PART V

PILOT PROJECT EXPERIMENT

CHAPTER 25

INTERSECTION IMPROVEMENTS

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CHAPTER 25 INTERSECTION IMPROVEMENTS

25.1 GENERAL

Background

The GOK requested JICA during the Preparatory Study carried out by Social Development Department of JICA Tokyo Headquarters in February 2004 to implement pilot projects under the Master Plan to examine the effectiveness of the proposed methodology. The pilot projects aimed to alleviate traffic congestion and improve traffic management. Candidates for the pilot project proposed by GOK are as follows:

- Traffic management including the improvement of junction
- Improvement of the missing link

Objectives

In order to response to the request of the GOK, JICA decided to carry out the Pilot Project during the course of the Study. However, due to budgetary limitations and short duration provided for not only to accomplish the Pilot Project itself but also to feedback the results to the on-going Mater Plan, improvement of the missing link was omitted from the scope of the Pilot Project. This was accepted by the GOK during the 1st Technical Working Group Discussion as well as the Steering Committee held in July 2004. Since then, the main objectives of the Pilot Project were re-defined as follows:

- To examine effects and impacts of improving geometrical configurations of junctions as well as installation of signal system
- To feedback the above results to the formulation of a Master Plan as well as the preparation of a Pre-Feasibility Study for priority projects.

Contents

Although the contents and location of the Pilot Project had been proposed by GOK and determined by JICA, the Study Team had investigated them again from traffic engineering perspective and general conditions assessment, such as social and environmental. The followings are the proposed contents of the Pilot Project:

- Modification of physical configurations of a particular junction
- Installation of traffic signal system in the same junction
- Monitor the conditions such as traffic volume as well as environmental conditions and public acceptance of the target junction before, during, and after the above described improvement works

25.2 SELECTION OF INTERSECTION

Alternatives

Generally, there are two types of junctions in the Study Area, namely intersections and roundabouts. Some of these junctions are signalized and some are not or signalized before but not functioning now. Converting the physical structure of a junction from one type to another had been done before in Nairobi City which could serve as reference of the Study. Two junctions are converted from non-signalized intersections to non-signalized roundabouts together with dualling of approaching and departing arterial along Langata Road in Nairobi South, in the late 1990's under the KUTIP[1]. The alternatives of the Pilot Projects are shown in Figure 25.2-1.

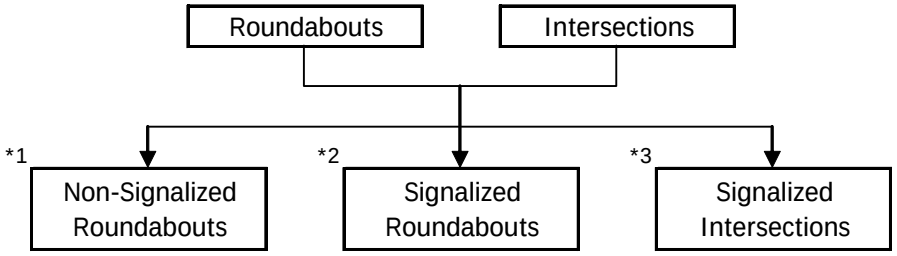


FIGURE 25.2-1 ALTERNATIVES OF THE PILOT PROJECT

TABLE 25.2-1 ADVANTAGES AND DISADVANTAGES OF THE ALTERNATIVES

From	Non-Signalized Intersections		Non-Signalized Roundabouts	
To	Non-Signalized Roundabouts*1	Signalized Roundabouts*2	Signalized Intersection*3	Signalized Roundabouts*2
Civil Works	Maximum (require enough space for circular lanes as well as approaching and departing lanes)		Moderate (require space for exclusive right turn lane along approaching lane)	Minimum or Not Required
Signal System	Not Required	Required (at least 4-phase system)	Required (at least 2-pahses system)	Required (at least 4-phase system)
Reduction of Traffic Congestions	Medium (if volume yet exceeding capacity) to Minimum (if volume already exceeding capacity)		Maximum (if volume yet exceeding capacity) to Medium (if volume already exceeding capacity)	Minimum (if volume already exceeding capacity)
Reduction of Traffic Accidents	Medium	Maximum	Medium	Maximum

[1] *Kenya Urban Transport Improvement Project carried out by World Bank in 1997*

Advantages and Disadvantages

Advantages and disadvantages of converting the physical configuration of junctions from particular type to another are shown in Table 25.2-1. The variables used for comparison are magnitude of required civil works, installation of signal system, impact to traffic congestion and traffic accidents.

Selection Procedures

Selection of experimental intersection for the Pilot Project was carried out through 4 steps as shown in Figure 25.2-2.

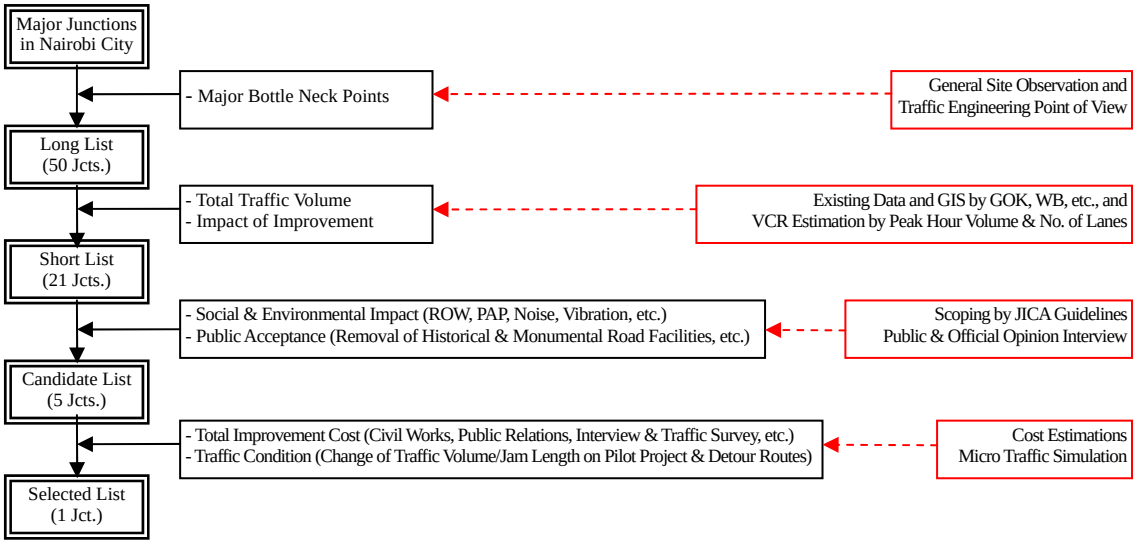


FIGURE 25.2-2 PROCEDURE OF LOCATION SELECTION

Long List

The Study Team observed the junctions which CCN proposed to improve in the Urbanized Area of City of Nairobi, and then selected 50 junctions as major bottle neck points in the said area as shown in Table 25.2-2 (“Long List”). In the list, 35 are roundabouts and the remaining 15 are intersections.

After selecting the 50 intersections, the Study Team reviewed the available traffic data and the traffic conditions at site and selected 21 intersections as shown in Table 25.2-3.

TABLE 25.2-2 LONG LIST OF THE PILOT PROJECT (MAJOR BOTTLENECK POINTS)

Type	No.	Name of Junction (Name of Roads Intersected)	Type	No.	Name of Junction (Name of Roads Intersected)
Roundabout	1.	Westlands (Chiromo Rd. / Lantana Rd.)	Roundabout	26.	Outer Ring Rd. / Airport North Rd.
	2.	Museum (Uhuru Hw. / Museum Hill Rd.)		27.	Jogoo Rd. / Likoni Rd.
	3.	University (Uhuru Hw. / University Way)		28.	Jogoo Rd. / First Ave.
	4.	Kenyatta (Uhuru Hw. / Kenyatta Av.)		29.	Jogoo Rd. / Lusaka Rd.
	5.	Railway Club (Uhuru Hw. / H. Selassie Av.)		30.	Lusaka Rd. / Enterprise Rd.
	6.	Bunyala (Uhuru Hw. / Bunyala Rd.)		31.	River Rd. / Tom Mboya St.
	7.	Nyayo Stadium (Uhuru Hw. / Langata Rd.)		32.	Muranga Rd. / Tom Mboya St.
	8.	Moi Av. / Haile Selassie Av.		33.	Museum Hill Rd. / Ngara Rd.
	9.	Haile Selassie Av. / Race Course Rd.		34.	Ngara Rd. / Muranga Rd.
	10.	Ring Road Pumwani / Landhies Rd.		35.	Ring Road Ngara / Juja Rd.
	11.	Ngara Rd. / Race Cource Rd.	Intersection	36.	Kenyatta Av. / Koinange St.
	12.	Ring Road Parkland / Lower Kabete Rd.		37.	Kenyatta Av. / Muindi Mbingu St.
	13.	Forest Rd. / Limuru Rd.		38.	Kenyatta Av. / Wabera St.
	14.	Forest Rd. / Ring Road Ngara		39.	Kenyatta Av. / Kimathi St.
	15.	Muthaiga Rd. / Thika Rd.		40.	Kenyatta Av. / Moi Av.
	16.	Ngong Rd. / Mbagathi Way		41.	Kenyatta Av. / Tom Mboya St.
	17.	Argwings Khodhek Rd. / Valley Rd.		42.	Moi Av. / City Hall Way
	18.	Argwings Khodhek Rd. / Woodlands Ave.		43.	Moi Av. / Ronald Ngara Rd.
	19.	Ngong Rd. / Elgeyo Market Rd.		44.	Moi Av. / Haranbee Av.
	20.	Ngong Rd. / Naivasha Rd.		45.	University Way / Koinange St.
	21.	Waiyaki Way / James Gichuru Rd.		46.	University Way / Muindi St.
	22.	Limuru Rd. / Muthaiga Rd.		47.	Haile Selassie Av. / Ragati Rd.
	23.	Thika Rd. / Outer Ring Rd.		48.	Muranga Rd. / Park Rd.
	24.	Outer Ring Rd. / Juja Rd.		49.	Lusaka Rd. / Dunga Rd.
	25.	Outer Ring Rd. / Jogoo Rd.		50.	Mombasa Rd. / Airport North Rd.

Short List

JICA's GIS Team assisted by SoK[2] and had carried out similar traffic counts at 21 major junctions in the same area from mid to end of January 2004, and these 21 junctions are part of the above "Long List". As a result, these 21 junctions were assumed to be as "Short List" as shown in Table 25.2-3. In this "Short List", 18 are roundabouts and the remaining 3 are intersections. According to these data, traffic volume passing through these junctions varied roughly from 10 to 50 thousand vehicles in daytime on a 12-hour basis (07:00 to 19:00).

Evaluation

To select several candidate intersections from the "Short List", the Study Team has applied rough Volume-Capacity Ratio (VCR) analysis. This method is based on the present traffic volume in any given peak hour versus the capacity of junction in terms of number of lanes applicable. The followings are the evaluation procedures with this method;

- The daily traffic volume was converted to peak hour volume by simply applying assumed peak hour factor with 0.10[3]

[2] *Survey of Kenya, (Department of Survey), Ministry of Lands and Housing.*

[3] *Common peak hour factor is assumed as 0.10 for this analysis, although the value might vary from place to place. Generally, the value tended to show much smaller (less than 0.10) in urbanized area, and much bigger (larger than 0.10) in rural area.*

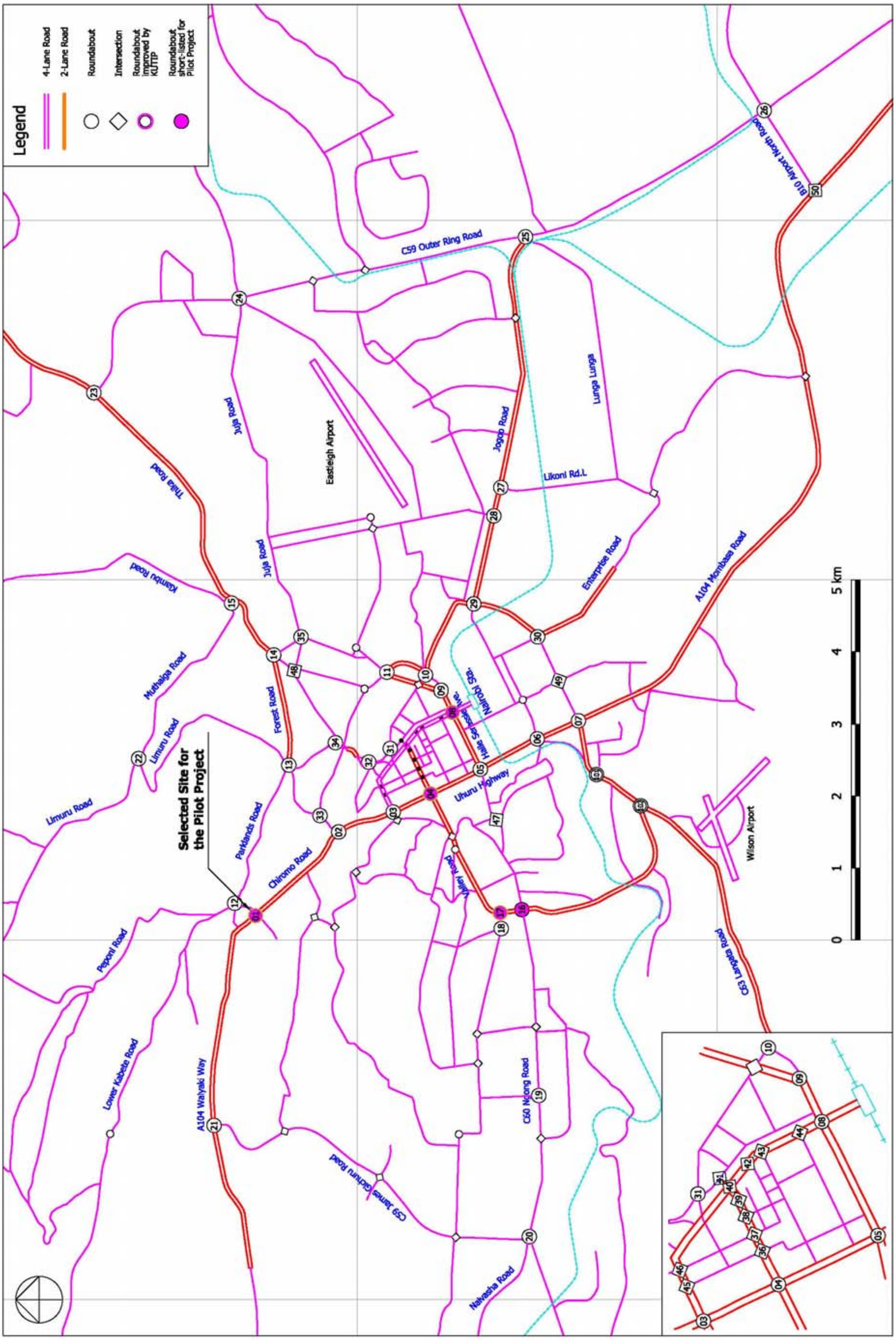


FIGURE 25.2-3 LONG LIST OF THE PILOT PROJECT (MAJOR BOTTLE NECK POINTS)

TABLE 25.2-3 SHORT LIST OF THE PILOT PROJECT WITH OBSERVED TRAFFIC

(Unit: 100 Vehicles per 12-hours)

Type	No.	Name of Junction (Name of Roads Intersected)	N	S	W	E	X	Y	Section Total	Through Total
Roundabout	1.	Westlands (Chiromo Rd. / Lantana Rd.)	467	337	99	150			527	263
	2.	Museum (Uhuru Hw. / Museum Hill Rd.)	402	506		274			591	296
	3.	University (Uhuru Hw. / University Way)	602	390	317	344			827	413
	4.	Kenyatta (Uhuru Hw. / Kenyatta Av.)	390	365	374	338			734	367
	5.	Railway Club (Uhuru Hw. / H. Selassie Av.)	576	722	352	386			1,018	509
	6.	Bunyala (Uhuru Hw. / Bunyala Rd.)	808	340	198	321	78		873	436
	7.	Nyayo Stadium (Uhuru Hw. / Langata Rd.)	349	428	323	308			704	352
	8.	Moi Av. / Haile Selassie Av.	216	77	347	331			486	243
	10.	Ring Road Pumwani / Landhies Rd.	298	289	208	435			615	308
	11.	Ngara Rd. / Race Cource Rd.	260	205	169	298			466	233
	13.	Forest Rd. / Limuru Rd.	402	358	98	153	186		599	299
	14.	Forest Rd. / Ring Road Ngara	452	303	166	145			533	267
	16.	Ngong Rd. / Mbagathi Way	246	257	267	252			511	256
	17.	Argwings Khodhek Rd. / Valley Rd.	227	246	292	114			440	220
	23.	Thika Rd. / Outer Ring Rd.	359	443		259			531	265
	29.	Jogoo Rd. / Lusaka Rd.	374	293		534			601	300
	32.	Muranga Rd. / Tom Mboya St.	672	168	93	389	41	135	749	375
	34.	Ngara Rd. / Muranga Rd.	413	672	223	107	36		726	363
Intersec.	36.	Kenyatta Av. / Koinange St.	151	149	342	230			436	218
	40.	Kenyatta Av. / Moi Av.	124	166	91	51			216	108
	47.	Haile Selassie Av. / Ragati Rd.	149	68	121	221			280	140

Data Source: JICA GIS Study Team (Kokusai Kogyo Co., Ltd)

- Assumed capacity of carriage way (approach lane, exit lane, circular lane) is fixed as 1,500 vehicles per hour per lane[4] for whatever type of junction (i.e. roundabout, or intersection)
- For roundabout, the capacity of junction shall be determined by the number of circular lanes, and traffic volume pass through the junction shall be determined by the sum of inbound traffic from all approaching legs.
- For intersection, the capacity of junction shall be determined by the number of approach lanes, and traffic volume pass through the junction shall be determined by the sum of higher inbound traffic from corresponding opposed leg. (i.e. either North or South bound traffic whichever higher, plus either East or West bound traffic which ever higher, and if there are more than 4 legs, plus remaining traffic flows whichever higher)

The results of the evaluation for these 21 junctions both with present configuration and converted configuration, are summarized in Table 25.2-4.

[4] *Basic capacity of carriage way is around 2,000 pcu/hr/lane (1,800~2,200 pcu/hr/lane). In this analysis, it is assumed as 1,500 vehicles/hr/lane considering mixture of different size of vehicles (passenger car unit [pcu], varies from 0.5 for motorcycle to 3.0 for articulated truck) and conflict with side obstacles and other traffic, narrow lane width, and/or loss time caused by delay of re-start, entangled traffic flows around the junctions.*

TABLE 25.2-4 RESULTS OF EVALUATION FOR 21 SHORT LISTED JUNCTIONS

Type	No.	Name of Junction (Name of Roads Intersected)	No. of Legs	Roundabout		Intersection							Recommended Configuration	Effect of Conversion
				No. of C. Lanes	VCR	No. of A. & E. Lanes						VCR		
Roundabout	1.	Westlands (Chiromo Rd. / Lantana Rd.)	4	2	1.76	4	6	2	2			1.28	I/S	1.37
	2.	Museum (Uhuru Hw. / Museum Hill Rd.)	3	3	1.31	6	6		2			1.48	R/A	0.89
	3.	University (Uhuru Hw. / University Way)	4	3	1.84	6	6	4	4			1.24	I/S	1.48
	4.	Kenyatta (Uhuru Hw. / Kenyatta Av.)	4	4	1.22	6	6	6	6			0.85	I/S	1.44
	5.	Railway Club (Uhuru Hw. / H. Selassie Av.)	4	3	2.26	6	6	4	4			1.45	I/S	1.56
	6.	Bunyala (Uhuru Hw. / Bunyala Rd.)	5	3	1.94	6	6	2	4	1		2.08	R/A	0.93
	7.	Nyayo Stadium (Uhuru Hw. / Langata Rd.)	4	3	1.56	6	4	4	2			1.74	R/A	0.90
	8.	Moi Av. / Haile Selassie Av.	4	3	1.08	4	4	4	4			0.94	I/S	1.15
	10.	Ring Road Pumwani / Landhies Rd.	4	2	2.05	4	2	2	4			1.69	I/S	1.21
	11.	Ngara Rd. / Race Cource Rd.	4	2	1.55	2	4	2	4			1.43	I/S	1.09
	13.	Forest Rd. / Limuru Rd.	5	2	2.00	2	2	2	4	2		2.29	R/A	0.87
	14.	Forest Rd. / Ring Road Ngara	4	2	1.78	4	2	4	2			1.49	I/S	1.19
	16.	Ngong Rd. / Mbagathi Way	4	2	1.70	2	4	2	2			1.71	R/A	1.00
	17.	Argwings Khodhek Rd. / Valley Rd.	4	2	1.47	4	2	2	2			1.79	R/A	0.82
	23.	Thika Rd. / Outer Ring Rd.	3	2	1.77	4	4		2			1.60	I/S	1.10
	29.	Jogoo Rd. / Lusaka Rd.	3	3	1.33	4	4		4			1.51	R/A	0.88
	32.	Muranga Rd. / Tom Mboya St.	6	4	1.25	4	2	2	2	2	2	2.87	R/A	0.44
	34.	Ngara Rd. / Muranga Rd.	5	3	1.61	2	2	2	2	2		3.10	R/A	0.52
Intersec.	36.	Kenyatta Av. / Koinange St.	4	2	1.45	2	2	2	2			1.64	R/A	1.13
	40.	Kenyatta Av. / Moi Av.	4	2	0.72	2	2	2	2			0.86	R/A	1.19
	47.	Haile Selassie Av. / Ragati Rd.	4	2	0.93	2	2	2	2			1.23	R/A	1.32

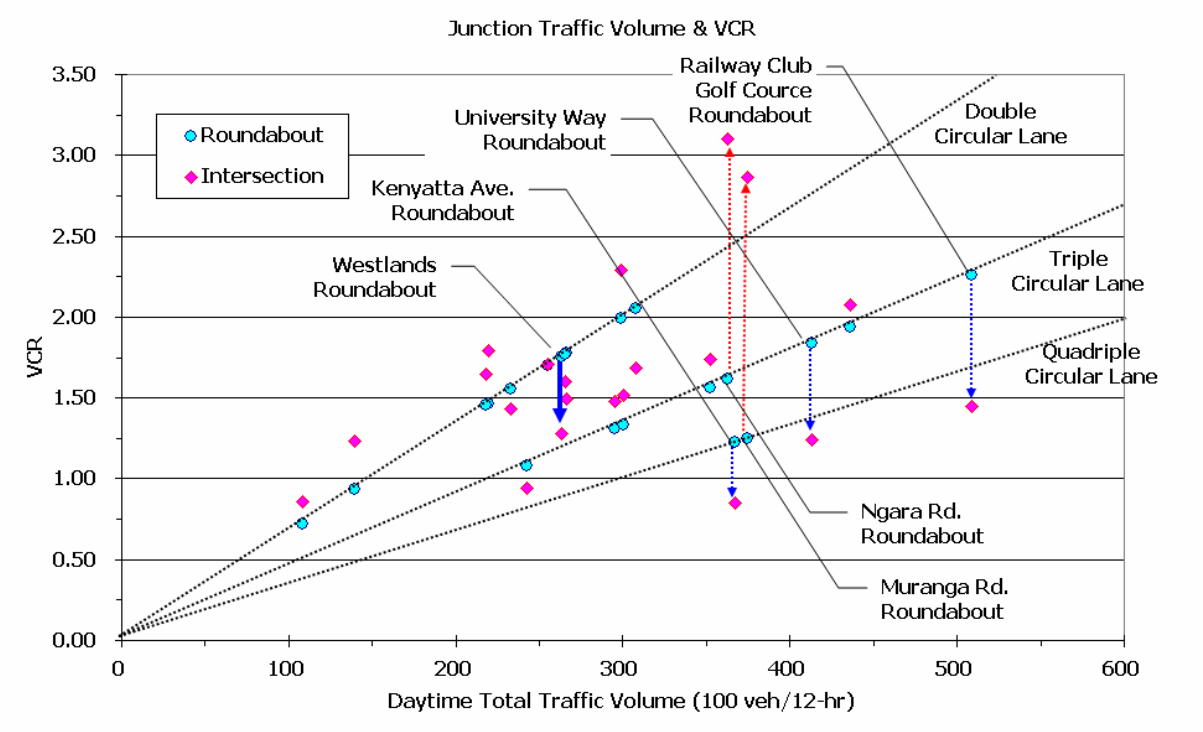


FIGURE 25.2-4 ESTIMATED VCR CHANGE IN CASE OF CONVERSION

Figure 25.2-4 shows estimated VCR change for intersections. VCR for roundabouts is subject to number of circular lanes. Therefore, VCR improvement for roundabout shall be easily achieved by adding extra circular lane(s) theoretically, if there is no physical restriction to road reserves, etc. Or just convert its configuration to intersection, if number of joining legs is less than 4. On the other hand, if the number of joining legs is more than 4 (i.e. 5 or 6 legs,

such as No. 6, 13, 32, and 34 of the intersections), conversion from roundabout to intersection are not recommendable, since some of incoming flows increase significantly, and conventional type intersection will not be able to handle all flows efficiently, unless some legs are assigned to outgoing flows only. In addition, some un-signalized intersections without heavy traffic volume may be better to be roundabout rather than original style, as seen as those junctions converted from intersections to roundabouts under KUTIP.

According to this result, in terms of VCR changes, some roundabout type junctions (No. 1, 3, 4, 5, 8, 10, 11, 14, 23, and 29) are recommendable to convert to conventional intersection while some are not (No. 2, 6, 7, 13, 16, 17, 32, and 34). In addition, one of the remaining three un-signalized intersections (No. 47) might be convertible from present style to roundabout if such conversion is practically possible. The remaining two intersections (No.36, and 40) are located in the CBD, and conversion from present style to roundabout is not practically possible. Provision of exclusive right turn lane and/or additional through path lane is recommended to increase the capacity of these junctions.

Candidate List

Table 25.2-5 shows the evaluated score for short listed candidate intersections for the pilot project. In terms of effect for conversion, the highest effect is seen at Railway Club Roundabout (No.5, marked 1.56 from 2.26 to 1.45), followed by University Way Roundabout (No.3, 1.48 = 1.84 / 1.24), Kenyatta Avenue Roundabout (No. 4, 1.44 = 1.22 / 0.85), and Westlands Roundabout (No.1, 1.37 = 1.76 / 1.28). All these roundabouts are located along International Arterials; consist of Uhuru Highway, Chiromo Road, and Waiyaki Way. Except Westlands Roundabout, other junctions are located at two major arterials merged each other and those roundabouts are signalized[5]. Although, precise effects shall be determined by detail analysis in the course of Master Plan, actual effect may be much less than estimated. This is because the evaluation method did not consider whether an intersection is signalized or not.

In addition, the VCR method is not the only indicator to evaluate the necessity of improvement of the junction. In this experiment, there are several criteria that are considered, such as financial, social, environmental issues, as well as time framework. With all that in mind, the Study Team has established an evaluation matrix to select the most suitable location to carry out the Pilot Project as shown in Table 25.2-6.

5 *University Way Roundabout was signalized before, but it is not working at this moment*

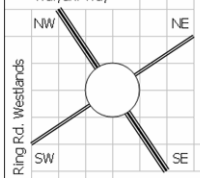
TABLE 25.2-5 EVALUATED SCORE FOR SHORT LISTED CANDIDATE JUNCTIONS FOR THE PILOT PROJECT

#	Name of Junction	Engineering Evaluation				Environmental & Social Evaluation				Other Evaluation			Overall Evaluation		Remarks
	(Name of Roads Intersected)	Effect	Affect	Cost	Sub Total	Regulation	Interview	Work Shop	Sub Total	O & M	Traffic Safety	Sub Total	Total	Score	
1.	Westlands (Chiromo Rd. / Lantana Rd.)	2	3	3	24	3	5	5	26	3	3	12	62	1st	R/A to I/S
2.	Museum (Uhuru Hw. / Museum Hill Rd.)	0	3	3	12	1	2	5	16	1	5	12	40		R/A to R/A
3.	University (Uhuru Hw. / University Way)	2	2	1	18	3	3	5	22	3	3	12	52	4th	R/A to I/S
4.	Kenyatta (Uhuru Hw. / Kenyatta Av.)	2	3	1	20	3	2	5	20	3	3	12	52	3rd	R/A to I/S
5.	Railway Club (Uhuru Hw. / H. Selassie Av.)	3	1	1	22	3	2	5	20	3	3	12	54	2nd	R/A to I/S
6.	Bunyala (Uhuru Hw. / Bunyala Rd.)	0	2	2	8	3	2	5	20	1	5	12	40		R/A to R/A
7.	Nyayo Stadium (Uhuru Hw. / Langata Rd.)	0	3	2	10	3	3	5	22	1	5	12	44		R/A to R/A
8.	Moi Av. / Haile Selassie Av.	1	4	2	18	3	1	3	14	3	3	12	44		R/A to I/S
10.	Ring Road Pumwani / Landhies Rd.	1	3	3	18	3	2	3	16	3	3	12	46		R/A to I/S
11.	Ngara Rd. / Race Course Rd.	1	4	3	20	3	2	3	16	3	3	12	48		R/A to I/S
13.	Forest Rd. / Limuru Rd.	0	3	3	12	1	1	3	10	1	5	12	34		R/A to R/A
14.	Forest Rd. / Ring Road Ngara	1	3	3	18	3	1	3	14	3	3	12	44		R/A to I/S
16.	Ngong Rd. / Mbagathi Way	0	3	4	14	3	3	3	18	1	5	12	44		R/A to R/A
17.	Argwings Khodhek Rd. / Valley Rd.	0	4	4	16	3	2	3	16	1	5	12	44		R/A to R/A
23.	Thika Rd. / Outer Ring Rd.	1	3	4	20	3	1	3	14	3	3	12	46		R/A to I/S
29.	Jogoo Rd. / Lusaka Rd.	0	3	3	12	3	1	3	14	3	3	12	38		R/A to I/S
32.	Muranga Rd. / Tom Mboya St.	0	3	3	12	3	1	3	14	1	5	12	38		R/A to R/A
34.	Ngara Rd. / Muranga Rd.	0	3	4	14	3	1	3	14	1	5	12	40		R/A to R/A
36.	Kenyatta Av. / Koinange St.	1	4	2	18	3	1	3	14	1	3	8	40		I/S to R/A
40.	Kenyatta Av. / Moi Av.	1	5	2	20	3	1	3	14	1	3	8	42		I/S to R/A
47.	Haile Selassie Av. / Ragati Rd.	1	4	2	18	3	1	3	14	1	3	8	40		I/S to R/A
	Weighed Points	**30**	**10**	**10**	**50**	**10**	**10**	**10**	**30**	**10**	**10**	**20**	**100**		

TABLE 25.2-6 COMPARISONS FOR CANDIDATE JUNCTIONS FOR THE PILOT PROJECT

1. Westlands (Chiromo Rd. / Lantana Rd.)

Schematic Plan



Roundabout	Inner Circle		44	/	66	m	Traffic Volume	Section	NW	SE	SW	NE
	Outer Circle		60	/	82	m		Daytime	467	337	99	150
	Lane			2				Peak Ratio		0.10		
	Area(In/Out)	2,281	/	4,251	m^2			D-Factor		0.75		
Leg	Section	NW	SE	SW	NE			Peak Hour	35	25	7	11
	Lane	4	6	2	2			Per Lane	18	8	7	11
	RoW	75	60	30	30			Max Direct.	18		11	
	Median	Y	Y	N	N			Saturate Vol.		29		

Volume Capacity Ratio

Roundabout (as un-controlled)
VCR= 79 / 30 = 2.63

Intersection (as controlled)
VCR= 29 / 15 = 1.92

Improvement Effect = 1.37

Recommendation (Score= 62 / Priority= 1st)

Most suitable candidate, in terms of scale of traffic volume and expected improvement effect.

Remarks

Traffic on Ring Road Westlands toward NE is affecting junction's traffic flow, and width of carriage way of said road is limited.

Bus bays on Chiromo Road are located too near the Junction, and double parking Matatu are disturbing smooth traffic flow.

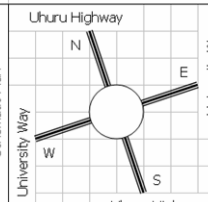
Parking lots occupied road reserves of Waiyaki Way & Chiromo Road cause road alignment shift of those arterials.

Electric poles & street lights in the roundabout island are required to relocate in case of improvement works.

Traffic signal installed recently is not working now, due to lack of in cooperating civil works in the experimental attempt.

3. University (Uhuru Hw. / University Way)

Schematic Plan



Roundabout	Inner Circle		40			m	Traffic Volume	Section	N	S	W	E
	Outer Circle		63			m		Daytime	602	390	317	344
	Lane			3				Peak Ratio		0.10		
	Area(In/Out)	1,257	/	3,117	m^2			D-Factor		0.75		
Leg	Section	N	S	W	E			Peak Hour	45	29	24	26
	Lane	6	6	4	4			Per Lane	15	10	12	13
	RoW	50	50	50	50			Max Direct.	15		13	
	Median	Y	Y	Y	N			Saturate Vol.		28		

Volume Capacity Ratio

Roundabout (as un-controlled)
VCR= 124 / 45 = 2.76

Intersection (as controlled)
VCR= 28 / 15 = 1.86

*Improvement Effect = 1.48

Recommendation (Score= 52 / Priority= 4th)

Not recommendable, in terms of cost and number of affected traffic volume.

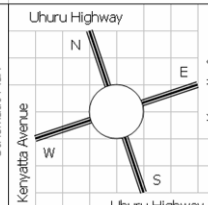
Remarks

Signalized roundabout (Out of Order)

Signal sequence is uncertain.

4. Kenyatta (Uhuru Hw. / Kenyatta Av.)

Schematic Plan



Roundabout	Inner Circle		40			m	Traffic Volume	Section	N	S	W	E
	Outer Circle		70			m		Daytime	390	365	374	338
	Lane			4				Peak Ratio		0.10		
	Area(In/Out)	1,257	/	3,848	m^2			D-Factor		0.75		
Leg	Section	N	S	W	E			Peak Hour	29	27	28	25
	Lane	6	6	6	6			Per Lane	10	9	9	8
	RoW	50	50	50	50			Max Direct.	10		9	
	Median	Y	Y	Y	Y			Saturate Vol.		19		

Volume Capacity Ratio

Roundabout (as un-controlled)
VCR= 110 / 60 = 1.83

Intersection (as controlled)
VCR= 19 / 15 = 1.27

*Improvement Effect = 1.44

Recommendation (Score= 52 / Priority= 3rd)

Not recommendable, in terms of cost and number of affected traffic volume.

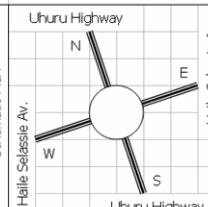
Remarks

Signalized roundabout

Signal sequence is around 120-sec, and each leg is assigned around 30-sec green-phase & 90-sec red-phase.

5. Railway Club (Uhuru Hw. / H. Selassie Av.)

Schematic Plan



Roundabout	Inner Circle		40			m	Traffic Volume	Section	N	S	W	E
	Outer Circle		63			m		Daytime	576	722	352	386
	Lane			3				Peak Ratio		0.10		
	Area(In/Out)	1,257	/	3,117	m^2			D-Factor		0.75		
Leg	Section	N	S	W	E			Peak Hour	43	54	26	29
	Lane	6	6	4	4			Per Lane	14	18	13	14
	RoW	50	50	50	50			Max Direct.	18		14	
	Median	Y	Y	N	Y			Saturate Vol.		33		

Volume Capacity Ratio

Roundabout (as un-controlled)
VCR= 153 / 45 = 3.39

Intersection (as controlled)
VCR= 33 / 15 = 2.17

*Improvement Effect = 1.56

Recommendation (Score= 54 / Priority= 2nd)

Not recommendable, in terms of cost and number of affected traffic volume.

Remarks

Signalized roundabout

Signal sequence is around 120-sec, and each leg is assigned around 30-sec green-phase & 90-sec red-phase.

TABLE 25.2-7 EVALUATION CRITERIA FOR THE SELECTION OF JUNCTION

Engineering Criteria	
- Effect (VCR Change):	>2.0=5, >1.75=4, >1.50=3, >1.25=2, >1.00=1
- Affect (Daytime Traffic Volume in Thousand):	<25.0=5, <50.0=4, <75.0=3, <100.0=2, >100.0=1
- Cost (Total Number of Lanes Merged):	<8=5, <12=4, <16=3, <20=2, >20=1
Environmental & Social Criteria	
- Regulation (RoW, PAP, Noise, Vibration, etc.):	Category-C=5, Category-B=3, Category-A=1
- Interview (include Residents / Shop Owner / Road Users / Operators):	Acceptable=5, Average=3, Not Acceptable=1
- Workshop (include GOK Officials, Experts from University, Donors, NGOs, Citizens, etc.):	Acceptable=5, Average=3, Not Acceptable=1
Other Criteria	
- Operation & Maintenance (Traffic Signal System, etc.):	Uncontrolled Roundabout = 5 Uncontrolled Intersection = 5 Controlled Intersection = 3 Controlled Roundabout = 1
- Traffic Safety (Accident Rate, etc.):	Controlled Roundabout = 5 Uncontrolled Roundabout = 3 Controlled Intersection = 3 Uncontrolled Intersection = 1

The evaluation criteria adopted for the selection of junction for pilot project is shown in Table 25.2-7. From engineering point of view, VCR change is the most important indicator, followed by affected traffic volume and construction cost. Note that affected traffic volume is set as negative factor, since this is a public experiment and there are possible negative impacts such as delay to crossing pedestrians and increase of air pollution.

From environmental and social point of view, negative impacts, such as increase of air pollution, additional right of way acquisitions, relocation of houses and/or shops, and excess noise and/or vibration, etc. shall be minimized. Moreover, opinion of the public as well as decision makers shall be considered.

In addition, operation and maintenance cost and traffic safety aspects shall be considered from various point of view after the experimental stage, since operation of installed signal system must be continued after the Pilot Project Experiment.

Based on the results of the evaluation, the Study Team decided to carry out the Pilot Project Experiment at the Westlands Roundabout although there are several issues to be considered when experimental works take place. These issues are as follows:

- Traffic on Ring Road Westlands toward Sarit Centre side is affecting junction's smooth traffic flow since the right turning and/or crossing traffic along the road blocked the through traffic. Spillback of traffic reached up to Westlands Roundabout and particularly serious during peak hours. Further, the width of carriage way of the said road is limited due to illegally parked vehicles occupying the road reserve.

- Bus bays on Chiromo Road (both north and south bounds) are located too close to the junction and double parking Matatus are always disturbing the smooth traffic flow.
- Parking lots occupied the road reserves on Waiyaki Way and Chiromo Road cause road alignment shifts along those two arterials running from northwest to southeast axis and limit further widening of the said arterials.
- Electric poles and street lights in the roundabout island may be required to re-install in case of improvement works.
- Traffic signal installed by resident contributors recently is not working now due to lack of incorporating civil works in the experimental attempt.

The first two issues mentioned above have been constantly criticized by the Westlands Resident Association (WRA) since mid 1990's, prompting the City Council of Nairobi (CCN) to hold several meetings with them. However, no concrete measures had been taken by either party until this particular junction was selected as the priority candidate location of the Pilot Project Experiment.

The above described issues and other recommendations proposed by WRA are summarized in Table 25.2-8 together with demarcation between the GOK and the Study whose actions are expected.

Only few measures recommended by WRA could be practically carried out under the Pilot Project due to financial and jurisdictional limitations and duration allowed for the Study Team to undertake the public experiment. Therefore, outputs of the Pilot Project might also be minimal, although expectations of the officials and residents as well as road users are high.

TABLE 25.2-8 DEMARCATION OF WRA RECOMMENDATION

Principal Bottlenecks Identified by the Association	P/P	M/P	GOK
1. The Roundabout at Uchumi/Mall (Westlands R/A)	O	O	O
2. The Roundabout at the Sarit Centre		O	O
3. Ring Road (Westlands)		O	O
4. Mpaka Road		?	O

Causes of Congestion Identified by the Association	P/P	M/P	GOK
1. Poor configuration of the main traffic arteries		O	O
2. Inappropriately located Matatu stops		O	O
3. Absence of adequate road markings or signs, resulting in lack of lane discipline		O	O
4. Inadequate parking facilities and lack of parking/stopping discipline among motorists		O	O
5. Poor maintenance of existing roads, leading to potholes and flooding during the rains		O	O
6. Arbitrary location of kiosks and vendors			O

Recommendations by the Association	P/P	M/P	GOK
1. Widening of Roads and Provision of Additional Lanes			
a. Widen Ring Road [2-lane undivided to 4-lane divided])		O	O
b. Reducing size of Sarit Centre Roundabout		O	O
2. Bus Stop Relocations & Enlargement			
a. Relocations and enlargement of Outbound Bus Stop		O	O
b. Enlargement of Inbound Bus Stop		O	O
c. Enlargement or Relocation of Parklands Road Bus Stop		?	O
3. Use of Alternative Roads by Providing More Access Points			
a. Provision of Access to Karuna Rd. from the Waiyaki Way (for Lower Kabete and Peponi Road Users)		?	O
b. Provision of Bridge Exit at Crossway in Parklands		?	O
4. Improved Maintenance - Roads & Footpaths			
a. Ensuring Adequate Drainage in Sarit Center R/A			O
b. Tarmacking of Karuna Road			O
c. Regular Maintenance and Inspection of All Road			O
d. Provision of Maintenance Office			O
5. Discipline Road Users with Road Markings and Traffic Signs			
a. Provision of No Left/Right Turn, No Stopping, and No Parking Signs at Designated Sections of Roads		?	O
b. Provision of Traffic Officers			O
6. Relocate Obstructions - Kiosks & Hawkers			
a. Enlargement and/or Relocation of Market			O
b. Provision and/or Improvement of Footpaths	limited	O	O
c. Prohibition of Heavy Lorries at Sarit Centre R/A			O
7. Parking Provision			
a. Provision of Parking Facilities by Commercial Building		?	O
b. Limitation of Parking Charge Activities by NCC			O
8. Measures for Pedestrians			
a. Provision of Paved Footpaths	limited	O	O
b. Provision of Heavy Penalties for Parking on Footpaths		?	O
9. Street Lights			
a. Provision of Street Lights			O
10. Increase the Number of Traffic Police			
a. Ensuring the Recommendations Above			O

Remarks; P/P: Pilot Project, M/P: Master Plan, GOK: Government of Kenya, whom actions are expected

25.3 GEOMETRICAL DESIGN

25.3.1 Design

In order to improve geometrical configurations of the target junction (Westlands Roundabout), the Study Team proposed three (3) different alternatives with traffic signal installation as given condition as shown in Figure 25.3-1, Figure 25.3-2 and Figure 25.3-3. The followings are alternative configurations and their required works:

Alternative-1 (Conventional Intersection)

- Removal of existing roundabout island and wide median along Waiyaki Way
- Enlargement of curb of return and provision of traffic islands at all four corners
- Provision of exclusive right turn lanes along Chiromo Road, Waiyaki Way, Ring Road Westlands and Rhapta Road
- Provision of exclusive left turn lanes along Chiromo Road and Waiyaki Way

Alterantive-2 (Compromised Intersection)

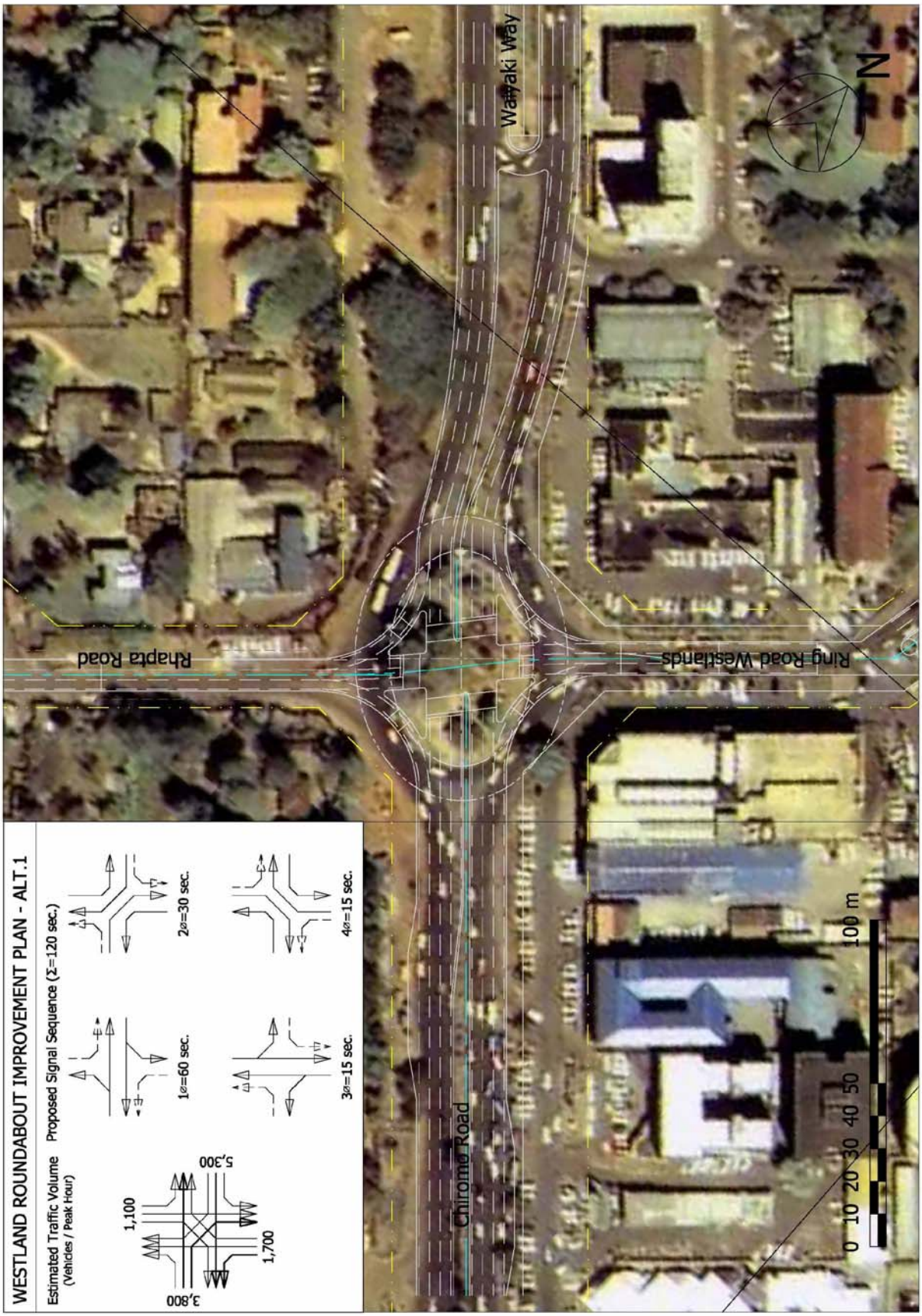
- Extension of existing median on Chiromo Road and Waiyaki Way up to existing roundabout island
- Provision of traffic channels for right turner for all four roads, inside the existing roundabout island
- Provision of traffic channels for through traffic for Ring Road Westlands and Rhapta Road, inside the existing roundabout island

Alternative-3 (Modified Roundabout)

- Extension of existing median on Chiromo Road and Waiyaki Way, up to existing roundabout island
- Reducing the size of existing oval shaped centre island to smaller circle shaped island and provision of extra circular lane along modified centre island

Common Works

- Provision of signal system in accordance with junction's configuration
- Provision of sidewalks at all four corners and zebra crossings
- Provision of guard rails and/or guard posts along carriage way
- Provision of lane markings and other traffic signboards
- Relocation of existing road furniture and/or service lines, if required
- Extension and/or cleaning of existing drainage system, if required



Satellite Image Source: QuickBird® by Globe Images Inc. through U.N. Regional Centre for Mapping of Resources for Development, Kasarani Rd., Nairobi

FIGURE 25.3-1 PROPOSED CONVENTIONAL INTERSECTION (ALTERNATIVE-1)

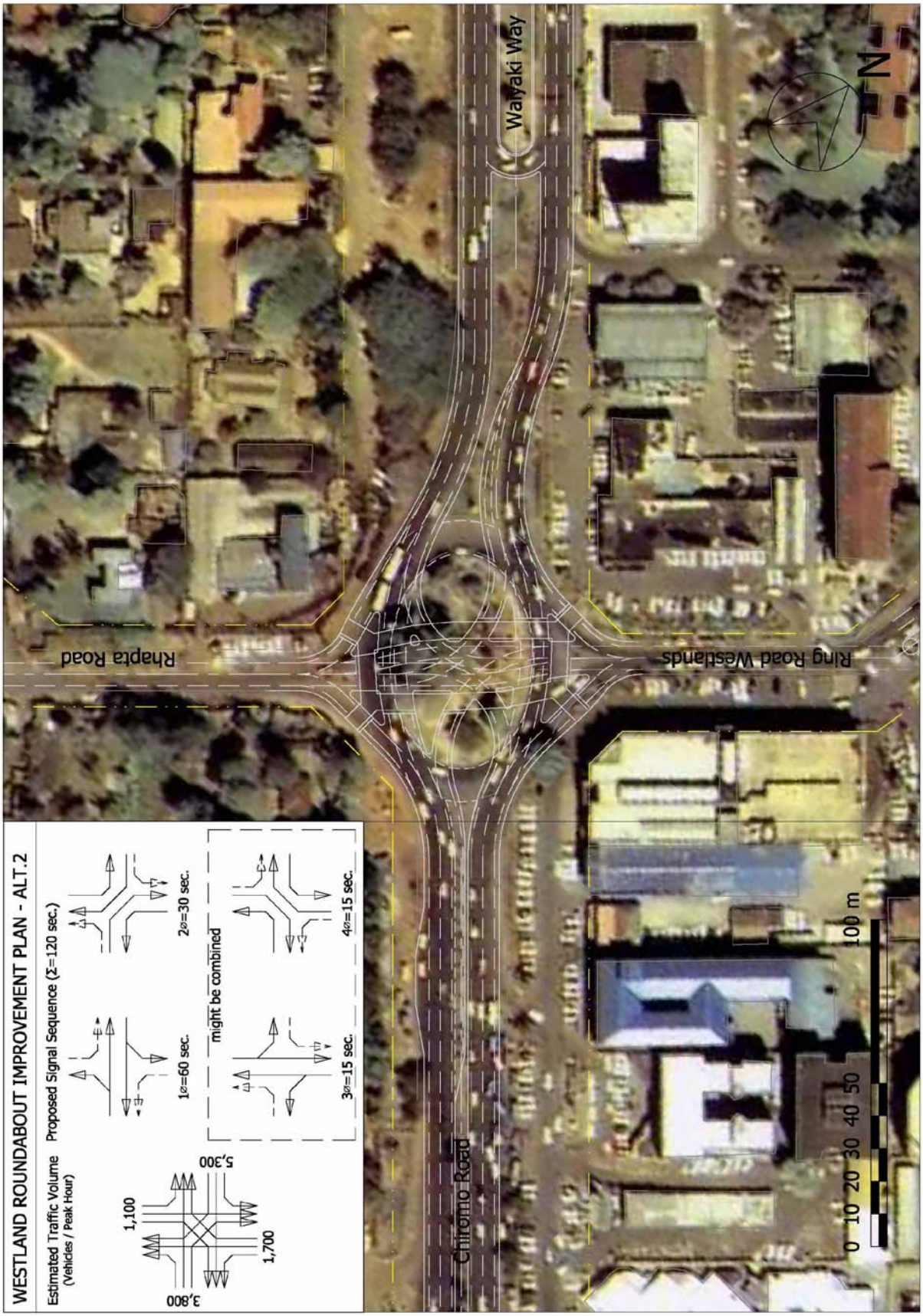


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FIGURE 25.3-2 PROPOSED COMPROMIZED INTERSECTION (ALTERNATIVE-2)

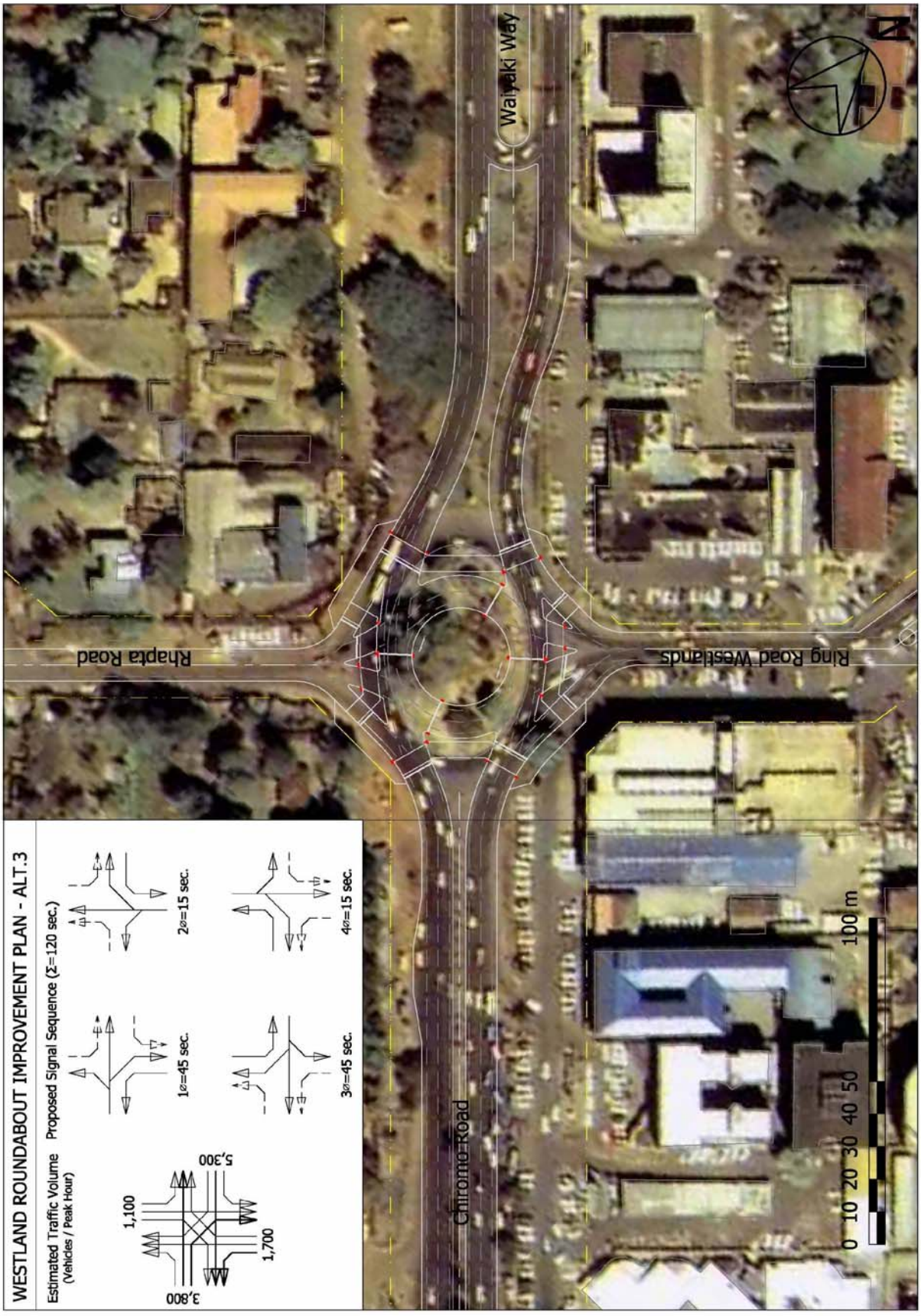

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FIGURE 25.3-3 PROPOSED MODIFIED ROUNDABOUT (ALTERNATIVE-3)

25.3.2 Advantages and Disadvantages

Table 25.3-1 presents advantages and disadvantages of the alternatives. The above mentioned three (3) alternatives are evaluated by their advantages and disadvantages in terms of civil works, signal systems, handling capacity, operational restrictions, and traffic conflicts. The results are presented in the 1st Technical Workshop held in July 2005. After several discussions with the officials of GOK, both parties agreed and confirmed to introduce Alternative-3.

TABLE 25.3-1 ADVANTAGES AND DISADVANTAGES OF ALTERNATIVES

Contents		Alternative-1	Alternative-2	Alternative-3	Remarks
Civil Works		Large	Medium	Medium	Removal of Roundabout
Signal System	Vehicle	4 pcs	4 pcs	4 pcs	300 mm Heads for Arterials
	Vehicle	8 pcs	8 pcs	16 pcs	200mm Heads for Collectors, Exclusive Right & Left Turn Lanes, and Circular Lanes
	Pedestrian	16 pcs	28 pcs	16 pcs	200mm Heads
	Controller	6 phase	6 phase	8 phase	Minimum Requirement for Vehicle Control
Handling Capacity		High	Medium-High	Medium	Vehicle Movements
Operational Restrictions		U-Turn Not Allowed	U-Turn Not Allowed	U-Turn Allowed	Especially Traffic from Chiromo Road
Traffic Conflicts	Vehicle vs. Vehicle	High	Medium	Low	Especially during Power Failure and/or Amber Blinking Operation
	Vehicle vs. Pedestrian	High	Low	Medium	Crossing Length per Signal

25.4 IMPLEMENTATION

25.4.1 Implementation of Experiments

Pre-Construction Stage

Before conducting the Civil Works, the following preparatory measures were carried out:

- Environmental Clearance from NEMA
- Public Announcement for Project Implementation

Construction Stage

Before, during, and after conducting the Civil Works, the following monitoring measures were carried out:

- Traffic Survey [Traffic Volume with Movement by Classification, Queue Length, and Travel Speed]
- Environmental impacts Survey [Noise, Particle Matters, and Air Pollutants (NO, NOx, NO_2, CO)]
- Social Considerations Survey [Public Opinion Interview Survey]

Post Construction Stage

After completion of the Civil Works, and before and during activating signal system, the following signal pattern settings were carried out:

- Signal Pattern Setting-1 (Primary Setting)
- Signal Pattern Setting-2 (Revised Setting-1)
- Signal Pattern Setting-3 (Revised Setting-2)
- Signal Pattern Setting-4 (Revised Setting-3)
- Signal Pattern Setting-5 (Optimum Setting)

25.4.2 Conditional Measures

Based on the other existing roundabouts setting in Nairobi CBD[6], as well as drivers' historical experiences, counterclockwise operation is introduced to this roundabout for primary and revised settings to avoid confusion of road users, hence avoid severe traffic accidents.

The following traffic signal setting patterns are provided by the Study.

Signal Setting Pattern-1 (Primary Setting)[7]

- Prevention of vehicle accidents and protection of pedestrian safety

Signal Operation; Cycle ; 100 seconds
Major Arterials[8] ; 54 seconds (54%)
Collector Roads[9] ; 36 seconds (36%)
Loss Time ; 10 seconds (10%)

Signal Setting Pattern-2 (Revised Setting-1)[10]

- Lesser prevention and protection, priority to major arterials

Signal Operation; Cycle ; 120 seconds
Major Arterials ; 85~90 seconds (71~75%)
Collector Roads ; 35~30 seconds (29~25%)
Loss Time ; 0 seconds (0%)

[6] *Uhuru Highway with Haile Selassie Av./Kenyatta Av./(University Way, during 90's) Moi Av. with Haile Sellassie Av., and other major roundabouts throughout the Nairobi City*
[7] *Carried out on 14-Feb-05 (Mon) and 15-Feb-05 (Tue) only*
[8] *Waiyaki Way and Chiromo Road*
[9] *Ring Road Westlands and Rhapta Road*
[10] *Carried out from 21-Feb-05 (Mon) to 04-Mar-05 (Fri)*

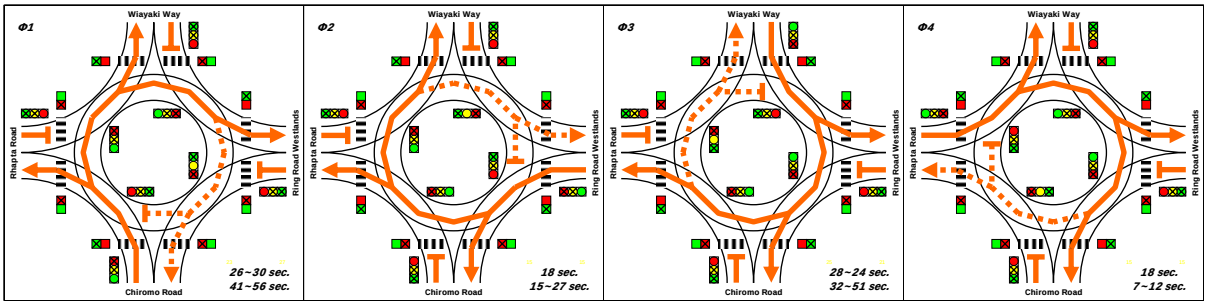


FIGURE 25.4-1 ORIGINAL COUNTER CLOCKWISE SIGNAL SEQUENCE (PATERN-1 & PATERN-2)

Signal Setting Pattern-3 (Revised Setting-2)[11]

- Least prevention and protection, priority to both arterials and collectors-1

Signal Operation Cycle ; 120 seconds
Major Arterials ; 90~100 seconds (75~83%)
Collector Roads ; 40~30 seconds (33~25%)
Loss Time ; -10 seconds (-8%)

Signal Setting Pattern-4 (Revised Setting-3)[12]

- Least prevention and protection, priority to both arterials and collectors-2

Signal Operation Cycle ; 120 seconds
Major Arterials ; 95~105 seconds (79~88%)
Collector Roads ; 45~35 seconds (38~29%)
Loss Time ; -20 seconds (-16%)

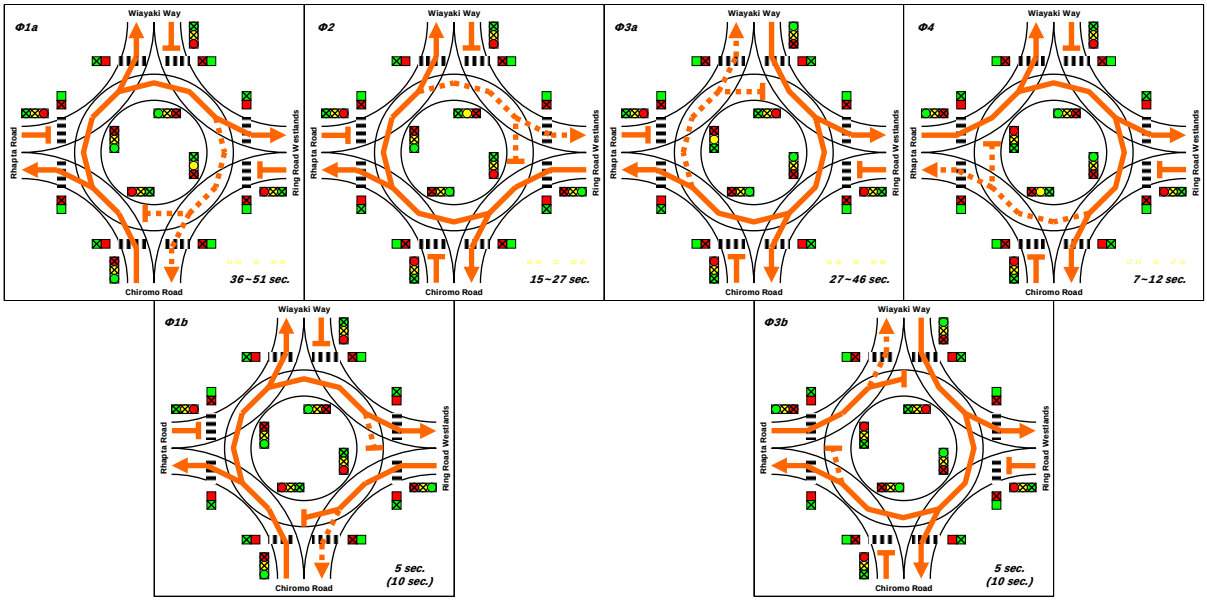


FIGURE 25.4-2 MODIFIED COUNTER CLOCKWISE SIGNAL SEQUENCE (PATERN-3 & PATERN-4)

[11] *Carried out from 07-Mar-05 (Mon) to 07-Apr-05 (Thu)*

[12] *Planned to be implemented from mid May 2005, after resumption of the Study Team activities in Kenya, but never implemented, due to crisis*

Signal Setting Pattern-5 (Optimum Setting)[13]

- Least prevention and protection, greater efficiency (2-phase plus turning movement clearance phase operation)

Signal Operation Cycle ; 90 seconds
Major Arterials ; 40~43+13~15 seconds (61~64%x2=118~129%)
Collector Roads ; 30~24+4~5 seconds (32~38%x2=64~76%)
Loss Time ; 3 second (3%)

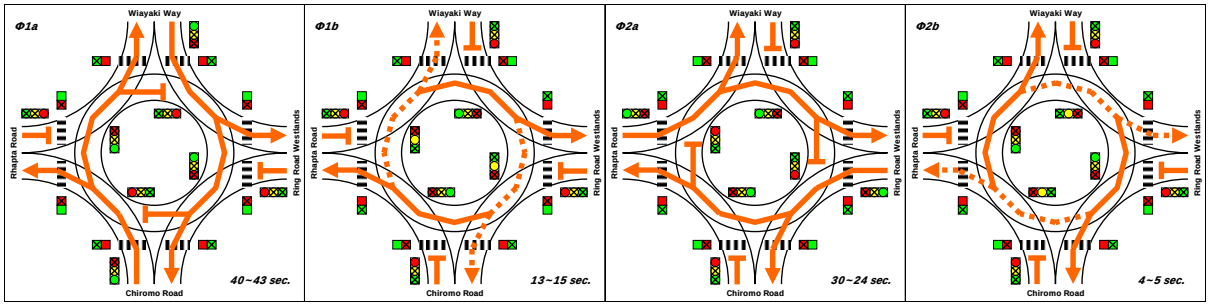


FIGURE 25.4-3 TWO-PHASE WITH TURNING MOVEMENT CLEARANCE PHASE SIGNAL SEQUENCE (PATERN-5)

The Primary setting was not accepted by the motorists due to the delay caused by the traffic signal, although this setting aimed to protect crossing pedestrian as well as vehicles conflict by applying enough inter-green time between those conflicting movements. More than fourth-fifths of pedestrians, however, appreciated the maximum protection provided by this traffic signal setting.

The Study Team then introduced the Revised setting-1. The Revised setting-1 continued for two (2) weeks, without experiencing serious traffic jam.

After on-site observation of revised setting-1, the Study Team and the CCN officials concluded to give priority to both major arterials as well as collector roads to maximize vehicles' operation efficiencies. This can be done by giving advance green to collector roads and split morning peak and evening peak hours as well as off peak hour settings into two parts to meet the actual traffic flow pattern. These modifications were carried out under the Revised-2 and the Revised-3.

The revised setting-3 was in effect in mid March 2005, and the Study Team and CCN exchanged the Letter of Completion of the Pilot Project at that time.

During the Study Team's absence between mid March and mid May 2005, regrettably, this counterclockwise signal setting of Revised setting-3 was suspended by the GOK authorities in

[13] *Implemented from 21-Jun-05 (Tue) to Present*

mid April 2005, after receiving a series of outcry from motorists strongly. These opinions are supported by a part of media.

After resumption of the activities in Kenya for Pre-Feasibility Study, the Study Team and Counterpart Team have decided to implement optimum setting from mid June 2005 and prepared press statement and public notice as shown in Figure 25.4-4. The press statement addressed the objectives of the Pilot Project and informed the general public that the signal would be switching on again to complete the Study.

PRESS STATEMENT

Ministry of Roads and Public Works

WESTLANDS ROUNDABOUT

JICA Japan International Cooperation Agency

We acknowledge comments from the general public regarding traffic signals which were installed recently at the reconstructed Westlands Roundabout in Nairobi. We would like to assure the public that all the issues they raised are being addressed. This notwithstanding, we would like to clarify certain aspects of this project which some motorists and sections of the media seem to have misunderstood.

● ***Why was there a need to improve and install lights at the Westlands Roundabout?***

To address the perennial transport problems being experienced within Nairobi and its environs and seek a lasting solution, the Government of Kenya (GOK) requested for Technical Assistance from the Government of Japan towards this effort.

The Government of Japan accepted the request. But to sufficiently address a problem of this magnitude, a thoroughly detailed study was necessary. This eventually led to what was called ***"The Study on Master Plan for Urban Transport in Nairobi Metropolitan Area"***, which aims to formulate an urban transport system for the target year 2025. The study commenced in July 2004 and was funded by the Government of Japan through Japan International Cooperation Agency (JICA). It was to involve Japanese experts and Kenyan counterparts.

During the initial stages of the Study, the Government of Kenya requested a JICA Study Team to implement specific pilot projects as part of the process of formulating the Master Plan in order to examine how to:-

- Ease traffic congestion in the city.
- Cater for the safety of other road users such as pedestrians, physically challenged and cyclists who have been largely ignored in the design of roads in the city.
- Effectively manage traffic at road junctions through improvement of existing facilities; and
- Improve or construct missing links within the city's road network.

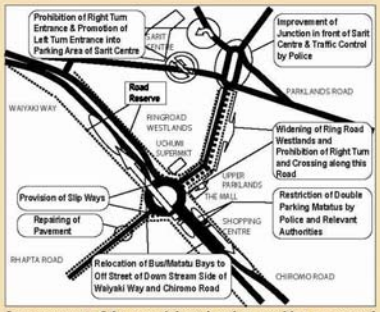
● ***Why was Westlands Roundabout selected?***

Because of a variety of reasons, Westlands Roundabout was selected to be the pilot project out of several other options. Much experimentation and data collection was to be done here which was to be useful for the wider Study on the Masterplan.

Various alternatives were considered on how to improve the roundabout. These included a simple cross-junction controlled by traffic lights. Finally at a technical workshop held in July 2004, expansion of the roundabout, installation of traffic lights and other related works was agreed upon. Much attention was to be given to vehicular traffic movement and pedestrian safety. This was because, over the years, the needs for pedestrians, cyclists and those with mobility handicaps in the city had been overlooked in infrastructure design and development. As a result, many pedestrians and cyclists became victims of road carnage particularly in urban areas where majority of users are pedestrians.

Westlands Roundabout is designed to benefit both motorists and pedestrians.

Pedestrians, particularly school children and the physically challenged can now cross the road safely.



Improvement of the roundabout involves working on several other areas within Westlands which will be done soon.

● ***What was the aim of improvement of the Westlands Roundabout?***

Many people who have expressed sentiments about the improved Westlands Roundabout particularly after the traffic lights were switched on did not seem to understand the aim of the project. But we do not blame them for this. What the Study Team was doing was to examine through this pilot project the effects and impacts of improving the layout of the roundabout, configuration of junctions, installation of traffic signals as well as other traffic management measures like lane widening, relocation of bus stops and conversion of streets into one-way traffic etc.

● ***What was the scope of the project?***

The project entailed traffic data collection, modification of geometric layout (reduction of island size and provision of extra circular lanes in the roundabout), provision of paved pedestrian walkways, road markings and installation of traffic signals.

It also entailed monitoring of traffic, environmental conditions and public opinion at the junction ***before, during*** and ***after*** improvement works.

As a contribution to the pilot project, the Government of Kenya and the City Council of Nairobi were to undertake the following works:

i) Widen all approaches to the roundabout
ii) Relocate bus stops near the roundabout
iii) Widen Ring Road up to Sarit Centre roundabout and improve Sarit Centre roundabout.

These works are expected to commence soon.

● ***Were stakeholders involved in selection of the Westlands Roundabout?***

Yes. Three consultative stakeholder meetings have been held since the start of the project to disseminate the findings of the Study Team and seek comments. The last such conference is scheduled for 27th May 2005 at Kenya Science Teachers College.

● ***Our observation so far***

With the improvement of the roundabout, traffic congestion has been reduced substantially and vehicle speeds increased. However, this has greatly endangered pedestrians when crossing the road when traffic signals are off. So it has become necessary to have the traffic lights on for the safety of pedestrians. While some motorists may perceive traffic signals as an obstruction that creates delays, they should not ignore the needs of pedestrians whose right of way is enhanced by the traffic lights. ***To strike a balance between the two, we shall make all the necessary adjustments to the traffic lights until optimal operation is achieved like in other signalized roundabouts and junctions within the city.***

● ***Signals switch-on and appeal to motorists***

We would like to advise road users and pedestrians using the Westlands roundabout that the study is still going on and cannot be completed unless the traffic lights are switched on and its effect incorporated in the overall study. So the signal lights will inevitably be switched on soon to allow collection of data. We request motorists to be patient, understanding and appreciate this study process until it is complete. The exercise is being carried out with all city road users (pedestrians and motorists) in mind and for their own safety.

Eng. F.G. Ngachu
Chief Engineer (Roads)
Ministry of Roads and Public Works.

FIGURE 25.4-4 PRESS STATEMENT

CHAPTER 26

OUTCOMES
AND
PUBLIC OPINIONS

CHAPTER 26 OUTCOMES AND PUBLIC OPINIONS

To evaluate the outcomes of the Pilot Project as a Public Experiment, a series of monitoring surveys such as traffic survey (i.e. traffic volume counts, travel speed, and queue length surveys), environmental impact survey (i.e. noise level, suspended dust, and air pollutants surveys), and social consideration survey (i.e. public opinion interview survey), were conducted before, during, and after the Pilot Project Experiment between August 2004 and July 2005.

26.1 TRAFFIC SURVEY

26.1.1 Traffic Volume Counts

Sectional Traffic Volume

Table 26.1-1 shows daytime inbound traffic volume at Westlands Roundabout. Traffic volume passing through Westlands Roundabout during daytime between 06:30 and 18:30 varied from 45 to 65 thousand pcu's (passenger car units) in total, of which 16 to 28 thousand are from Waiyaki Way, 18 to 30 thousand are from Chiromo Road, about 5 to 8 thousand are from Ring Road Westlands, and about 4 to 5 thousand are from Rhapta Road, throughout the Pilot Project Experiment period.

TABLE 26.1-1 DAYTIME INBOUND TRAFFIC VOLUME AT WESTLANDS ROUNDABOUT

(unit: pcu's per 12-hr)

Stage	Waiyaki Way	Ring Road Westlands	Chiromo Road	Rhapta Road	Total	Date of Survey
Before-1	18,329	7,036	29,713	4,671	59,749	13-Aug-04
Before-2	18,292	6,553	17,594	4,444	46,883	29-Oct-04
During-1	23,311	7,093	26,572	4,288	61,264	20-Dec-04
During-2	22,221	8,211	26,967	3,594	60,993	21-Jan-05
After-1	16,500	5,493	19,410	3,838	45,241	15-Feb-05
After-2	28,060	6,855	25,211	4,764	64,890	06-Jul-05
Average	21,119	6,874	24,245	4,267	56,503	

Turning Movements

Table 26.1-2 shows the turning movement matrix at Westlands Roundabouts. According to the turning movement survey before the pilot project, about 85% of the traffic coming from Waiyaki Way went through toward City Centre through Chiromo Road; while the traffic turning left to Ring Road Westlands and right to Rhapta Road was less than 10%. In contrast, although about half of the traffic coming from Chiromo Road went through to Waiyaki Way, more than one-quarter made right turn to Ring Road Westlands, and more than 10% made U-turn at the roundabout.

For traffic from Ring Road Westlands, about half made right turn toward Waiyaki Way, and more than one quarter went through to Rhapta Road, and about one fifth made left turn to Chiromo Road. For traffic from Rhapta Road, more than half made right turn toward Chiromo Road, and about 30% went through to Ring Road Westlands, turning left to Waiyaki Way was just one eighth.

TABLE 26.1-2 TURNING MOVEMENT MATRIX AT WESTLANDS ROUNDABOUTS (BEFORE PILOT PROJECT)

Origin \ Destination	Waiyaki Way (NW)	Ring Road Westlands (NE)	Chiromo Road (SE)	Rhapta Road (SW)
Waiyaki Way (NW)	2.9%	5.0%	84.8%	7.3%
Ring Road Westlands (NE)	49.3%	1.4%	21.3%	27.9%
Chiromo Road (SE)	51.2%	27.4%	12.3%	9.1%
Rhapta Road (SW)	12.5%	29.1%	56.2%	2.3%

Crossing Pedestrian

Table 26.1-3 presents daytime crossing pedestrian volume at Westlands Roundabout. Pedestrian crossing at Westlands Roundabout during daytime between 06:30 and 18:30 marked around 25 thousand in total, of which about 16 thousand were crossing at Chiromo Road (7.5 are at signal near the roundabout, and 8.5 are at stairs in front of bus/matatu stops), followed by about 4.5 thousand at Ring Road Westlands, about 3 thousand at Rhapta Road, and 2 thousand at Waiyaki Way.

TABLE 26.1-3 DAYTIME CROSSING PEDESTRIAN VOLUME AT WESTLANDS ROUNDABOUT

(unit: pedestrians per 12-hr)

Stage	Waiyaki Way	Ring Road Westlands	Chiromo Road-1	Chiromo Road-2	Rhapta Road	Total	Date of Survey
After-2	1,764 (7%)	4,327 (17%)	7,387 (29%)	8,487 (34%)	3,273 (13%)	25,238 (100%)	06-Jul-05

Note: Chiromo Road-1: at Signal, Chiromo Road-2: at Stairs in front of Bus/Matatu Stops

26.1.2 Queue Length

Table 26.1-4 presents maximum queue length at Westlands Roundabout. Maximum queue was observed along Waiyaki Way in the morning peak hours with 1,200 m, and along Chiromo Road in the afternoon peak hours with 1,500 m during the Pilot Project construction works.

For Rhapta Road, maximum queue of 730m was observed after installation of signal system. On the other hand on the Ring Road Westlands, queue on the approaching lane became longer and the exiting lane became shorter after installation of signal system.

These situations were improved after readjusting signal settings on Rhapta Road as well as Ring Road Westlands by applying 5 to 10 seconds advance greens for said roads.

In addition, after the introduction of new 2-phase signal setting, queue lengths on most of approaching lanes, except Ring Road Westlands, was significantly reduced, even total traffic volume marked the highest.

TABLE 26.1-4 MAXIMUM QUEUE LENGTH AT WESTLANDS ROUNDABOUT

(unit: m)

Stage	Waiyaki Way	Ring Road Westlands-In	Chiromo Road	Rhapta Road	Ring Road Westlands-Out	Date of Survey
Before-1	230	220	>500	260	n/a	13-Aug-04
Before-2	450	230	700	300	300	29-Oct-04
During	1,220	300	1,510	400	290	21-Jan-05
After-1	1,200	320	760	730	265	15-Feb-05
After-2	210	300	410	220	180	06-Jul-05

26.1.3 Travel Speed

Table 26.1-5 shows average travel speed at Westlands Roundabout. Average travel speed on approaching lanes as well as exiting lanes increased during the Pilot Project under the geometrically improved condition without signal system, then decreased after signal system activated. However, monitoring survey indicated that this condition was improved gradually after signal setting modified to give much more priority to vehicle's movements at the expense of inter green time, in other word pedestrian's and motorist's safety.

In addition, after the introduction of new 2-phase signal setting, the travel speed of most of approaching lanes was recovered almost the same level or better level than that of recorded during the Pilot Project under the geometrically improved condition without signal system.

However, out-bound speed on Chiromo Road (toward the CBD) decreased to almost half, since traffic control by police is introduced at Museum Hill Roundabout located 1.6km to the City Centre from Westlands Roundabout. The spillback of queue on the road reached almost 0.6km from the Westlands Roundabout.

TABLE 26.1-5 AVERAGE TRAVEL SPEED AT WESTLANDS ROUNDABOUT

(unit: km/hr)

Stage	Waiyaki Way		Ring Road Westlands		Chiromo Road		Rhapta Road		Average	
Before	18.3 [E]	46.1 [B]	5.1 [F]	7.8 [F]	7.1 [F]	35.2 [C]	2.9 [F]	17.2 [D]	7.3 [F]	27.3 [C]
During	33.7 [C]	55.0 [A]	7.1 [F]	8.2 [F]	12.2[F]	37.1 [C]	6.0 [F]	17.6 [D]	13.6 [E]	30.0 [B]
After-1	11.3 [F]	45.6 [B]	1.9 [F]	6.3 [F]	5.6 [F]	37.1 [C]	4.4 [F]	15.9 [D]	5.5 [F]	25.6 [C]
After-2	31.3 [C]	45.5 [B]	6.1 [F]	10.9 [E]	27.1 [D]	19.1 [E]	13.9 [E]	17.7 [D]	20.9 [C]	25.2 [C]

Note: Left=Approaching Flows, Right=Exiting Flows, Waiyaki Way & Chiromo Road assumed as Class II (Intermediate), and Ring Road & Rhapta Road assumed as Class III (Urban) for Judgment of LoS [Source: Highway Capacity Manual 1994]

Therefore, average speed on approaching side marked the highest and LOS (Level of Service) reached "C", while that of exiting side marked the lowest, although LOS still remained "C".

26.2 ENVIRONMENTAL CONDITION SURVEY

26.2.1 Noise Level

Table 26.2-1 shows noise level at Westlands Roundabout. Noise level along arterial roads (Waiyaki Way and Chiromo Road) is slightly larger than that of collector roads (Ring Road Westlands and Rhapta Road) throughout the Pilot Project Experiment.

TABLE 26.2-1 NOISE LEVEL AT WESTLANDS ROUNDABOUT

(unit: dB)

Stage	Waiyaki Way	Ring Road Westlands	Chiromo Road	Rhapta Road	Date of Survey
Before	72.6~89.3	66.6~85.0	77.0~91.3	69.9~84.9	29-Oct-04
During	63.3~82.0	64.8~73.1	68.6~83.5	62.6~75.2	21-Jan-05
After-1	63.5~89.2	60.7~80.1	62.6~93.7	60.2~84.3	15-Feb-05
After-2	69.2~86.7	70.3~86.5	67.3~86.5	68.6~86.7	22-Jun-05

26.2.2 Particle Matters (Suspended Dust)

Table 26.2-2 shows particle matters at Westlands Roundabout. Total particle matters occurred at higher level in the morning and afternoon than noon time, although both coarse and fine particle matters were drastically reduced after commencement of the Pilot Project largely because of well maintained carriageway during civil work and paved side walks where measurement devices were set up.

After passing about half year since the civil works are completed, the data indicated that total particle matters have increased again and reached about 300 $\mu g/m^3$ level at any given time.

TABLE 26.2-2 PARTICLE MATTERS AT WESTLANDS ROUNDABOUT

(unit: $\mu g/m^3$)

Stage	Coarse	Fine	Total	Date of Survey
Before	367~845	260~666	650~1,105	29-Oct-04
During	111~133	16~26	137~150	21-Jan-05
After-1	77~351	17~39	114~369	22-Feb-05
After-2	143~268	61~143	286~329	22-Jun-05

26.2.3 Air Pollutants (NO, NOx, NO_2, and CO)

Table 26.2-3 shows air pollutants at Westlands Roundabout. All four indicators decreased some amounts during the Pilot Project Experiment before activating the signal system, and then increased after activating the signal system. This maybe caused by waiting vehicles, especially heavy vehicles, that have to make stop-and-go most of the time since the signal system is activated.

After about half year since the civil works are completed, the data indicated that NO and NO_x level still remained high while NO_2 and CO level decreased to the same level before the Pilot Project.

TABLE 26.2-3 AIR POLLUTANTS AT WESTLANDS ROUNDABOUT

(unit: ppb [NO/NOx/NO_2], ppm [CO])

Stage	NO	NOx	NO_2	CO	Date of Survey
Before	2.0~25.0 (11.4)	5.0~29.0 (14.3)	0.0~11.5 (3.5)	2.8~4.3 (3.3)	29-Oct-04
During	2.0~15.0 (7.3)	1.0~32.0 (9.6)	0.0~20.0 (2.6)	3.0~3.5 (3.3)	21-Jan-05
After-1	4.0~38.0 (10.7)	8.0~42.0 (16.6)	0.0~26.0 (5.9)	2.5~5.0 (3.7)	22-Feb-05
After-2	5.0~35.0 (13.0)	6.0~50.0 (16.7)	1.0~18.0 (3.7)	2.5~4.0 (3.1)	22-Jun-05

Note: Figures are showing Minimum (on the left), Maximum (on the right), and Average (in the parenthesis) during daytime 12-hr observations.

26.3 SOCIAL CONSIDERATIONS SURVEY

26.3.1 Survey Method

The social consideration surveys were conducted at different stages of the Pilot Project Experiment at several locations inside the City of Nairobi (i.e. shopping centres, transport terminals, and petrol stations) targeting various road users (both MT and NMT users).

Pre-condition survey was carried out in the preparation stage of the Pilot Project for public acceptance for the project in mid August 2004. A series of monitoring surveys were also carried out before (mid October 2004), during (mid January 2005), and after (mid February 2005) the commencement of the Pilot Project. In addition, supplemental survey was carried out after the operation of the traffic signal control with new phase setting on 21 June 2005.

Survey results are shown in the following sectors.

26.3.2 Pre-Condition Survey

Simple Analysis

- Interviewees Attributes
  - Effective Answering Rate (1,021 samples):
    - ¤ Effect ---------- 92%
    - ¤ Not Effect ---------- 8%
  - Gender Structure:
    - ¤ Male ---------- 60%
    - ¤ Female ---------- 40%
  - Generation Structure:
    - ¤ Young (under 29 years old) ---------- 41%
    - ¤ Middle (30 to 49 years old) ---------- 43%

  - ¤ Senior (over 50 years old) ---------- 16%
- Major Occupation:
  - ¤ Student ---------- 15%
  - ¤ Specialists (Lawyer, Professor, etc.) ---------- 14%
  - ¤ Merchants & Traders ---------- 13%
  - ¤ Company Employees ---------- 12%
  - ¤ Drivers ---------- 12%
- Major Transportation Mode:
  - ¤ Matatu ---------- 34%
  - ¤ Bus ---------- 21%
  - ¤ Private Car ---------- 15%

- [Q.0] Necessity of junction improvement in the City of Nairobi
  - ¤ Yes ---------- 70%
  - ¤ No ---------- 14%
  - ¤ I don't know ---------- 16%
- [Q.1-1] Type of junction to be improved (from who answered Yes on Q.0)
  - ¤ Un-Controlled Intersection ---------- 41%
  - ¤ Signalized Intersection ---------- 4%
  - ¤ Un-controlled Roundabout ---------- 47%
  - ¤ Signalized Roundabout ---------- 7%
- [Q.1-2] Most desirable junction to be improved (from the same above, after weighing)
  - ¤ 1st : Westlands R/A ---------- 19%
  - ¤ 2nd : Ngong Rd. w/ Mbagathi Rd. R/A ---------- 10%
  - ¤ 3rd : University Way R/A ---------- 10%
  - ¤ 4th : Nyayo Stadium R/A ---------- 9%
  - ¤ 5th : Ring Road Pumwani w/ Landhies Rd. R/A ---------- 7%
- [Q.2] Reason why interviewees think it is not necessary to improve junction (from who answered No on Q.0)
  - ¤ Traffic jam is caused by improper traffic management; comprehensive plan shall be required most ---------- 45%
  - ¤ Traffic jam is caused by too many cars, not by junction's configuration ---------- 40%
  - ¤ It is historical land mark; preservation of such landscape shall be carried out 0%
  - ¤ There is a possibility to increase the serious accident rate ---------- 2%
  - ¤ Improvement of one junction may induce much severe traffic jam at the other junctions ---------- 11%
  - ¤ Others (Make road passable first then deal with junction, should have more traffic police and street light, etc.) ---------- 3%
- [Q.3] Counter measures to be undertaken, beside improvement of junction (for all interviewees)
  - ¤ Apply number control (i.e. odd day for odd number plate car, even day for even number plate car) ---------- 7%
  - ¤ Apply much more vehicle ownership tax and/or congestion tax ---------- 10%

- ¤ Provide much more public transport means (such as commuter bus, tram, etc.) ---------- 34%
- ¤ Provide much more road facilities for NMT (such as bicycle path, foot path, etc.) ---------- 44%
- ¤ Others (Widening & Bypass Construction, Terminal Construction & Improvement, Lane Separation, Zone Control, Time Control, Public Transport Encouragement, Other Traffic Management, etc.) ---------- 6%

Cross Analysis

- Mode by Occupation
  - White collars (i.e. civil servants, corporate executives, specialists, and company employees) tend to use motorized transport, such as private or corporate cars, buses, and matatus, although usage of private or corporate cars by company employees is relatively lower and those of public transport is relatively higher than others.
  - Blue collars (i.e. merchants & traders, drivers, labours, and farmers), students, and housewives tend to use public transport, such as buses and matatus.
- Consensus by Transport Mode
  - More than 70% of motorized transport (including private & corporate cars, buses, matatus, and motorcycles) users support junction improvement.
  - In contrast, less than half of non-motorized transport (including bicycle, walker, and railway) users support junction improvement.
- Consensus by Occupation
  - More than 70% of white collars and merchants & traders or drivers, who are also motorized transport users, support junction improvement.
  - In contrast, labours, farmers, and housewives, who are public transport users, tend to not be able to judge, as result, less than half of them support junction improvement.
- Type of Junction to be improved by Transport Mode
  - About half of interviewees who favour of junction improvement, regardless their transport mode, support improvement of either un-controlled intersections or un-controlled roundabouts
  - More than 70% of motorized transport users support improvement of un-controlled intersection.
- Reason Why Oppose by Transport Mode
  - Regardless their transport mode, reason why opposed to junction improvements were mainly they felt that traffic jam is caused by improper traffic management and/or too many cars.
- Other Counter Measures to be taken by Transport Mode
  - Regardless their transport mode, favour of much more provision of public transport means and non-motorized facilities are more than 70%.
  - Even 10 to 15% of private or corporate car users supported number control and

ownership / congestion taxes, and which rate is higher than that of other mode users.

- Other Counter Measures to be taken by Opinion
  - Who had favour of junction improvements also support provision of much more public transport means and non-motorized transport facilities.
  - Who opposed junction improvements tend to show less support to provision of public transport means and ownership / congestion taxes relatively, and more support to number control and other ideas.
  - Who do not judge either one of junction improvements support provision of public transport means and non-motorized facilities evenly, and no support for number control.

26.3.3 Monitoring Surveys

Simple Analysis

Table 26.3-1 shows summary of monitoring surveys in the course of Pilot Project Experiment:

TABLE 26.3-1 SUMMARY OF MONITORING SURVEYS

Number of Respondents		**Before**	**During**	**After**
		507	548	518
Q.1-1	**Gender**	**Before**	**During**	**After**
	Male	57.2%	69.5%	67.8%
	Female	42.8%	29.9%	32.2%
	Missing / No Answer	0.0%	0.5%	0.0%
Q.1-2	**Generation**	**Before**	**During**	**After**
	15-29 years (Youth)	34.1%	41.6%	37.1%
	30-49 years (Middle)	54.0%	48.4%	52.5%
	Over 50 years (Senior)	11.6%	9.3%	10.2%
	Missing / No Answer	0.2%	0.7%	0.2%
Q.1-3	**Occupation**	**Before**	**During**	**After**
	Company Employee	15.4%	15.3%	12.5%
	Corporate Executive	3.4%	6.8%	2.7%
	Diplomat	2.8%	2.9%	1.7%
	Professional / Specialist	11.0%	12.6%	15.3%
	Civil Servant / Politician	6.7%	9.9%	12.0%
	Merchant / Trader	16.8%	10.4%	10.4%
	PSV Driver	22.1%	13.3%	17.2%
	Other Driver	1.2%	8.4%	13.5%
	Labourer	3.9%	3.8%	3.3%
	Farmer	0.8%	0.0%	0.4%
	Housewife	3.4%	2.0%	0.8%
	Student	6.9%	10.4%	8.7%
	Others	4.5%	2.0%	1.4%
	Missing / No Answer	1.2%	2.2%	0.2%
Q.1-4	**Main Mode of Transport**	**Before**	**During**	**After**
	Private Car	21.3%	29.9%	30.9%
	Company / Organization Car	8.5%	5.5%	8.3%
	Bus	15.2%	3.3%	4.2%
	Matatu	43.2%	46.9%	49.0%
	Motor Cycle	0.8%	0.5%	0.0%

	Bicycle	1.6%	0.7%	1.2%
	Walk	7.1%	7.5%	5.6%
	Commuter Train	2.0%	0.0%	0.8%
	Missing / No Answer	0.4%	5.7%	0.0%
Q.2	**Thinking about road transport, would you say you are;**	**Before**	**During**	**After**
	Very Satisfied	0.8%	12.0%	4.8%
	Fairly Satisfied	27.6%	33.8%	45.9%
	Dissatisfied	40.8%	35.4%	34.7%
	Very Dissatisfied	30.6%	18.4%	14.3%
	Missing / No Answer	0.2%	0.4%	0.2%
Q.3	**Have you read/heard about on-going changes at Westland Roundabout?**	**Before**	**During**	**After**
	Yes	59.8%	93.1%	92.9%
	No	39.1%	4.6%	4.6%
	Do not know	0.8%	2.2%	2.1%
	Missing / No Answer	0.4%	0.2%	0.4%
Q.4	**If yes, what does change mean do you?**	**Before**	**During**	**After**
	It will inconvenience my shopping	1.4%	2.9%	0.8%
	It will cause traffic jam	3.4%	13.9%	42.5%
	It is good action by the authorities	14.8%	28.6%	23.0%
	It will lead to more organized traffic flow, save time	37.3%	41.8%	20.5%
	It will improve my business	0.0%	0.5%	0.2%
	It will cause air pollution	1.8%	2.7%	2.5%
	Others	0.8%	6.2%	3.3%
	Missing / No Answer	40.6%	3.3%	7.3%
Q.5	**Do you think the changes are necessary?**	**Before**	**During**	**After**
	Yes	57.0%	85.4%	70.1%
	No	2.6%	9.9%	25.3%
	Do not know	0.2%	4.7%	4.1%
	Missing / No Answer	40.2%	0.0%	0.6%
Q.6	**What is your most trusted sources of information on transport issues**	**Before**	**During**	**After**
	Radio	48.7%	54.6%	59.1%
	Television	27.6%	16.2%	18.3%
	Newspapers	17.8%	13.9%	10.8%
	Bill Boards / Banners	3.0%	11.5%	10.0%
	Others	2.6%	2.7%	1.2%
	Missing / No Answer	0.4%	1.1%	0.6%
Q.7	**What problems do you encounter at the Westlands Roundabout?**	**Before**	**During**	**After**
	Traffic Jam	73.6%	73.0%	62.5%
	Time Wasting	13.4%	12.2%	20.5%
	Traffic Accidents	4.9%	1.8%	1.9%
	Sound Pollution due to Hooting	2.2%	1.6%	1.9%
	Air Pollution	0.8%	0.9%	0.2%
	No Problem	1.8%	6.4%	5.8%
	Others	1.0%	2.7%	5.6%
	Do not know	2.4%	1.3%	1.0%
	Missing / No Answer	0.0%	0.0%	0.6%
Q.8	**Do you think the Westlands Roundabout needs improvements?**	**Before**	**During**	**After**
	Yes	88.2%	91.6%	81.9%
	No	8.9%	5.8%	16.2%
	Do not know	2.8%	2.4%	1.9%
	Missing / No Answer	0.2%	0.2%	0.0%

Q.9	If answer "Yes" on Q.8, how should it be improved?	Before	During	After
	Change Size of the Roundabout	12.8%	20.3%	12.7%
	Introduce Traffic Signals	17.9%	21.4%	8.5%
	Provide Slip Roads	15.2%	15.1%	8.9%
	Relocate Matatus/Bus Stops	12.8%	15.5%	20.3%
	Widen Lanes	20.7%	14.2%	17.4%
	Others	7.9%	5.5%	4.4%
	Do not know	0.6%	2.2%	1.5%
	Missing / No Answer	12.0%	5.8%	26.3%
Q.10	**If answer "No" on Q.8, why?**	**Before**	**During**	**After**
	Traffic jam is caused by improper traffic management	3.7%	1.8%	9.8%
	Traffic jam is caused by too may cars, not junction	3.7%	1.8%	3.7%
	It can possibly increase accidents	0.2%	0.4%	0.2%
	Improvement can induce severe traffic jam at other junctions	0.2%	0.9%	1.7%
	It is a historical land mark	0.8%	0.4%	0.0%
	Others, specify	1.2%	0.0%	0.2%
	Missing / No Answer	90.1%	94.7%	84.4%
Q.11	**What counter measures should be undertaken beside junction improvement?**	**Before**	**During**	**After**
	Apply Number Control	1.8%	2.4%	1.5%
	Increase Parking Fees	1.2%	5.3%	7.3%
	Increase Vehicle Ownership Tax	1.2%	0.9%	1.2%
	Provide More Road Facilities for NMT	8.9%	26.1%	25.7%
	Bypass Construction	41.2%	37.8%	36.3%
	Provide More Public Transport Means	7.7%	6.8%	4.4%
	Allocating different lanes to different types of vehicles	14.8%	11.3%	13.9%
	Zone Control	5.5%	2.7%	3.7%
	Others	5.3%	3.1%	1.7%
	Do not know	11.6%	3.1%	2.9%
	Missing / No Answer	0.8%	0.5%	1.4%
Q.12	**Comment on modification on of Westlands Roundabout**	**Before**	**During**	**After**
	Workable	74.2%	62.6%	43.1%
	Not Workable	20.7%	30.5%	53.7%
	Do not know	4.3%	5.7%	3.1%
	Missing / No Answer	0.8%	1.3%	0.2%
***Q.13**	**Are you being inconvenienced by construction works and there after?**	**Before**	**During**	**After**
	Yes	-	28.6%	53.7%
	No	-	66.2%	42.1%
	Do not know	-	4.6%	4.2%
	Missing / No Answer	-	0.5%	0.0%
****Q.14**	**If answer "Yes" on Q.13, what matter causes your inconvenience?**	**Before**	**During**	**After**
	Not Alleviate Traffic Jam	-	-	41%
	Not Alleviate Time Wasting	-	-	9%
	Not Decrease Traffic Accidents	-	-	2%
	Not Decrease Air Pollution	-	-	0%
	Others	-	-	1%
	Missing / No Answer	-	-	47%
****Q.15**	**Were you satisfied with the Old Roundabout before construction as pedestrian?**	**Before**	**During**	**After**
	Yes	-	-	17.1%
	No	-	-	82.5%
	Do not know	-	-	0.5%

**Q.16	**If answer "No" on Q.15, what was the reason for your dissatisfaction?**	**Before**	**During**	**After**
	Crossing Roads	-	-	53.4%
	Inconvenient Sidewalk	-	-	37.9%
	Others	-	-	7.5%
	Do not know	-	-	1.1%
**Q.17	**Are you satisfied with the New Roundabout after construction as pedestrian?**	**Before**	**During**	**After**
	Yes	-	-	84.8%
	No	-	-	14.7%
	Do not know	-	-	0.5%
**Q.18	**If answer "Yes" on Q.17, what is the reason for your satisfaction?**	**Before**	**During**	**After**
	Zebra (Pedestrian) Crossing	-	-	52.5%
	Newly Provided (Paved) Sidewalk	-	-	18.4%
	Expanded (Paved) Median	-	-	10.1%
	Traffic Signal Control	-	-	18.4%
	Others	-	-	0.6%
**Q.19	**If answer "No" on Q.17, what is the reason for your dissatisfaction?**	**Before**	**During**	**After**
	A Number of Vehicles	-	-	22.6%
	Period of Pedestrian Crossing Time	-	-	16.1%
	Vehicles of Traffic Offence	-	-	45.2%
	Others	-	-	16.1%

Note: *Q.13 was interviewed during and after stages of the Pilot Project Experiment
**Q.14~Q.19 were interviewed only after stage of the Pilot Project Experiment

26.3.4 Supplemental Survey

Simple Analysis

The followings are summary of supplemental public opinion survey after resumption of the signal operation with new 2-phase settings:

TABLE 26.3-2 SUMMARY OF SUPPLEMENTAL SURVEY

Number of Respondents			1,254
Q.1-1	**Interviewee's Attribute**		
		MT Users	49.2%
		NMT Users	50.8%
Q.1-2	**Place of Interview**		
		Shopping Centres	48.1%
		Petrol Stations	45.2%
		Others	6.7%
Q.1-3	**Gender**		
		Male	63.1%
		Female	36.9%
Q.1-4	**Generation**		
		15-29 years (Youth)	31.7%
		30-49 years (Middle)	54.9%
		Over 50 years (Senior)	13.4%
Q.1-5	**Occupation**		
		GOK Officials	12.0%
		Diplomat / International Organization	3.4%
		Corporate Executive	8.4%
		Professional / Specialist	8.1%
		Company Employee	18.1%
		Merchant / Trader	15.5%
		Driver	6.4%
		Labourer	10.0%
		Farmer	3.3%
		Housewife	3.4%
		Student	10.3%
		Others	1.3%
Q.1-6	**Main Mode of Transport**		
		Private Car	41.0%
		Company / Organization Car	10.9%
		Bus	2.9%
		Matatu	20.2%
		Motor Cycle	2.3%
		Bicycle	2.0%
		Walk	19.7%
		Commuter Train	0.5%
		Others (Taxi)	0.5%
Q.2	**Are you aware that the Westlands Roundabout has been improved**?		
		Yes	97.2%
		No	2.6%
		Do not know	0.2%
Q.3	**Is the present signal setting[1] better than the previous ones[2]?**		
		Yes	88.8%
		No	10.8%
		Do not know	0.3%
Q.4	**What kinds of change in traffic conditions do you find in comparison to the previous signal settings?**		
Q.4-1	**Vehicle's Waiting Time in the Queue**		
		Very Improved	43.4%

[1] 2-phase with turning movement clearance phase since 2 weeks ago (from 21st June 2005 to now on)

[2] Counterclockwise operation as same as the other signalized roundabout (mid Feb. ~ mid Apr. 2005)

	Improved	39.4%
	No Change	10.4%
	Worsened	6.8%
Q.4-2	**Pedestrian's Waiting Time before Crossing**	
	Very Improved	33.3%
	Improved	50.9%
	No Change	13.4%
	Worsened	2.5%
Q.4-3	**Traffic Safety among the Vehicles**	
	Very Improved	29.2%
	Improved	41.7%
	No Change	26.1%
	Worsened	3.0%
Q.4-4	**Traffic Safety between the Vehicles and the Pedestrians**	
	Very Improved	33.4%
	Improved	47.7%
	No Change	16.7%
	Worsened	2.2%
Q.4-5	**Traffic Noise caused by the Vehicles**	
	Very Improved	23.2%
	Improved	21.6%
	No Change	46.8%
	Worsened	8.4%
Q.5	**What the other time frame(s) should the lights be "On" beside the current time frames[3]?**	
	The lights should be "On" much earlier in a.m.	44.3%
	The lights should be "Off" much later in a.m.	51.4%
	The lights should be "On" much earlier in p.m.	47.9%
	The lights should be "Off" much later in p.m.	16.7%
	The lights should be "On" during the weekend	4.5%
Q.6	**Do you think similar improvement works should be applied to other junction(s)?**	
Q.6-1	**Necessity of Geometrical Improvement**	
	Yes	77.8%
	No	13.4%
	Do not know	8.8%
Q.6-2	**Necessity of Traffic Safety Facilities**	
	Yes	81.7%
	No	13.3%
	Do not know	5.0%
Q.6-3	**Necessity of Traffic Signal Installation**	
	Yes	79.0%
	No	15.8%
	Do not know	5.2%
Q.7	**If your answer is "Yes" on Q.6, which junctions are needed to be improved? (weighed average)**	
1st	Museum Hill (Uhuru Highway / Museum Hill Road)	14.9%
2nd	Railway Club (Uhuru Highway / Haile Selassie Avenue)	8.7%
3rd	Mbagathi Way / Ngong Road	8.2%
4th	Forest Road / Muranga Road	7.2%
5th	James Gichuru Road / Gitanga Road	6.9%
6th	Bunyala (Uhuru Highway / Bunyala Road)	6.8%
7th	University (Uhuru Highway / University Way)	6.4%
8th	Muthaiga (Muranga Road / Thika Road)	5.8%
9th	City Stadium (Jogoo Road / Lusaka Road)	5.1%
10th	Nyayo Stadium (Uhuru Highway / Langata Road)	4.8%

[3] Current signal control is applied to 07:00~09:00 in a.m., and 16:00~18:00 in p.m. of weekday only

Q.8	Which kinds of measures to improve traffic condition in the Nairobi Metropolitan Area in terms of Traffic Management?	(weighed average)
1st	Improvement of Public Transport Means	25.4%
2nd	Enhancement of Enforcement Measures	15.6%
3rd	Improvement of Non Motorized Transport Facilities	14.7%
4th	Improvement of Traffic Education Measures	14.6%
5th	Introduction of Environmental Friendly Fuel and Engine	8.4%
6th	Introduction of Staggered Working Hours	6.9%
7th	Increase of Parking Fee in CBD & Vicinities	4.6%
8th	Introduction of Heavy Vehicle Ban during the Peak Hours or Daytime	4.0%
9th	Introduction of Number Plate Control of Vehicles	2.9%
10th	Increase of Vehicle Ownership Tax	2.5%

CHAPTER 27

MAJOR FINDINGS AND RECOMMENDATIONS

CHAPTER 27 MAJOR FINDINGS AND RECOMMENDATIONS

27.1 MAJOR FINDINGS

During the implementation of the Pilot Project Experiment at Westlands Roundabout, the Study Team and the Counterpart Team had learned several important facts which were not clear and/or not taken into account very much before conducting the of junction improvement works.

These findings shall be utilized for further development of the NMA through the improvement of traffic condition, in terms of traffic management, including engineering, education, enforcement together with natural and social environment (4E), especially when conducting similar traffic condition improvement works in the busy CBD or residential districts[1] in Nairobi City, or the other town centres and their adjacent residential area.

The followings are the findings and examples of proposed measures which are to be carried out on a series of traffic improvement projects under the short term action plan in the NMA;

27.1.1 Engineering Aspect

Expansion of Traffic Capacity

Since major bottleneck points of traffic flows during peak hours in the NMA are basically observed at the major junctions throughout the city within the radius of about 5 to 10 km from the city centre where major radial arterials merged each other or crossed with the other arterials or collectors, such as ring roads.

A counter measure to deal with this crucial condition is simply by increasing the junction capacity. Its method however varied from very simple and cost effective one to very complicated and expensive one, depending to the characteristics of traffic flow, available land space, magnitude of positive and negative impacts, and so on.

Although the countermeasure that people tend to expect is drastic one like grade separation, this kind of measure should be carefully studied since it is costly and taking time to construct. Therefore, it has short range negative impacts against the economic activities, and medium to long range negative impacts against the natural and social environment, as well as landscape of the City, which most of the major cities in the developed courtiers may have already lost and/or ignored during their development stage.

[1] Such as Westlands, Parklands, Mutahiga, Gigili, Kilimani, Lavington, as well as Karen and Dagoretti

Therefore, authorities concerned shall always take into account these alternative countermeasures based on the cost and benefit analysis, together with public consensus as well as natural and social environment points of view.

The followings are the alternatives which NMA had already experienced recently and/or will have to conduct in the near future;

- Modification of Geometrical Configuration of Junction
  - Provision of extra approaching and exiting lane(s)
  - Provision of exclusive right turn and/or left turn lane
  - Provision of extra circular lane(s) inside roundabout
  - Reduction of inter-stop line distance
  - Enlargement or reduction of centre island diameter of roundabout
  - Provision of traffic islands (channelization)

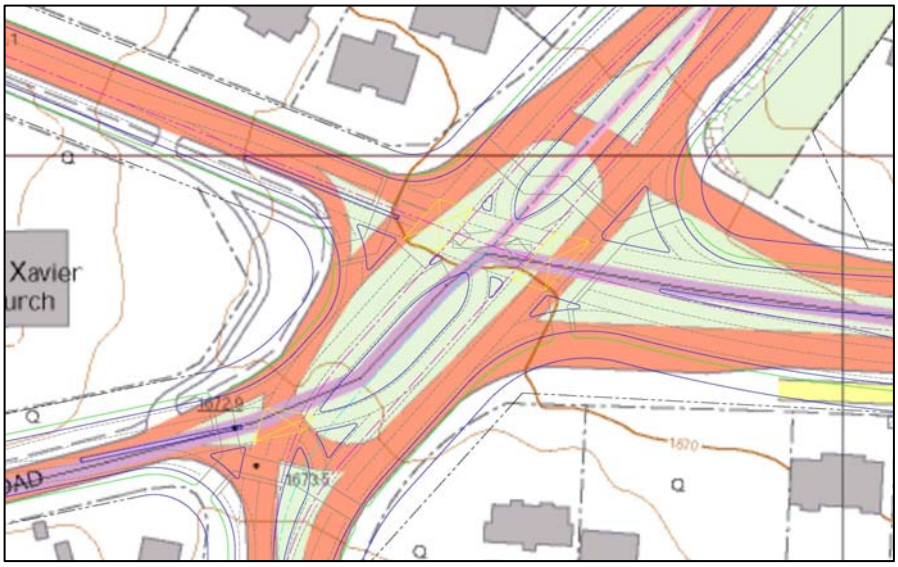


FIGURE 27.1-1 EXAMPLE OF MODIFICATION OF GEOMETRICAL CONFIGURATION

- Conversion of Geometrical Configuration of Junction
  - Conversion of non-signalized intersection to non-signalized roundabout[2]
  - Conversion of non-signalized intersection to signalized intersection
  - Conversion of non-signalized roundabout to signalized roundabout[3]
  - Conversion of signalized roundabout to signalized intersection
  - Conversion of signalized intersection to grade separation

[2] Example: Junctions of Langata Rd with Mbagathi Rd and Ole Sangale Rd / Gandhi Av (under the KUTIP)
[3] Example: Junction of Chiromo Rd / Waiyaki Way with Ring Rd Westlands (under the Pilot Project)

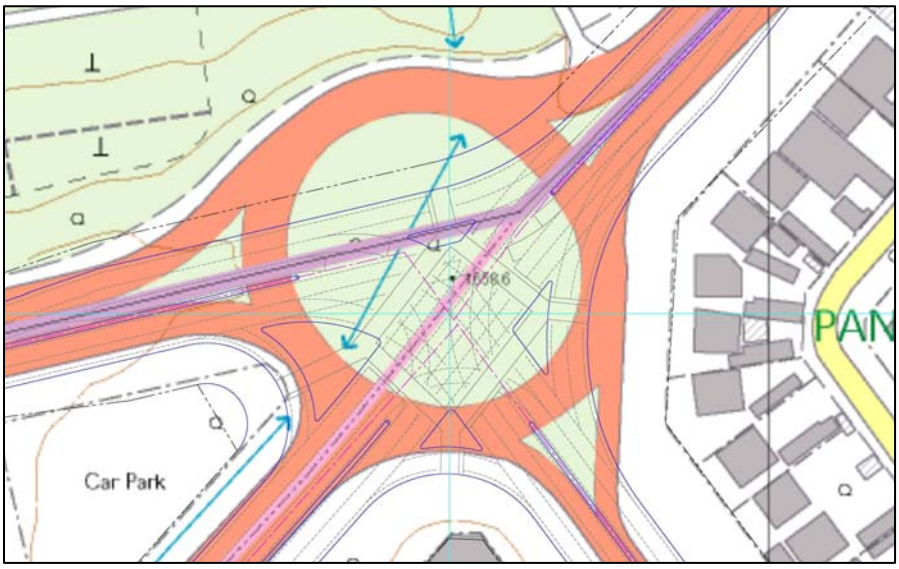


FIGURE 27.1-2 EXAMPLE OF CONVERSION OF GEOMETRICAL CONFIGURATION

Securing of Traffic Safety

Beside the above traffic capacity expansion measures, to eliminate and/or reduce potential hazards among road users, not only drivers and passengers but also pedestrians, especially those physically challenged people and children as well as senior citizens, the following measures shall be taken into account for not only at the bottleneck junctions but also along the other traffic corridors;

- Provision of Proper NMT Facilities
  - Provision of adequate (3 to 5 m in width) paved sidewalks
  - Provision of gird rails and/or bollards for NMT
  - Provision of clear cross walk and markings
  - Provision of raised cross walks or depressed side walks
  - Provision of pedestrian bridge with slope for bicycle and wheel chair

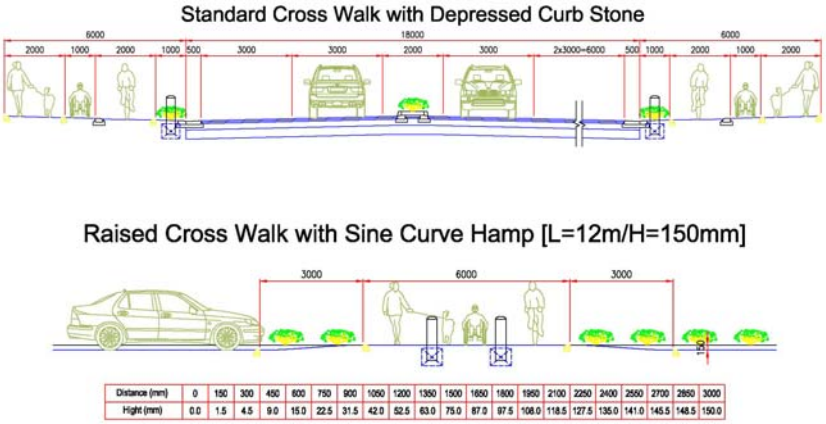


FIGURE 27.1-3 EXAMPLE OF NMT FACILITIES

- Provision of Proper Traffic Guidance Facilities
  - Provision of traffic lane markings
  - Provision of traffic signboards
  - Provision of guard posts for traffic signals and signboards

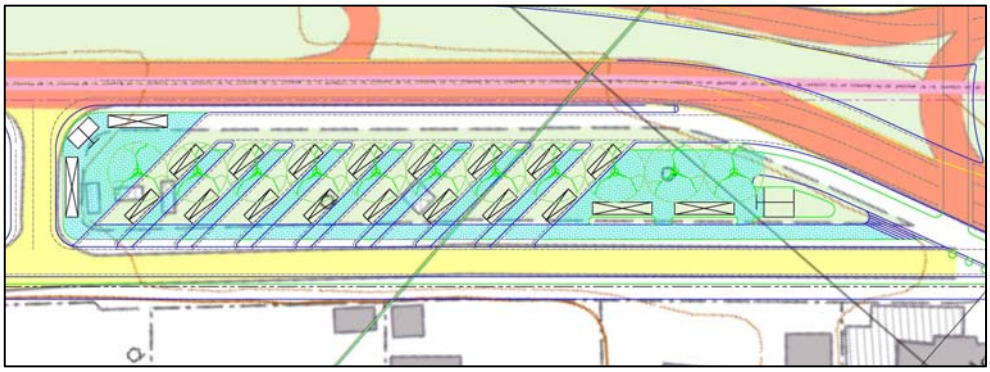
Source; http://solutions.3m.com/

FIGURE 27.1-4 EXAMPLE OF TRAFFIC GUIDANCE FACILITIES

Improvement of Urban Environment

Further improvement of urban environments relating to the traffic and transport activities, the following measures shall be taken into account not only for natural environment aspect but also for social environment as well as urban security aspects;

- Provision of Public Transport Facilities
  - Provision of off-street bus and matatu stops
  - Provision of waiting and resting facilities for passengers and drivers
  - Introduction of public transport exclusive / priority lane(s)



Source: JICA Study Team

FIGURE 27.1-5A EXAMPLE OF PUBLIC TRANSPORT FACILITIES

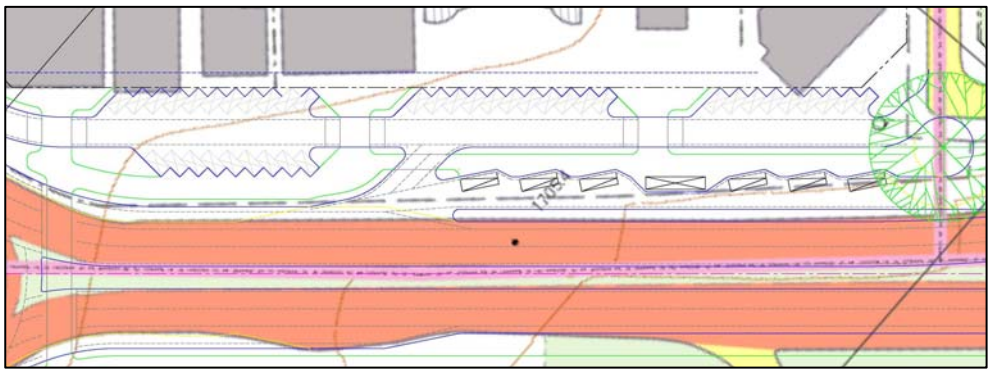


FIGURE 27.1-5B EXAMPLE OF PUBLIC TRANSPORT FACILITIES

- Provision of Other Street Facilities
  - Provision of street lighting devises
  - Provision of storm drainage system
  - Provision of landscape
  - Provision of open space for street vendors
  - Provision of off-street parking spaces / buildings

Source: http://www.glasdon.com/

FIGURE 27.1-6 EXAMPLE OF OTHER STREET FACILITIES

- Provision of Environmental Friendly System
  - Provision of un-leaded gasoline
  - Provision of non-sulphide diesel fuel
  - Introduction of bio-fuel, hybrid, fuel cell engine
  - Provision of periodical vehicle inspection scheme

Source; http://www.utcpower.com/

FIGURE 27.1-7 EXAMPLE OF ENVIRONMENTAL FRIENDLY SYSTEM

27.1.2 Education and Enforcement Aspects

Review of Traffic Education Scheme

Since NMA have so-called “traffic park” located just northern edge of Uhuru Park diagonally opposite of Nairobi University Complex, it seemed that the authorities concerned used to be aware of the importance of traffic education targeting the school children in the past.

This awareness however is barely present as all private driving schools in Kenya do not have their own driving course, beside the relatively short durational on-road training and in-house lecturing, without properly arranged manuals for vehicle manoeuvre, traffic law, physical and mental condition required.

This lack of proper driving education program resulted to lack of awareness of responsibility to other road users. Over speeding and manoeuvring at the expense of approaching lane to get pass another vehicle are common practice of car, matatu and lorry drivers. Driving under the influence of alcohol is also reported. Notable exceptions however are those activities aimed to enhance traffic awareness carried out by privately owned bus operators like City Hopper and local NGOs with the assistance of international donors like “Matatu Operator Association”.

There was also observation that even those highly educated personnel, like part of mass media and/or authorities concerned which normally owned cars, do not understand that vehicle drivers are not only the road users and therefore consideration to other users should be made.

To reduce traffic accidents in the Study Area, which has the worst record within the East African Region according to a study funded by World Bank (Productivity and Liveable Cities, 2001), the following comprehensive traffic education measures shall be implemented as soon as possible;

- Provision of Traffic Education Courses/Manuals
  - Provision of courses/manuals to learn proper traffic rules and manner as well as risk for driving car and crossing road, to all kinds of road users, such as drivers, passengers, pedestrians, bicyclists, and vendors.

Source: http://www.city.hachioji.tokyo.jp/dorojigyo/kotsujigyo/kyoiku.htm

FIGURE 27.1-8 EXAMPLE OF TRAFFIC EDUCATION MEASURES

Law Enforcement

In conjunction with the above-mentioned traffic education measures, the following law enforcement measures shall be carried out by traffic police and other relevant authorities concerned;

- Provision of Disciplines for Traffic Control
  - Provision of strong discipline for traffic police and vehicle inspection officers to be able to take necessary counter actions against the traffic rule violators, such as over speeding, over loading, signal ignorance, driving under alcohol/drug influence, illegal parking, on the site basis.
- Provision of Disciplines for Road Reserve Control
  - Provision of strong discipline for the central and local government officials to be able to take necessary counter actions against the illegal land usages, encroachments of road reserve, and other illegal activities, such as damaging road facilities by traffic accidents and/or excavation works.

Source: http://www.haenni-scales.com/ http://www.opticsplanet.net/radar-guns.html

FIGURE 27.1-9 EXAMPLE OF LAW ENFORCEMENT MEASURES

27.1.3 Natural and Social Environment Aspects

Environmental Consideration

To protect "Green City in the Sun" and to follow "Green Belt Movement" by Professor Wangari Maathai (2004 Nobel Peace Prize Winner), the following vital measures shall be taken into account wherever improvement works are taken place;

- Provision of Public Consensus
  - Provision of proper public announcement toward all road users and land owners as well as residents and street vendors
  - Provision of chance for stakeholder meetings
  - Provision of public opinion research through interview and questionnaires
- Provision of Environmental Impact Assessment (EIA)
  - Provision of proper monitoring surveys for air pollutants, noise level, traffic volume, queue length, travel speed, as well as public opinion, and other important indicators
  - Provision of proper environmental clearance certificate from NEMA through environmental impact assessment under strategic environmental assessment (SEA) scheme

FIGURE 27.1-10 EXAMPLE OF ENVIRONEMTAL CONSIDERATION MEASURES

27.1.4 Administration Aspects

Financial View

To avoid unnecessary overlapping project by different authorities and/or to implement project on time, the following measures shall be carried out prior to new project and/or improvement works;

- Provision of Budget
  - Coordination with other relevant authorities (i.e. KRB, MRPW, MOLG, MOT,

MOLH, Traffic Police, MOF, etc.)

- Provision of budget through relevant fund in advance (i.e. RMFL, LATF, Foreign Official Assistance, etc.)

Engineering View

To minimize unnecessary idling time, the following fundamental measures shall be implemented in the course of any improvement works;

- Provision of Technical Guideline
  - Provision of proper technical guidelines for planning, surveying, designing, and cost estimation, as well as construction supervision
- Provision of Certificates and/or Permit Required
  - Confirmation of road reserve certificate (from MOLH)
  - Provision of environmental control certificate (from NEMA)
  - Provision of construction permit (from MRPW, MOLG, CCN)
  - Provision of traffic control permit (from Traffic Police)
- Coordination with Public Service Providers
  - Provision of alignment drawings for existing signal, power, telephone, optical fibber, water, and sewer line(s), together with location of their poles and/or manholes
- Coordination with Public Transport Operators
  - Re-routing of public transport and/or re-location of bus/matatu stops during the construction works (through MOT)

27.2 RECOMMENDATIONS

Figure 27.2-1 presents the expected follow-up actions by the GOK to improve traffic conditions in the Westlands area.

Immediate Actions without Big Investments

- Prohibition of right turn entrance and promotion of left turn entrance into parking area of the Sarit Centre
- Restriction of double parking matatu by traffic police and relevant authorities
- Repairing of pavement on Rhapta Road
- Improvement of junction in front of the Sarit Centre, and traffic control by police

Immediate Actions with Big Investment

- Relocation of bus/matatu bays to off-street of down stream side of Waiyaki Way and Chiromo Road
- Widening of Ring Road Westlands and prohibition of right turn and crossing along

this Road

- Provision of Slip Way (together with widening of Ring Road Westlands and Rhapta Road)

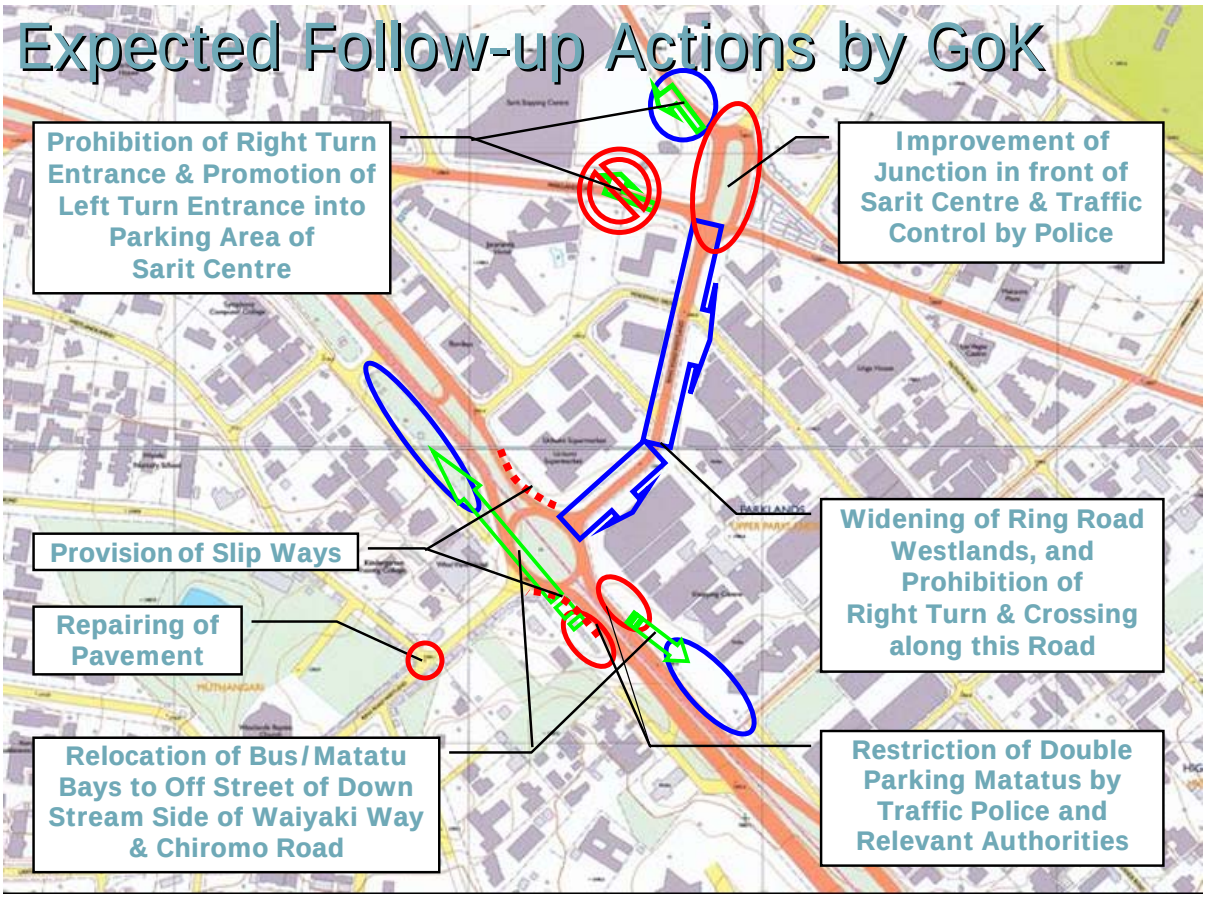


FIGURE 27.2-1 EXPECTED FOLLOW-UP ACTIONS BY GOK