6.5 INFLUENCE OF BRT PRE-FS ON THE SHORTLISTED PROJECTS

6.5.1 OUTLINE OF THE BRT PRE-FS

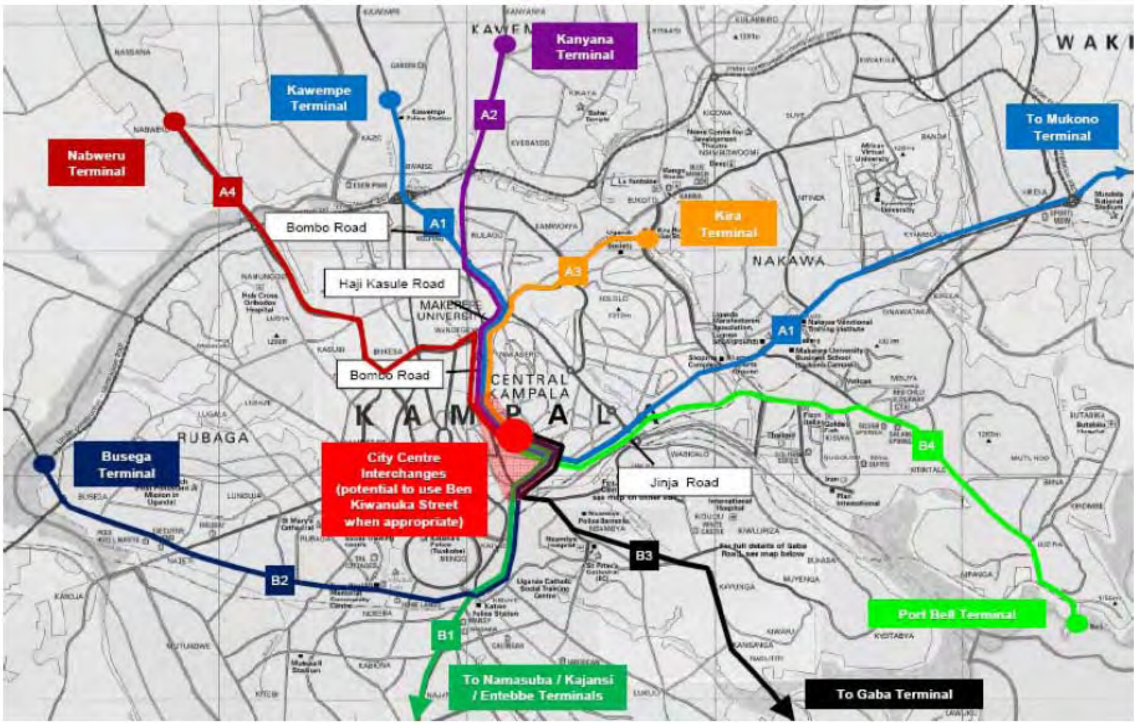
(1) Progress of the BRT Pre-FS

The BRT Pre-FS commenced in November 2009 and had progressed in parallel with this JICA Study. The BRT consultants submitted the Interim Report to MoWT in February 2010, Draft Final Report in April 2010 and Final Report in May 2010.

The WB has financed the feasibility study and detailed design of BRT pilot project under its Transport Sector Development Project (TSDP). It shall include review of the BRT Pre-FS, feasibility study, the preparation of design and bidding documents, EIA/PC and a resettlement action plan and the necessary institutional set up for the implementation and management of the system for the BRT Pilot Project. The consultancy services are expected to commence in early 2011 and will take about 12 months.

(2) BRT Routes in Pre-FS and Investment Cost Requirements

According to the draft final BRT Pre-FS and its presentation to the Technical Committee on April 28, 2010, eight BRT routes have been planned for the long-term (2030) as shown in Figure 6.5.1. However, both the draft final and final reports did not show either a total BRT operation length or investment cost. The Study Team estimated the planned BRT operation length to be approximately 120 km in total (Table 6.5.1), measured from satellite photos. The total investment cost would be approximately US$ 900 million, including dedicated BRT lane construction and existing road widening for general traffic.



Source: BRT Pre-FS Final Report, May 2010, MoWT

Figure 6.5.1 Planned Routes of BRT in GKMA

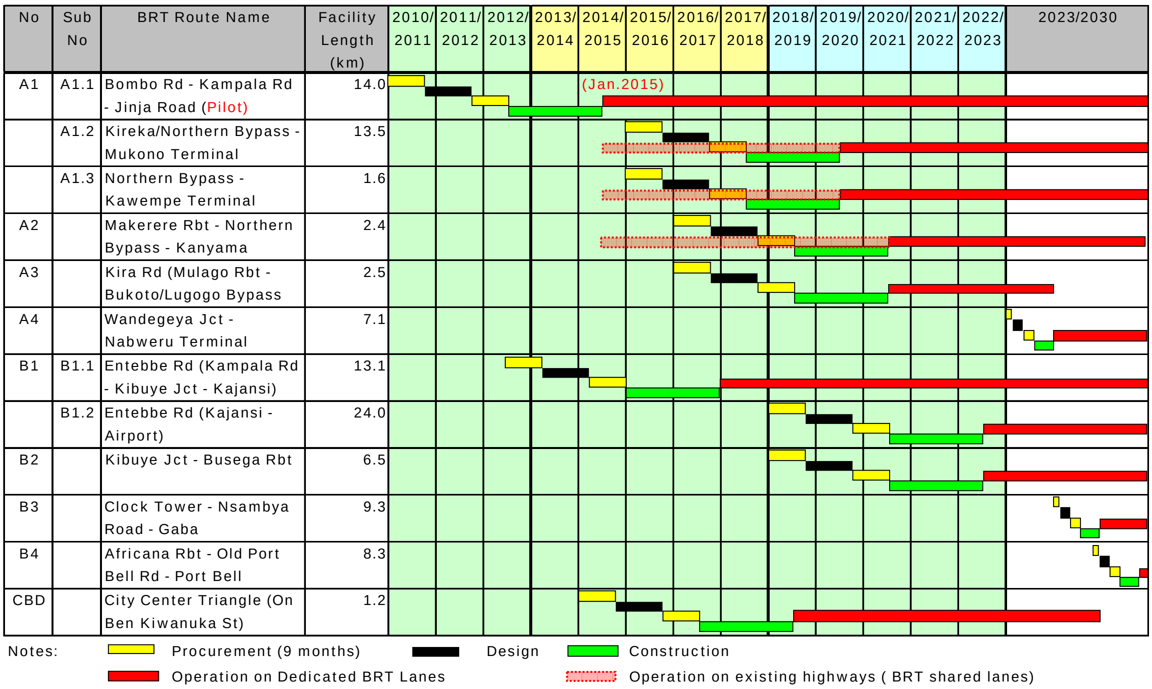
Table 6.5.1 Summary of BRT and Estimated Investment Costs (Assumption)

Route No.	BRT Route	Route Length (km)	Road Length* (km)	City Center IC (No.)	BRT Terminal (No.)	BRT Stations** (No.)	BRT Investment Cost# Mill US$
A1	Jinja Rd - Kampala Rd - Bombo Rd	29.10	29.10	1	3	36	220.6
A2	City Center IC - Makerere Rbt - Northern Bypass - Kanyama Terminal (Gayaza Rd)	5.80	2.40		1	7	16.2
A3	City Center IC Kira Rd (Mulago Rbt - Bukoto/Lugogo Bypass Jct)	4.90	2.50		1	6	14.8
A4	City Center IC - Wandegeya Jct - Nabweru Terminal (Hoima Rd)	9.00	7.10		1	11	48.1
B.1	City Center IC - Entebbe Rd - Queen's Way/(Katwe Rd) - Entebbe Airport Rd	37.60	37.10		2	47	230.8
B.2	City Center IC - Kibuye Rbt - Busega Rbt	10.00	6.50		1	13	44.0
B.3	City Center IC Clock - Tower - Nsambya Road - Gaba	10.60	9.30		1	13	62.9
B.4	Africana Rbt - Old Port Bell Rd - Port Bell	10.40	8.30		1	13	56.2
CBD	CBD Triangle (Ben Kiwanuka St)	1.20	1.20			2	8.1
	Sub-Total	118.60	103.50	1	11	148	701.8
	BRT Bus (12 m long)						180.0
	BRT Feeder System						24.0
	Total						905.8

Notes: * Construction length of the BRT facilities (road widening for 2 BRT dedicated lanes and 4 general traffic), including BRT stations, but not counting the section length duplicated by routes.
** The number of estimated BRT stations at a average interval of 800 m, including these duplicated by route
# BRT investment cost estimated based on unit price of the BRT Pilot Project in the BRT Pre-FS
Source: Assumption by the Study Team based on BRT Pre-FS Draft Final Report (Apr.2010)

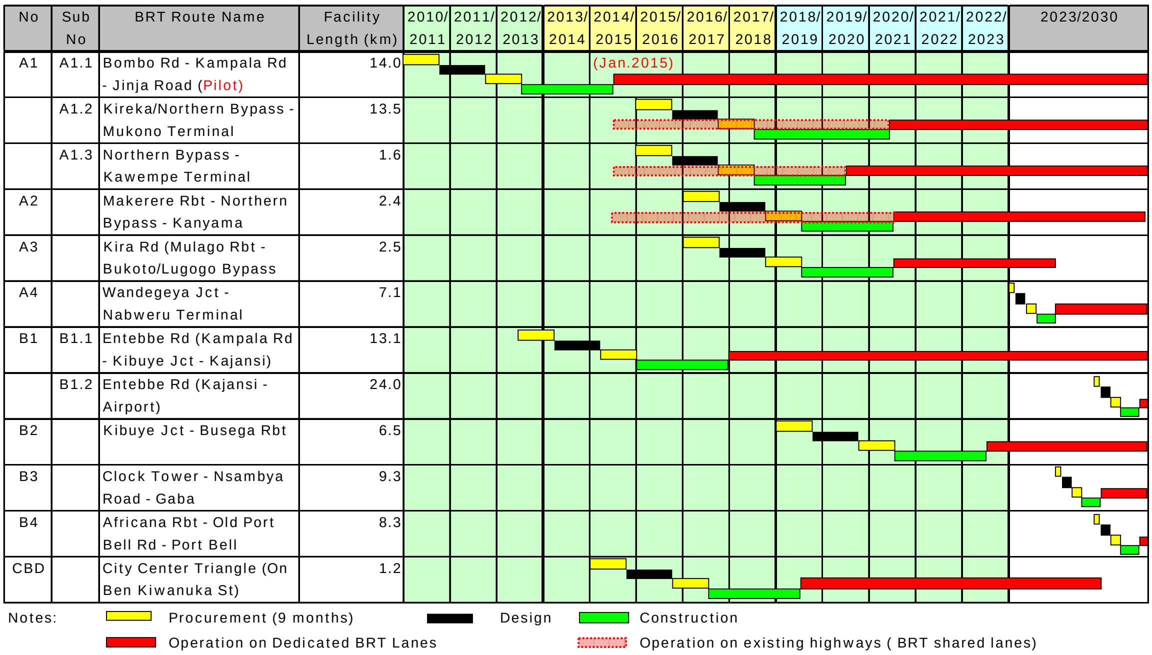
(3) Anticipated BRT Project Implementation in BRT Pre-FS

The BRT route length, its configuration including location of bus stations, implementation schedule and costs are unclear in the BRT Pre-FS final report, except the pilot project. The Study Team assumed two implementation scenarios for the BRT development to estimate the traffic flow and volume on the GKMA trunk road network, flyovers, shortlisted road projects and junctions for the Pre-FS projects in 2013, 2018 and 2023 as shown in the following figures.



Source: Assumed by the Study Team based on BRT Pre-FS Draft Final Report / Presentation, April 2010

Figure 6.5.2 Anticipated BRT Plan Implementation Schedule (Scenario 1)



Source: Assumed by the Study Team based on BRT Pre-FS Draft Final Report / Presentation, April 2010

Figure 6.5.3 Anticipated BRT Plan Implementation Schedule (Scenario 2)

The major difference between two scenarios is that the start of operation of B1.2 Kajansi – Entebbe Airport Section (24 km in length) on Entebbe Airport Road is before year 2023 in Scenario 1 and after 2023 in Scenario 2.

The Study Team assumed that BRT Route B2, Kibuye Jct – Busega Rbt, on Masaka Road should be operated by 2023 since its passenger demand is the third largest, according to the BRT Pre-FS as indicated in the following table.

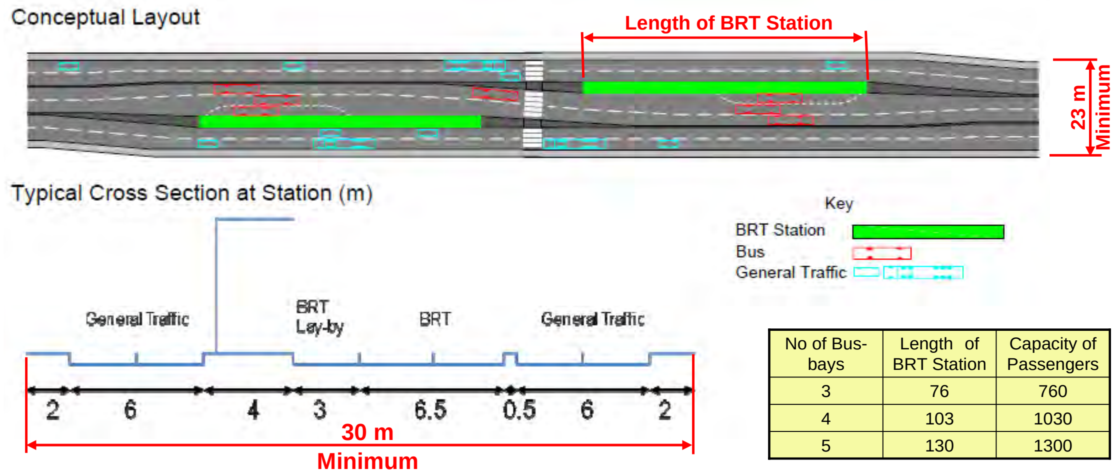
Table 6.5.2 Two-way Passenger Demand by BRT Route

BRT Route	Road Name	Two-way Passenger Demand (per day)
A1	Jinja Rd	133,258
B1	Entebbe Rd	105,503
B2	Masaka Rd	82,599
A1	Bombo Rd	80,670
A2	Gayaza Rd	58,182
A4	Hoima Rd	55,449
A3	Kira Rd	37,461
B3	Gaba Rd	33,058
B4	Old Port Bell Rd	19,769

Source: BRT Pre-FS DFR, April 2010

(4) Conceptual Layout and Typical Section of BRT Plan

Figure 6.7.4 shows a conceptual layout plan and typical cross section at BRT station. BRT is at the median operating on dedicates lanes and its stations are located bilaterally to minimize land acquisition. It needs a minimum width of 30 m to layout BRT lanes, two general traffic lanes and two sidewalks at both sides. The width can be reduced to 23 m at normal (non-station) sections. The length of BRT station varies from 76 – 130 m depending on the required passenger capacity. Pedestrians cross at grade to access to the BRT stations.



No of Bus-bays	Length of BRT Station	Capacity of Passengers
3	76	760
4	103	1030
5	130	1300

Source: The Study Team based on BRT Pre-FS Final Report

Figure 6.5.4 Conceptual Layout Plan and Typical Cross Section at BRT Station

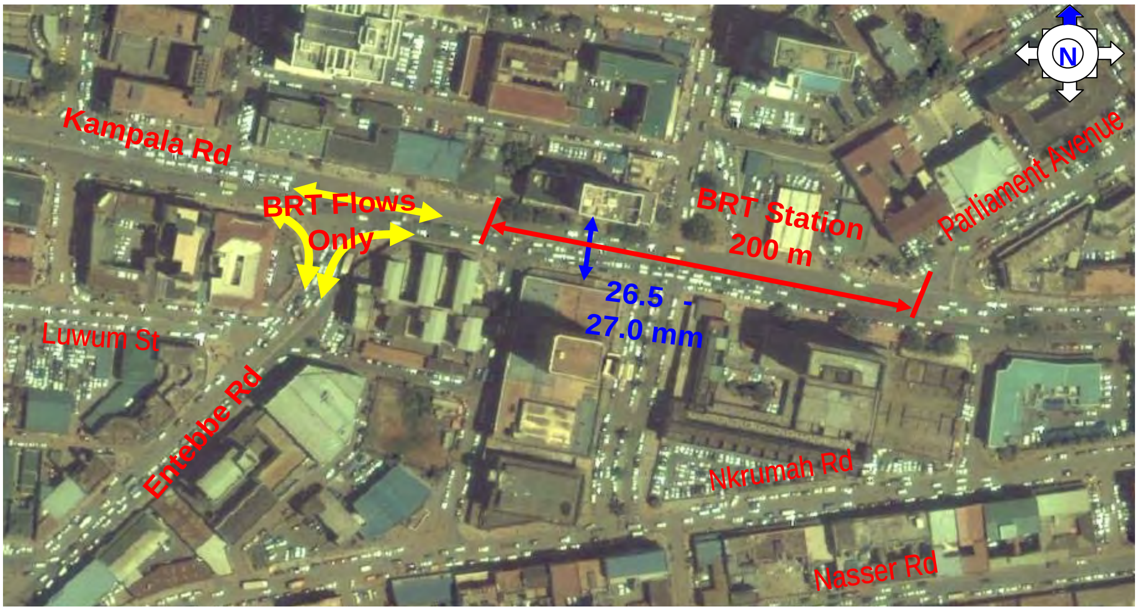
However, the Study Team has noted that:

- Roadside drainage spaces are required at both sides in the suburbs
- A minimum of 3 m width sidewalk is required for the city center
- As the existing ROW is mostly 24 – 27 m in the city center, many building demolition is required to allocate three lanes for BRT and its station, and four lanes for the general traffic
- Not applicable for Ben Kiwanuka Street since the existing ROW is only 14-15m between Mini Price Jct – Equatoria Jct.
- At grade access of passengers at the city center might cause disruption of BRT operation itself.
- As all BRT routes concentrate on Kampala Road, it might cause new traffic congestion by BRT buses after the implementation of the BRT final stage.

The Study Team recommends that these issues should be addressed in the feasibility study and detailed design of the BRT pilot project, with the involvement of stakeholders and public.

(5) Close of Kampala Road/Entebbe Road Junction to General Traffic

In the final report of the BRT Pre-FS, it has been confirmed that Kampala Road/Entebbe Road Junction will be opened for only BRT (Figure 6.5.5) and closed to the general traffic. Although the general traffic is allowed to use Nasser Road / Nkrumah Road alternatively, which are located along the railways yard in parallel with Kampala Road, the current traffic flow directing to/from the city center (CBD and commercial center) would change drastically. In addition, as three BRT stations and one BRT city center interchange are located between Entebbe Jct and Equatoria Jct, the general traffic would find it difficult to pass Kampala Road except for just accessing the buildings along it. Function of Kampala Road would change to BRT road and a services road. There seems to be two reasons behind this; one is the physical difficulty to secure 30 m standard ROW along Kampala Road, and the other is discouraging use of the private cars in the city center and divert them to the BRT.

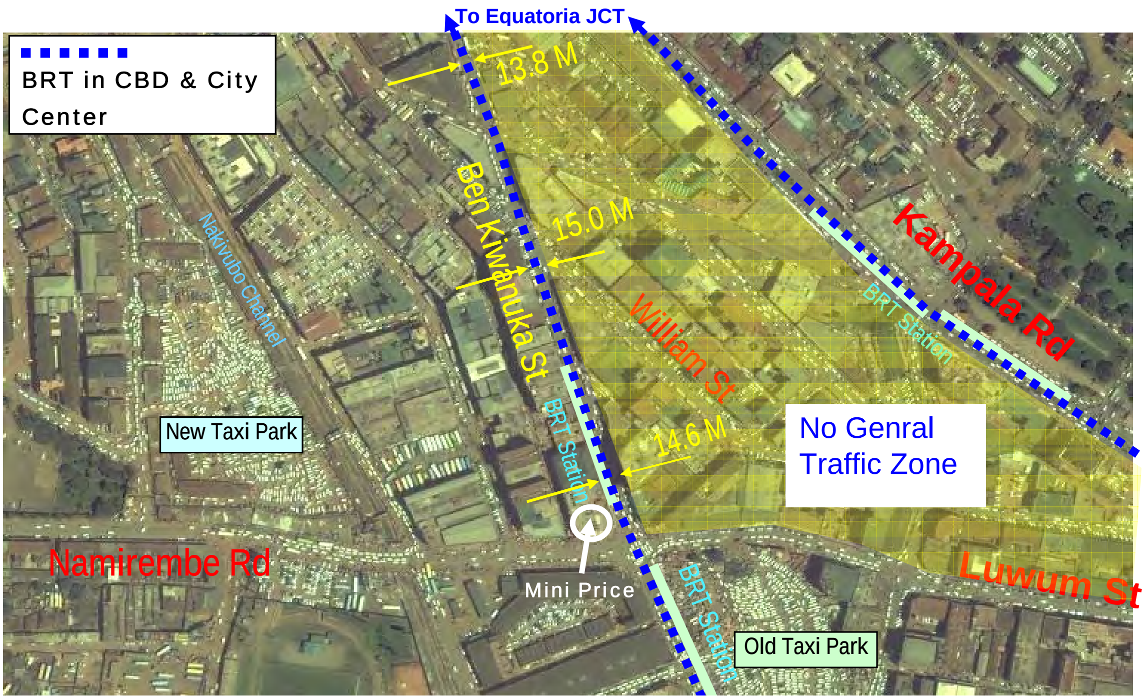


Source: The Study Team based on interpretation of BRT Pre-FS Final Report

Figure 6.5.5 Closure of Kampala / Entebbe Roads Junction for General Traffic

(6) No General Traffic on Ben Kiwanuka Street in CBD Triangle

In the Final Report of BRT Pre-FS, it is not clear how BRT is introduced at Ben Kiwanuka Street as the existing ROW is only 14-15 m wide between Mini Price Jct – Equatoria Jct (Figure 6.5.6). As BRT stations were planned to be located at Mini Price, no general traffic is physically possible to pass this road.



Source: The Study Team based on interpretation of BRT Pre-FS Final Report

Figure 6.5.6 ROW Width at Ben Kiwanuka Street and Location of BRT Stations

(7) Missing Information of BRT in Final Report for Basic Design of JICA Pre-FS Projects

The BRT Pre-FS Final Report did not provide specific information required for the basic design of JICA Pre-FS projects, including:

- Implementation plan for the BRT route except for its pilot project
- Definite traffic flows (volume) by direction for junctions design, including required number of left and right turn lanes
- BRT operation frequency for signalization planning and traffic capacity check
- Geometric alignments of BRT and crossing method on roundabouts
- Specified locations and dimensions of BRT stations
- Passenger approach, either by at-grade access or pedestrian bridges
- Feeding system (by other transport modes) of passengers for BRT stations

Hence, the basic design for the shortlisted projects would need many assumptions which might be changed in the BRT FS and detailed design stage.

6.5.2 BRT ROUTES AND STATIONS IN THE DRAFT FINAL REPORT AND EFFECTS ON SHORTLISTED PROJECTS

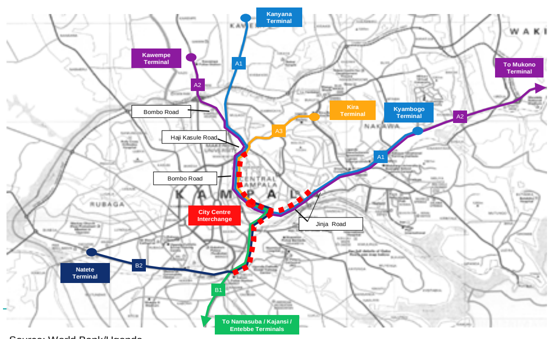
(1) BRT Pilot Project in Interim and Draft Final Reports

The BRT pilot project in the interim report stage was 7.6 km, as follows:

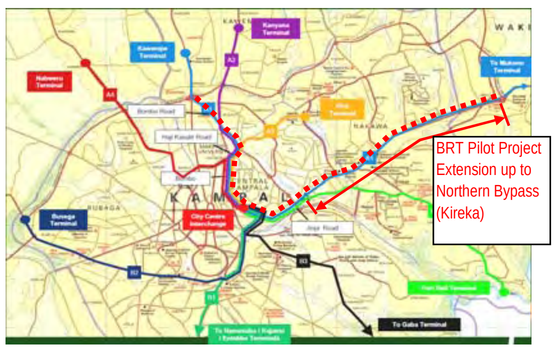
- Mulago Rbt to Africana Rbt through Haji Kasule Road – Bombo Road – Kampala Road and Jinja Road (length 4.6 km)
- Entebbe Jct to Kibuye Rbt through Entebbe Road and Queen's Way (length 3.0 km)

However, the BRT pilot project routes were changed in the Draft Final Report from Bwaise Rbt (Northern Bypass) to Kireka Rbt (Northern Bypass) through Bombo Road - Haji Kasule Road – Bombo Road – Kampala Road and Jinja Road (length 14.0 km) as shown in the following figure.

BRT Pilot Project



Source: World Bank/Uganda

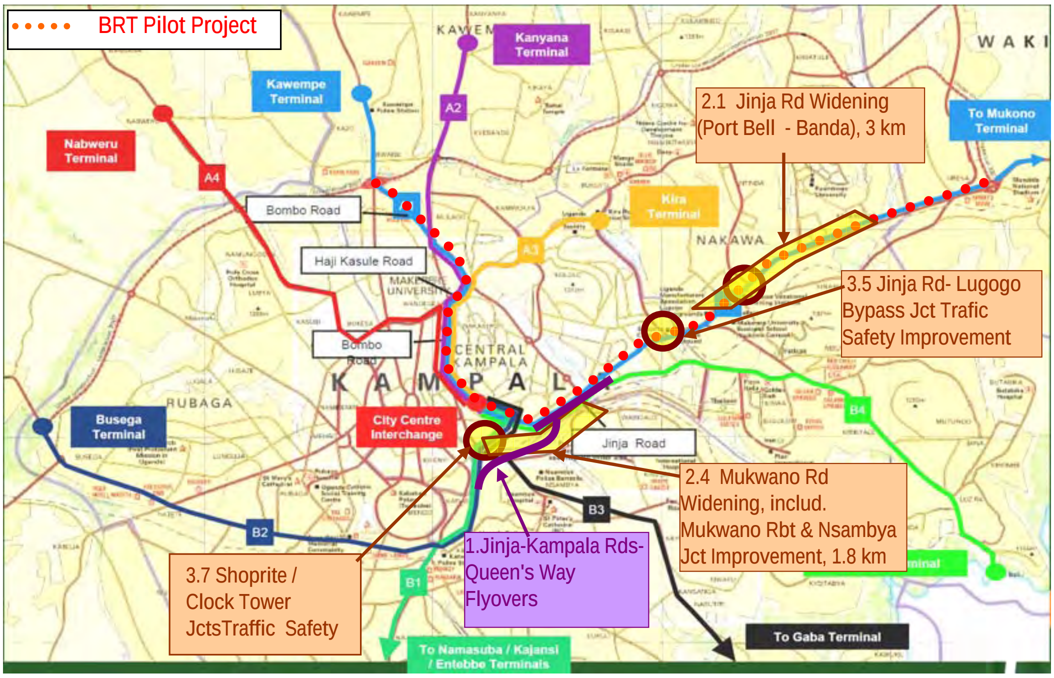


BRT Pre-FS Interim Report (Feb. 2010) **BRT Pre-FS Draft Final Report (Apr. 2010)**

Figure 6.5.7 BRT Pilot Project in Interim Report and Draft Final Report

Three of the five Pre-FS short-listed projects, i.e., Jinja – Kampala Rds Flyover, Lugogo Bypass Jct Traffic Safety Improvement and Jinja Road Widening (Port Bell – Banda), are located within the BRT pilot project as shown in Figure 6.5.8. The other two Pre-FS short-listed projects, Shoprite / Clock Tower Traffic Safety and Mukwano Rd Widening, are also located on the planned BRT routes of B1 and B3.

BRT Pre-FS did not show several important configurations/dimensions and implementation schedule for the overall BRT plan, which are required for the basic design level Pre-FS of the JICA short-listed projects. These are left to the feasibility study and detailed design consultant of BRT Pilot Project which will commence in early 2011 for about 12 months period. Even then, the basic concepts of BRT in the Pre-FS might be changed during the FS and detailed design stage as a result of the technical and financial reviews or public consultations.



Source: The Study Team based on BRT Pre-FS Draft Final Report, April 2010, MoWT

Figure 6.5.8 Short-List Projects on BRT Pilot Project Route

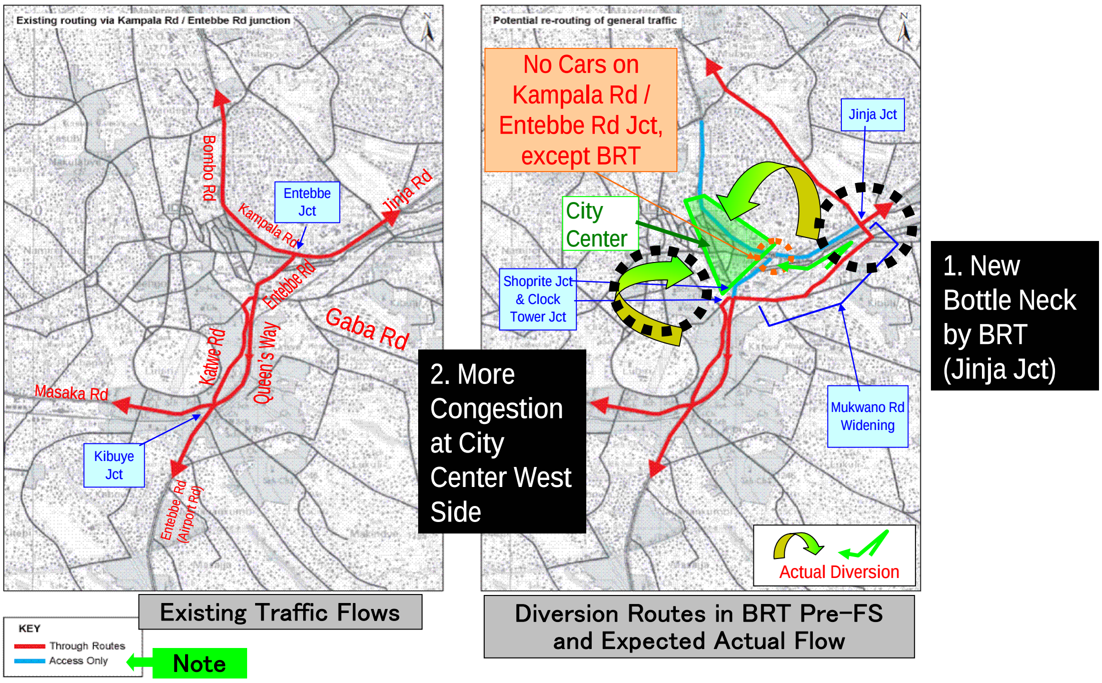
The Study Team has obtained new information from UNRA on June 28, 2010 that the GOU is discussing on an extension of the BRT pilot project from 14 km to 20 km. The extension will be along Bombo Road on the northern part and Jinja Road on the eastern part but not for the south along B1 route (Entebbe Road / Queen's Way).

According to the draft TOR for FS/detailed design of BRT pilot project in the BRT Pre-FS final report, the study will concentrate on the BRT pilot corridor identified in the Pre-FS for the Development of a Long Term Integrated BRT System for GKMA. *However it will also make provision for a spur route (B1) towards Entebbe.*

UNRA has requested the Study Team to incorporate recommendations or suggestions to any plans and ideas, which MoWT/UNRA should considerer when carrying out the FS/detailed design of the BRT pilot project, in the Study report.

(2) Closure of Entebbe Junction to General Traffic and Change of Traffic Flows

If BRT is introduced, Kampala Rd/Entebbe Rd Junction in CBD will either be closed to the general traffic according to BRT Pre-FS Draft Final Report, or passage on it will be very much limited. The BRT Pre-FS suggested rerouting general traffic flows from Entebbe Road to Nsambya/Mukwano/Yusufu Lule Roads and Jinja Road as shown in the following figure.



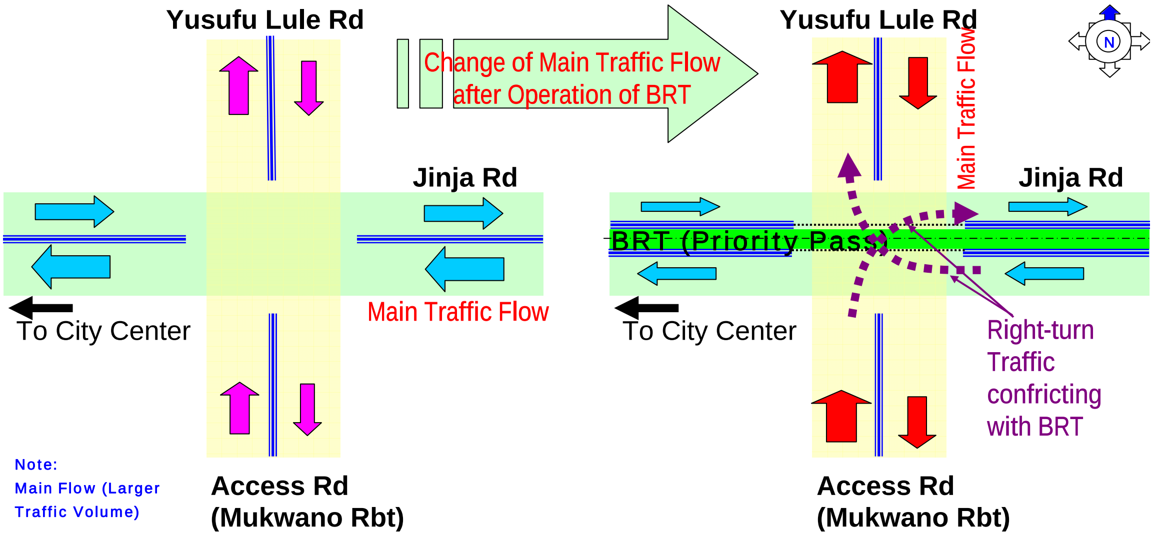
Source: The Study Team based on BRT Pre-FS Draft Final Report

Figure 6.5.9 Rerouting of General Traffic Flow by Close of Kampala Road / Entebbe Road Junction

As most of the traffic destination is the city center, this rerouting would cause the following problems:

- Traffic congestion at Jinja Road / Yusufu Lule Road Junction (Jinja Jct) will become a serious bottle neck.
- Accesses to the city center from the west side become worse as more congestions are anticipated with the diversion of the general traffic from Katwe/Entebbe Road to Natete Road/Namirembe Road and Kisenyi Road
- The current traffic capacity of Nsambya / Kibuli / Mukwano Roads, including Nsambya Jct and Mukwano Rbt, will become significantly insufficient.

The main traffic flow on Jinja Jct would be changed from the east - west direction to the north – south direction as shown in Figure 6.5.10 (refer to Chapter 5 as to the detailed analysis of traffic flow change by the Entebbe Jct closure).



Source: JICA Study Team

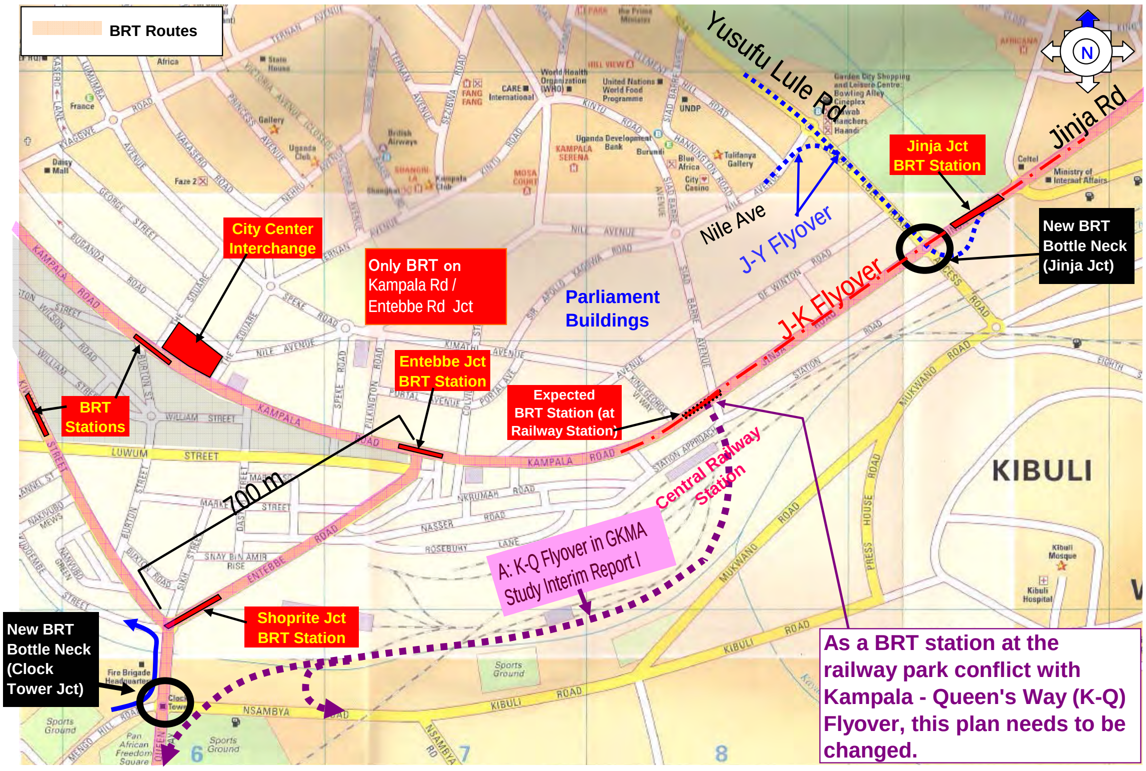
Figure 6.5.10 Change of Main Traffic Flow from East-West (Jinja Road) Direction to North-South (Yusufu Lule – Mukwano Road) Direction by BRT Introduction

A flyover should be constructed on the direction of the main traffic flow. If BRT is introduced, Yusufu Lule - Mukwano Rds Flyover on the north-south direction would carry more traffic flow than Jinja – Kampala Rds Flyover. Hence, the Study Team recommended that Yusufu Lule - Mukwano Rds Flyover instead of Jinja – Kampala Rds Flyover to reduce traffic congestion on Jinja Junction.

(3) BRT Station at Railway Park conflicting with Kampala Road - Queen's Way Flyover

Although some locations of BRT stations on its pilot project are not much clear in the BRT Draft Final Report, considering stations are provided at every 500 – 700 m in the city center, a BRT station would be located on Kampala Road near the railway station. A Kampala – Queen's Way Flyover was planned in December 2009 at the time when BRT configurations were not yet clear in terms of relieving serious traffic congestion at Shoprite Junction to divert the traffic flow from Entebbe Road to said flyover.

However, since the flyover will conflict with the anticipated BRT Station at the railway park in the BRT Draft Final Report, as indicated in the following figure, this plan is required to be changed. New flyover plans should address the new traffic bottlenecks at Clock Tower Junction.



Source: The Study Team based on BRT Pre-FS Draft Final Report

Figure 6.5.11 Kampala – Queen's Way Flyover conflicting with Anticipated BRT Station

6.5.3 COORDINATION OF SHORTLISTED PROJECTS WITH BRT PLANS

(1) Coordination of Flyover Projects with BRT Plan

Introduction of BRT is a given condition for this JICA Pre-FS. The BRT plan has more priority than other road and transport plans in this Study. The BRT Pre-FS and the JICA Study have progressed in parallel since November 2009 and, therefore, there has been not much clear coordination between both plans up to March 2010, as the basic BRT configuration was not established yet.

The Study Team has modified the plans of the flyover and other shortlisted projects in June 2010, to coordinate with the BRT plan in its draft final report of April 2010, as shown in Table 6.5.3 and Figure 6.5.12.

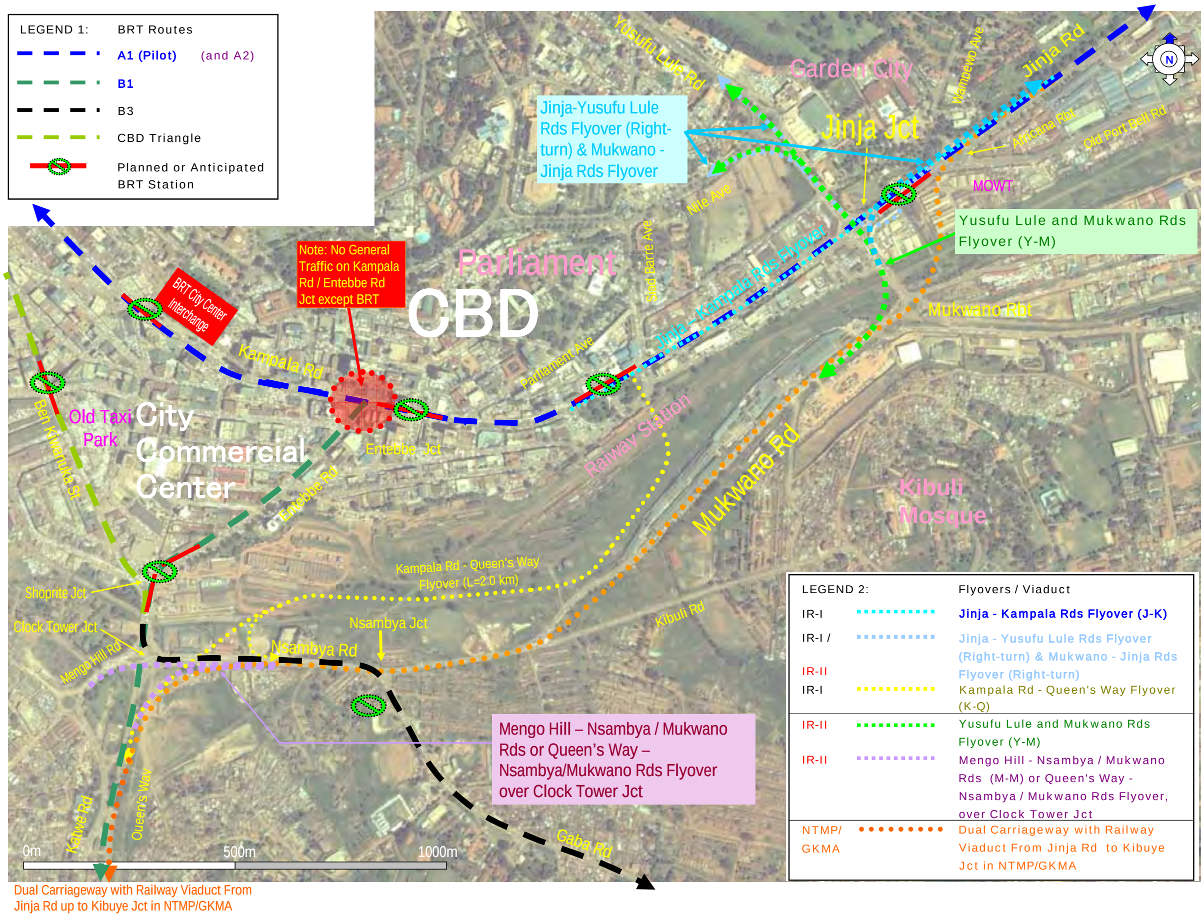
As Jinja Road Widening (Port Bell Jct – Banda) and Lugogo Bypass Junction Improvement are located on the BRT Pilot Project route, the Study Team omitted these two short-listed projects from the Pre-FS list.

Table 6.5.3 Summary of Coordination of Pre-FS Projects with BRT Plan

Short List Project	BRT Route	Affect of BRT Plan in DFR on Short List Projects	Coordination Method
1.1 Jinja-Kampala Rds Flyover	A1and A2 (On BRT Pilot)	• As Entebbe Jct is closed to the general traffic, main traffic flow at Jinja Junction will change from the east-west to the north-south direction • BRT stations between Jinja Jct and Africana Rbt • New bottleneck at Jinja Jct by BRT Plan	• Change to a flyover for the north-south direction, Yusufu Lule and Mukwano Rds Flyover (Y-M) to meet the main traffic flow change by BRT • Crossing two railways lines
1.2 Jinja - Yusufu Lule Rds Flyover (Right-turn)	A1and A2 (On BRT Pilot)	• Not much influence by BRT	• Jinja - Yusufu Lule Rds Right-turn Flyover as in Interim Report I • Provide Mukwano - Jinja Rds Right-turn Flyover to reduce conflict with BRT
1.3 Kampala Rd - Queen's Way Flyover	B1, B2 and B3	• As Entebbe Jct is closed to the general traffic, not much traffic is expected on this flyover • Anticipated BRT station at the front of railway park, where J-K flyover in-ramp was originally planed • New bottleneck at Clock Tower Jct caused by BRT Plan	• Plan a flyover to meet new traffic flows by BRT, Mengo Hill – Nsambya/Mukwano Rds Flyover or Queen’s Way - Nsambya/Mukwano Rds Flyover, over Clock Tower Jct
2.4 Mukwano Rd Widening, including Mukwano Rbt and Nsambya Jct Capacity Improvement	B3	• Substantial traffic volume increase will be caused by rerouting the general traffic from Entebbe Road to Nsambya,/ Kibuli/ Mukwano Rds	• Dual carriageway to accommodate Mengo Hill (or Queen’s Way) – Nsambya/Mukwano Rds Flyover and Yusufu Lule – Mukwano Rds Flyover
3.7 Shoprite / Clock Tower Jcts Traffic Safety Improvement	B1 and B2	• BRT stations at Shoprite Junction • Substantial Traffic Volume increase for Mengo Hill (or Queen’s Way) – Mukwano Rds through Clock Tower Jct	• Plan pedestrian bridges which do not conflict with the anticipated BRT stations for Shoprite Jct • Plan a flyover to meet new traffic flows by BRT, Mengo Hill – Nsambya/Mukwano Rds Flyover or Queen’s Way - Nsambya/Mukwano Rds Flyover, over Clock Tower Jct

Source: JICA Study Team

The major traffic flows on Clock Tower Junction will also be influenced by BRT in line with the closure of Entebbe / Kampala Rds Junction to the general traffic. It will also be influenced by the use of Queen’s Way for both BRT and the general traffic by widening it to six to eight lanes (refer to Section 4.3.3(4) of this report). To minimize traffic flow conflict between the BRT and the general traffic, a flyover will be necessary either from Mengo Hill Road to Nsambya / Mukwano Rds or from Queen’s Way to Nsambya / Mukwano Rds (Right-turn Flyover).



Source: JICA Study Team

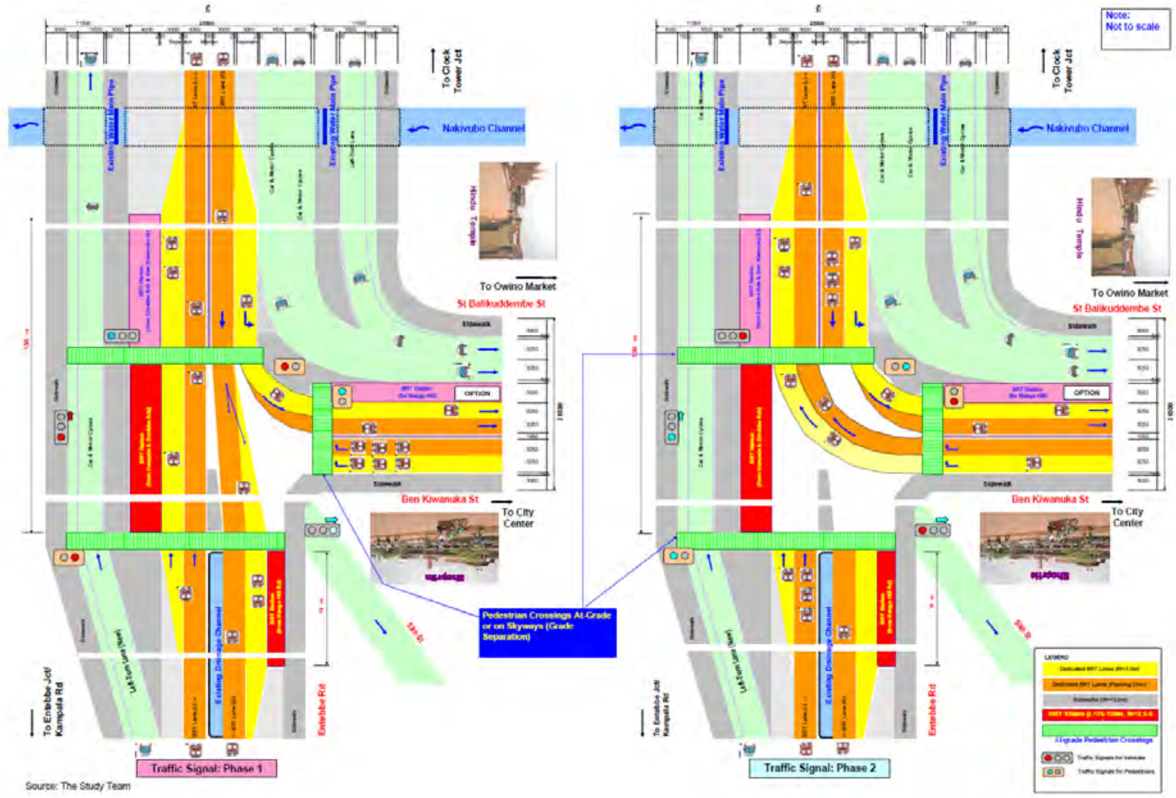
Figure 6.5.12 BRT Plan and Coordination of Flyovers of Pre-FS

(2) Shoprite Junction

Three BRT lines (B1, B3 and CBD Triangle Lines) are planned to pass through Shoprite Junction. BRT stations could be located at this junction as shown in the following figure. The basic plan for pedestrians accessing the BRT station is based on at grade crossing presented in the BRT Pre-FS. It is however not clear even in the BRT Final Report as to the restriction or flow of the general traffic.

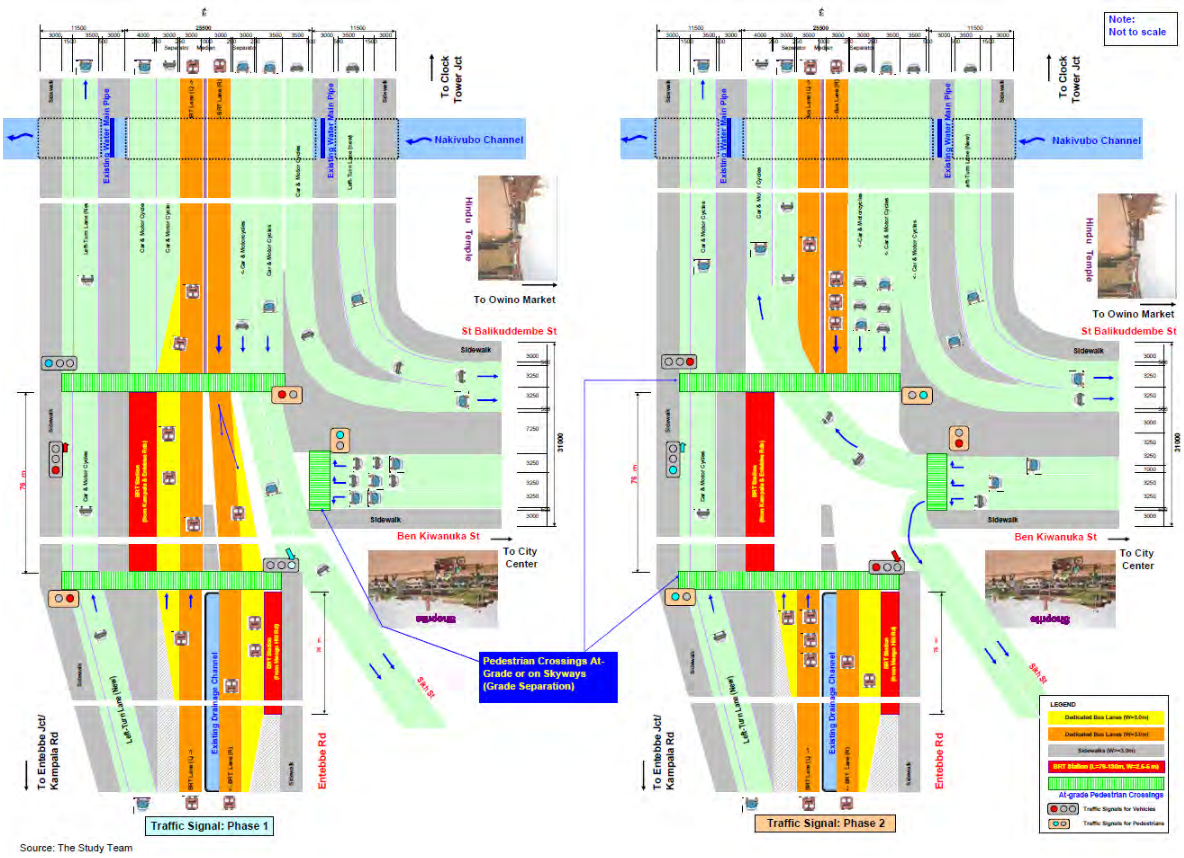
The Study Team assumed BRT lane configuration and station arrangement on Shoprite Junction at the final stage as shown in Figure 6.5.13, based on the current available information and engineering judgment for the preliminary design. Since operation of the BRT on CBD Triangle might be delayed compared with BRT Route B1, BRT lanes from Ben Kiwanuka Street could still be used by the general traffic and mini-buses. Figure 6.5.14 shows an intermediate configuration of the Shoprite Junction operation.

As there are a lot of pedestrians and bicycle taxis (boda boda) crossing the junction for traveling to/ from the central commercial center, the Study Team has planned pedestrian bridges at this junction to ensure not only safety but support of undisturbed operation of the BRT.



Source: JICA Study Team

Figure 6.5.13 Configuration of BRT Stations at Shoprite Junction at Final Stage (Assumption)



Source: JICA Study Team

Figure 6.5.14 Intermediate Configuration of BRT Stations at Shoprite Junction (Assumption)

(3) Clock Tower Junction

BRT Final Report is not clear as to BRT routes between Clock Tower Junction and Kibuye Roundabout. Thus, there would be two possible alternatives, as follows:

- Alternative 1: Use only Queen's Way by widening it from the current two lanes to six to eight lanes for both outbound and inbound BRT and general traffic (right alignment in Figure 6.5.15).

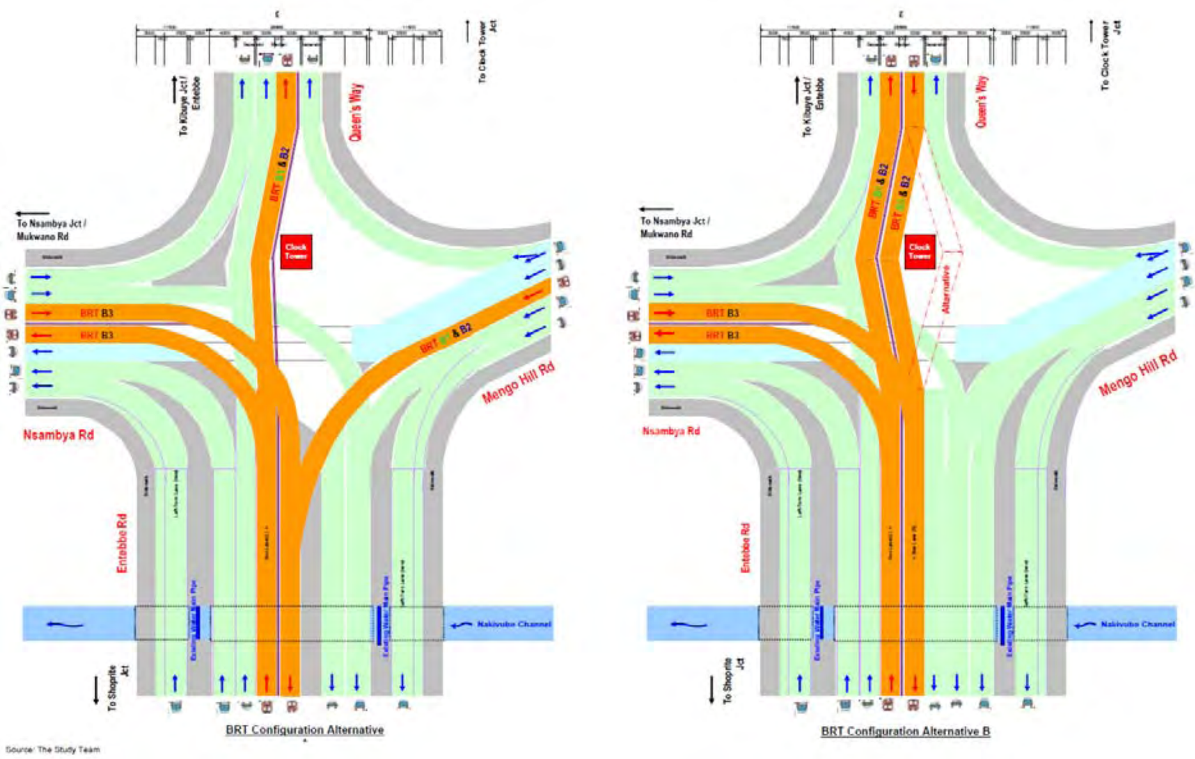
- Alternative 2: Use Queen's Way for outbound BRT and general traffic and Katwe Road / Mengo Hill Road for inbound BRT and general traffic (left alignment in Figure 6.5.15).

Hence, a flyover would become necessary at either:

- Between Mengo Hill Road and Nsambya/Mukwano Rds passing over Clock Tower, or

- From Queen's Way to Nsambya/Mukwano Rds (Right-turn Flyover) passing over Clock Tower.

As a railways line is located between Clock Tower and Nsambya (Kibuli) Junction and BRT B3 was planned for Gaba, the flyover might be required to pass over these facilities in the future when BRT B3 is introduced for Gaba or depending on the resumption of the railway operation.



Source: JICA Study Team

Figure 6.5.15 Assumed Configuration of BRT Stations at Shoprite Junction (Assumption)

It should be further noted that Clock Tower Junction Improvement should be planned as a total system of the road network between Jinja Road and Entebbe Airport Road passing through Mukwano Road, Nsambya Road, Clock Tower Jct, Queen's Way, Kibuye Rbt and Entebbe Airport Road, in line with the Dual Carriageway Railways Viaduct Plan in NTMP/GKMA and BRT Plan (refer to Section 4.3.3(4).

The Study Team has discussed with UNRA on June 28, 2010 whether BRT should be introduced on Queen's Way or Katwe Road between Clock Tower Jct and Kibuye Rbt, since the Study Team needs to conduct a preliminary design for Clock Tower Junction. Both sides shared the same view that BRT should consider only widening of Queen's Way to six or eight lanes by utilizing the existing railways ROW since Katwe Road is too narrow to accommodate BRT. Hence, a flyover between Queen's Way and Nsambya/Mukwano Rds would have advantages compared with the Mengo Hill - Way and Nsambya/Mukwano Rds flyover.

6.6 FINAL SHORT-LISTED PROJECTS FOR PRE-FEASIBILITY STUDY

6.6.1 REVIEW OF LONG LIST

The Study Team recommended five short-listed projects, flyovers for preliminary design and other related items for the basic design level pre-FS, based on MCA and other considerations.

However, it has become clear that the short-listed projects are either directly or indirectly affected by the BRT introduction as analyzed in Section 6.5. It was further noted that the basic concepts of BRT Pre-FS might be changed during its FS and detailed design stage as a result of technical and financial reviews or public consultations.

Taking the latest development of BRT study, It was decided to conduct the Pre-FS with preliminary design for the three final short-listed projects namely, Flyover Projects, Mukwano Road Widening and Shoprite / Clock Tower Traffic Safety Improvement, in accordance with the original scope of work signed by both governments on March 1, 2007. Jinja Road Widening and Lugogo Bypass Junction Improvement will not be excluded since these duplicate with the FS and detailed design of BRT Pilot Project.

The Study Team has reviewed the MCA in Table 6.4.3 by taking the latest information from the sub-projects into account. The sub-projects in the initial long list but are located along the BRT pilot project routes were omitted from the MCA review list as their improvement, including road widening and junction improvement, shall be undertaken under the BRT FS/detailed design.

Table 6.6.1 Review of Sub-Projects in Long List

No	Sub-Component Name	Replacement or Change	Reason of Omission or Addition	Sub-Component Name in the New Long List
1.1	Jinja-Kampala Rds Flyover	Replacement by Yusufu Lule – Mukwano Rds Flyover		Yusuf Lule-Mukwano Rds Flyover
1.3	Kampala Rd – Queen's Way Flyover	Replacement by Queen's Way – Nsambya / Mukwano Rds Flyover Clock Tower Jct		Queen's Way – Nsambya / Mukwano Rds Flyover Clock Tower Jct
2.1	Jinja Road (Port Bell Jct - Banda/Northern Bypass Section)		Omission since this is on BRT Pilot Project	-
2.1a	Jinja Road (Banda - Northern Bypass Section)		Omission since this is on BRT Pilot Project	-
2.2	Bombo Road (Makerere Rbt - Northern Bypass Section), including Makerere Rbt Flyover		Omission since this is on BRT Pilot Project	-
2.6		Widening of Queen's Way and Flyover on Kibuye Rbt	Addition taking request of MoWT into account	Queen's Way-Nsambya/Mukwano Rds Flyover (Right-turn)
3.5	Jinja Rd - Lugogo Bypass Junction Improvement		Omission since this is on BRT Pilot Project	-

Source: JICA Study Team

The Study Team also reviewed requirements for widening the Makerere Hill Road from four-lane dual carriageway to six-lane carriageway road as BRT is introduced along this route. The preliminary estimated cost, land acquisition and resettlement are revised as shown in the following table.

Table 6.6.2 Review of Five Levels Scores for Cost, Land Acquisition and Resettlement Evaluation

Project Component	Project No.	Project Cost		Land Acquisition				Resettlement		
		ICB (Estimate)	5-Grade Score	Area of Land required	Secured ROW (estimate)	ROW to be acquired	5-Grade Score	Number of Buildings	Resettlement (estimate)*	5-Grade Score
Weight		(US$ Mill)		(ha)		(ha)		(number)	(household)	
Yusufu Lule - Mukwano Rds Flyover	1.1 (Phase 1)	49.83	2	0.52	79%	0.11	4	1 (0)	1	4
	1.2 (Phase 1)	37.67	2	2.50	74%	0.65	3	11 (2)	17	3
	1.3 (Phase 3)	7.08	4	0.60	100%	0.00	5	4 (0)	4	4
Combination of Dual Carriageway, Flyover and Junction Improvement	2.3	7.19	4	4.00	10%	3.60	1	22	>50	1
	2.4	5.39	4	3.94	70%	1.19	2	9 (2)	15	3
	2.5	5.95	4	0.33	90%	0.03	4	0 (0)	0	5
	2.6	13.44	3	5.80	80%	1.16	2	15 (15)	>50	1
Individual Junction Improvement	3.1	0.87	5	0.12	20%	0.10	4	5 (5)	10-20	3
	3.2	0.87	5	0.24	20%	0.19	4	1 (1)	5	4
	3.3	0.87	5	0.24	20%	0.19	4	2 (1)	10	4
	3.4	0.71	5	0.18	70%	0.05	4	1 (1)	5	4
	3.6	0.87	5	0.25	0%	0.25	4	5 (5)	20-50	2
	3.7	4.20	4	1.17	45%	0.64	3	4 (0)	4	4
Average Value		10.38				0.63				
Max Value		49.83				3.60				
Note: Evaluation Criteria at 5-levels	1	Over 50	V.Very Large			Over 1.5	Very Large		>50	Large
	2	20-50	Very Large			1.0-1.5	Large		20-50	Medium
	3	10-20	Large			0.5-1.0	Medium		10-20	Small
	4	3-10	Medium			0 - 0.5	Small		up to 10	Very Small
	5	Up to 3	Small			0	None		0 (none)	None

Note: Total number of buildings (Number of private buildings)

Source: JICA Study Team

The following table shows the result of the MCA review. The flyovers have still higher priority compared with other projects.

Table 6.6.3 shows a review result of Multi Criteria Analysis to be used as confirmation of the final short-listing of Pre-FS projects.

Table 6.6.3 Review of Multi Criteria Analysis (MCA) for New Long List

Multi Criteria Analysis (MCA) Results with Weighted Index

Project Component	Sub-Component No.	Sub-Component Name	Consistency with Superior Plans 25%		Engineering Factors 25%		Socio-Economic Factors 30%				Environmental Impacts 20%		Total (evaluated score with weight)	Order of Priority by MCA	Remarks (Estimated number of households required resettlement)
			Consistency with TMP-GKMA	Policy of Government of Uganda on Priority	Function of Road	Technical Effectiveness to Traffic Jam	Traffic Volume (Current)	Project Cost	Contribution to CBD/C.Center Development Sustainability	Interview Ranking by Stakeholders on Traffic Jam*	Land Acquisition	Resettlement Requirements			
Weight			12.5%	12.5%	12.5%	12.5%	7.5%	7.5%	7.5%	7.5%	10.0%	10.0%	100.0%		
Flyover / Viaduct	1.1 (Phase 1)	Yusufu Lule - Mukwano Rds Flyover	14.5	15.3	14.8	15.9	8.7	3.8	11.1	8.1	11.8	12.4	116.4	2	Resettlement (less than 10)
	1.2 (Phase 1)	Jinja - Yusufu Lule Flyover (Right-turn) and Mukwano - Jinja Rds Flyover (Right-turn)	14.5	15.3	14.8	12.7	8.7	3.8	11.1	8.1	8.9	9.3	107.1	4	Resettlement (10-20)
	1.3 (Phase 2)	Queen's Way - Nsambya / Mukwano Rds Flyover (Right-turn)	11.6	12.3	14.8	12.7	10.8	7.5	11.1	13.5	14.8	12.4	121.5	1	Resettlement (less than 10)
Combination of Dual Carriageway, Flyover and Junction Improvement	2.3	Makerere Hill Road, including Sir Apollo Kaggwa Rd Jct	14.5	12.3	11.8	12.7	8.7	7.5	6.6	10.8	3.0	3.1	91.0	10	Resettlement (more than 50)
	2.4	Mukwano Rd, including Mukwano Rbt and Nsambya Jct Capacity Improvement	8.7	15.3	14.8	15.9	8.7	7.5	8.9	8.1	5.9	9.3	103.1	5	Resettlement (10-20)
	2.5	Mutesa Rd - Kaweesa Rd - Kabasu Rd (South Inner Ring Road)	8.7	9.2	11.8	9.6	2.2	7.5	4.4	2.7	11.8	15.5	83.4	13	No Resettlement
	2.6	Widening of Queen's Way and Flyover on Kibuye Rbt	14.5	15.3	14.8	15.9	10.8	5.6	8.9	8.1	5.9	3.1	103.0	6	Resettlement (more than 50)
Individual Junction Improvement	3.1	Hoima Rd - Kimera/ MasiroKawala Rd Jct (Kasubi Jct)	14.5	12.3	8.9	9.6	6.5	9.4	2.2	2.7	11.8	9.3	87.1	12	Resettlement (10-20)
	3.2	Kira Road - Acacia/ Babiha Av/ Kayunga Rd	14.5	9.2	11.8	12.7	6.5	9.4	4.4	2.7	11.8	12.4	95.5	8	Resettlement (less than 10)
	3.3	Kira Rd - Ntinda Rd	14.5	12.3	11.8	12.7	6.5	9.4	2.2	2.7	11.8	12.4	96.3	7	Resettlement (less than 10)
	3.4	Port Bell (Nakawa) - Old Port Bell Rd	14.5	9.2	8.9	12.7	4.3	9.4	4.4	2.7	11.8	12.4	90.4	11	Resettlement (less than 10)
	3.6	Ben Kiwanuka Rd - Luwum St	8.7	12.3	8.9	6.4	4.3	9.4	11.1	13.5	11.8	6.2	92.5	9	Resettlement (20-50)
	3.7	Shoprite & Clock Tower Traffic Safety Improvement	8.7	12.3	14.8	12.7	10.8	7.5	11.1	13.5	8.9	12.4	112.7	3	Resettlement (less than 10)

Notes: [yellow] The priority projects recommended for the pre-feasibility study. [pink] The projects for which resettlement is estimated more than 50 households and EIA is required in accordance with the environmental guideline of JICA.

Source: JICA Study Team

The Study Team conducted sensitivity tests by changing the weights allocated to the evaluation of main and sub-factors as indicated in Table 6.6.4. Case 1 gave 50% to the engineering factors, Case 2 gave 50% to the socio-economic factors, Case 3 gave 40% to the consistency with superior plans and Case 4 emphasized the environmental impact allocating 40%.

Table 6.6.4 Sensitivity Test Results for the MCA

Component	Project No.	Evaluation Items	Evaluated Rank with Weight (%) Change					Average Case 1 - Case 4
			Standard	Case 1	Case 2	Case 3	Case 4	
		Consistency with Superior Plans	25%	20%	20%	40%	20%	
		Engineering Factors	25%	50%	20%	20%	20%	
		Socio-Economic Factors	30%	20%	50%	20%	20%	
		Environmental Impacts	20%	10%	10%	20%	40%	
		Total	100%	100%	100%	100%	100%	
Flyover / Viaduct	1.1 (Phase 1)	Yusufu Lule - Mukwano Rds Flyover	2	1	2	1	2	1
	1.2 (Phase 1)	Jinja - Yusufu Lule Flyover (Right-turn) and Mukwano - Jinja Rds Flyover (Right-turn)	4	6	5	4	4	4
	1.3 (Phase 2)	Queen's Way - Nsambya / Mukwano Rds Flyover (Right-turn)	1	2	1	2	1	1
Combination of Dual Carriageway, Flyover and Junction Improvement	2.3	Makerere Hill Road, including Sir Apollo Kaggwa Rd Jct	10	8	13	7	13	10
	2.4	Mukwano Rd, including Mukwano Rbt and Nsambya Jct Capacity	5	5	9	6	8	6
	2.5	Mutesa Rd - Kaweesa Rd - Kabasu Rd (South Inner Ring Road)	13	12	8	13	9	12
	2.6	Widening of Queen's Way and Flyover on Kibuye Rbt	6	3	12	3	11	7
Individual Junction Improvement	3.1	Hoima Rd - Kimera/ MasiroKawala Rd Jct (Kasubi Jct)	12	11	10	10	10	10
	3.2	Kira Road - Acacia/ Babiha Av/ Kayunga Rd	8	9	6	9	6	8
	3.3	Kira Rd - Ntinda Rd	7	7	4	8	5	5
	3.4	Port Bell (Nakawa) - Old Port Bell Rd	11	10	7	12	7	9
	3.6	Ben Kiwanuka Rd - Luwum St	9	13	11	11	12	13
	3.7	Shoprite & Clock Tower Traffic Safety Improvement	3	4	3	5	3	3

Notes: ▭ The priority projects recommended for the pre-feasibility study.
Source: JICA Study Team

The results are quite stable in ranking from the 1st to 5th, with order of priorities as flyover projects (Project No. 1.1, 1.2 and 1.3), Project No.2.4-Mukwano Rd widening and Project No.3.7-Shoprite and Clock Tower Traffic Safety Improvement. The widening of Queen's Way and Flyover on Kibuye Rbt was ranked as the 7th priority. However, as estimated resettlement is more than 50 households near Kibuye Rbt, EIA including public consultation becomes necessary.

6.6.2 FINAL SHORTLISTED PROJECTS FOR PRE-FEASIBILITY STUDY

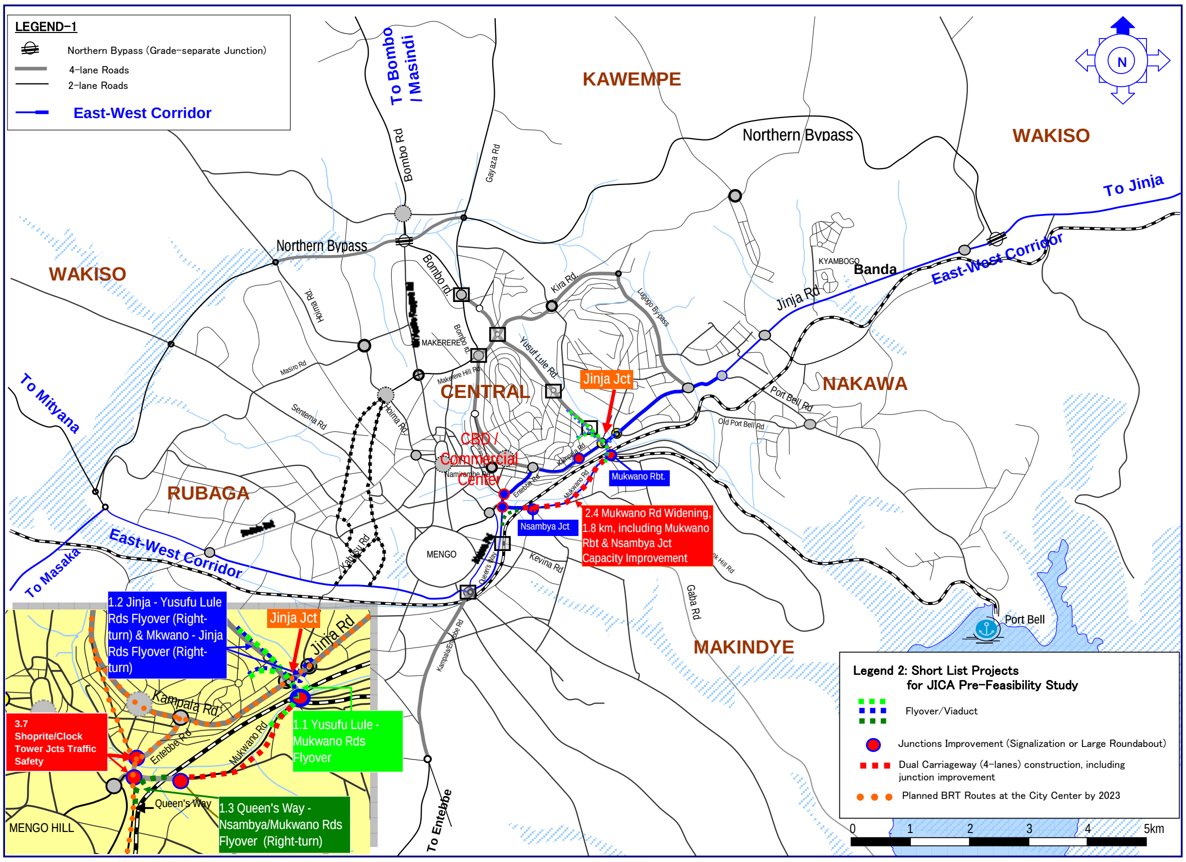
Table 6.6.5 and Figure 6.6.1 summarize the short-listed projects (refer to Annex 3 as to profile of the short-listed projects).

Table 6.6.5 Final Shortlisted Projects for Pre-FS

Project No	Project Name	Basic Project Concept			Implementation Period	Priority by Multi Criteria Analysis
		Project Length (km)	Viaduct/ Flyover Length (km)	Carriageway & Junction Improvement		
1.1 (Phase 1)	Yusufu Lule and Mukwano Rds Flyover	1.7	1.5	Dual Carriageway (two-ways 2 lanes)	Medium Term (2018)	2
1.2 (Phase 1)	Jinja - Yusufu Lule Rds Flyover (Right-turn) & Mukwano - Jinja Rd Flyover (Right-turn)	2.3	1.9	Single Carriageway	Medium Term (2018)	4
1.3 (Phase 2)	Mengi Hill - Nsambya / Mukwano Rds Flyover (Right-turn)	0.6	0.5	Single Carriageway	Long Term (2023)	1
2.4	Mukwano Rd Widening, including Mukwano Rbt and Nsambya Jct Capacity Improvement	1.8	-	Dual Carriageway (Add. 2 lanes) & Mukwano Rbt and Nsambya Jct improvement	Medium Term (2018)	5
3.7	Shoprite & Clock Tower Jcts Traffic Safety	-	-	Pedestrian Bridges & Separated Left-turn	Medium Term (2018)	3

Note: A preliminary planning of a flyover on Kibuye Roundabout was included in the Study addressing to the proposal of MoWT in line with Dual Carriageway Railway Viaduct Plan in NTMP/GKMA (refer to Annex 8 as to the plan).

Source: JICA Study Team



Source: JICA Study Team

Figure 6.6.1 Final Shortlisted Projects Selected for Pre-FS

CHAPTER 7 PRELIMINARY DESIGN FOR PRE-FEASIBILITY STUDY PROJECTS

7.1 NATURAL CONDITIONS IN PROJECT AREA

7.1.1 GEOLOGICAL CONDITIONS

(1) Geological Condition Survey

The purpose of the geological survey is to confirm the depth of the bearing layer for flyovers and other geological information to design for other ancillary facilities by drilling the borehole and performing the Standard Penetration Test (SPT) at each point. The scope of the work is as follows:

- Boring: 6points
- SPT at 1 m interval

The scheduled and actual drilling depth of each location is as follows:

Table 7.1.1 Drilling Depth of Each Location

Number	Location	Scheduled depth (m)	Actual depth (m)
No.1	Railway Station Park	10	10
No.2	Jinja Junction	20	18
No.3	Africana Roundabout	20	20
No.4	Cemetery	10	10*
No.5	Mukwano Roundabout	20	20.5
No.6	Garden City Roundabout	10	13.5

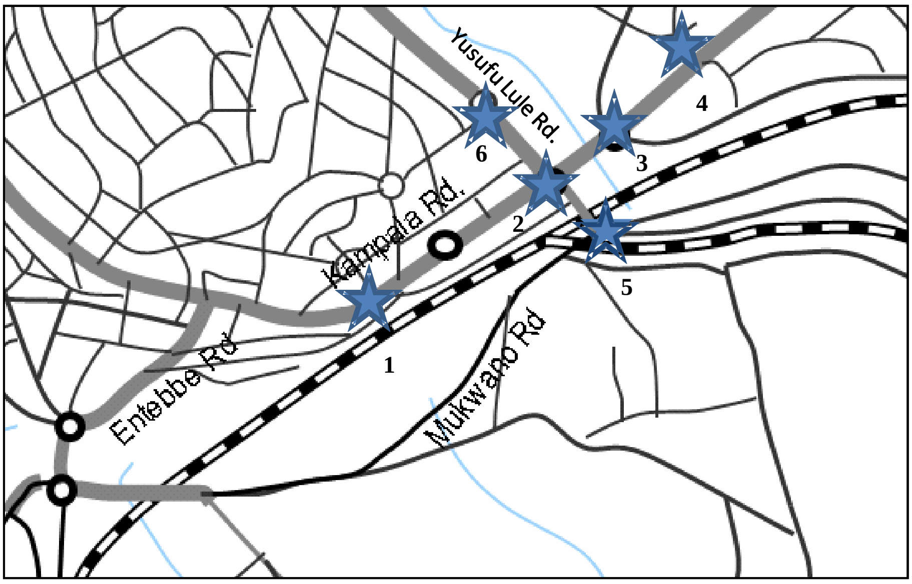
* Note: The first drilling terminated at 3 m because of possibly hitting hard gravel and was not able to continue drilling. Then second point was located 1 m from the first drilling point and drilled until 10 m.
Source: JICA Study Team

The location of the boring points is along the flyover plan including alternative plan. Location map of the drilling point and coordinates are shown in Table 7.1.2 and Figure 7.1.1.

Table 7.1.2 Coordinates of Each Boring Location

No.	Location	Latitude	Longitude	Survey Date
1	Railway Station Park	454100	34905	28/04/2010
2	Jinja Junction	454675	35327	23/04/2010
3	Africana Roundabout	454906	35481	17/04/2010
4-1*	Cemetery-1	455080	35624	23/04/2010
4-2	Cemetery-2	455080	35625	26/04/2010
5	Mukwano Roundabout	454811	35121	20/06/2010
6	Garden City Roundabout	454485	35534	23/06/2010

Source: JICA Study Team



Source: JICA Study Team

Figure 7.1.1 Location Map of the Boring Point

(2) Results

The results of SPT (N-value) and lithology are shown in Table 7.1.3. The geological columns of the six locations are shown in Appendix.

Table 7.1.3 Results of N Value of Each Location

Depth(m) \ Location	No.1		No.2		No.3		No.4		No.5		No.6	
1	6	Quaternary sandy silt	10	Quaternary sandy silt	5	Quaternary sandy silt	13	Quaternary sandy silt	6	Quaternary sandy silt	7	Quaternary sandy silt
2	6		9		11		15		2		10	
3	5		11		14		20		15		18	
4	22		18		19		14		14		11	
5	22	Precambrian phyllite schist (weathered)	25		23		40	Precambrian phyllite schist (weathered)	28		33	Precambrian phyllite schist (weathered)
6	22		26		24		51		22		79	
7	30		25	Precambrian phyllite schist (weathered)	20	Precambrian phyllite schist (weathered)	86		52	Precambrian phyllite schist (weathered)	89	
8	35		45		39		88		26		50	
9	52		40		41		71		28		35	
10	40		127		45		98		13		28	
11			75		60				12		30	
12			21		72				12		23	
13			60		76				22		30	
14			63		114				47			
15			72		58				60			
16			79		69				57			
17			106		66				41			
18			76		156				75			
19			72						55			
20			118						45			

Source: JICA Study Team

The stratigraphy of the upper layer consists of quaternary sandy silt and the lower layer consists of precambrian weathered metamorphic base rock. The geological cross section along Jinja and Kampala Road is shown in Figure 7.1.2. Characteristic features of each layer are as follows:

Quaternary Sandy Silt

The thickness of this deposit layer is about 6 m in the lower location (No.2 and No.3) and 4-5 m in the upper location (No.1 and No.4). The geology consists mainly of brownish sandy silt. The N-value of this layer is between 5 and 26. Soft ground (defined as those with N-value lower than 4 for cohesive soil and lower than 10 for sandy soil) does not exist in the drilling area. The average N-value of this layer is 15.

Precambrian Base Rock (Phyllite/Schist)

Below the sandy silt layer, weathered base rock of precambrian appears and continues until the end of the drilling depth. This base rock consists of schist and phyllite, which is a type of foliated metamorphic rock primarily composed of quartz, sericite mica, and chlorite. The high contents of grey and metal-like colored mica are observed in drilling samples. The N-value of this layer is between 20 and 127. The average N-value of this layer is 64.

Water Table

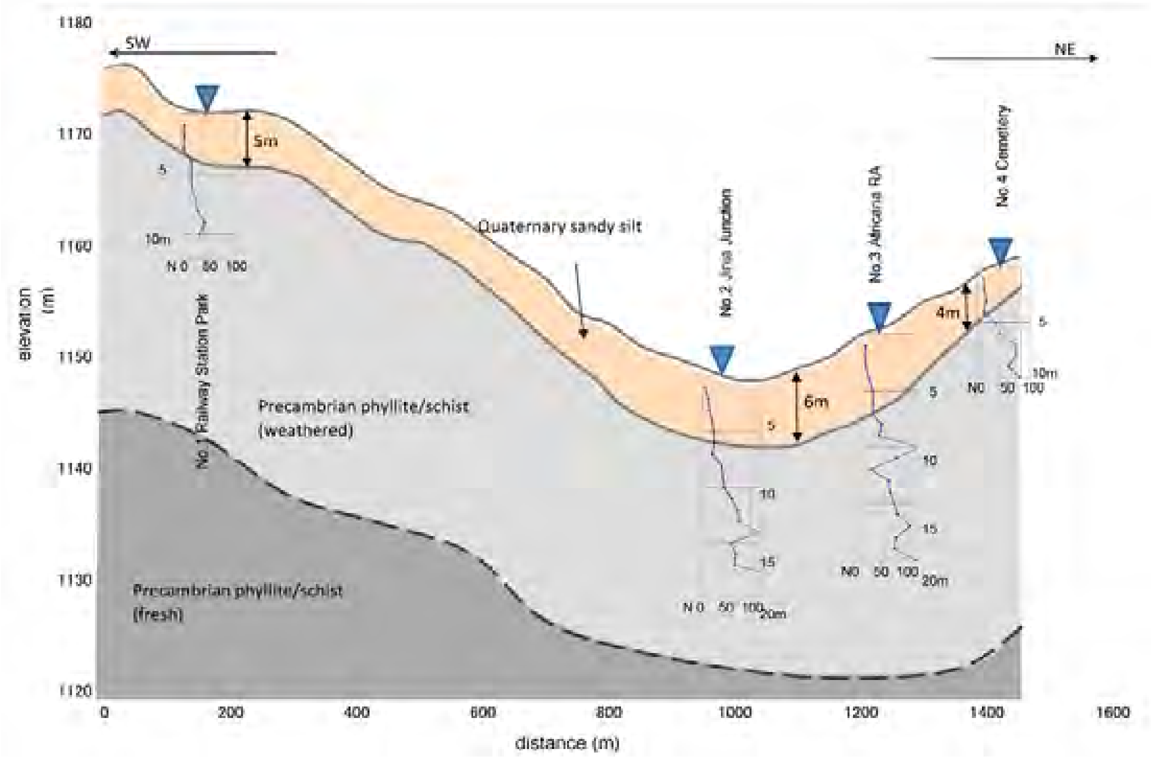
The water table of each location is shown in Table 7.1.4.

Table 7.1.4 Water Table of Each Point

Unit: m (from ground level)

Location	No.1	No.2	No.3	No.4	No.5	No.6
Water Table	N/A	3.0	1.4	N/A	N/A	N/A

Source: JICA Study Team



Source: The Study Team

Figure 7.1.2 Geological Cross Section along Jinja and Kampala Roads

7.1.2 HYDROLOGICAL CONDITIONS

(1) Hydrological Condition

Prior to the hydrological analysis of the Pre-FS project, basic data for the hydrological analysis shall be considered and analyzed. The design flow of the relevant catchment area will be calculated by Rational Method. The Rational Method is old; however, it is still the most available method for a wide range of catchment area up to 500 km^2. In the Rational Method, the design flow is shown in the following formula:

Q=1/3.6 x106 C·I·a or Q=1/3.6 x C·I·A

Where:

Q: design flow (m^3/sec)

C: Runoff coefficient

I: Rainfall intensity in time of concentration (mm/h)

A: Catchment area (km^2)

a: Catchment area (m^2)

(2) Catchment Area

As described in Chapter 2.2 (Natural Condition), Kampala City is divided into eight major catchment areas and several sub-catchment areas which are shown in Table 7.1.5. The detailed survey for the relevant catchment area will be performed at a later stage in this study for the hydrological design.

Table 7.1.5 Eight Major Catchment Areas in Kampala City

Drainage System		Catchment Area (km^2)	Number of sub-catchment area
No.	Name		
1	Nakivubo	37.9	43
2	Lubigi	65.8	72
3	Nalukolongo	32.8	32
4	Kansanga	17.1	23
4A	Gaba	2.1	
5	Mayanja/Kaliddubi	41.1	12
6	Kinawataka	27.5	23
7	Nalubaga	11.0	26
7A	Nakelere/Nalubaga	2.5	
8	Walufumbe	14.1	37
8A	Mayanja North	2.3	

Source: Nakivubo Channel Rehabilitation Project (NCRP)

(3) Rainfall Analysis

1) Available Data

Daily rainfall data from 1974 to 2009 except 1982 in Kampala City were obtained from the Department of Meteorology.

2) Frequency Analysis of Daily Rainfall

A statistical analysis was done on the rainfall data at Kampala Station as shown in Table 7.1.6 to determine the 1-day return period rainfall. Three statistical distribution methods (Gumbel, Log Normal Distribution, Log Pearson III) were calculated using the observed rainfall records. In this study, log normal distribution method is applied as this method is still the most widely used distribution in hydrological analyses and is also used in the drainage design of the Nakivubo Channel Rehabilitation Project (NCRP).

Table 7.1.6 Day Rainfall Return Period at Kampala Rainfall Station

Duration / Method	1 Day Return Period Rainfall (mm)					
	2	5	10	20	50	100
Gumbel	58.0	70.4	78.6	86.4	96.6	104.2
Log Normal	57.8	69.9	78.1	85.9	96.1	103.9
Log Peason III	57.0	69.5	78.7	88.3	101.7	112.6

Source: JICA Study Team

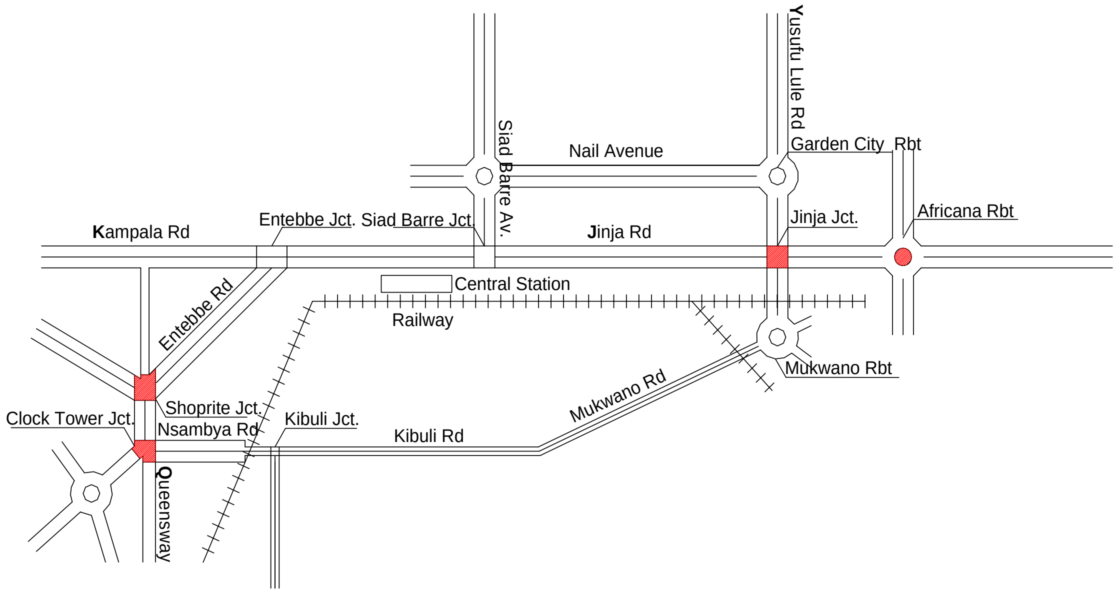
7.2 FLYOVER (VIADUCT) PROJECTS

7.2.1 ALTERNATIVE PLAN STUDY

(1) Objectives and Flow of Alternative Plan Study

The objective of the Pre-FS is to determine the most technically feasible, economically viable, environmentally acceptable and socially optimal option for decongestion in Kampala urban area. The study will also determine the impact of decongestion project on poverty reduction and environment.

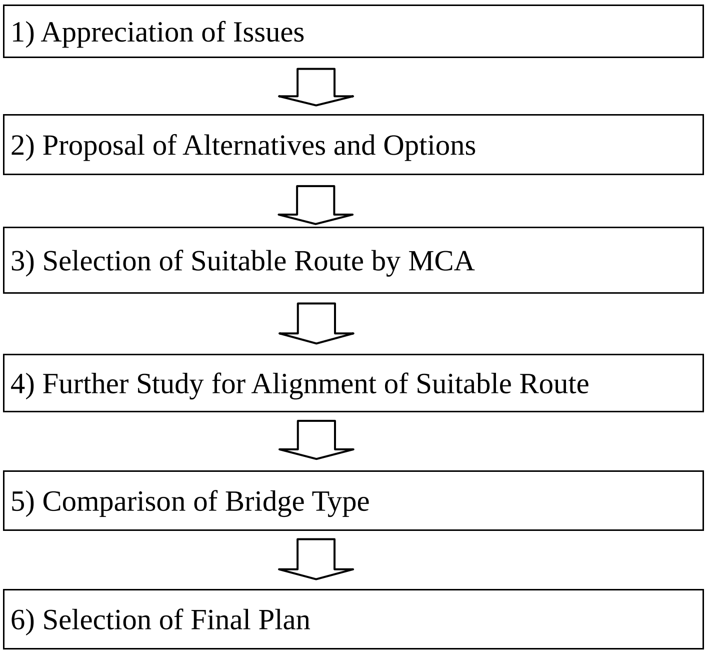
The purpose of the flyover project is to alleviate serious traffic jam at the Kampala urban center shown in the following figure. In particular, traffic capacity increase through flyover construction is one of the best solutions of traffic jam for Africana, Jinja, Shoprite and Clock Tower Junctions as widening of the existing Jinja and Kampala roads are impossible without demolition of many buildings along the road.



Source: JICA Study Team

Figure 7.2.1 Target Area and Junctions in Kampala City Center for Traffic Decongestion

The approach of Pre-FS, flow of each work and its description are as shown in Figure 7.2.2.



Source: JICA Study Team

Figure 7.2.2 Pre-FS Study Flowchart

1) Appreciation of Issues

Existing traffic issues are recognized based on the related reports and confirmed through the visual site survey, traffic volume survey, natural condition survey and so on.

2) Proposal of Alternatives and Options

Based on the traffic studies, possible alternatives and options responding to the site situation are proposed.

3) Selection of Suitable Route by Multi Criteria Analysis (MCA)

The merits and drawbacks of each alternative and option should be determined by use of MCA. The comparative data for selection is provided.

4) Further Study for Alignment of Suitable Route

Horizontal and vertical alignments for suitable route selected by the MCA are reviewed to obtain maximum effect and minimum negative impact to social environment.

5) Comparison of Bridge Type

The most suitable bridge type for the flyover is selected in consideration of the construction cost, geological survey results and landscape.

6) Selection of Final Plan

Final plan selected through the above steps is presented.

(2) Design Standards and Typical Cross Sections

1) Applicable Design Standards

The application of proper design standards will ensure road safety, high standard service level and comfort for road users through the provision of adequate sight distance and roadway space.

The design and construction standards for new roads and bridges have been established by Ministry of Works and Transport (MoWT) in Uganda. These design standards were published as Road Design Manual and aimed to (a) maintain a degree of uniformity, particularly across administrative boundaries, (b) enable satisfactory designs to be produced, even where there is not a high degree of expertise, and (c) ensure that the funds for public works were not misspent, through inappropriate designs, or through inadequate provision for future traffic growth or current operations. The construction specification, on the other hand, is intended to be used for the rehabilitation of existing road network, construction of new highways and bridges and maintenance of existing roads and structures.

The following is the composition of MoWT's Road Design Manual:

- Vol. 1: Geometric Design
- Vol. 2: Hydrology and Hydraulics Design
- Vol. 3: Pavement Design
  - Part I: Flexible Pavement
  - Part II: Rigid Pavement
  - Part III: Gravel Roads
  - Part IV: Pavement Rehabilitation Guide
- Vol. 4: Bridge Design

The latest version of the manual was published in July 2005 and this supersedes the manual of November 1994.

The Road Design Manual is intended for use in the design of all rural roads in Uganda. The purpose of the manual is to give guidance and recommendations to the engineers responsible for the design of rural roads. Accordingly, as only limited description is available for urban roads in the manual, it would be necessary to refer to other design standards and manuals (such as AASHTO and Japanese Urban Road Standard) to set out some specific parameters which are not stipulated in Road Design Manual in Uganda.

2) Geometric Design Parameters

Geometric design standard was prepared as a part of the Road Design Manual in Uganda. Summary of geometric design parameters for paved road in urban and peri-urban areas are shown in Table 7.1.1. There are six design classes of road defined in the standard, i.e., design classes I, II and III for bitumen surface roads and design classes A, B and C for gravel surface roads. The Road Design Manual recommends the application of design speed of 50 km/h in urban and peri-urban areas. In urban and peri-urban areas, however, design speed less than 50 km/h should be applied due to unavoidable reasons such as land acquisition and/or irremovable buildings. Hence, standards for design speeds of 40 km/h and 30 km/h are shown in the same table.

Table 7.2.1 Summary of Geometric Design Parameters in the Manual

Design Element	Unit	Urban/Peri-Urban							e-max: 4%	
		Paved Ia (Dual Carriageway)	Paved Ib	Paved II	Paved III	Gravel A	Gravel B	Gravel C		
Design Speed	km/h	50	50	50	50	50	50	50	40	30
Min. Stopping Sight Distance	m	60	58	58	60	60	60	60	45	30
Min. Passing Sight Distance	m	345	345	345	345	345	345	345	285	217
Min. Horizontal Curve Radius	m	100	100	100	100	100	100	100	60	35
Max. Gradient (desirable)	%	6	6	6	9	7	9	7	No Discription	No Discription
Max. Gradient (absolute)	%	8	8	8	11	9	11	9	No Discription	No Discription
Minimum Gradient in cut	%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-	-
Maximum Superelevation: e	%	4	4	4	4	4	4	4	-	-
Crest Vertical Curve stopping	K_{min}	9	9	9	9	9	9	9	5	3
Crest Vertical Curve passing	K_{min}	126	126	126	126	126	126	126	86	50
Sag Vertical Curve stopping	K_{min}	11	11	11	11	11	11	11	8	4
Normal Cross fall	%	2.5	2.5	2.5	2.5	4	4	4	-	-
Shoulder Cross fall	%	4	4	4	4	4	4	4	-	-
Right of Way	m	40	60	30	30	30	30	30	-	-

Source: Road Design Manual (Vol. 1: Geometric Design), July 2005

Table 7.2.2 Headroom

Road Class	Headroom (m)
A,B & C	5.0
Lower Road Class	4.5
Footway and Cycle way	2.5
Under High-power Cable	6.0
Under Low-power Cable	5.0

Source: Road Design Manual (Vol. 1: Geometric Design), July 2005

Finally, the Study Team recommends application of design speed of 40 km/h for the flyover because flyovers proposed by the Study Team are planned in built-up areas. Improvement to a constant high design speed would mean a substantial increase in construction cost with the commensurate increase in affected area. In addition, design speed for other roads without flyover is 50 km/h in accordance with the Road Design Manual in Uganda. Geometric parameters for design speed of 40 km/h and 50 km/h are shown below.

Table 7.2.3 Summary of Applicable Geometric Design Parameters for the Project

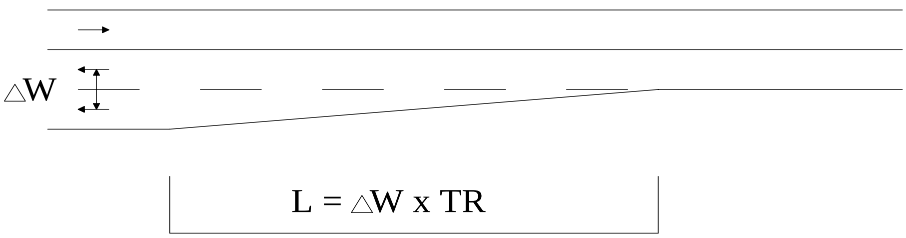
Design Element	Unit	Parameter		Remarks
Design Speed	km/h	40	50	Recommended Design Speed for the Flyover
Min. Stopping Sight Distance	m	45	60	Uganda Design Manual
Min. Passing Sight Distance	m	285	345	Uganda Design Manual
Min. Horizontal Curve Radius	m	60	100	Uganda Design Manual
Min. Length of Curve	m	70	80	Japanese Standard: Design Speed x 6sec.
Max. Radius for use of a spiral curve	m	150	290	Uganda Design Manual: $R > V^3/432$
Spirals Lengths	m	R=60→L=53m, R=80→L=40m R=100→L=32m, R=120→L=27m R=150→L=21m	R=100→L=62m, R=150→L=41m R=200→L=31m, R=250→L=25m R=290→L=22m	SATCC 1998: $L=0.0702 \times V^3/(R \times C)$ C: Rate of increase in centripetal acceleration (m/s3); $1<C<3$ (1.438 is recommended)
Max. Gradient (desirable)	%	6	6	Uganda Design Manual
Max. Gradient (absolute)	%	8	8	Uganda Design Manual
Crest Vertical Curve stopping	K_{min}	5	9	Uganda Design Manual
Crest Vertical Curve passing	K_{min}	86	126	Uganda Design Manual
Sag Vertical Curve stopping	K_{min}	8	11	Uganda Design Manual
Max. Superelevation (e)	%	4	4	Uganda Design Manual
Normal Cross fall	%	2.5	2.5	Uganda Design Manual
Shoulder Cross fall	%	4	4	Uganda Design Manual

Source: JICA Study Team

Table 7.2.4 Minimum Length for Diverging Section (Transition Rate: TR)

Decrease or Increase of lane number (Source: Japanese Standard)

Design Speed (km/h)	Rural Area	Urban and Peri-urban Area
80	1/50	1/40
60	1/40	1/30
50	1/30	1/25
40	1/25	1/20
30	1/20	1/15
20	1/15	1/10



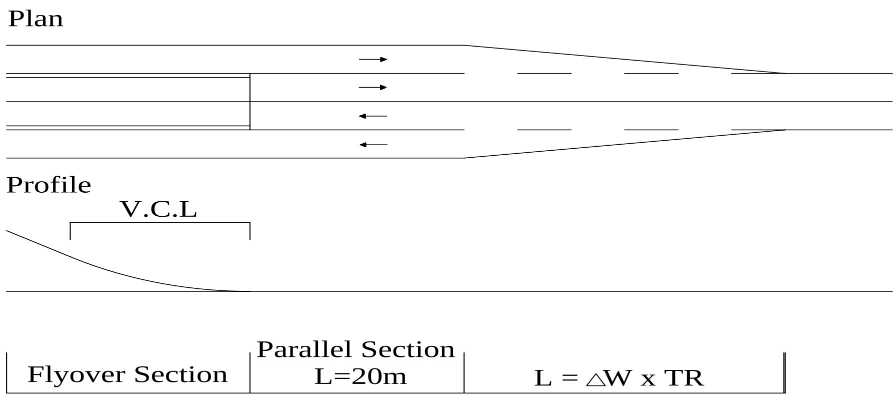
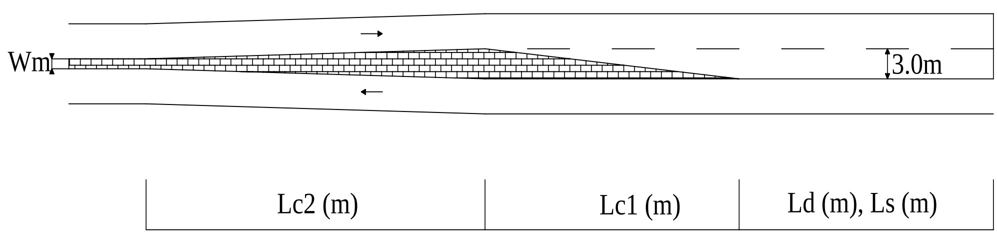


Figure 7.2.3 Merging and Diverging with Flyover (Source: Japanese Standard)

In addition, for reasons of economy, junction design speed should be set at 30 km/h (design speed of roads minus 20 km/h). Main design parameters for junction are as follows:



Wm: Median Strip Width
Lc1 = Length of diverging section: min. 30 m
Ld = Length of deceleration section: min. 30 m
Ls = Length of staking (storage) section: min. 10 m
Lc2 = Ghost Island taper: min 10 x ΔW (lateral transition width)

Source: JICA Study Team

Figure 7.2.4 General Configuration for Right Turn Lane

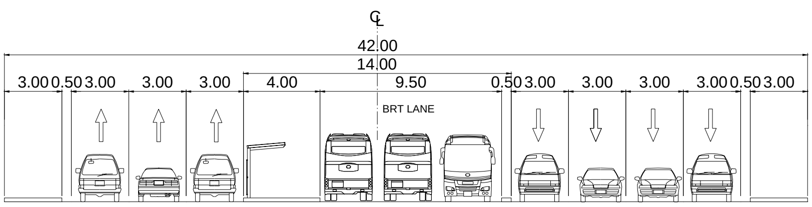
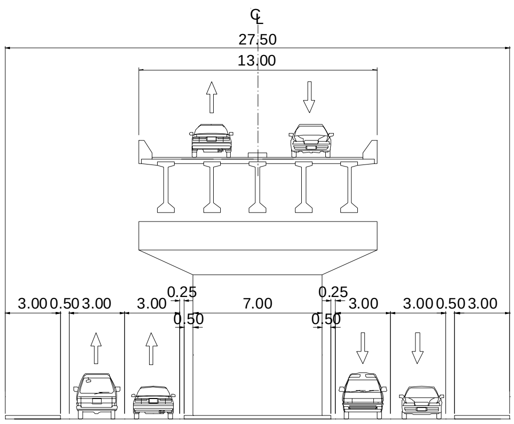
Table 7.2.5 Width of Channel for Right and/or Left Turn (Semi-trailer Class)

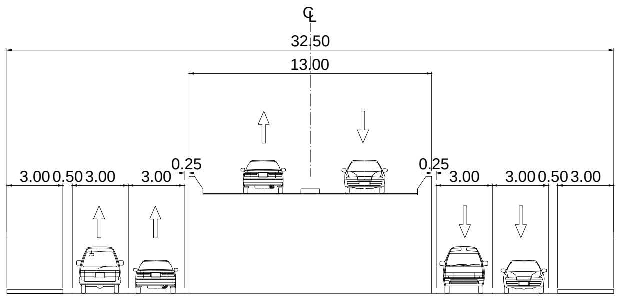
Outside Radius (m)	Design Vehicle
	Semi-trailer
8 to 9	N/A
9 to 12	N/A
12 to 13	N/A
13 to 14	8.5
14 to 15	8.0
15 to 16	7.5
16 to 17	7.0
17 to 19	6.5
19 to 21	6.0
21 to 25	5.5
25 to 30	5.0
30 to 40	4.5
40 to 60	4.0
60	3.5

Source: Geometric Standard of Japan

3) Typical Cross Sections for Road Improvement

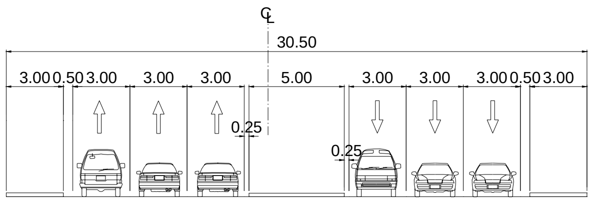
The Study Team set out the typical cross sections for relevant roads as shown in the figures below based on the geometric design standards in Uganda, Final Report for the BRT and required lane number for relevant intersections derived from calculation.

<table>
<tr><th>Typical Cross Sections</th><th>Description</th></tr>
<tr><td>
</td><td>Jinja Road
(Station section for the BRT: Between Africana Roundabout and Jinja Junction)</td></tr>
<tr><td>
</td><td>Yusufu Lule Road
(Flyover section)</td></tr>
</table>



Yusufu Lule Road

(Approach Section)



Access Road

(Flyover Section)

Source: JICA Study Team

Figure 7.2.5 Typical Cross Sections for Existing Road Improvement

(3) Alternative Routes and Project Concept

1) Existing Traffic Condition at Bottleneck Points

Non-interrupted flow sections and interrupted flow sections exist on road. The former means high class roads (i.e., highway) in which access control is applied while the latter means low class roads which are provided with access to each road. Traffic congestion and delay on interrupted flow sections are usually caused by existence of an intersection and/or a roundabout.

In Kampala City, a rapid traffic volume increase has been generating some bottleneck points. Jinja, Clock Tower, Shoprite Intersection and Africana, Mukwano, Garden City Roundabout are notably located as main bottleneck points. Existing conditions of these junctions were evaluated as follows by use of the traffic survey results by the Study Team.

Table 7.2.6 Existing Conditions of Main Bottleneck Points

Indicator		Intersection			Roundabout		
		Jinja	Shoprite	Clock Tower	Africana	Mukwano	Garden City
Saturation	A.M.	1.15	1.72	1.01	-	-	-
	P.M.	1.10	1.07	1.03	-	-	-
Delay Time*	A.M.	-	-	-	158.7sec	37.8sec	1913.1sec
	P.M.	-	-	-	148.7sec	20.9sec	1089.7sec

*: per 15minutes

Source: JICA Study Team

Evaluation indicators are respectively different for an intersection and a roundabout. A signalized intersection is normally evaluated by use of saturation degree as follows:

Table 7.2.7 Evaluation of Signalized Junction by Saturation Degree

Saturation Degree	Situation
0.8 > S	Desirable Situation
$0.8 \leq S \leq 1.0$	Acceptable Situation
1.0 < S	Capacity Shortage (Bottleneck)

Source: JICA Study Team

On the other hand, according to the Highway Capacity Manual (HCM), a roundabout is evaluated by level of service (LOS) derived from control delay for each lane. LOS criteria are given in Table 7.2.8 below:

Table 7.2.8 Level-of-Service Criteria for Roundabouts

Level of Service (LOS)	Average Control Delay (s/veh)
A	0 - 10
B	10 - 15
C	15 - 25
D	25 - 35
E	35 - 50
F	>50

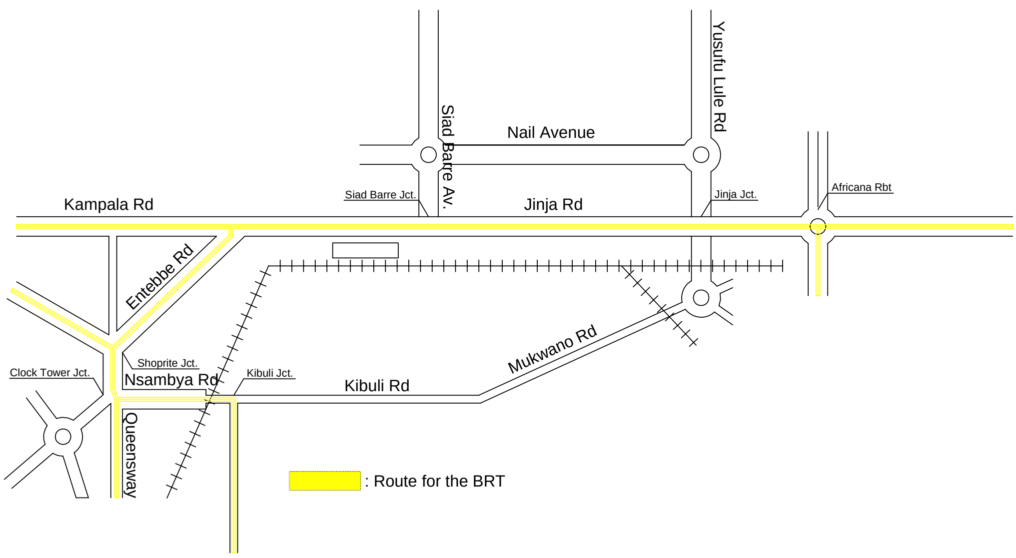
*Delay: Definition of delay is a time lag between non-interrupted flow (case of no interrupted facilities such as intersection) and interrupted flow.

Source: Highway Capacity Manual

The computed results for Jinja, Shoprite and Clock Tower indicate that intersection capacity is not sufficient for the existing traffic volume. Additionally, saturation degree which is over 1.0 means the impossibility to control by existing configuration such as lane number and phasing of the traffic signal. The LOS of Africana Roundabout and Garden City Roundabout is categorized into level “F”. The HCM recommends at least level “C” in urban area.

2) Considerable Future Plan (BRT)

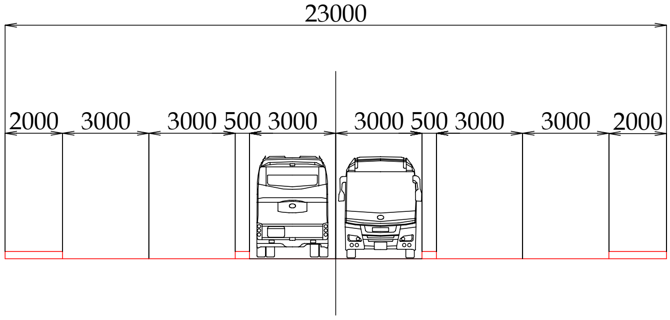
The Ugandan government and World Bank are now studying the introduction of the BRT in Kampala City. According to the Interim Report, the BRT is introduced on the following roads:



Source: JICA Study Team

Figure 7.2.6 BRT Routes Proposed by BRT Pre-FS in Final Report (May 2010)

As regards lane number for general vehicles, 2-lane for each direction will be allocated. However, shoulders and on-parking spaces will disappear (see figure below). Additionally, the usage of Entebbe/Kampala Junction by public vehicles will be restricted.



Source: JICA Study Team

Figure 7.2.7 Typical Cross Section with BRT at Off Station Section

For these reasons, as discussed in Chapter 5, traffic between the CBT and Jinja side will be diverted from Kampala Road to Nile Avenue-Yusufu Lule Road and/or Nsambya Road-Mukwano Road.

3) Project Concepts and Alternatives

The flyover project concept is dictated by the required road functions. Given the above mentioned situations, the required road functions are defined as follows:

- To increase traffic capacity at bottleneck points,
- To accommodate future traffic demand and flow,
- To consider the future plan such as the BRT,
- To consider minimizing the negative impacts to social environment, and

Finally, based on the above concepts:

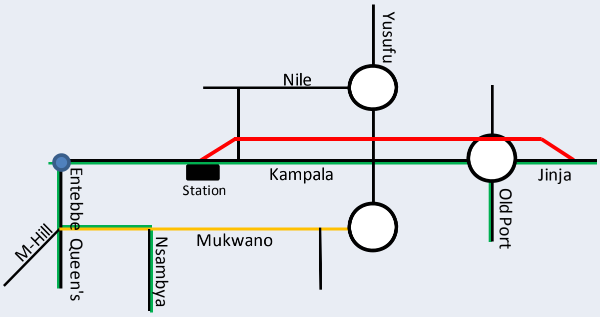
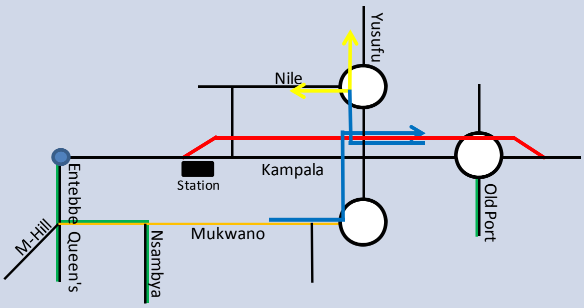
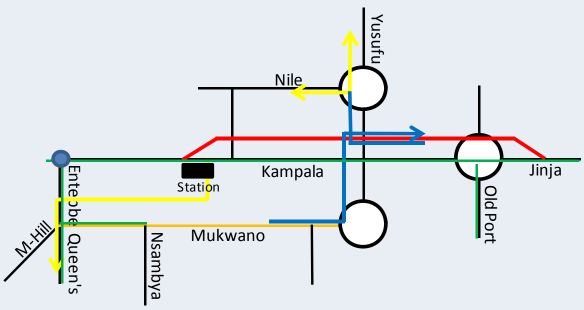
- To create smooth traffic flow in urban area

The following alternatives were proposed as scenarios corresponding to the concepts of the flyover project as mentioned above.

A: Jinja Road – Kampala Road - Queens Way-Yusufu Lule Road Flyovers

The purpose of Jinja – Kampala Roads (J-K) Flyover is basically to provide a substantial traffic jam solution for Africana Roundabout, Jinja Intersection and Siad Barre Avenue Intersection by continuously crossing over these three junctions. Also, three Flyovers are added for right turn traffic, i.e., from Jinja Road to Yusufu Lule Road and Nile Avenue and from Mukwano Road to Jinja Road, which are often interrupted by the BRT. J-K Flyover together with these three Flyovers will fulfill such function.

Additionally, the purpose of Kampala Road – Queen’s Way (K-Q) Flyover is to alleviate the traffic jam at Shoprite Intersection and Clock Tower Intersection through a bypass that partially accomodates the south-north traffic between Kampala Road and Clock Tower Junction.

Phase	Jinja-Kampala-Yusufu Lule + Kampala-Queen's Way Flyovers	
1		J↔K Flyover starts from the front of the central station park then overpassing Siad Barre Intersection and lands at about 450 m after Africana Roundabout. Route of J-K Flyover overlaps the BRT Pilot Project Route proposed by WB. Project Length: 1,960 m of which Bridge and Retaining Wall Section: 1,560 m
2		2-1: J→Y Flyover, M→J Flyover 2-2: Y→N Flyover These three Flyovers accommodate the right-turn traffic which is interrupted by the BRT. J-Y Flyover diverges from J-K Flyover and lands in front of the Golf Course Hotel. Y-N Flyover diverges from J-Y Flyover and lands at Nile Avenue. M-J Flyover starts from the crossing point of Press House Road on Mukwano Road. and converges to J-K Flyover. Project Length: 2,290 m of which Bridge and Retaining Wall Section: 2,085 m
3		K→Q Flyover starts from central station park and connects to Queen's way through railway land. K-Q Flyover is operated as one-way from north to south and plays a role of a bypass for the section between Kampala Road and Clock Tower Junction. Project Length: 1,800 m of which Bridge and Retaining Wall Section: 1,740 m

2-way Main Road 2-way Flyover 1-way Flyover BRT Route No through zone

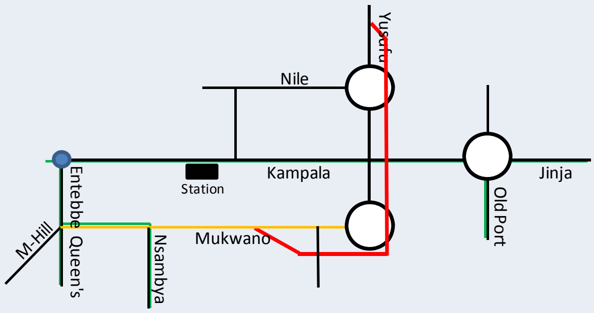
Source: JICA Study Team

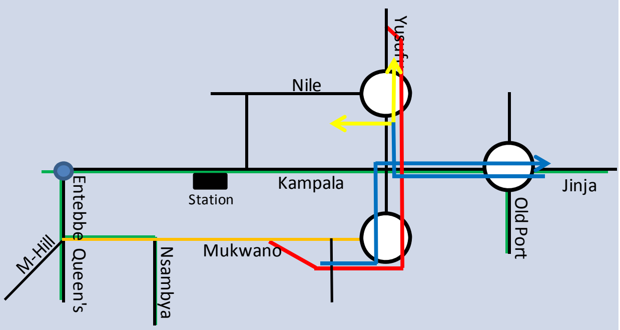
Figure 7.2.8 Alternative and Options for J-K-Q-Y Flyover

B: Yusufu Lule – Mukwano – Jinja + Clock Tower Flyovers

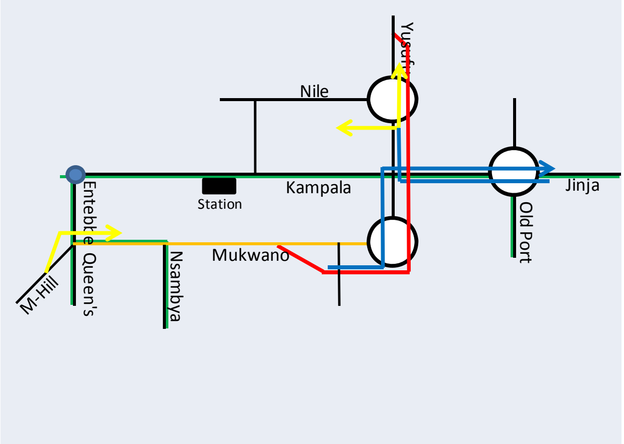
The purpose of Yusufu Lule – Mukwano Roads (Y-M) Flyover is basically to provide a substantial traffic jam solution to the future traffic demand and flow by overpassing Jinja Intersection, Garden City Roundabout and Mukwano Roundabout. Also, three Flyovers are added for right turn traffic (from Jinja to Yusufu and Nile, from Mukwano to Jinja) which is interrupted by the BRT. Y-M Flyover together with these three Flyovers will fulfill such function.

Additionally, the purpose of Clock Tower Flyover is to alleviate the traffic jam at Clock Tower Intersection because main traffic flow will be changed from south-north to east-west under the new restriction of the introduction of the BRT.

<table>
<tr><th>Phase</th><th colspan="2">Yusufu-Mukwano-Jinja + Clock Flyover</th></tr>
<tr><td>1</td><td>
</td><td>Y↔M Flyover overpasses Jinja Junction, Garden City Roundabout and Mukwano Roundabout. In this plan, north-south line (Yusufu Lule Road-Mukwano Road) is supposed to be a main traffic line and is linked by continuous 2-lane bridge. This bridge starts in front of Kampala Golf Course and lands on the widened Mukwano Road.

Project Length: 1,660 m
of which
Bridge and Retaining Wall Section: 1,550 m</td></tr>
<tr><td>2</td><td>
</td><td>2-1:
J→Y Flyover
M→J Flyover
2-2:
Y→N Flyover
Functions of these three Flyovers are same as J-K's Flyovers. J-Y Flyover overpasses Africana Roundabout, Jinja Intersection and Garden City Roundabout and then converges to Y-M flyover. Y-N Flyover diverges from J-Y Flyover and lands at Nile Avenue. M-J Flyover diverges from Y-M Flyover and overpasses Mukwano Roundabout, Jinja Junction and Africana Roundabout.

Project Length: 2,245 m
of which
Bridge and Retaining Wall Section: 2,190 m</td></tr>
</table>

3		Clock Tower Flyover shares the traffic flow which crosses from west to east on Clock Tower Intersection. It starts from Mengo Hill Road and overpasses Clock Tower Intersection and then lands before the level crossing on Nsambya Road. Project Length: 550 m of which Bridge and Retaining Wall Section: 300 m

2-way Main Road — 2-way Flyover — 1-way Flyover — BRT Route — No through zone

Source: JICA Study Team

Figure 7.2.9 Alternative and Options for Y-M-J+Q Flyovers

7.2.2 EVALUATION OF ALTERNATIVE PLANS

(1) Evaluation Method and Criteria

The most preferable route is examined in this sub-chapter. Selection of preferable route should not only consider the economic viewpoint but also take into account the negative impact to social environment and project effect to decongestion. Hence, the most preferable route is selected based on the following criteria.

Table 7.2.9 Criteria for Selection of Preferable Route and Option

Main Criteria	Sub-Criteria and Description
Consistency with the BRT	✓ Consistency during construction stage ✓ Any conflict such as necessary road width
Social Environment	✓ Number of resettlement and buildings to be demolished - Private - Public ✓ Area of land acquisition - Private - Public
Economic Efficiency	✓ Project cost ✓ Hypothetical obligation cost: Simple comparative indicator for decision of priority in projects. Formula: Project cost/c.p.u.-km
Traffic Demand	✓ Future traffic demand
Contribution to Decongestion	✓ Saturation at intersection ✓ Delay time at roundabout

Source: JICA Study Team

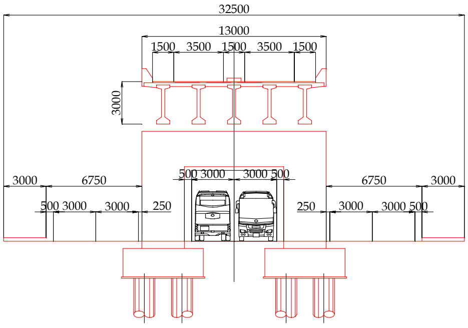
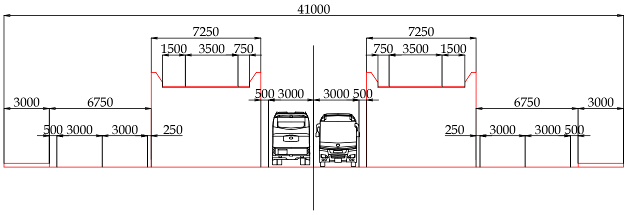
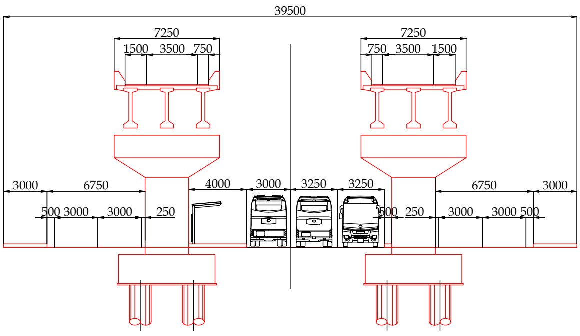
(2) Evaluation and Comparison of both Flyover Projects

1) Coordination with the BRT Pilot Project

As mentioned before, the BRT will be introduced at Kampala Road and Jinja Road as a pilot project. Decongestion is also one of the purposes of the BRT project. Hence, collaboration and harmonization between the BRT project and flyover project are key issues for the success of decongestion in the urban area of Kampala. Issues between the BRT and both flyover projects

(JKY+KQ and YMJ+C) are shown in following table to avoid conflicts.

Table 7.2.10 Coordination with the BRT Plan

	JKY+KQ Flyover	YMJ+C Flyover
Route	J-K Flyover overlaps the BRT Pilot Project route.	Right turn Flyovers (J-Y Flyover and M-J Flyover) overlap BRT Pilot Project route.
Plan & Design	Detailed data such as exact location of stations, configuration and exact cross section are required for the design of J-K-Q-Y Flyover. Hence, design of flyover should await the completion of the detailed design of the BRT.	Design of flyover can proceed based on assumptive conditions.
Cross Section	 Normal Bridge Section W=32.5 m  Approach Section W=41.0 m  At Station Section W=39.5 m	Typical cross sections in Sub-chapter 7.2.3 are applied.
Construction	J-K Flyover must be constructed together with the BRT Pilot. It means that it is necessary to prepare budget for flyover together with the BRT Project.	Y-M Flyover will not be dependent on the BRT Pilot Project.

Source: JICA Study Team

2) Social Environment

So far, J-K Flyover has the most negative impact to social environment. Demolition of 14 high buildings along Kampala Road and Jinja Road (between Entebbe/Kampala Intersection and Jinja Intersection) is required for the construction of J-K Flyover with the BRT. If the BRT project is cancelled, demolition of 14 buildings might be avoided because typical cross section fits within the existing road width. Negative impacts to social environment by other flyover and Flyovers are not so significant. Most of the buildings required to be demolished for flyover and Flyover construction are properties of the government. Note that the area and number of buildings in this sub-chapter are rough estimations for purposes of comparison. Hence, this result is not the final data for the resettlement in this project.

Table 7.2.11 Impact on Social Environment

Phase	Flyover Name	Building demolition (no.)					Land Acquisition		
		Private				Public	Private		Public
		Buildgs		Houses					
I	J-K Flyover	14	Jinja Rd	3	Mogas	1 house (MOWT) 1 house (MOL) 1 house (U.E.C.***)	4,315m2		5,730m2
II	J-Y Right Turn Ramp M-J Right Turn Ramp Y-N Left Turn Ramp	0	-	0	-	2 houses (MOWT) 3 houses (U.E.C.***) 1 Power Transformer	4,340m2	(Railway:1,410m2)	11,120m2
III	K-Q Flyover	2	Central Station (part)	0	-	-	25,270m2	(Railway: 25,270m2)	2,860m2
Total (1)*		**16**		**3**		**9**	**33,925m2**	**(26,680m2)**	**19,710m2**
Total (2)**		**2**		**0**		**8**	-	-	-
I	Y-M Flyover (Dual)	0	-	0	-	-	18,090m2	(Railway:2,680m2)	340m2
I'	Y-M Flyover (Single)	0	-	0	-	-	13,485m2	(Railway:2,215m2)	210m2
II	J-Y Right Turn Ramp	0	-	2	-	5 houses (MOWT) 4 houses (MOL)	11,375m2		9,315m2
	M-J Right Turn Ramp		-		-	4 houses (U.E.C.***) 1 Power Transformer			
	Y-N Left Turn Ramp		-		-	-			
III	Clock Tower Flyover	1	Uganda Telecom	0	-	1 Posta Uganda	1,750m2		2,500m2
Total (1)*		**1**		**2**		**15**	**31,215m2**	**(4,895m2)**	**12,155m2**
Total (2)**		**1**		**2**		**11**	-	-	-

*Total (1): With BRT Project
**Total (2): Without BRT Project
*U.E.C.: Uganda Electral Commision
Source: JICA Study Team

3) Economic Efficiency

Economic efficiency is evaluated by project cost and hypothetical obligation cost. The cost estimation for Flyover Project is conducted considering the possibility of international competitive bidding (ICB). Note that project cost in this sub-chapter is only a rough estimation for purposes of comparison. Hence, this project cost is not the finalized project cost.

Table 7.2.12 Economic Efficiency

Phase	Flyover Name	Construction Cost	DD/CS (5%)	Resettlement			Project Cost (a)	pcu/day (Y2023)	pcu-km/day (b)	Obligation Cost (a)/(b)x20-year US$/pcu-km	
				Building Compensation	Land Acquisition	Sub-Total					
		Amount (M US$)	Amount (M US$)	Amount (M US$)	Amount (M US$)	Amount (M US$)	Amount (M US$)			US$	Average
I	J-K Flyover	48.7	2.4	14.2	1.6	18.1	66.8	6,116	11,620	0.79	**0.52**
II	J-Y Right Turn Ramp	30.7	1.5	0.0	1.6	3.1	33.8	3,540	3,540	0.56	
	M-J Right Turn Ramp							2,700	2,430		
	Y-N Left Turn Ramp							5,900	2,360		
III	K-Q Flyover	28.9	1.4	2.0	9.1	12.5	41.4	13,700	24,660	0.23	
Total		108.3	5.4	16.2	12.2	33.8	**142.0**	-	-	-	
I	Y-M Flyover (Dual)	47.5	2.4	0.0	6.5	8.9	56.4	9,635	16,380	0.47	**0.36**
I'	Y-M Flyover (Single)	36.5	1.8	0.0	4.9	6.7	43.1	9,635	16,380		
II	J-Y Right Turn Ramp	30.7	1.5	0.1	4.1	5.7	36.4	7,730	7,730	0.24	
	M-J Right Turn Ramp							9,700	8,730		
	Y-N Left Turn Ramp							9,900	3,960		
III	Clock Tower Flyover	6.0	0.3	1.0	0.6	1.9	7.9	15,900	4,770	0.23	
Total		84.2	4.2	1.1	11.2	16.5	**100.8***	-	-	-	

*Typical cross section of dual carriageway is considered in the project cost.
Source: JICA Study Team

Hypothetical obligation cost is a simple indicator for deciding the prioritization of projects. Value of hypothetical obligation cost per se has no meaning; smaller value indicates a high priority.

4) Traffic Demand

The highest demand is observed in Clock Tower Flyover followed by the K-Q Flyover. This indicates that bypasses through Clock Tower Intersection and Shoprite Intersection are required. From comparison of both main flyovers (J-K-Y and Y-M-J), traffic demand of Y-M-J Flyover is approximately 1.5 times that of J-K-Y Flyover. In the comparison of both projects, average traffic demand of Y-M-J+Q Flyover Project is higher than that of J-K-Q-Y Flyover Project, as expected.

Table 7.2.13 Criteria for Selection of Preferable Route and Option

Phase	Flyover Name	Project Length	Traffic Volume	
			pcu/day (Y2023)	pcu-km/day
I	J-K Flyover	1,960m	6,116	11,620
II	J-Y Right Turn Ramp	2,290m	3,540	3,540
	M-J Right Turn Ramp		2,700	2,430
	Y-N Left Turn Ramp		5,900	2,360
III	K-Q Flyover	1,800m	13,700	24,660
	Average		7,435	
I	Y-M Flyover	1,660m	9,635	16,380
II	J-Y Right Turn Ramp	2,245m	7,730	7,730
	M-J Right Turn Ramp		9,700	8,730
	Y-N Left Turn Ramp		9,900	3,960
III	Clock Tower Flyover	550m	15,900	4,770
	Average		9,667	

Source: JICA Study Team

5) Contribution to Decongestion

The most important purpose of flyover project is to contribute to decongestion in urban area. Contribution to decongestion by flyover is evaluated by the situation of traffic jam at junctions and roundabouts. Both flyover projects have great effect on alleviation of traffic jam at intersections and/or roundabouts. YMJ+C Flyover Project showed high advantage at three intersections and/or roundabouts. On the other hand, JKY+KQ Flyover Project showed high advantage at two roundabouts. In both cases, however, alleviation of traffic jam at Mukwano Roundabout will be difficult because a large number of traffic is concentrated on Mukwano Road due to the introduction of the BRT.

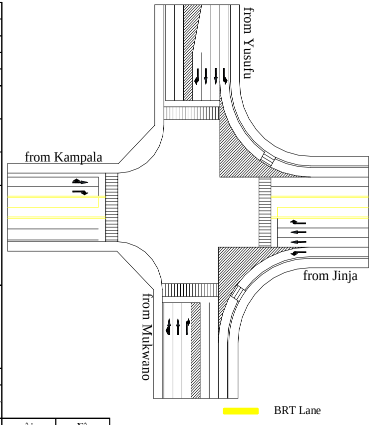
Table 7.2.14 Change of Saturation and Delay Time by Flyover

Intersection And Roundabout	Y2010	Y2023		
	Traffic Survey Results	With BRT & Intersection Improvement Without Flyover	With BRT & Intersection Improvement & JKY+KQ Flyover	With BRT & Intersection Improvement & YMJ+C Flyover
Jinja	1.14	1.71	0.86	0.72
Clock Tower	1.04	0.93	0.96	0.60
Shoprite	1.97	0.81	0.78	0.78
Africana	158.7s	27.4s	8.4s	9.9s
Mukwano	37.8s	409.3s	143.6s	190.1s
Garden City	1913.1	108.1s	33.4s	23.2s

Source: JICA Study Team

Name of Intersection: Jinja Junction (L=60m)
Scale of Intersection: Large (K=3)
Number of Pedestrian: Small (f_L=0.85)

Approach	A		B			C			D			λi	Σλ
	from Kampala Rd		from Yusufu Lule Rd			from Jinja Rd			from Mukwano Rd				
	LT+TR	RT	LT	TR	RT	LT	TR	RT	LT+TR	TR	RT		
Number of Lane	1	1	1	2	1	1	2	1	1	1	1		
Basic value of saturation flow rate	2000	1800	1800	2000	1800	1800	2000	1800	2000	2000	1800		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
(Lane width: m)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
(Gradient: %)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
(Share of large vehicle: %)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
(Share of left turn: %)	0.00	-	-	-	-	-	-	-	0.00	-	-		
(E_{LT})	1.26	-	-	-	-	1.26	-	-	1.26	-	-		
(Effective green time: sec)	30.00	-	-	30.00	-	30.00	30.00	-	30.00	30.00	-		
(Green time for pedestrian: sec)	25.00	-	-	-	-	25.00	-	-	25.00	-	-		
Adjustment coefficient by pedestrian: fl	0.85	-	0.85	-	-	0.85	-	-	0.85	-	-		
Reduction Coefficient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
(Share of right turn: %)	-	-	-	-	-	-	-	-	-	-	-		
(Probability of right turn: f)	-	-	-	-	-	-	-	-	-	-	-		
(Effective green time: sec)	-	30.00	-	-	30.00	-	-	30.00	-	-	30.00		
(No. of right turn for transition time: K)	-	3.00	-	-	3.00	-	-	3.00	-	-	3.00		
Saturation flow ratio	2000	1800	1800	4000	1800	1778	4000	1800	2000	2000	1800		
Traffic volume (pcu/hr)	403	0	1019	755	0	1557	682	130	558	558	304		
(Left turn or Right turn)	0	0	1019	-	0	1557	-	130	0	-	304		
Flow ratio	0.20	0.00	-	0.19	0.00	-	0.17	0.07	0.28	0.28	0.17	λi	Σλ
Phase ratio phase-1	0.20	-	-	-	-	-	0.17	-	-	-	-	0.20	0.72
Phase ratio phase-2	-	0.00	-	-	-	-	-	0.07	-	-	-	0.07	
Phase ratio phase-3	-	-	-	0.19	-	-	-	-	0.28	0.28	-	0.28	
Phase ratio phase-4	-	-	-	-	0.00	-	-	-	-	-	0.17	0.17	



Source: JICA Study Team

Figure 7.2.10 Required Configuration and Lane Number of Jinja Junction (YMJ+C Flyover)

(3) Multi Criteria Analysis (MCA)

Taking the above evaluation factors into account, the multi-criteria analysis (MCA) methodology was adopted in deciding which alternative, either J-K-Y+KQ Flyovers of the original plan in Interim Report I or an alternative plan of Y-M-J Flyovers + Clock Tower Flyover in this Interim Report II, has greater advantages.

The weights and 5-grade scoring criteria for each factor are as shown in the following table. The largest weight of 30% was given to engineering factors that evaluate how effective the subject flyovers are to reduce traffic congestion on Jinja and Clock Tower junctions. Factors for coordination with the BRT plan, socio-economic effectiveness and environmental negative impacts are given 20%, 30% and 20%, respectively. These factors were tested for sensitivity as explained hereafter.

Table 7.2.15 Evaluation Factor and Weight

Grade Scoring at Five Levels (5: Highest, 1: Lowest)

Grade	Engineering Factors (Saturation Degree*)		Coordination with BRT Plan	Socio-Economic Factors		Environmental Impacts	
	30%		20%	30%		20%	
	(Jinja Jct)	(Clock Tower Jct)		Traffic Volume (pcu/km)	Project Cost (US$ Mill)	Land Acquisition (m^2)	Resettlement Requirements (No. of buildings)
Weight	15.0%	15.0%	20.0%	15.0%	15.0%	10.0%	10.0%
5	< 0.70 (Most Desirable)	< 0.70 (Most Desirable)	Assist/Support BRT Operation	>10000	< 70	< 20000	< 5
4	0.70 - 0.80 (More Desirable)	0.70 - 0.80 (More Desirable)	No Conflict with BRT Operation	8000 - 10000	70 - 90	20000 - 30000	5 - 10
3	0.80 - 0.90 (Desirable)	0.80 - 0.90 (Desirable)	Minor Conflict with BRT Operation	6000 - 8000	90 - 110	30000 - 40000	10 - 15
2	0.90 - 1.00 (Acceptable)	0.90 - 1.00 (Acceptable)	Conflict with BRT Operation	4000 - 6000	110 -130	40000 - 50000	15 - 20
1	> 1.00 (Shortage of Capacity)	> 1.00 (Shortage of Capacity)	Serious Conflict with BRT Operation	< 4000	> 130	>50000	> 20

Note: * evaluation of junctions saturation base on Japanese Standards with some modification but the Study Team

Source: JICA Study Team

The above factors were scored using a 5-level scale based on the above criteria as shown in Table 7.2.16.

Table 7.2.16 Evaluation of 5-Grade Scores

Grade Scoring at Five Levels (5: Highest, 1: Lowest)

Plan	Project Name	Engineering Factors (Saturation)		Coordination with BRT Plan	Socio-Economic Factors *		Environmental Impacts		Total	Evalution by Grade Scoring	Remarks
		30%		20%	30%		20%		(evaluated score with weight)		
		(Jinja Jct)	(Clock Tower Jct)		Traffic Volume	Project Cost	Land Acquisition	Resettlement Requirements			
Weight		15.0%	15.0%	20.0%	15.0%	15.0%	10.0%	10.0%	100.0%		
Original Plan in IR-1	J-K-Q-Y Rds Flyover	3 (0.85)	4 (0.79)	2	3 (7,435)	1 (143)	1 (53,6335)	1 (28)	2.25	2	Needed to construct with BRT
Alternative Plan in IR-2	Y-M-J Flyover + C Flyover	4 (0.75)	5 (0.60)	5	4 (9,668)	3 (101)	3 (43,370)	3 (18)	4.00	1	
Average		3.50	4.50	3.50	3.50	2.00	2.00	2.00	3.13		

Note: * As EIRR (Economic Internal Rate of Return) is not available, traffic volume and project cost, which are key factors for EIRR calculation, are used.

Source: JICA Study Team

The 5-grade scoring is a factor-specific independent evaluation that does not consider the possible biases which may exist among other factors. Thus, initial scoring was normalized to MCA scores in order that average scores would have equal basis for all factors (Table 7.2.17).

Table 7.2.17 Multi Criteria Analysis Scores

Multi Criteria Analysis (MCA) Results with Weighted Index

Plan	Project Name	Engineering Factors (Saturation)		Coordination with BRT Plan	Socio-Economic Factors*		Environmental Impacts		Total (MCA Score)	Order of Priority by MCA	Remarks
		30%		20%	30%		20%		(evaluated score with weight)		
		(Jinja Jct)	(Clock Tower Jct)		Traffic Volume	Project Cost	Land Acquisition	Resettlement Requirement			
Weight		15.0%	15.0%	20.0%	15.0%	15.0%	10.0%	10.0%	100.0%		
Original Plan in IR-1	J-K-Q-Y Rds Flyover	12.9	13.3	11.4	12.9	7.5	5.0	5.0	68.0	2	Needed to construct with BRT facilities
Alternative Plan in IR-2	Y-M-J Flyover + C Flyover	17.1	16.7	28.6	17.1	22.5	15.0	15.0	132.0	1	

Source: JICA Study Team

Sensitivity tests were carried out by changing the weights allocated to the main and sub-factors, especially in terms of the BRT plan, as indicated in Table 7.2.18. Case 1 gave 50% to the engineering factors and Case 2 gave 40% to the socio-economic factors while neglecting the coordination with the BRT factor.

Table 7.2.18 Sensitivity Tests for Multi Criteria Analysis (MCA)

Evaluation Main Factor	Sub-Factor	Distribution of Score			MCA Score Comparison					
					Original Plan in IR-1 (JKQY)			Alternative Plan in IR-2 (YMJ +		
		Standard	Case 1	Case 2	Standard	Case 1	Case 2	Standard	Case 1	Case 2
Engineering Factors	Jinja Jct	15.0%	25.0%	20.0%	12.9	21.4	17.1	17.1	28.6	22.9
	Clock Tower Jct	15.0%	25.0%	20.0%	13.3	22.2	17.8	16.7	27.8	22.2
	Sub-Total	30.0%	50.0%	40.0%	26.2	43.7	34.9	33.8	56.3	45.1
Coordination with BRT Plan		20.0%	**0.0%**	**0.0%**	11.4	**0.0**	**0.0**	28.6	**0.0**	**0.0**
Socio-Economic	Traffic Volume	15.0%	15.0%	20.0%	12.9	12.9	17.1	17.1	17.1	22.9
	Project Cost	15.0%	15.0%	20.0%	7.5	7.5	10.0	22.5	22.5	30.0
	Sub-Total	30.0%	30.0%	40.0%	20.4	20.4	27.1	39.6	39.6	52.9
Environmental Impacts	Land	10.0%	10.0%	10.0%	5.0	5.0	5.0	15.0	15.0	15.0
	Resettlement	10.0%	10.0%	10.0%	5.0	5.0	5.0	15.0	15.0	15.0
	Sub-Total	20.0%	20.0%	20.0%	10.0	10.0	10.0	30.0	30.0	30.0
Total		100.0%	100.0%	100.0%	68.0	74.0	72.1	132.0	126.0	127.9

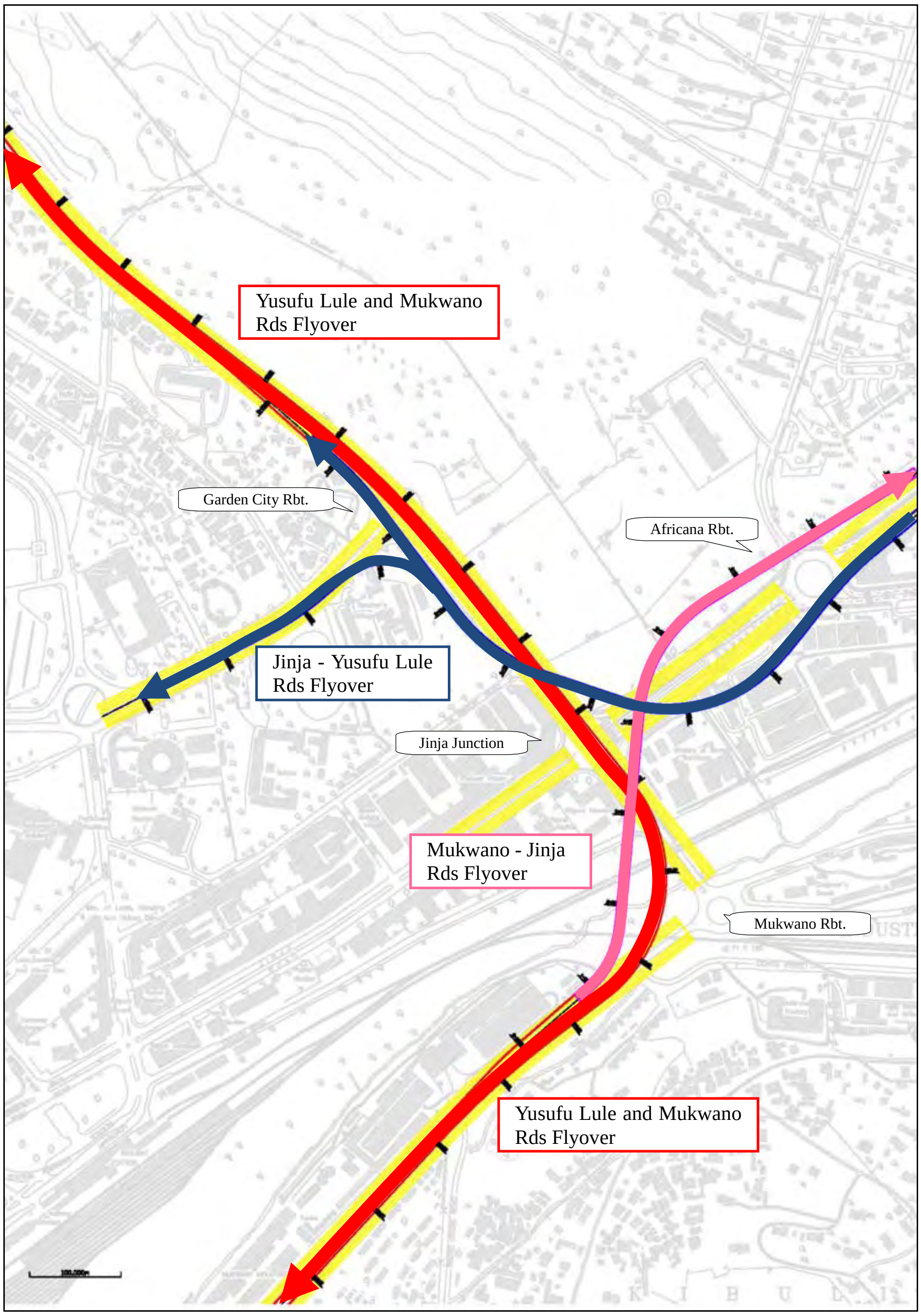
Source: JICA Study Team

All evaluations in the above tables indicate that the package of the Y-M-J Flyover + Clock Tower Flyover Project has more advantages compared to the J-K-Y+KQ Flyover Project. Hence, the Study Team recommends conducting the preliminary design and implementation plan study for the Y-M-J Flyover + Clock Tower Flyover Project.

7.2.3 ALTERNATIVE STRUCTURE PLANS

(1) Overall Flyover Plan

The purpose of flyover construction is to alleviate the serious traffic jam at the Kampala urban center. In particular, traffic capacity increase by flyover construction is one of the best solutions for traffic decongestion at Africana, Jinja, Garden City and Mukwano Junction/Roundabouts.



Source: JICA Study Team

Figure 7.2.11 Jinja Junction Flyover Plan

Three flyover crossings are required as follows:

➢ Yusufu Lule and Mukwano Roads Flyover (Y-M Flyover)

- ✓ Railway
- ✓ Mukwano Roundabout
- ✓ Nakivubo Channel
- ✓ Railway
- ✓ Jinja Junction with Right turn lane
- ✓ Garden City Roundabout.

➢ Mukwano – Jinja Roads Flyover (M-J Flyover)

- ✓ Railway
- ✓ Nakivubo Channel
- ✓ Railway
- ✓ Yusufu Lule Road and Y-M Flyover
- ✓ Jinja Road with BRT
- ✓ Africana Roundabout

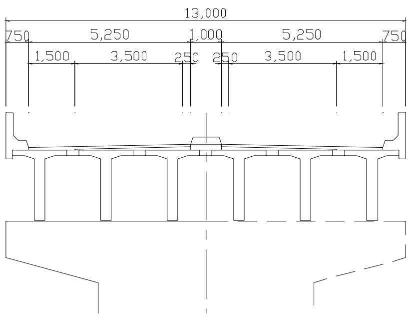
➢ Jinja – Yusufu Lule Roads Flyover (J-Y Flyover)

- ✓ Africana Roundabout.
- ✓ Jinja Road with BRT and M-J Flyover
- ✓ Yusufu Lule Road and Y-M Flyover
- ✓ Garden City Roundabout

(2) Typical Cross Section for Flyover

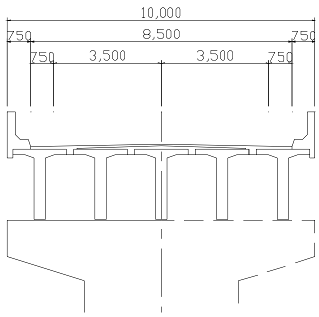
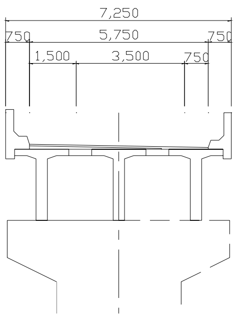
Based on the geometric design standards in Uganda and preliminary planning of the projects, the Study Team has set out the typical cross sections for flyover projects as shown in Tables 7.2.19 – 7.2.20.

Table 7.2.19 Typical Cross Section of Flyovers (1)

Typical Cross Section	Description
	**Yusufu Lule and Mukwano Roads Flyover:** 2-lane dual carriageway with 1.00 m median strip, 0.25 m (right side) & 1.50 m (left side) shoulder widths. In the future, it is possible to operate it as 3-lane (reversible lane) by removal of median strip.

Source: The Study Team

Table 7.2.20 Typical Cross Section of Flyovers (2)

Typical Cross Section	Description
	**Mukwano – Jinja Roads Flyover,** **Jinja – Yusufu Lule Roads Flyover:** 2-lane single carriageway with 0.75 m shoulder width.
	**Jinja – Yusufu Lule Flyover (branch),** **Nile Avenue Flyover:** One-way Flyover with 1.5 m (left side) and 0.75 m (right side) shoulder widths.

Source: JICA Study Team

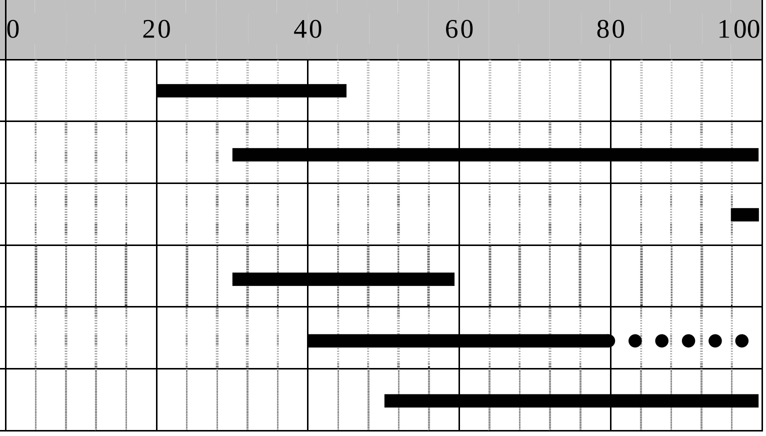
(3) Applicable Span Length

The most economical and common structure type in Uganda is PC girder. The applicable span lengths for the PC T girder bridge are between 20 and 45 m and described as follows:

The span arrangement and alignment layout are the key elements to determine the superstructure types. From our experiences in Uganda and other countries, the applicable superstructure types are i) Steel I Girder, ii) Steel Box Girder, iii) Steel Arch, iv) PC T Girder, v) PC Box Girder, and vi) PC Extra-dosed. Span length is predefined by the superstructure type. The table below shows the applicable span lengths for various superstructure types.

Table 7.2.21 Applicable Span Length by Bridge Type

Bridge Type		Applicable Span Length (m)
		0 20 40 60 80 100
PC	T Girder	
	Box Girder	
	Extra-dosed	
Steel	I Girder	
	Box Girder	
	Arch	

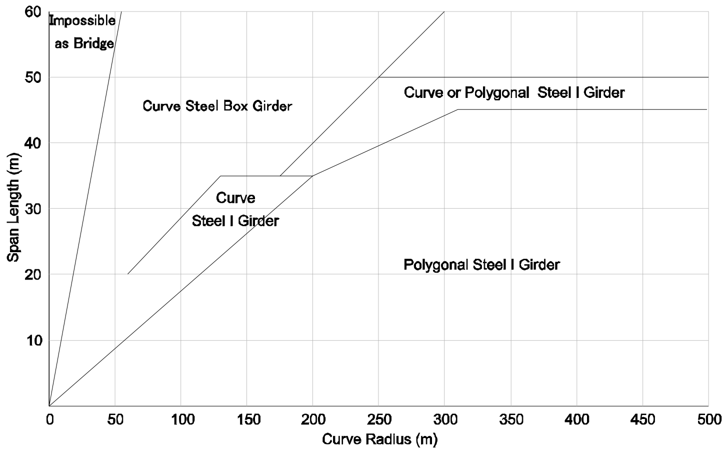


Source: Design Data Book (Japan Association of Steel Bridge Construction),
PC Bridge Design Manual (Japan Pre-stressed Concrete Contractors Association)

Economical PC T Girder is recommended in the straight line bridge of less than 45 m span length. It is because the concrete of main materials are available in this country. Since separate branches (span length of 40 m) for Flyover are required to be widened, it adopts the Steel I Girder.

(4) Span Length and Curve Radius by Alignment

According to the overall flyover plan based on the preliminary planning of the projects, many curvilinear parts are within the route alignment. Steel girder with high torsional rigidity is adopted on the curved alignment. The cross section is determined based on the following figure.



Source: Steel Highway Bridge Design Manual

Figure 7.2.12 Curve Radius – Span Length Graph

(5) Bridge Type Selection

Based on the applicable span length by bridge type and span length-curve radius by alignment, Table 7.2.23 shows the bridge type selection for this project.

Table 7.2.22 Bridge Type with Property

Bridge Property		Widening Section	Curve Section – Radius (m)	
			From 60 to 160 m	More than 300 m
Span Length	Less than 40 m	Steel I Girder	Steel I Girder	PC T Girder
	From 55 to 60 m	-----	Steel Box Girder	PC Box Girder
	More than 80 m			(Comparison Study)

Source: JICA Study Team

Table 7.2.23 Result of Bridge Type Selection

Yusufu Lule and Mukwano Rds Flyover

Start	Length (m)	End	Bridge No.	Max. Span Length (m)	Curve Radius (m)	Widening Width (m)	Material Type	Girder Type
0 + -55.00	120.0	0 + 65.00	Access Road (Mukwano Rd side)					
0 + 65.00	120.0	1 + 85.00	YM-1	40.00	---	13.00	PC	T
1 + 85.00	120.0	3 + 5.00	YM-2	40.00	---	13.00	PC	T
3 + 5.00	120.0	4 + 25.00	YM-3	40.00	1,000	13.00 to 23.00	Steel	I
4 + 25.00	435.0	8 + 60.00	YM-4	80.00	160	13.00	Steel	Box
8 + 60.00	120.0	9 + 80.00	YM-5	40.00	---	13.00	PC	T
9 + 80.00	240.0	12 + 20.00	YM-6	90.00	1,000	13.00	(Comparison Study)	
12 + 20.00	120.0	13 + 40.00	YM-7	40.00	1,000	20.25 to 13.00	Steel	I
13 + 40.00	200.0	15 + 40.00	YM-8	40.00	600	13.00	PC	T
15 + 40.00	200.0	17 + 40.00	YM-9	40.00	600	13.00	PC	T
17 + 40.00	110.0	18 + 50.00	Access Road (Yusufu Lule Rd side)					

Mukwano - Jinja Rds Flyover

Start	Length (m)	End	Bridge No.	Max. Span Length (m)	Curve Radius (m)	Widening Width (m)	Material Type	Girder Type
0 + 84.50	264.5	3 + 49.00	MJ-1	60.00	100	10.00	Steel	Box
3 + 49.00	210.0	5 + 59.00	MJ-2	60.00	160	10.00	Steel	Box
5 + 59.00	160.0	7 + 19.00	MJ-3	40.00	---	10.00	PC	T
7 + 19.00	111.0	8 + 30.00	Access Road (Jinja Rd side)					

Jinja - Yusufu Lule Rds Flyover include Yusufu Lule Ramp

Start	Length (m)	End	Bridge No.	Max. Span Length (m)	Curve Radius (m)	Widening Width (m)	Material Type	Girder Type
0 + 0.00	105.00	1 + 5.00	Access Road (Jinja Rd side)					
1 + 5.00	170.00	2 + 75.00	JY-1	60.00	300	10.00	PC	Box
2 + 75.00	68.00	3 + 43.00	JY-2	34.00	160	10.00	Steel	I
3 + 43.00	330.00	6 + 73.00	JY-3	80.00	160	10.00	Steel	Box
6 + 73.00	17.14	6 + 90.14	JY-4	37.00	---	10.00 to 14.50	Steel	I
0 + 0.00	56.86	0 + 56.86						
0 + 56.86	180.50	2 + 37.36	JY-5	55.00	300	7.25	PC	Box

Nile Avenue Ramp

Start	Length (m)	End	Bridge No.	Max. Span Length (m)	Curve Radius (m)	Widening Width (m)	Material Type	Girder Type
0 + 58.00	110.0	1 + 68.00	NA-1	55.00	60	7.25	Steel	Box
1 + 68.00	120.0	2 + 88.00	NA-2	40.00	300	7.25	PC	T
2 + 88.00	110.7	3 + 98.70	Access Road (Nile Avenue side)					

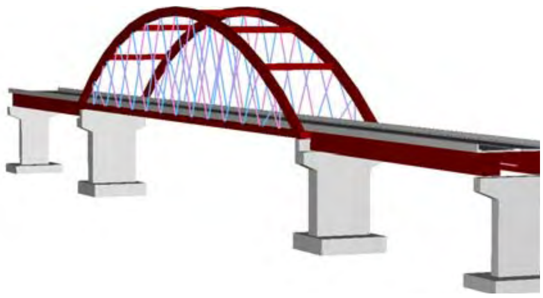
Source: JICA Study Team

7.2.4 EVALUATION OF ALTERNATIVE STRUCTURE PLANS

(1) Alternative Bridge Type

In the case of more than 300 m curve radius, which can be regarded as almost linear, there is no restriction in the selection of bridge type. Bridge No. YM-6 of Table 7.2.24 corresponds to this category. Therefore, based on applicable span length, comparison study was carried out on the four types of bridges shown below.

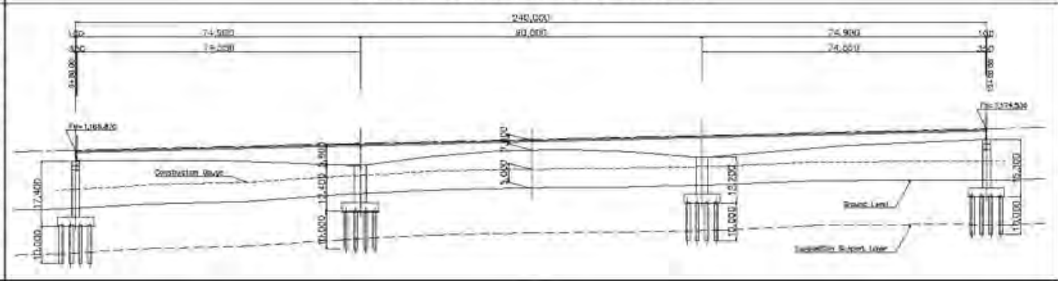
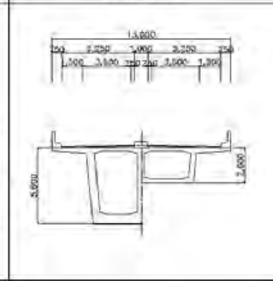
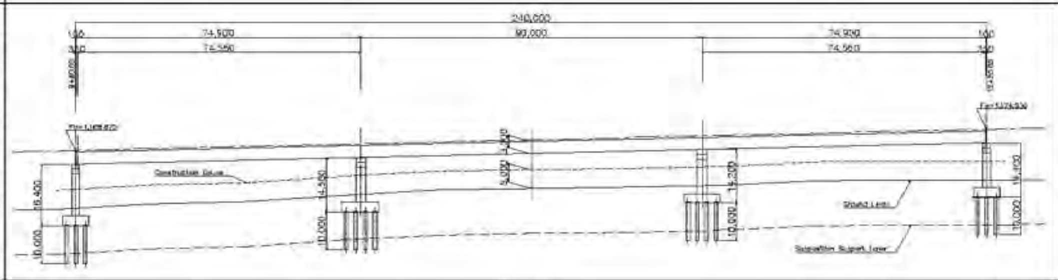
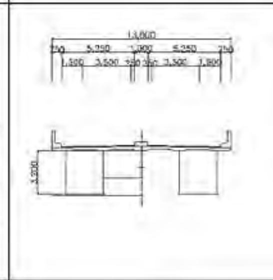
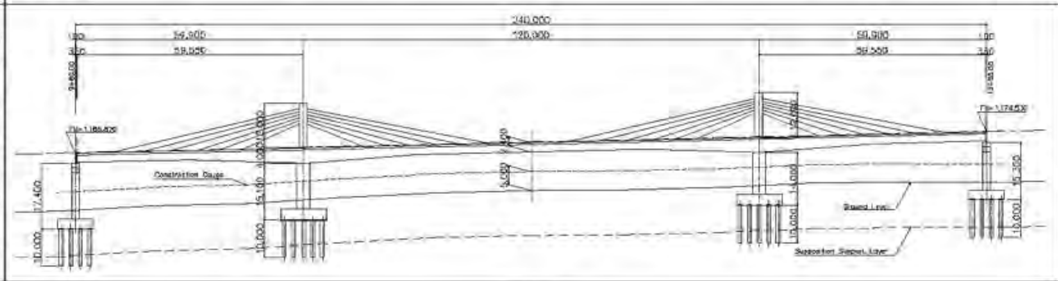
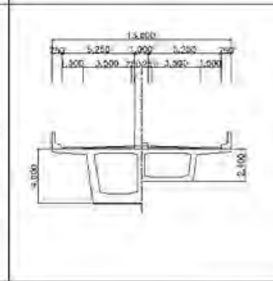
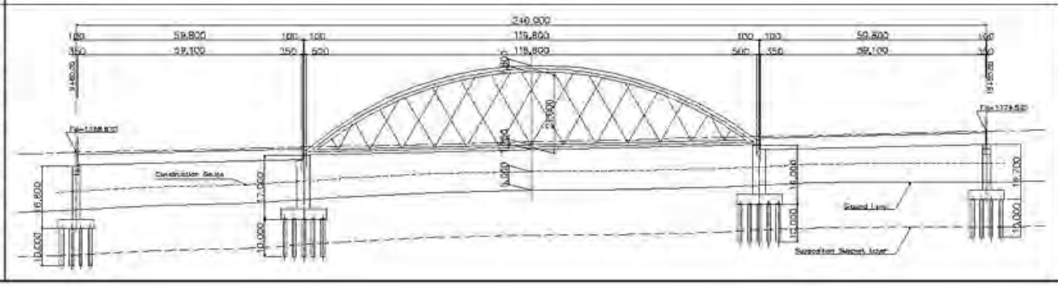
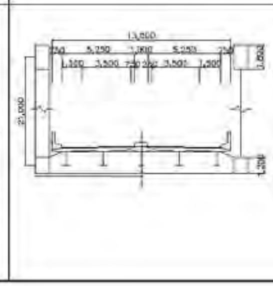
Table 7.2.24 Alternative Bridge Type for Bridge No. YM-6

Alt.1 PC Box Girder Bridge	Alt.2 Steel Box Girder Bridge
	
Alt.3 PC Extra-dosed Bridge	Alt.4 Steel Arch with Steel Box Girder Bridge
	

Source: JICA Study Team

(2) Comparison Study

Result of comparison study is shown in Figure 7.2.13. From the view of economic efficiency, 3-span continuous PC Box Girder Bridge is determined as the best option in this Pre-FS. However, since this project is realized as the first flyover in Greater Kampala, PC Extra-dosed Bridge with a main tower, of which cost is a few percent more than the total Pre-FS flyover project cost estimate, is also recommended in view of creating a great landscape as a symbol of the capital Kampala City, if the budget allows. The bridge type should be further examined and discussed in the FS stage in a comprehensive manner from the aspects of engineering, economic efficiency, maintenance and so on.

	Layout of Yusufu Lule and Mukwano Rds Flyover YM-6 Bridge	Cross Section	Description	Evaluation
Alternative No.1 PC Box Girder Bridge			Alternative No.1 is PC box girder type. The main girder (center span length of 90.0m) is erected as the cantilever construction method in the site. Therefore, during the erection of the superstructure will be to bypass the current existing road. The total construction cost is lowest in any alternatives. This alternative is the Best option for the most economical. Cost Estimate (USD) (1) Superstructure 4,978,156 (2) Substructure 693,208 (3) Foundation 919,233 TOTAL 100% 6,590,597	Best option
Alternative No.2 Steel Box Girder Bridge			Alternative No.2 is Steel box girder type. The main girder will be manufactured with excellent in a quality control at a factory. Construction period in the site is short by the crane erection. However, it is necessary to major materials in international procurement and transportation. The total construction cost is higher than Alt. No.1. Cost Estimate (USD) (1) Superstructure 8,989,333 (2) Substructure 651,280 (3) Foundation 738,778 TOTAL 157% 10,379,392	Not recommended from cost saving view point
Alternative No.3 PC Extra-dosed Bridge			Alternative No.3 is PC Extra-dosed type. The main girder is erected as the cantilever construction method in the site. Therefore, during the erection of the girder will be to bypass the existing road. Some materials will be procured overseas. The total construction cost is slightly higher than Alt. No.1. This type with a main tower, in order to create great landscape as a symbol of the capital Kampala city, it possible to accept. Cost Estimate (USD) (1) Superstructure 5,538,960 (2) Substructure 884,452 (3) Foundation 1,040,344 TOTAL 113% 7,463,757	Acceptable
Alternative No.4 Steel Arch Bridge			Alternative No.4 is Steel Arch type with Steel box girder bridge. Contribute to the creation of great scenery. The arch and girder will be manufactured with excellent in a quality control at a factory. However, construction period in the site is long by the cable crane erection. Moreover, it is necessary to major materials in international procurement and transportation. The total construction cost is the highest. Cost Estimate (USD) (1) Superstructure 8,865,227 (2) Substructure 1,048,300 (3) Foundation 859,889 TOTAL 163% 10,773,416	Not recommended from cost saving view point

Source: JICA Study Team

Figure 7.2.13 Comparison Table of Bridge No. YM-6

(3) Best Option

Best bridge type option is shown in Table 7.2.25.

Table 7.2.25 Best Option of Bridge Type

Yusufu Lule and Mukwano Rds Flyover

Bridge No.	Number of Span	Bridge Length (m)	Span Length (m)						Bridge Type
YM-1	3	120.00	40.00	40.00	40.00				PC T Girder
YM-2	3	120.00	40.00	40.00	40.00				PC T Girder
YM-3	3	120.00	40.00	40.00	40.00				Steel I Girder
YM-4	6	435.00	55.00	80.00	80.00	80.00	80.00	60.00	Steel Box Girder
YM-5	3	120.00	40.00	40.00	40.00				PC T Girder
YM-6	3	240.00	75.00	90.00	75.00				PC Box Girder
YM-7	3	120.00	40.00	40.00	40.00				Steel I Girder
YM-8	5	200.00	40.00	40.00	40.00	40.00	40.00		PC T Girder
YM-9	5	200.00	40.00	40.00	40.00	40.00	40.00		PC T Girder
Total		1,675.00							

Mukwano - Jinja Rds Flyover

Bridge No.	Number of Span	Bridge Length (m)	Span Length (m)						Bridge Type
MJ-1	5	264.50	50.00	54.50	60.00	50.00	50.00		Steel Box Girder
MJ-2	4	210.00	40.00	60.00	60.00	50.00			Steel Box Girder
MJ-3	4	160.00	40.00	40.00	40.00	40.00			PC T Girder
Total		634.50							

Jinja - Yusufu Lule Rds Flyover include Yusufu Lule Ramp

Bridge No.	Number of Span	Bridge Length (m)	Span Length (m)						Bridge Type
JY-1	3	170.00	55.00	60.00	55.00				PC Box Girder
JY-2	2	68.00	34.00	34.00					Steel I Girder
JY-3	5	330.00	60.00	70.00	60.00	80.00	60.00		Steel Box Girder
JY-4	2	74.00	37.00	37.00					Steel I Girder
JY-5	4	180.50	35.00	55.00	50.50	40.00			PC Box Girder
Total		822.50							

Nile Avenue Ramp

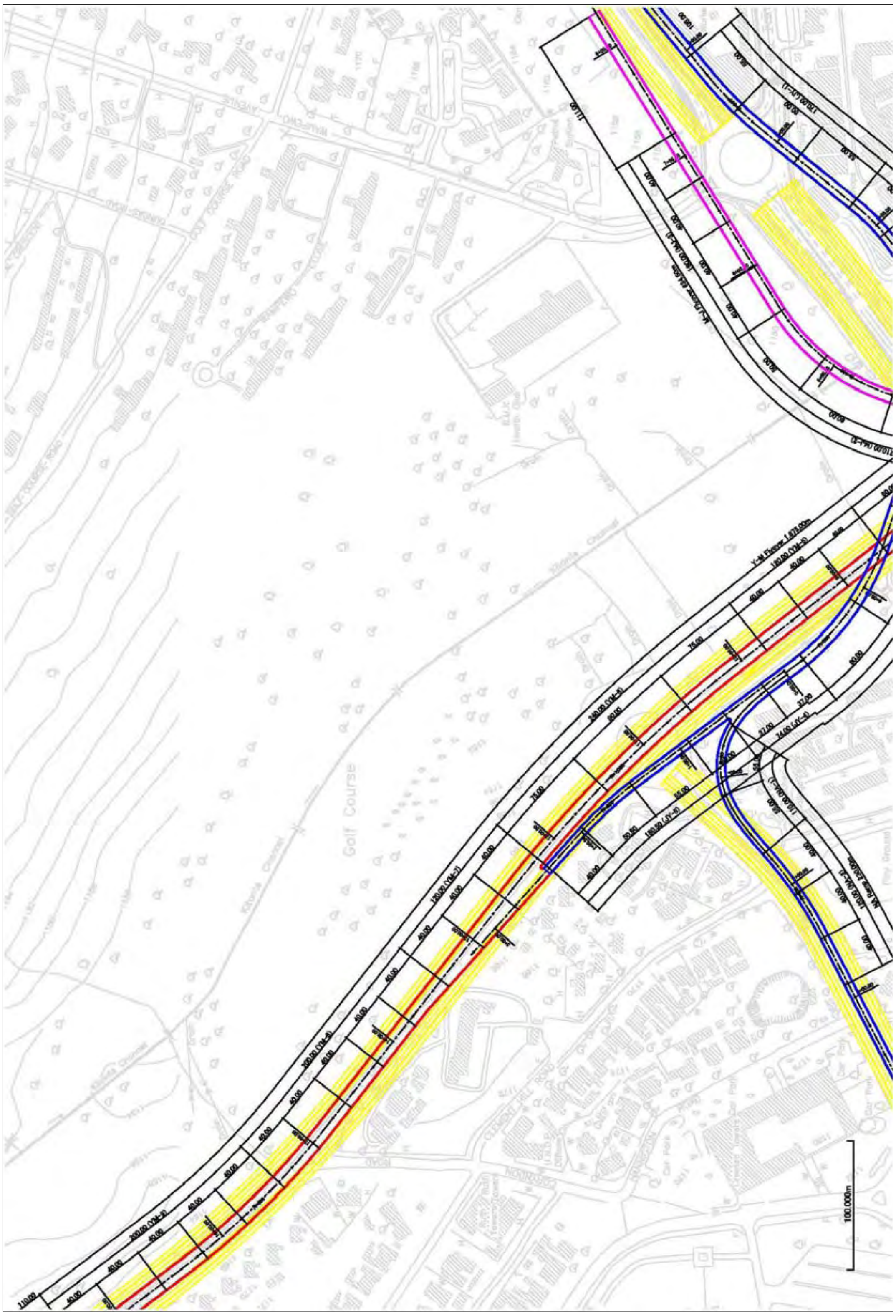
Bridge No.	Number of Span	Bridge Length (m)	Span Length (m)						Bridge Type
NA-1	2	110.00	55.00	55.00					Steel Box Girder
NA-2	3	120.00	40.00	40.00	40.00				PC T Girder
Total		230.00							

Source: JICA Study Team

7.2.5 PRELIMINARY DESIGN FOR BEST ALTERNATIVES

(1) Preliminary Design for Flyovers with Span Arrangement

Results of the preliminary design appropriate to the flyover plan are shown in Figures 7.2.14 – 7.2.15.



Source: JICA Study Team

Figure 7.2.14 Preliminary Flyover Plan (Northern Area)

Source: JICA Study Team

Figure 7.2.15 Preliminary Flyover Plan (Southern Area)

(2) Overall Layout and Cross Section

Overall layout view and cross section of these flyovers are shown in "Volume II: Preliminary Design Drawings for Pre-FS Projects".

7.2.6 QUANTITY ESTIMATES OF MAJOR ITEMS

(1) Preliminary Work Quantities for the Project

Work quantities for the construction of the project was preliminarily calculated based on the design for introduction of flyovers and improvement of existing roads. Quantities for major work items are shown in the following table.

Table 7.2.26 Preliminary Work Quantities for the Project

ITEM	UNIT	QUANTITY		
		Mukwano-Yusuf Lule Flyover	Mukwano-Jinja Flyover Jinja-Yusuf Lule Flyover, Yusuf Lule-Nile Flyover	TOTAL
DRAINAGE				
Concrete Pipe Culverts	m	260	70	330
Concrete for Drainage Facilities	m3	3,150	860	4,010
Concrete Karbing, Channeling, Open Drains	m	5,210	1,420	6,630
EARTHWORKS AND PAVEMENT				
Scarification and Recompaction of Existing Pavement Layers	m2	19,460	4,220	23,680
Common Exavation	m3	780	210	990
Embankment	m3	18,622	12,907	31,528
Subbase Course	m3	1,740	150	1,890
Base Course	m3	1,920	310	2,230
Asphalt Concrete Pavement	m3	2,810	560	3,370
Asphalt Concrete Surfacing on Bridge Deck	m2	18,668	13,211	31,878
STRUCTURES				
Steel Box Girder	t	2,339	3,370	5,709
Steel I Girder	t	882	291	1,173
Steel Pier	t	520	0	520
Concrete PC-T Girder	m3	5,434	1,359	6,793
Concrete PC-Box Girder	m3	2,711	2,380	5,090
Bored Pile	m	4,522	2,475	6,997
Structural Concrete	m3	12,013	9,526	21,539
Reinforing Bars	t	2,343	1,574	3,917

Source: JICA Study Team

(2) Breakdown of Flyover

Breakdowns of quantity required for the construction of the Yusufu Lule and Mukwano Roads Flyover, Mukwano – Jinja Roads Flyover and Jinja – Yusufu Lule Roads Flyover are shown in the following tables.

Table 7.2.27 Quantity Table of Yusufu Lule and Mukwano Rds Flyover

	Yusuf Lule and Mukwano Rds Flyover (1/3)	Unit	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		SubTotal
Superstructure	Bridge Type		PC T Girder			PC T Girder			Steel I Girder			Steel Box Girder								
	Bridge Length	m	120.000			120.000			120.000			435.000								795.0
	Span Length	m	40.000	40.000	40.000	40.000	40.000	40.000	40.000	40.000	40.000	55.000	80.000	80.000	80.000	80.000	60.000			795.0
	Width	m	13.000	13.000	13.000	13.000	13.000	13.000	13.000	18.000	21.500	13.000	13.000	13.000	13.000	13.000	13.000			
	Bridge Area	m2	520.00	520.00	520.00	520.00	520.00	520.00	520.00	720.00	860.00	715.00	1,040.00	1,040.00	1,040.00	1,040.00	780.00			10,875.0
	Median & Sidewall Width	m	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500			
	Concrete - PC T Girder	m3	286.0	286.0	286.0	286.0	286.0	286.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			1,716.0
	Concrete - PC Box Girder	m3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	Reinforcement - PC Girder	tf	28.6	28.6	28.6	28.6	28.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			171.6
	Steel - I Girder	tf	0.0	0.0	0.0	0.0	0.0	0.0	109.2	151.2	180.6	0.0	0.0	0.0	0.0	0.0	0.0			441.0
	Steel - Box Girder	tf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	236.0	457.6	457.6	457.6	457.6	273.0			2,339.4
	Election	tf	743.6	743.6	743.6	743.6	743.6	743.6	109.2	151.2	180.6	236.0	457.6	457.6	457.6	457.6	273.0			7,242.0
	Pavement	m2	420.0	420.0	420.0	420.0	420.0	420.0	420.0	620.0	760.0	577.5	840.0	840.0	840.0	840.0	630.0			8,887.5
Substructure	Total Height	m	9.500	9.700	12.900	14.900	14.900	14.600	14.400	14.200	14.000	12.400	12.500	12.900	2.000	2.000	2.000	15.000		
	Concrete - Beam & Column	m3	156.0	138.8	183.6	211.6	211.6	207.4	204.6	213.8	227.0	235.8	222.8	229.8	0.0	0.0	0.0	220.2		2,662.9
	Concrete - Pilecap	m3	136.5	99.8	99.8	99.8	99.8	99.8	99.8	99.8	152.3	178.5	228.0	228.0	266.0	266.0	266.0	99.8		2,519.3
	Reinforcement - Pier	tf	35.1	28.6	34.0	37.4	37.4	36.9	36.5	37.6	45.5	49.7	54.1	54.9	31.9	31.9	31.9	38.4		621.9
	Steel - Pier	tf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	180.0	170.0	170.0	0.0		520.0
Foundation	Pile Length	m	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	7.000	7.000	7.000		
	No. of Pile	No.	15	12	12	12	12	12	12	12	18	21	20	20	24	24	24	12		
	Bored Pile	m	150.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	180.0	210.0	200.0	200.0	240.0	168.0	168.0	84.0		2,440.0

	Yusuf Lule and Mukwano Rds Flyover (2/3)	Unit	(P15)	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29			SubTotal
Superstructure	Bridge Type		PC T Girder			PC Box Girder			Steel I Girder			PC T Girder								
	Bridge Length	m	120.000			240.000			120.000			200.000								680.0
	Span Length	m	40.000	40.000	40.000	75.000	90.000	75.000	40.000	40.000	40.000	40.000	40.000	40.000	40.000	40.000				680.0
	Width	m	13.000	13.000	13.000	13.000	13.000	13.000	21.500	18.000	13.000	13.000	13.000	13.000	13.000	13.000				
	Bridge Area	m2	520.00	520.00	520.00	975.00	1,170.00	975.00	860.00	720.00	520.00	520.00	520.00	520.00	520.00	520.00				9,380.0
	Median & Sidewall Width	m	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500				
	Concrete - PC T Girder	m3	286.0	286.0	286.0	0.0	0.0	0.0	0.0	0.0	0.0	286.0	286.0	286.0	286.0	286.0				2,288.0
	Concrete - PC Box Girder	m3	0.0	0.0	0.0	828.8	1,053.0	828.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				2,710.5
	Reinforcement - PC Girder	tf	28.6	28.6	28.6	107.7	142.2	107.7	0.0	0.0	0.0	28.6	28.6	28.6	28.6	28.6				586.4
	Steel - I Girder	tf	0.0	0.0	0.0	0.0	0.0	0.0	180.6	151.2	109.2	0.0	0.0	0.0	0.0	0.0				441.0
	Steel - Box Girder	tf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
	Election	tf	743.6	743.6	743.6	2,179.6	2,774.7	2,179.6	180.6	151.2	109.2	743.6	743.6	743.6	743.6	743.6				13,523.7
	Pavement	m2	420.0	420.0	420.0	787.5	945.0	787.5	760.0	620.0	420.0	420.0	420.0	420.0	420.0	420.0				7,680.0
Substructure	Total Height	m		17.100	16.700	17.100	12.700	12.600	14.800	14.400	14.200	13.300	13.400	13.500	13.600	13.500	13.600			
	Concrete - Beam & Column	m3		242.4	236.8	294.3	242.6	240.1	243.2	232.6	213.8	189.2	190.6	192.0	193.4	192.0	193.4			3,096.3
	Concrete - Pilecap	m3		99.8	99.8	180.5	403.2	403.2	323.0	152.3	99.8	99.8	99.8	99.8	99.8	99.8	99.8			2,359.9
	Reinforcement - Pier	tf		41.1	40.4	57.0	77.5	77.2	67.9	46.2	37.6	34.7	34.8	35.0	35.2	35.0	35.2			654.7
	Steel - Pier	tf		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Foundation	Pile Length	m		7.000	7.000	7.000	10.000	10.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000			
	No. of Pile	No.		12	12	16	25	25	21	18	12	12	12	12	12	12	12			
	Bored Pile	m		84.0	84.0	112.0	250.0	250.0	147.0	126.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0			1,641.0

	Yusuf Lule and Mukwano Rds Flyover (3/3)	Unit	(P29)	P30	P31	P32	P33	A2	SubTotal	Total
Superstructure	Bridge Type		PC T Girder							
	Bridge Length	m	200.000						200.0	1,675.0
	Span Length	m	40.000	40.000	40.000	40.000	40.000		200.0	1,675.0
	Width	m	13.000	13.000	13.000	13.000	13.000			
	Bridge Area	m2	520.00	520.00	520.00	520.00	520.00		2,600.0	22,855.0
	Median & Sidewall Width	m	2.500	2.500	2.500	2.500	2.500			
	Concrete - PC T Girder	m3	286.0	286.0	286.0	286.0	286.0		1,430.0	5,434.0
	Concrete - PC Box Girder	m3	0.0	0.0	0.0	0.0	0.0		0.0	2,710.5
	Reinforcement - PC Girder	tf	28.6	28.6	28.6	28.6	28.6		143.0	901.0
	Steel - I Girder	tf	0.0	0.0	0.0	0.0	0.0		0.0	882.0
	Steel - Box Girder	tf	0.0	0.0	0.0	0.0	0.0		0.0	2,339.4
	Election	tf	743.6	743.6	743.6	743.6	743.6		3,718.0	24,483.6
	Pavement	m2	420.0	420.0	420.0	420.0	420.0		2,100.0	18,667.5
Substructure	Total Height	m		13.700	13.000	12.600	9.600	8.800		
	Concrete - Beam & Column	m3		194.8	185.0	179.4	137.4	142.4	839.0	6,598.2
	Concrete - Pilecap	m3		99.8	99.8	99.8	99.8	136.5	535.5	5,414.7
	Reinforcement - Pier	tf		35.3	34.2	33.5	28.5	33.5	164.9	1,441.5
	Steel - Pier	tf		0.0	0.0	0.0	0.0	0.0	0.0	520.0
Foundation	Pile Length	m		7.000	7.000	7.000	7.000	7.000		
	No. of Pile	No.		12	12	12	12	15		
	Bored Pile	m		84.0	84.0	84.0	84.0	105.0	441.0	4,522.0

Source: JICA Study Team

Table 7.2.28 Quantity Table of Mukwano – Jinja Rds Flyover

	Mukwano - Jinja Rds Flyover	Unit	Quantity																	Total
			(P9)	Pmj1	Pmj2	Pmj3	Pmj4	Pmj5	Pmj6	Pmj7	Pmj8	Pmj9	Pmj10	Pmj11	Pmj12	Amj2				
Superstructure	Bridge Type			Steel Box Girder					Steel Box Girder				PC T Girder							
	Bridge Length	m		264.500					210.000				160.000							634.5
	Span Length	m		50.000	54.500	60.000	50.000	50.000	40.000	60.000	60.000	50.000	40.000	40.000	40.000	40.000				634.5
	Width	m		10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000				
	Bridge Area	m2		500.00	545.00	600.00	500.00	500.00	400.00	600.00	600.00	500.00	400.00	400.00	400.00	400.00				6,345.0
	Median & Sidewall Width	m		1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500				
	Concrete - PC T Girder	m3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	220.0	220.0	220.0	220.0				880.0
	Concrete - PC Box Girder	m3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
	Reinforcement - PC Girder	tf		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	22.0	22.0	22.0				88.0
	Steel - I Girder	tf		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
	Steel - Box Girder	tf		165.0	190.8	228.0	165.0	165.0	116.0	228.0	228.0	165.0	0.0	0.0	0.0	0.0				1,650.8
	Election	tf		165.0	190.8	228.0	165.0	165.0	116.0	228.0	228.0	165.0	572.0	572.0	572.0	572.0				3,938.8
	Pavement	m2		425.0	463.3	510.0	425.0	425.0	340.0	510.0	510.0	425.0	340.0	340.0	340.0	340.0				5,393.3
Substructure	Total Height	m		13.400	14.200	18.400	23.200	23.000	19.500	14.500	10.400	10.300	11.200	11.400	11.400	10.600				
	Concrete - Beam & Column	m3		139.0	147.0	189.0	290.0	287.5	200.0	150.0	109.0	108.0	117.0	119.0	119.0	136.5				2,111.0
	Concrete - Pilecap	m3		84.0	84.0	84.0	180.5	180.5	84.0	84.0	84.0	84.0	84.0	84.0	84.0	105.0				1,306.0
	Reinforcement - Pier	tf		26.8	27.7	32.8	56.5	56.2	34.1	28.1	23.2	23.0	24.1	24.4	24.4	29.0				410.0
	Steel - Pier	tf		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
Foundation	Pile Length	m		10.000	10.000	10.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000				
	No. of Pile	No.		9	9	9	12	12	9	9	9	9	9	9	9	12				
	Bored Pile	m		90.0	90.0	90.0	84.0	84.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	84.0				963.0

Source: JICA Study Team

Table 7.2.29 Quantity Table of Jinja – Yusufu Lule Rds Flyover with Yusufu Lule Flyover

	Jinja - Yusuf Lule Rds Flyover	Unit	Quantity																	Total
			Ajy1	Pjy1	Pjy2	Pjy3	Pjy4	Pjy5	Pjy6	Pjy7	Pjy8	Pjy9	Pjy10	Pjy11	Pjy12	Pjy13	Pjy14	Pjy15	(P21)	
Superstructure	Bridge Type			PC Box Girder			Steel I Girder		Steel Box Girder					Steel I Girder		PC Box Girder				
	Bridge Length	m		170.000			68.000		330.000					74.000		180.500				822.5
	Span Length	m		55.000	60.000	55.000	34.000	34.000	60.000	70.000	60.000	80.000	60.000	37.000	37.000	35.000	55.000	50.500	40.000	822.5
	Width	m		10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	7.250	7.250	7.250	7.250	
	Bridge Area	m2		550.00	600.00	550.00	340.00	340.00	600.00	700.00	600.00	800.00	600.00	370.00	370.00	253.75	398.75	366.13	290.00	7,728.6
	Median & Sidewall Width	m		1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	
	Concrete - PC T Girder	m3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Concrete - PC Box Girder	m3		440.0	480.0	440.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	190.3	319.0	292.9	217.5	2,379.7
	Reinforcement - PC Girder	tf		55.0	60.0	55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8	39.9	36.6	26.1	295.4
	Steel - I Girder	tf		0.0	0.0	0.0	68.0	68.0	0.0	0.0	0.0	0.0	0.0	77.7	77.7	0.0	0.0	0.0	0.0	291.4
	Steel - Box Girder	tf		0.0	0.0	0.0	0.0	0.0	228.0	308.0	228.0	400.0	228.0	0.0	0.0	0.0	0.0	0.0	0.0	1,392.0
	Election	tf		1,155.0	1,260.0	1,155.0	68.0	68.0	228.0	308.0	228.0	400.0	228.0	77.7	77.7	498.6	837.4	768.9	569.9	7,928.1
	Pavement	m2		467.5	510.0	467.5	289.0	289.0	510.0	595.0	510.0	680.0	510.0	314.5	314.5	201.3	316.3	290.4	230.0	6,494.9
Substructure	Total Height	m	8.200	11.800	18.000	23.300	26.200	26.600	26.900	26.600	26.400	24.200	18.800	17.300	13.900	11.600	11.800	12.000		
	Concrete - Beam & Column	m3	100.5	103.0	165.0	291.3	327.5	340.0	343.8	340.0	337.5	310.0	199.0	178.0	162.0	80.8	82.4	84.0		3,444.7
	Concrete - Pilecap	m3	105.0	84.0	84.0	133.0	133.0	180.5	180.5	180.5	180.5	180.5	84.0	84.0	126.0	73.5	73.5	73.5		1,956.0
	Reinforcement - Pier	tf	24.7	22.4	29.9	50.9	55.3	62.5	62.9	62.5	62.2	58.9	34.0	31.4	34.6	18.5	18.7	18.9		648.1
	Steel - Pier	tf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Foundation	Pile Length	m	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000		
	No. of Pile	No.	9	9	9	12	12	12	12	12	12	12	9	9	15	9	9	9		
	Bored Pile	m	63.0	63.0	63.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	63.0	63.0	105.0	63.0	63.0	63.0		1,197.0

Source: JICA Study Team

Table 7.2.30 Quantity Table of Nile Avenue Flyover

	Nile Avenue Ramp	Unit	Quantity																	Total
			(Pjy12)	Pna1	Pna2	Pna3	Pna4	Ana2												
Superstructure	Bridge Type			Steel Box Girder		PC T Girder														
	Bridge Length	m		110.000		120.000														230.0
	Span Length	m		55.000	55.000	40.000	40.000	40.000												230.0
	Width	m		7.250	7.250	7.250	7.250	7.250												
	Bridge Area	m2		398.75	398.75	290.00	290.00	290.00												1,667.5
	Median & Sidewall Width	m		1.500	1.500	1.500	1.500	1.500												
	Concrete - PC T Girder	m3		0.0	0.0	159.5	159.5	159.5												478.5
	Concrete - PC Box Girder	m3		0.0	0.0	0.0	0.0	0.0												0.0
	Reinforcement - PC Girder	tf		0.0	0.0	16.0	16.0	16.0												47.9
	Steel - I Girder	tf		0.0	0.0	0.0	0.0	0.0												0.0
	Steel - Box Girder	tf		163.5	163.5	0.0	0.0	0.0												327.0
	Election	tf		163.5	163.5	414.7	414.7	414.7												1,571.1
	Pavement	m2		316.3	316.3	230.0	230.0	230.0												1,322.5
Substructure	Total Height	m		9.000	8.400	8.300	8.600	8.200												
	Concrete - Beam & Column	m3		60.0	68.2	67.4	69.8	72.9												338.3
	Concrete - Pilecap	m3		73.5	73.5	73.5	73.5	76.1												370.1
	Reinforcement - Pier	tf		16.0	17.0	16.9	17.2	17.9												85.0
	Steel - Pier	tf		0.0	0.0	0.0	0.0	0.0												0.0
Foundation	Pile Length	m		7.000	7.000	7.000	7.000	7.000												
	No. of Pile	No.		9	9	9	9	9												
	Bored Pile	m		63.0	63.0	63.0	63.0	63.0												315.0

Source: JICA Study Team

7.3 MUKWANO ROAD WIDENING PROJECT

7.3.1 ALTERNATIVE PLAN STUDY

(1) Objectives

As discussed in Chapter 5 (future traffic demand), after introduction of the BRT, Mukwano Road will function as the east-west trunk road instead of Kampala/Jinja Roads. Accordingly, a heavy traffic jam at Mukwano Roundabout will become the worst situation. In addition, non-interrupted flow sections on Mukwano Road will cause a heavy traffic jam due to insufficient capacity and lane number for the future traffic demand.

Given such situation, the Study Team has proposed the improvement of Mukwano Road including Mukwano Roundabout and Kibuli Junction.

(2) Design Standards and Typical Cross Sections

1) Applicable Design Standards

As described in Sub-chapter 7.2.1, the Road Design Manual is intended for use in the design of all rural roads in Uganda. The purpose of the manual is to give guidance and recommendations to the engineers responsible for the design of rural roads. Accordingly, as only limited description is available for urban roads in the manual, it would be necessary to refer to other design standards and manuals (such as AASHTO and Japanese Urban Road Standard) to set out some specific parameters which are not stipulated in the Road Design Manual of Uganda.

2) Geometric Design Parameters

The Study Team recommends application of design speed of 50 km/h for Mukwano Road, which lies in a built-up area, in accordance with the Road Design Manual in Uganda. Geometric parameters for design speed of 50 km/h and design speed of 30 km/h for intersection are shown in Sub-chapter 7.2.1.

3) Required Lane Number

Lane number planned for the improvement should satisfy the future traffic demand. According to the result of the future traffic demand forecast in Chapter 5, vehicle number on Mukwano Road will increase up to 55,700 pcu per day. As a result, 4-lane for both directions will be required as follows:

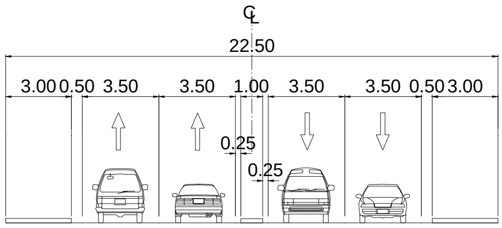
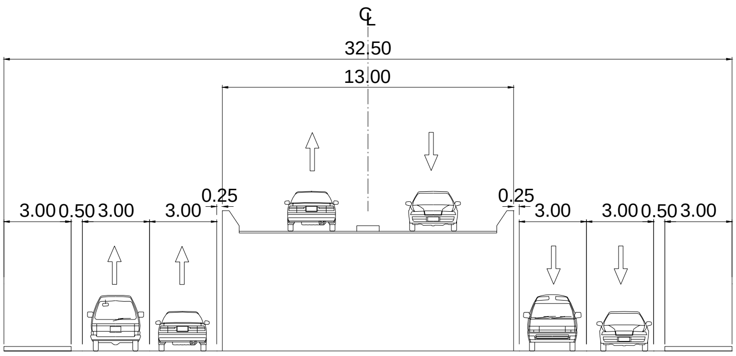
Table 7.3.1 Necessary Lane Number for Mukwano Road (Y2023)

Traffic Volume (Y2023)	Peak in 24h	K-value	Peak pcu /direction	Capacity/ hour (Multi lane)	Necessary Lane Number/direction
55,700pcu	0.074	0.7	2,885	2,200pcu	1.31=2

Source: JICA Study Team

4) Typical Cross Sections for Road Improvement

The Study Team sets out the typical cross sections for Mukwano Road as shown in the figures below. Dual carriageway with median of 1.0 m is proposed for Mukwano Road. Lane width is 3.5 m and shoulder width is 0.5 m. Consequently, carriageway width is 7.5 m. Total road width is 22.5 m including side walk. However, lane width of flyover section is 3.0 m because the utilizable width of flyover section is limited.

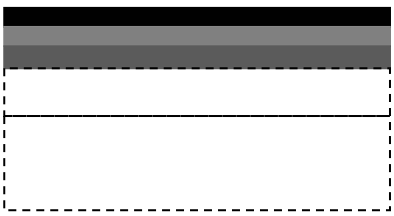
Typical Cross Sections	Description
	**Mukwano Road** (Normal section)
	**Mukwano Road** (Flyover section)

Source: JICA Study Team

Figure 7.3.1 Typical Cross Sections of Mukwano Road

5) Pavement Composition

Pavement composition for improvement was decided using example from the grant aid project of GOJ because survey for sub-grade strength (CBR) was not carried out. In this study, the thickest pavement composition applied for grant aid project was set as the pavement composition required for Mukwano Road improvement. The following figure shows the assumed pavement compositions.

Type of Pavement Composition	Description
	**New Construction (Widening Area)** As Surface: 50 mm As Binder: 50 mm Base Course: 200 mm (Crushed Stone) Sub-base Course: 300 mm (Natural Gravel)
	**Rehabilitation (Existing Pavement Area)** As Surface: 50 mm As Binder: 50 mm Leveling: 10 mm (Stripping of existing pavement)

Source: JICA Study Team

Figure 7.3.2 Assumed Pavement Compositions

(3) Alternative Plans and Project Concept

1) Existing Traffic Condition at Bottleneck Points

Two major bottleneck points exist on Mukwano Road. One is Mukwano Roundabout and the other point is Nsambya/Kibuli Junction. Existing conditions of these junction and roundabout were evaluated as follows by use of the traffic survey results of the Study Team.

Table 7.3.2 Existing Conditions of Main Bottleneck Points on Mukwano Road

Indicator		Nsambya/Kibuli Junction	Mukwano Roundabout
Saturation	A.M.	1.34	-
	P.M.	1.00	-
Delay Time*	A.M.	-	37.8sec
	P.M.	-	20.9sec

Note *: per 15minutes
Source: JICA Study Team

The computed result of Nsambya/Kibuli Junction indicates that intersection capacity is not sufficient for the existing traffic volume. As explained before, the saturation degree which is over 1.0 means impossibility to control by existing configuration such as lane number and phasing of the traffic signal. The LOS of Mukwano Roundabout is categorized into level “D” in the morning. The HCM recommends at least level “C” in urban area.

2) Project Concepts and Alternatives

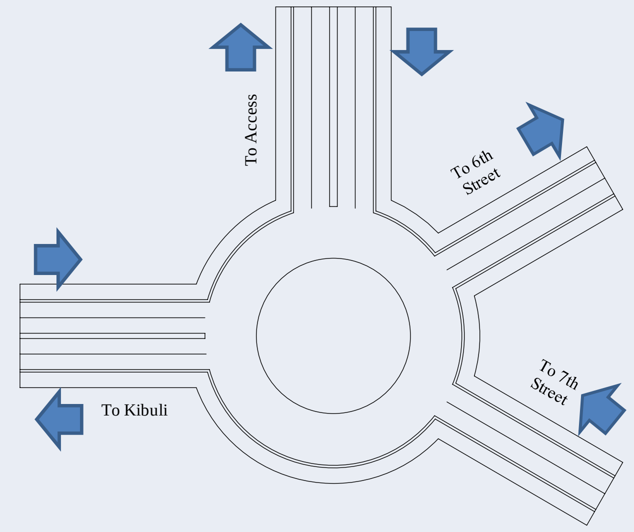
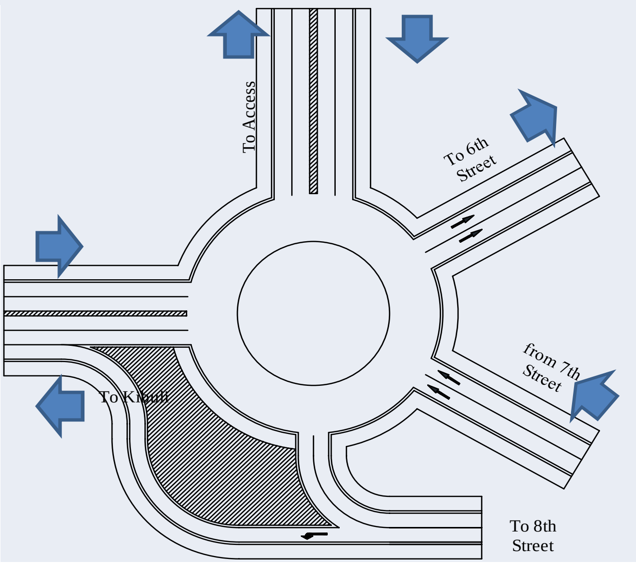
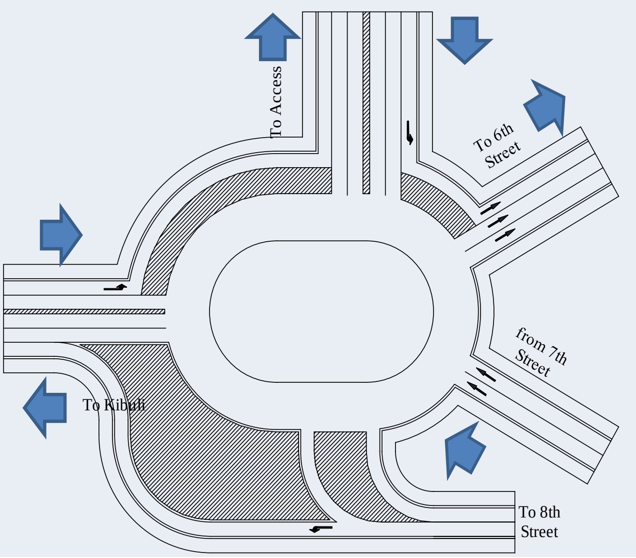
Given the abovementioned situation, the required road functions are defined as follows:

- ✓ Widening of Mukwano Road and part of Nsambya Road from 2-lane to 4-lane (dual carriageway construction of 1.8 km) for accommodating future traffic demand and flow,

- ✓ Junction improvement of Mukwano Roundabout and Nsambya/Kibuli Junction, in line with dual carriageway construction, and

- ✓ To consider minimizing the negative impacts to social environment.

Typical cross section including lane number and configuration of Nsambya/Kibuli Junction is decided automatically in accordance with the future traffic volume. Therefore, the following alternatives for improvement of Mukwano Roundabout were proposed as scenarios corresponding to the concepts of Mukwano Road Improvement Project.

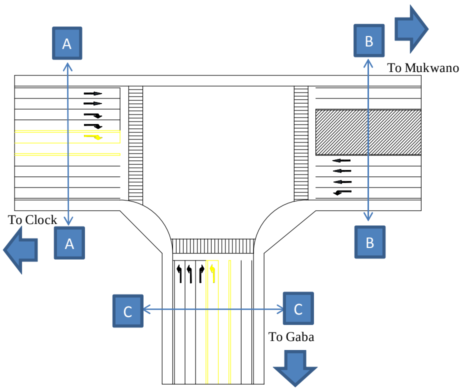
Alt	Configuration	Description
A		1. Change the existing small diameter roundabout of 25 m to a larger diameter (50-60 m) roundabout 2. Reducing the inflow leg to roundabout is an effective measure. From this viewpoint, one-way operation is applied on 6th Street and 7th Street.
B		1 and 2 noted above plus: 3. Combine 8th Road to the new roundabout for elimination of T-junction. T-junction of 8th Street is close to Mukwano Roundabout and has a large number of traffic. For this situation, existence of T-junction is one factor of traffic jam at Mukwano Roundabout.
C		1, 2 and 3 noted above plus: 4. Reducing the inflow traffic to roundabout is an effective measure. From this viewpoint, critical traffic flows with left turn are removed from roundabout through a bypass lane.

Source: JICA Study Team

Figure 7.3.3 Alternative and Options for Mukwano Roundabout Improvement

Name of Intersection: Kibuli Junction
Taget Year: 2023
Scale of Intersection: Large (K=3)
Number of Pedestrian: Small (f_L=0.85)

Approach	A		B		C			
	from Clock		from Mukwano		from Gaba			
	TR	RT	LT	TR	LT	RT		
Number of Lane	2	2	1	3	2	1		
Basic value of saturation flow rate	2000	1800	1800	2000	1800	1800		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00		
(Lane width: m)	3.50	3.50	3.50	3.50	3.50	3.50		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00		
(Gradient: %)	1.00	1.00	1.00	1.00	1.00	1.00		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00		
(Share of large vehicle: %)	0.00	0.00	0.00	0.00	0.00	0.00		
Reduction coefficient	1.00	1.00	1.00	1.00	1.00	1.00		
(Share of left turn: %)	-	-	100.00	-	100.00	-		
(E_{LT})	-	-	-	-	-	-		
(Effective green time: sec)	-	-	-	-	-	-		
(Green time for pedestrian: sec)	-	-	-	-	-	-		
Adjustment coefficient by pedestrian: fl	-	-	0.85	-	0.85	-		
Reduction Coefficient	1.00	1.00	1.00	1.00	1.00	1.00		
(Share of right turn: %)	-	-	-	-	-	-		
(Probability of right turn: f)	-	-	-	-	-	-		
(Effective green time: sec)	-	-	-	-	-	-		
(No. of right turn for transition time: K)	-	-	-	-	-	-		
Saturation flow ratio	4000	3600	1800	6000	3600	1800		
Traffic volume (pcu/hr)	1418	1281	256	2,221	1,731	418		
(Left turn or Right turn)	-	1281	256	-	1,731	418		
Flow ratio	0.35	0.36	0.14	0.37	0.48	0.23	λi	Σλ
Phase ratio — phase-1	0.35	0.36	-	-	0.24	-	0.36	0.97
Phase ratio — phase-2	-	-	0.14	0.37	-	-	0.37	
Phase ratio — phase-3	-	-	-	-	0.24	0.23	0.24	



Source: JICA Study Team

Figure 7.3.4 Required Configuration and Lane Number of Nsambya/Kibuli Junction

7.3.2 EVALUATION AND RECOMMENDATION

(1) Evaluation Method and Criteria

The most preferable configuration of Mukwano Roundabout is examined in this sub-chapter. Selection of preferable configuration was executed by project effect to decongestion.

Table 7.3.3 Criteria for Selection of Preferable Route and Option

Criteria	Sub-Criteria and Description
Contribution to decongestion	✓ Delay time at roundabout

Source: JICA Study Team

(2) Evaluation and Comparison for Mukwano Roundabout Improvement

The most important purposes for Mukwano Roundabout improvement are:

- To function as east-west trunk road
- To contribute to decongestion in urban area

Considering delay time viewpoint only, the effect of Alt.-A seems to be greater than those of Alt.-B and C. However, negative effect of T-Junction at 8th Street is not included in this delay time (135.1 s) because numeric evaluation of negative impact with close junction is difficult. For this reason, alternatives should be evaluated by both delay time and negative impact of 8th Street. As a result, Alt.-C was selected as the most effective improvement plan for Mukwano Roundabout.

Table 7.3.4 Change of Saturation and Delay Time by Improvement

Intersection And Roundabout	Y2010	Y2023		
	Traffic Survey Results	Alt.-A	Alt.-B	Alt.-C
Mukwano Rounabout	37.8 s	135.1 s	230.1 s	180.3 s
T-Junction at 8th Street	Close Junction of Mukwano Roundabout	Negative effect of T-Junction at 8th Street remained at Mukwano Roundabout	Negative effect of T-Junction at 8th Street is solved.	Negative effect of T-Junction at 8th Street is solved.
Kibuli Junction	1.34	0.97		

Source: JICA Study Team

(3) Recommendation

Alt.-C is still categorized into level "F" LOS. As mentioned above, the HCM recommends at least level "C" in urban area. The most effective measure is to disperse inbound traffic to Mukwano Roundabout. Therefore, upgrading of Nsambya/Gaba Road to dual carriageway which is planned in NTMP/GKMK should proceed in conjunction with the Mukwano Road Improvement Project.

Source: JICA Study Team

Figure 7.3.5 Proposal of Upgrading of Nsambya/Gaba Road

7.3.3 PRELIMINARY WORK QUANTITIES FOR THE PROJECT

Work quantities for the construction of the project were preliminarily calculated based on the design for widening of the roads. Quantities for major work items are shown in the following table.

Table 7.3.5 Preliminary Work Quantities for the Project

ITEM	UNIT	QUANTITY
DRAINAGE		
Concrete Pipe Culverts	m	500
Concrete for Drainage Facilities	m3	6,110
Concrete Karbing, Channeling, Open Drains	m	11,200
EARTHWORKS AND PAVEMENT		
Scarification and Recompaction of Existing Pavement Layers	m2	15,800
Common Exavation	m3	10,840
Embankment	m3	21,910
Subbase Course	m3	10,730
Base Course	m3	8,460
Asphalt Concrete Pavement	m3	5,570
STRUCTURES		
Structural Concrete	m3	680
Reinforing Bars	t	68

Source: JICA Study Team

7.4 SHOPRITE AND CLOCK TOWER JUNCTIONS TRAFFIC SAFETY IMPROVEMENT PROJECT

7.4.1 ALTERNATIVE PLAN STUDY

(1) Objectives

Improvements of Shoprite and Clock Tower junctions were planned in Kampala Urban Traffic Improvement Plan (KUTIP) in 2003. In response to the request from GOU, Shoprite and Clock Tower junctions were changed from roundabout to signalized junctions by a grant aid of GOJ in 2005-2007. However, many traffic accidents and serious traffic jam have happened at these junctions with unexpected increase of traffic and mixed traffic consisting of motorized traffic (general vehicles, taxis and bike taxis) and non-motorized traffic (pedestrians and bicycle taxis).

Given the above situation, the Study Team has proposed the traffic safety improvement project for both junctions.

(2) Design Standards

1) Applicable Design Standards

As described in Sub-chapter 7.2.1, the Road Design Manual is intended for use in the design of all rural roads in Uganda. The purpose of the manual is to give guidance and recommendations to the engineers responsible for the design of rural roads. Accordingly, as only limited description is available for urban roads in the manual, it would be necessary to refer to other design standards and manuals (such as AASHTO and Japanese Urban Road Standard) to set out some specific parameters which are not stipulated in the Road Design Manual in Uganda.

2) Geometric Design Parameters

The Study Team recommends application of design speed of 50 km/h in accordance with the

Road Design Manual in Uganda. Geometric parameters for design speed of 50 km/h and design speed of 30 km/h for intersection are shown in Sub-chapter 7.2.1.

3) Pavement Composition

Pavement composition for improvement of both junctions was applied using the same composition as with the Mukwano Road Improvement Project. The assumed pavement composition is shown in Figure 7.3.2.

(3) Alternative Plans and Project Concept

1) Existing Traffic Condition at Both Junctions and Kibuye Roundabout

Shoprite Junction and Clock Tower Junction are serious bottleneck points in Kampala City. In addition to these junctions, Kibuye Roundabout linked to Clock Tower Junction via Queen's way and Katwe Road is also a serious bottleneck point. Kibuye Roundabout will be affected by the improvement of both junctions. Hence, impacts to Kibuye Roundabout were also considered. Existing conditions of these junction and roundabout were evaluated using the traffic survey results of the Study Team as follows:

Table 7.4.1 Existing Conditions of Relevant Junctions and Roundabout

Indicator		Shoprite Junction	Clock Tower Junction	Kibuye Roundabout
Saturation	A.M.	1.72	1.01	-
	P.M.	1.07	1.03	-
Delay Time*	A.M.	-	-	61.8 sec
	P.M.	-	-	210.4 sec

Note *: per 15 minutes
Source: JICA Study Team

From the computed results of saturation and delay time, the situations of Shoprite Junction in the morning peak and Kibuye Roundabout in the evening peak were chaotic without doubt. Calculation result of Clock Tower Junction also indicates that intersection capacity is not sufficient for the existing traffic volume.

2) Preconditions for Improvement

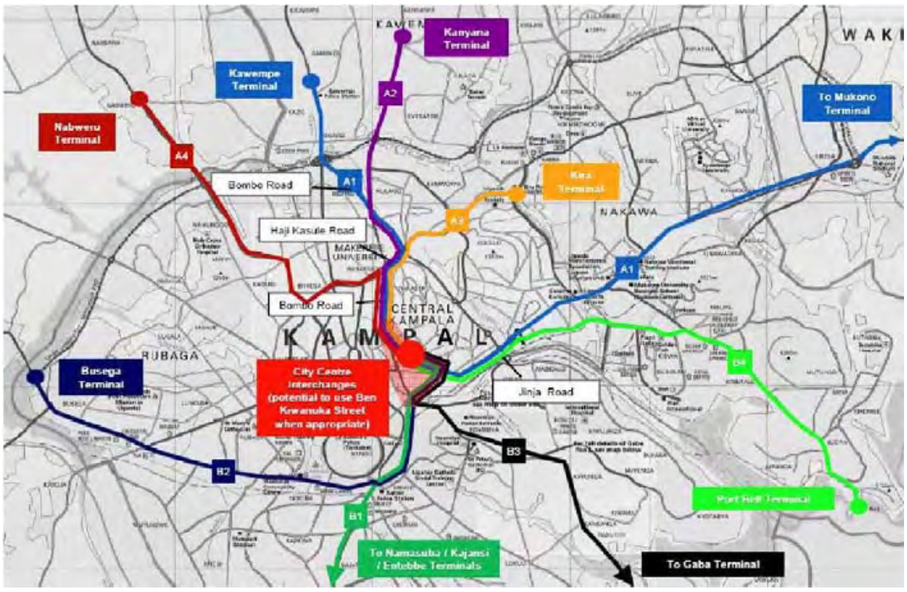
The following conditions were considered in the improvement plan:

A. Introduction of the BRT (at the time of 2023)

In service: A1, A2, A3, B1, B2 and Ben Kiwanuka Street

Non-operating: A4, B3, B4

Routes shown with red letter have an impact on the Junction Improvement Plan. Note that land required for non-operating section should be kept.



Source: Final Report of the BRT Pre-Fs (May 2010)

Figure 7.4.1 BRT Routes Planned by BRT Pre-FS

B. Preservation of Clock Tower

The clock tower in the Clock Tower Junction is one of the historical monuments in Kampala City. This monument was built in memory of Queen Elizabeth II following her first visit to Uganda in the 1950s. Relocation or removal of this monument will make improvement of both junctions easy and will upgrade the visibility of drivers. However, this monument should be preserved at the current location because removal will cause large social impacts. In addition, relocation of this monument will be difficult due to unsound structures.

Figure 7.4.2 Clock Tower

3) Project Concepts and Alternatives

Given above mentioned situations and preconditions, the following concepts were proposed:

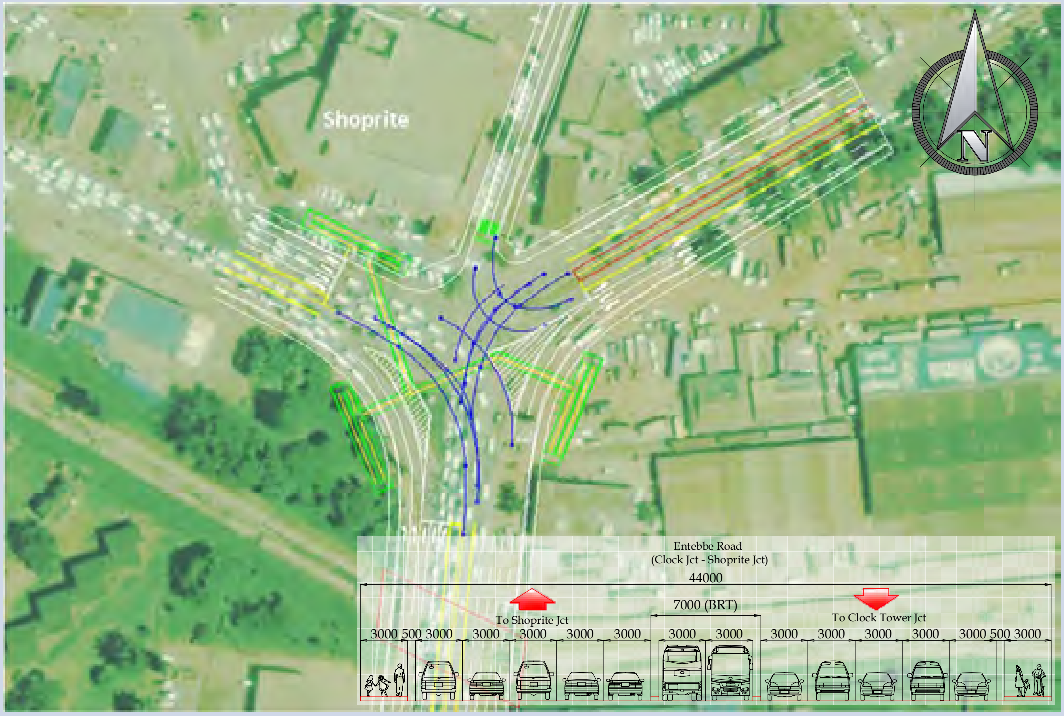
- ✓ To reduce traffic accidents by segregating vehicles and non-motorized traffic (pedestrians),
- ✓ To provide sufficient capacity corresponding to the future traffic demand and flows,
- ✓ To coordinate with the future plan such as the BRT, and
- ✓ To consider minimizing the negative impacts on social environment.

The following three alternatives were proposed based on the improvement concepts and discussion with key stakeholders:

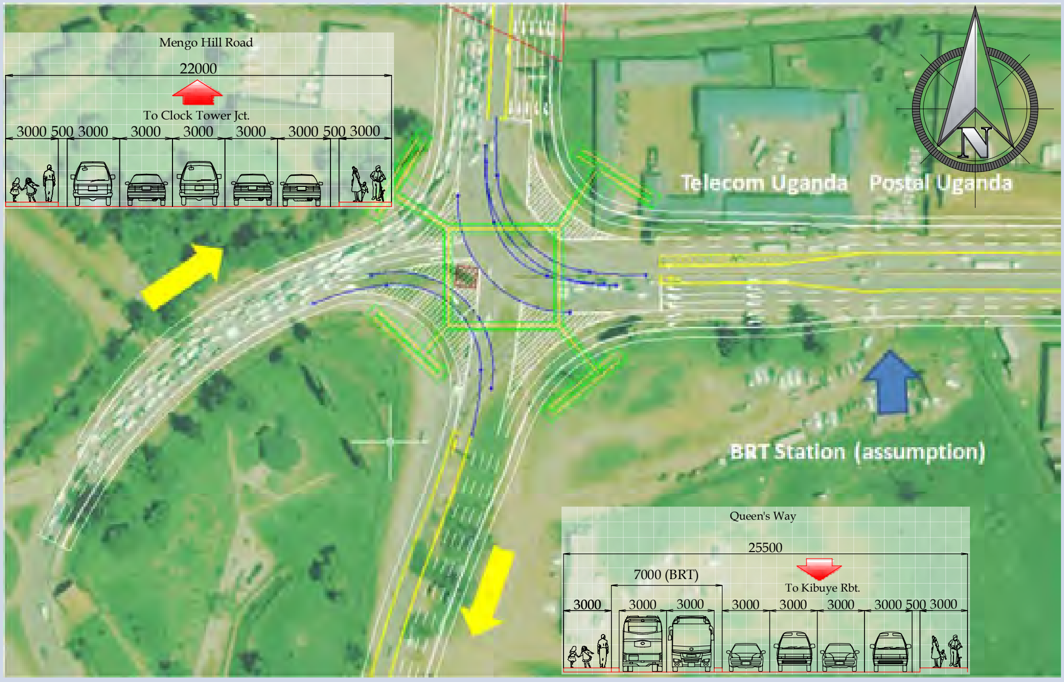
Alternative-1

Current one-way operation on Queen's way and Mengo Hill Road will be continued in the future.

Configuration and Main Typical Cross Sections of Shoprite Jct.



Configuration and Main Typical Cross Sections of Clock Tower Jct.



Source: JICA Study Team

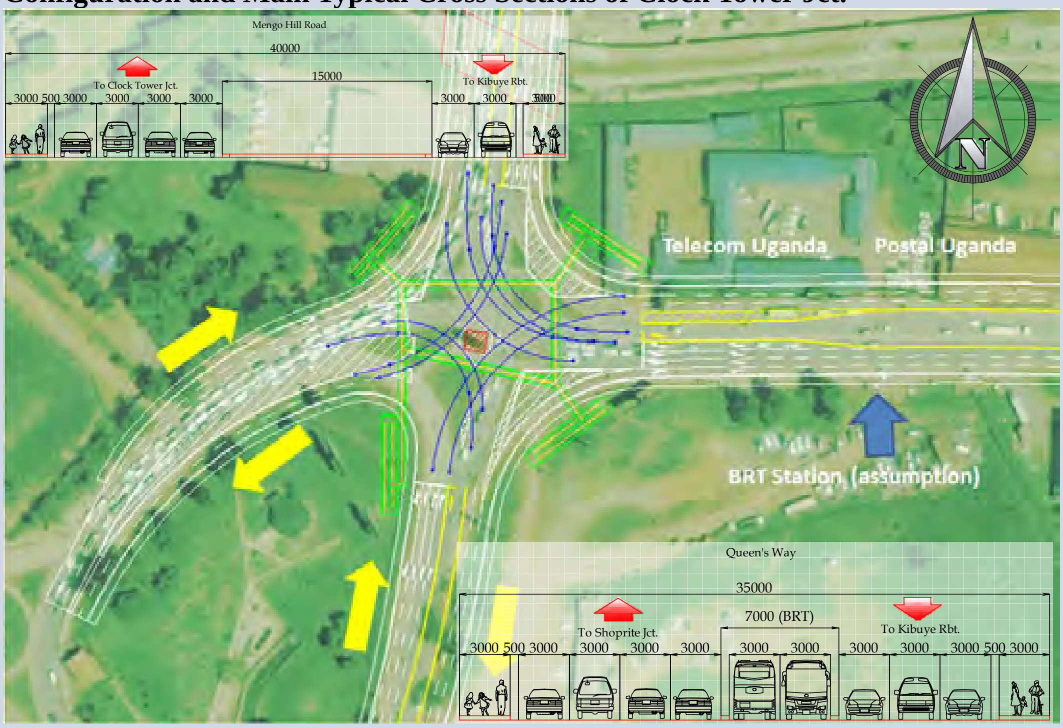
Figure 7.4.3 Shoprite/Clock Tower Jct. Improvement Plan (Alt.-1)

Alternative-2

Current one-way operation on Queen's way and Mengo Hill Road will be changed to two-way for both sides in the future.

Configuration and Main Typical Cross Sections of Shoprite Jct.

Configuration and Main Typical Cross Sections of Clock Tower Jct.



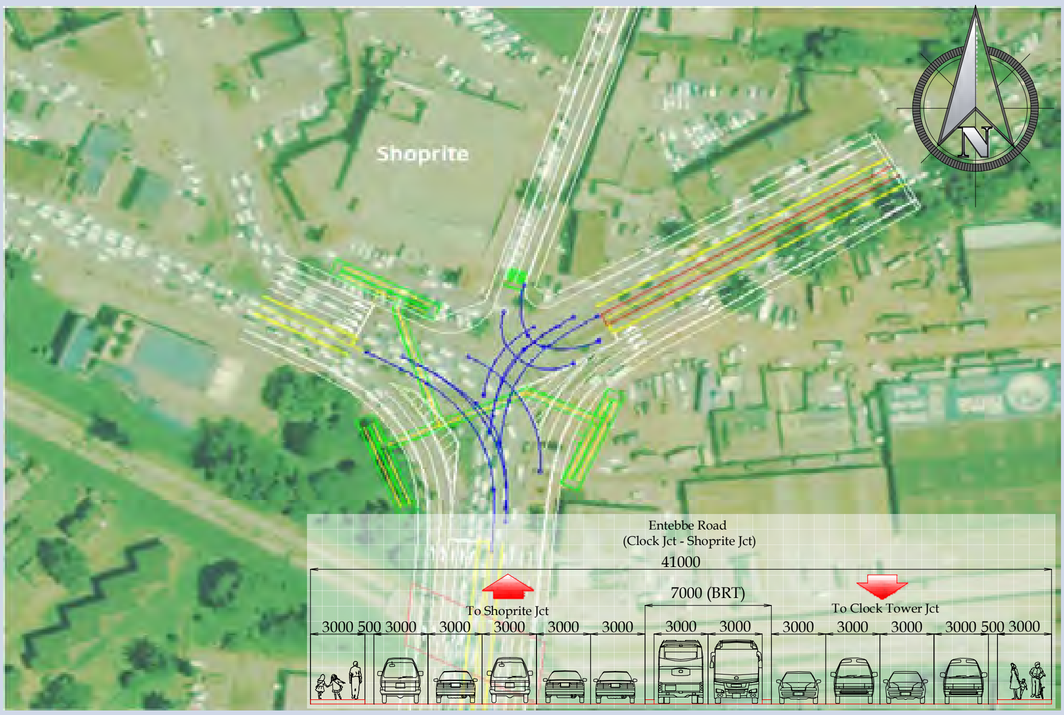
Source: JICA Study Team

Figure 7.4.4 Shoprite/Clock Tower Jct. Improvement Plan (Alt.-2)

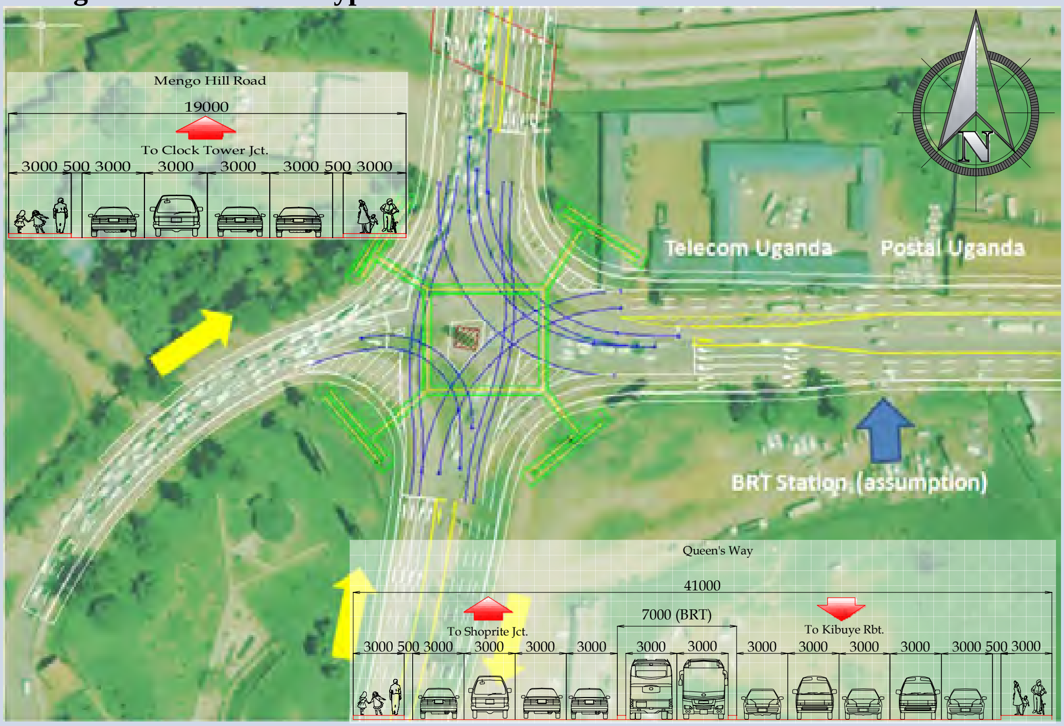
Alternative-3

Current one-way operation on Queen's way will be changed to two-way for both sides in the future. Mengo Hill Road will be continued current one-way operation.

Configuration and Main Typical Cross Sections of Shoprite Jct.



Configuration and Main Typical Cross Sections of Clock Tower Jct.



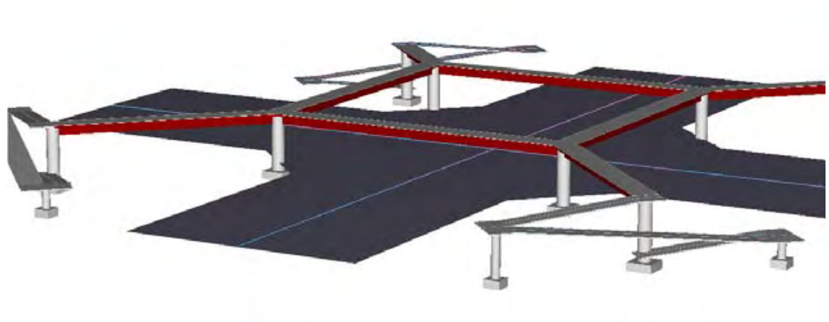
Source: JICA Study Team

Figure 7.4.5 Shoprite/Clock Tower Jct. Improvement Plan (Alt.-3)

4) Necessity of Pedestrian Bridges

Non-motorized traffic including pedestrians (48,000 daily) going across junctions causes not only reduction of road capacity but also increase of risk of traffic accident. However, ensuring safety of vulnerable road users such as pedestrian is the highest priority. In the drivers' view, unruly pedestrian flows and crossings not only cause traffic congestion on the road but also endanger their safety. This improvement project should make both junctions safer for pedestrians. For this purpose, separation of non-motorized traffic and motorized traffic is quite an effective measure.

From above viewpoints and improvement concepts, pedestrian bridges are planned for both safety and capacity improvements. Image of pedestrian bridge on Clock Tower Junction is shown in Figure 7.4.6. All non-motorized traffic can use pedestrian bridge with gentle slope.



Source: JICA Study Team

Figure 7.4.6 Image of Pedestrian Bridge on Clock Tower Junction

7.4.2 EVALUATION OF ALTERNATIVE PLANS

(1) Evaluation Method and Criteria

The most effective configuration and operation are examined in this sub-chapter. Selection of the most effective configuration and operation should not only consider the economic viewpoint but also take into account the negative impact to social environment and project effect to decongestion. Hence, the following criteria were applied for selection of suitable improvement plan.

Table 7.4.2 Criteria for Selection of Suitable Improvement Plan

Main Criteria	Sub-Criteria and Description
Consistency with the BRT	✓ Consistency during construction stage ✓ Any conflict such as necessary road width
Social Environment	✓ Number of resettlement and buildings to be demolished - Private - Public ✓ Area of land acquisition - Private - Public
Economic Efficiency	✓ Project cost
Contribution to Decongestion	✓ Saturation at intersection ✓ Delay time at roundabout

Source: JICA Study Team

(2) Evaluation and Comparison of both Flyover Projects

1) Coordination with the BRT Plan

As mentioned before, the BRT will be introduced on Entebbe Road, Ben Kiwanuka Street, Nsambya Road and Queen's Way. Impact of introduction of the BRT to each alternative is nearly identical. Location of the BRT station is expected in the section between Shoprite Junction and Clock Tower Junction. However, distance between two junctions is not enough for setting of the station. This issue is common to all alternatives.

2) Social Environment

Improvement of Clock Tower Juntion has the largest impact on Postal Uganda and Uganda Telecom. Both facilities should be relocated regardless of alternatives. On the other hand, in improvement of Shoprite Junction, a part of the parking area of Shoprite should be utilized for the setting of the pedestrian bridge. Area of land required and number of resettlement are summarized in Table 7.4.3. Note that area of land required and number of resettlement in this sub-chapter are rough estimations only for purposes of comparison. Hence, this result is not the final data for the resettlement in this project.

Table 7.4.3 Impact on Social Environment

Criteria	Alt.-1	Alt.-2	Alt.-3
Area (m^2)	12,614	13,905	13,468
No. of Resettlement	8	6	6

Source: JICA Study Team

3) Economic Efficiency

Economic efficiency is evaluated by project cost. The cost estimation for improvement project is conducted considering the possibility of ICB. Note that project cost in this sub-chapter is a rough estimation only for purposes of comparison. Hence, this project cost is not the finalized project cost.

Table 7.4.4 Economic Efficiency

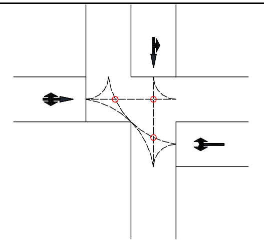
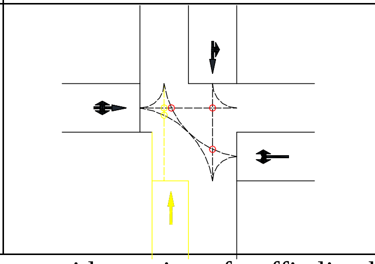
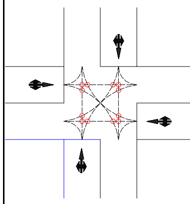
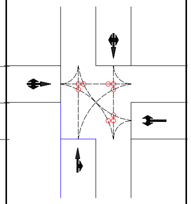
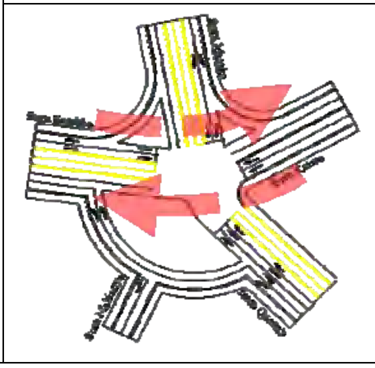
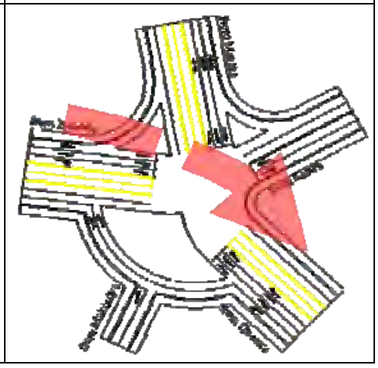
Criteria	Alt.-1	Alt.-2	Alt.-3
Project Cost (USD)	11,193,581	13,831,139	13,835,623
Ratio (Alt.-1=100)	100.0	123.6	123.6

Source: JICA Study Team

4) Contribution to Decongestion

The most important purpose for junction improvement project is to contribute to decongestion in urban area. Contribution to decongestion by junction improvement project is evaluated using the situation at junctions and delay time at roundabouts. However, as mentioned previously, traffic jam at Kibuye Roundabout is chaotic. Therefore, as precondition, Kibuye Roundabout is also improved from the roundabout to the junction. The detailed process of improvement of Kibuye Roundabout is shown in Annex 8.

Table 7.4.5 Change of Saturation by Junction Improvement

<table>
<tr><th rowspan="2">Junction and/or Roundabout</th><th>Y2010</th><th colspan="3">Y2023</th></tr>
<tr><th>Traffic Survey Results</th><th>Alt.-1</th><th>Alt.-2</th><th>Alt.3</th></tr>
<tr><td>Shoprite</td><td>1.72</td><td>0.78</td><td>0.88</td><td>0.88</td></tr>
<tr><td>Clock Tower</td><td>1.03</td><td>0.96</td><td>1.63</td><td>1.28</td></tr>
<tr><td rowspan="2">Operation</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Junction operation is to avoid crossing of traffic line by use of control facility such as traffic signal. Hence, in case of equal conditions, decrease of crossing point means decrease of saturation. In addition, one-way operation is also to reduce crossing of traffic line. (No. of crossing: Existing: 3, Alt.-1: 5, Alt.-2: 12, Alt.-3: 12)</td></tr>
<tr><td>Kibuye</td><td>210.4 s
(1.37*)</td><td>1.23</td><td>2.20</td><td>2.20</td></tr>
<tr><td colspan="2" rowspan="2">Kibuye plus
Kibuye Flyover**</td><td>0.93</td><td colspan="2">1.47</td></tr>
<tr><td></td><td colspan="2"></td></tr>
</table>

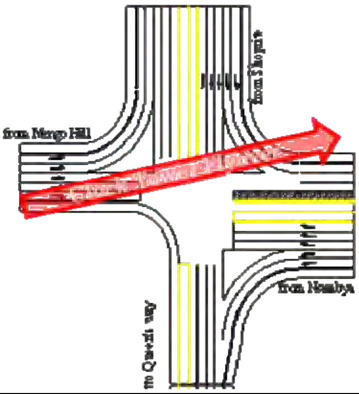
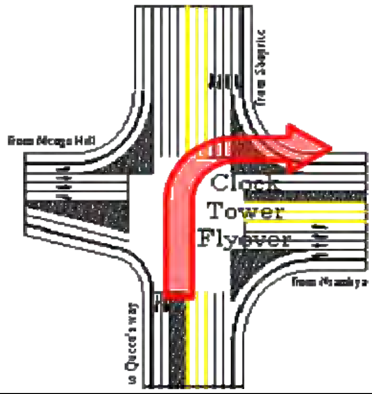
Note: *: In case Kibuye Roundabout is a signalized junction. (Assumption)
**: Detailed data for Kibuye Flyover is shown in Annex 8.
Source: JICA Study Team

In case of Alt.-2 and 3, serious traffic jam will not be solved at both Clock Tower Junction and Kibuye Roundabout. It means that changing operation from one-way to two-way for both directions is mildly effective.

(4) Necessity of Clock Tower Flyover

Given the above situation, impacts of Clock Tower Flyover were considered in all alternatives. As a consequence, flyover of Alt.-1 has great effect toward smoothness of traffic. On the other hand, flyovers of Alt.-2 and 3 also have great effects toward decongestion. However, they do not achieve smoothness of traffic. This means that investments on flyovers of Alt.-2 and 3 are only half measures.

Table 7.4.6 Impacts of Clock Tower Flyover

	Y2023		
	Alt.-1	Alt.-2	Alt.3
Saturation without Flyover	0.96	1.63	1.28
Saturation with Flyover	0.65	1.44	0.99
Configuration			
Additional Area (m2)	5,850 m2	5,450 m2	
Additional Resettlement No.	1 (Public facility)	1 (Public facility)	
Additional Cost (US$)	4,250,000 US$ (100)	6,440,000 US$ (152)	

Source: JICA Study Team

(5) Applicable Improvement Plan

Most evaluations in the above tables indicate that Alt.-1 is an acceptable improvement plan. Therefore, the Study Team recommends applying Alt.-1 as the better improvement plan for Clock Tower and Shoprite junctions at this stage. Main reasons for this are:

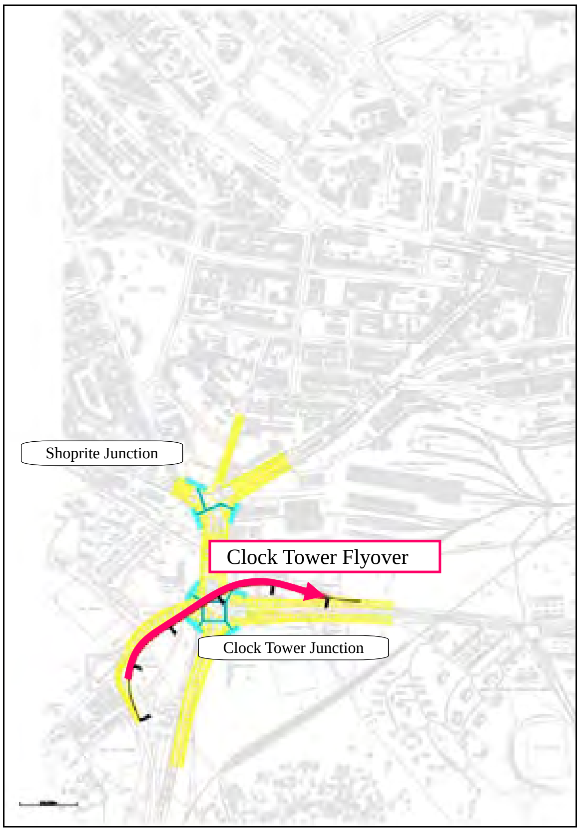
- highest effect to smoothness of traffic
- low project cost

Clock Tower Flyover in Alt.-1 will create additional effect. However, Alt.-1 without Clock Tower Flyover will function adequately up to 2023 (target year) or later. Hence, Clock Tower Flyover should be considered in conjunction with the progress of the BRT plan after completion of the proposed improvement plan. More study and discussion are required to identify what function should be given to Katwe Road and Queen's Way and the configuration of the BRT in this section.

7.4.3 ALTERNATIVE STRUCTURE PLAN

(1) Overall Flyover Plan

The purpose of flyover project is to alleviate serious traffic jam at urban center. In particular, traffic capacity increase by flyover construction is the only solution of traffic jam for Clock Tower Junction.



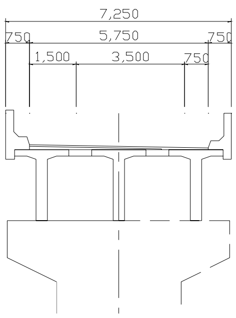
Source: The Study Team

Figure 7.4.7 Overall Flyover Plan of Clock Tower Junction

(2) Typical Cross Section for Flyover

Based on the geometric design standards in Uganda and preliminary planning of the projects, the Study Team set out the typical cross sections for flyover projects as shown in Figures 7.4.7.

Table 7.4.7 Typical Cross Section of Clock Tower Flyover

Typical Cross Section	Description
	**Clock Tower Flyover:** One-way Flyover with 1.5m (left side) and 0.75m (right side) shoulder width.

Source: JICA Study Team

(3) Applicable Span Length

The span arrangement and alignment layout are the key elements to determine the superstructure types. From our experiences in Uganda and other countries, the applicable superstructure types are the following: i) Steel I Girder, ii) Steel Box Girder, iii) Steel Arch, iv) PC T Girder, v) PC Box Girder, and vi) PC Extra-dosed.

Span length is predefined by the superstructure type. The table below shows the applicable span lengths for various superstructure types.

Table 7.4.8 Applicable Span Length by Bridge Type

Bridge Type		Applicable Span Length (m) 0 20 40 60 80 100
PC	T Girder	
	Box Girder	
	Extra-dosed	
Steel	I Girder	
	Box Girder	
	Arch	

Source: Design Data Book (Japan Association of Steel Bridge Construction),
PC Bridge Design Manual (Japan Pre-stressed Concrete Contractors Association)

(4) Span Length and Curve Radius by Alignment

According to the overall structure plan based on the preliminary planning of the projects, many curvilinear parts are within the route alignment. On the curved alignment, steel girder with high torsional rigidity is adopted. The cross section is determined based on the following figure:

Source: Steel Highway Bridge Design Manual

Figure 7.4.8 Curve Radius – Span Length Graph

(5) Bridge Type Selection

Based on the applicable span length by bridge type and span length-curve radius by alignment, Table 7.3.9 shows the bridge type selection for this project.

Table 7.4.9 Bridge Type with Property

Bridge Property		Widening Section	Curve Section – Radius (m)	
			From 60 to 160 m	More than 300 m
Span Length	Less than 40 m	Steel I Girder	Steel I Girder	PC T Girder
	From 55 to 60 m	-----	Steel Box Girder	PC Box Girder
	More than 80 m			(Comparison Study)

Source: JICA Study Team

Table 7.4.10 Result of Bridge Type Selection

Clock Tower Flyover

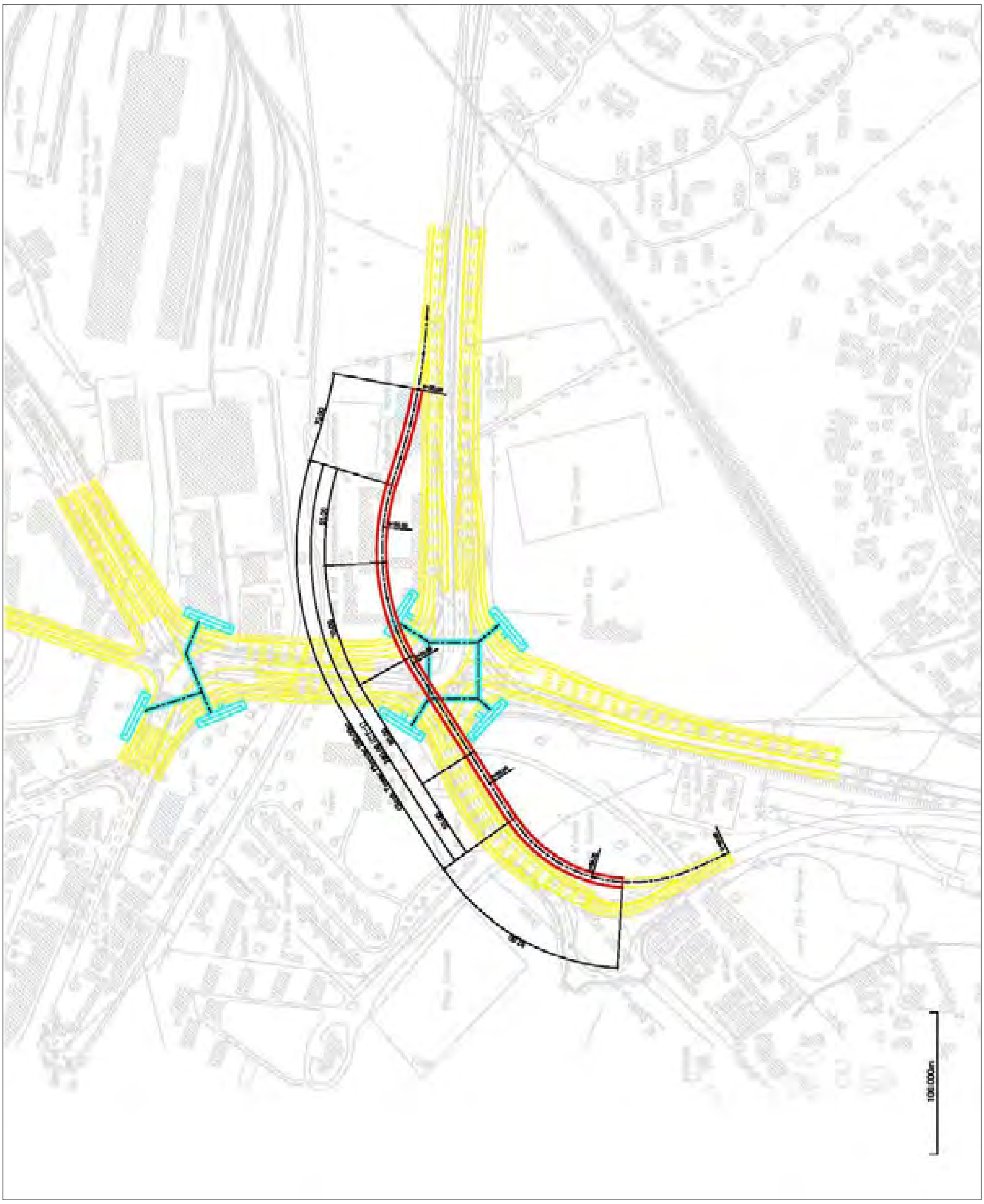
Start	Length (m)	End	Bridge No.	Max. Span Length (m)	Curve Radius (m)	Widening Width (m)	Material Type	Girder Type
0 + 78.00	92.0	1 + 70.00	Access Road (Mengo Hill Rd side)					
1 + 70.00	260.0	4 + 30.00	CT-1	80.00	155	7.25	Steel	Box
4 + 30.00	70.0	5 + 0.00	Access Road (Nsambya Rd side)					

Source: JICA Study Team

7.4.4 PRELIMINARY DESIGN FOR BEST ALTERNATIVES

(1) Preliminary Design for Flyovers with Span Arrangement

Results of preliminary design appropriate to the flyover plan are shown in Figure 7.4.9.



Source: JICA Study Team

Figure 7.4.9 Preliminary Flyover Plan of Clock Tower Junction

(2) Overall Layout and Cross Section

Overall layout view and cross section of the flyover are shown in "Volume II: Preliminary Design Drawings for Pre-FS Projects".

7.4.5 PRELIMINARY WORK QUANTITIES FOR THE PROJECT

(1) Improvement of Shoprite and Clock Tower Junctions

Work quantities for the construction of the Project were preliminarily calculated based on the design for improvement of Shoprite and Clock Tower junctions. Quantities for major work items are shown in the following table.

Table 7.4.11 Preliminary Work Quantities for the Project

ITEM	UNIT	QUANTITY		
		SHOPRITE AND CLOCK TOWER JCTS IMPROVEMENT PROJECT		
		Shoprite	Clock Tower	TOTAL
DRAINAGE				
Concrete Pipe Culverts	m	66	196	262
Concrete for Drainage Facilities	m3	907	2,365	3,272
Concrete Karbing, Channeling, Open Drains	m	2,094	4,868	6,962
EARTHWORKS AND PAVEMENT				
Scarification and Recompaction of Existing Pavement Layers	m2	5,786	12,855	18,641
Common Exavation	m3	0	0	0
Embankment	m3	0	0	0
Subbase Course	m3	1,355	3,512	4,867
Base Course	m3	1,196	2,929	4,125
Asphalt Concrete Pavement	m3	1,176	2,750	3,926
Asphalt Concrete Surfacing on Bridge Deck	m2			
STRUCTURES				
Steel Box Girder	t			0
Bored Pile	m			0
Structural Concrete	m3	733	539	1,272
Precast Concrete	m3	146	290	436

Source: JICA Study Team

(2) Breakdown of Flyover

Breakdown of quantity required for construction of the Clock Tower Flyover is shown in the following table.