and the estimated time travel.

2) Signal Control Function (MODERATO)

MODERATO is a real-time signal control system aimed at reducing and dispersing traffic congestion and reducing traffic accidents. MODERATO consists of three blocks: Signal Control subordinate block, Signal control block and the traffic information block. It is possible to connect 128 signal controllers and 640 vehicle detectors to one subordinate signal controller.



Source: UTMS Society of Japan

Figure 2.2 Outline of Traffic Control System

The main functions of MODERATO are as follows:

- To determine the split and cycle length based on queues and traffic volumes calculated from detector information.
- To process offset follow-up, perform signal controller based sensitive control monitoring and perform operation command and monitoring based on the signal control information received from the signal control block.

MODERATO is capable of handling any traffic conditions from unsaturated to supersaturated. The control objectives for each mode are as follows:

- In light traffic, it forms a safe traffic flow by not only reducing delays and stops, but also controlling speed.
- When close to saturation, increase the green-signal time efficiency of the major junctions to maximize the processing of traffic volumes and thus reduce the occurrence of traffic congestion.
- In the event of super saturation, it directly determines the split and cycle length by taking into consideration the traffic congestion length calculated from the detector information. In addition, from the viewpoint of traffic management at major junctions, priority control is performed on conflicting traffic flow.

The split at the major junctions is the most influential parameter in the traffic processing capability. In order to delay the occurrence of traffic congestion as much as possible, when traffic volumes are near saturation, appropriate green-signal time allocation is required.

3) Traffic Information Provision Function[5].

Based on the traffic congestion, traffic regulation and special events information collected from each device, MODERATO edits the information for each target and distribution medium.

The basic information edited by this function is as follows:

- Road Congestion information
- Road Regulation Information
- Road accident information.
- Road construction information.
- Route guidance information.

MODERATO evaluates the priority of the medium against the collected information and decides the contents of the information to be provided.

(2) Traffic Control Equipment

The traffic equipment consists of the equipment to be put in the control center and the terminal equipment such as traffic signals. However, the size of the central equipment depends on the type and number of terminal equipment to be installed.

The central equipment group consists of the signal block having functions such as the host apparatus, system monitoring equipment and the subordinate equipment group with controls the terminal equipment. Table 2.2 below gives the overview of the central equipment group.

Table 2.2 Overview of Traffic Control System Devices.

Host Equipment Group	
Signal Control Block	Processes the traffic information of the signal control subordinate device and also calculates the cycle, split, and offset. It also determines a cycle within a subarea and connects/disconnects subareas and then transmits the control information of those signal constants to the subordinate devices.
Traffic Information Block (Uncovered by this project)	Aggregates the data generated by the signal control subordinate device for each link (section) based on the detector traffic information.
Information Provision Block	Automatically selects the information with the highest utility value for each provision point from various kinds of traffic information and edits the contents to suit the format of the information medium.
System Management Block	Monitors the operation status of each device, wiring and terminal in the system and issues an alarm in case of any abnormality and manages error history.

[5] Traffic Information Provision Function was excluded in the Grant Aid Programme

Network Monitoring Device	Monitors the LAN connection of each device and secures backup routes in case of a network failure.
Subordinate Equipment Group	
Signal Control Subordinate Device	Based on the control information generated by the signal control block, this device controls the terminals of traffic signals, monitors them for any abnormalities and generates traffic information from detector data. It also performs terminal control according to the right turn response control and dilemma control as received from the signal control block.
Information Provision Subordinate Device (uncovered)	Displays traffic congestion status and road conditions throughout the control area on a map or message board.
Operation Section	
Central Display Board Control device	Displays traffic congestion status and road conditions throughout the control area on a map or message board.
Human-machine Relay device	Relays information with to control console (HMI).
ITV Central Unit (Uncovered)	Monitors the output of images such as those from junction surveillance cameras and controls the surveillance cameras.
Control Desk	The console intervenes in signal control, traffic information provision and controlling and dispatching of information provided to other organizations based on radio communication from police and various types of information from the traffic control system.

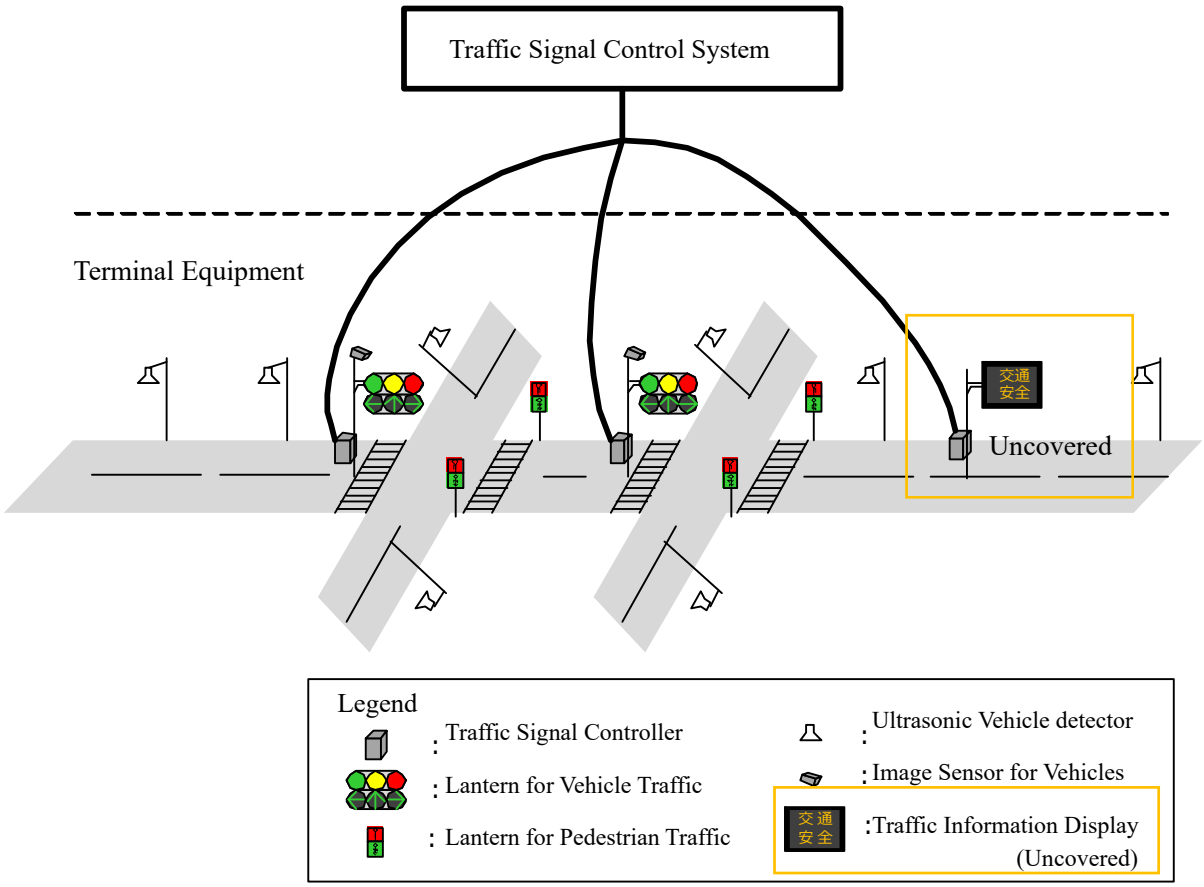
The MODERATO system is introduced in the UTMP. It suggests installing traffic signals at about 200 junctions, installing vehicle detectors on about 2,000 road sections, and installing VMS bulletin boards at about 20 major locations in the city.

The traffic control system introduced in this project shall have the functions to ensure future scalability and control developed junctions.

(3) Traffic Control System

The traffic control system organizes traffic information at each point based on information obtained from vehicle detectors. It then calculates optimal signal control parameters based on that traffic information to improve traffic smoothness and safety in the area. It also provides relevant information on the traffic information board, etc. (not yet developed in this project), and allocates and guides traffic volumes and traffic flows appropriately.

Traffic Control System



Source: Nippon Signal Co., Ltd.

Figure 2.3 Overview of the Traffic Control System

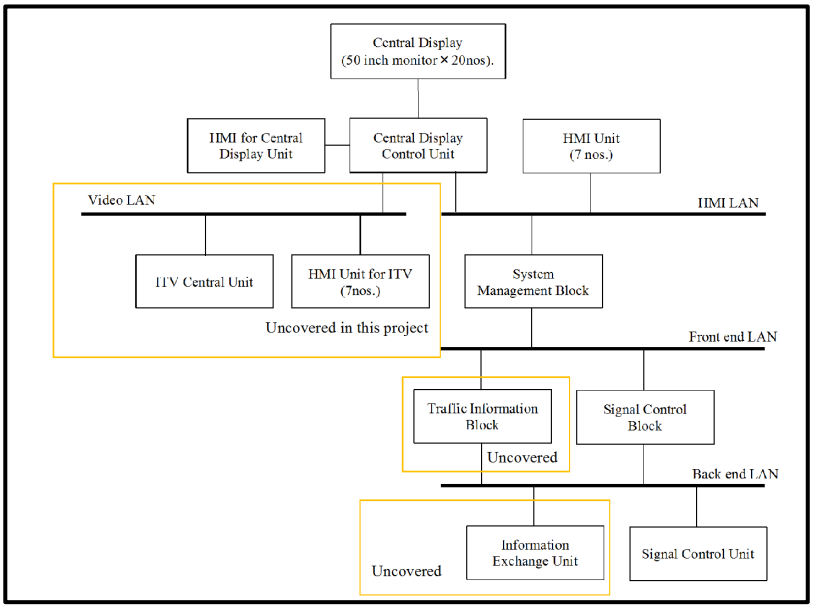
The traffic control system consists of the following three functions.

[A] Traffic Information Processing Function

Information collected from the vehicle detectors arranged at each entrance and road section for critical junctions is received after being processed by the signal control subordinate device. Junction and route information are generated, then estimations are made for managed traffic volumes, saturated traffic flow rates, queue lengths, estimated travel times, etc.

[B] Signal Control (MODERATO) Function

MODERATO is a real-time signal control system that aims to reduce traffic congestion, distribute traffic, and reduce traffic accidents.



Source：JICA Study Team

Figure 2.4 Traffic Control System Structure

MODERATO is composed of three blocks: a signal control subordinate device, a signal control block, and a traffic information block. One signal control subordinate device can be connected to 128 signal controllers and 640 vehicle detectors.

The main functions of MODERATO are as follows.

- Split and cycle length are determined based on traffic volumes and queues calculated from detector information.
- MODERATO conducts follow-up processing for offsets based on the signal control information received from the signal control block. It then performs sensitive control monitoring, operation commands, and operation monitoring via the signal controller.

MODERATO can handle various traffic conditions, from non-saturated to supersaturated conditions. The control objectives for each mode are as follows.

- During periods of light traffic, it works not only to reduce delays and stops but also to create safe traffic flows by controlling speeds, etc.
- During periods of near saturation, it increases the time efficiency for green lights at critical junctions to maximize managed traffic volumes and prevent traffic congestion from occurring.
- During periods of supersaturation, it takes into account the traffic congestion queue length calculated from the detector information and sets this as the load, then directly determines the split and cycle length. In addition, MODERATO uses priority control for competing traffic flows based on traffic management at critical junctions.

A split at a critical junction is the most influential parameter for the ability to manage traffic. It is necessary to allocate appropriate green light times in order to delay occurrences of traffic congestion as much as possible in near saturation conditions.

(4) Traffic Control Equipment

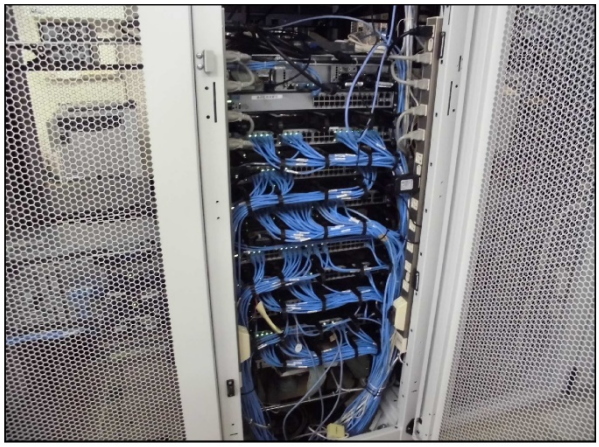
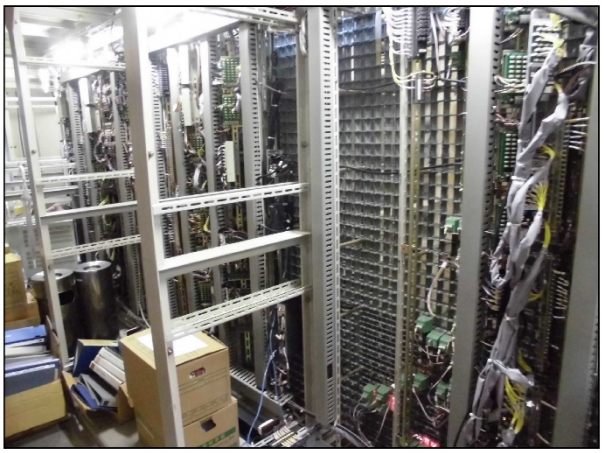
Equipment refers to central equipment installed at the control center and traffic signal equipment and other terminal equipment. The scale of the central equipment is determined by the type of terminal equipment and the number installed.

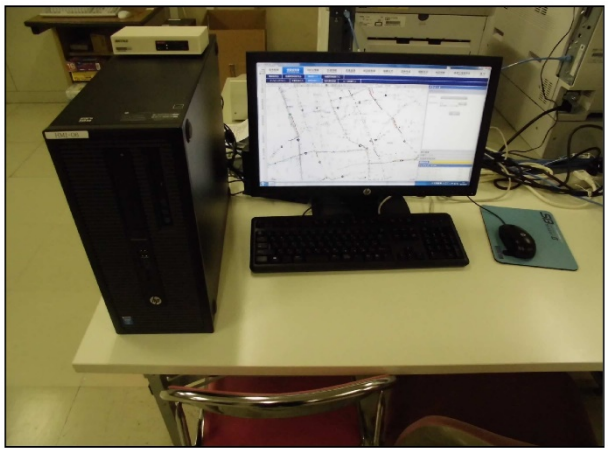
The central equipment group consists of a signal control block functioning as the host equipment, etc., and a subordinate group that performs system monitoring and terminal control.

*Not included in this grant aid programme

Signal Control Block

Traffic Information Block (Uncovered)

	
System Management Block	Network Monitoring Device
	
Signal Control Subordinate Device	Subordinate Information Provision Equipment
	
CCTV Central Equipment (uncovered)	Central Display Console (reverse)

	
HMI Console	CCTV (Uncovered)

Terminal equipment

The terminal equipment in the system is broadly composed of detectors, signal lights, and controllers. Signal lights are designed according to Uganda standards as well as "The Manual on Traffic Signal Design and Installation" created for the Technical Cooperation Project. Considering that Uganda was formerly a British colony, vertical traffic signals used in the UK are to be used, and their arrangements are based on the traffic flowing through the junctions.

Source：JICA Study team

Photograph 2.1 Signal Head Layout

Detectors, installed on road sections and emphasizing low cost, are to use sound waves. At junctions, stagnation occurs in right turn lanes due to short turn arrows. This means vehicles protrude from the back of the lane, and the traffic congestion and accidents this causes is a concern. The stagnation of vehicles in a right turn lane is accurately detected by image detectors installed in the section. Extending the right turn arrow prevents vehicles from protruding due to stagnation.

Furthermore, in order to accurately grasp traffic flow, signals shall be full traffic-actuated if there are no constraints on land use.

Table 2.3 Specification of Traffic Control Equipment

Sl. No.	Name of the Equipment	Purpose	Number	Location of Installation	Dimension (in mm)	Weight	Power Consumption	Remark
1	Signal Control Block	Consolidation of signal controllers, generating command and send to each controller	1 No.	Traffic Control Centre Machine Room	600(W)×2000(H)×1000(D)	210kg	400VA	Power configuration and weight might vary due to internal configuration.
2	System Management Block	Accumulation of mid term and long term data, supervision of overall system	1 No.	Traffic Control Centre Machine Room	600(W)×2000(H)×1000(D)	290kg	1800VA	Power configuration and weight might vary due to internal configuration.
3	Signal Control Unit	Accumulation of vehicular detectors and generation of signal parameter, sending command	1 No. (for 32 junctions)	Traffic Control Centre Machine Room	600(W)×2000(H)×1000(D)	290kg	1200VA	Power configuration and weight might vary due to internal configuration. (128 controller/ system)
4	Central Display	Displaying various data	1 No. (55 inch monitor total 20 Nos.)	Traffic Control Centre	55 inch Multi Monitor	37kg	400VA	
5	Central Display Controller Unit	Process data for showing on central display	1 No.	Traffic Control Centre	600(W)×2000(H) ×1000(D)	Less than 300kg	Less than 3KVA	Power configuration and weight might vary due to internal configuration.
6	HMI for Central Display Controller Unit	Operation and control of central display	1 No.	Traffic Control Centre	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Display Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	
7	HMI Unit	Operation & confirmation of each equipment and information	2 Nos.	Traffic Control Centre	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	
			2 Nos.	Main Office	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Display Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	
			1 No.	Maintenance Room	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Display Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	
			1 No.	Office for Stand by Policeman	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Display Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	
			1 No.	Traffic Control Centre Machine Room	Main Unit178(W)×350(H)×379(D) Liquid Crystal Display Unit 518(W)×380(H))×160(D)	Main Unit 7kg Liquid Crystal Display Unit 4kg	Main Unit 300VA Liquid Crystal Display Unit 30VA	

Study for VMS (Uncovered in this Project, Reference only)

■ Background of VMS in Kampala

Traffic congestion in Kampala is unpredictable and very much fluctuating in different days of the weeks irrespective of control method of the junction. Information of traffic flow can control the driving behaviour of drivers and assist them to change their route which can eventually reduce traffic in saturated junctions and divert the traffic towards less congested route. In addition, in congested situation also receiving early information of probable traffic jam can ease some psychological stress from the drivers. Therefore, it is considered to install some VMS boards at different locations of the route towards city centre and eventually these boards will guide the traffic to choose the appropriate route travelling to city centre.

■ Needs Assessment

Discussing with the relative personnel and organization some items which might be shared through VMS are listed. The present situation of various items which are expected to be used by VMS is described hereby.

(1) Road Infrastructure:

Kampala Flyover construction is expected to be constructed from 2018 and due to construction work it is also anticipated that traffic congestion might get worse in the nearby area of wampeo roundabout and clock tower. During construction work, it will be necessary to divert some traffic from these areas in order to reduce traffic congestion.

Kampala Entebbe Expressway construction is underway which is managing by UNRA. Traffic information from this expressway needs to be shared with TCC as this is going to be a major corridor of traffic movement in Kampala.

(2) Parking:

KCCA is practicing on street parking management through engaging a contractor named Multiplex. The contractor is managing the parking toll of the system and paying to KCCA a fixed amount as per contract. The management of parking system is yet to be automated and KCCA is expecting to introduce automation parking system in future. Apart from these on street parking facilities KCCA planned to establish new parking spaces in Kampala to solve the problem of insufficient parking spaces. Except KCCA private companies are also showing interests to build commercial parking facilities in Kampala specially in CBD whose information are expected to be shared with KCCA in future. Information regarding empty spaces of parking area will be shared with the driver before he or she approaches to any parking lot.

(3) Traffic Accident Information:

At present, accident data collection is not collected or updated real time basis. In future, the accident data is expected to receive instantly from Uganda Police and using VMS this information can be shared with road users to divert the traffic from that route.

(4) VIP Movement:

VIP’s move through the city without any prior notice and the present traffic control system is not capable to allow priority control for them. In fact, there is no proper way to disseminate this information to general road users at present. In future, when the MODERATO signal system will be under operation, the VIP movement is expected to be smoother and eventually safer.

(5) Event Information:

Due to some special event such as holiday market certain areas of the city are expected to be congested some time. This kind of information might be shared with the road users which would eventually help to manage traffic through TDM.

■ Message Types to Display

In order to decide the messages needs to be displayed meetings with KCCA, UNRA and interview with some car drivers who drive through the city every day were held. The display messages will be limited to basic information as followings:

- Expected travel time to city centre
- Expected delay at some particular area/route due to events or VIP movements etc.
- Incident information: accident occurrence, road closure, diversion information etc.
- Cautionary messages: 'Wear Helmet', 'Don't Drink and Drive' etc.
- Weather information such as heavy rain forecast

In future, the VMS's will show the following information:

- Parking information: Information of different parking plots which are managed by KCCA and private owners needs to be shared.
- Information of traffic situation in expressway

Another important matter is the language to display. As most of the drivers can read and understand English it is proposed to display only in English.

■ Type and Size of VMS board

For Kampala city the messages to be shown are basically text based. Therefore, it is not required to use 7 colour display, as it is very much costly and mainly used for expressway where the traffic speed is very high.

Common available sizes of VMS boards are shown hereby in mm.

- Type 1: (W)2340×(H)1640×(D)360: 3 rows of display with 3 colour font
- Type 2: (W)2760×(H)2250×(D)361: 4 rows of display with 3 colour font
- Type 3: (W)1800×(H)500×(D250); small display

Depending on the available road side space and traffic lanes of the route the size needs to be selected. In order to ensure proper visibility and accommodate sufficient fonts, type 2 board is recommended for Kampala. The font size to be displayed must be minimum 300 mm high.

Figure A typical 4 row VMS board installed in Japan.

■ How VMS works

Central control centre analyses the information collecting from different sources such as: traffic detectors, CC cameras, information from police etc. and automatic settings of message selects the prioritized message to display for the road users. Each VMS board has a controller of its own where the algorithm of displaying the messages

will be stored and based on the program stored at TCC display time to time. To manage the information sharing another software needs to be designed which is an essential part of central control centre and is controlled by HMI (human machine interface) device. Overall process of VMS functioning is shown in Figure below.

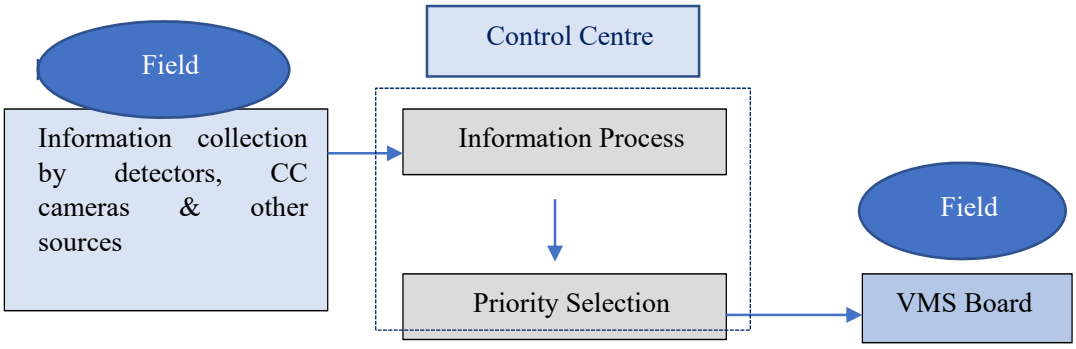
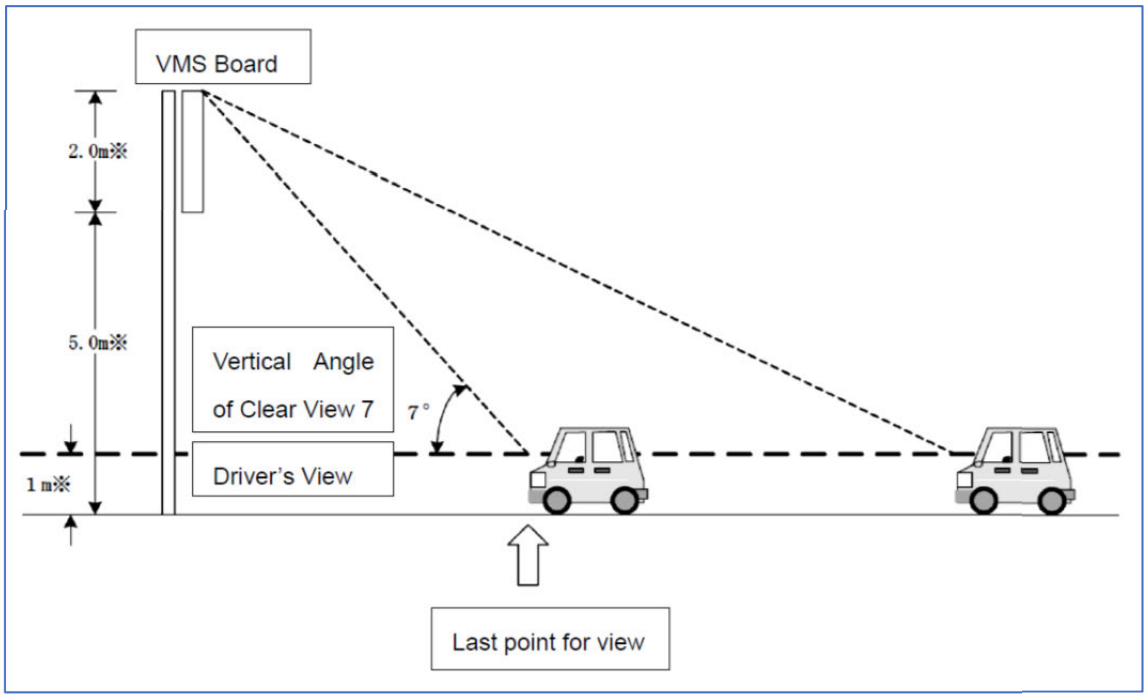


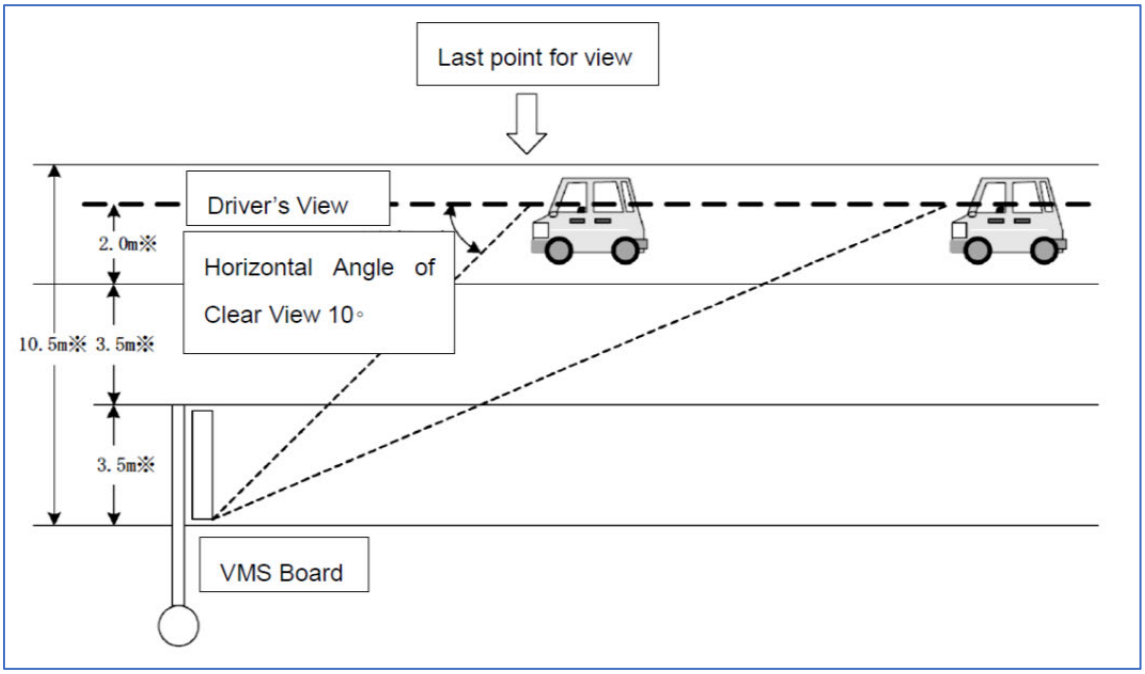
Figure Overall Process of Functioning VMS

■ Positioning of VMS Board

VMS boards will be set up at road side maintaining the minimum vertical clearance distance of Ugandan standards. The visibility from the drivers' seat should be ensured; therefore, the messages of the VMS should be clearly visible and readable from app. 100m distance. The highest travel speed of the vehicle is assumed as 60kmph and 5 secs are sufficient to read the messages.



Source: Tokyo Metropolitan Police Department



Source: Tokyo Metropolitan Police Department

Figure View from the Driver's Seat from Different Angle of the Roads

■ Proposed Location of VMS Installation

12 locations are selected primarily for VMS installation and these proposed locations of VMS installation are showed in Figure below.

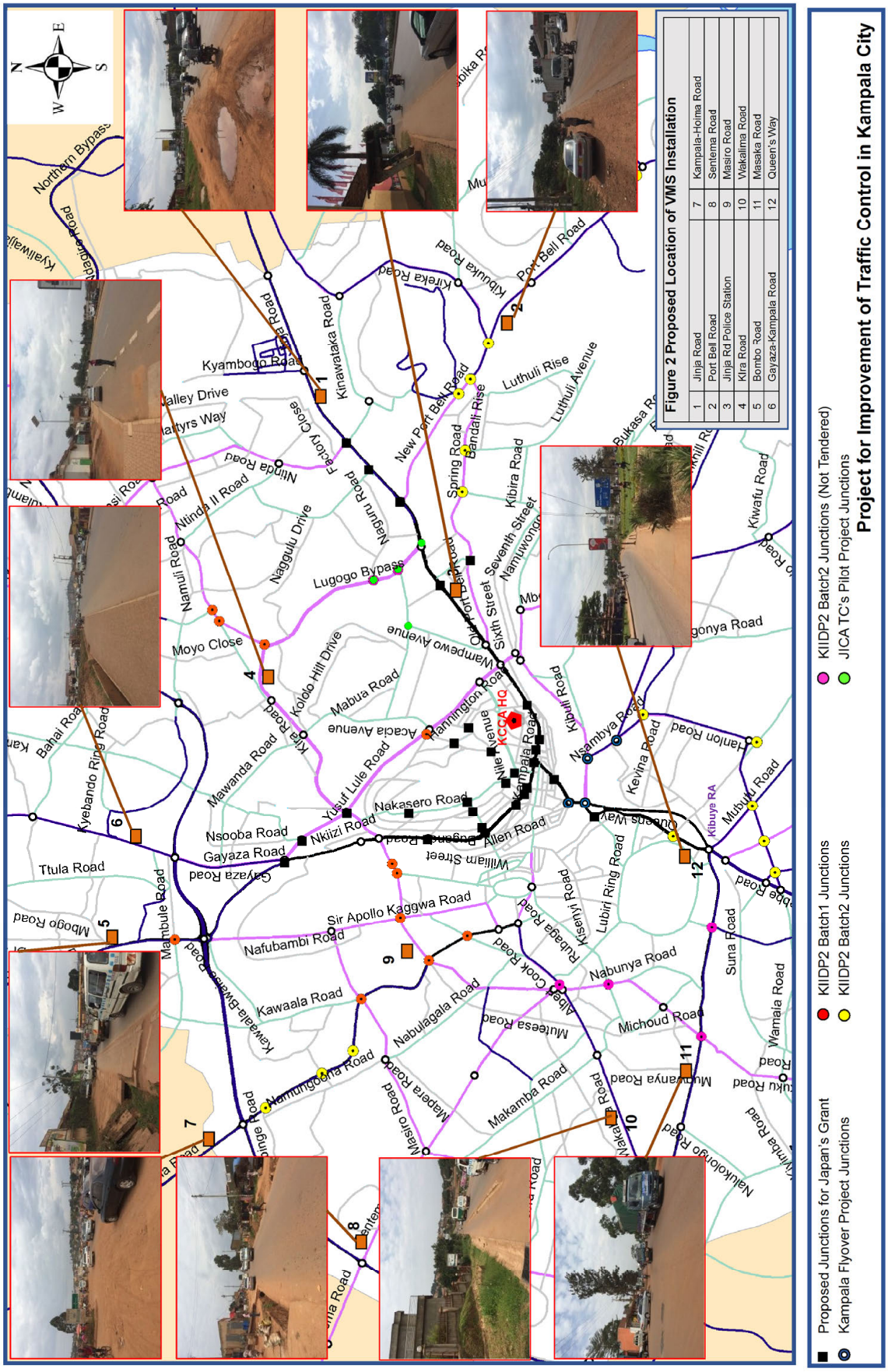


Figure Proposed VMS Locations

2.2.2 Consideration for Introduction of MODERATO system

(1) Understanding methods of project effects

In order to understand the of influence on wide-area traffic flow and evaluation of large-scale infrastructure, the four-step method has been used. In particular, a network assignment method has been used for estimation of traffic volume and speed per road. While network assignment enabled examination of influence on the entire urban area, it reflected effects of the junction improvement only as a capacity change of connecting roads. Also, the network was often assigned by daily traffic volume in Japan and did not reflect accurate conditions of peak hours. Therefore, microscopic simulation, which can represent and evaluate effects of improvement on the traffic flow in a more detailed level by every car, is used in many cases today. It enables evaluation of changes to geometric structure of a junction, changes of signal indication, influence of parked vehicles on the main traffic lane, declines in vehicle speed caused by crossing pedestrians, etc. It performs simulations for every vehicle to understand details of estimation of individual time delay, increase of parking time caused by congestion growth, influence on fuel consumption caused by acceleration and deceleration, etc. while the network assignment often evaluated effects uniformly based on the average speed.

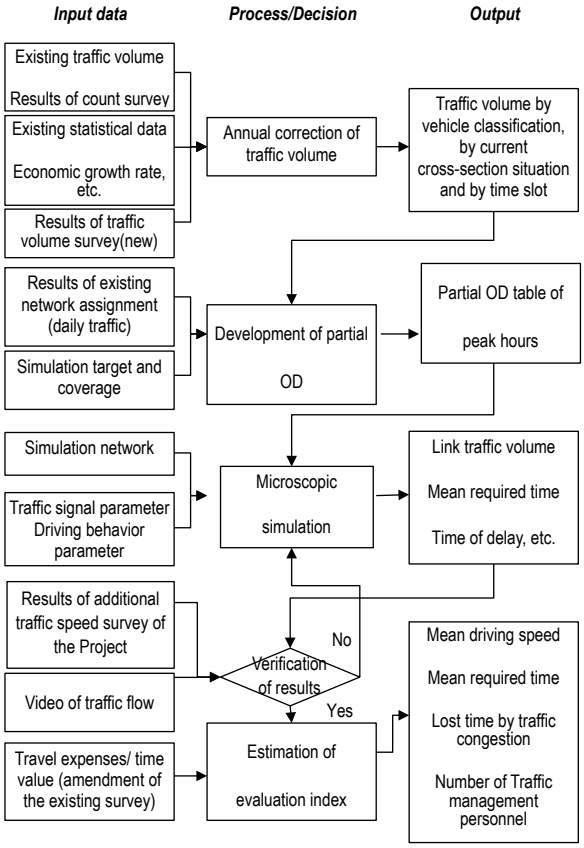


Figure 2.5 Flow of quantitative evaluation index calculation

Figure 2.5 shows the flow of estimation of quantitative evaluation indices using the simulation software VISSIM. It needs an OD table of the specific area (partial OD table) to evaluate a road network that is connected to multiple junctions. The results of the network assignment around the urban central area of Kampala using JICA STRADA can be obtained from "Greater Kampala Road Network Improvement Project Preparatory Survey" implemented by JICA. The Study Team would amend and update the assignment results to that of the latest year using results of the traffic volume count survey that will be newly conducted and make an OD table of the morning and evening peak hours. For this work, OD Calibrator of JICA STRADA, the route information output function of User Equilibrium Assignment and others will be used. The partial OD that was made will be input into a VISSIM network that was developed separately with signal conditions and driving behaviors to execute a Microscopic simulation. For use of Microscopic simulation, the existing conditions should be reproduced carefully first and then driving behaviors should be reproduced in a video with conditions of a traffic congestion scene, etc. The Study Team would also confirm its consistency with results of the traffic speed survey.

In this survey, simulations of conventional Fixed-timing control and control over an entire area with VISSIM are to be conducted and compared to grasp the effects of control with MODERATO.

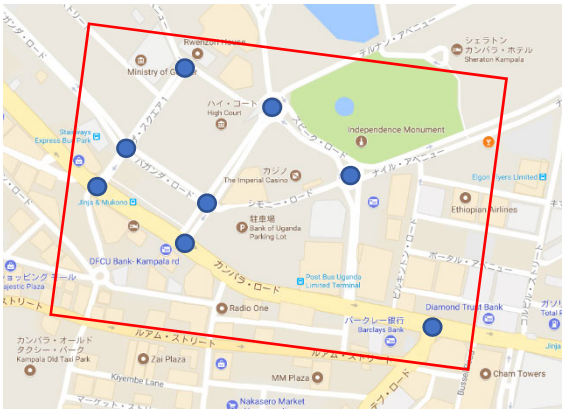
Areas targeted for simulations are near Rwenzori Courts, Grand Imperial Hotel, City Square Kampala, and Entebbe Rd. These make up an area with consecutive junctions in the center of Kampala City's CBD where traffic congestion is obvious during peak morning and evening times.

(2) Simulation Conditions

Automobiles account for 45% of passing traffic, followed by minibuses (matatus) at 31%, and boda-bodas at 20%. Large-sized vehicle traffic (4%) is extremely low. Impediments to traffic due to large-sized vehicles is rare. As in Figure 1.25, peak road traffic in Kampala City is at 8:00 AM, and the simulation targets this time frame.

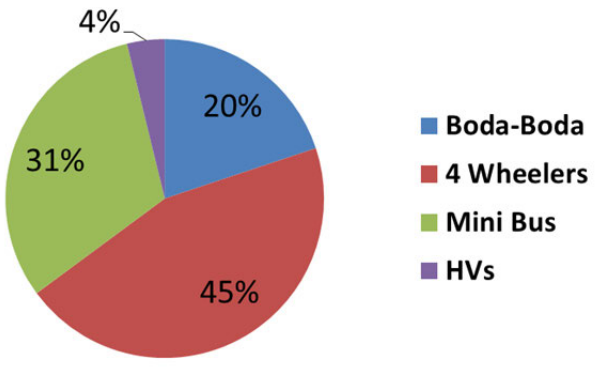
In addition to the data from this survey conducted in 2017, the traffic volume also referenced data from that conducted in 2010.

Regarding the traffic volume data from 2010, because the traffic volume is expected to have increased with the increase in the vehicle ownership rate, the traffic volume by section surveyed at the same location for 2010 and 2017 was calculated and adjusted at a ratio of 1.17.



Source：JICA Study Team

Figure 2.7 Study Network of Simulation



Source：JICA Study Team

Figure 2.6 Vehicle Composition of Study Network

The traffic volume at 8:00, the peak time frame, is as shown in

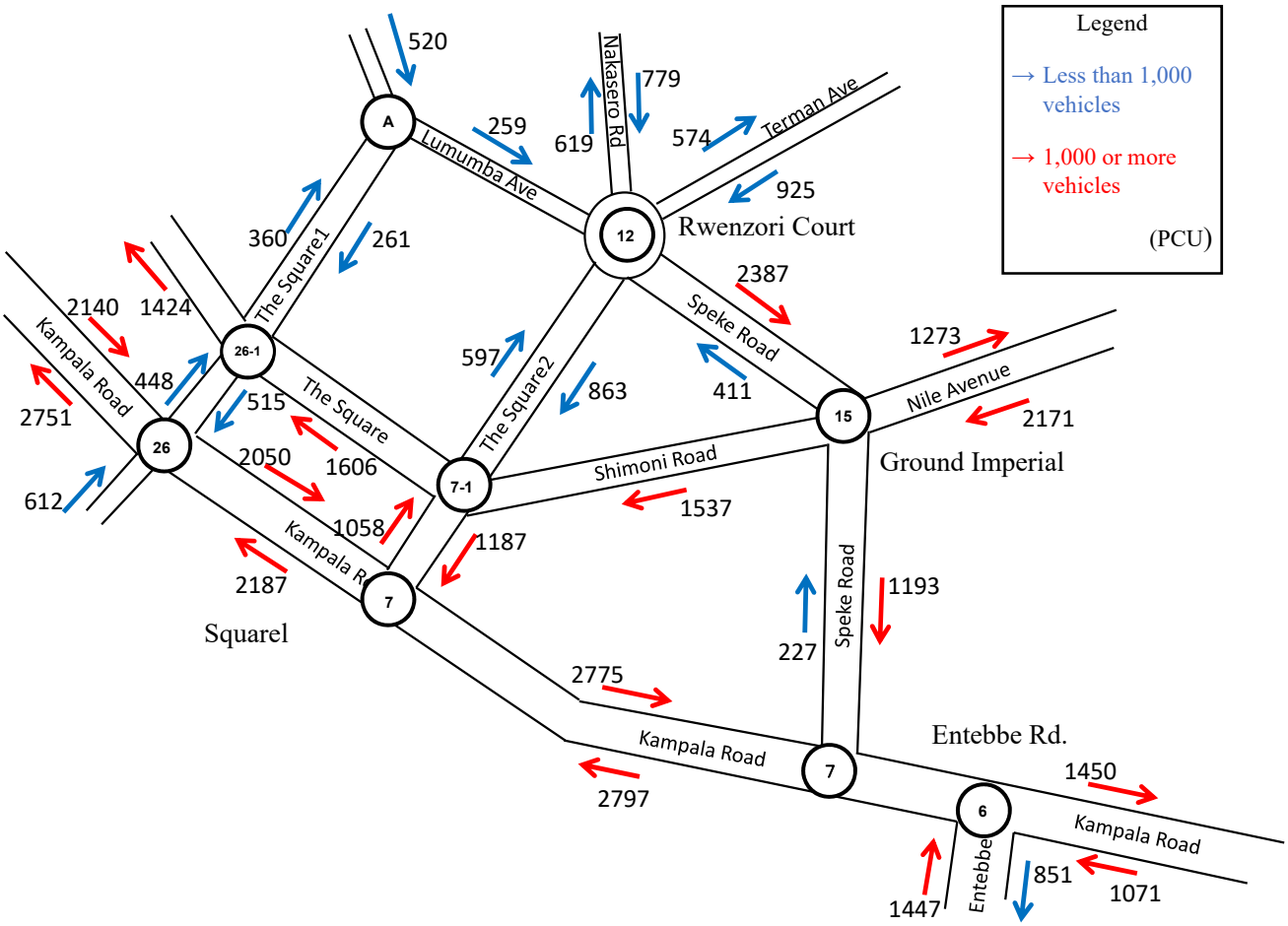
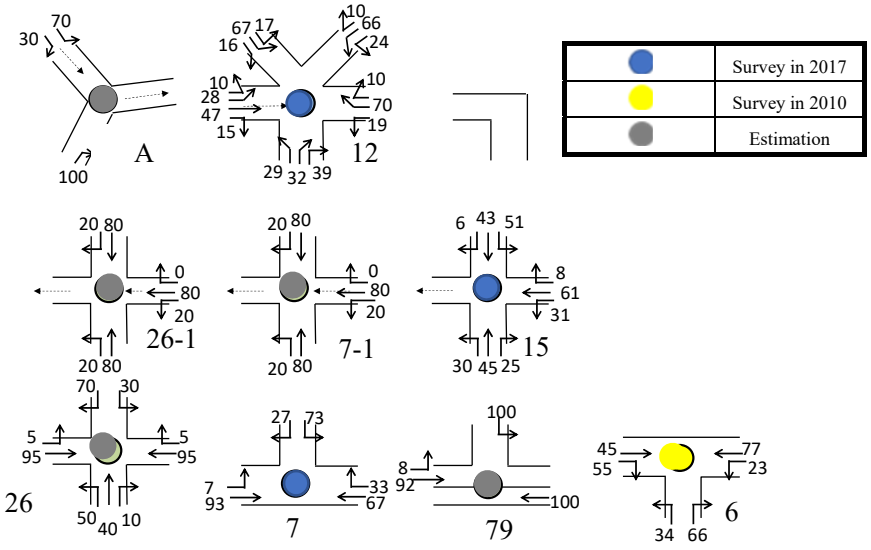


Figure 2.8 Traffic Volume in Simulation Target Area

The branching ratios in each junction are as see in Figure 2.9.



Source: JICA Study Team

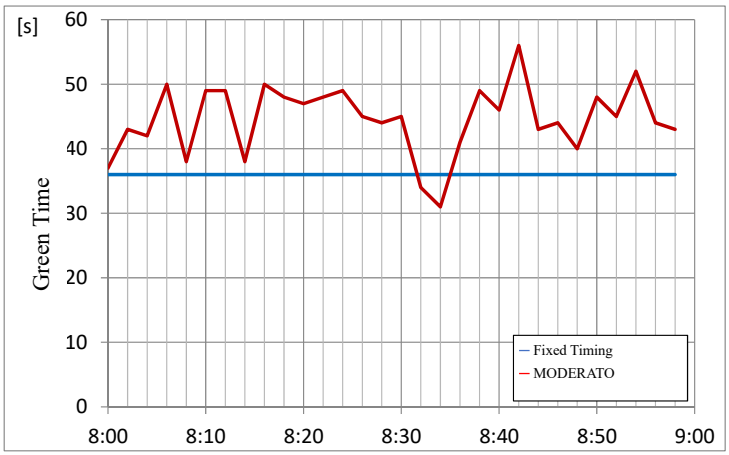
Figure 2.9 Branching Ratios in Simulation Target Junctions

(3) Setting Simulation Cases

The simulation is carried out in two cases: Fixed-timing signals, the conventional method of control, and MODERATO-controlled signals.

Fixed-timing signal control is also called point control because it displays [Green] [Yellow] [Red] signals in one predetermined duration. With this signal control, while an optimal pattern is selected from a plurality of patterns depending on the day and time, the time for a green light is constant regardless of traffic conditions.

On the other hand, MODERATO control calculates the time for green lights according to traffic demand based on information from vehicle detectors. This means that the times for green lights change automatically, even when traffic demand changes based on the time or season.

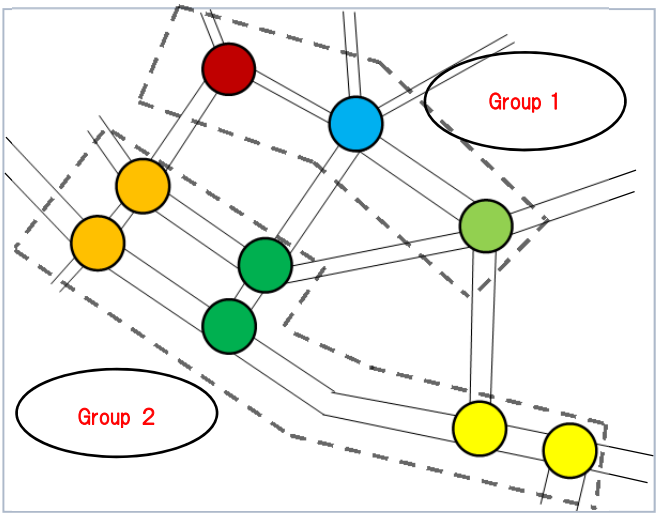


Source：JICA Study Team

Figure 2.10 Comparison of Green Time at Junction No.7

For example, differences in the times for green lights in junction 7 in Figure 2.8 are shown in Figure 2.10.

MODERATO is able to group junctions together and control an entire area. It determines critical junctions and those junctions catching up from within the group and allows them to coordinate with each other. As a result, MODERATO improves safety and facilitates traffic by preventing and minimizing traffic congestion, preventing traffic accidents, etc. in the area as a whole. The group in the target area is as shown in Figure 2.11.

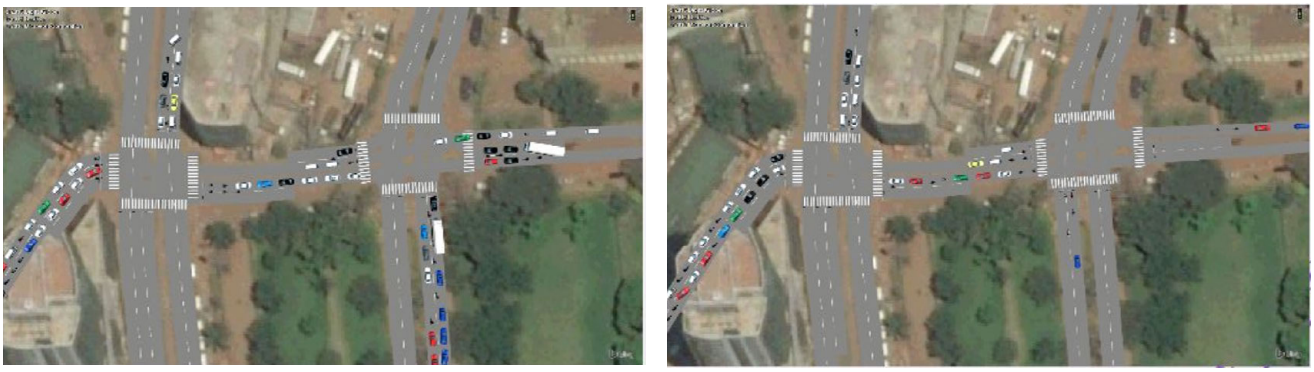


Source：JICA Study Team

Figure 2.11 MODERATO Area Control Grouping

(4) Simulation Results

Simulation results have been summarized in the form of a video to make the information more visual.



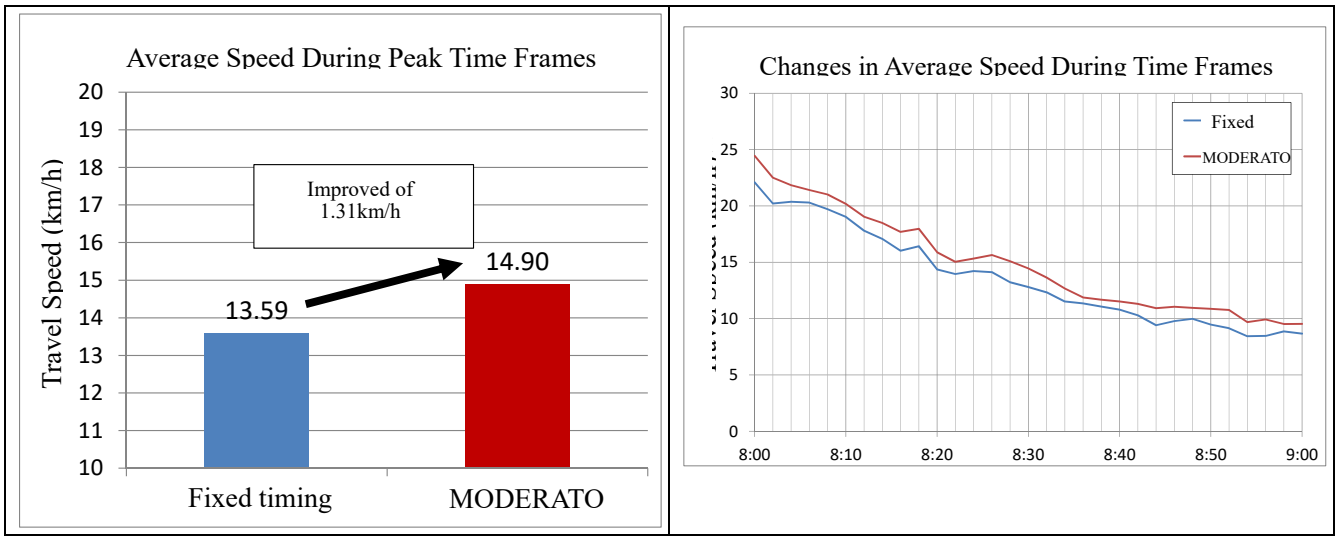
Fixed-timing Control　　MODERATO Control

Source: JICA Study Team

Figure 2.12 Simulation Results (Video)

Figure 2.12 shows screenshots from the video comparing pre-timed control and MODERATO control in junctions 4 and 6. As shown in the figure, when compared with the same traffic volumes, MODERATO control shows less congestion. This is the result of managing the traffic rationally by creating a relationship between junctions 4 and 6.

The Study Team also quantified the effects of MODERATO control in addition to the video by using the average speed of vehicles, total travel times, and total delay times.

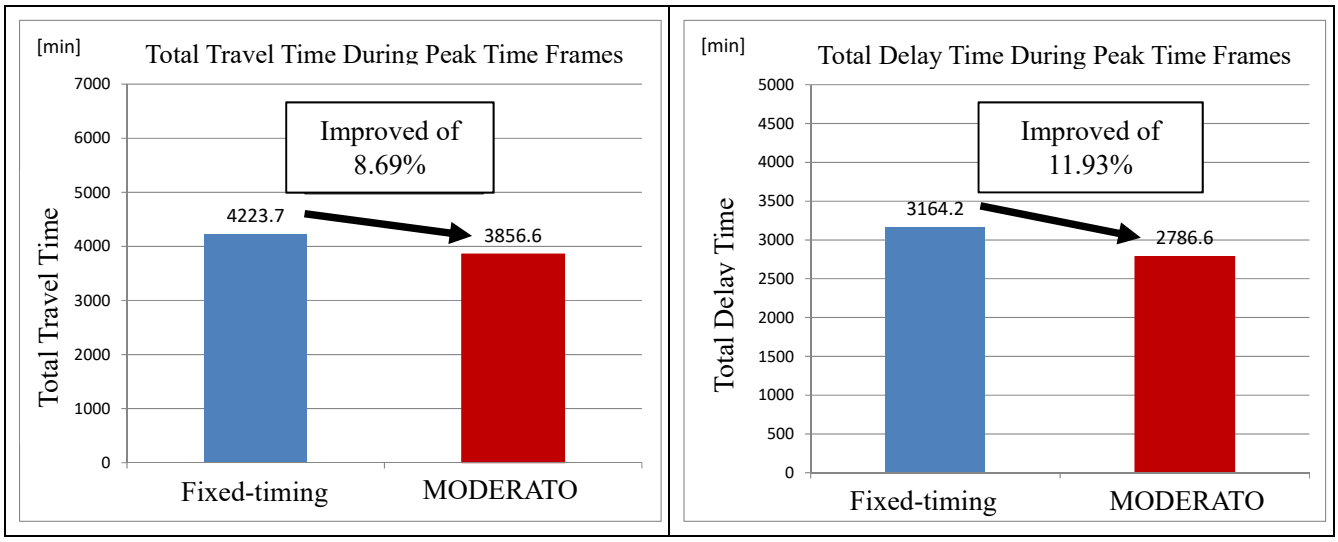


Source: JICA Study Team

Figure 2.13 Calculated Results for Average Speed

As shown in Figure 2.13, by using MODERATO control, the average travel speed was increased by about 1.31 km/h when compared to the Fixed-timing control. Also, the travel speed while using MODERATO signal control during the studied time frame (8:00–9:00) maintained a high speed without falling below that of the Fixed-timing signal control.

Using MODERATO control, travel time was reduced by 8.69%, and delay time was improved by 11.93%.



Source: JICA Study Team

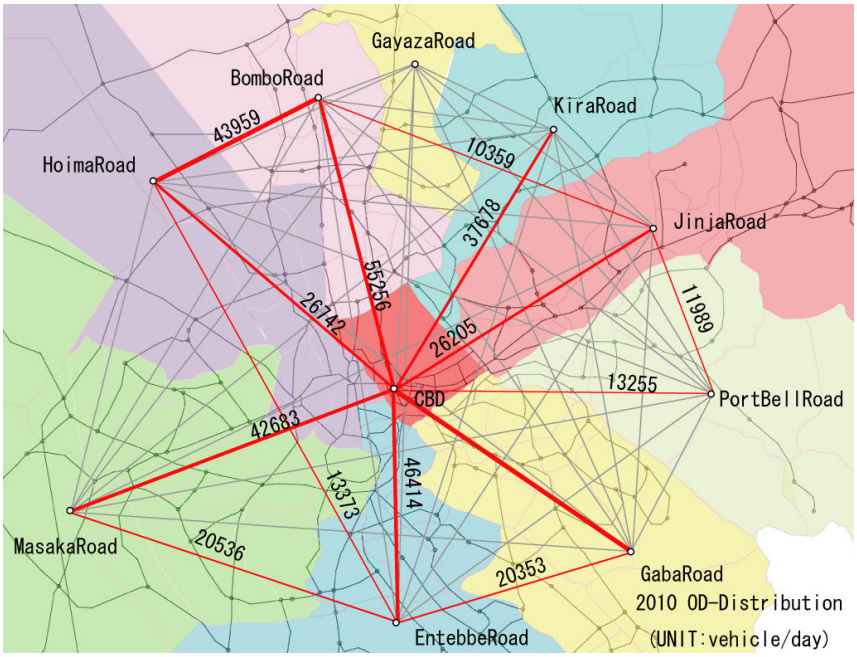
Figure 2.14 Comparison of Travel Times and Delay Times

As explained above, improvements in traffic flow are expected with MODERATO control when compared to conventional Fixed-timing control. In situations where there is little room for road development and where it is difficult to increase road capacity, as is the case with Kampala City, there is the possibility of improving efficiency of the road network by changing the method of control.

2.2.3 Junction Improvements

(1) Improvement Policy

This project aims at eliminating traffic congestion in Kampala City in order to revitalize the economy of Uganda. For this reason, eliminating the bottlenecks of Central Division, where traffic congestion occurs most frequently, will be the priority of the project.



Source: The Study on Greater Kampala Road Network and Transport Improvement in the Republic of Uganda (JICA)

Figure 2.15 OD Disirelines（2010）

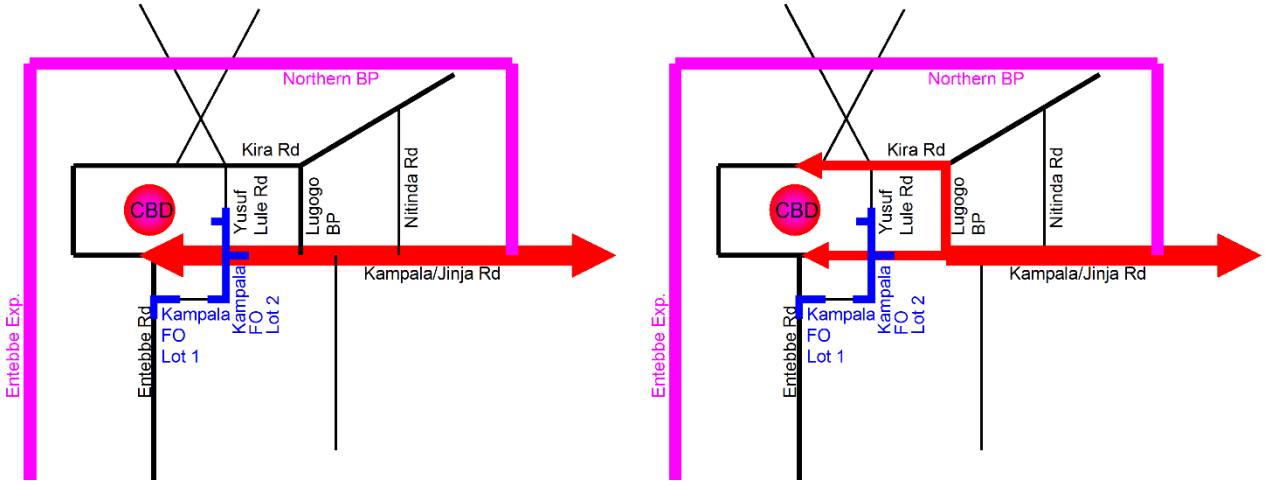
As mentioned before, Kampala has a large-scale transport improvement programmeme. However, implementation of the Kampala Flyover Project, one of the programme, has been delayed and there seems no prospect for the start time of the BRT project.

The construction duration of the Kampala Flyover is 4 years, which means that even at its earliest, completion will be by mid-2023. Due to traffic restrictions during the construction period, the capacities of the Kitgum House junction, Wampewo roundabout and Garden city roundabout, which are subject to Lot2, will greatly be reduced.

In addition, in the BRT scenario, the number of lanes allocated to general traffic will decrease due to most matatus and some private cars switching to BRT. For this reason, the roads may fall into super saturation and traffic congestion may not be resolved since general traffic will not have switched to BRT because some programme, including the Kampala Flyover programme, are planned and designed assuming that BRT will start its operation in 2018.

Therefore, some management measures such as detouring traffic flow for Kampala-Jinja road (Kitgum House Junction, Wampewo RA, and Garden City RA) to Lugogo bypass and Kira Rd for the time being is necessary.

Since BRT still has many unresolved problems, the Study Team considers this management for the selected junctions since its highly likely that this management measure will be implemented for a mid-to-long period.



Source: JICA Study Team

Figure 2.16 Kampala/Jinja Road Management Plan

(2) Selection of Target Junctions.

1) Selected Long List

Table 2.4 shows the long list of 92 junctions that were picked from Figure 1.13.

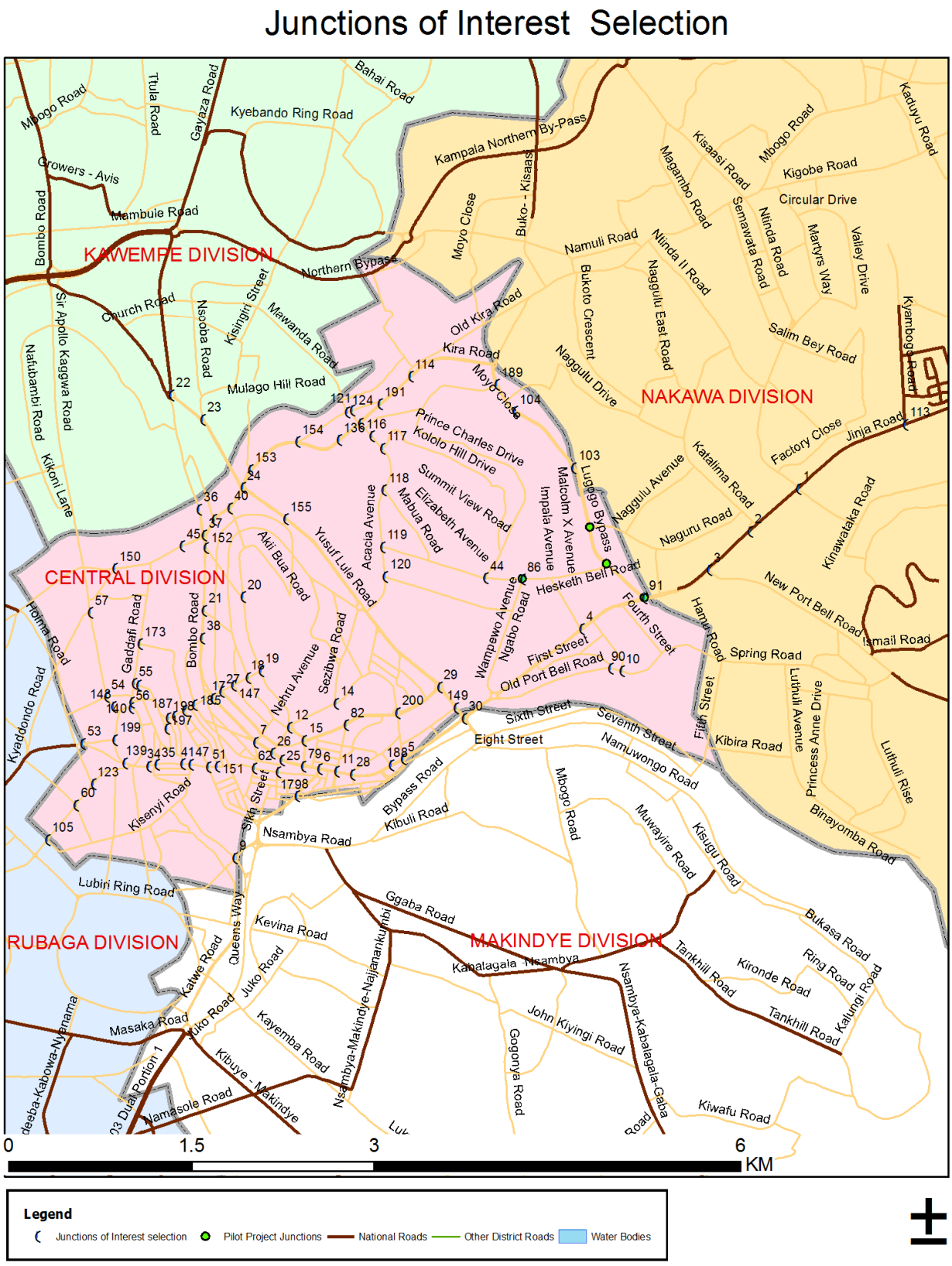
Table 2.4 Long list of Junctions

Junction Number	Junction Name	Division	Junction Type	Connecting Road Names	Road Surface	Map_Class	Old Road Class	New Road Class
1	Spear Motors	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU
2	JinaRd Katalima Rd	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU
3	Nakawa	NAKAWA DIVISION	Signalized-Junction	Jinja Road	Paved	Primary Roads	UC I	KU
4	Third Street	CENTRAL DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU
5	Station	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
6	Entebbe	CENTRAL DIVISION	Signalized-Junction	Kampala Road	Paved	Primary Roads	UC I	KU
7	Square	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
8	Nasser Road	CENTRAL DIVISION	Un-signalized Junction	Entebbe Road	Paved	Primary Roads	UC I	KU
9	Mengo Hill Rd	CENTRAL DIVISION	Roundabout	Katwe Road	Paved	Primary Roads	UC I	KU
10	Umeme Headquarters	CENTRAL DIVISION	Un-signalized Junction	Nile Avenue	Paved	Tertiary Roads	UC III	KA
11	Uganda House	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
12	Rwenzori Courts Roundabout	CENTRAL DIVISION	Roundabout	Nakasero Road	Paved	Tertiary Roads	UC III	KA
14	Kintu Rd/Sezibwa Rd	CENTRAL DIVISION	Un-signalized Junction	Kintu Rd	Paved	Tertiary Roads	UC III	KA
15	Grand Imperial Roundabout	CENTRAL DIVISION	Roundabout	Speke Road	Paved	Tertiary Roads	UC III	KA
17	Equatorial/ Kyagwe Rd	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU
18	Kyagwe Road Lumumba Ave	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
19	NakaseroRoad Kyagwe Road	CENTRAL DIVISION	Un-signalized Junction	Nakasero Road	Paved	Tertiary Roads	UC III	KA
20	Nigerian Embassy/Nakasero Rd	CENTRAL DIVISION	Un-signalized Junction	Nakasero Road	Paved	Tertiary Roads	UC III	KA
21	QueensLn\ Bombo Rd	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU
22	Kubiri	KAWEMPE DIVISION	Roundabout	Bombo Road	Paved	Primary Roads	UC I	KA
23	Mortuary	KAWEMPE DIVISION	Roundabout	Bombo Road	Paved	Primary Roads	UC I	KA
24	Mulago Roundabout	CENTRAL DIVISION	Roundabout	Kira Road	Paved	Secondary Roads	UC II	KA
25	Kampala Road/ Dustur Street	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
26	Kampala Road/ Square 2	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
27	KyagweRd Buganda Rd	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
28	Wampeewo Roundabout	CENTRAL DIVISION	Roundabout	Jinja Road	Paved	Primary Roads	UC I	KU
29	Garden City Roundabout	CENTRAL DIVISION	Roundabout	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA
30	Kitgum House Junction	CENTRAL DIVISION	Signalized-Junction	Jinja Road	Paved	Primary Roads	UC I	KU
32	Kampala Rd/ Parliamentary Ave	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
34	Namirembe Road Berkely Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA
35	Namirembe Road Berelay Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA
36	Bombo Road Nkizi Road Connection I	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU
37	Wandegeya Junction	CENTRAL DIVISION	Signalized-Junction	Bombo Road	Paved	Primary Roads	UC I	KU
38	Bombo Road William Street	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU
40	Haji Musa Kasule Road Nakasero Hill Road	CENTRAL DIVISION	Un-signalized Junction	Haji Musa Kasule Road	Paved	Secondary Roads	UC II	KA
41	Namirembe Road Mackay Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA
44	Upper Kolo Terrace Prince charlse Drive	CENTRAL DIVISION	Un-signalized Junction	Upper Kololo Terrace	Paved	Tertiary Roads	UC III	KA
45	Makerere Hill Road Makerere Mosque Connection	CENTRAL DIVISION	Un-signalized Junction	Makerere Hill Road	Paved	Secondary Roads	UC II	KA
47	Namirembe Road Kisenyi Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA
51	Namirembe Road Allen Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA
53	Fort Road Namirembe Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA

Junction Number	Junction Name	Division	Junction Type	Connecting Road Names	Road Surface	Map_Class	Old Road Class	New Road Class
54	Sir Apollo Kagwa Road Nsalo road	CENTRAL DIVISION	Un-signalized Junction	Nsalo Road	Paved	Secondary Roads	UC II	KA
55	Rashid Khamisi Road Gaddafi Road Roundabout	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA
56	Matia Mulumba Road Gaddafi Road	CENTRAL DIVISION	Un-signalized Junction	Matia Mulumba Road	Paved	Tertiary Roads	UC III	KA
57	Kyadondo Road Sir Apollo Kagwa Road	CENTRAL DIVISION	Un-signalized Junction	Sir Apollo Kaggwa Road	Paved	Secondary Roads	UC II	KA
60	Rubaga Road Butikiro Road	CENTRAL DIVISION	Un-signalized Junction	Rubaga Road	Paved	Tertiary Roads	UC III	KA
62	Luwumu Street Burton street	CENTRAL DIVISION	Un-signalized Junction	Luwum Street	Paved	Tertiary Roads	UC III	KA
79	Kampala Road Speke Road	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
82	Nile Avenue Colville Street	CENTRAL DIVISION	Un-signalized Junction	Nile Avenue	Paved	Tertiary Roads	UC III	KA
86	Upper Kololo Terrace Wampeewo Avenue	CENTRAL DIVISION	Un-signalized Junction	Upper Kololo Terrace	Paved	Tertiary Roads	UC III	KA
90	Old Port Bell Road Third Street	CENTRAL DIVISION	Un-signalized Junction	Old Port Bell Road	Paved	Secondary Roads	UC II	KA
91	Jinja Road Luggo Bypass	CENTRAL DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU
103	Lugogo Bypass Nviiri Lane	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA
104	Lugogo Bypass Mackenzie Vale Road	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA
105	Rubaga Road Kisenyi Road	CENTRAL DIVISION	Un-signalized Junction	Rubaga Road	Paved	Tertiary Roads	UC III	KA
113	JinjaRd_KyambogoEstateRd	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU
114	Kira Road Musizi Lane	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
115	Acacia Avenue Kira Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
116	Acacia Avenue Cooper Road	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA
117	Acacia Avenue KololoHill Drive	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA
118	Acacia Avenue Mabua Road	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA
119	Acacia Avenue Upper Kololo Terrace	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA
120	Acacia Avenue Lower Kololo Terrace	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA
121	Kayunga Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Tufnell Drive	Paved	Tertiary Roads	UC III	KA
123	Hoima Road Rubaga Road	CENTRAL DIVISION	Un-signalized Junction	Hoima Road	Paved	Tertiary Roads	UC III	KA
124	Mawanda Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Mawanda Road	Paved	Tertiary Roads	UC III	KA
136	Katego Road Kira Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
139	Namirembe Road Old Kampala Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA
140	Ginnery Road Gaddaffi Road	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA
143	School Road Boundary Close	CENTRAL DIVISION	Un-signalized Junction	Boundary Close	Paved	Tertiary Roads	UC III	KA
146	Haji Musa Kasule Road Nkilizi Road	CENTRAL DIVISION	Un-signalized Junction	Haji Musa Kasule Road	Paved	Secondary Roads	UC II	KA
147	Kyagwe Road George Street	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
149	Yusuf Lule Road Dewinton Street	CENTRAL DIVISION	Un-signalized Junction	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA
150	Kyadondo Road Makerere Hill Road	CENTRAL DIVISION	Un-signalized Junction	Makerere Hill Road	Paved	Secondary Roads	UC II	KA
151	Namirembe Road Nakivubo Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA
152	Bombo Road Wandegeya Road	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU
153	Kira Road Upper Mulago Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
154	Kira Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
155	Yusuf Lule Road Muwafu Road	CENTRAL DIVISION	Un-signalized Junction	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA
173	Gaddafi Road Mapabana Road	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA
179	Luwum Street Dastur Street	CENTRAL DIVISION	Un-signalized Junction	Luwum Street	Paved	Tertiary Roads	UC III	KA
185	Kyagwe Road William Street	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA

Junction Number	Junction Name	Division	Junction Type	Connecting Road Names	Road Surface	Map_Class	Old Road Class	New Road Class
186	Kyagwe Road Nakivubo Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
187	Kyagwe Road Makay Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
188	Kampala Road King George Way	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU
189	Lugogo Bypass Prince Charise Drive	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA
191	Kira Road Turfnell Drive	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA
193	Rashid Khamisi Road Martin Road	CENTRAL DIVISION	Un-signalized Junction	Rashid Khamis Road	Paved	Tertiary Roads	UC III	KA
197	Kyagwe Road Rashid Khamisi Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
198	Kyagwe Road Mackay Lane	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA
199	Old Kampala Road Fort Road	CENTRAL DIVISION	Un-signalized Junction	Old Kampala Road	Paved	Tertiary Roads	UC III	KA
200	Subway Round about	CENTRAL DIVISION	Roundabout	Nile Avenue	Paved	Tertiary Roads	UC III	KA

Source: JICA Study Team



Source: JICA Study Team

Figure 2.17 Long List of Junctions

2) Selected Short List

The junctions shown in Table 2.6 and Figure 2.18 were assessed using the following criteria and 28 junctions were shortlisted.

Table 2.5 Assessment Criteria for the Short List

	C1	C2	C3	C4	C5	C6	C7
Criteria	Is it located in the CBD?	Is it not overlapping with other road development projects?	Is it one of the KCCA major junctions?	Is it located along Kampala-Jinja road?	Is it manually controlled by the traffic police?	Is it currently a roundabout?	Does it have a big impact on traffic management as shown in Figure 2.16
Importance	3	2	3	2	1	3	3

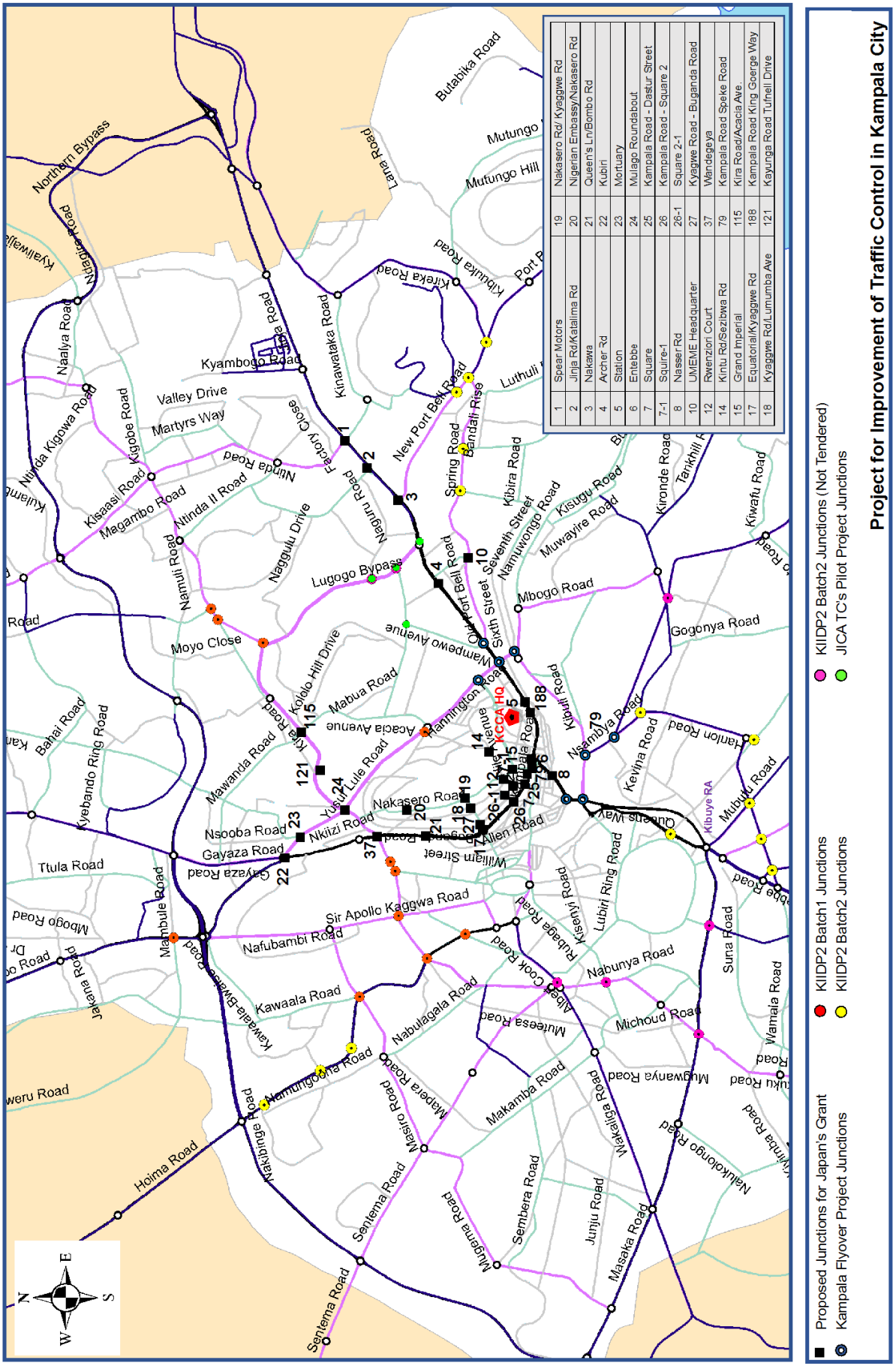
Source: JICA Study Team

Table 2.6 Results of the Short List Assessment.

JCT No.	Junction Name	Old Road Class	New Road Class	C1 CBD	C2 Other Plan	C3 KCCA 24	C4 K/J	C5 Manual Control	C6 Roundabout	C7 Traffic Management	Total
1	Spear Motors	UC I	KU	2	3	3	3	3	2	3	54
2	JinaRd Katalima Rd	UC I	KU	2	3	3	3	3	2	1	48
3	Nakawa	UC I	KU	2	3	3	3	3	1	3	52
4	Third Street	UC I	KU	2	3	3	3	1	2	3	50
5	Station	UC I	KU	3	3	3	3	3	2	1	52
6	Entebbe	UC I	KU	3	3	3	3	2	1	1	47
7	Square	UC I	KU	3	3	3	3	3	2	1	52
8	Nasser Road	UC I	KU	3	3	3	1	2	2	3	49
10	Umeme Headquarters	UC III	KA	3	3	3	1	2	2	3	49
12	Rwenzori Courts Roundabout	UC III	KA	3	3	3	1	3	3	1	48
14	Kintu Rd/Sezibwa Rd	UC III	KA	3	3	3	1	3	1	3	52
15	Grand Imperial Roundabout	UC III	KA	3	3	3	1	3	3	1	48
17	Equatorial/ Kyagwe Rd	UC I	KU	3	3	3	1	3	2	3	52
18	Kyagwe Road Lumumba Ave	UC III	KA	3	3	3	1	2	2	3	49
19	NakaseroRoad Kyagwe Road	UC III	KA	3	3	3	1	2	2	3	49
20	Nigerian Embassy/Nakasero Rd	UC III	KA	3	3	3	1	2	2	3	49
21	QueensLn\ Bombo Rd	UC I	KU	3	3	3	3	3	2	1	52
22	Kubiri	UC I	KA	3	3	1	1	3	3	3	46
23	Mortuary	UC I	KA	3	3	1	1	3	3	3	46
24	Mulago Roundabout	UC II	KA	3	3	3	1	3	3	3	54
25	Kampala Road/ Dustur Street	UC I	KU	3	3	1	3	3	2	3	52
26	Kampala Road/ Square 2	UC I	KU	3	3	1	3	3	2	3	52
27	KyagweRd Buganda Rd	UC III	KA	3	3	1	3	3	2	3	52
37	Wandegeya Junction	UC I	KU	3	3	1	3	3	1	3	50
79	Kampala Road Speke Road	UC I	KU	3	3	1	3	3	2	3	52
115	Acacia Avenue Kira Road	UC II	KA	3	3	1	1	3	2	3	46
121	Kayunga Road Tufnell Drive	UC III	KA	3	3	1	1	3	2	3	46
188	Kampala Road King George Way	UC I	KU	3	3	1	3	3	2	3	52

Source: JICA Study Team

In addition to the 28 junctions, 2 junctions namely 7-1, Square-1 and 26-1, Square 2-1 are included as they are dominated in terms of traffic movement by the junction of 7 and 26, respectively.



Source: JICA Study Team

Figure 2.18 Junctions on the Short List.

(3) Details of Improvement

The details of the improvement are classified into four types of improvement work based on the results of the field survey.

Table 2.7 Types of Junction Improvement

Type	Types of junction improvement（traffic signal installation is compulsory）
A	Convert a roundabout junction into a Cross or T-junction.
B	Utilize the existing median strip to make a right-turn lane. Widen a section of the current narrow roads. (From about 3m to 5m).
C	Setup a right turn lane using the existing median strip.
D	Install a traffic signals without doing any road improvement (Overlaying the pavement and marking of the road are done)

Source: JICA Study Team

Type A: Construction work to convert an existing roundabout into a Cross- or T-shaped junction with traffic signals. The traffic volume of roundabouts in central Kampala City exceeds their scale and traffic capacities and causes traffic congestion bottlenecks. The traffic queues flowing into a roundabout from neighboring junctions extend to inside the circle, which gets filled up and those vehicles prevent the inflow/outflow of the traffic from the directions that are not congested. This generates a paralyzed 'gridlock' situation. Converting the roundabouts into signalized junctions will help organize traffic flow. However, this will be a lot of construction work involving the relocation of underground installations and road drainage facilities within the roundabouts. Some existing roundabouts also have grown-up trees and monuments, which will need special attention during their relocation, during the junction improvement works.

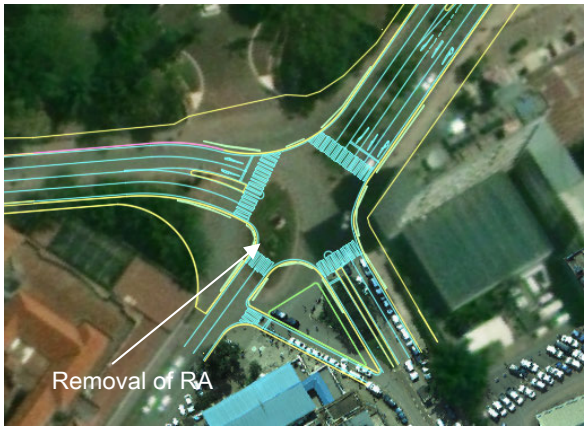
Type B: This construction work involves widening of the current road width to ensure sufficient number of traffic lanes (including right-turn lane) for smooth traffic flow. It involves the relocation of road drainage facilities (e.g. gutters) that are laid on the borders between the sidewalks and the road.

Type C: This construction work involves securing a sufficient number of traffic lanes (including a right-turn lane) to facilitate a smooth traffic flow. However, improvement works are within the median strip only without changing the existing road width (sidewalks). It's a very much easier construction, than Type B, since it doesn't necessitate any relocation of underground facilities and drainages.

Type D: It's the simplest construction since it involves only the installation of new traffic signals and no junction geometry improvements. Road markings are necessary to ensure smooth traffic flow, but it is advisable to have a new overlay since some parts of the road might be damaged.

Example of types are shown in Table 2.8

Table 2.8 Images of Types of Junction Improvement

<table>
<tr><th>Type A （e.g. No.15 Rwenzori Roundabout）</th><th>Type B （e.g.No.1 Spear Motors Junction）</th></tr>
<tr><td>Drawing
 
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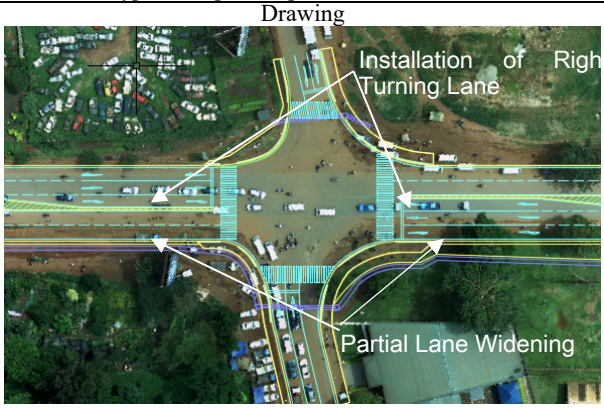
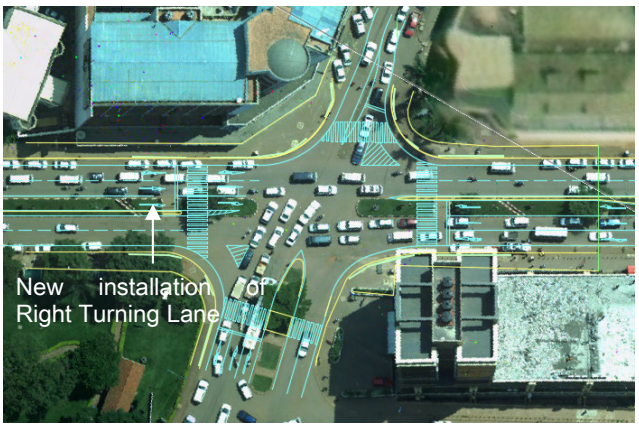
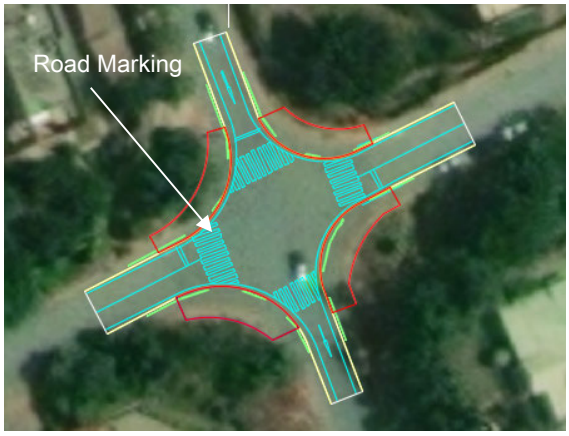
 
</td></tr>
<tr><td>Work Outline
<u>Removal of Existing Roundabouts.</u>
- Removal of plants, drainage, curs, clock towers and commercial billboards.
- Removal of the existing underground.
- Relocation of the existing underground structures and overhead lines (Covered by Uganda Government)
<u>New Construction Work</u>
- Pavement, drainage, and road markings.
- Installations of traffic signals and road lighting.</td><td>Work Outline
<u>New Construction</u>
- Construction and pavement of new right-turn lanes, road marking work.
- Installation of median strips.
- Overlay work of the existing paved section.
- Installation of traffic signals and road lighting.</td></tr>
<tr><th>Type C （e.g. No.5 Station Junction）</th><th>Type D （e.g. No.18 Kyaggwe Rd/Lumumba Ave Junction）</th></tr>
<tr><td>Drawing
 
</td><td>Drawing
 
</td></tr>
<tr><td>Work Outline
<u>Removal of the existing median strips.</u>
- Removal of plants and curbs.
<u>New Construction</u>
- Construction and pavement of new right-turn lanes, road markings.
- Installation of median strips.
- Overlay work of the existing pavement section.
- Installation of traffic signals and road lighting</td><td>Work Outline
<u>New Construction</u>
- Installation of traffic signals and road lighting.</td></tr>
</table>

Source: JICA Study Team

Table 2.9 Work Type Applications to Proposed Junctions

No	Junction Name	Existing Geometry of Junction	Manual Control by Police	Improvement Work Type
1	Spear Motors	X-junction	Applied	B
2	Jinja Rd/Katalima Rd	T-junction	Applied	B
3	Nakawa	T-junction (signalized)	Not Applied	B
4	Archer Road	T-junction	Not Applied	C
5	Station	X-junction	Applied	C
6	Entebbe	T-junction (signalized)	Not Applied	C

No	Junction Name	Existing Geometry of Junction	Manual Control by Police	Improvement Work Type
7	Square	T-junction	Not Applied	C
7-1	Square -1	X-junction	Applied	D
8	Nasser Road	X-junction	Applied	C
10	UMEME Headquarter	T-junction	Not Applied	D
12	Rwenzori Court	Roundabouts	Not Applied	A
14	Kintu Rd/Sezibwa Rd	T-junction	Not Applied	D
15	Grand Imperial	Roundabouts	Applied	A
17	Equatorial/Kyaggwe Rd	X-junction	Not Applied	D
18	Kyaggwe Rd/Lumumba Ave	X-junction	Not Applied	D
19	Nakasero Rd/ Kyaggwe Rd	X-junction	Not Applied	D
20	Nigerian Embassy/Nakasero Rd	T-junction	Not Applied	D
21	Queen's Ln/Bombo Rd	T-junction	Applied	D
22	Kuburi Roundabout	Roundabouts	Not Applied	A
23	Mortuary Roundabout	Roundabouts	Not Applied	A
24	Mulago Roundabout	Roundabouts	Not Applied	A
25	Kampala Road- Dastur Street	T-junction	Applied	C
26	Kampala Road - Square 2	X-junction	Applied	D
26-2	Square -2	X-junction	Applied	D
27	Kyagwe Road- Buganda Road	X-junction	Not Applied	D
37	Wandegeya	X-junction	Applied	B
79	Kampala Road Speke Road	X-junction	Not Applied	D
115	Kira Road/Acacia Ave.	X-junction	Not Applied	D
188	Kampala Road King Goerge Way	X-junction	Not Applied	D
122	Kayunga Road Tufnell Drive	X-junction	Not Applied	D

Source: JICA Study Team

(4) Design Policy

The basic policy for road design is as follows:

- Make junction improvements using the available land on the site, without any additional land acquisition.
- Plan not to modify as many places with underground facilities as possible to avoid the relocation of those underground installations.
- Set design vehicles for each junction to determine the configuration of the junction based on the vehicle-passing conditions of the junction.
- Convert roundabouts into signalized junctions. (Relocation and removal of the monuments, trees, utility poles and buried objects will be involved).

(5) Junction Design Standards

The design standards applied in this project are as follows.

Junction Design

- Planning and Design of Level Crossing (Basic edition, applied edition), Japan Society of Traffic Engineers (herein referred to as 'Japan Standards'）
- Planning and Design of At-Grade Junction, Kampala Smart Traffic Project(KSTP)
- Traffic Signal Design and Installation,（KSTP）
- Road Design Manual Volume1: Geometric Design, (Ministry of Work and Transport):（Herein referred to as Uganda Road Standards）

Pavement Design

- Road Design Manual Volume3: Pavement Design, (Ministry of Work and Transport)
- AASHTO Guide for Design of Pavement Structures 1993

Drainage Design

Road Design Manual Volume 2: Drainage Design, (Ministry of Work and Transport)

(6) Junction Planning

This project is not for the improvement of the entire road network but rather for design improvement of some special junctions. Thus, plan and design improvements will be for the junctions' sections only and do not include linear planning and design of the whole span of the roads. The basic policy for junction planning and design is as follows:

- Determine the junction flow path trajectory using the design target vehicles that conform to the actual site to determine the positions of the stop lines.
- Setup a pedestrian crossing by following the traffic signal installation at the target junctions.
- Determine the appropriate configuration (storage length, taper length, and lane shift length) of the junction crossings.
- Plan for a plant area for the space that remains after converting a roundabout to a T-Junction.

1) Design Target Vehicles and their Path

The design target vehicles are classified into three types: largely small-size vehicle (passenger vehicles), medium-size vehicles (large buses) and semi-trailers. The paths for these 3 vehicle types are determined by comparing the road standards between Uganda and Japan and the Japan Road Standard, which specifies larger path radii, will be adopted so that the vehicles can safely pass through the junctions.

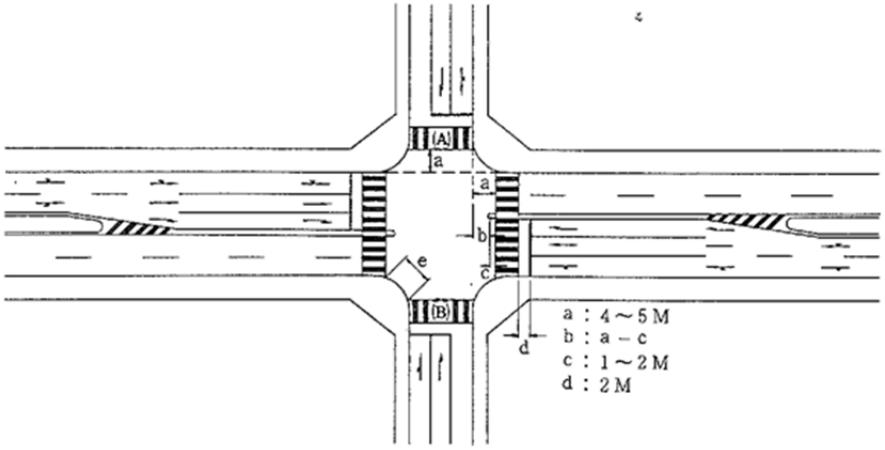
Table 2.10 Design Target Vehicles and Path Radii

Standard	Uganda Road Standards			Japanese Standards		
Design Target Vehicle	Minimum outer radius (m)	Minimum inner radius (m)	Flow Radius (m)	Minimum outer radius (m)	Minimum inner radius (m)	Flow radius (m)
Small-size vehicles	7.3	4.2	3.1	8.0	4.0	4.0
Medium-size vehicles	12.8	7.4	5.4	13.0	7.5	5.5
Semi-trailers	13.7	5.8	7.9	13.0	4.5	8.5

Source: JICA Study Team

2) Pedestrian Crossing Installation Position.

There are generally many road accidents involving motorcycles and pedestrians and left-turning motor vehicles at junctions. In Uganda, boda-boda riders particularly have poor road manners and there to enhance the safety of pedestrians from left-turning boda-bodas and vehicles, pedestrian crossings will be placed 4 to 5m away from junctions.

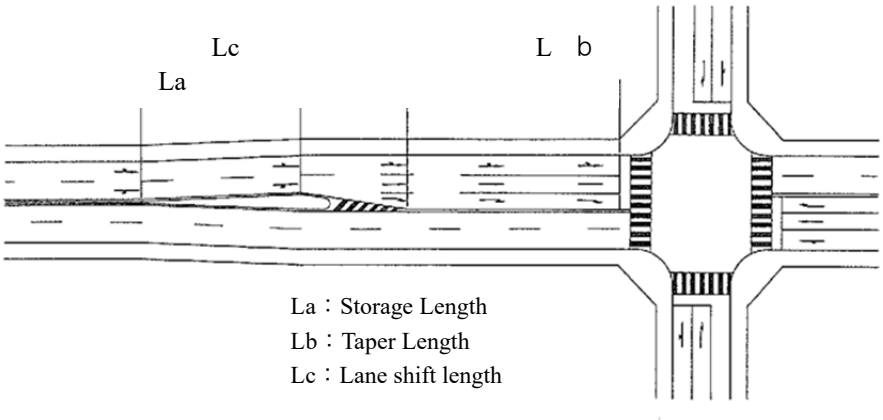


Source: Planning and design of Level Crossing (Basic Edition, Advanced Edition, Case Studies), Japan Society of Traffic Engineers.

Figure 2.19 Position to install pedestrian crossings.

3) Cross-sectional Configuration of Junctions.

Cross-sectional configuration of junctions will be determined based on the Japan Standards. However, for sites where a sufficient storage length cannot be arranged due to the space availability or where a right-turn lane cannot be installed, the cross-section will be planned to suit that site. For the taper length and lane shift length, the larger value of the minimum value specified in the Japan Standards and the value that was calculated according to actual site conditions will be the adopted value.



Source: Planning and Design of Level Crossing (Basic Edition, Advanced Edition, Case Studies), Japan Society of Traffic Engineers

Figure 2.20 Names of Cross-section structure of Junction

Table 2.11 Standard for Cross-section Configuration.

Configuration of Junction Crossing	Minimum Value (m)	Calculated Value (m)
Taper Length	20	V x W/6
Lane shift length	35	V x W/3

V：Design Speed（50km/h）, W：Lateral lane volume shift （m）
Source: JICA Study Team

(7) Pavement Design

1) Design Principal

The principal for the pavement design, based on the field survey results, should be as follows.

- The axle load coefficient and the pavement design year plan for the Kampala Flyover design need to be correlated in order to calculate the axle load for the pavement design.
- The Study Team proposes that the current roundabout pavement composition is compared to AASHTO and the Uganda Road Design Pavement Manual in order to have a safe pavement composition。
- Since the traffic volume of the sites where the median strips will be removed to place a right-turn lane is considered to be small as only right-turning vehicles will pass, adopt the pavement composition of the road class that is recommended by KCCA at those sites.

2) Design Year Plan and Axle Load Coefficient.

Design Year Plan

In the Uganda Road Design Manual Pavement manual, it is assumed that arterial roads like Kampala-Jinja should last up to 15~20 years. Considering the reliability of road pavement, 10~15years should be adequate for the roads in the area surrounded by Kampala-Jinja and Yusuf Lule roads since very few large-sized vehicles go through that area. The Study Team considers the design lifespan under this project at 15 years to be adequate since that of Kampala Flyover is planned for 2033.

Table 2.12 Pavement Design Planned Period

		Importance/Level of Service	
		Low	High
Design Data Reliability	Low	10– 15 Years	15 years
	High	0 – 20 Years	15 – 20 Years

Source: SATCC

Axle Load Coefficient

The same axle load coefficient that's being used for the Kampala Flyover Project, whose design has already started, will be adapted to the project.

Table 2.13 Pavement Axle Load Coefficient

Project	Vehicle Category and VEF			
Jinja Bridge	Large Bus	Two-axle	Semi-trailer	-
	0.56	4.20	15.80	-
Mpigi	Large Bus	Medium	Heavy	A-Truck
	2.00	3.50	5.00	8.00
Jinja BP	Large Bus	Two-axle	Three-axle	Four-axle and more
	-	4.50	5.97	6.12
Kampala Flyover	Large Bus	Medium	Heavy	-
	2.00	3.60	5.27	-

Source： Final Report of the Preparatory Survey on the Greater Kampala Roads Improvement Project in the Republic of Uganda

3) Pavement composition of the right-turn lane section.

Remove the existing median strip and construct a new pavement composition. The right-turn lane is provided at the

Kampala-Jinja and Entebbe road and according to the road class shown in the table below, the pavement composition proposed by KCCA standard to Class A. Therefore, the pavement composition of the right-turn lane will be of Class A. Since the scope of work is small, a crusher run should be used for the lower layer of the road sub base instead of a lime-stabilized sub base.

Table 2.14 Pavement Configuration proposed by KCCA.

Feature	Proposed KCCA Road Classification Criteria			
New Road Class	U	A	B	C
General Description	High Standard Dual carriageway road carrying traffic predominantly through traffic with limited access and may have motorway restrictions	Good standard single/dual carriageway road with frontage access and more than two side roads per km	Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at grade pedestrian crossings	Busy road carrying local traffic with traffic friction from frontage activity, side roads, bus stops, loading and unloading plus several at grade pedestrian crossings
Speed Limit	70kmph	50kmph	40kmph	30kmph
Desirable Pavement Layer Structure.	Surfacing layer: AC 50mm Base Course Layer: Crushed Stone GB1-150mm Sub base Course layer: CB2 Lime-stabilized Natural Gravel- 175mm Capping layer: Natural Gravel 100mm	Surfacing layer: AC 50mm Base Course Layer: Crushed Stone GB1-150mm Sub base Course layer: CB2 Lime-stabilized Natural Gravel- 175mm Capping layer: Natural Gravel 100mm	Surfacing layer: AC 50mm Base Course Layer: Crushed Stone GB1-150mm Sub base Course layer: CB2 Lime-stabilized Natural Gravel- 175mm Capping layer: Natural Gravel 100mm	Surfacing layer: AC 50mm Base Course Layer: Crushed Stone GB1-150mm Sub base Course layer: CB2 Lime-stabilized Natural Gravel- 175mm Capping layer: Natural Gravel 100mm

Source：KCCA

4) Composition of Pavement in Widened Sections

Junction No. 1, the Spear Motors junction, requires lane widening based on the results of an axle load estimation and a geological survey and according to the Uganda paving manual, the pavement composition of the widened section of this junction shall be as follows.

- Results of axle load estimation (equivalent single axle load (ESAL)): 22.0 x 10^6
- CBR: 6
- Uganda manuals S3, T8 apply.

Asphalt Pavement	15 cm
Base Course	20 cm
Subbase Course	32.5 cm

2.2.4 Traffic Control Centre Building

(1) Cooperation Scale

For the 3-storey scheme that satisfies the design condition proposed by KCCA, floors from the semi-basement to semi-ground floor become the parking and storage (available number of cars parking: 12 cars, 8 motorcycles) and the traffic control centre function is placed in the first and second floor. The scale and content of each rooms are planned as below for this project's traffic control centre.

Table 2.15 Outline of Facilities in the TCC

Building Description	Description of the Facilities
Traffic Control Centre (semi-basement and semi-ground floors are the parking and storage, 3-stories high)	Semi-basement floor: parking, security check room, power room, water tank room, staircase Semi-ground floor: parking, security check room, storage, staircase First floor: director room, vice-director room, manager room, secretary room, office room (centre operation, system operation plan), machinery room, vault room, night duty room, hot water room, maintenance room, communication connection room, conference room, restroom (male and female), storage, staircase, common corridor Second floor: control room, traffic control guidance room, waiting room for police, security check booth, locker room (male and female), halogen fire extinguishing chamber, storage, restroom (male and female), handicap restroom, staircase, common corridor, outdoor unit space, connecting bridge to existing building

Source: JICA Study Team

The information sent from the detector and controller is processed and analyzed by the traffic control centre and adjusted in the control room, where a large monitor is installed, which is placed in the top floor to avoid the central column from blocking the visions of coordinators and for the visitors to easily see. It relates to the machinery room downstairs by a cable inside the EPS (electric pipe space/shaft) and each floor is planned as a raised floor to provide the freedom of the placement of equipment and the area around the feet. The Study Team would deal with the floor load by the thickness of the slab and the air conditioning would manage the temperature and humidity 24 hours. The security would be thoroughly managed for the entry and exit of the control room and machinery room by contactless card. There are two system operation officers at all times and four at emergency times. There is a waiting room for traffic police closely positioned in case of VIP support and disaster measures. There is a maintenance room close to the machine room for the daily repair and maintenance of equipment, and 2 people correspond 24 hours. There is a space possible of accommodating maximum of 30 people at the floor where the traffic control guidance room is, where you can in addition tour the control room, educate the traffic rules and manners though videos showing examples of traffic signals, traffic signs and traffic accidents.

(2) Facility Plan

The required rooms and layouts for the Traffic Control Centre are shown as below.

Table 2.16 Required Rooms and Layouts for the Traffic Control Centre

Floor	Required Rooms and Layouts
2nd Floor	Control Room: The main room of the Traffic Control Centre installed with a large screen. It is planned for the system to operate 24 hours and capable of accommodating maximum of 4 people. Traffic Control Guidance Room: The main purpose is the tour of the Traffic Control Centre and learning the function of it. Through this, we educate the traffic rules and traffic ethics to the other traffic instructors and the room becomes also a space for exhibition and training. Based on a single class (30 people size) of a public school, we plan the accommodating capacity to 30 people. Waiting Room for Police: There are two people standing-by coordinating with the control room for VIP security and disaster measures. Halogen Fire Extinguishing Chamber: Extinguishing gas is required for extinguishing fire of computers, so the Study Team plans this room for storing the cylinder necessary and operating them. The cylinders are carried using the elevator in the existing KCCA building. Locker Room: A locker room (male and female) is planned for the changing of clothes and storing baggage for staffs. Common Space: Storage and restroom (including handicap restrooms) are planned.

1st Floor	Office Room: There is a space planned for accommodating maximum seven people in charge of operating the centre and four people in charge of planning the operation of the system. Conference Room: 10 people per room is planned. Director Room: A room for one director of the Traffic Control Centre is planned. Machinery Room: A machinery room that has the machinery and servers mainly related to the equipment installed in the control room. The floor is planned as a raised floor. Maintenance Room: A room planned for the maintenance personnel for the facility and ITS system. Vault Room: A room planned for placing the vault. Mainly the software for ITS and backup data are stored. Hot Water Room: It is planned to place a sink and a microwave stand. Night Duty Room: Mainly for the replacement personnel of emergencies (24-hour schedule) to take a nap. The planned number of people is two and a restroom and shower room are also planned inside the room.
Semi-Basement and Semi-Ground Floors	Parking: A space including the storage part and able of parking 12 cars and 8 motorcycles.

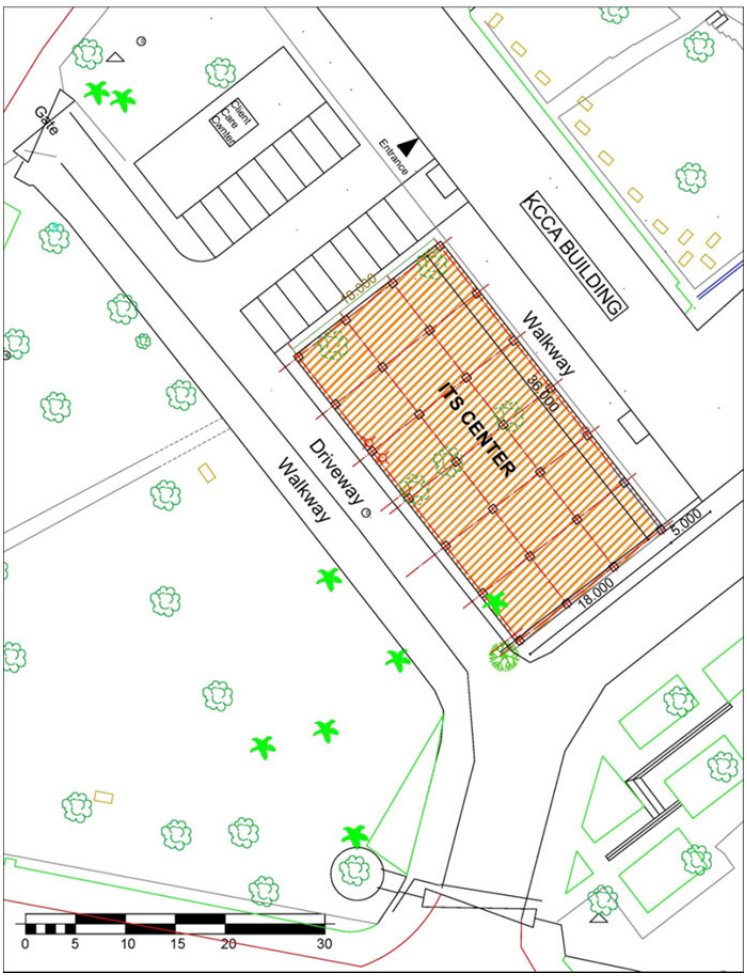
(3) Architecture Plan

Based on the plan of newly building a Traffic Control Centre inside the site of KCCA, we have confirmed the proposed project site and examined the proposed facility composition, layout plan and circulation of each rooms and staffs.

1) Site Planning

The proposed site for the new facility is a part of the existing KCCA area. Thus, JICA Study Team considered the appropriate layout and its planned subject-range in relation to the existing KCCA building sub-entrance, which stands next to the facility in the existing site, Physical Planning and Land Transaction Client Care Centre (CCC) and the green space and made it as in Figure 2.21

In Uganda, when you cut down trees, it is required to plant the double of trees you cut down. JICA Study Team plans cutting down 7 existing trees shown in Figure 2.21, in the planned site, so the Study Team plans to compensate 14 trees.



Source: JICA Study Team

Figure 2.21 Traffic Control Centre Planned Site

2) Layout Planning

The Traffic Control Centre's layout plan is considering the function linkage to the existing relating facilities. Especially the Study Team secured the necessary distance between the buildings, in order to install a connection bridge between the existing KCCA Building and the new Traffic Control Centre.

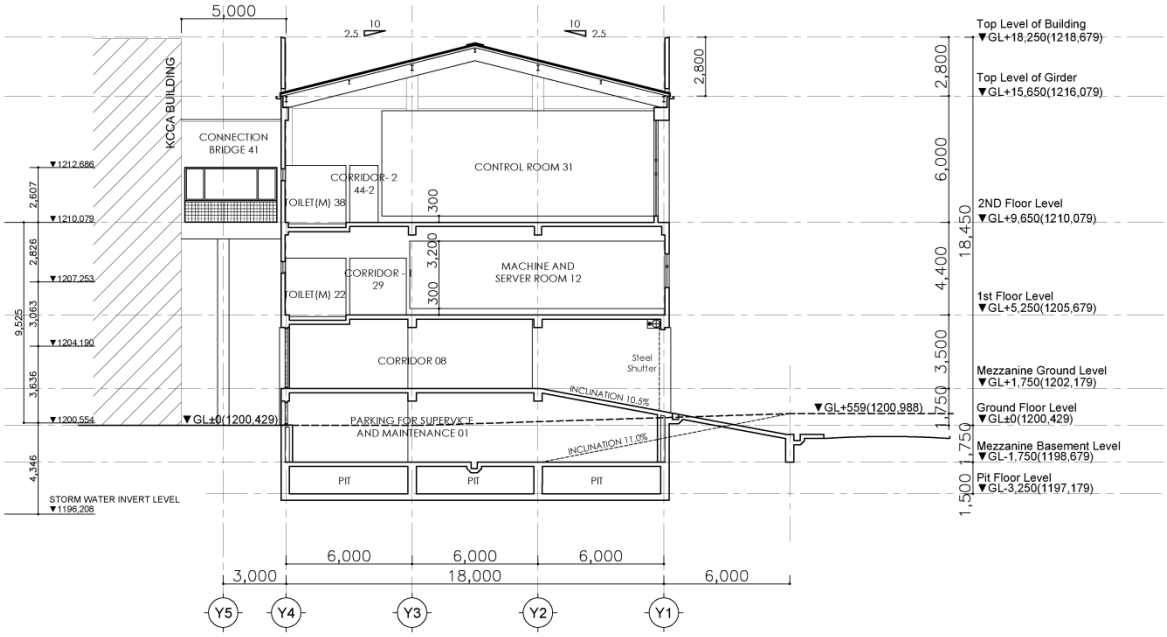
3) Floor Planning

The floor planning is based on the zoning and examination of the function and scale of each room. The main direction of the floor planning is arranging the entrance half-floor higher than the entrance of the existing building and separating with the entrance of the parking and laying out the electric machinery room on the street-side, so that the loading and maintenance becomes smooth.

The water tank room is planned to be layout below the elevated tank on the rooftop. The 1st floor is constituted by machinery room, office management rooms and night duty room and the 2nd floor is constituted by the control room and learning and exhibition space for the tour of the visitors. The Study Team would plan for the access to the 2nd floor by using the elevator of the existing KCCA building and cross over the bridge for carrying the cylinder for the Halogen Fire Extinguisher and heavy equipment and also for handicap people. In addition, the Study Team would plan a handicap restroom on the 2nd floor.

4) Section Planning

Consider thoroughly the condition that it is a Traffic Control Centre and the natural feature and climate of Kampala City for the section planning and take in note the following points. Plan the access to the existing KCCA building from the bridge on the 2nd floor and set the height of the 1st floor and semi-ground floor based on the 2nd floor. Plan the parking in 2 levels (Semi-basement and Semi-ground floors) and make the height that can use the efficient semi-basement floor for the access to the parking. Plan the pitched roof as a design covering the roof with parapet similar to the existing KCCA building.



Source: JICA Study Team

Figure 2.22 Section Planning Drawing

5) Structure Plan

[A] Design Principal

The Study Team would make the following principal for structure design of the project.

- Properly grasp the ground condition, such as the geological feature, ground water level and bearing layer of the proposed site and design a safe and efficient foundation and semi-basement floor.
- Design the structural type without difficulties in usage, considering also the deflection of long-term loading and oscillation.
- Design it the basis that the building does not lose its yield strength in terms of strong wind and short-term loading times and has enough safety.
- Apply the construction method and structure design simple and durable that bring better constructability.

[B] Construction Method and Material Used.

The Construction method is mainly rigid frame structure made with reinforced concrete, which is common and economical locally. Also, the roof structure of the main parts is steel structure, which the Study Team plans it to be a pitched roof using colored galvalume metal roofing.

[C] Structural Design Principal

Design the bearing layer by sand and/or gravel with the N-value equal to 16 or more, found at 1.0m below or deeper than the existing ground level and the long-term allowable bearing capacity 120kN/m^2.

- Design a layer 150mm thick of crushed stone below the earth floor.
- Design a spread foundation (mat foundation) at lowest level of the foundation and soil stabilization (1.0m or deeper than GL-3.55m) by adding cement based solidifying material at low points (between X6-X7) in relation to the site gradient. The height of GL-3.55m and conduct. Design crushed stone 150mm + leveling concrete 50mm at the ground below the foundation.
- There are almost no earthquakes observed in Uganda but employ the base shear coefficient Co=0.1 that is applied in other grant projects as a safety design for the earthquake-resistant design.
- Apply the basic wind pressure 30m/sec for the wind-resistant design.
- The loading capacity for the roof, office and parking is the values below based on the Japanese standards for the design loading capacity.

• Design Loading Capacity for the Floor and Joists	• Roof：900N/m2 • Office：2,900N/m2 • Parking：4,000N/m2

(4) Design Specifications

1) Status of the Surrounding infrastructure and the existing facilities.

The following results of the surrounding infrastructure and existing facilities were obtained following discussions with UMEME Ltd, (the power company), National Water & Sewerage Corporation (the water company), etc. and a field survey of the existing KCCA premises.

[A] Water Supply

On the western side of the site is a National Water and Sewerage Corporation 200mmφ main distribution pipe running from the southwest to the northeast. The existing water supply draws water from this main pipe through a 50mmφ pipe. This water supply lead-in pipe was retired and the new lead-in has been in use since February 2017.

The water supply method and volume from the existing water supply are as follows:

- Water supply lead-in system.

  Service pipe diameter: 50mmφ, meter size: 50mmφ

- Water Supply Method

  System: Overhead water tank method

  Overhead water tank capacity: External dimensions 2m x 2m x 1m(height)

  Capacity: 4,000litres, No. of tanks: 2units

- Actual water supply quantity data.

The table below is the water supply quantity data that was received from KCCA during the field survey.

Table 2.17 Actual Calculated values of the water supply quantity

	2017					
	February	March	April	May	June	Monthly Average
Water Supply Quantity	1752m^3/month	1820m^3/month	1949m^3/month	1524m^3/month	2304m^3/month	1870m^3/month

Source: Billing information from National Water & Sewerage Corporation to KCCA

The above average daily water consumption of the KCCA premises, which is covered by grant aid, was calculated from the average monthly water consumption above:

Average Daily Water Consumption 1870m3/day ÷ 30days/month ＝62.3m3/day

[B] Water supply method for the planned Traffic Control Center

The Study Team provided explanations to National Water & Sewerage Corporation New Connections Department about the water supply method (water receiving tank, pump, overhead water tank method) for the planned building. In this discussion, the Study Team agreed that instead of running another service pipe from the existing 50mm service pipe, the Study Team will connect a new service pipe exclusively for this project with the 200mm water main (from Sir Apollo Kaggwa Road or Kimathi Avenue). NWSC also informed us that the current supply water pressure of the water main is 1.2MPa. NWSC does not have a unit price for the water service work and thus are supposed to prepare a cost estimate after they measure and confirm the positions of the building and water pipes after construction has begun. However, they agreed to make an estimate in advance based on the drawings to be provided.

[C] Waste Water.

In Kampala city, buildings are not equipped with septic tanks, and domestic sewage (sewerage and other waste water) is discharged directly to the sewerage pipes managed by NWSC, which then treats it. It was thus agreed that the domestic sewage from the toilets, washrooms etc. of the planned building will be discharged directly to the NWSC sewerage pipes.

[D] Electric Power

The existing KCCA building receives power from UMEME's underground transmission line (11kV/0.415kV), which is stepped down via its power room. The capacity of the power room equipment is approximately 282KVA.

The existing KCCA building's electrical system and distribution status are as follows:

- Low voltage power (from UMEME) → 415V 3-phase, 4-wire, 50Hz,
- Existing power receiving equipment.

  Power receiving system: Low voltage power 414V, 3-phase,4-wire, 50Hz

  Year of Construction: 1947 (As heard)

- Distribution System

3-phase, 4-wire, 415V/240V, grounding method: TN-C method (neutral conductor and protective conductor combines method)

Main Breaker: 400A

The main low-voltage line from the power room is sent to the power distribution board of the EPS shaft of the existing building using cables. The Study Team requested for the actual data of the power consumption (the

maximum demand power and the power consumption) of the existing buildings.

- Power supply to the planned Traffic Control Center.

A meeting between the UMEME Customer Service engineer, the KCCA electrical engineer and the study team in-charge was held. The Study Team explained the overview of the project and the estimated capacity (500KVA) and below is the feasibility of the method.

Power Entry: A new dedicated power room, separate from that of the existing building, will be setup and it will draw power from UMEME's medium power line to exclusively feed power to the traffic control center.

UMEME believes that the above method is appropriate and KCCA also agreed with it.

It was also confirmed that medium power (11kV, 3phase, 3-cable, 50Hz) could be tapped from UMEME. The Study Team further requested for a quotation for the cost of the medium power for the planned power equipment capacity equivalent to 500kVA.

2) Planned Traffic Control Center Facilities.

[A] Water supply Equipment

National Water & Sewerage Corporation is exclusively in charge of water supply business (water distribution, water supply and water discharge) in Uganda. Through the discussion with the National Water & Sewerage Corporation, the Study Team reached the agreement that water will be drawn to the traffic control center from the 200mm water main that is laid along the west-side road (Apollo Kaggwa Road) or the south-side road (Kimathi Avenue) of the planned site without using the existing water service system (50 mm) for KCCA.

National Water & Sewerage Corporation will supply water to the planned Traffic Control Center.

Main water pipe diameter 200mmφ

Water Pressure 1.2MPa

- Estimated daily water consumption:

Number of Consumers:	Traffic Control Center	Staff	15 people	
		Visitors		30 people
		Total		45 people
	Existing building		Staff	219 people
			Visitors	70 people
			Total	289

Water consumption per unit was calculated from the actual values of the existing KCCA.

Average daily water consumption (actual value) 62.3m3/day

No. of users in existing building approx. 290 people

Average daily water consumption per person 215liters/person/day

Maximum water consumption per person 323liters/person/day

(Average water consumption x 1.5

Based on the above conditions, the daily consumption of the traffic control center is:

Staff	15people x 323liters/person/day	＝ 4,845liters/day
Visitor	30people x 323 liters/person/day	＝ 9,690liters/day
Total		14,535 liters/day →15m3/day

- Water supply System and Capacity of the main equipment

As a water supply system for the 5-story building, the Study Team planned to establish an overhead storage tank (receiving tank + pump + elevated tank) to ensure a stable water supply with enough pressure to supply the whole building using gravity. Considering the aspect of hygiene, the receiving and overhead tanks will be of FRP make that can be placed on the ground. The tanks will be twin type to make it possible for cleaning without cutting off water supply.

The capacity of the water receiving tank and the overhead water tank should be equivalent to the daily consumption and the average hourly water supply, respectively. The water-receiving tank will be placed in the ground water tank room.

Water Receiving Tank:	Capacity	15m3/day × 100% ＝ 15m3
	External Dimensions	3m × 3m × 2m（Height）
Overhead water tank:	Capacity	15m3/day × 1/8 × 2 ＝ 3.75m3
	External Dimensions	1m × 2m × 2m (height)

- Prevention of Cross Contamination

In order to prevent a reverse flow due to the negative pressure inside the piping, a backflow prevention valve will be installed in the water supply system of the planned traffic control center.

[B] Drainage Equipment

The plan is to discharge the domestic sewage to the sewage pipes managed by National Water & Sewerage Corporation. The rainwater collected at the roof of the building and the surface around the building shall be discharged to the existing public drainage system.

[C] Sanitary Equipment

Most of the toilets installed in the existing KCCA building are western style toilets and a few others are Asian-style toilets. In this project, all the toilets in the restrooms will be western style toilets. The Study Team shall also add toilets for the disabled on the 4th floor.

[D] Fire Fighting Equipment

The Fire protection law for buildings is not developed in Uganda. Instead, the building designer in accordance with the British Standard (BS) determines installation of fire-fighting equipment and the Ministry in charge of construction applications examines it. In this case indoor fire hydrants and fire extinguishers effective for putting out the initial fire will be installed based on the building use and scale. Also, a halogen gas fire extinguishing system will be installed in the control and machine rooms.

[E] Air-conditioning Equipment

Kampala City, which is the target site of this project is located almost at the equator at 0deg 19min north, and 1135m above sea level. It has a savannah climate with a dry season in January and July and abundant rainfall from March to May, and in November. Considering such a climate and the planned building room use, air conditioning will be installed in the rooms where the appropriate indoor environment needs to be maintained. The following rooms will be equipped with general air conditioning equipment.

【4th Floor】 Control Room, Visitor's room.

【3rd Floor】 Police standby room, machine room, machine room (for server storage), communication connection room, director room, conference rooms (2), secretary room, office room (for operation staff of the center), office room (for system operation planning staff)

【Ground Floor】 Electrical room, water receiving tank room

As general air conditioning equipment, plan for split-type air conditioners that can be individually operated.

[F] Ventilation Equipment

In order to eliminate bad odors, heat, and humidity, install ventilation equipment in the rooms listed in Table 2.18 below. With reference to the ASHRAE standards mentioned earlier and the design standards of Japanese Ministry of Land, Infrastructure and Transport, the table below shows the ventilation equipment design standards to be applied.

Table 2.18 Ventilation Equipment Design Standards

Room Name	Ventilation Type	Unit Ventilation Volume	Remarks
Living Room	Exhaust fan only	6times/hour	
Bathroom	Exhaust fan only	10times/hour	For elimination of bad odor
Water Receiving tank room	Exhaust fan only	3times/hour	
Electrical Room	Exhaust fan only	10times/hour	For heat elimination

Source: JICA Study Team

[G] Transformer Equipment

The existing facilities receive the low-voltage power of 415V from UMEME and distribute it from the power room to each power distribution board. From the consultation with UMEME on supply of power to the planned building, UMEME expressed the opinion that instead of getting the low-voltage power from the existing power room, a new exclusive medium-voltage power line should be planned for traffic control center. The understanding was that the cost of the new power line would be borne by the Uganda side.

Received Power: 11kV, 3phase, 3wire, 50Hz

- Problems of the existing electrical facilities.

  There are no existing schematic drawings of the existing electrical facilities. The electrical room for the low-voltage power is equipped with old feeder boards and newly installed feeder boards, which are all mixed together and the cables between those boards are all on the floor without any cable arrangement. In addition, a low-voltage AVR (Automatic Voltage Regulator) that was installed was left disassembled and abandoned. The Study Team measured the voltage fluctuation with a HIOKI power quality analyzer (3197) from June 20th ~ 27th. The observed fluctuation range was about -20~5V per day.

- Estimated Capacity

Table 2.19 shows the calculated estimated capacities of the transformer equipment.

Table 2.19 Estimated Load Capacities

Load Name	Load Density (VA/m2)	Floor Area (m2)	Load Capacity (KVA)	Remarks
Office level, traffic control center level				
Lighting outlet load	50	1360	68.0	
Air-conditioning equipment	85	740	62.9	
Sanitary Equipment	-	-	30.0	

Traffic Control System Equipment	-	-	100.0	(Rough estimate)
Parking Level				
Lighting outlet load	20	2505	50.1	
Air-conditioning equipment	-	-	-	
Sanitary Equipment	-	-	-	
Electrical room, Generator room, Water tank room				
Lighting outlet load	20	144	12.0	
Air-conditioning equipment	85	108	9.2	
Sanitary equipment	-	-	11.0	
Total Traffic Control Center Power load			343.2	

Source: JICA Study Team

From Table 2.19 above, the total estimated capacity of the equipment is 343.2KVA. Assuming that the demand ratio is 50%, the maximum demand power will be 171.6KVA.

[H] Emergency Power Equipment

During the survey in Kampala, the Study Team experienced situations where the generator was started several times, every time there was a power outage (of about 2~4 minutes). In addition, the Study Team observed a power outage of about 90 minutes from 8p.m. on June 22nd while measuring voltage, with the HIOKI power quality analyzer (3197) from June 20th to 27th, in the existing low-voltage room.

KCCA is equipped with one emergency generator with details as follows:

- Outside generator room 350KVA x 1 unit

- Maintenance Conditions

The periodic inspection is done every 100hours of operation and spare parts are available from an outsourced service provider. Outside the 100hrs, inspection is also carried if the generator did not start automatically. The traffic control center will be in a 24-hour operation. The control room, machine room and electrical room will also need air conditioning management all the time. This means that continuous operation of the equipment is vital and thus a new emergency generator will be installed. In addition, for the period between power outage and generator start-up, a backup power UPS (uninterruptible power supply) device will also be installed. The Study Team is planning to install a generator that can accommodate the minimum load in order to protect enable the traffic control center function during power outages. The capacity of the emergency generator is expected to be 70% of the maximum power demand.

【Type】 Indoor installation.

【Capacity】 3-phase, 4-wire, 380V 50Hz 125kVA

【Operating Time】 10hours(Long time operation specifications)

【Fuel】 Petrol

【Quantity】 1 unit

[I] Main Equipment

From the 3-phase 4-wire 415/240V 50Hz low-voltage main power in the electrical room, power will be classified by system based on the load applications and facilities. It will then be distributed to each place via the distribution switchboard. The main capacity is set to satisfy the proper voltage drop and allowable current value according to the capacity of the equipment to be connected. For the cabling system, the cable rack method will be used, in principle, inside the shaft and conduits for the other places. The power distribution system should be as follows.

Distribution System	Main:	3φ4W 240V/415V
	Single Phase load:	1φ2W 240V
	Power load:	3φ3W415V

[J] Lighting Equipment

Putting into consideration the maintenance and running cost, the straight-type LED (light emitting diode) should be planned for the rooms and corridors. In reference to the average of the international illumination standards and JIS (Japanese Industrial Standards), and taking account of the current situations in Uganda, the illumination level (general illumination) should be specified as follows:

Table 2.20 Design Illumination Level

Office rooms, Control room	500lux
Director and Secretary's rooms	500lux
Night duty room, Hot water room	200lux
Electrical room, Machine room	200lux
Corridors, Staircases	100lux
Restrooms, Storage room, Locker room	100lux

Source: JICA Study Team

In principle, each room should have a separate circuit to enable the switching on/off the light. Power is distributed to the lights and power outlets using a single-phase 2-wire 240V. Plan to install appropriate guide and emergency lights in rooms such as the entrance & exit room, control and machine rooms and evacuation routes such as the staircases.

[K] Telephone Equipment

The Study Team plans to install a telephone switch box in the power room on the ground floor of the traffic control center. Telephones are to be installed in the following rooms: office room (for operation staff of the center), office room (for system operation planning staff), control room, director's room, secretary's room, and maintenance room. The number of service lines and extensions for the planned building are assumed to be 1 and 6 respectively.

It was agreed that the telephone line will be drawn from the existing building server room to the terminal board of the planned traffic control center and the KCCA will be responsible for the wiring and its costs.

[L] Local Area Network (LAN) Equipment

An office LAN is planned for the control room on the 4th floor, the visitor room, and the office rooms (center and system operations) on the 3rd floor.

It was agreed that an optical cable would be drawn from the server room of the existing KCCA bedroom to the switch that will be installed in the planned traffic control center, and KCCA will be responsible for the cabling and any costs involved.

[M] Common Antenna Television Equipment

The common antenna television equipment will be installed in the planned building. Since detailed information regarding situations such as accidents can be acquired from TV broadcasts, a TV outlet will be installed in control room on the 4th floor, officer room (central operations) on the 3rd floor and the director's room.

[N] Entry and Exit Control Equipment

An entry and exit control system will be installed in the planned building. Since entry and exit to the 3rd floor machine room and 4th floor control room must be strictly limited to only permitted personnel, an entry & exit

contactless card management system will be installed with the control rack in the office on the 3rd floor.

[O] Closed-Circuit Television (CCTV) Equipment.

CCTV system will be installed in the planned building. The CCTV cameras will be installed in the following places: the security check, parking security check, emergency staircase, electrical room, and entry & exits points to the receiver water tank room all on the ground floor and the security check and control room on the 4th floor. The surveillance monitor should be installed in the office room (central operations) on the 3rd floor.

[P] Emergency Call Equipment

An emergency call button will be installed in the disabled personnel restroom on the 4th floor is planned and emergency call display equipment will be installed in the 3rd floor office (center operations).

[Q] Fire Alarm Equipment

A fire alarm system will be installed in the planned building, with bells, red lights, push buttons on each floor and each warning zone. In order to detect any fire in its early stages, an automatic fire alarm system with smoke detectors will be installed. A fire alarm receiver will be installed in the office room (Center operations) on the 3rd floor.

[R] Lightning Rod Equipment

The height of the planned building is less than 20m, and also it is protected by the lightning rod equipment of the existing building. Thus, a lightning rod equipment would not be installed.

2.2.5 Optical Fiber Network Design

(1) Specifications for Optical Cables

The optical fiber network is an information communication network that efficiently performs large-capacity transfer of information taking advantage of the characteristics of optical fibers. Its characteristics and properties shall be as follows.

1) Single-mode (SM) Optical Fiber

This is optical fiber that has only one light propagation mode. Because single-mode optical fiber is extremely thin with the mode field diameter of 10 μm (1 micrometer is 1/1000 mm) and the difference in refractive index between the core and the cladding is small, it only conveys the light in the fundamental mode. Its distinctive characteristics include the lack of distortion due to mode delay, which occurs in multi-mode fiber, and small attenuation over a wide range of bandwidths. To make the most of these characteristics, it is used mainly for long-distance, high-speed transfer of large-capacity data in trunk line networks.

2) Closure

Optical fiber is so delicate that any excessive bending or external pressure directly results in transmission loss, and sophisticated techniques are required for making connections. The basic performance of the closure, including waterproofing, airtightness, and hydrostatic pressure resistance, shall be as follows.

[A] Waterproof Characteristics

Splash-proof Characteristics for Aerial Application

When the closure is hung and water is splayed all over the closure from the height of 300 mm – 500 mm above it using a spray nozzle over the full range from vertical to 180°at the water volume of approximately 10 liters/minute and the water pressure of 50-150 kPa for 5 minutes or more, the absence of water ingress must be confirmed.

Airtightness Characteristics for Underground Application

When the closure is charged with the internal pressure of 98000 Pa {1.0 kgf/m^2}, immersed in water, and left to stand for 24 hours, the absence of gas leak must be confirmed.

[B] Hydrostatic Pressure Resistance Characteristics for Underground Application

When the closure after assembly is immersed in a pressurized tank at the water pressure of 98,000 ± 9,800 Pa (1.0 ± 0.1 kgf/m^2), the absence of deformation, cracking, and water ingress must be confirmed.

[C] Tensile Strength

When the end of the cable connected to the closure is pulled with the force of 980 N (100 kgf) or 70% of the strength of the housing, the absence of abnormality in components must be confirmed.

(2) Network Design

1) Network Requirements

In the traffic signal control system, the control server installed at KCCA (Kampala Capital City Authority) centrally controls the traffic signals at intersections by communicating with traffic signal controllers at road intersections over TCP/IP. It is intended thereby to mitigate traffic congestion and optimize travel time. The layer underneath TCP/IP is the Ethernet on the optical fiber installed in Kampala City. The present design is the network design that makes possible the replacement of the Ethernet frame over the assumed optical fiber network.

[A] Scope of Replacement

- Replacement of the Ethernet frame, which is the data link layer as defined by IEEE 802 series.
- It is assumed that there are single-mode optical fiber as the physical layer underneath and IP as the network

layer above.

[B] Topology

- Connections shall be made from the traffic signal control server located at KCCA to the traffic signal controllers at intersections.
- The traffic signal controllers at all intersections shall be connected to the traffic signal control server on one-to-one correspondence.
- Therefore, the topology shall consist of radial connections from the control server at KCCA to all intersections.

[C] Monitoring System

- All communication devices proposed in this design shall be monitored centrally using the terminal located at KCCA.
- In addition to alive monitoring, the monitoring system shall be able to detect conditions such as whether or not a loss of power has preceded circuit disconnection, so that a certain amount of information on the cause of trouble can be obtained without sending engineers to the intersection in problem.

2) Design Conditions

[A] Topology

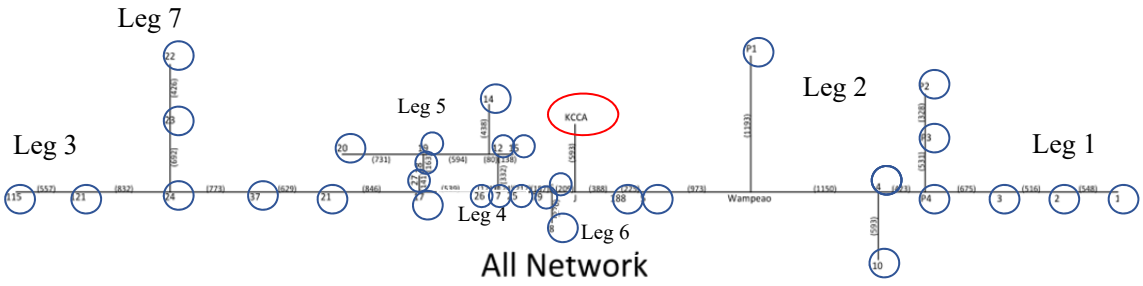
This is a star-shaped network in which fiber core wire bundles from Leg1 to Leg7 (13 bundles in total including branch lines) are extended from KCCA (Kampala Capital City Authority) at the center to junctions (1-8, 10, 12, 14, 15, 17-24, 37, 115, 121, 188, and P1-P4).

The present design pertains to the design of the fiber network configuration of the lower layer used by the IP network.

The origin is the server room in the KCCA building, and the terminuses are the traffic signal systems installed at intersections.

Each bundle of the optical fiber core wires planned for installation is referred to as a “Leg.”

The notations such as “12” and “P4” indicated below are intersection IDs. J and Wompewo are not included in intersection IDs.



Source: JICA Survey Team

Figure 2.23 Network Diagram

[B] Junctions

Table 2.21 Positioning of Intersections in the Network

32
13
84

* A branch, e.g., L2-1 is not regarded as an offshoot of L2 core, but is interpreted as running through the same route as L2 from the origin at KCCA.

	Fiber bundle	Description	IDs of intersections accommodated						Number of intersections
1	Leg1	East-bound long-distance line. There is L1-1 branch at P4.	1	2	3	P4			4
2	Leg1-1	Route branching from P4	P2	P3					2
3	Leg2	East-bound short-distance line. Shares the same conduit line with L1 up to 4. There is L2-1 branch.	10	4	5	188			4
4	Leg2-1	Branching from Wampeao.	P1						1
5	Leg3	West-bound long-distance line. There is L3-1 branch.	115	121	24	37	21		5
6	Leg3-1	Branching from 17.	27						1
7	Leg4	West-bound short-distance line. Shares the same conduit line with L3 up to 17.	17	26	7	25	79	6	6
8	Leg5	West-bound short-distance line 2. Shares the same conduit line with L3, L4, and L7 up to 7.	20	19	12				3
9	Leg5-1	Branching from 12?	14						1
10	Leg5-2	Branching from 12.	15						1
11	Leg5-3	Branching from 19.	18						1
12	Leg6	South-bound short-distance line. Shares the same conduit line with L3, L4, L5, and L7 up to 6.	8						1
13	Leg7	East-bound long-distance line 2. Shares the same conduit line with L3 up to 24.	22	23					2
	Total number of cores		Total number of intersections→						**32**

Source: JICA Survey Team

Table 2.22 List of Intersection Distance

	Core line group (Leg)	Intersection ID	Distance from origin at KCCA (m)
1	L1	P4	3,752
2	L1	3	4,427
3	L1	2	4,943
4	L1	1	5,491
5	L1-1	P3	4,283
6	L1-1	P2	4,611
7	L2 (L1, L2)	188	981
8	L2 (L1, L2)	5	1,206
9	L2	Wampeao	2,179
10	L1, L2	4	3,329
11	L2	10	3,922
12	L2（L2-1)	P1	3,372
13	L3	115	5,647
14	L3	121	5,090
15	L3	24	4,258
16	L3	37	3,485

17	L3	21	2,856
18	L3（L3-1）	27	2,151
19	L4	J	593
20	L4	6	802
21	L4	79	959
22	L4	25	1,176
23	L4	7	1,300
24	L4	26	1,471
25	L4	17	2,010
26	L5	12	1,632
27	L5	19	2,306
28	L5	20	3,037
29	L5 (L5-1)	14	2,150
30	L5 (L5-2)	15	1,770
31	L5 (L5-3)	18	2,469
32	L6	8	959
33	L7	23	4,950
34	L7	22	5,376
Distance	Longest distance	115	**5647**
	Shortest distance	J	593
	Mean distance		2910
Intersection ID	1-8	8	9 is an unassigned number
	10	1	11 is an unassigned number
	12	1	13 is an unassigned number
	14-15	2	16 is an unassigned number
	17-27	11	28-36 are unassigned numbers
	37, 79	2	
	115, 121, 188	3	
	P1-P4	4	
	Total	32	34 – 2 (J and Wampewo） = 32

Source: JICA Survey Team

3) Number of Fiber Cores from KCCA

To obtain the number of fiber cores supporting 1 core (1 core for both transmission and reception) or 2 core (1 core each for transmission and reception) fiber communication sufficient for the accommodation of all of the 32 intersections planned for accommodation, it is assumed that at least 64 cores (32 × 2) are provided.

[A] Fiber Length and Attenuation

Design is developed assuming fiber lengths of 10 km or less. The actual distance to the farthest intersection (intersection ID: 115) is 5.4 km. Optical fiber is assumed to be fusion spliced without connector connection as a rule. There shall be only two points of physical connection producing significant attenuation in the fiber; one is “optical termination box” in the building and the other is “patch panel,” which is the optical fiber terminal facility in the server room rack. The value of attenuation shall be calculated for the distance from the origin at KCCA to the two points of physical connection of fiber (optical termination box and patch panel). However, this shall not apply when existing fiber optic on-premises facilities in the KCCA building are used.

Table 2.23 Calculation of Fiber Length Distance (m)

Leg1

	Segment	P4	3	2	1	P3	P2
L1	KCCAtoJ	593	593	593	593	593	593
L1	Jto188	388	388	388	388	388	388
L1	188to5	225	225	225	225	225	225
L1	5toWampeao	973	973	973	973	973	973
L1	Wampeaoto4	1150	1150	1150	1150	1150	1150
L1	4toP4	423	423	423	423	423	423
L1	P4to3		675	675	675		
L1	3to2			516	516		
L1	2to1				548		
L1	P4toP3					531	531
L1	P3toP2						328
	Total distance	3752	4427	4943	5491	4283	4611

Leg2 （including Leg2-1）

	Segment	188	5	Wampewo	4	10	P1
L2	KCCAtoJ	593	593	593	593	593	593
L2	Jto188	388	388	388	388	388	388
L2	188to5		225	225	225	225	225
L2	5toWampeao			973	973	973	973
L2	Wampeaoto4				1150	1150	
L2	4to10					593	
L2	WampewotoP1(L2-1)						1193
		981	1206	2179	3329	3922	3372

Leg3 （including Leg3-1）

	Segment	115	121	24	37	21	27
L3	KCCAtoJ	593	593	593	593	593	593
L3	Jto6	209	209	209	209	209	209
L3	6to79	157	157	157	157	157	157
L3	79to25	217	217	217	217	217	217
L3	25to7	124	124	124	124	124	124
L3	7to26	171	171	171	171	171	171
L3	26to17	539	539	539	539	539	539
L3	17to21	846	846	846	846	846	
L3	21to37	629	629	629	629		
L3	37to24	773	773	773			
L3	24to121	832	832				
L3	121to115	557					
L3-1	17to27						141
		5647	5090	4258	3485	2856	2151

Leg4

	Segment	J	6	79	25	7	26	17
L4	KCCAtoJ	593	593	593	593	593	593	593
L4	Jto6		209	209	209	209	209	209
L4	6to79			157	157	157	157	157

L4	79to25				217	217	217	217
L4	25to7					124	124	124
L4	7to26						171	171
L4	26to17							539
		593	802	959	1176	1300	1471	2010

Leg5 （including Leg5-1, 5-2, and 5-3）

	Segment	12	Unlisted branch (no signals)	19	20	14	15	18
L5	KCCAtoJ	593	593	593	593	593	593	593
L5	Jto6	209	209	209	209	209	209	209
L5	6to79	157	157	157	157	157	157	157
L5	79to25	217	217	217	217	217	217	217
L5	25to7	124	124	124	124	124	124	124
L5	7to12	332	332	332	332	332	332	332
L5	12to unlisted branch		80	80	80	80		80
L5	Unlisted branch to19			594	594			594
L5	19to20				731			
L5-1	Unlisted branch to14					438		
L5-2	12to15						138	
L5-3	19to18							163
		1632	1712	2306	3037	2150	1770	2469

Leg6

	Segment	J	8
L6	KCCAtoJ	593	593
L6	Jto6		209
L6	6to8		157
Total distance		593	959

Leg7

	Segment	23	22
L7	KCCAtoJ	593	593
L7	Jto6	209	209
L7	6to79	157	157
L7	79to25	217	217
L7	25to7	124	124
L7	7to26	171	171
L7	26to17	539	539
L7	17to21	846	846
L7	21to37	629	629
L7	37to24	773	773
L7	24to23	692	692
L7	23to22		426
Total distance		4950	5376

Source: JICA Survey Team

4) Configuration of Optical Fiber

[A] Closure at Cable Raising Point

The underground access hole (HH, handhole) located near each intersection for the connection to the intersection shall contain a closure box for the branching of optical fiber.

[B] Termination Box (PD Board and PT Board)

An optical fiber termination box known as a premise distribution cabinet (commonly known as PD board) and a premise terminator cabinet (commonly known as PT board) must has been installed in the building. It is assumed that these PT board and PD board has been installed in the building. For convenience, this is referred to as optical termination box in the present design.

There must be an optical termination box for optical fiber for accommodating and fixing fiber core bundles from Leg1 to Leg7 installed on-premises in the KCCA building. The optical termination box must contain the jigs for accommodation of fiber branches (tape core wires, alignment parts, etc.), making it possible for the cores to be led out, provided with fiber end face treatment and connector connection, and also provided with connector terminal treatment. The form of the terminal connectors must be female SC connectors for the connection of on-premises lines.

The core wire bundles from Leg1 to Leg7 shall be first accommodated in the optical terminating box and then connected to the patch panels in the KCCA server room via optical fiber on-premises lines.

[C] On-premises Line

It is assumed that optical fiber on-premises lines in the KCCA building can be used from the above-mentioned optical termination box to the server room where network devices are installed, and if on-premises lines are not available, these shall be installed separately anew.

5) Network Wiring Standards and Specifications

[A] Type of Fiber

The type of optical fiber shall be single-mode fiber (SMF) specified as SMF: G652 in ITU-T G652.

[B] Type of Optical Cable

The type of optical fiber cable shall be in accordance with single-mode fiber OS2 specified as ISO/IEC 11801, and the transmission loss of the fiber shall be no more than 0.3 dB per km when a wavelength of 1550 nm is used.

[C] Type of Optical Cable Connector

The form of connectors for optical termination boxes and patch panels shall be SC connectors meeting IEC 61754-4 standard or LC connectors meeting IEC 61754-20 standard.

[D] Type of UTP Cable

The standard for UTP cables shall be CAT5e (enhanced category 5) or CAT6 standard cables defined in TIA/EIA-568-B in 1000 Base-T transmission.

[E] Fiber Length and Attenuation

As the fiber length is reported to be 5.4 km at the maximum, corresponding 10km standards and either 10/100 Base-FX or 1000 Base-BX shall be used.

[F] Ethernet (LAN)

The communication speed in optical fiber segments is either 10/100M or 1 Gbps, the standard for Ethernet at the communication speed of 10/1000M shall be 100 Base-FX under the communications standard IEEE 802.3u (2 core) and that for 1 Gps shall be the BiDi (Bi-Directional) standard under the IEEE 802.3ah standard for 1-core bidirectional communication.
The connection between the media converter and the network devices that have switch connection with it shall be

IEEE 802.3 in the case of 10 Mbps, 100 Base-T under the IEEE 802.3u standard in the case of 100 Mbps, and 1000 Base-T under the IEEE 802.3ab standard in the case of 1 Gbps.

[G] Matters Related to IP

IP and related communications protocol shall be in accordance with the RFC (Request for Comment) defined by IETF (Internet Engineering Task Force).

6) Power Supply and Other Environmental Conditions

The places where communication devices are installed shall have the following environmental conditions.

- An AC 100-240V 50/60Hz power shall be provided.
- The power supply shall be sufficient for the operation of the devices.
- Supply voltage fluctuation and frequency fluctuation shall be kept sufficiently low.
- There shall be a surge arrestor that protects the devices against surge voltage caused by lightening strike or the like.
- The heat generated from the operation of communication devices shall be dissipated sufficiently.
- The devices shall be installed in an environment without much dust or vibration.
- Air temperature and humidity shall be within the ranges for stable operation of the devices (in particular, there shall be no freezing or condensation).

(3) Design Policy

It has been decided that the configuration of the network of the data link layer shall be designed as follows.

1) Network Configuration

To realize the communication facility that is robust against unstable power supply and ambient environmental conditions, circuits using media converters (MC) shall be configured. Because of the stability of price and cost effectiveness, a network using 10/100 Base-X and 1000 Base-X shall be configured.

Connection shall be made radially between the central system at KCCA and each traffic signal system via 10/100 Base-X and 1000 Base-X, and each traffic signal shall be connected directly with the center. There shall be no en-route communication devices for repeating or aggregation. Modular MC equipment shall be used at the center to increase the mounting density. Stand-alone MCs shall be used on the traffic signal side.

2) Monitoring System

A monitoring system shall be installed for the purpose of ensuring quick response to troubles and reducing personnel cost.

Monitoring shall be implemented by the use of a central modular MC with monitoring function, which monitors the MC on the traffic signal side in addition to the modular MC. The MC on the traffic signal side must be capable of being monitored by the central MC.

To facilitate appropriate assessment of communication trouble, monitoring must include not only alive monitoring but also at least the detection of a loss of power. In addition, it is desirable that the system has other functions that are effective for the assessment of situation, such as light level measurement.

To perform sequential observation of situation using the monitoring function of the modular MC, a PC for monitoring shall be provided, and a monitoring system shall be installed in it.

The monitoring function shall use SNMP (Simple Network Management Protocol) for transactions with the monitoring terminal, and it shall be able to exchange information using SNMP’s standard MIB (Management Information Base), as well as using original vendor-specific MIB in the case where expanded monitoring functions are supported.

3) Design Details

An overview of the present design is shown below.

Table 2.24 Overview of Network Design

Design overview	Mainly, the following 3 features: "1. Number of intersections planned for the installation of traffic signals (32)" "2. Number of fiber core wires planned for installation (84)" "3. To design 32 IP networks assigning a /24 IP address block (172.30.(1-32).0/24) to each intersection traffic signal."

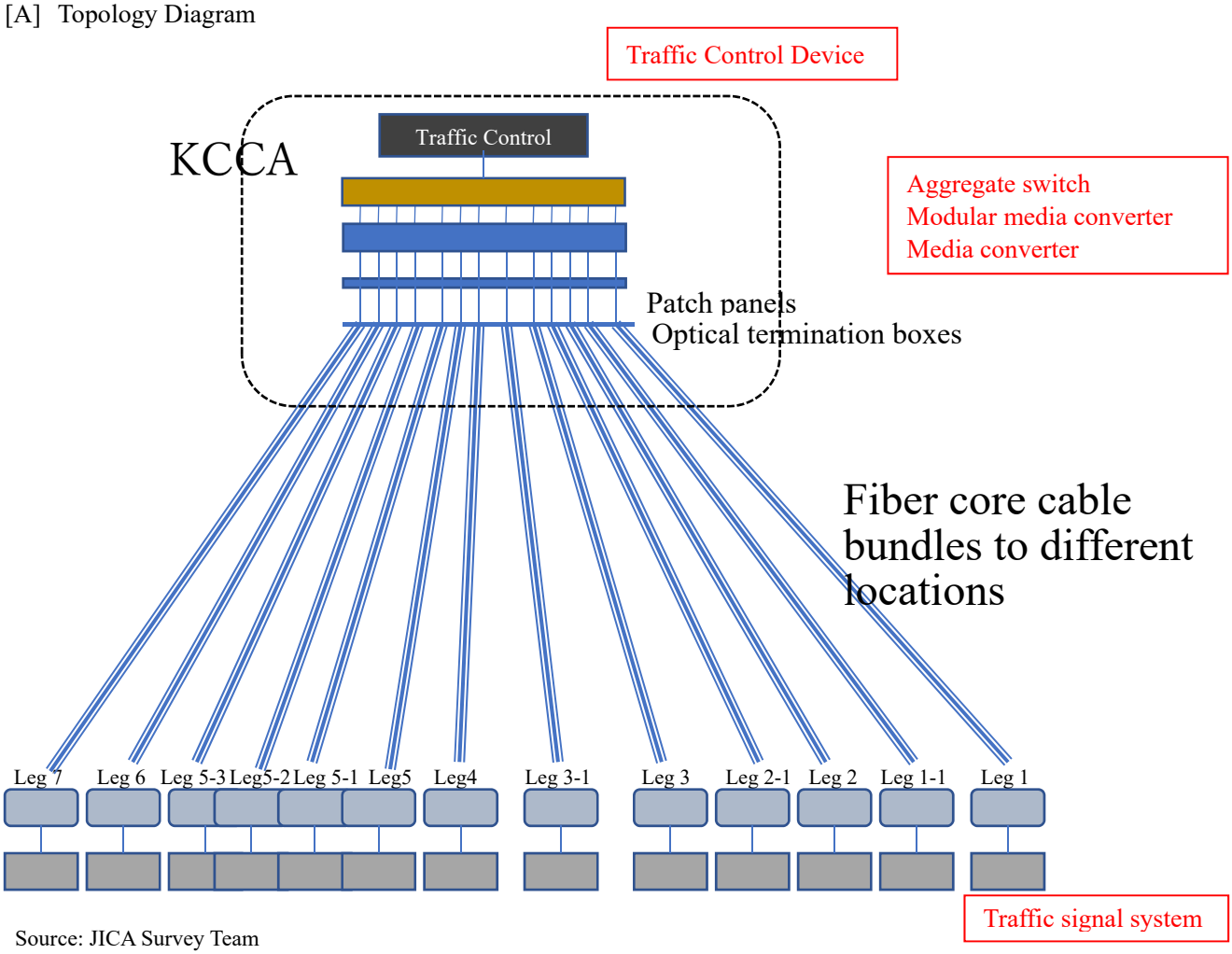
0	Assumption and exclusion		The present design assumes the presence of newly installed optical fiber core wires with complete cable termination and wiring to the inside of the server room in the KCCA building for network component devices. Existing on-premises optical wiring, optical closure, existing optical termination box, core lead out, existing connectors, existing on-premises lines, existing patch panels, 19 inch racks, etc. are not included in the scope and are not considered here. With respect to traffic signals and traffic signal systems, only IP interfaces and Ethernet interfaces are included in the scope of this design, whereas the design, installation, management, and operation of traffic signals and traffic signal systems are outside of the scope of design, except that the information on network aspects is used for reference.
1	Number of intersections planned for installation of traffic signals (number of intersection IDs)	32	→ The number of nodes is the same as the number of accommodation interfaces. The media converter must have 32 × 2 = 64 interfaces (host and client). The switch needs to accommodate 32 ports.
2	IP address	64	→ Each of 32 networks divided by /24 is assigned two IP addresses, one for the traffic signal system (ending in 100) and one for the gateway address (ending in 1). The total count is 32 × 2 = 64.
3	IP subnet	1	→ Subnet is /24 (netmask = 255.255.255.0).
4	IP-assigned network	1	The design shall be such that each traffic signal system is accommodated in a /24 network address. Corresponding to the number of intersection IDs, 32 networks are assigned in this way. For example, the first network is traffic signal 172.30.1.100/24 with gateway 172.30.1.1, the second is traffic signal 172.30.2.100/24 with gateway 172.30.2.1, and so on. (See proposed detailed design below.)
5	Fiber bundles	13	A plan with 13 bundles including Leg1 to Leg7 and their branches running from KCCA in star topology is assumed. There are 13 bundles in total, including Leg1 to Leg7 and six branches (Leg1-1, Leg2-1, Leg3-1, Leg5-1, Leg5-2, and Leg5-3). It is assumed that the 13 bundles have been led into the server room, and connector termination work at the end of fibers has been completed.
6	Total number of fiber cores	84	Because the total number of cores in Leg1 to Leg7 and their branches has been specified to be 84, this number is used in the design. → Four patch panels can accommodate the networks in the case of 1U 24-port type accommodation, since 24 × 4 = 96. Six panels shall be used in the case of patch panel layout design allowing for classification by Leg and reserve capacity.
7	Fiber core wire label names	84	Core wire label names shall be given to fiber bundles (Legs) to be accommodated. Examples: If intersection ID 121 is accommodated in the 4th core wire of Leg3 (10 cores) → LEG3(10)-04-121; If the 5th core wire of Leg5 (12 cores） is vacant → LEG5-05-R （R stands for Reserve). Core wire label names shall include "-S-" to indicate the single-mode fiber type.
8	Devices needed to be provided		Optical fiber cables, patch panels, media converters, optical modules (SFP), metal UTP cables, and accommodation switches. In addition, optical termination boxes, 19-inch rack, rack shelves, etc., if necessary.
9	Network accommodation configuration		Networks shall be composed of optical patch panels, media converters, module media converter, and switch. End terminals are small media converters. At the KCCA center, optical fiber is terminated at patch panels, and then the fiber cables from patch panels in

			the rack are led to the modular media converter to accommodate all lines, converted from optical interface to metal UTP, and connected to the switch via UTP cables. The number of connection lines from the terminal media converters to the switch is 32.
10	Number of patch panels	Option 1: 6 Option 2: 4	Patch panels shall be of a type that accommodates 24 ports in a 1U-size panel. In Option 1, six panels (144 ports in total) are used for accommodation according to the units of the Legs of fiber core wire bundles with some reserve capacity. Option 2 is a compact implementation using four panels (96 ports) to save space.
11	Patch panel assignment	Option 1: 144 Option 2: 96	Accommodation in patch panels shall be made in ascending order of the panel number associated with fiber bundles (Leg) mentioned in a separate item. Patch panel ports shall be given patch interface names, which are a combination of the patch panel number and the port number. “S” indicating the single-mode fiber type shall be included. Example: The 4th interface in the 3rd patch panel → P3-S-04
12	Media converter	2	A media converter that can accommodate at least 32 module SFPs accepting optical fiber shall be selected. The transfer to the LAN shall be made via 100 Base-T or 1000 Base-T metal UTP cables. Accommodation of 64 interfaces in the total of optical and metal interfaces must be possible. No special settings on the media converter are made other than those for the monitoring of the main unit. In addition, it is desirable to provide a stand-by unit in case of mechanical failure.
13	Cable selection		Single-mode optical fiber meeting OS2 specifications shall be used.
14	Connector form selection		LC connectors shall be used.
	Optical module selection		Considering the reduction of the number of cores, reduction of man-hours, and the ease of management, 100 Base-FX or 1000 Base-BX shall be selected. Because the longest distance to the terminal is 5.4 km, the wavelength used in 1-core shall be the same in all SFP modules, and SFPs shall be of the same type.
15	Patch panel type selection		LC connectors shall be used. Because 1-core type media converters are assumed, a type with a separate patch port for each core shall be used. Patch panels with connectors handling transmission TX and reception RX as a set shall not be used (to prevent erroneous connection).
16	Aggregation switch		All on the same VLAN, 32 interfaces are aggregated and connected to the traffic control LAN switch (LAG is desirable). No special settings other than those for monitoring function are made.
17	Traffic Signal Control Device		The traffic signal control device installed at the center (referred to as traffic signal control device here for convenience). This is the gateway device with Ethernet interface, to which the traffic signal device of each intersection terminal is eventually connected as an IP network via the network fiber line. The IP address used a the gateway for this device and the Ethernet interface are included in the design, whereas the installation, configuration, and management are excluded from the scope of design.

Source: JICA Survey Team

4) Configuration

[A] Topology Diagram



Source: JICA Survey Team

Figure 2.24 Network Topology

In traffic signal systems, the fiber core wire of each fiber bundle (Leg1 to 7) is connected to KCCA via the nearby handhole and the closure connection in the handhole. The layout of devices in the KCCA building is explained here. Inside of KCCA, fiber bundles are first accommodated in optical termination boxes. The optical termination boxes are installed in a dedicated room in the optical fiber building, in electric pipe space (EPS), or the like. The bundles are raised from outside to the building and led into the building conduits.

On-premises fiber facilities in the building are used or new on-premises fiber lines are installed from the optical termination boxes to the server room containing network devices. The on-premises fiber lines are connected to the patch panel for each Leg installed in the 19-inch rack in the server room. Optical fiber is connected from the patch panels to the media converter installed in the same 19-inch rack or a nearby 19-inch rack. The media converter, in the above example, is connected to the aggregation switch via UTP cables after conversion to 1000 Base-T interface at 1 Gbps. The aggregation switch is connected to the traffic signal control device equipped with Ethernet interface.

5) Specifications for Devices

[A] Device Specifications

Central Modular Media Converter

・ Main Unit

This shall be chassis-based equipment in which multiple media converters (line cards) can be mounted. There may be more than one chassis. In that case, at least 10 MCs can be aggregated in each unit.

・ Interface

Each line card must have the following interfaces:

10/100 Base-X or 1000 Base-X port: at least 1 port

10/100 Base-T or 1000 Base-T port: at least 1 port

・ Power Supply

Redundant power supply must be provided.

AC 100-240 V, 50/60 Hz must be supported.

Hot swap must be supported.

・ Fixation of Housing

Mounting and fixation of the housing on a 19-inch rack must be possible.

・ Operating Temperature

Use in the temperature range from 0℃ to 55℃ must be possible.

・ Monitoring

Monitoring using ICMP and SNMP (v1/v2c) must be possible.

Monitoring of MCs on the traffic signal side using Ethernet OAM or the like must be possible.

UTP ports and a serial console for monitoring must be provided.

Media Converters on the Traffic Signal Side

・ Interface

At least one 10/100 Base-X or 1000 Base-X port must be provided.

At least one 10/100 Base-T or 1000Base-T port must be provided.

The interface toward the center must use Bi-Di SFP.

・ Power Supply

AC 100-240V, 50/60 Hz must be supported.

・Fixation of Housing

Fixation of the housing onto a wall surface must be possible.

・ Operating Temperature

Use in the temperature range from 0℃ to 55℃ must be possible.

・ Monitoring

Monitoring from the central MC using Ethernet OAM or the like must be possible.

Monitoring System

・ Monitoring Software

It must be capable of exchanging monitoring information with the modular MC on SNMP and supplying the information to the manager via a user interface.

It must be capable of performing L3 alive monitoring on ICMP and providing the manager with the information on situation.

It must be capable of accumulating monitoring information, visualizing it in graphs and other forms, and offering it for diagnosis after the occurrence of trouble.

・ Monitoring Terminal

It must have an OS on which the monitoring software can operate and installation of the monitoring software must be possible.

It must have sufficient performance and storage capacity for monitoring.

6) Layout of Devices

The boundary of design responsibility for the network configuration in the present design shall be the two points at the patch panel and the media converter out of the various elements in the KCCA building, including fiber-accommodating optic termination box, patch panel, media converter, aggregation switch, and traffic control device.

Origin: Each intersection traffic signal system (Ethernet interface) — Local media converter

→（To fiber closure in underground handhole）

→Leg1 to Leg7 optical fiber bundles

（To inside of KCCA building）

→- Optical terminal box

（KCCA on-premises line fiber）

→ **Patch panel --- Media converter --- Aggregation switch**

Terminus: Traffic signal control device (Ethernet interface)

The following shows the details of the devices introduced in the present design. To indicate the scope of design explicitly, the Figure below include directly related devices and parts, in addition to the devices in the scope of design. See the Configuration section above for an overview of the overall configuration and the devices and parts constituting the overall system.

Table 2.25 Overview of Facilities to Be Introduced

List of Facilities to Be Introduced

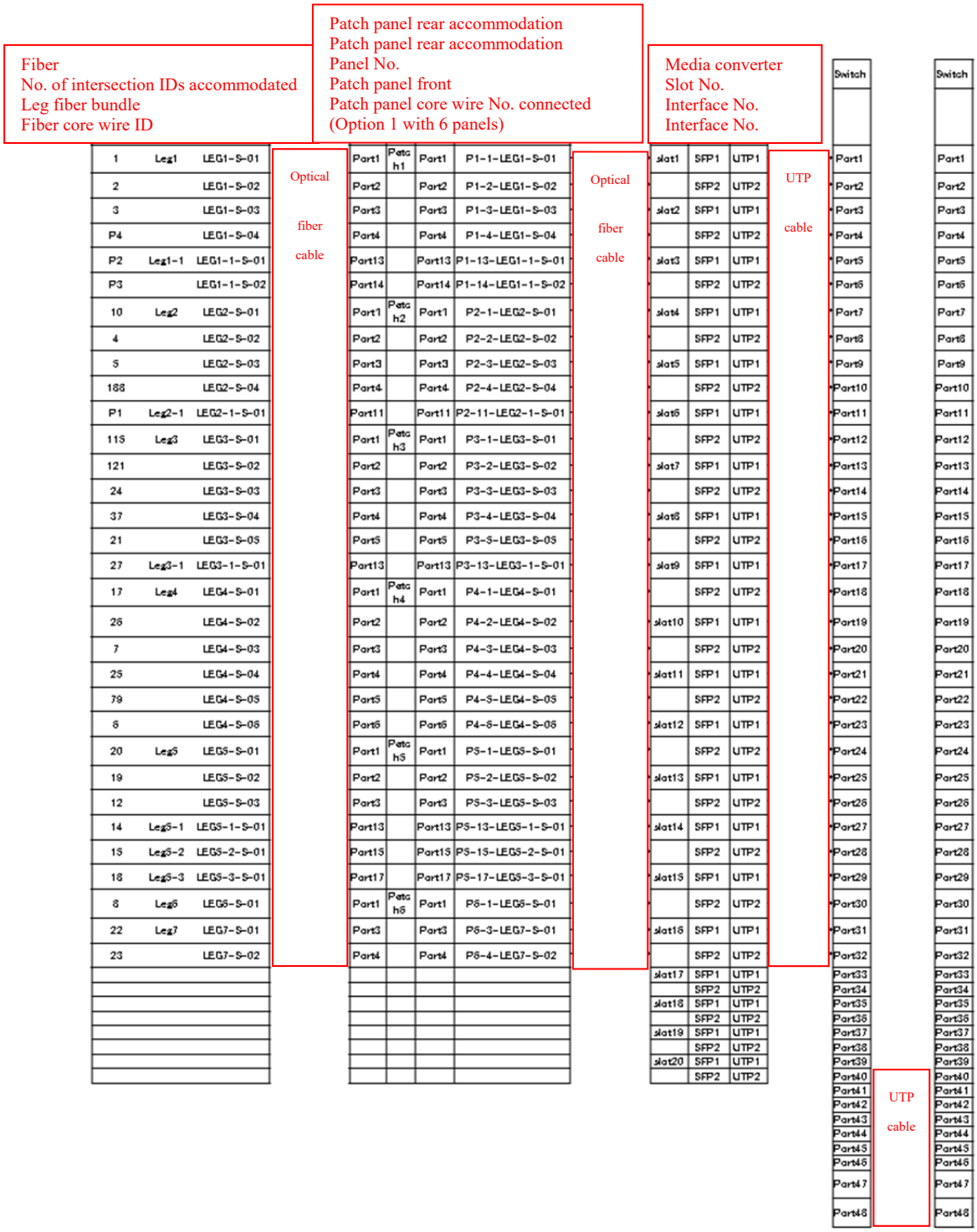
The scope of the present design is shown by the red frame in 3 and 4 below.

		Overview and associated parts	Quantity	Remarks
0	Optical fiber core wire cable, single-mode	L1 to L7, 84 cores	13 bundles	
		Optical closure	32	Fiber lead-out at each intersection
1	Optical fiber termination box	Box main unit	1	Facility in KCCA building
		Tape core wire		Inside of termination box
		Internal alignment terminal		Inside of termination box
	Optical fiber on-premises line cable	Single-mode fiber Length depends on the situation of on-premises facilities.	84 sets	From termination box to patch panel
2	19-inch rack	Main unit	1	
		M5 screws and nuts	As needed	
		Line arrangement panel	2 to 6	To be installed in the 19-inch rack in Item 2. Although it is outside of the scope of design responsibility, it should desirably be procured.
3	Patch panel	Installed in the rack	4 or 6 panels	Two accommodation options using either 4 or 6 panels
		Optical fiber single-mode patch cable (about 3 m)	32	
4	Modular media converter	Main unit	2	Including one stand-by unit
		Line card	20	
		Optical module SFP	34	
		240-V power supply cable	2	
	Media converter	Main unit	32	To be installed locally at intersections
		240-V power supply cable	32	
5	Fiber accommodation switch	Main unit	1	
		Stand-by unit	1	
		UTP cable (about 3 m)	34	32 for accommodation + 2 for traffic control LAN switch = 34
6	Traffic control LAN switch （built in to L3 router）		1	Assumed to be installed prior to the present design
7	Miscellaneous devices (Operation Device, Storage Device)		1 set	Assumed to be installed prior to the present design

Source: JICA Survey Team

7) Wiring Connection and Patch Panel Diagram

The following shows the patch panel connection diagram.



Source: JICA Survey Team

Figure 2.25 Patch Panel Connection Diagram

An NTT Electronics modular media converter is used here as an example.

Table 2.26 Fiber Core Wire ID

	Bundle No.	Core No.	Core wire ID	Intersection ID accommodated
1	Leg1	Core1	LEG1-S-01	1
2		Core2	LEG1-S-02	2
3		Core3	LEG1-S-03	3
4		Core4	LEG1-S-04	P4
5		Core5	LEG1-S-05	
6		Core6	LEG1-S-06	
7		Core7	LEG1-S-07	
8		Core8	LEG1-S-08	
9		Core9	LEG1-S-09	
10		Core10	LEG1-S-10	
11		Core11	LEG1-S-11	
12		Core12	LEG1-S-12	
13	Leg1-1	Core1	LEG1-1-S-01	P2
14		Core2	LEG1-1-S-02	P3
		Core3	LEG1-1-S-03	
		Core4	LEG1-1-S-04	
15	Leg2	Core1	LEG2-S-01	10
16		Core2	LEG2-S-02	4
17		Core3	LEG2-S-03	5
18		Core4	LEG2-S-04	188
19		Core5	LEG2-S-05	
20		Core6	LEG2-S-06	
21		Core7	LEG2-S-07	
22		Core8	LEG2-S-08	
23		Core9	LEG2-S-09	
24		Core10	LEG2-S-10	
25	Leg2-1	Core1	LEG2-1-S-01	P1
26		Core2	LEG2-1-S-02	
27		Core3	LEG2-1-S-03	
28		Core4	LEG2-1-S-04	
29		Core5	LEG2-1-S-05	
30		Core6	LEG2-1-S-06	
31		Core7	LEG2-1-S-07	
32		Core8	LEG2-1-S-08	
33		Core9	LEG2-1-S-09	
34		Core10	LEG2-1-S-10	
35	Leg3	Core1	LEG3-S-01	115
36		Core2	LEG3-S-02	121
37		Core3	LEG3-S-03	24
38		Core4	LEG3-S-04	37
39		Core5	LEG3-S-05	21
40		Core6	LEG3-S-06	
41		Core7	LEG3-S-07	
42		Core8	LEG3-S-08	
43		Core9	LEG3-S-09	
44		Core10	LEG3-S-10	

45		Core11	LEG3-S-11	
46		Core12	LEG3-S-12	
47	Leg3-1	Core1	LEG3-1-S-01	27
48		Core2	LEG3-1-S-02	
49	Leg4	Core1	LEG4-S-01	17
50		Core2	LEG4-S-02	26
51		Core3	LEG4-S-03	7
52		Core4	LEG4-S-04	25
53		Core5	LEG4-S-05	79
54		Core6	LEG4-S-06	6
55		Core7	LEG4-S-07	
56		Core8	LEG4-S-08	
57		Core9	LEG4-S-09	
58		Core10	LEG4-S-10	
59		Core11	LEG4-S-11	
60		Core12	LEG4-S-12	
61	Leg5	Core1	LEG5-S-01	20
62		Core2	LEG5-S-02	19
63		Core3	LEG5-S-03	12
64		Core4	LEG5-S-04	
65		Core5	LEG5-S-05	
66		Core6	LEG5-S-06	
67		Core7	LEG5-S-07	
68		Core8	LEG5-S-08	
69		Core9	LEG5-S-09	
70		Core10	LEG5-S-10	
71		Core11	LEG5-S-11	
72		Core12	LEG5-S-12	
73	Leg5-1	Core1	LEG5-1-S-01	14
74		Core2	LEG5-1-S-02	
75	Leg5-2	Core1	LEG5-2-S-01	15
76		Core2	LEG5-2-S-02	
77	Leg5-3	Core1	LEG5-3-S-01	18
78		Core2	LEG5-3-S-02	
79	Leg6	Core1	LEG6-S-01	8
80		Core2	LEG6-S-02	
81	Leg7	Core1	LEG7-S-01	22
82		Core2	LEG7-S-02	23
83		Core3	LEG7-S-03	
84		Core4	LEG7-S-04	

Source: JICA Survey Team

8) Design Number of Patch Panels Accommodated

Table 1.27 below shows an overview of the design number of patch panels accommodated.

Table 2.27 Overview of the Design Number of Patch Panels Accommodated

At the maximum, 13 sets of 12-core fiber.
The total number of cores is 84. Six sets of 24-port patch panels are assumed: 24x6=144

		Number of intersections （Number of cores used）	Number of cores by Leg	Accommodating patch panel, Option 1 Accommodation with reserve capacity using 6 panels Design with surplus capacity Accommodation of 1U 24-port units	Accommodating patch panel, Option 2 Compact accommodation using 4 panels Design with maximum density Accommodation of 1U 24-port units
1	Leg1	4	12	Patch1	Patch1
2	Leg1-1	2	2	Patch1	Patch2
3	Leg2	4	10	Patch2	Patch2
4	Leg2-1	1	10	Patch2	Patch2
5	Leg3	5	12	Patch3	Patch1
6	Leg3-1	1	2	Patch3	Patch3
7	Leg4	6	12	Patch4	Patch3
8	Leg5	3	12	Patch5	Patch4
9	Leg5-1	1	2	Patch5	Patch4
10	Leg5-2	1	2	Patch5	Patch4
11	Leg5-3	1	2	Patch5	Patch4
12	Leg6	1	2	Patch6	Patch3
13	Leg7	2	4	Patch6	Patch3
	Total No. of cores →	32	84		
				144 ports in total of all patches	96 ports in total of all patches

Source: JICA Survey Team

9) Proposed Patch Assignment

Table 2.28 Proposed Patch Assignment (Option with 6 Panels)

Panel No.	Port No.	Core wire ID accommodated	Intersection ID accommodated
Patch1	Port1	LEG1-S-01	1
	Port2	LEG1-S-02	2
	Port3	LEG1-S-03	3
	Port4	LEG1-S-04	P4
	Port5	LEG1-S-05	
	Port6	LEG1-S-06	
	Port7	LEG1-S-07	
	Port8	LEG1-S-08	
	Port9	LEG1-S-09	
	Port10	LEG1-S-10	
	Port11	LEG1-S-11	
	Port12	LEG1-S-12	
	Port13	LEG1-1-S-01	P2
	Port14	LEG1-1-S-02	P3
	Port15		
	Port16		
	Port17		

	Port18		
	Port19		
	Port20		
	Port21		
	Port22		
	Port23		
	Port24		
Patch2	Port1	LEG2-S-01	10
	Port2	LEG2-S-02	4
	Port3	LEG2-S-03	5
	Port4	LEG2-S-04	188
	Port5	LEG2-S-05	
	Port6	LEG2-S-06	
	Port7	LEG2-S-07	
	Port8	LEG2-S-08	
	Port9	LEG2-S-09	
	Port10	LEG2-S-10	
	Port11	LEG2-1-S-01	P1
	Port12	LEG2-1-S-02	
	Port13	LEG2-1-S-03	
	Port14	LEG2-1-S-04	
	Port15	LEG2-1-S-05	
	Port16	LEG2-1-S-06	
	Port17	LEG2-1-S-07	
	Port18	LEG2-1-S-08	
	Port19	LEG2-1-S-09	
	Port20	LEG2-1-S-10	
	Port21		
	Port22		
	Port23		
	Port24		
Patch3	Port1	LEG3-S-01	115
	Port2	LEG3-S-02	121
	Port3	LEG3-S-03	24
	Port4	LEG3-S-04	37
	Port5	LEG3-S-05	21
	Port6	LEG3-S-06	
	Port7	LEG3-S-07	
	Port8	LEG3-S-08	
	Port9	LEG3-S-09	
	Port10	LEG3-S-10	
	Port11	LEG3-S-11	
	Port12	LEG3-S-12	
	Port13	LEG3-1-S-01	27
	Port14	LEG3-1-S-02	
	Port15		
	Port16		
	Port17		
	Port18		

	Port19		
	Port20		
	Port21		
	Port22		
	Port23		
	Port24		
Patch4	Port1	LEG4-S-01	17
	Port2	LEG4-S-02	26
	Port3	LEG4-S-03	7
	Port4	LEG4-S-04	25
	Port5	LEG4-S-05	79
	Port6	LEG4-S-06	6
	Port7	LEG4-S-07	
	Port8	LEG4-S-08	
	Port9	LEG4-S-09	
	Port10	LEG4-S-10	
	Port11	LEG4-S-11	
	Port12	LEG4-S-12	
	Port13		
	Port14		
	Port15		
	Port16		
	Port17		
	Port18		
	Port19		
	Port20		
	Port21		
	Port22		
	Port23		
	Port24		
Patch5	Port1	LEG5-S-01	20
	Port2	LEG5-S-02	19
	Port3	LEG5-S-03	12
	Port4	LEG5-S-04	
	Port5	LEG5-S-05	
	Port6	LEG5-S-06	
	Port7	LEG5-S-07	
	Port8	LEG5-S-08	
	Port9	LEG5-S-09	
	Port10	LEG5-S-10	
	Port11	LEG5-S-11	
	Port12	LEG5-S-12	
	Port13	LEG5-1-S-01	14
	Port14	LEG5-1-S-02	
	Port15	LEG5-2-S-01	15
	Port16	LEG5-2-S-02	
	Port17	LEG5-3-S-01	18
	Port18	LEG5-3-S-02	
	Port19		

	Port20		
	Port21		
	Port22		
	Port23		
	Port24		
Patch6	Port1	LEG6-S-01	8
	Port2	LEG6-S-02	
	Port3	LEG7-S-01	22
	Port4	LEG7-S-02	23
	Port5	LEG7-S-03	
	Port6	LEG7-S-04	
	Port7		
	Port8		
	Port9		
	Port10		
	Port11		
	Port12		
	Port13		
	Port14		
	Port15		
	Port16		
	Port17		
	Port18		
	Port19		
	Port20		
	Port21		
	Port22		
	Port23		
	Port24		

Source: JICA Survey Team

Table 2.29 Proposed Patch Assignment, Option with 4 Panels

Panel No.	Port No.	Core wire ID	Intersection ID
Patch1	Port1	LEG1-S-01	1
	Port2	LEG1-S-02	2
	Port3	LEG1-S-03	3
	Port4	LEG1-S-04	P4
	Port5	LEG1-S-05	
	Port6	LEG1-S-06	
	Port7	LEG1-S-07	
	Port8	LEG1-S-08	
	Port9	LEG1-S-09	
	Port10	LEG1-S-10	
	Port11	LEG1-S-11	
	Port12	LEG1-S-12	
	Port13	LEG3-S-01	115
	Port14	LEG3-S-02	121
	Port15	LEG3-S-03	24
	Port16	LEG3-S-04	37
	Port17	LEG3-S-05	21

	Port18	LEG3-S-06	
	Port19	LEG3-S-07	
	Port20	LEG3-S-08	
	Port21	LEG3-S-09	
	Port22	LEG3-S-10	
	Port23	LEG3-S-11	
	Port24	LEG3-S-12	
Patch2	Port1	LEG1-1-S-01	P2
	Port2	LEG1-1-S-02	P3
	Port3	LEG2-S-01	10
	Port4	LEG2-S-02	4
	Port5	LEG2-S-03	5
	Port6	LEG2-S-04	188
	Port7	LEG2-S-05	
	Port8	LEG2-S-06	
	Port9	LEG2-S-07	
	Port10	LEG2-S-08	
	Port11	LEG2-S-09	
	Port12	LEG2-S-10	
	Port13	LEG2-1-S-01	P1
	Port14	LEG2-1-S-02	
	Port15	LEG2-1-S-03	
	Port16	LEG2-1-S-04	
	Port17	LEG2-1-S-05	
	Port18	LEG2-1-S-06	
	Port19	LEG2-1-S-07	
	Port20	LEG2-1-S-08	
	Port21	LEG2-1-S-09	
	Port22	LEG2-1-S-10	
	Port23		
	Port24		
Patch3	Port1	LEG3-1-S-01	27
	Port2	LEG3-1-S-02	
	Port3	LEG4-S-01	17
	Port4	LEG4-S-02	26
	Port5	LEG4-S-03	7
	Port6	LEG4-S-04	25
	Port7	LEG4-S-05	79
	Port8	LEG4-S-06	6
	Port9	LEG4-S-07	
	Port10	LEG4-S-08	
	Port11	LEG4-S-09	
	Port12	LEG4-S-10	
	Port13	LEG4-S-11	
	Port14	LEG4-S-12	
	Port15	LEG6-S-01	8
	Port16	LEG6-S-02	
	Port17	LEG7-S-01	22
	Port18	LEG7-S-02	23
	Port19	LEG7-S-03	
	Port20	LEG7-S-04	

	Port21		
	Port22		
	Port23		
	Port24		
Patch4	Port1	LEG5-S-01	20
	Port2	LEG5-S-02	19
	Port3	LEG5-S-03	12
	Port4	LEG5-S-04	
	Port5	LEG5-S-05	
	Port6	LEG5-S-06	
	Port7	LEG5-S-07	
	Port8	LEG5-S-08	
	Port9	LEG5-S-09	
	Port10	LEG5-S-10	
	Port11	LEG5-S-11	
	Port12	LEG5-S-12	
	Port13	LEG5-1-S-01	14
	Port14	LEG5-1-S-02	
	Port15	LEG5-2-S-01	15
	Port16	LEG5-2-S-02	
	Port17	LEG5-3-S-01	18
	Port18	LEG5-3-S-02	
	Port19		
	Port20		
	Port21		
	Port22		
	Port23		
	Port24		

Source: JICA Survey Team

10) Test Methods

・ Confirmation of Attenuation in Optical Fiber

1. Measure the optical output level of the SFP device on the modular media converter side.
2. Measure the optical input level at the media converter on the traffic signal system side.
3. Record the difference between 2 and 1, and confirm that it is within the predetermined range of specification.
4. Measure the optical output level of the SFP device of the media converter on the traffic signal system side.
5. Measure the optical input level on the modular media converter side.
6. Record the difference between 5 and 4, and confirm that it is within the predetermined range of specification.

・ Confirmation of Power Supply

1. Confirm power supply voltage using a multimeter.

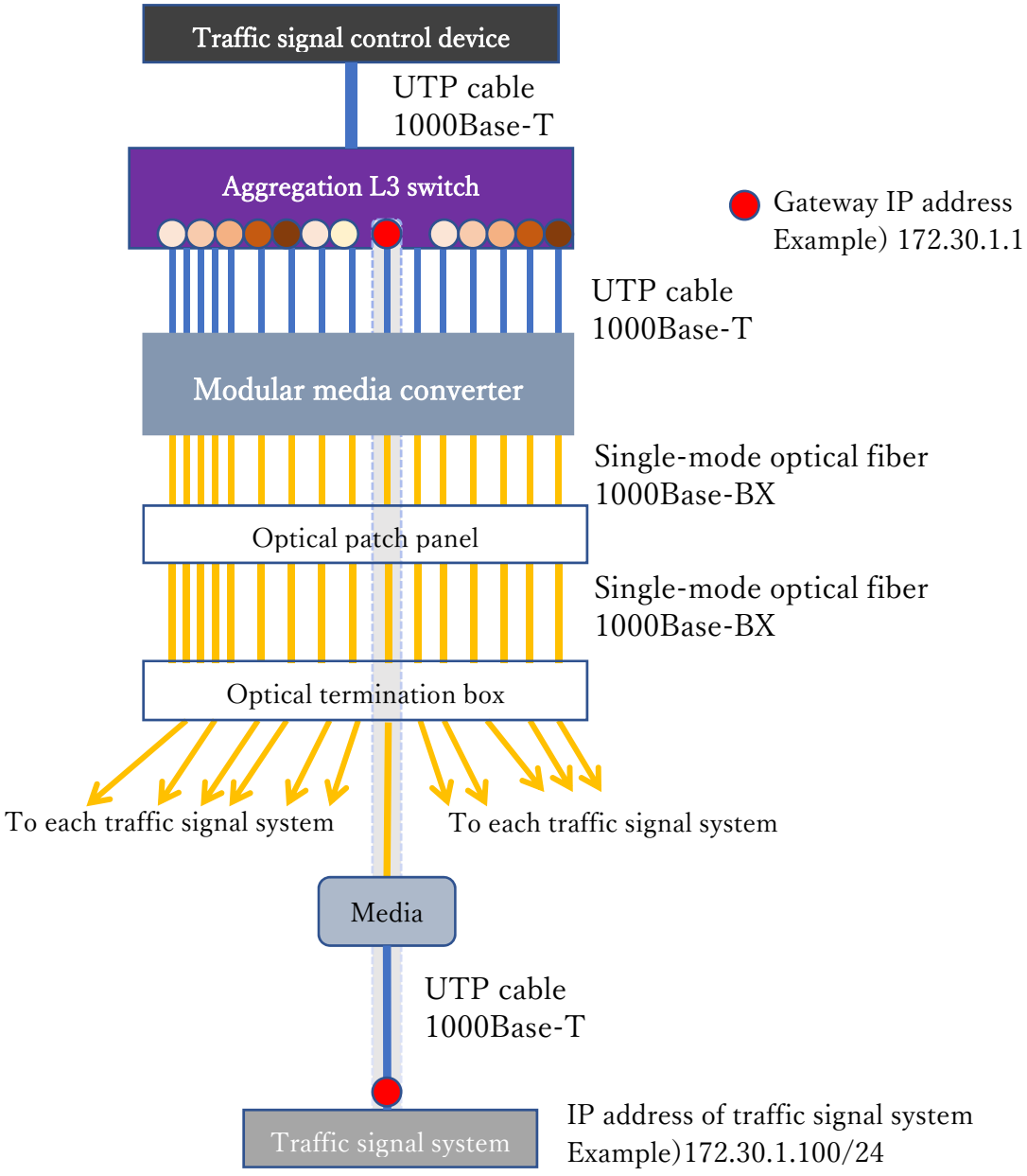
2. Confirm that grounding has been made properly.

・ Confirmation of MC Connection and Frame Exchange

After connecting a testing PC to the media converter on the intersection side and setting up an IP address, perform 32-ms ping packet loss tests 1000 times targeting at the gateway address of the L3 aggregation switch in the local network. Confirm the presence or absence of communication errors at the MC.

11) Example Configuration Using Commercially Available Products

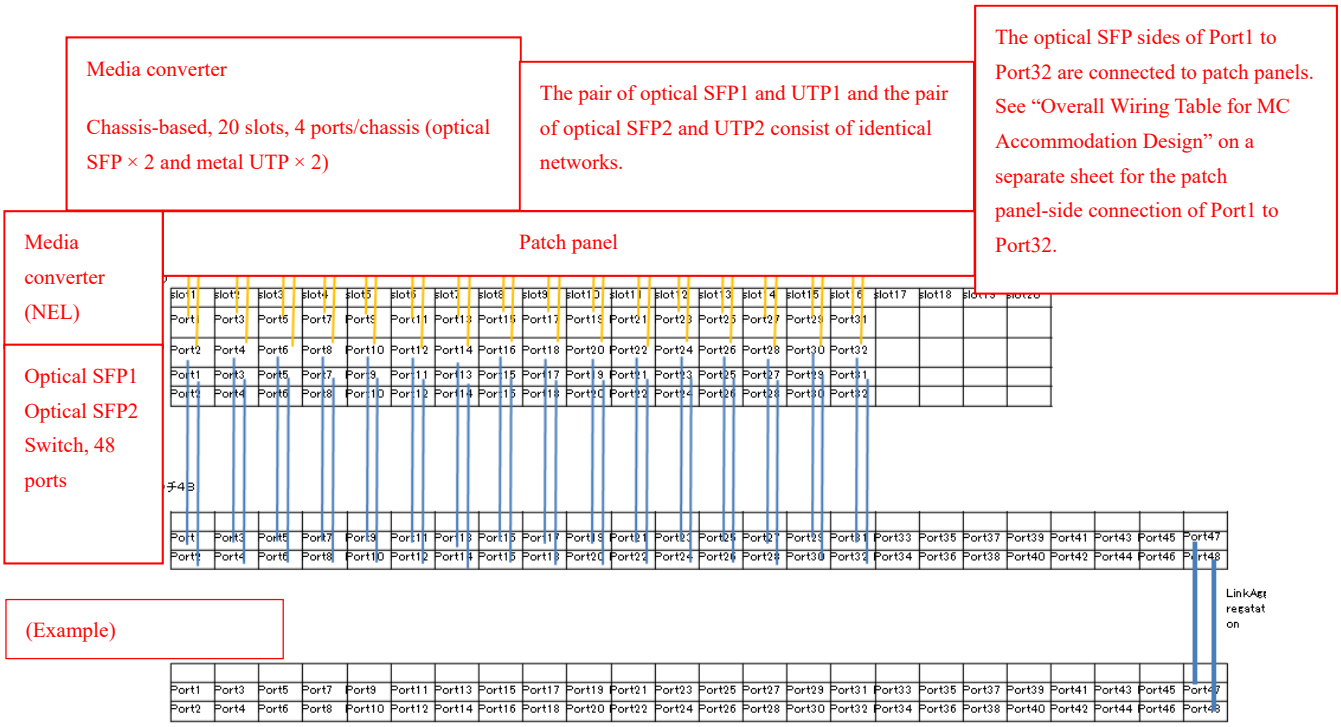
・NEL[6]



Source: JICA Survey Team

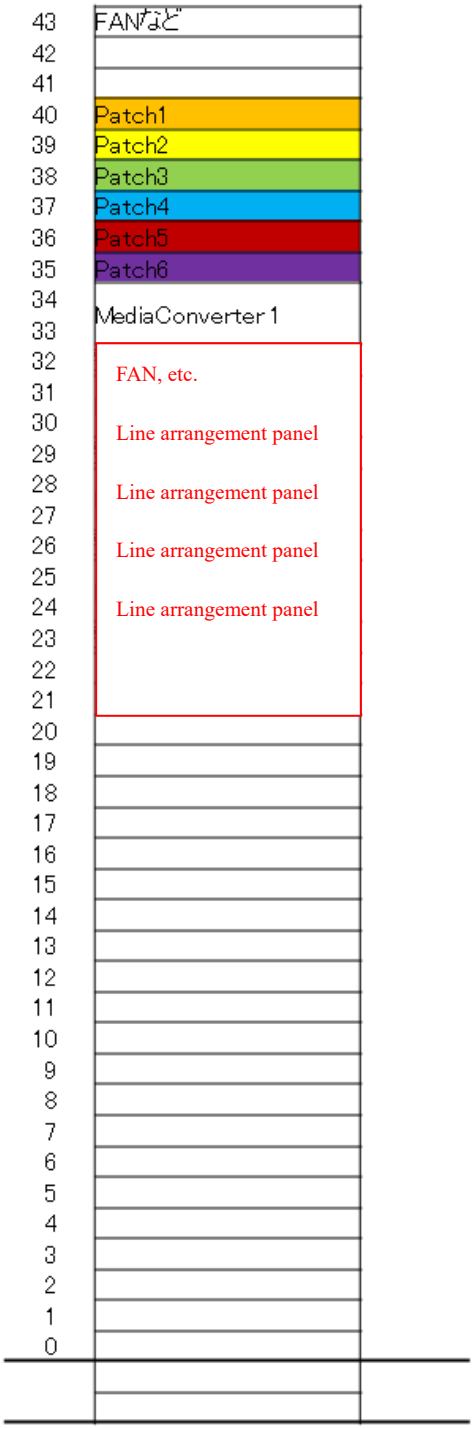
Figure 2.26 An Example of Possible Device Configuration

[6] NTT Electronics



Source: JICA Survey Team

Figure 2.27 Overview Diagram of Cable Connection Wiring between Media Converter and Switch



Source: JICA Survey Team

Figure 2.28 Conceptual Diagram of Accommodation in 19-inch Rack (Option with 6 Patch Panels)

Reference Configuration of L3 Network

Proposed network configuration enabling IP communication is presented here. This will be constructed on the Ethernet network. As this chapter is outside of the scope of work, this proposal is presented only for reference.

(1) Proposed Network Design

If the size of a broadcast domain is too large, propagation of trouble may expand widely in the event of trouble (such as broadcast storm). Therefore, the design has been developed to minimize the size of broad cast domains by accommodating the server and each traffic signal in one network each.

1) Subnet Configuration

Each of the 32 intersections with traffic signals is assigned a /24 (netmask: 255.255.255.0) network. The IP address of the traffic signal system has the 4th octet set at 100 (example: 172.30.1.100), and the central L3 switch has the 4th octet set at 1.

(Using the example of 172.30.1.1) the L3 switch is configured to have 32 /24 gateway interfaces. The addresses that have 0 as the 4th octet and that have 255 as the 4th octet are not used, because the former is the network address and the latter is the broadcast address.

Table 2.30 Network Address Configuration, 32 Networks

	Network address	Available IP addresses
1	172.30.1.0/24	172.30.1.1 to 254
2	172.30.2.0/24	172.30.2.1 to 254
3	172.30.3.0/24	172.30.3.1 to 254
4	172.30.4.0/24	172.30.4.1 to 254
5	172.30.5.0/24	172.30.5.1 to 254
6	172.30.6.0/24	172.30.6.1 to 254
7	172.30.7.0/24	172.30.7.1 to 254
8	172.30.8.0/24	172.30.8.1 to 254
9	172.30.9.0/24	172.30.9.1 to 254
10	172.30.10.0/24	172.30.10.1 to 254
11	172.30.11.0/24	172.30.11.1 to 254
12	172.30.12.0/24	172.30.12.1 to 254
13	172.30.13.0/24	172.30.13.1 to 254
14	172.30.14.0/24	172.30.14.1 to 254
15	172.30.15.0/24	172.30.15.1 to 254
16	172.30.16.0/24	172.30.16.1 to 254
17	172.30.17.0/24	172.30.17.1 to 254
18	172.30.18.0/24	172.30.18.1 to 254
19	172.30.19.0/24	172.30.19.1 to 254
20	172.30.20.0/24	172.30.20.1 to 254

21	172.30.21.0/24	172.30.21.1 to 254
22	172.30.22.0/24	172.30.22.1 to 254
23	172.30.23.0/24	172.30.23.1 to 254
24	172.30.24.0/24	172.30.24.1 to 254
25	172.30.25.0/24	172.30.25.1 to 254
26	172.30.26.0/24	172.30.26.1 to 254
27	172.30.27.0/24	172.30.27.1 to 254
28	172.30.28.0/24	172.30.28.1 to 254
29	172.30.29.0/24	172.30.29.1 to 254
30	172.30.30.0/24	172.30.30.1 to 254
31	172.30.31.0/24	172.30.31.1 to 254
32	172.30.32.0/24	172.30.32.1 to 254

Source: JICA Survey Team

Table 2.31 Server System Network

1	172.20.100.0/24	172.20.100.1 to 254

Source: JICA Survey Team

Table 2.32 Proposed IP Address Design

	List of IP address design			
	Intersection ID	Traffic signal IP address	Subnet mask	Default gateway address (L3 switch address)
1	1	172.30.1.100	255.255.255.0	172.30.1.1
2	2	172.30.2.100	255.255.255.0	172.30.2.1
3	3	172.30.3.100	255.255.255.0	172.30.3.1
4	P4	172.30.4.100	255.255.255.0	172.30.4.1
5	P2	172.30.5.100	255.255.255.0	172.30.5.1
6	P3	172.30.6.100	255.255.255.0	172.30.6.1
7	10	172.30.7.100	255.255.255.0	172.30.7.1
8	4	172.30.8.100	255.255.255.0	172.30.8.1
9	5	172.30.9.100	255.255.255.0	172.30.9.1
10	188	172.30.10.100	255.255.255.0	172.30.10.1
11	P1	172.30.11.100	255.255.255.0	172.30.11.1
12	115	172.30.12.100	255.255.255.0	172.30.12.1
13	121	172.30.13.100	255.255.255.0	172.30.13.1
14	24	172.30.14.100	255.255.255.0	172.30.14.1
15	37	172.30.15.100	255.255.255.0	172.30.15.1
16	21	172.30.16.100	255.255.255.0	172.30.16.1
17	27	172.30.17.100	255.255.255.0	172.30.17.1
18	17	172.30.18.100	255.255.255.0	172.30.18.1
19	26	172.30.19.100	255.255.255.0	172.30.19.1
20	7	172.30.20.100	255.255.255.0	172.30.20.1
21	25	172.30.21.100	255.255.255.0	172.30.21.1
22	79	172.30.22.100	255.255.255.0	172.30.22.1
23	6	172.30.23.100	255.255.255.0	172.30.23.1
24	20	172.30.24.100	255.255.255.0	172.30.24.1
25	19	172.30.25.100	255.255.255.0	172.30.25.1
26	12	172.30.26.100	255.255.255.0	172.30.26.1
27	14	172.30.27.100	255.255.255.0	172.30.27.1
28	15	172.30.28.100	255.255.255.0	172.30.28.1
29	18	172.30.29.100	255.255.255.0	172.30.29.1
30	8	172.30.30.100	255.255.255.0	172.30.30.1
31	22	172.30.31.100	255.255.255.0	172.30.31.1
32	23	172.30.32.100	255.255.255.0	172.30.32.1

Source: JICA Survey Team

Table 2.33 Proposed Server System Addresses

1	Server1	172.20.100.10	255.255.255.0	172.20.100.1
2	Server2	172.20.100.11	255.255.255.0	172.20.100.1
3	Server3	172.20.100.12	255.255.255.0	172.20.100.1
4	Server4	172.20.100.13	255.255.255.0	172.20.100.1

Source: JICA Survey Team

Table 2.34 Proposed Monitoring PC Addresses

1	Monitoring PC 1	172.20.100.200	255.255.255.0	172.20.100.1
2	Monitoring PC 2	172.20.100.201	255.255.255.0	172.20.100.1

Source: JICA Survey Team

Table 2.35 Proposed L3 Switch Addresses

	List of IP address design			
	Interface ID （VLAN）	Traffic signal IP address	Subnet mask	Remarks
1	1	172.30.1.1	255.255.255.0	
2	2	172.30.2.1	255.255.255.0	
3	3	172.30.3.1	255.255.255.0	
4	P4	172.30.4.1	255.255.255.0	
5	P2	172.30.5.1	255.255.255.0	
6	P3	172.30.6.1	255.255.255.0	
7	10	172.30.7.1	255.255.255.0	
8	4	172.30.8.1	255.255.255.0	
9	5	172.30.9.1	255.255.255.0	
10	188	172.30.10.1	255.255.255.0	
11	P1	172.30.11.1	255.255.255.0	
12	115	172.30.12.1	255.255.255.0	
13	121	172.30.13.1	255.255.255.0	
14	24	172.30.14.1	255.255.255.0	
15	37	172.30.15.1	255.255.255.0	
16	21	172.30.16.1	255.255.255.0	
17	27	172.30.17.1	255.255.255.0	
18	17	172.30.18.1	255.255.255.0	
19	26	172.30.19.1	255.255.255.0	
20	7	172.30.20.1	255.255.255.0	
21	25	172.30.21.1	255.255.255.0	
22	79	172.30.22.1	255.255.255.0	
23	6	172.30.23.1	255.255.255.0	
24	20	172.30.24.1	255.255.255.0	
25	19	172.30.25.1	255.255.255.0	
26	12	172.30.26.1	255.255.255.0	
27	14	172.30.27.1	255.255.255.0	
28	15	172.30.28.1	255.255.255.0	
29	18	172.30.29.1	255.255.255.0	
30	8	172.30.30.1	255.255.255.0	
31	22	172.30.31.1	255.255.255.0	
32	23	172.30.32.1	255.255.255.0	
33	200	172.20.100.1	255.255.255.0	Traffic Control LAN network （Server accommodation network）

Source: JICA Survey Team

(2) Routing

Static routing shall be used, avoiding the use of dynamic routing such as that employing a routing protocol.

1) Configuration of Each Device

Traffic signal system: Each device is set up to have the default gateway that is address of the local IP network with the 4th octet changed to 1.

（Example: If the traffic signal system is 172.30.1.100/24 → the default gateway is set up to be 172.30.1.1.）

Server: The server is configured to have the address 172.20.100.1 in the server's local IP network (traffic control LAN), which is the networ

2.2.6 Preliminary Design Drawings

Preliminary Design Drawings are attached at the end of this document.

2.2.7 Construction and Procurement Plan

(1) Construction and Procurement Policy

The proposed junctions are the critical points of the traffic network of Kampala City and are currently bottlenecks. There are the KIIDP2 that is being financially supported by the World Bank and the Flyover Construction Programme that is planned to be implemented using the ODA from Japan in Kampala. It is expected for the traffic load on the network to increase, so maintaing the current traffic to the project area during the construction period should be taken into account the most and is the key point for the construction plan. It is also a construction within the city having commercial and educational facilities nearby, so the safety management should be thoroughly upheld and the impact to the social environment should be the minimum.
The Study Team would make use as much as possible the resource of Uganda for the procurement of equipment, but for the main equipment that has the risk of quality assurance, the Study Team would procure from a third country or from Japan. The Study Team would think primarily of effectively utilizing and train the human resources of Uganda and promote technological transfer.

(2) Consideration on Procurement

Components of this project are divided into facilities construction including junction improvement, information infrastructure improvement, construction of control center construction, and provision of equipment for traffic control system equipment to be installed at control center.

These two components are interrelated but there is a big difference in the contents of the two components, so it is considered reasonable to use separate procurement.

As for the provision of equipment, the number of Japanese manufacturers that can offer MODERATO system is limited, so overseas experiences shall not matter. In addition, in this case, a trading company with proven track record of introducing traffic control and management system will be a bidder, but in this case the evidence that the MODERATO system can provide (eg agreement document on bidding with MODERATO system maker or agreement document concerning designated subcontract) Consider asking for submission.

(3) Construction Plan Consideration

The improvement by signalization) at the existing roundabout is included in the facility construction of this project as described before. The roundabouts that become the problem are all in the CBD, which is the bottleneck of the traffic network that has a striking traffic jam in both peak and off-peak times, so it is impossible to conduct the improvement construction while blocking the traffic for a long duration of time.

Thus, it is required to make the minimum impact to the current traffic for the improvement construction and it is necessary to conduct according to the construction plan reflecting the results of careful planning and discussions with the authorities concerned and stake holders.

The construction methods for the improvement of the roundabout proposed by the Consultant include the following 2 ways. The selection of method depends on the necessity of earthwork and scale of the proposed roundabout.

	
Construction Method 1 (No significant change in earthwork and height.) ・ After removal of the problematic property, construct the pavement along the shape in the future inside the junction and open the traffic. ・ The traffic after opening would be controlled by the temporary traffic light. ・ Secure space for the construction of the boundary drainage by placing a temporary barricade on the edge of the pavement. ・ After completion of the boundary drainage, conduct the construction of the edge of the pavement according to the shape in the future. Applied junctions: Mulago, Ground Imperial	Construction Method 2 (Change in earthwork and height) ・ After removal of the problematic property, guide the current traffic to the half of the RA. The half left would be the construction space for earthwork. ・ The traffic would be controlled by temporary traffic light after opening. ・ After completion of the half section of the earthwork, construct the pavement to the shape in the future and open the traffic. ・ Secure space for the construction of the boundary drainage by placing a temporary barricade on the edge of the pavement. ・ After completion of the boundary drainage, conduct the construction of the edge of the pavement according to the shape in the future. Applied junction: Rwenzori Court

Source：JICA Study Team

Figure 2.29 Construction Method of the Roundabout Improvement

(4) Work and Procurement Responsiblity

This project includes two components as described before. The work and procurement responsibility by the two components are summarized in the following Table 2.36.

Table 2.36 Work and Procurement Responsibility by Components

Component	Facility Construction	Equipment Provision
Procurement	・ The material and equipment (signal light, detector, control equipment, protective facility, power supply cable, information transferring cable, signal post, detector post, conduit and handhole cover) regarding the improvement of junction. ・ The material and equipment (paving material and concrete secondary product) regarding the engineering works for the improvement of junction. ・ Development work of information infrastructure (optical fiber cable, accessory and handhole cover). ・ The equipment and material (building material, power equipment, air conditioning equipment, waterworks, building management and security related material and office furniture) regarding architecture work.	・ Control equipment installed in the traffic control centre (including cable).

Construction and Installation	・ Construction regarding the improvement of the junction (earthwork, drainage, boundary work, traffic light installment, detector installment, wiring work, handhole installment work, traffic management work and trial operation adjustment work). ・ Development work of information infrastructure (laying optical cable and installing accessory, handhole work, laying conduit and trial operation adjustment work). ・ Architecture work (removal of structure within site, drainpipe removal, earthwork, framework construction, finishes construction, power equipment work, plumbing system work, air conditioner work, landscape work and installment of office furniture)	・ Control system equipment installment (including wiring work). ・ Trial operation adjustment of the central control system. ・ Initial operation guidance. ・ System monitoring of the defect period.

Source：JICA Study Team

(5) Construction Supervision Plan/Procurement Management Plan

In conducting this project, first both between the government of Japan and Uganda would conclude an exchange note (E/N) regarding the gratis fund of this project and JICA and the government of Uganda" would conclude a grant agreement (G/A). After the conclusion of them, the consultant would conclude a consultancy service agreement regarding the detailed design, bidding assistants and construction supervision with KCCA, Uganda's executing agency according to the recommendation letter issued by JICA. The contents included in the consultant agreement are the following.

[A] Facility Construction

a. Bidding Document Preparation

・ Prepare a bidding contract document based on the results of this research report and gain approval by KCCA. The content of the preparation operation of the bidding contract document is described as the following.

・ Prepare drawings and BOQ

・ Preparation of the bidding instruction and construction contract

b. Conduct of the Construction Bidding

The consultant would assist the construction bidding implemented by KCCA. The service content of the bidding assistance is described as the following.

・ Bid notice

・ Prequalification

・ Bid briefing and explanation at site

・ Technical and financial evaluation

・ Contract negotiation

c. Construction Supervisory Services

After verification of construction contract by JICA, consultant can issue the Notice to Proceed to the Contractor and start the construction supervisory services. For the construction supervisory services, the construction progress status would be directly reported to KCCA and the Japanese embassy in Uganda and would prepare administrative work regarding working progress situation, quality, safety and payment and technical operations such as proposals for the improvement of construction to the Contractors. Also the coordination between JICA, the Japanese embassy and the government of Uganda would be done as necessary. The main contents are described as in the Table 2.37.

Table 2.37 The content of the construction supervisory service

Service Items	Service Description
Approval of the Construction Plan and Working Drawings	Checking and approving if the construction plan, schedule, and construction drawings submitted by the contractor complies with the contract, contract drawings and specifications, etc.
Progress Control	Receive a report of the construction progress by the Contractor and provide instructions so that the construction finishes within the construction period.
Quality Control	Inspect and approve if the construction material and quality of the construction complies with the contract drawings and specifications.
Construction Outcome Control	Inspect the finished sections and shapes of the plan and check if the finished shape is in accordance with the design, at the same time check the quantity.
Certificate Preparation	Prepare the necessary certificates at the millstones when the payment to the Contractor, completion of the construction, the end of the period of guarantee against defects and so on.
Submission of a Report	Inspect the construction monthly report, finished drawings and finished photos prepared by the contractors and submit to Uganda government and JICA. Also create a completion repot after the construction is finished and submit to JICA.

Source：JICA Study Team

[B] Equipment Provision

a. Bidding documents preparation and b. Bidding process regarding vendor procurement are the same as in [A] Facilities Construction. As for equipment procurement supervision, the progress of facility construction work will be overseen, the location and period of storage, as well as installation time of the equipment will be supervised, and an initial training for operating the system equipment will be provided.

Table 2.38 Details of Procurement and Supervision

Service Items	Service Description
① Plan approval	Inspect the documents submitted by the Supplier (procurement plan, operation sheet, and equipment layout), and approve them after verifying that they follow the contract, contract plan, specification documents, etc.
② Witnessed factory inspection	Verify system operation, after production of equipment. Inspect the amount and functions described in the specification documents.
③ Pre-shipping equipment inspection by a third party	After the witnessed factory inspection, the contractor will pack all equipment and materials to prepare shipment. Plan an inspection by a third party and attend the inspection.
④ Progress Control	After receiving a report about construction progress of the facility from the Contractor, give necessary directions to finish equipment installation following the project prgramme.
⑤ Commissioning and adjustment	After installation at the site, test run the equipment to verify if it fulfills the required functions. Conduct commissioning and adjustment for single equipment and for an overall system.
⑥ Output supervision	Inspect consistency with the procurement plan and drawings.
⑦ Preparation of Certificates	Prepare certificates that are required for the payment for the vender, construction completion, and expiration of the warranty period.
⑧ Report submission	Closely examine the documents prepared by the vender, add comments, and submit the documents to Uganda government and JICA. In addition, prepare a completion report when procurement is completed, and submit the report to JICA.

Source: JICA Study Team

(6) Quality Management Plan

Quality management of facility construction works will be conducted based on the specification documents, prepared in the project. The specification documents will be governed by AASHTO or Japanese standards/testing methods. The quality management plan (draft) and output management plan (draft) are shown in Table 2.39 and Table 2.40.

Table 2.39 Quality Management Plan (draft)

Construction Work	Subjects	Inspections, Supervision, Tests, etc.	Inspection/Test frequency
Earthwork (underground pipe installation), asphalt paving, fill-up ground, subgrade, and structural object backfill	Material management	CBR test, soil property test (specific gravity, particle size, water content, liquid/plastic limit, density), aggregate test (specific gravity, particle size, strength, water absorption rate), bituminous material (certificate of quality, table of composition)	Before construction
	Routine management	Compaction density test, water content, bituminous material (stability, flow value, porosity, Marshall test, temperature)	Immediately after construction Once a day for each layer of construction
Concrete work	Batcher plant; (as needed)	Measuring equipment, kneading performance, static load, measurement controller, dynamic load test, kneading performance	Before construction, every month (every 3 months for dynamic load)
	Materials	Inspect based on the cement, water specification certificate. Fine/crude aggregate test, particle size, specific gravity, water absorption rate, weight per unit, durability, alkaline aggregate reaction	Before construction and when materials to be used are changed
	Concrete standard test	Determine the composition by conducting test kneading. Slump, air volume, temperature, specimen strength	Before construction
	Routine management	Fresh concrete: air volume, slump, temperature	Consecutive 5 units at the beginning, then every 50m^3 and when making test pieces
		Casting concrete: casting method, compaction, jointing location, curing method, laitance processing	Witnessed inspection when casting
		Concrete test piece: test piece compressive strength test, concrete management chart preparation	Make a test piece once a day. 7 days and 28 days after casting
Reinforcing steel	Materials	Reinforcing steel materials are checked by the inspection certificate from a manufacturing factory. Quality, tension test, bending test	Before construction
	Installation inspection Routine management	Inspect the following items after installation: material size, dimension, layout, overlap length, overlap, fixed status, joint processing status	Before concrete construction: 100% inspection for each casting area

Source: JICA Study Team

Table 2.40 Work Control Plan

Construction	Type of Construction	Items	Standard Value	Remarks
Earthwork	Fill-up ground	Planned height	0cm or more	20m interval
		Width	-10cm or more	Same as above
	Road base	Planned height	-2.5cm or more	Same as above
		Finish thickness	-5cm or more	Same as above
		Width	-10cm or more	Same as above
Paving	Asphalt paving	Width	-3cm or more	Same as above
		Thickness	-1.5cm or more	Same as above
Foundation	Spread foundation	Ground base height	Planned design height or less	4m mesh
Concrete structure		Planned height	±5cm	
		Thickness	±75mm or ±3%	

Source: JICA Study Team

(7) Equipment and Materials Procurement Plan (Facilities Construction)

a. Labor

Demand for architect engineers and workers is high in Uganda. In Kampala City, skilled workers can be secured, including carpenters, plasterers, electricians, and heavy machine operators.

b. Various regulation items and work conditions (days off, work hours, etc.) in an aid receiving country, based on the Labour Law and other regulations.

According to UBOS, the unemployment rate in Uganda is 3.8% (2012), but it is expected to be much higher in the rate. Due to remarkable population concentration in Kampala City in recent years, the unemployment rate in Kampala City is estimated to be higher than the national average. This imbalance between job offerings and job applications is likely resulting in unfavorable working conditions for general workers. In construction sites, in particular, casual labors are readily available, but workers with special skills are lacking in terms of both quantity and quality. There are many cases where Kenyan and Indian workers living in Uganda are employed.

For employing workers, employees are required to comply with the Labor Law (revised in May, 2000) in Uganda. Working conditions specified in the Labor Law are shown below.

Table 2.41 Working Conditions in Uganda

Weekly Working Hour	48 hours
Overtime Payment:	When exceeding the weekly working hour (48 hours), overtime payment is calculated by: Hourly rate x 1.5 x overtime hours Hourly rate x 2.0 x overtime hours (Sundays/holidays)
Weekly Recess	24 consecutive hours
Recess during Work Hours	30 minutes per 6 hours of work
Transportation Expenses, Housing Benefit	Appropriate amount
Maternity Leave	4 weeks (women only)
Social Insurance (NSSF):	10% of the wage is borne by an employer (5% is borne by employees)
Minimum Wage	UGX136,000/month (2017)

・ Holidays

Workers have a right to take days off on national holidays. Holidays in Uganda are:

New Year's Day (January, 1), NRM Liberation Day (January,26), Women's Day (March, 8), Good Friday (April, 18), Easter Monday (April, 21), Martyr's Day (June, 3), National Heroes Day (June, 9), Eid al-Fitr (End of Ramadan), Eid al-Adhuha (Feast of the Sacrifice), Christmas (December, 25), and Boxing Day (December, 26).

In addition to the holidays above, the president can declare and create other holidays.

・ Day off per week

Workers have a right to take 24 consecutive hours of rest per week. The day off is taken on a customary rest day (Sunday) or a day that is agreed between the two parties.

In accordance with a regulation issued by a minister, workers in an administrative position or workers who work for a family facility employing five dependents or less can be excluded from a weekly day off. 30 minutes rest time should be given to workers who work eight hours or more.

c. Construction Materials

Main works of this project are road construction and building work. Major materials required for the road construction and building work (materials for concrete and asphalt) can be procured within Uganda. However, the supply quantity and quality need to be reconfirmed.

Cables for this project need to be buried underground, and insulated materials are required for them. However, underground wiring is uncommon in Uganda, and such materials are hardly available there. Flexible tube material for cables is also uncommon and cannot be procured

The list of suppliers of major materials is shown in Table 2.42.

Table 2.42 Country Origins by Construction Materials

Construction Materials	Local Procurement	Procurement in Japan	Procurement in Third Countries	Remarks
Reinforcing Steel		○	○	
Cement	○			
Concrete Admixture		○	○	
Reinforcing Steel		○	○	
Temporary Steel Material	○			
Asphalt Concrete	○			
Crushed Rock/Sand	○			
Mold Material	○			
Timbering/Scaffolding	○			
Concrete Pipe	○			
Flexible Tube		○	○	
Electric Wire Cable		○	○	
Optical Cable	○			
Coating Material	○			
Aluminum Sash	○	○		
Lighting Apparatus	○	○		
Air Conditioning		○		
Sanitary Fixture	○			
Monitoring Camera Equipment		○		
Access Management Equipment		○		
Furniture	○			

Source: JICA Study Team

(8) Plan for initial operation training and operation instruction

Training for initial operation and instruction for routine operation of the control center system of package 2 are included in the scope of equipment supplier and are also conducted in the soft component by a consultant. Details of the instructions from the consultant are described in (8) Soft component plan below.

(9) Soft component plan

a. Objectives

For maintaining functions of the traffic control system, supervision of the function-constituting hardware and software is essential. Normal operation of the hardware is a prerequisite for proper system operation, and the software (e.g., constant) should also be adapted to changes in traffic conditions. Supervision of such changes is important.

MODERATO is a key part of the control system function. It can respond to routine variations in traffic conditions, but cannot be adapted to changes of traffic flow, such as construction of new road or facilities that attract people/cars in nearby areas. Therefore, engineers who operate the traffic control centre are required to be experts of the traffic control system functions, and to have skills to add necessary changes.

Support from Japanese traffic control and MODERATO expert engineers is essential for cultivating the engineers after employment.

The objective of the soft component is cultivation of engineers, who are able to accurately comprehend traffic conditions and enforce necessary control via the control equipment, by providing technical guidance for traffic control analyses.

With this background, support from this component is necessary for smooth launch of the project, and for ensuring sustainability and expandability of the effect of the cooperation.

b. Points of concern

The Manual for Traffic Signal Design & Installation had been prepared in the Technical Cooperation Project. While conducting a pilot project covering four junctions, the Manual for Area Traffic Control, regarding the area traffic control which characterizes MODERATO, will be prepared.

Programme regarding the traffic control/management conducted (or planned) in the Technical Cooperation Project are summarized below.

Table 2.43 Technical Cooperation Project Traffic Control Programme

Signal Design, Installation, and Maintenance	Area Traffic Control/Supervision (Plan)
Principals of traffic control by signal	Basic concept of the area traffic control
Types of control scheme and selection	Control principle
Considerations in conducting signal control	Organization of traffic information
Signal phasing design	Determination of control mode
Estimation of a traffic capacity at signalized junctions	Subarea setting
Junction delay and signal cycle length	Tree, cycle, split, and offset setting
Installation method of lighting devices and field equipment	Control intervention and unlock
Wiring design	Simple constant setting
Field control device maintenance	MODERATO system configuration
	10. HMI operation

Source: JICA Study Team

The soft component is a traffic control technology transfer programme. It further develops/applies the knowledge about MODERATO that was acquired through the Technical Cooperation Project, taking into account the practice, which sampled the 30 junctions and areas covered for free of charge. Therefore, important points in traffic control of the 30 junctions will be learned (Phase 1), and then the control technologies adapted to the sites will be transferred (Phase 2).

Table 2.44 Details of Soft Component

Phase 1 (Before installation of the control equipment)	Programme-1 Lecture/survey/practice	(1) Traffic control system and signal control system training (2) Design procedure for a signal controlling constant for 30 junctions (3) Signal control plan for 30 junctions ① Understanding of traffic conditions of the subject area ・ Extraction of important junctions, based on the traffic conditions of the subject area, such as congestions. ・ Various traffic surveys focusing on the important junctions ② Examination of important junction control ・ Signal control policy ・ Road shape ・ Traffic regulation ③ Extraction of junctions with right turn sensing or other systems ④ Subarea composition plan ⑤ Detailed design of signal control

Phase 2 (After installation of the control equipment)	Programme-2 Practice	(1) Analysis of information of detectors in the 30 junctions (after determining important junctions) (2) Tentative design of various constants, based on information
	Programme-3 OJT	(1) Verification of signal control constant setting for 30 junctions (2) Detector operation status verification (3) System test

Source: JICA Study Team

c. Outcome of the soft component

[A] Phase 1 (before installation of the control equipment)

・ Programme-1：Understanding of traffic conditions in the control area, and acquisition of a control theory

Participants will understand traffic conditions and acquire a traffic control theory through lectures and field surveys. They will also learn setting for the important junctions and subarea grouping based on the field survey results.

[B] Phase 2 (after installation of the control equipment)

・ Programme-2：System constants setting

Participants will learn the setting of the system constants based on information collected from detectors.

・ Programme-3：Implementation of traffic control work

Participants will test run the entire system and carry out traffic control work with assistance.

d. Confirmation of achievement

Table 2.45 summarizes the outcomes, and items/methods to check, in order to review achievement in each activity.

Table 2.45 Items for Checking Achievement and Checking Method

Items for Checking Achievement and Checking Method	Items for Checking Achievement and Checking Method	Items for Checking Achievement and Checking Method
Programme-1 Understanding of traffic conditions in the control area Acquisition of a control theory	(1) Ability to understand traffic flow in the control area (2) Ability to understand the junction analysis method (3) Ability to understand the traffic control theory (4) Ability to set important junctions and subareas (5) Ability to design details of signal control	(1) Oral examination by Japanese experts (check sheet and discussion)
Programme-2 System parameter setting	(1) Ability to understand parameter setting (2) Ability to set parameter based on existing data	(1) Constant setting result
Programme-3 Implementation of traffic control operation	(1) Ability to initiate the system (2) Ability to operate the system without any trouble (3) Ability to take special measures about emergency vehicle traffic	(1) Six hours or longer operation of the control system (peak hours in AM and PM)

Source: JICA Study Team

e. Target Trainees of Soft Component

Target trainees of the soft component are currently employed KCCA engineers. Depending on the status of establishing/operating a traffic control unit, newly recruited engineers are planned to be included as appropriate.

Table 2.46 shows the expected subjects of soft component.

Table 2.46 Subjects of Soft Component

Organization	Department	Division	Programme	Number of People
KCCA	DoETS	System operation plan	1,2,3	4
Uganda Police Force	Traffic	Traffic regulation/control	1,3	3
KCCA	DoETS	Center operation	2,3	11
KCCA	DoETS	Maintenance	3	11

Source: JICA Study Team

f. Soft component input plan

The technical guidance in the Soft Component consists of three programme and is provided before system implementation and during system operation. Since there are no traffic control engineers in Uganda, local resources will not be used. Each programme will be directly taught by Japanese consultants, who are needed for the training. The Japanese consultants should have the following experiences and skills.

1) Traffic Control Technology 1 (college graduates 30 years, junior college graduates, 35 years or more)

Engineer assigned as “Traffic Control Technology 1” must have an experience in traffic control in Japan, and be well versed in the system composition, operation method, and academic theories, including the control theory. The engineers in “Traffic Control Technology” must have participated in JICA’s Kampala Road Traffic Project.

2) Traffic Control Technology 2 (college graduates 12 years, junior college graduates, 16 years or more)

Engineer assigned as “Traffic Control Technology 2” must have an experience in road traffic related projects or have graduated from a college with a relevant degree. They must have an experience in the same area in JICA’s technical cooperation projects and have an excellent English communication skill as well. Based on the experience in the technical guidance during the Technical Cooperation Project, the engineers in this category will mainly provide linguistic assistance to the “Traffic Control Technology 1” and will support training management and monitoring during the lectures before installation of the control equipment. For the OJT training after installation of the control equipment, the engineers will be divided into two groups and simultaneously lecture/teach the operating conditions of the detector and control equipment terminals, and the operating conditions of the central control equipment. Therefore, the two engineers in this category will be dispatched.

Table 2.47 Soft Component Input Plan

Phase	Operation Resource	Period
Programme-1	Japanese consultant 1 (Traffic control technology-1) Japanese consultant 2 (Traffic control technology-2)	5 days
Programme-2	Japanese consultant 1 (Traffic control technology-1) Japanese consultant 2 (Traffic control technology-2)	5 days
Programme-3	Japanese consultant 1 (Traffic control technology-1) Japanese consultant 2 (Traffic control technology-2)	14 days
Transportation (travel 2 times)	Phase 1 (4 days round trip) Phase 2 (4 days round trip)	8 days
	Total	32 days

Source: JICA Study Team

Details of the Japanese consultant activities are shown in Table 2.48.

Table 2.48 Consultant Activity Plan

Phase 1 (Before system implementation)		
Name of Expert	Work Detail	Working Days
Traffic Control Technology 1	Programme 1 【field work】 Lecture preparation Lecture (traffic control, control system, control constant design) Joint field survey (understanding of traffic conditions) Exercise (signal control plan)	 0.5 day 1.0 day 1.0 day 2.5 days Total 5.0 days
Traffic Control Technology 2	Programme 1 【field work】 Provision of support for lecture preparation, and management of training Evaluation of achievement, preparation of a report, and reporting	 4.0 days 1.0 day Total 5.0 days
Phase 2 (During system test run)		
Name of Expert	Work Detail	Working days
Traffic Control Technology 1	Programme 2 【field work】 Lecture preparation Lecture (analysis of detector information) Practical training (constant setting) Programme 3 【field work】 OJT preparation Guidance for system operation Evaluation of a proficiency level, and review	 0.5 day 2.0 days 2.0 days Total 4.5 days 0.5 days 10.0 days 4.0 days Total 14.5 days
Traffic Control Technology 2	Programme 2,3 【field work】 Lecture OJT support, and management of training Evaluation of achievement, preparation of a report, and reporting	 18.0 days 1.0 day Total 19.0 days

Source: JICA Study Team

g. Outcomes of the Soft Component

Outcomes of the Soft Component

- A completion report for submitting to KCCA and JICA (in English and Japanese)
- Updated MODERATO operation manual (prepared in the “The Project for Capacity Enhancement of KCCA in Management of Traffic Flow in Kampala City”) (in English)

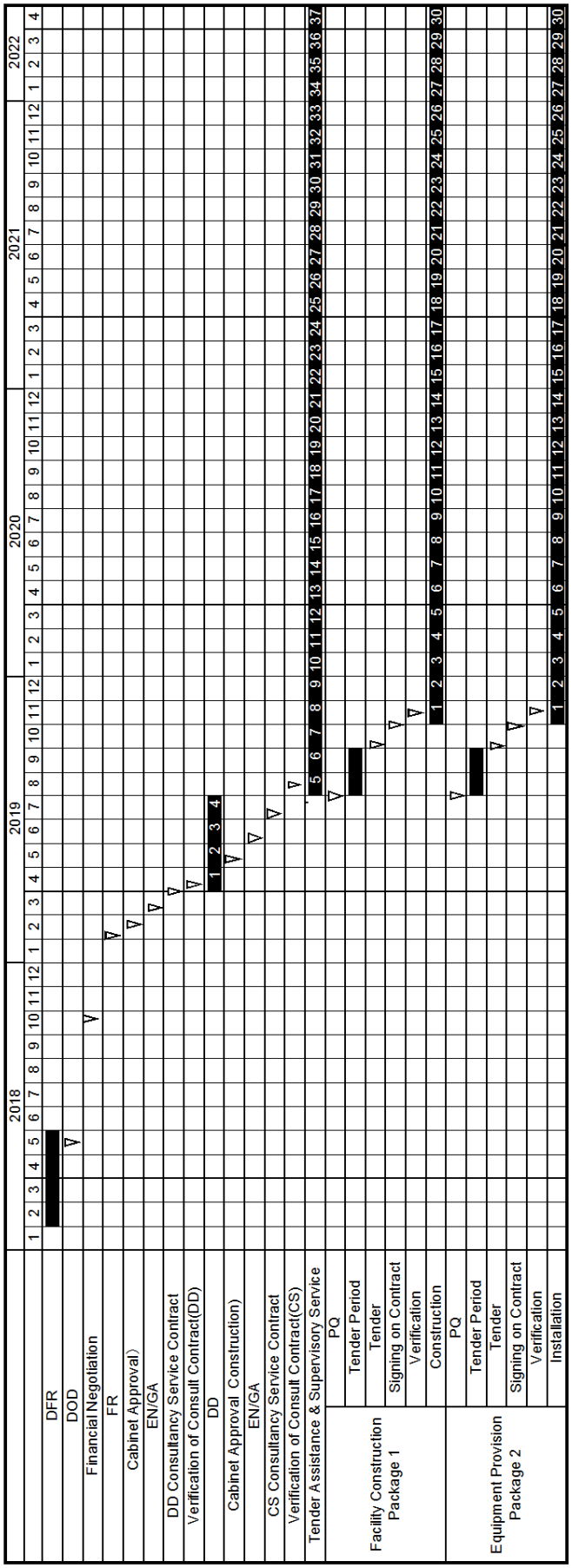
h. Implementation Schedule

The project will be implemented by each component (package), and procurement will be conducted individually.

Table 2.49 shows the implementation schedule (draft), taking into account the result of this survey. E/N and G/A will be executed after completion of this survey, and the project will be implemented from detail design, preparation of bidding documents, bidding, and to construction.

The execution design will be initiated from the field survey. Detailed design, specifications preparation, bidding document preparation, and bidding assistance will be conducted as a part of domestic work. Then an explanation of the detailed design will be provided to KCCA. Tender assistance and vendor contract related tasks will be subsequently performed.

Table 2.49 Project Implementation Schedule



Source: JICA Study Team

2.3 Outline of Responsibilities by the Recipient Country

Outline of responsibilities by the recipient country is described as follows,

(1) General Responsibilities

- Banking arrangement
- Notification of authority to pay (A/P) and payment of service charge

(2) Responsibilities in Project Operation

- Acquisition of construction site/ renting of temporary site, compensation for relocation, removal/relocation of obstructing objects (including trees)
- Exemption from paying custom duty for importing products and custom clearance fee
- Give necessary facilitation for Japanese regarding to bring in procured products and services obtained within the framework of authentication contract into the country
- Exempt Japanese from paying custom duty, domestic tax, and value-added tax for the products and services procured within the framework of authentication contract
- Coordination with relevant authorities and apply/proceed with certification procedure regarding relocation/installation of electricity, waterworks, sewerage, and other supplementary facility close to the site (including suppling of power to the traffic signal facility)
- Maintenance of the road of operation and maintenance area outside of the area designated to be improved by Japan, and the site of KCCA
- Proper use and maintenance/management of facility constructed by grant assistance
- Pay necessary expense for constructing facility outside of the cost covered by this grant assistance

For relocating utilities, KCCA covers the cost for waterworks and electricity, while the cost for the facility of telephone company is covered by the company.

Table 2.50 shows the cost information obtained by KCCA from the company, for relocating waterworks and electricity.

Table 2.50 Cost for Relocating Waterworks and Electricity

<table>
<tr>
<td>
NATIONAL WATER & SEWERAGE CORPORATION
KAMPALA WATER
Our Ref: NWSC-KW/SWSM/3/2018
Your Ref:
Date: 7th February 2018
P. O. BOX 70255 KAMPALA
PLOT 18/20 6TH STREET
INDUSTRIAL AREA
TEL: 041-315500/1
FAX: 041-349020
Executive Director,
Kampala City Council Authority,
P.O. Box 7010, Plot 1-3 Apollo Kaggwa Road,
Kampala, Uganda.
Project: PROPOSED PROJECT FOR THE IMPROVEMENT OF TRAFFIC CONTROL IN KAMPALA CITY
Subject: Relocation of NWSC Water and Sewer Network
Reference is made to your letter dated 6th November 2017 regarding this matter.
Following your communication, Kampala Water compiled detailed drawings and developed Bills of Quantities totaling to UGX 13,040,622,554 (Thirteen Billion, Forty Million, Six Hundred Twenty Two Thousand Five Hundred Fifty Four Shillings).
Please note that these are engineering estimates for your reference while planning the execution of the proposed road works along the proposed alignments. (Refer to the attached BOQs and Softcopy of the Drawings).
We hope that this information will ease planning, design and implementation of this project.
Yours Sincerely;
Moses Bigabwa Bategeka
Senior Manager Water Supply
</td>
<td>
UMEME
Rwenzori House | 1 Lumumba Avenue | P.O Box 23841 | Kampala | Uganda
fax (+256 41 434 6199) | tel (+256 41 434 4760) (+256 31 236 0600) | www.umeme.co.ug
February 7, 2018
CM/an/17/1 &W.O. NO.10560/000/481
The Director,
Directorate of Engineering & Technical Services,
Kampala Capital City Authority,
P. O. Box 7010,
KAMPALA.
Dear Sir,
LINE DIVERSION IN KAMPALA CITY FOR KAMPALA CAPITAL CITY AUTHORITY- (30 SITES)
Further to your application, the scheme has been evaluated and the lines can be diverted subject to final authorisations and availability of materials. Please refer to the attached cost schedule.
The provisional cost to you for these works valid for two months from the date of this quotation is:
Shs.41,016,138,090= excluding cost of wayleaves.
Note that the above cost shall be reviewed after your submission of the detailed drawings per site.
In a bid to avoid delays, the wayleaves costs shall be assessed later for your subsequent settlement. This sum assumes that the work will be commenced and completed in early course.
Attached is a form, which you will please complete and return, to affirm your acceptance of the sum quoted. No payment should be made at this stage.
When the proposals are finalised, an invoice will be sent to you followed by payment in full, to facilitate commencement of works. Note that the construction works will be scheduled according to UMEME's capacity to deliver.
Yours faithfully,
Clare Mukasa
REVENUE CYCLE MANAGER
SQ 1
c.c: Network Manager Planning & Loss Reduction
Regional Manager Kampala West
District Manager Metro
</td>
</tr>
<tr>
<td>Waterworks relocation cost UGX13,040,622,554 (apx. USD3,622,395)</td>
<td>Electricity relocation cost UGX108,122,580 +UGX206,794,659=UGX314,917,239(Approx.USD83,978)</td>
</tr>
</table>

Source：UMEME and NWSC

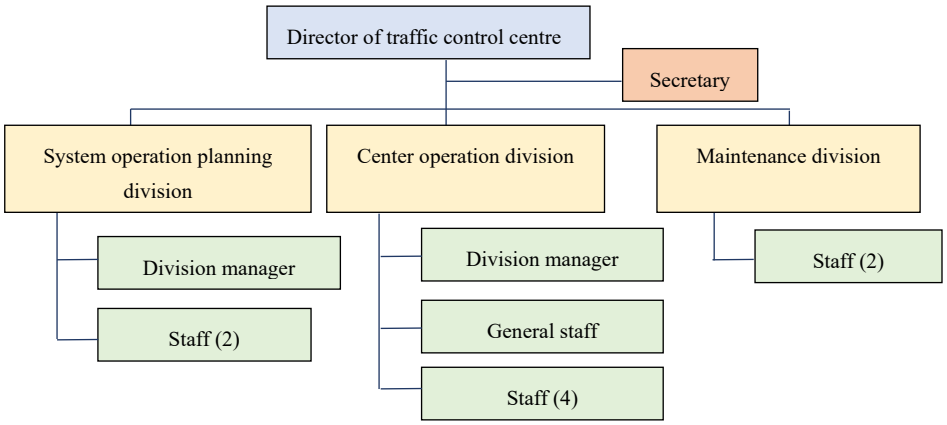
(3) Other

- Contracting with Japanese consultant to conduct execution design and construction management
- Contracting with Japanese contractor and equipment/material procurer

2.4 Operation/ Maintenance Management Plan of Project

2.4.1 Organization

This traffic control centre is the first facility established in Uganda, and there is also no other facility similar to a highway management centre. Therefore, it is necessary to establish a new organization within KCCA for the operation, management, and maintenance of the facility. The traffic control centre maintenance management organization (temporary name: traffic control unit) proposed by the consultant will be established under DoETS, to be a part of engineering division. Following is the content of the proposed new organization.



Source：JICA Study Team

Figure 2.30 Organization of Traffic Control Unit (proposal)

For the operation of traffic control centre, expected tasks for each above person in charge are as follows.

a. System operation planning manager

- Plan measures for improving system functionalities and traffic signal control by periodically monitor traffic congestion condition and extract issues along with statistical application.
- Collect traffic control data including estimated travel time and traffic density, and revise/improve traffic signal control operation for the troubling routes indicated by the collected data.
- When it is estimated that traffic is condensed to the area affecting traffic-controlled area, preliminary measure shall be planned by coordinating with relevant departments.
- Improve and supplement the functionalities of the system to adapt to the changes of traffic conditions within the traffic-controlled area, or new needs in traffic system.

b. Centre operation manager

- Monitor traffic conditions by using central display panel and control desk and intervene in the control of traffic signal as necessary, or check and verify the traffic congestion information provided by VMS and others.
- Collect traffic information via radio/telephone communication and intervene in advance in the control of traffic signal when traffic congestion is expected to occur and continue monitoring the condition.
- When unexpected case, such as traffic accident occurs, check and verify the contents of provided information from VSM including traffic restriction condition or detour/bypass recommendation.
- Intervene in traffic signal control to reduce traffic congestion by traffic restriction for guarding VIP.
- Monitor traffic congestion condition caused by traffic restriction and take similar action as the last item for quick relief of traffic congestion after the restriction is terminated.

- Gather information of large-scale events, and monitor traffic conditions in case of such events and take similar action as the item before last.
- Through the operation works of the centre, propose an improvement plan required for the cases of altering traffic signal control plan, or improving and supplementing functionalities of the system by coordinating with system operation planning division.

c. Maintenance manager

- It is a position to conduct overall maintenance works of the traffic control system equipment. Other than daily inspection and maintenance, it makes regular inspection in specified cycle, and special inspection as necessary for the cases with the occurrence of many troubles.
- Daily inspection and maintenance: inspect the operation conditions via the system monitoring device of the central, terminal equipment, and take necessary action to arrange repairing of equipment in failure.
- Regular inspection: inspect each equipment according to the check list with the specified cycle of inspection for each equipment.
- Special inspection: conduct special inspection and repair work for the equipment with high frequency of trouble indicated by error log.

2.4.2 Traffic Control Centre Operation

Subject of the maintenance and management for the traffic control system has both aspects in hardware and software. It is indispensable to establish a system and secure budget for proper maintenance/ management to maintain and increase its functionality.

(1) Tasks of Manager

Other than the system operation, conduct works for maintenance, and works requiring administrative judgement including system development planning and sophistication.

- Works for traffic control centre operation and clerical works related with operation planning
- Works related with the provision of traffic information
- Clerical works related with system maintenance
- Planning of expansion, development, and sophistication of the system
- Clerical works for improving the system
- Improvement and planning of traffic signal control

(2) Tasks Commissioned to Private Sector

It is practical to outsource those tasks with highly sophisticated system maintenance and inspection requiring expertise by budgeting its cost.

- Inspection, maintenance, and repair of the system
- Handling troubles of the system and terminal equipment
- Improvement of traffic signal control beyond the extent of daily works
- Alteration of quorum related with other functionalities

It is not expected to be implemented daily for the above commissioned works unless there is no increase/decrease of proposed junctions, except inspection, maintenance and repair works of the system.

For the inspection and maintenance of the system, remote management is applied from Japan via the Internet and other methods by procurer for fixed period of time.

(3) Maintenance and Management of Terminal Facility

Maintenance and management of terminal facility is conducted by external commission. KCCA is implementing these external commissions via framework contract, and there are those contractors (maintenance and inspection trustee) who undertake those commissions.

a. KCCA's extent of responsibility

Subject of the maintenance and management works includes various type of terminal devices such as traffic signal facility (hereafter called as "terminal devices") all over Kampala City, along with their construction and installation works, or relocation of obscuring devices.

The works for maintenance and management are intended to realize a safe and comfortable traffic society by defining necessary items for the maintenance and management department of the terminal devices. The person in charge shall communicate and coordinate with the trustee of the "commission work for the maintenance and inspection of traffic signal facility and others" (hereafter called "maintenance and inspection trustee"), give instruction to prevent from trouble, order examination of the operation condition of vehicle detectors and devices, renew information of the drawings for terminal device installation, manage terminal devices, manage, and add up data related with terminal devices.

Extent of the responsibility of the department in charge is the tasks to monitor the operation condition of the terminal devices, and to maintain functionalities of the terminal devices when some trouble occurrence of the functionality of those devices is reported, or some trouble might be expected.

b. Content of the tasks for maintenance and inspection

・ Periodic inspection work

Periodic inspection work means to check functionalities of terminal devices, and replace maintenance material, or electronically or mechanically adjust and modify the devices in case if preventive measure is considered necessary.

・ Maintenance work

Maintenance work means to check operation conditions of terminal devices by patrolling them, and rush to the concerned site in case some kind of trouble occurs with the functionality or the external appearance of those devices, and in case if possibility of such trouble is anticipated, or when notified by KCCA's department in charge, and work to maintain normal function and external appearance.

Establish necessary organization to dispatch personnel and reach at the concerned site of trouble within 1 hour or so, regardless of time of such trouble's occurring.

・ Inspection and cleaning works of lantern and the like

Inspection and cleaning works of lantern means inspection and cleaning conducted for maintaining the functionalities of traffic signal light.

・ Stock monitoring works for maintenance parts of traffic signal facility and others

Stock monitoring works for maintenance parts of traffic signal facility means managing stock replacement parts for maintenance work, and storing in storage and managing recyclable equipment pulled off from construction or repairing works of traffic signals.

・ Management of maintenance material and others

For conducting inspection and maintenance works, prepare and manage following maintenance material and others necessary for the work.

Regarding those necessary maintenance materials (maintenance parts, consumables), commissioned trustee, in

principal, shall prepare them in their own responsibility, and securely manage their stock not to disrupt the maintenance and inspection works from the lack of maintenance materials or others.

Maintenance material shall be properly stored under the responsibility of trustee.

The key of the terminal devises lent by the instruction of KCCA, specifications, instruction manual, drawings for the installation of traffic signal facility, circuit diagram and others shall be properly stored under the responsibility of the trustee and shall be returned promptly after the contract period of this commissioned work is terminated.

For conducting inspection and maintenance works, prepare following necessary equipment and others under the responsibility of the trustee, and take necessary procedure required for them.

Prepare and provide measuring instrument, vehicle etc. necessary for inspection and maintenance works.

Table 2.51 Measuring Instrument for Inspection and Maintenance Works

	Name	Purpose
1	Tester	Voltage and current measuring for alternating and direct current
2	Cramp meter	Measuring load current and leakage current of alternating current
3	Earthing resistance meter	Measuring earth resistance
4	Insulation resistance meter	Measuring insulation resistance
5	Inclinometer	Measuring inclination angle of a column
6	Each type of console	Make setting by connecting to equipment, or collect log data (*as necessary)

Source：Technical Cooperation Project

Table 2.52 Vehicles for Maintenance Work

	Necessary vehicle	Purpose
1	Maintenance car	Transportation to terminal devices for bringing tools and workers
2	Elevated work vehicle	Work at elevated positions for lighting instrument, detector, columns

Source：Technical Cooperation Project

Use properly calibrated measuring instrument.

Prepare and arrange communication devices to contact KCCA and operation monitoring work department (telephone, fax, computer, etc.). Those communication devices shall be able to transmit photo data in necessary resolution for inspection and maintenance works.

Prepare and arrange equipment to be used for producing report document and others (computer, color printer, etc.).

- Implementation of safety measures

Implement safety measure and carry out necessary procedure for inspection and maintenance works under the responsibility of commissioned trustee.

When working on the road, provide and station traffic guidance expert to properly guide traffic vehicles and pedestrians and thoroughly implement safety measure.

- Submitting document and report

Commissioned trustee shall submit the following documents to KCCA to receive approval.

- Yearly inspection plan document
- Organization system chart and list of workers
- Specifications and management chart of measuring instrument and vehicles

- Report document based on the specification of each task
- List of maintenance materials, keys and specifications for leasing terminal devices, and management method of material stocks and others.

2.5 Estimated Project Cost

(1) Costs by Japanese side

Confidential

Table 2.53 Project cost breakdown

Confidential

(2) Cost by Ugandan side

The expenses incurred by the Ugandan side are estimated to be 500 million yen for expenses required for construction monitoring, relocation costs and power supply related expenses.

(3) Operation and Maintenance Cost

It is estimated at 19 million yen per year.

CHAPTER 3 PROJECT EVALUATION

3.1 Prerequisites for the Project

Prerequisites for implementing the project are described below. Relocation and/or removal of existing structures that hinder the project, compensation, and issue of approval documents from authorities concerned are in principle to be proceeded after E/N and completed by the notice of constructor's preliminary review.

- Junction improvement works in this project requires the relocation and/or removal of existing structures that hinder the planned site designated by KCCA.
- Twenty-one trees must be removed for the junction improvement works, which requires appropriate environmental measures.
- Before implementing the junction improvement project, confirmation discussions of the Project Brief (drafted in this survey) by KCCA, the executing agency, and NEMA, the environment management authority, are necessary.
- Acquisition of sites for a construction camp as well as for material and equipment storage (sports facility owned by KCCA) is required.
- In order to ensure a traffic safety during the project, KCCA is required to conduct traffic safety campaign for road users and residents. KCCA is required to provide support and cooperation for the customs clearance of and tax exemption for materials and equipment used in the project, as well as to implement management and maintenance works after completion of the project. Details of these requirements are described in 2.3 and 2.4.

This project will be the first grant aid project for KCCA. Therefore, KCCA, the executing agency, is required to understand the provider's contributions on implementing such grant aid project. KCCA is also required to thoroughly understand and comply with provisions of each contract entered into with the consultant and with the constructor, as well as the system of such contracts.

3.2 Recipient’s Responsibilities Required for Successful Completion of the Entire Project

Recipient’s responsibilities required to realize and maintain the impact of the project are as follows:

- In order to implement the project smoothly, the Partner should arrange the budget on Uganda side described in "2.3 Outline of Responsibilities by the Recipient Country" of this report earlier.
- In order to ensure sustainable functions of the traffic control centre and terminal equipment, KCCA should establish an organization described in "2.4 Operation/ Maintenance Management Plan of Project" in this report for the management and maintenance.
- KIIDP2 with financial support from the World Bank of which KCCA is one of the clients, and the Kampala Flyover Project as a loan project of Japan are planned to implement the junction improvement works of this project simultaneously. Therefore, KCCA is required to establish a council which will be in charge of the traffic management, to share information about the progress of works and detouring routes, and to minimize the possible burden on the current traffic.

3.3 External Conditions

External conditions required to realize and maintain the impact of the project are as follows:

- Traffic congestion of the city is continuously increasing. Main reasons for such heavy traffic include low traffic capacity, and low road performance due to poor management and maintenance of the existing network (many potholes and cracks of roads occur). It is considered to be the priority to maximize the performance of existing road network before developing new roads, and thus KCCA will be required to have a strategy for improving its capacity for management and maintenance of the traffic network.
- There are some aspects in road administration in Kampala City where authorities in charge are not clear

between KCCA and UNRA, and particularly, opinions and plans for traffic projects by UNRA alone are found occasionally.

It is expected to see the appropriate impact of this project by satisfying such external conditions described above.

3.4 Project Evaluation

3.4.1 Validity

In "Vision 2040", a development plan of Uganda, the development of economic infrastructure is one of the major issues to be addressed. It is expected that developing economic infrastructure will facilitate the movement of people and goods, enlivening the economy. The development of economic infrastructure will be achieved by realizing four points described below:

- Improve the governance of infrastructure and transport sector
- Improve the access by connecting traffic network between international and regional highways
- Facilitate economic activities by improving competitiveness of transportation infrastructure, including airports and railways
- Residents are enabled to use high-quality transportation infrastructure

The efficiency of road traffic (competitiveness) is enhanced by improvement and advanced management of the junction, and residents are enabled to use high-quality transportation infrastructure.

3.4.2 Effectiveness

(1) Quantitative effect

[A] Effect on reducing journey time

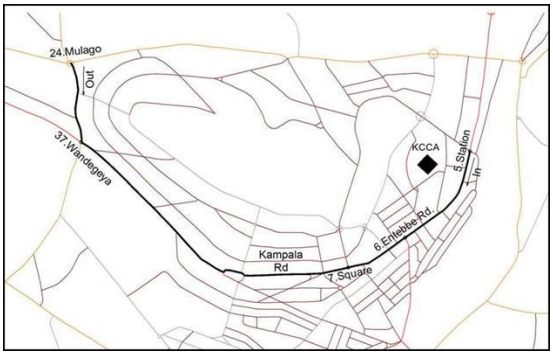
The traffic speed increases by the junction improvement and the control by MODERATO system within the network.

Table 3.1 Effects of Project Implementation

		Reference Value (Y2017)	Target Value(Y2025) (after 3 years from the Project Completion)
Average Travel Speed（km/h）[7]		10.95	14.70
Average Travel Time (Min)	In	10.4	8,7
	Out	13.8	10.0
Average Passengers （Pax/dat）		424,100	597,800

Source: JICA Study Team

[7] The target to be monitored is an intersection where the congestion at the peak time (measurement time zone 7: 00-8: 00) is conspicuous and the road network shape is complicated (In: start point 5. Station / end point 24. Mulago, Out: start point 24. Mulago / End point 5. Station) We selected a network including five places. The "average travel speed" was the average value of In / Out.



[B] The number of junctions controlled manually by traffic police officers

Controlling the traffic manually will not be necessary by the junction improvement, and the traffic control at junctions will be reproducible.

Table 3.2 Effect of the project implementation (manual control)

	No Projects	Junction Improvement
No. of junctions (within the proposed area)	17	0

Source: JICA Study Team

(2) Quantitative effect

The qualitative effects expected by the implementation of this project are described as follows:

[A] Promoting efficiency of the city

The journey time within the city's road network will be reduced, and economic activities in the Greater Kampala Metropolitan Area will enliven as well as the lives of residents will become stable, contributing the improved efficiency of the city and to reduce secondary poverty.

[B] Reducing accidents at junctions

Traffic accidents due to heavy traffic will be reduced and the traffic safety will be enhanced by the junction improvement. It is also expected to reduce fatal accident cases, since the current roundabout will be replaced with signal junctions, and thus the distance that pedestrians walk across the road will be shortened.

[C] Increasing the employment

It is expected that new employment opportunities will increase among engineers and laborers of Uganda due to recruitment for this project. Reduced time and cost of access from surrounding areas to Kampala City will lead large-scale retail stores to be opened in the City, providing new employment opportunities for residents living in wider commutable area.

KAMPALA CAPITAL CITY AUTHORITY (KCCA)
THE REPUBLIC OF UGANDA

PREPARATORY SURVEY FOR THE PROJECT FOR IMPROVEMENT OF TRAFFIC CONTROL IN KAMPALA CITY

FINAL REPORT

ANNEXES

FEBRUARY 2019

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS GLOBAL CO., LTD.
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

PREPARATORY SURVEY FOR
THE PROJECT FOR IMPROVEMENT OF TRAFFIC CONTROL IN KAMPALA CITY
FINAL REPORT ANNEXES
TABLE OF CONTENTS

A Study Members

A.1 1st Survey in Uganda (June, 2017)

Name	Designation	Organization
Ogino Hiroyuki	Team Leader (TL)	JICA Infrastructure and Peacebuilding Department
Iwano Junnosuke	Coordinator (CO)	JICA Infrastructure and Peacebuilding Department
Izawa Tetsuro	Chief Consultant (CC)	Oriental Consultants Global Co., Ltd.
Morimoto Hiroyuki	Deputy Chief Consultant (DCC)	Oriental Consultants Global Co., Ltd.
Yokoi Akira	Traffic Control System/O&M Expert (TCE)	Oriental Consultants Global Co., Ltd.
Nakajima Yasuhiro	Architect (AR)	Oriental Consultants Global Co., Ltd.
Kikuchi Youta	Building Facility Designer (BFD)	Oriental Consultants Global Co., Ltd.
Kawasaki Ikumasa	Junction Designer (JD)	Eight-Japan Engineering Consultants Inc.
Sawaguchi Tsutomu	Cost Estimator /Construction Planning (CEC)	Oriental Consultants Global Co., Ltd.
Ishikawa Haruhisa	Cost Estimator /Construction Planning (CEB)	Oriental Consultants Global Co., Ltd.
Ikutame Junki	Environmental Expert (EE)	Eight-Japan Engineering Consultants Inc.
WU Chiehyu	Natural Condition Survey Engineer (NCE)	Oriental Consultants Global Co., Ltd.

A.2 2nd Survey in Uganda (August, September, 2017)

Name	Designation	Organization
Kawahara Shuntaro	Team Leader (TL)	JICA Infrastructure and Peacebuilding Department
Iwano Junnosuke	Coordinator (CO)	JICA Infrastructure and Peacebuilding Department
Izawa Tetsuro	Chief Consultant (CC)	Oriental Consultants Global Co., Ltd.
Morimoto Hiroyuki	Deputy Chief Consultant (DCC)	Oriental Consultants Global Co., Ltd.
Yokoi Akira	Traffic Control System/O&M Expert (TCE)	Oriental Consultants Global Co., Ltd.
Nakajima Yasuhiro	Architect (AR)	Oriental Consultants Global Co., Ltd.
Debnath Pallab	VMS Designer (VD)	Oriental Consultants Global Co., Ltd.
Noda Sora	Communication System Expert (CE)	Oriental Consultants Global Co., Ltd.

A.3 Draft Outline Design Presentation Mission (April, May and June 2018)

Name	Designation	Organization
Tanaka Kenshiro	Team Leader (TL)	JICA Infrastructure and Peacebuilding Department
Takada Yuuichiro	Coordinator (CO)	JICA Infrastructure and Peacebuilding Department
Izawa Tetsuro	Chief Consultant (CC)	Oriental Consultants Global Co., Ltd.
Morimoto Hiroyuki	Deputy Chief Consultant (DCC)	Oriental Consultants Global Co., Ltd.
Yokoi Akira	Traffic Control System/O&M Expert (TCE)	Oriental Consultants Global Co., Ltd.
Nakjima Yasuhiro	Architect (AR)	Oriental Consultants Global Co., Ltd.

B Study Programme

B.1 1st Survey in Uganda (June 2017)

Days	Date	Ogino Hiroyuki	Iwano Junnosuke	Izawa Tetsuro	Morimoto Hiroyuki	Yokoi Akira	Nakajima Yasuhiro	Kikuchi Youta	Kawasaki Ikumasa	Sawaguchi Tsutomu	Ishikawa Haruhisa	Ikutame Junki	WU Chiehyu
		TL	CO	CC	DCC	TCE	AR	BFD	JD	CEC	CEB	EE	NCE
1	June 1			Survey in UG									
2	June 2												
3	June 3												
4	June 4	Survey in UG			Survey in UG	Survey in UG		Survey in UG	Survey in UG	Survey in UG		Survey in UG	
5	June 5												
6	June 6												
7	June 7												
8	June 8												
9	June 9												
10	June 10												
11	June 11												
12	June 12						Survey in UG				Survey in UG		Survey in UG
13	June 13	Signing on MM											
14	June 14			Survey in UG									
15	June 15												
16	June 16												
17	June 17												
18	June 18												
19	June 19												
20	June 20												
21	June 21												
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25	June 25												
26	June 26												
27	June 27												
28	June 28												
29	June 29												
30	June 30												
31	July 1												
32	July 2												
33	July 3												
34	July 4												
35	July 5												
36	July 6												
37	July 7												

B.2 2nd Survey in Uganda (August, September, 2017)

Days	Date	Kawahara Shuntaro	Iwano Junnosuke	Izawa Tetsuro	Morimoto Hiroyuki	Yokoi Akira	Nakajima Yasuhro	Debnath Pallab	Noda Sora
		TL	CO	CC	DCC	TCE	AR	VD	NCE
1	Aug.4								
2	Aug.5								
3	Aug.6								
4	Aug.7								
5	Aug.8								
6	Aug.9								
7	Aug.10								
8	Aug.11								
9	Aug.12								
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25	Aug.28								
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27	Aug.30								
28	Aug.31								
29	Sep.1								
30	Sep.2								
31	Sep.3								
32	Sep.4								
33	Sep.5								
34	Sep.6								
35	Sep.7								
36	Sep.9								
37	Sep.10								
38	Sep.11								
39	Sep.12								
40	Sep.13								
41	Sep.14								

Survey in UG

Survey in UG

Survey in UG

Survey in UG

Survey In UG

Signing on MM

Survey in UG

B.3 Draft Outline Design Presentation Mission (April, May and June 2018)

Days	Date	Tanaka Kenshiro	Takada Yuuichiro	Izawa Tetsuro	Morimoto Hiroyuki	Akira Yokoi	Nakajima Yasuhiro
1	Apr.23						Survey in UG
2	Apr.24						
3	Apr.25						
4	Apr.26					Survey in UG	
5	Apr.27						
6	Apr.28						
7	Apr.29						
8	Apr.30						
9	May 1						
10	May 2						
11	May 3						
12	May 4						
13	May 5						
14	May 6						
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31	May 23						
32	May 24						
33	May 25						
34	May 26			Survey in UG	Survey in UG		
35	May 27						
36	May 28						
37	May 29						
38	May 30						
39	May31	Signing on MM					
40	Jun 1						
41	Jun .2						
42	Jun .3						

C List of Personnel Discussed

Organization	Title	Name
Kampala Capital City Authority (KCCA)	Executive Director	Jennifer Musisi
Kampala Capital City Authority (KCCA)	Director of Engineering and Technical Service	Andrew Kitaka
Kampala Capital City Authority (KCCA)	Deputy Director Road Management	Jacob Byamukama
Kampala Capital City Authority (KCCA)	Manager, Directorate of Engineering and Technical Services	Joel Wasswa
Kampala Capital City Authority (KCCA)	Deputy Director, ICT, Office of the Executive Director	Martin Sekajja
Kampala Capital City Authority (KCCA)	Traffic Engineer, Directorate of Engineering and Technical Services	Fortunate Biira
Ministry of Finance, Planning and Economic Development (MOFPED)	Secretary	Maris Wanyara
World Bank	Senior Urban Specialist	Martin Onyach Olaa
Uganda National Roads Authority (UNRA)	Head of Design	Patrick Muleme
National Environment Management Authority(NEMA)	Environment Audit & Assessment	Osikol Esther
NITA-U	Network Manager	Allan Kyazze
JICA Uganda Office	Chief Representative	Kyosuke Kawazoe
JICA Uganda Office	Chief Representative	Yutaka Fukase
JICA Uganda Office	Representative	Shinichi Saito

D Minutes of Discussion

D.1 The MD at Draft Outline Design Presentation Mission

Minutes of Discussions
on the Preparatory Survey for the Project for
Improvement of Traffic Control in Kampala City
(Explanation on Draft Preparatory Survey Report)

With reference to the minutes of discussions signed between the Kampala Capital City Authority (hereinafter referred to as "KCCA") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 13th June and 12th September, 2017 and in response to the request from the Government of the Republic of Uganda (hereinafter referred to as "Uganda") dated March 2017, JICA dispatched a Preparatory Survey Team (hereinafter referred to as "the Team") for an explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for the Project for Improvement of Traffic Control in Kampala City (hereinafter referred to as "the Project").

As a result of the discussions, both sides confirmed on the main items described in the attached sheets.

Kampala, 31st May, 2018

Kenshiro Tanaka
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Jennifer Semakula Musisi PhD (h.c)
Executive Director
Kampala Capital City Authority
The Republic of Uganda

Witness

Maris Wanyera
For: Permanent Secretary / Secretary to the Treasury Ministry of Finance, Planning and Economic Development
The Republic of Uganda

ATTACHEMENT

1 Objective of the Project

Both sides confirmed that the objective of the Project is to ease traffic congestion of Kampala City through development of traffic signal network including optic fiber trunk lines, construction of a building for Traffic Control Center, improvement of junctions and installation of equipment for Traffic Control Center, thereby contributing to optimization of traffic flow in Kampala City.

2 Contents of the Draft Report

After the explanation of the contents of the Draft Report by the Team, the Ugandan side agreed to its contents.

3 Components of the Project

Both sides agreed the sites and contents of the Project as shown in Annex 1.

4 Confidentiality of the cost estimate and technical specifications

Both sides confirmed that the cost estimate and the technical specifications of the Project should never be disclosed to any third parties except for Ministry of Finance, Planning and Economic Development until all the contracts under the Project are concluded.

5 Disbursement Procedure and Flow Chart of Grant Aid Projects

The Team explained to the Ugandan side that the detail disbursement procedure and flow chart of Grant Aid Project is as attached in Annex 3.

6 Timeline for the project implementation

The Team explained to the Ugandan side that the expected timeline for the project implementation is as attached in Annex 4.

7 Cost estimate

Both sides confirmed that the cost estimate including the contingency explained by the Team, as shown in Annex 5, is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

8 Expected outcomes and indicators

Both sides agreed that key indicators for expected outcomes are as follows. The Ugandan side will be responsible for the achievement of agreed key indicators targeted in year 2024 and shall monitor the progress based on those indicators.

[Quantitative indicators]

Effect		Base Value (2017)	Target Value (2024)
Average travel speed (km/h)		10.95	14.90
Average travel time (minutes)	In	10.4	8.6
	Out	13.8	9.9
Average daily passenger (number/daily)		424,100	572,700

* Route to be monitored is the section between junctions 5 and 24 where the congestion at peak time (7:00-8:00) is conspicuous.

[Qualitative indicators]

- Facilitation of traffic flow and logistics in Kampala City by securing smooth road transportion
- Improvement of road network efficiency
- Reduction of traffic accidents (Improvement of traffic safety)

9 Technical assistance ("Soft Component" of the Project)

Considering the sustainable operation and maintenance of the products and services granted through the Project, technical assistance is planned under the Project. The Ugandan side confirmed to deploy necessary number of counterparts who are appropriate and competent in terms of its purpose of the technical assistance as described in the Draft Report.

10 Undertakings of the Project

Both sides confirmed the undertakings of the Project as described in Annex 5 which will be used as an attachment of G/A.

Both sides confirmed that customs duties, internal taxes and other fiscal levies as stipulated in 1.(2)-5 of Annex 5 may be imposed in Uganda will be budgeted for by KCCA without using the Grant, according to the agreement between the Government of Uganda and the Government of Japan.

Both sides confirmed that such customs duties, internal taxes and other fiscal levies shall be clarified in the bid documents by KCCA during the implementation stage

of the Project.

The Ugandan side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project in Annex 5. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.

11 Tax Treatment

Both sides confirmed the tax treatment for the Japanese Grant Aid Project based on the following letters from Ministry of Finance Planning and Economic Development (MOFPED) in Uganda attached as Annex 6.

- Letter: Ref. No. TPD 130/167/01 dated 19th July 2017
- Letter: Ref. No. TPD 130/167/01 dated 6th April 2018

12 Monitoring during the implementation

The Project will be monitored by the Executing Agency and reported to JICA using the form of Project Monitoring Report (PMR) attached as Annex 7. The timing of submission of the PMR is described in Annex 5.

13 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.

14 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, Sustainability). The result of the evaluation will be publicized. The Uganda side is required to provide necessary support for the data collection.

15 Schedule of the Survey

JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Uganda side in August 2018.

16 Environmental and Social Considerations

16-1 General Issues

16-1-1 Environmental Guidelines and Environmental Category

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 B because; the Project is not considered to be a large-scale road project; is not located in a sensitive area; and has none of the sensitive characteristics under the Guidelines, it is not likely to have a significant adverse impact on the environment.

16-1-2 Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist attached as Annex 8. Both sides confirmed that in case of major modification of the content of the Environmental Checklist, the Uganda side shall submit the modified version to JICA in a timely manner.

16-2 Environmental Issues

16-2-1 Environmental Impact Assessment (EIA)

Both sides confirmed the EIA report is not required for the Project in the country's legal system.

16-2-2 Environmental Management Plan and Environmental Monitoring Plan

Both sides confirmed Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) of the Project is as Annex 9, respectively. Both sides agreed that environmental mitigation measures and monitoring shall be conducted based on the EMP and EMoP, which may be updated during the detailed design stage.

16-3 Environmental and Social Monitoring

16-3-1 Environmental and Social Monitoring

Both sides agreed that the Uganda side will submit results of environmental and Social monitoring to JICA by using the monitoring form attached as Annex 10. The timing of submission of the monitoring form is described in Annex 5.

16-3-2 Information Disclosure of Monitoring Results

Both sides confirmed that the Uganda side will disclose results of environmental and social monitoring to local stakeholders through their website / in their field

offices.

The Uganda side agreed JICA will disclose results of environmental and social monitoring submitted by the Uganda side as the monitoring forms attached as Annex 10 on its website.

17 Other Relevant Issues

17-1 Standardization of Traffic Control System in Kampala City

KCCA has understood applicability and effectiveness of MODERATO system, and area traffic control system for Kampala City. KCCA will also run a pilot project for testing MODERATO system at four (4) junctions under the technical cooperation project, named "The Project for Enhancement of KCCA in Management of Traffic Flow in Kampala City," supported by JICA.

Both sides reconfirmed that the Project and other JICA-related projects; "Kampala Flyover Construction and Road Upgrading Project" and the above mentioned technical cooperation project would cover most of the busy and critical junctions in Kampala City by using MODERATO system when those are realized.

In consideration of all these facts, KCCA has decided to use MODERATO system technology as the standard for urban area traffic control to coordinate traffic signals in Kampala City.

17-2 Coordination with other Relevant Projects in Kampala City

For the smooth implementation of the Project, the Team reiterated the importance of coordination among various transport sector projects in Kampala City supported by several donors.

For example, KCCA has already arranged that the junction improvement work at Kira Road and Acacia Avenue will be done by Kampala Infrastructure Improvement and Development Project Phase 2 (hereinafter referred to as "KIIDP2"), and the installation of signals at same place will be done by the Project.

Both sides confirmed that KCCA would take a coordinating role and share all the related information with JICA for avoiding duplication of inputs and modification of the Project plan during implementation.

17-3 Sustainable Operation and Maintenance

The Team reiterated the importance of sustainable operation and maintenance of the Project, which is a critical factor for success of the Project. Both sides confirmed the institutional and financial arrangement plan to be established by

KCCA for sustainable operation and maintenance of equipment provided by the Project with assistance of the above mentioned technical cooperation project.

The Ugandan side agreed to allocate budget, human resources with skills, and goods necessary for the proper and sustainable operation and maintenance of the facilities and the equipment under the Project based on the Draft Report. Specifically, the Ugandan side agreed to take necessary measures to train and allocate sufficient human resources with adequate skills to functionalize MODERATO system in the Traffic Control Centre before the completion of the Project.

17-4 Relocation of Utilities

The Team emphasized again that the relocation of utilities could negatively affect the smooth implementation of the Project without an adequate management for it. Both sides reviewed the procedures, expected bottlenecks, and cost for the relocation of utilities, and the Ugandan side agreed that KCCA would take necessary actions to deal with those matters, including securing the necessary budget, before and during implementation of the Project.

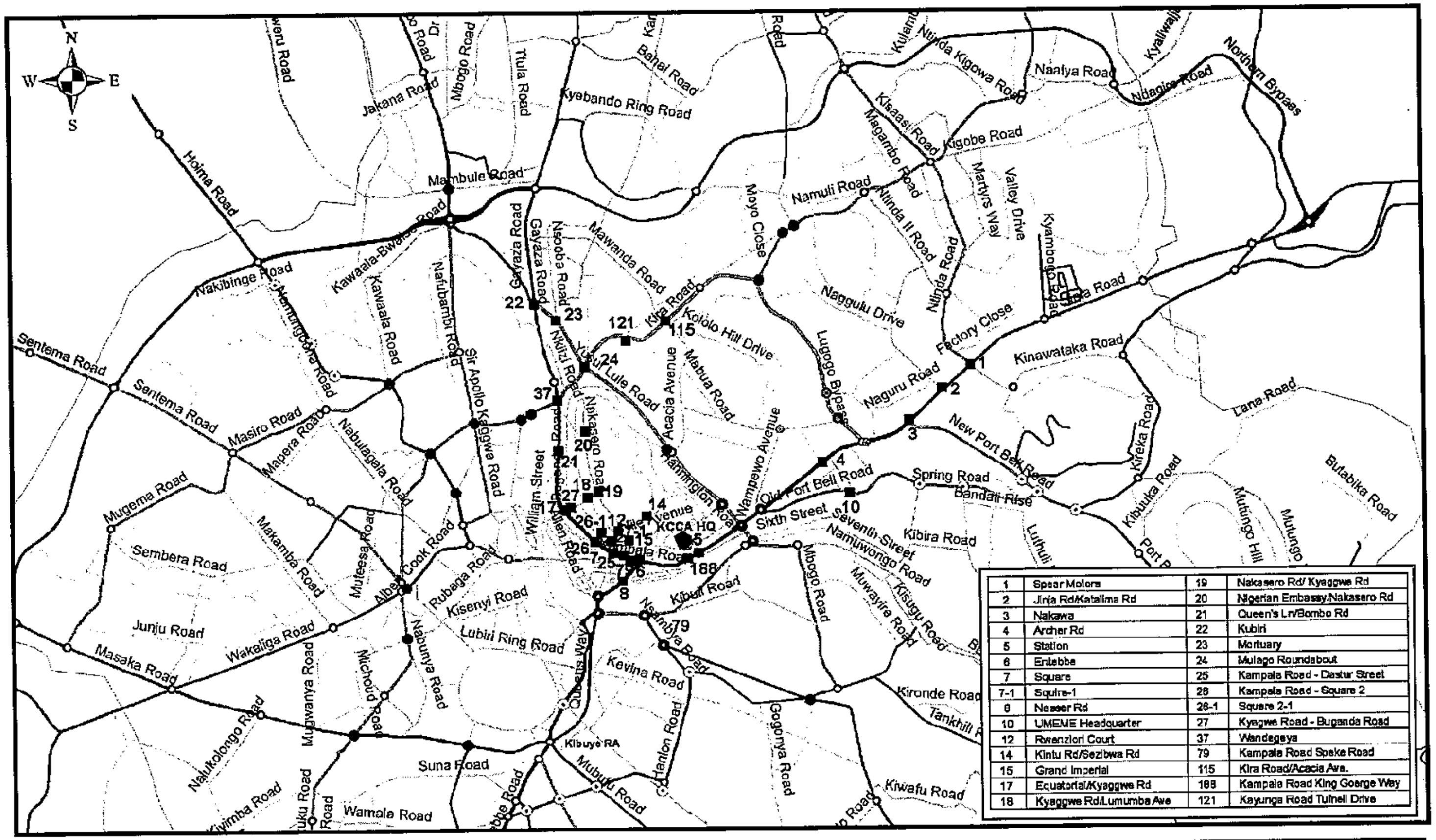
17-5 Safety Measures

To avoid accidents on site during the implementation of the Project, the Ugandan side agreed to cause the consultant and the contractor to enforce safety measures such as setting safety assurance to the site, providing information for security control to public, and deploying adequate security personnel, based on "The Guidance for Management of Safety for Construction Works in Japanese ODA Projects."

17-6 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.

Annex 1 Project Sites
Annex 2 Organization Chart
Annex 3-1 Japanese Grant
Annex 3-2 Procedure of Japanese Grant
Annex 3-3 Financial Flow of Grant
Annex 4 Project Implementation Schedule
Annex 5 Undertakings to be taken by the Government of Uganda
Annex 6 Tax Treatment of Japanese Grant Aid Projects


N
W
E
S
Holma Road
Nakibinge Road
Kawaala-Bwaise Road
Kawaala Road
Nafubambi Road
Sir Apollo Kaggwa Road
Mambule Road
Jakana Road
Mbogo Road
Ttula Road
Gayaza Road
Nsooba Road
Nkiizi Road
Kyebando Ring Road
Bahai Road
Mawanda Road
Kira Road
Kololo Hill Drive
Lule Road
Acacia Avenue
Mabua Road
Mayo Close
Namuli Road
Ntinda II Road
Nagguru Drive
Lugogo Bypass
Naguru Road
Factory Close
Kinawataka Road
New Port Bell Road
Spring Road
Bandali Rise
Old Port Bell Road
Sixth Street
Seventh Street
Namuwongo Road
Kibira Road
Mbogo Road
Kibuli Road
Muwayire Road
Kisugu Road
Kironde Road
Tankhill Road
Kiwafu Road
Gogonya Road
Hanlon Road
Kevina Road
Kibuye RA
Lubiri Ring Road
Kisenyi Road
Rubaga Road
Albert Cook Road
Muteesa Road
Nabulagala Road
Masiro Road
Mapera Road
Sentema Road
Mugema Road
Sembera Road
Makamba Road
Junju Road
Wakaliga Road
Masaka Road
Mutwanya Road
Michoud Road
Nabunya Road
Nalukolongo Road
Suna Road
Wamala Road
William Street
Nakasero Road
Wampewo Avenue
KCCA HQ
Kyambogo Road
Kisaasi Road
Magambo Road
Kigobe Road
Martyrs Way
Valley Drive
Ntinda Kigowa Road
Naalya Road
Ndagire Road
Northern Bypass
Kireka Road
Kibuuka Road
Mutungo Hill
Mutungo
Butabika Road
Lana Road
Luthuli
Port Bell Road

1	Spear Motors	19	Nakasero Rd/ Kyaggwe Rd
2	Jinja Rd/Katalima Rd	20	Nigerian Embassy/Nakasero Rd
3	Nakawa	21	Queen's Ln/Bombo Rd
4	Archer Rd	22	Kubiri
5	Station	23	Mortuary
6	Entebbe	24	Mulago Roundabout
7	Square	25	Kampala Road - Dastur Street
7-1	Squire-1	26	Kampala Road - Square 2
8	Nasser Rd	26-1	Square 2-1
10	UMEME Headquarter	27	Kyagwe Road - Buganda Road
12	Rwenzlori Court	37	Wandegeya
14	Kintu Rd/Sezibwa Rd	79	Kampala Road Speke Road
15	Grand Imperial	115	Kira Road/Acacia Ave.
17	Equatorial/Kyaggwe Rd	188	Kampala Road King Goerge Way
18	Kyaggwe Rd/Lumumba Ave	121	Kayunga Road Tufnell Drive

■ Proposed Junctions for Japan's Grant
● KIIDP2 Batch1 Junctions
● KIIDP2 Batch2 Junctions (Not Tendered)
○ Kampala Flyover Project Junctions
○ KIIDP2 Batch2 Junctions
○ JICA TC's Pilot Project Junctions

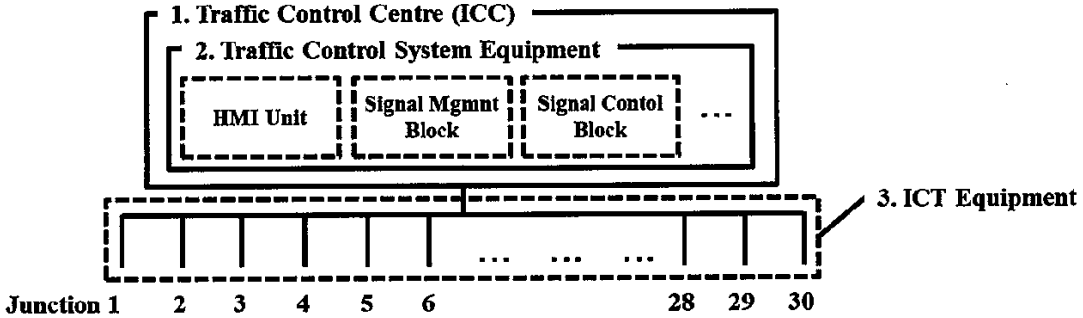
Project for Improvement of Traffic Control in Kampala City

1

Project Components

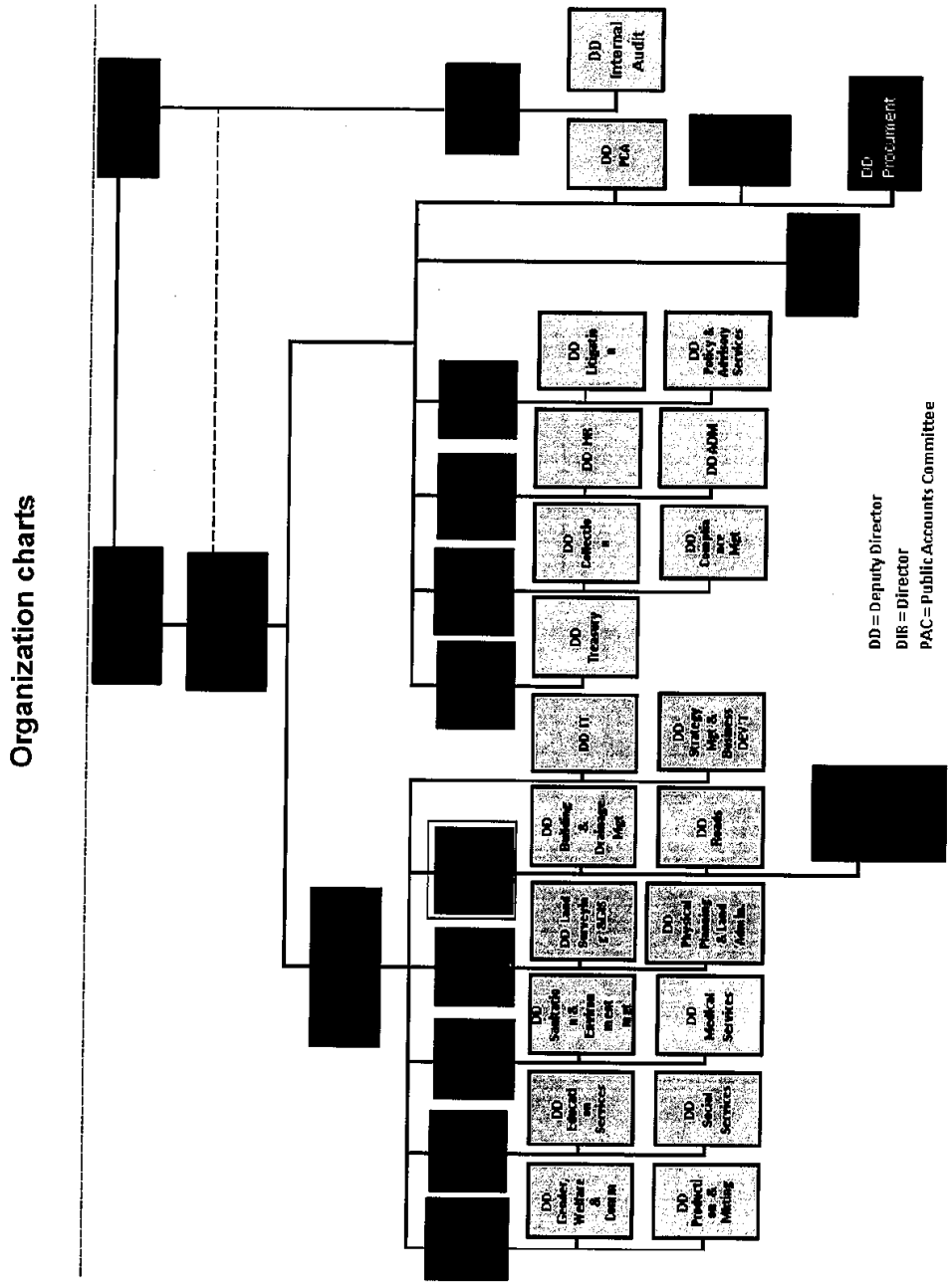
#	Components	Details
1	Traffic Control Centre (TCC)	Reinforced concrete construction. Semi-basement and three floors above ground Internal / external finish, outer walls: mortar bed, coating finish (wall coat); floors: porcelain tile, coating finish (urethane coating), etc. Inner walls: mortar bed, coating finish
2	Traffic Control System Equipment	One signal control block, one system management block, one signal control subordinate device, central display boards (twenty 55-inch monitors), one controller for the central display boards, one central display board HMI, seven HMI units
3	ICT Equipment	Laying flexible fiber optic cable (2C: 679m, 4C: 859m, 8C: 4,488m, 12C: 17,927m) tube: 12,654m; Laying concrete pipes: 954m
4	Improvement of Junctions	Improvements to 30 junctions (321 lanterns for vehicles, 220 lanterns for sidewalks, 28 controllers, 37 image detectors, ultrasonic detector piping and wiring work)

Outline of TCC system



***with lanterns for vehicles and sidewalks, controllers, image detectors, ultrasonic detector piping and wiring work**

Annex 2

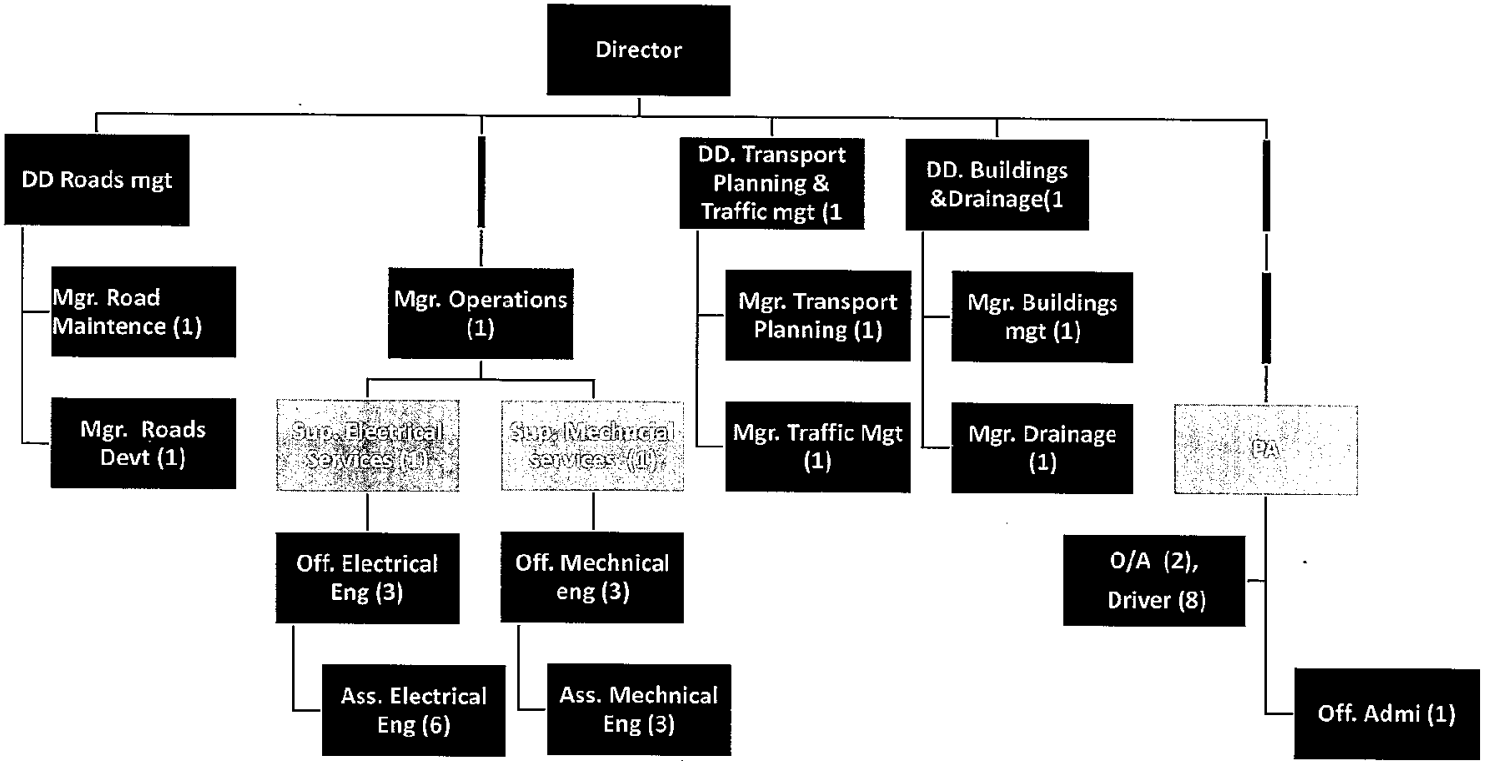

Organization charts
DD Internal Audit
DD PCA
DD Procurement
DD Policy & Advisory Services
DD HR
DD ADM
DD Treasury
DD IT
DD Physical Planning & Land Mgt
DD Medical Services
DD Social Services
DD = Deputy Director
DIR = Director
PAC = Public Accounts Committee

1

Annex 2

Organogram of Engineering and Technical Services

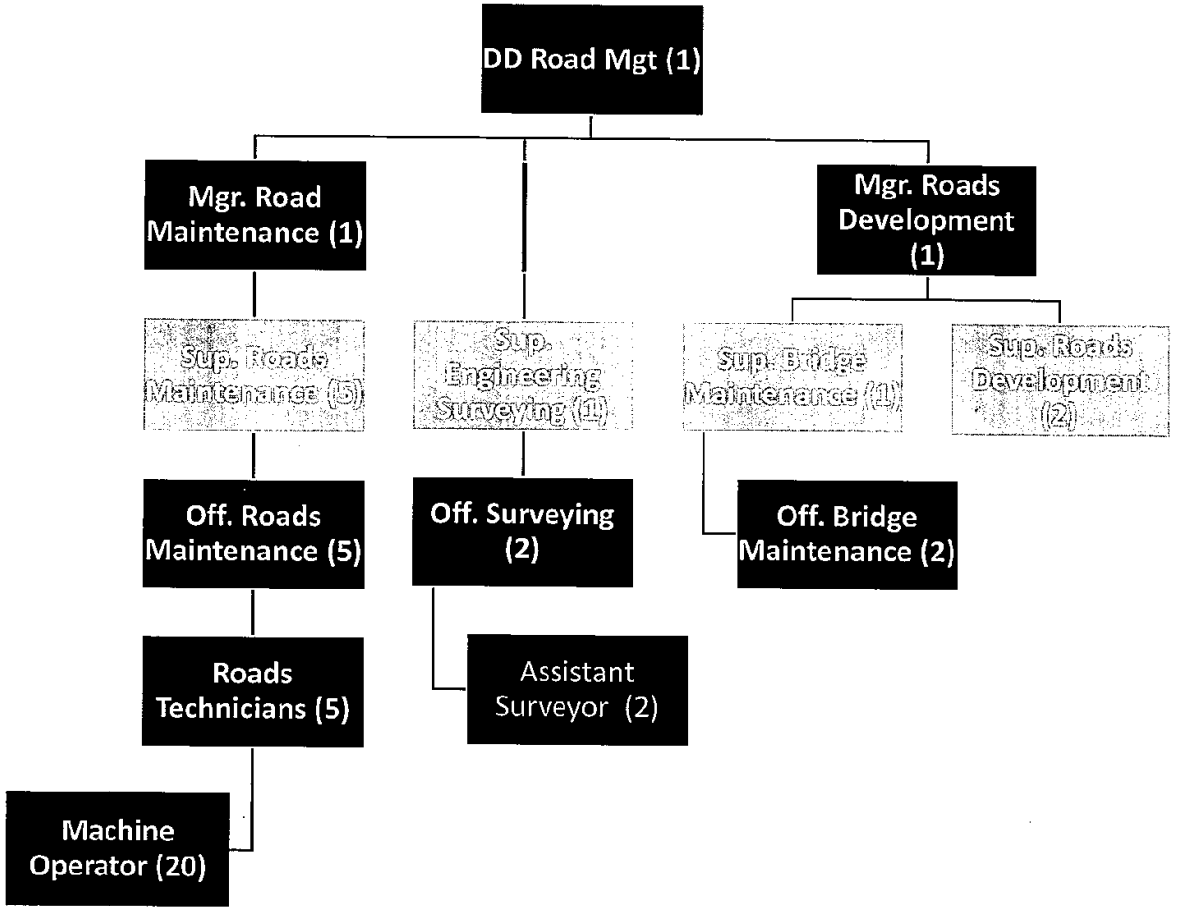
a) Director's Office



Annex-17

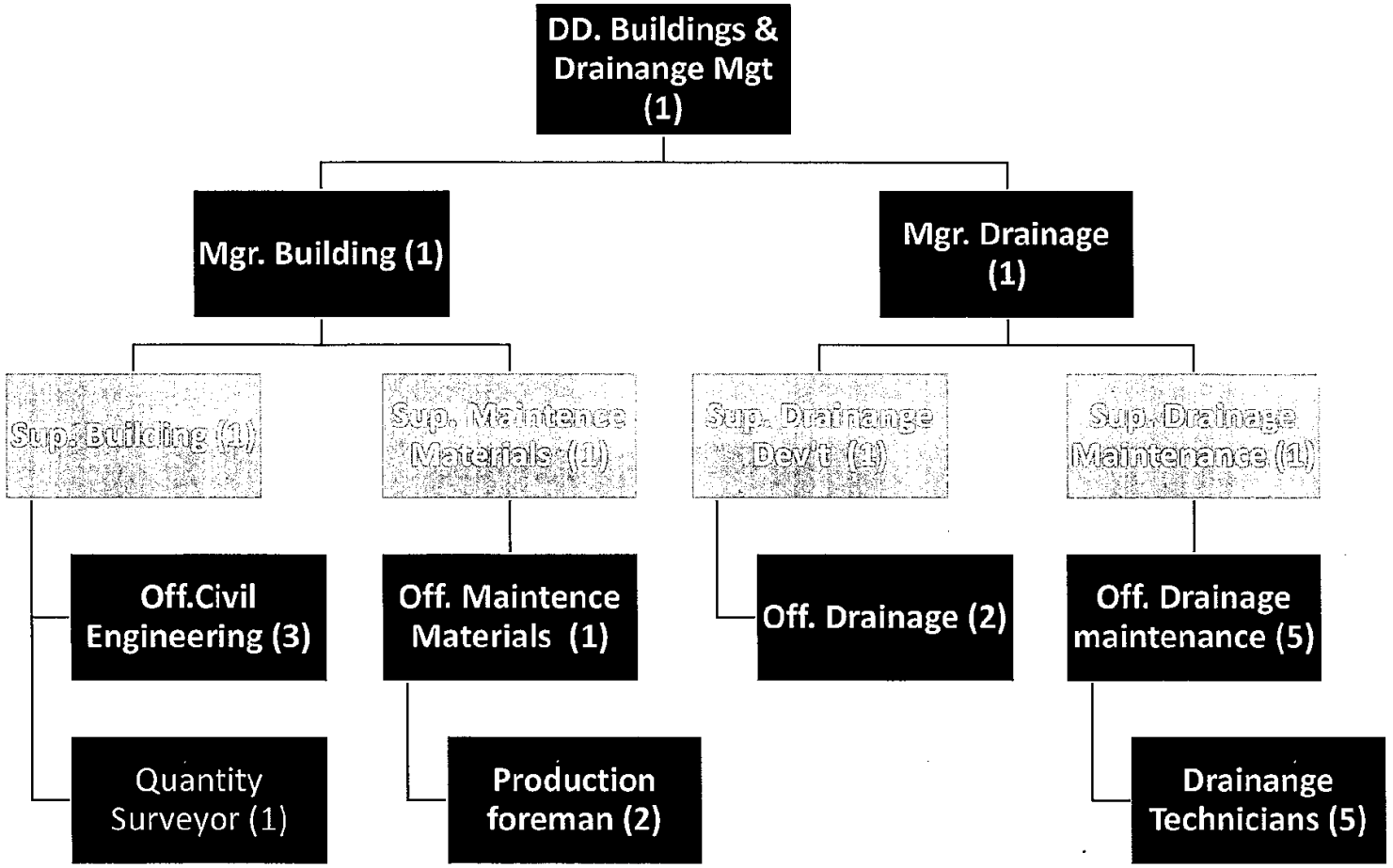
Annex 2

Organogram of Road Management Department



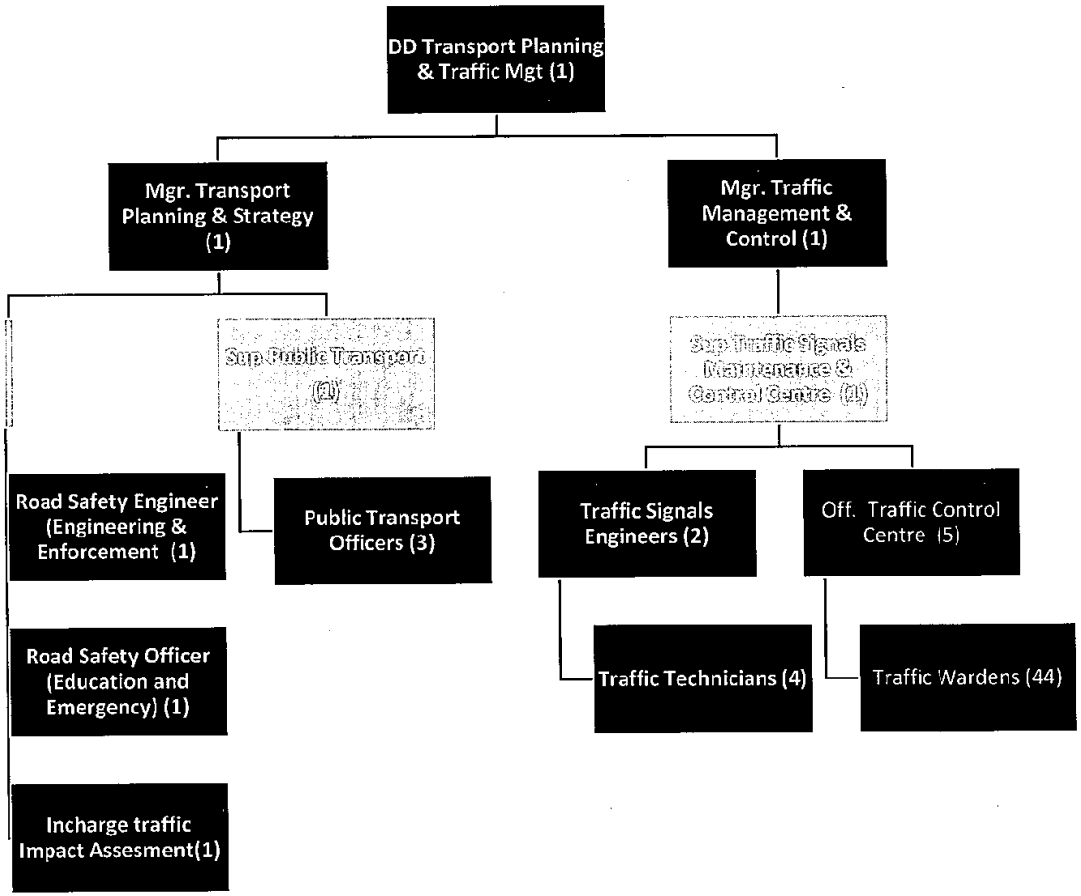
Annex 2

Organogram of Department of Buildings and Drainage Management



Annex 2

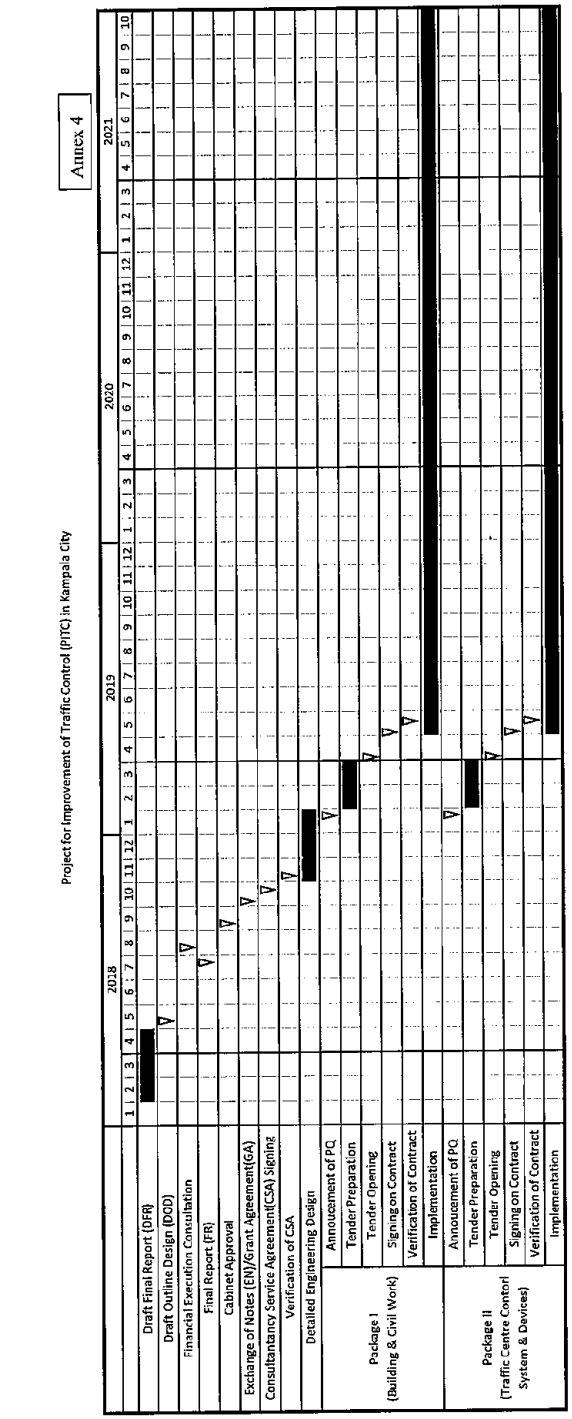
Organogram of Transport Planning and Traffic Management



Annex-20

Annex-3　Japan's Grant System Templete

Annex-4



Annex 5

Major Undertakings to be taken by the Government of Uganda

1. Specific obligations of the Government of Uganda which will not be funded with the Grant

(1) Before the Tender

NO	Items	Deadline	In charge	Cost (1,000UGX)	Ref.
1	To open Bank Account (Banking Arrangement (B/A)).	within 1 month after signing of the G/A	MoFPED	8,411	-
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant.	within 1 month after signing of the G/A	KCCA	201	-
3	To approve the operational and maintenance plan for the Project with budgetary request.	before start of the construction	KCCA	-	the Draft Report
4	To secure the following lands. 1) right of way for the Project location 2) temporary construction yard and stockyard near the Project area 3) disposal site near the Project area	before notice of the tender document(s)	KCCA	-	-
5	To clear, level and reclaim the following sites. 1) remove utilities 2) existing facilities	before notice of the tender document(s)	KCCA	*630,000	the Draft Report
6	To obtain the planning, zoning, building permit.	before notice of the tender document(s)	KCCA	-	-
7	To submit Project Monitoring Report (with the result of Detailed Design).	before preparation of the tender document(s)	KCCA	-	-

(B/A: Banking Arrangement, A/P: Authorization to pay, G/A: Grant Agreement)

* The estimated costs to be borne by the Executing Agency will be calculated in the later stage.

(2) During the Project Implementation

NO	Items	Deadline	In charge	Cost (1,000UGX)	Ref.
1	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Suppliers.	within 1 month after the signing of the contract(s)	KCCA	84,110	the Draft Report
2	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 signing of the contract	KCCA		
	2) Payment commission for A/P	every payment	KCCA		
3	To ensure prompt unloading and customs clearance at ports of disembarkation in the country of the Recipient and to assist the Supplier(s) with internal transport therein.	during the Project	KCCA	-	-
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 under the verified contract 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	KCCA	-	-
5	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	during the Project	KCCA / URA	*xxx	the Draft Report

	and/or the services be borne by its designated authority without using the Grant.				
6	To bear all the expenses, other than those covered by the Grant, necessary for construction of the implementation of the Project.	during the Project	KCCA	-	-
7	To submit Project Monitoring Report.	every month	KCCA	-	-
	1) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	KCCA	-	-
8	To implement EMP and EMoP.	during the construction	KCCA	-	-
9	To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report.	during the construction	KCCA	-	-
10	To relocate the existing signals where possible.	during the Project	KCCA	-	-
11	To approve necessary measure for traffic control.	during the construction	KCCA /UPF	-	-

* The estimated costs to be borne by the Executing Agency will be calculated in the later stage.

(3) After the Project

NO	Items	Deadline	In charge	Cost (1,000UGX)	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/Periodic inspection	After completion of the construction	KCCA	5,213,000	-
2	To implement EMP and EMoP.	for a period based on EMP and EMoP	KCCA	-	-
3	To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually. - The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between KCCA and JICA.	for three (3) years after the Project	KCCA	-	-

2. **Other obligations of the Government of Uganda**

Confidential

Annex 6

Telephone : 256 41 4707 000
: 256 41 4232 095
Fax : 256 41 4230 163
: 256 41 4343 023
: 256 41 4341 286
Email : finance@finance.go.ug
Website : www.finance.go.ug

In any correspondence on this subject please quote No. TPD 130/167/01

THE REPUBLIC OF UGANDA

Ministry of Finance, Planning & Economic Development
Plot 2-12, Apollo Kaggwa Road
P.O. Box 8147
Kampala
Uganda

July 19, 2017

The Chief Representative,
Japan International Cooperation Agency
Uganda Office
KAMPALA

RE: TAX TREATMENT OF JAPANESE GRANT AID PROJECTS

I refer to your letter dated 22nd June, 2017 seeking to confirm the tax treatment of Japanese grant aid projects. This is a follow up on the outcome of the meetings with officials of the Tax Policy Department held at the Ministry on 4th April, 2017 and 16th May, 2017 respectively.

This is therefore to reiterate Governments commitment to the implementation of the framework agreed to between the Government of Japan and the Government of the Republic of Uganda by means of Note Verbales NV/JE/009 dated 13th January 2017, NV/JE/031/17 dated 20th February, 2017 and ASI 179/326/01 dated 23rd March, 2017.

We accordingly wish to reaffirm that the Japanese grant shall not be used to pay taxes. Taxes arising from the execution of the project shall be borne by Government of Uganda. It is also understood that the intervention on income tax (PAYE, Corporate Tax and Withholding Tax) shall only apply to Japanese main contractors and Japanese sub-contractors. The Details of the implementation arrangements are as follows:

1. Taxes on import and re-export of necessary materials and equipment
   1.1. Taxes on import and re-export of necessary materials and equipment for exclusive use on the Japanese Grant Aid project are exempted from import duty under the East African Community Customs Management Act 2004.

2. Taxes on purchase of any products and/or any service in the Republic of Uganda which are necessary for the Project
   2.1. Value Added Tax (VAT)
      2.11. The VAT Act deems the payment of VAT on supplies to projects financed by a foreign government through a grant, donation or loan.

2.12. Based on the VAT Act, VAT shall be deemed to have been paid if the supply is for use solely and exclusively for the Japanese Grant Aid Project.

2.13. In case a supplier charges VAT to any products and/or any services which are for use solely and exclusively for the Japanese Grant Aid Project, URA shall refund the VAT to the contractors and sub-contractors assigned under the Japanese Grant Aid Project.

3. All taxes imposed on total income or on elements of income

3.1. Pay as You Earn (PAYE)

3.11. Based on Exchange Notes, PAYE for Japanese employees of Japanese main contractors and Japanese sub-contractors for Japanese Grant Aid Project shall be paid by the Government of Uganda executing agency.

3.1.2. The procedure for payment of PAYE of eligible resident office shall be as follows: Japanese main contractors and Japanese sub-contractors shall file PAYE returns with URA and submit a copy of the returns to the executing agency notifying them to pay the taxes.

3.2. Corporate Tax/ Withholding Tax

3.2.1. Based on Exchange Notes, Corporate Tax of Japanese main contractors and Japanese sub-contractors for Japanese Grant Aid Project shall be paid by the executing agency.

3.2.2. The procedure and tax treatment of Japanese main contractors and Japanese sub-contractors for Japanese Grant Aid project who are tax resident in Uganda shall be as follows:

3.2.2.1. Japanese main contractors and Japanese sub-contractors shall file returns with URA and submit a copy of the returns to the Executing Agency notifying them to pay the taxes.

3.2.3. The procedure and tax treatment of Japanese main contractors and Japanese sub-contractors for Japanese Grant Aid Project who are not tax resident of Uganda shall be as follows:

3.2.3.1. Where withholding tax is due, the Executing Agency shall pay tax due to URA.

4. To ensure smooth implementation of above mentioned items, JICA and MoFPED take measures as follows:

4.1 JICA and Executing Agency shall write to MoFPED informing

them of the Japanese main contractors and Japanese sub-contractors contracted to implement the Japanese Grant Aid Project.

4.2. The Ministry shall accordingly write to URA with a copy to JICA to confirm the Grant Aid project under implementation and Japanese main contractor and Japanese sub-contractor executing the project.

4.3. URA shall facilitate Japanese main contractors and Japanese sub-contractors in line with provisions 1, 2 and 3 above.

5. Any challenges that may be encountered in implementing the tax arrangements provided above shall be settled amicably between the JICA and the Ministry through mutual consultations.

6. In case of changes in relevant tax laws and regulations, the Ministry and JICA shall discuss necessary measures to take.

I hope this will facilitate the smooth implementation of the agreed programs. I also wish to take this opportunity to commend you for your continued cooperation.

Matia Kasaija (MP)
MINISTER OF FINANCE, PLANNING AND ECONOMIC DEVELOPMENT

C.C. Embassy of Japan in the Republic of Uganda
KAMPALA

C.C. The Commissioner General
Uganda Revenue Authority
KAMPALA

Telephone: 256 41 4707 000
: 256 41 4232 095
Fax : 256 41 4230 163
: 256 41 4343 023
: 256 41 4341 286
Email : finance@finance.go.ug
Website : www.finance.go.ug

In any correspondence on
this subject please quote No. TPD130/167/01

THE REPUBLIC OF UGANDA

Ministry of Finance, Planning &
Economic Development
Plot 2-12, Apollo Kaggwa Road
P.O. Box 8147
Kampala
Uganda

6th April 2018

Hon. Kazuaki Kameda,
Ambassador of Japan to the Republic of Uganda,
Embassy of Japan,
KAMPALA.

Your Excellency,

INCOME TAX TREATMENT OF JAPANESE GRANT AID PROJECT

Reference is made to the above captioned matter and to your letter dated 11th October, 2017.

This is to reiterate Government's position on income tax treatment of Japanese grant aid projects as provided for in the Note Verbale dated 13th January 2017 and 3rd July 2017. This is therefore to affirm that PAYE, Corporate Tax and Withholding Tax will be borne by the designated project executing agency without using Japanese grants. The benefits of the above treatment shall only apply to (i) main contractors and sub-contractors that are Japanese physical persons or Japanese juridical persons controlled by Japanese physical persons and to (ii) their employees who are not citizens of Uganda.

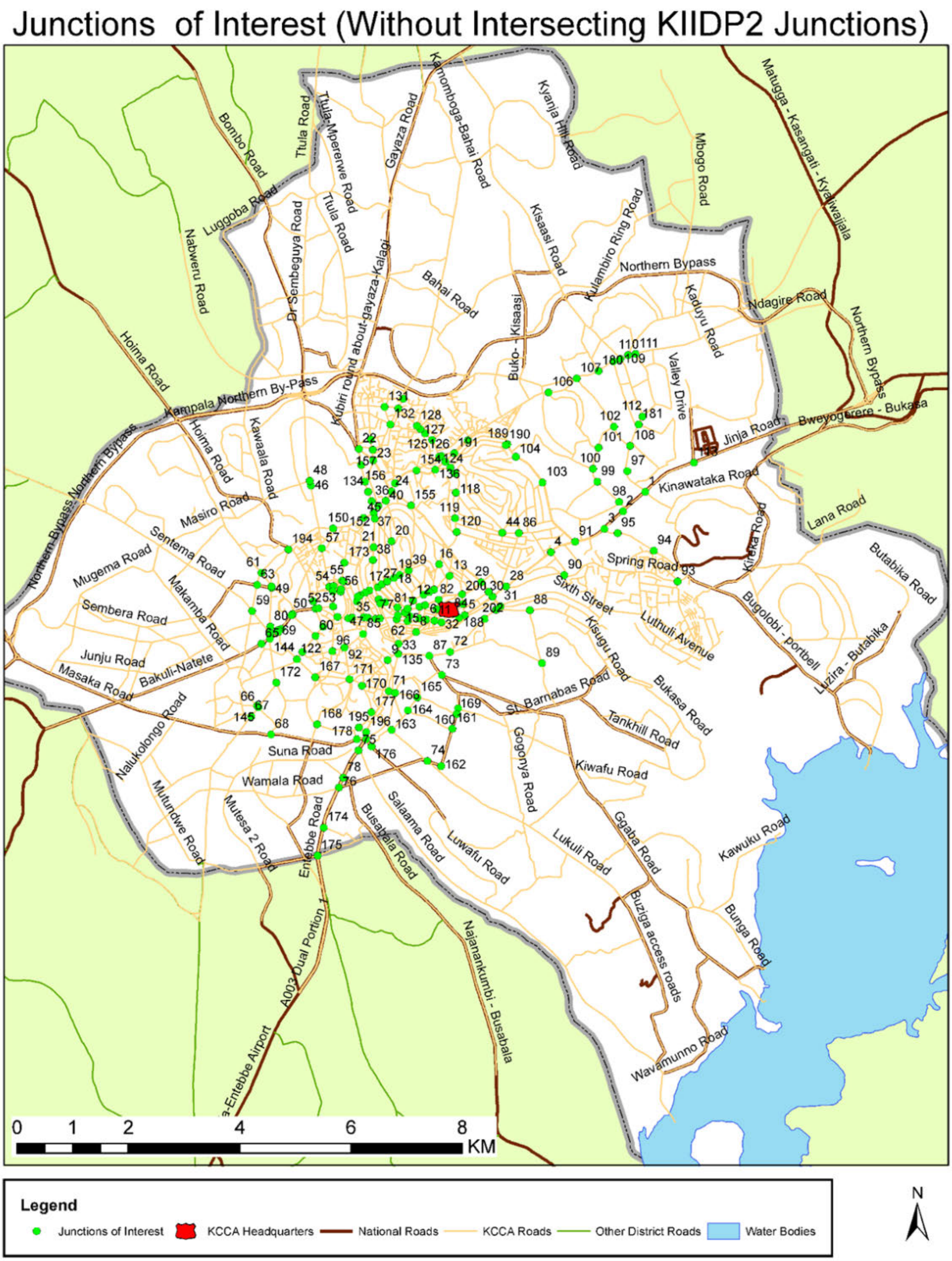
Please accept, Your Excellency, the assurances of my highest consideration.

Matia Kasaija (MP)
MINISTER OF FINANCE, PLANNING AND ECONOMIC DEVELOPMENT

C.c: The Chief Representative,
Japan International Cooperation Agency,
Uganda Office,
KAMPALA

C.c: The Commissioner General,
Uganda Revenue Authority,
KAMPALA

E Shortlist Evaluation Scores



Junction Number	Junction Name	Division	Junction Type	Connecting Road Names	Road Surface	Map_Class	Old Road Class	New Road Clas	C1 CBD	C2 Other P	C3 KCCA 2	C4 K/J	C5 Manual Contr	C6 Roundab	C7 Traffic Managem	Total
1	Spear Motors	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU	2	3	3	3	3	2	3	54
2	JinaRd Katalima Rd	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU	2	3	3	3	3	2	1	48
3	Nakawa	NAKAWA DIVISION	Signalized-Junction	Jinja Road	Paved	Primary Roads	UC I	KU	2	3	3	3	3	1	3	52
4	Third Street	CENTRAL DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU	2	3	3	3	1	2	3	50
5	Station	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	3	3	3	2	1	52
6	Entebbe	CENTRAL DIVISION	Signalized-Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	3	3	2	1	1	47
7	Square	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	3	3	3	2	1	52
8	Nasser Road	CENTRAL DIVISION	Un-signalized Junction	Entebbe Road	Paved	Primary Roads	UC I	KU	3	3	3	1	2	2	3	49
9	Mengo Hill Rd	CENTRAL DIVISION	Roundabout	Katwe Road	Paved	Primary Roads	UC I	KU	1	1	3	1	2	3	1	35
10	Umeme Headquarters	CENTRAL DIVISION	Un-signalized Junction	Nile Avenue	Paved	Tertiary Roads	UC III	KA	3	3	3	1	2	2	3	49
11	Uganda House	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	1	3	3	1	2	1	40
12	Rwenzori Courts Roundabout	CENTRAL DIVISION	Roundabout	Nakasero Road	Paved	Tertiary Roads	UC III	KA	3	3	3	1	3	3	1	48
14	Kintu Rd/Sezibwa Rd	CENTRAL DIVISION	Un-signalized Junction	Kintu Rd	Paved	Tertiary Roads	UC III	KA	3	3	3	1	3	2	3	52
15	Grand Imperial Roundabout	CENTRAL DIVISION	Roundabout	Speke Road	Paved	Tertiary Roads	UC III	KA	3	3	3	1	3	3	1	48
17	Equatorial/ Kyagwe Rd	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU	3	3	3	1	3	2	3	52
18	Kyagwe Road Lumumba Ave	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	3	1	2	2	3	49
19	NakaseroRoad Kyagwe Road	CENTRAL DIVISION	Un-signalized Junction	Nakasero Road	Paved	Tertiary Roads	UC III	KA	3	3	3	1	2	2	3	49
20	Nigerian Embassy/Nakasero Rd	CENTRAL DIVISION	Un-signalized Junction	Nakasero Road	Paved	Tertiary Roads	UC III	KA	3	3	3	1	2	2	3	49
21	QueensLn\ Bombo Rd	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU	3	3	3	3	3	2	1	52
22	Kubiri	KAWEMPE DIVISION	Roundabout	Bombo Road	Paved	Primary Roads	UC I	KA	3	3	1	1	3	3	3	46
23	Mortuary	KAWEMPE DIVISION	Roundabout	Bombo Road	Paved	Primary Roads	UC I	KA	3	3	1	1	3	3	3	46
24	Mulago Roundabout	CENTRAL DIVISION	Roundabout	Kira Road	Paved	Secondary Roads	UC II	KA	3	3	3	1	3	3	3	54
25	Kampala Road/ Dustur Street	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	1	3	3	2	3	52
26	Kampala Road/ Square 2	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	1	3	3	2	3	52
27	KyagweRd Buganda Rd	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	1	3	3	2	3	52
28	Wampeewo Roundabout	CENTRAL DIVISION	Roundabout	Jinja Road	Paved	Primary Roads	UC I	KU	3	1	1	3	3	3	1	42
29	Garden City Roundabout	CENTRAL DIVISION	Roundabout	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA	3	1	1	1	3	3	1	36
30	Kitgum House Junction	CENTRAL DIVISION	Signalized-Junction	Jinja Road	Paved	Primary Roads	UC I	KU	3	1	1	3	3	1	1	38
32	Kampala Rd/ Parliamentary Ave	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	1	3	1	2	1	40
34	Namirembe Road Berkely Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA	2	3	1	1	1	2	1	32
35	Namirembe Road Berelay Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA	2	3	1	1	1	2	1	32
36	Bombo Road Nkizi Road Connection I	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU	2	3	1	1	1	2	1	32
37	Wandegeya Junction	CENTRAL DIVISION	Signalized-Junction	Bombo Road	Paved	Primary Roads	UC I	KU	3	3	1	3	3	1	3	50
38	Bombo Road William Street	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU	3	1	1	1	1	2	1	28
40	Haji Musa Kasule Road Nakasero Hill Road	CENTRAL DIVISION	Un-signalized Junction	Haji Musa Kasule Road	Paved	Secondary Roads	UC II	KA	3	1	1	1	1	2	1	28
41	Namirembe Road Mackay Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA	2	1	1	1	1	2	1	26
44	Upper Kolo Terrace Prince charlse Drive	CENTRAL DIVISION	Un-signalized Junction	Upper Kololo Terrace	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
45	Makerere Hill Road Makerere Mosque Connection	CENTRAL DIVISION	Un-signalized Junction	Makerere Hill Road	Paved	Secondary Roads	UC II	KA	2	1	1	1	1	2	1	26
47	Namirembe Road Kisenyi Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
51	Namirembe Road Allen Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
53	Fort Road Namirembe Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
54	Sir Apollo Kagwa Road Nsalo road	CENTRAL DIVISION	Un-signalized Junction	Nsalo Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
55	Rashid Khamisi Road Gaddafi Road Roundabout	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
56	Matia Mulumba Road Gaddafi Road	CENTRAL DIVISION	Un-signalized Junction	Matia Mulumba Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
57	Kyadondo Road Sir Apollo Kagwa Road	CENTRAL DIVISION	Un-signalized Junction	Sir Apollo Kaggwa Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
60	Rubaga Road Butikiro Road	CENTRAL DIVISION	Un-signalized Junction	Rubaga Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
62	Luwumu Street Burton street	CENTRAL DIVISION	Un-signalized Junction	Luwum Street	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
79	Kampala Road Speke Road	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	1	3	3	2	3	52
82	Nile Avenue Colville Street	CENTRAL DIVISION	Un-signalized Junction	Nile Avenue	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
86	Upper Kololo Terrace Wampeewo Avenue	CENTRAL DIVISION	Un-signalized Junction	Upper Kololo Terrace	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
90	Old Port Bell Road Third Street	CENTRAL DIVISION	Un-signalized Junction	Old Port Bell Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
91	Jinja Road Luggo Bypass	CENTRAL DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU	1	3	1	3	1	2	1	36
103	Lugogo Bypass Nviiri Lane	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
104	Lugogo Bypass Mackenzie Vale Road	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
105	Rubaga Road Kisenyi Road	CENTRAL DIVISION	Un-signalized Junction	Rubaga Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
113	JinjaRd_KyambogoEstateRd	NAKAWA DIVISION	Un-signalized Junction	Jinja Road	Paved	Primary Roads	UC I	KU	1	3	1	3	1	2	1	34
114	Kira Road Musizi Lane	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	3	36
115	Acacia Avenue Kira Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	3	3	1	1	3	2	3	46
116	Acacia Avenue Cooper Road	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA	1	1	1	1	1	2	1	24
117	Acacia Avenue KololoHill Drive	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA	1	1	1	1	1	2	1	24
118	Acacia Avenue Mabua Road	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA	1	1	1	1	1	2	1	24
119	Acacia Avenue Upper Kololo Terrace	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA	1	1	1	1	1	2	1	24
120	Acacia Avenue Lower Kololo Terrace	CENTRAL DIVISION	Un-signalized Junction	Acacia Avenue	Paved	Tertiary Roads	UC III	KA	1	1	1	1	1	2	1	24
121	Kayunga Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Tufnell Drive	Paved	Tertiary Roads	UC III	KA	3	3	1	1	3	2	3	46
123	Hoima Road Rubaga Road	CENTRAL DIVISION	Un-signalized Junction	Hoima Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
124	Mawanda Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Mawanda Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
136	Katego Road Kira Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	3	36
139	Namirembe Road Old Kampala Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
140	Ginnery Road Gaddaffi Road	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
143	School Road Boundary Close	CENTRAL DIVISION	Un-signalized Junction	Boundary Close	Paved	Tertiary Roads	UC III	KA	1	3	1	1	1	2	1	30
146	Haji Musa Kasule Road Nkiizi Road	CENTRAL DIVISION	Un-signalized Junction	Haji Musa Kasule Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
147	Kyagwe Road George Street	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
149	Yusuf Lule Road Dewinton Street	CENTRAL DIVISION	Un-signalized Junction	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA	3	3	1	1	1	2	1	34
150	Kyadondo Road Makerere Hill Road	CENTRAL DIVISION	Un-signalized Junction	Makerere Hill Road	Paved	Secondary Roads	UC II	KA	2	1	1	1	1	2	1	26
151	Namirembe Road Nakivubo Road	CENTRAL DIVISION	Un-signalized Junction	Namirembe Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
152	Bombo Road Wandegeya Road	CENTRAL DIVISION	Un-signalized Junction	Bombo Road	Paved	Primary Roads	UC I	KU	3	3	1	1	1	2	1	34
153	Kira Road Upper Mulago Road	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	3	36
154	Kira Road Tufnell Drive	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	3	36
155	Yusuf Lule Road Muwafu Road	CENTRAL DIVISION	Un-signalized Junction	Yusuf Lule Road	Paved	Secondary Roads	UC II	KA	2	3	1	1	1	2	1	32
173	Gaddafi Road Mapabana Road	CENTRAL DIVISION	Un-signalized Junction	Gaddafi Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
179	Luwum Street Dastur Street	CENTRAL DIVISION	Un-signalized Junction	Luwum Street	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
185	Kyagwe Road William Street	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
186	Kyagwe Road Nakivubo Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
187	Kyagwe Road Makay Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	3	3	1	1	1	2	1	34
188	Kampala Road King George Way	CENTRAL DIVISION	Un-signalized Junction	Kampala Road	Paved	Primary Roads	UC I	KU	3	3	1	3	3	2	3	52
189	Lugogo Bypass Prince Charlse Drive	CENTRAL DIVISION	Un-signalized Junction	Lugogo Bypass	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	1	30
191	Kira Road Turfnell Drive	CENTRAL DIVISION	Un-signalized Junction	Kira Road	Paved	Secondary Roads	UC II	KA	1	3	1	1	1	2	3	36
193	Rashid Khamisi Road Martin Road	CENTRAL DIVISION	Un-signalized Junction	Rashid Khamis Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
197	Kyagwe Road Rashid Khamisi Road	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
198	Kyagwe Road Mackay Lane	CENTRAL DIVISION	Un-signalized Junction	Kyagwe Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
199	Old Kampala Road Fort Road	CENTRAL DIVISION	Un-signalized Junction	Old Kampala Road	Paved	Tertiary Roads	UC III	KA	2	3	1	1	1	2	1	32
200	Subway Round about	CENTRAL DIVISION	Roundabout	Nile Avenue	Paved	Tertiary Roads	UC III	KA	3	1	1	1	2	3	1	33