CHAPTER 4

PRESENT ROAD TRAFFIC SITUATION

4. PRESENT ROAD TRAFFIC SITUATION

4.1 Traffic Survey

4.1.1 Outline of the Survey

In order to understand the characteristics of present traffic movements in Kampala and to prepare basic data for future traffic demand forecasts, the following traffic surveys were carried out in February 1997:

(a) Roadside OD Survey

- 8 cordon stations
- 2 internal stations

(b) Traffic Flow Survey

- Weekly count
- 24 hour counts
- 12 hour counts
- Peak period counts

(c) Axle Load Survey

(d) Pavement Condition Survey

4.1.2 Roadside Interview Survey

A roadside interview survey was undertaken in order to provide information on travel movements by motorised vehicles. Eight of the roadside interview stations were located on a cordon close to the Kampala city limits, at the following locations:

- Jinja Road
- Port Bell Road
- Entebbe Road
- Masaka Road
- Hoima Road

- Bombo Road
- Gayaza Road
- Ggaba Road

The two other roadside interview sites were located on two heavily trafficked roads to the south of clock tower roundabout, namely:

- Queensway
- Katwe Road

These locations (references J1 to J10) are indicated in Fig. 4.1. The drivers of eight different types of vehicle were selected for interview, namely:

- Motorcycle and scooter
- Passenger car and four wheel drive vehicle
- Taxi/minibus (Matatu)
- Bus
- Pick-up truck
- Truck 2-axle
- Truck 3-axle or more
- Other - tractor, road roller etc.

At each site, interviewing took place on a single weekday between 7 am and 7 pm, the Uganda daylight hours. The target sample rate was 25% for all vehicle types. Police directed traffic and warning signs and safety equipment were provided. Each site was under the control of a supervisor.

On site, interviews were recorded on forms, four interviews per form. The information common to all four interviews consisted of 4 items, the interviewer's initials, the start time of the first interview, the end time of the last interview and the sample number. The data from each interview consisted of 6 items, namely vehicle type, origin zone, destination zone, journey purpose, number of passengers and commodity. Origin and destination addresses were recorded at various levels of precision, depending upon the proximity to central Kampala.

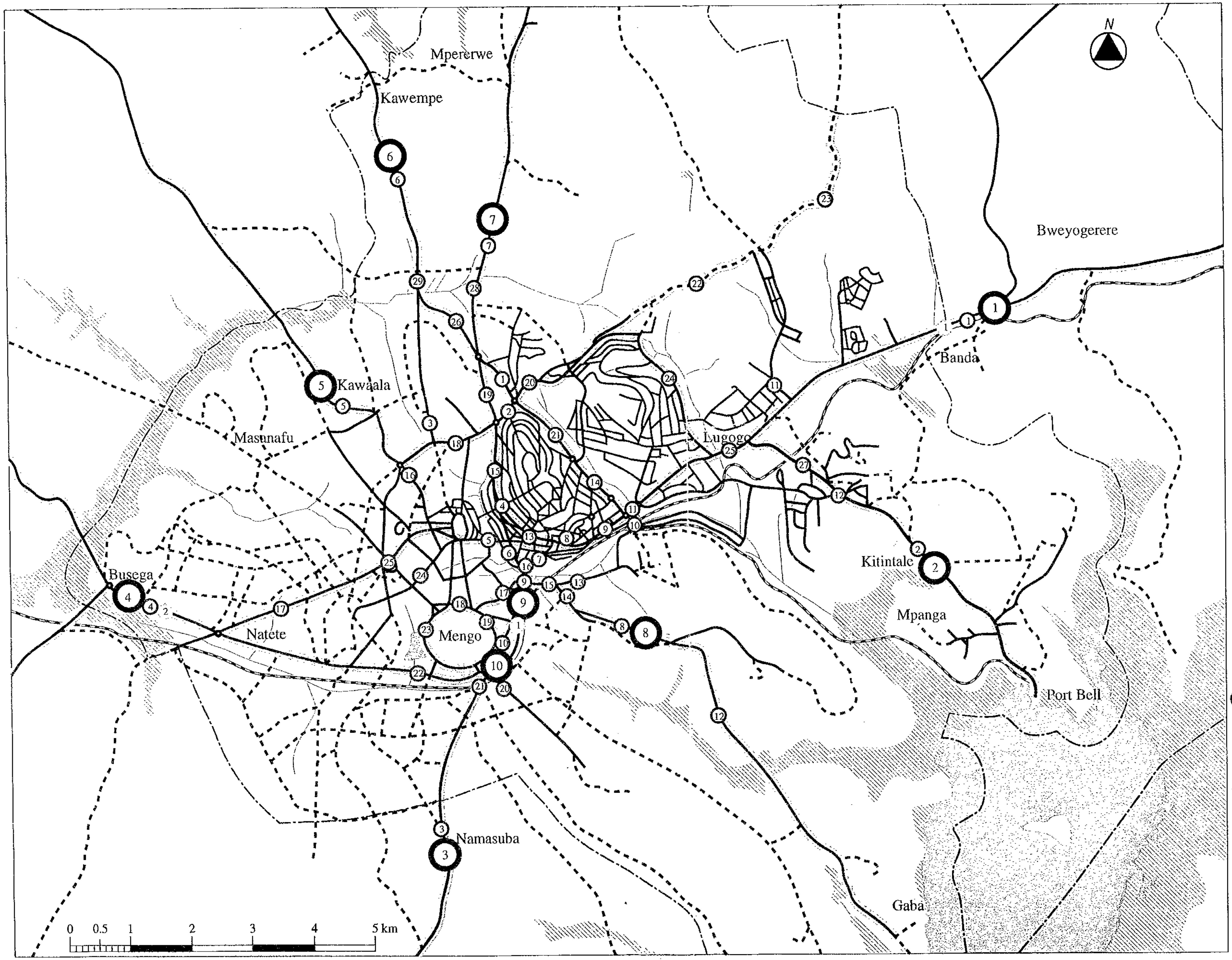
The number of vehicles interviewed at each survey point (usable interviews) and the total number of vehicles which passed each of the survey points are listed in Table 4.1.

Prior to data entry, the origin and destination addresses were converted to three digit zone codes. Each zone was a group of parishes in Kampala, a portion of Mpigi District (which surrounds Kampala), a group of Uganda districts or one or more external countries. The lists defining internal and external zone numbers are presented in Tables 2.1 and 2.2. In order to allow the traffic model to identify movements through Kampala, zones 500 and 502 were disaggregated. Zone 500 (Busiro district of Mpigi) was split into three according to the radial road used (Entebbe Road - 500, Masaka Road - 503, Hoima Road - 504); zone 502 (Kyaddondo district of Mpigi) was split into four (Jinja Road - 502, Hoima Road - 505, Bombo Road - 506, Gayaza Road - 507).

The interview data was entered into Excel spreadsheets, one per site and direction. A simple data structure was adopted, comprising a header record and one record per interview. The header record contained the station number, the date, the day of the week and the direction of interview.

Each interview record comprised the 10 items identified above. The data was converted to simple text files for error checking, expansion and matrix building. The error checking and data correction processes have been described in the progress report. Great emphasis was placed on ensuring that coded origins and destinations were compatible with the site location and direction of interview.

The roadside interviews yielded good information on average vehicle occupancy rates, which are of use in the computation of average values of time for each vehicle, for use in project evaluation. Table 4.2 summarises the data and displays these occupancy rates. A point to note is that the average occupancy rate for matatus is between 4 and 5 times those for cars and pick-up trucks.



Legend
Roadside Interview (Ref: J1 to J10)
Week Count (Ref: W1)
Night Time Count (Ref: N1 and N2)
Day Time Count (Ref: C1 to C29)
Peak Period Count (Ref: P1 to P25)
PSI Survey Sections

Figure 4.1
Locations of Roadside Interview OD Survey and Traffic Counts

Table 4.1 Traffic Volume and Number of Vehicles Interviewed

No. of Survey Point	Name of Survey Point	Traffic Volume			Number of Vehicles Interviewed		
		Direction (1)	Direction (2)	Both Directions	Direction (1)	Direction (2)	Both Directions
J1	Jinja Road	9041	9219	18260	1994	2101	4095
J2	Port Bell Road	3019	3156	6175	2036	1999	4035
J3	Entebbe Road	4357	4270	8627	2464	2245	4709
J4	Masaka Road	4067	3960	8027	1940	1951	3891
J5	Hoima Road	1996	1732	3728	1619	1415	3034
J6	Bombo Road	3791	3384	7175	1783	1823	3606
J7	Gayaza Road	3861	3468	7329	1468	1371	2839
J8	Ggaba Road	4763	4463	9226	2254	2087	4341
J9	Queensway	8589	9397	17986	1963	2071	4034
J10	Katwe Road	8585	5354	13939	2332	2111	4443
Total		52069	48403	100472	19853	19174	39027

* Direction (1) To Kampala
* Direction (2) From Kampala
* Locations on Figure 4.1

Table 4.2 Vehicle Occupancy Statistics

No. of Survey Point	Name of Survey Point		Vehicle Type							
			Motorcycles	Cars	Matatus	Buses	Pick-up	Truck 2-Axle	Truck 3+Axle	Other
			1	2	3	4	5	6	7	8
		4095	107	1826	850	55	813	341	99	4
J1	Jinja Road	20109	140	4473	9764	2282	2210	998	236	6
		4035	123	1561	1462	16	696	153	20	4
J2	Port Bell Road	19475	141	3367	13363	101	1954	495	46	8
		4709	109	1930	1452	15	812	306	75	10
J3	Entebbe Road	23824	157	4545	15560	185	2259	902	195	21
		3891	181	1139	1440	88	728	249	58	8
J4	Masaka Road	29680	247	3055	18921	4451	2160	698	130	18
		3034	126	680	1746	11	287	152	30	2
J5	Hoima Road	23129	165	1733	19508	435	804	392	86	6
		3606	123	938	1588	20	694	158	34	51
J6	Bombo Road	26435	174	2227	19951	1100	2279	522	91	91
		2839	166	1027	1019	0	453	118	25	31
J7	Gayaza Road	16891	226	2512	12325	0	1273	398	68	89
		4341	98	1944	1416	12	655	171	39	6
J8	Ggaba Road	21713	121	4025	15322	148	1552	441	94	10
		4034	95	1675	1362	10	598	232	58	4
J9	Queensway	17381	119	3415	11525	226	1336	610	140	10
		4443	229	1389	1768	13	680	293	69	2
J10	Katwe Road	20919	307	2973	14919	130	1673	724	185	8
Totals		39027	1357	14109	14103	240	6416	2173	507	122
		219556	1797	32325	151158	9058	17500	6180	1271	267
Average	Occupancy	5.6	1.3	2.3	10.7	37.7	2.7	2.8	2.5	2.2

4.1.3 Traffic Counts

Classified traffic counts were undertaken using tally counters. There were ten categories counted, the eight vehicle types selected for interview plus pedestrians and cyclists. The counts were of different durations and were undertaken for a variety of reasons.

A single weekly (7 * 12-hour) traffic count was made on Queensway in order to determine the flow level on each day relative to the average daily flow during a 7 day week.

Twelve hour daytime (7am to 7pm) traffic counts were carried out at the roadside interview sites. These provided control totals for computing the expansion factors to apply to interviews.

Twelve hour traffic counts were also undertaken at other sites, principally on the sections of road identified by MOWTC as suitable for improvement.

Two night-time (7pm to 7am) counts were carried out, at the Jinja Road and Masaka Road roadside interview sites, in order to determine the ratio of twenty-four hour flows to twelve hour flows.

Finally, a series of peak period counts, from 0730 to 0930, were made in order to provide supplementary information, firstly to determine how tidal the peak flows are, and secondly to assist in completing the base year matrices using matrix estimation (ME2) techniques.

The locations of the traffic counts are shown in Fig. 4.1 (References W1; C1 to C29; N1 and N2; P1 to P25 for weekly, daytime, night time and peak period counts).

(1) Information from the weekly traffic count

The result of the Queensway weekly traffic count is presented in Table 4.3. The counts were undertaken from Saturday 15 February to Wednesday 19 February and on Thursday 27 February and Friday 28 February (there was a road closure on February 20 and 21). Three noticeable features of the data are:

- lower flows on Sundays
- a higher than normal total flow on the Tuesday
- higher heavy goods vehicle flows on Thursday and Friday

Table 4.3 Weekly Variation of Traffic Flows

Vehicle Type Number	Vehicle Type Description	Date 15.02.97 Saturday	and 16.02.97 Sunday	Day 17.02.97 Monday	of 18.02.97 Tuesday	the 19.02.97 Wednesda	Week 27.02.97 Thursday	28.02.97 Friday	5-day Two-way Average	Weekend Two-way Average	7-day Two-way Average	5-day to 7-day ave Factor
		Inbound	Inbound	Inbound	Inbound	Inbound	Inbound	Inbound				
1	Motorcycles	482	386	408	439	441	478	509				
2	Cars	4421	3898	4110	3998	4103	4502	4471				
3	Minibuses	2180	2044	1628	2709	1473	1767	1684				
4	Buses	18	15	20	19	14	34	27				
5	Pick-ups	1367	823	1338	1543	1225	1202	1216				
6	2-Axle Trucks	423	242	439	369	453	550	558				
7	3+ Axle Trucks	106	63	92	138	86	105	103				
8	Other	0	1	3	3	2	2	2				
Total		8997	7472	8038	9218	7797	8640	8570				
		Outbound	Outbound	Outbound	Outbound	Outbound	Outbound	Outbound				
1	Motorcycles	540	339	553	555	528	505	586				
2	Cars	4171	3723	4211	5433	3991	4017	4361				
3	Minibuses	4135	3048	3621	4525	4140	3849	4107				
4	Buses	18	22	30	39	27	36	30				
5	Pick-ups	1284	838	1023	1053	1237	1201	1286				
6	2-Axle Trucks	554	288	506	468	540	624	640				
7	3+ Axle Trucks	102	57	98	107	102	95	133				
8	Other	1	0	6	1	1	2	3				
Total		10805	8415	10048	12181	10566	10329	11146				
	Private Vehicles	12266	10108	11652	13025	11528	11909	12434	12110	11187	11846	0.978232
	Heavy Vehicles	1185	650	1135	1082	1181	1374	1434	1241	918	1149	0.925487
	Public Transport Vehicles	6351	5129	5299	7292	5654	5686	5848	5956	5740	5894	0.989648
	All Vehicles	19802	15887	18086	21399	18363	18969	19716	19307	17845	18889	0.978363

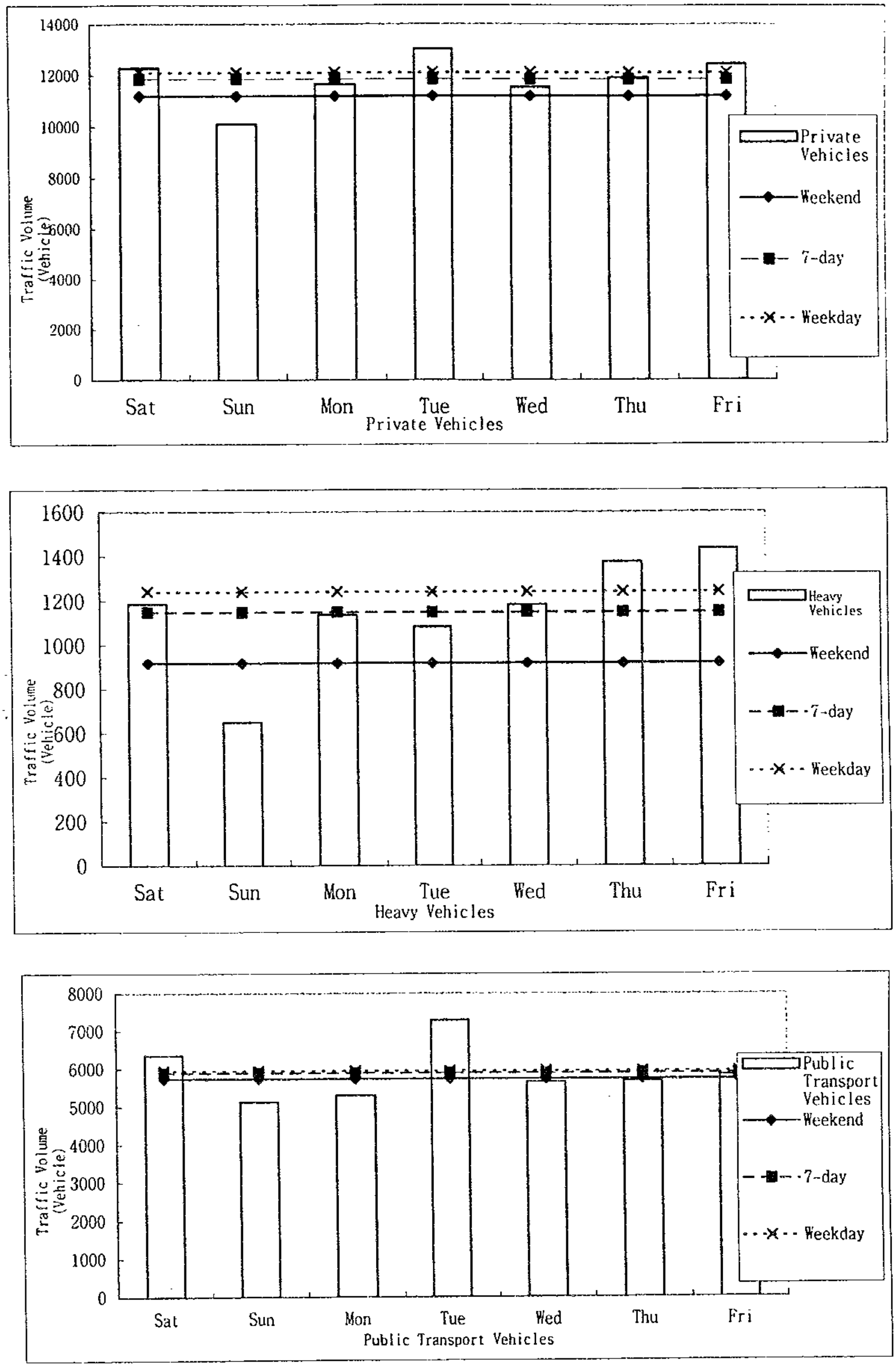


Fig 4.2 Weekly Variation of Traffic Flows

The Study Team felt that the first effect was likely to be systematic and therefore applicable to other sites. However, there is no obvious reason why flow should be higher on Tuesdays than on other weekdays. It is possible that goods traffic builds up towards the end of each week prior to a weekend lull, but with only one weekly site this conclusion must be tentative. The use of the weekly count was, therefore, to derive factors to convert 5-day average daily flows to 7-day average daily flows. Factors were derived for each of the three broad vehicle classes, namely private, heavy and public transport vehicles, to be used for matrix building. Fig. 4.2 graphs the weekly variation of each of these three vehicle classes.

(2) Other Traffic Counts

Tables 4.4 and 4.5 present a summary of the other traffic counts undertaken. Pedestrian counts are excluded. In Table 4.4, sites C1 to C29 are 12-hour (0700 - 1900) daytime counts. Sites N1 and N2 are 12-hour (1900 - 0700) night time counts at the same locations as site C1 (Jinja Road RSI site) and C4 (Masaka Road RSI site) respectively. Thus 24-hour (0700 to 0700) counts are available at two sites.

The first three count data columns of Table 4.4 and the 24-hour count include bicycles, which are numerous at certain locations. Other data displayed in Table 4.4 relates to motorised vehicles. The eight motorised vehicle types have been aggregated into three broad categories, namely:

private vehicles - motorcycles, cars, pick-up trucks and others

heavy vehicles - 2-axle trucks, 3+axle trucks

public transport - matatus, buses

As well as displaying the 12-hour daytime motorised traffic flows, Table 4.4 also shows the am peak period flows extracted from these counts. The peak period is a 2-hour period, either 7am to 9am or 8am to 10am depending on which has the higher two-way traffic flow. Peak period motorised flow is expressed as a percentage of 12-hour motorised flow. All the other percentages in Table 4.4 are percentages of 12-hour total flow (including bicycles).

Table 4.4 Traffic Volumes

Point	12h (0700 to 1900)						24h	Peak Period			
	Direction 1	Direction 2	Total	Motorized	Heavy Vehicle	Public Transport		Motorised	Private Vehicle	Heavy Vehicle	Public Transport
C1	10012	10046	20058	18260	1359	6467	24933	3118	1741	178	1199
	49.9%	50.1%	100.0%	91.0%	6.8%	32.2%	124.3%	17.1%			
C2	3529	3723	7252	6175	242	2381		1054	616	20	418
	48.7%	51.3%	100.0%	85.1%	3.3%	32.8%		17.1%			
C3	4857	4813	9670	8627	663	2757		1104	698	64	342
	50.2%	49.8%	100.0%	89.2%	6.9%	28.5%		12.8%			
C4	5664	5352	11016	8027	782	2903	14290	1303	660	118	525
	51.4%	48.6%	100.0%	72.9%	7.1%	26.4%	129.7%	16.2%			
C5	3059	2727	5786	3728	183	2031		837	347	34	456
	52.9%	47.1%	100.0%	64.4%	3.2%	35.1%		22.5%			
C6	5090	4330	9420	7175	595	3161		1350	670	90	590
	54.0%	46.0%	100.0%	76.2%	6.3%	33.6%		18.8%			
C7	6691	5702	12393	7329	433	2535		1578	845	60	673
	54.0%	46.0%	100.0%	59.1%	3.5%	20.5%		21.5%			
C8	5276	4984	10260	9226	343	2819		1764	1024	50	690
	51.4%	48.6%	100.0%	89.9%	3.3%	27.5%		19.1%			
C9	9575	10195	19770	17986	1066	5498		3488	1922	171	1395
	48.4%	51.6%	100.0%	91.0%	5.4%	27.8%		19.4%			
C10	10578	6910	17488	13939	911	6734		2764	981	156	1627
	60.5%	39.5%	100.0%	79.7%	5.2%	38.5%		19.8%			
C11	16460	21719	38179	35205	2048	10666		5579	3234	299	2046
	43.1%	56.9%	100.0%	92.2%	5.4%	27.9%		15.8%			
C12	5290	4870	10160	8742	229	2498		1907	1276	29	602
	52.1%	47.9%	100.0%	86.0%	2.3%	24.6%		21.8%			
C13	9144	15096	24240	23451	501	4688		3996	3041	98	857
	37.7%	62.3%	100.0%	96.7%	2.1%	19.3%		17.0%			
C14	11306	10670	21976	19861	834	901		3360	3052	122	186
	51.4%	48.6%	100.0%	90.4%	3.8%	4.1%		16.9%			
C15	13515	12983	26498	23520	409	10317		4388	1987	66	2335
	51.0%	49.0%	100.0%	88.8%	1.5%	38.9%		18.7%			
C16	4761	4657	9418	7841	206	4498		1872	517	56	1299
	50.6%	49.4%	100.0%	83.3%	2.2%	47.8%		23.9%			
C17	3675	3755	7430	6753	244	3185		1390	627	52	711
	49.5%	50.5%	100.0%	90.9%	3.3%	42.9%		20.6%			
C18	5831	5732	11563	10073	287	1346		2025	1709	47	269
	50.4%	49.6%	100.0%	87.1%	2.5%	11.6%		20.1%			
C19	7091	8059	15150	12474	496	6325		2511	857	95	1559
	46.8%	53.2%	100.0%	82.3%	3.3%	41.7%		20.1%			
C20	7718	6468	14186	12625	272	3051		2934	2294	27	613
	54.4%	45.6%	100.0%	89.0%	1.9%	21.5%		23.2%			
C21	8531	7249	15780	13870	688	649		2543	2347	64	132
	54.1%	45.9%	100.0%	87.9%	4.4%	4.1%		18.3%			
C22	3054	3310	6364	5932	197	771		1213	1076	22	115
	48.0%	52.0%	100.0%	93.2%	3.1%	12.1%		20.4%			
C23	108	83	191	136	0	6		26	26	0	0
	56.5%	43.5%	100.0%	71.2%	0.0%	3.1%		19.1%			
C24	1909	2349	4258	3343	219	137		962	889	28	45
	44.8%	55.2%	100.0%	78.5%	5.1%	3.2%		28.8%			
C25	13734	12915	26649	24668	1747	7667		4373	2579	239	1555
	51.5%	48.5%	100.0%	92.6%	6.6%	28.8%		17.7%			
C26	6885	6503	13388	10428	419	3861		2198	1160	76	962
	51.4%	48.6%	100.0%	77.9%	3.1%	28.8%		21.1%			
C27	3102	2265	5367	4759	192	678		827	695	27	105
	57.8%	42.2%	100.0%	88.7%	3.6%	12.6%		17.4%			
C28	6455	7436	13891	9177	440	3001		2045	1258	86	701
	46.5%	53.5%	100.0%	66.1%	3.2%	21.6%		22.3%			
C29	9569	8900	18469	14571	1074	5737		2791	1426	92	1273
	51.8%	48.2%	100.0%	78.9%	5.8%	31.1%		19.2%			
Totals				347901	17079	107268		65300	39554	2466	23280
Ratios*									5.65	6.93	4.61

* : Peak period to 12-hour ratios are for motorised traffic

Table 4.5 Peak Period Volumes

Point	Peak (0730 to 0930)							12h Estimated Volumes			
	Direction 1	Direction 2	Total	Motorised	Heavy Vehicle	Public Transport		Motorised	Private Vehicle	Heavy Vehicle	Public Transport
P1	1667	654	2321	1808	58	230		10052	8591	402	1060
P2	2938	2155	5093	4512	47	953		24566	19849	326	4391
P3	883	620	1503	1252	46	516		6596	3900	319	2378
P4	638	451	1089	1016	7	98		5649	5149	48	452
P5	2013	1721	3734	3223	71	1561		16677	8992	492	7193
P6	2822	2236	5058	4795	50	4096		22888	3668	346	18873
P7	2508	1991	4499	3921	151	745		21575	17097	1046	3433
P8	1090	839	1929	1853	16	57		10434	10060	111	263
P9	2698	1867	4565	4366	260	2061		22855	11558	1801	9497
P10	3514	2317	5831	4982	216	363		28054	24885	1496	1673
P11	775	601	1376	1202	126	302		6639	4375	873	1392
P12	1392	1062	2454	1953	53	650		10427	7065	367	2995
P13	1586	1241	2827	2133	192	421		11860	8591	1330	1940
P14	2305	1227	3532	3220	103	1372		16898	9863	713	6322
P15	1781	1854	3635	2962	187	1071		15861	9631	1295	4935
P16	6061	3421	9482	8265	236	4012		42824	22704	1634	18486
P17	2150	931	3081	2611	156	1336		13561	6324	1080	6156
P18	99	95	194	101	7	15		564	446	48	69
P19	202	108	310	242	11	20		1361	1193	76	92
P20	1219	706	1925	1587	32	725		8253	4691	222	3341
P21	2565	1946	4511	3658	151	1593		19204	10818	1046	7340
P22	1240	1291	2531	1773	217	578		9694	5528	1503	2663
P23	69	46	115	37	2	1		211	192	14	5
P24	919	624	1543	1304	32	480		6910	4476	222	2212
P25	1878	949	2827	2632	65	1252		13651	7432	450	5769

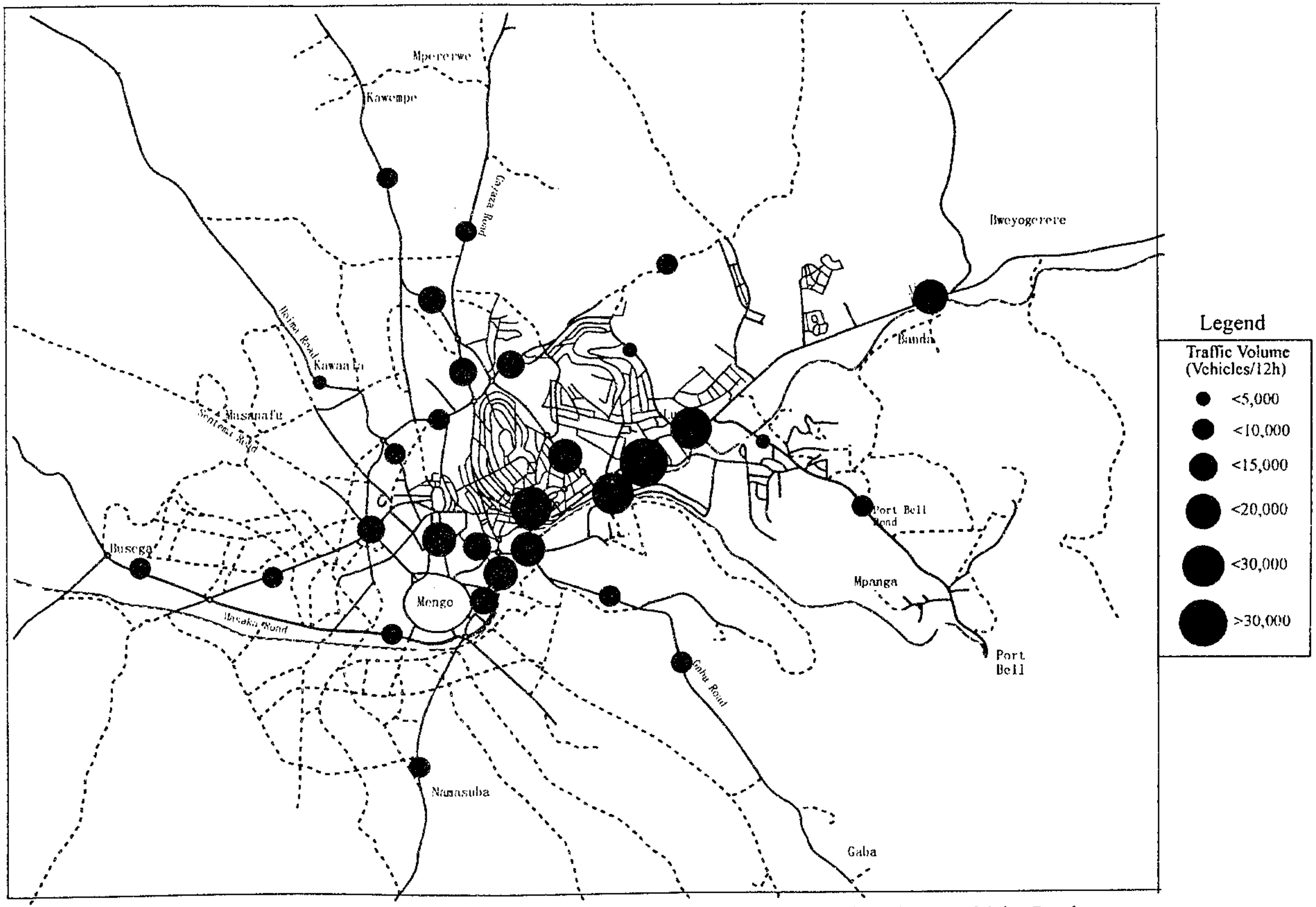


Fig.4.3 Traffic Volume on Major Roads

At the foot of Table 4.4, 12-hour and 2-hour motorised traffic flows are compared in aggregate (summed over all sites C1 to C29) and 12-hour to 2-hour flow ratios are computed for private vehicles, for heavy vehicles and for public transport vehicles.

Table 4.5 displays peak period (0730 to 0930) traffic volumes. The first three data columns include bicycles, the others relate to motorised traffic. The ratios computed at the foot of Table 4.4 have been used to produce estimated 12-hour motorised flows from the observed peak period motorised flows.

The flows in Tables 4.4 and 4.5 display 12-hour flows observed on or estimated for a weekday. Using the 5-day average to 7-day average conversion factors derived from the weekly count, 12-hour motorised flows which allow for lower weekend flows were computed. The results are displayed in Tables 4.6 (sites C1 to C29) and 4.7 (sites P1 to P25). For sites C1 to C29, the flows are displayed directionally. These 12-hour flows have been converted to pcus/hr on the basis of pcu factors of 1.1, 2.0 and 1.3 for private, heavy and public transport vehicles respectively. It is these directional pcus/hr flows that have been used to calibrate the base year traffic model.

For sites P1 to P25, the tidality towards Kampala of the morning peak period flows is indicated. Generally, tidality straddles the typical 60: 40 ratio that is found in many cities. The exceptions are sites P13 and P15, where there is an industrial estate to the east and a choice of routes to Kampala via the Clock Tower and Jinja Road roundabouts, and P19 and P23, where Katwe is a competing local centre of employment and the road quality is very poor. The remainder of the results for sites P1 to P25 are for two-way flows. For the purpose of traffic model calibration, it has been assumed that, averaged over the day, the flow will be the same in each direction; one-way pcus/hr flows are shown in the final column of Table 4.7.

The traffic model has been set to represent trips and flows during an average hour of a 7*12-hour week, i.e. an average daylight hour.

Table 4.6 Factored Observed 12-hour Flows and Pcus/hr

Point	Direction	Private Vehicles Pcu Factor 1.1	Heavy Vehicles Pcu Factor 2	Public Transport Pcu Factor 1.3	All Vehicles	Pcus/hr
C1	1	5086	607	3153	8846	909
	2	5126	650	3242	9018	929
C2	1	1687	136	1136	2959	300
	2	1787	88	1222	3096	311
C3	1	2594	283	1385	4262	435
	2	2499	330	1344	4173	430
C4	1	2204	352	1419	3975	414
	2	2042	372	1455	3869	407
C5	1	772	89	1100	1960	205
	2	709	80	911	1700	177
C6	1	1858	276	1577	3711	387
	2	1486	275	1552	3313	350
C7	1	2272	204	1304	3780	384
	2	1993	196	1206	3395	346
C8	1	3063	163	1440	4666	464
	2	2867	154	1350	4372	435
C9	1	6052	479	1864	8395	837
	2	5119	507	3579	9205	941
C10	1	3472	438	4515	8426	880
	2	2684	404	2151	5239	546
C11	1	9002	919	4917	14838	1511
	2	12995	975	5642	19612	1965
C12	1	3083	136	1277	4496	444
	2	2800	76	1196	4072	399
C13	1	6165	284	2178	8627	848
	2	11695	179	2463	14337	1369
C14	1	9016	375	509	9900	944
	2	8711	397	383	9491	906
C15	1	6544	160	4899	11602	1157
	2	5969	218	5315	11502	1159
C16	1	1596	105	2182	3884	400
	2	1472	85	2271	3828	395
C17	1	1623	97	1578	3299	336
	2	1627	129	1575	3331	341
C18	1	4064	148	700	4912	473
	2	4191	117	633	4941	472
C19	1	2485	272	3369	6126	638
	2	3044	187	2893	6123	624
C20	1	5163	144	1475	6782	657
	2	3934	107	1545	5587	546
C21	1	6595	338	348	7281	699
	2	5663	299	294	6255	601
C22	1	2620	94	10	2724	257
	2	2235	88	753	3076	301
C23	1	64	0	5	69	6
	2	64	0	1	65	6
C24	1	1289	87	50	1425	138
	2	1632	116	86	1834	178
C25	1	7793	801	3831	12425	1263
	2	7126	815	3759	11700	1196
C26	1	3055	191	1946	5193	523
	2	2957	196	1876	5030	507
C27	1	2216	91	366	2673	258
	2	1587	87	305	1979	193
C28	1	2506	192	1334	4032	406
	2	3104	215	1637	4956	498
C29	1	4090	259	2928	7277	735
	2	3496	734	2751	6982	741

Direction (1) To Kampala
Direction (2) From Kampala

Table 4.7 Factored Estimated 12-hour Flows and Pcus/hr

Point	Direction	Tidality	Private Vehicles Pcu Factor 1.1	Heavy Vehicles Pcu Factor 2	Public Transport Pcu Factor 1.3	All Vehicles	Pcus/hr	Pcus/hr (one-way average)
P1	1	69%	8402	372	1049	9823	946	473
	2	31%						
P2	1	58%	19413	301	4347	24061	2301	1150
	2	42%						
P3	1	58%	3814	295	2354	6463	654	327
	2	42%						
P4	1	57%	5036	45	447	5527	517	259
	2	43%						
P5	1	57%	8794	455	7121	16370	1653	827
	2	43%						
P6	1	57%	3311	320	18913	22544	2406	1203
	2	43%						
P7	1	56%	16721	967	3398	21087	2062	1031
	2	44%						
P8	1	57%	9839	103	260	10202	947	474
	2	43%						
P9	1	60%	11304	1666	9402	22371	2332	1166
	2	40%						
P10	1	62%	24338	1384	1656	27377	2641	1320
	2	38%						
P11	1	59%	4278	807	1378	6463	676	338
	2	41%						
P12	1	56%	6909	340	2965	10214	1011	506
	2	44%						
P13	1	46%	8402	1230	1920	11552	1183	592
	2	54%						
P14	1	68%	9646	660	6259	16564	1672	836
	2	32%						
P15	1	51%	9419	1193	4886	15502	1592	796
	2	49%						
P16	1	63%	22204	1512	18301	42017	4270	2135
	2	37%						
P17	1	70%	6185	999	6094	13279	1394	697
	2	30%						
P18	1	64%	437	45	68	550	55	27
	2	36%						
P19	1	31%	1166	70	91	1328	129	64
	2	69%						
P20	1	65%	4588	205	3307	8100	813	406
	2	35%						
P21	1	55%	10580	967	7267	18814	1918	959
	2	45%						
P22	1	54%	5406	1390	2637	9433	1013	506
	2	46%						
P23	1	49%	188	13	5	205	20	10
	2	51%						
P24	1	61%	4378	205	2190	6772	673	336
	2	39%						
P25	1	68%	7269	416	5711	13396	1354	677
	2	32%						

Direction (1) To Kampala

Direction (2) From Kampala

(3) Use of the 24-hour counts

The night time counts provide information to convert 12-hour flows to 24-hour flows. The weighted average factor is 1.28. There is no data in Uganda on which to assess seasonal variation of traffic flow. The Study team will assume that February, the month of the observations, is a typical month for traffic flows. Average daily traffic (ADT) in pcu terms will be the traffic model flows multiplied by the factor (12*1.28). Future year ADT estimates will be converted to vehicles on the basis of the vehicle composition encountered in the 1997 observed flows and the relative growth rates of the three vehicle categories concerned.

4.1.4 Axle Load Survey

This survey was carried out at the Jinja Road roadside interview site on the day of the roadside interview survey. A good sample of goods vehicles was obtained. The method was for drivers to move up the mini-ramp until the wheels of the front axle were at the weighing position. After that axle load was recorded, the driver would then move forward until the wheels of the second axle were at the weighing position, etc.

Tables 4.8 and 4.9 show the results of analyses by the Study Team.

4.1.5 Pavement Condition Survey

Pavement condition was determined by a PSI (Present Serviceability Index) survey. This used a moving observer method to evaluate pavement condition in sections, divided into sub-sections of up to 1 kilometre in length. The sections are summarised in Table 4.10 and shown on the location plan, Fig. 4.1.

The 10 characteristics for rating on the specimen PSI survey sheet included in the Inception Report were adopted and 5 additional characteristics were also rated, giving 15 characteristics in total, as follows:

1. Driving comfort

2. Speed change due to surface condition

3. Patching intensity

4. Degree of rutting

Table 4.8 Loaded Heavy Vehicle Weights (Tonnes)

	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
Total Weight	1002	438.2	140.2	1057.8	1964.4	353.2
Number of Vehicles	90	19	4	23	33	4
Number of Axles	180	57	16	115	198	28
Weight per Axle	5.6	7.7	8.8	9.2	9.9	12.6

Table 4.9 Heavy Vehicle Weights (Tonnes)

	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
Total Weight	1085	468	152.9	1098.2	2009.6	353.2
Number of Vehicles	105	23	6	26	35	4
Number of Axles	210	69	24	130	210	28
Weight per Axle	5.2	6.8	6.4	8.4	9.6	12.6

Table 4.10 Pavement Condition Survey Sections

File name	Description	C/way	From	To	Length		Surface	Condition
					dual	single	Type	
PSI11OC	Jinja Road	Dual, single	Kampala Road	Bweyogerere	1.75	7.75	AC	new
PSI120	Port Bell Road	Single	Lugogo	Port Bell		6.6	AC, SD	new for 1.8km, old / poor
PSI130	Gabba Road	Single	Nsambya	Gabba		9.5	SD	old
PSI140	Entebbe Road	Dual, single	Kampala Road	City Border	0.6	6	AC,SD	old
PSI150	Fort Portal Road	Single	Busega R@	5 km.		5	SD	old / fair
PSI160	Hoima Road	Single	Bakuli	Nansana		8.5	SD	old / fair
PSI170	Bombo Road	Single	Gayaza R@	Kawempe		5	AC	new
PSI180	Gayaza Road	Single	Wandegeya R@	Mperewe		5.9	SD	old failed
PSI190	Kira Road	Dual	Mulago R@	Ntinda	2.5	2.8	AC,SD	new / incomplete
PSI200	Masaka Road	Single	Entebbe Road	Old Masaka Road		9.6	AC,SD	old poor
PSI210	Lugogo By-Pass	Dual	Kira Police Station	Jinja Road	2.4		AC	new
PSI220	Kitante Road	Dual	Mulago R@	Jinja Road	2.5	0.9	AC	new
PSI230A	Mulago Hill Road	Dual, single	Mulago R@	Wandegeya R@	0.5		AC	new
PSI250	Natete Road	Single	Bakuli	Masaka Road		3.6	SD	old failed
PSI260	Luwum Street / Namirembe Road	Single	Kampala Road	Bakuli		2	AC	new
PSI275	Balintuma Road - Nakulabye	Single	Mengo	Nakulabye		1.7	AC	new
PSI277	Makerere Hill Road	Single	Wandegeya R@	Nakulabye		1.8	AC	new
PSI280	Ring Road Mengo	Single	Mengo Hill Road			3.6	SD	old failed
PSI290	Mengo Hill Road	Single	Temple R@	Ring Road Mengo		0.85	AC	old
PSI310	Kampala Road	Dual	Jinja Road	Bombo Road	2.5		AC	old
PSI330	South St / Bombo Rd. / Wandegeya R@	Single	Temple R@	Kampala Road		3.2	AC	old
PSI350	Katwe Road	Dual	Masaka Road	Temple R@	1.5		AC	old
Total					14.25	84.3		

R@ : roundabout

AC : asphalt concrete
SD : surface dressing

Table 4.11 Summary of PSI Survey Results (Factors 1 to 10)

Section	Description	Total length	Number of	Range of scores		Overall
		Kilometres	Observers	Minimum	Maximum	Mean
PSI110C	Jinja Road	9.5	3	2.7	4.9	3.65
PSI120	Port Bell Road	6.6	4	3.2	4.9	3.93
PSI130	Ggaba Road	9.5	2	3.2	4.1	3.74
PSI140	Entebbe Road	6.6	2	2.5	4.3	3.37
PSI150	Fort Portal Road	5	2	4.25	4.8	4.46
PSI160	Hoima Road	8.5	4	3.1	4.9	4.09
PSI170	Bombo Road	5	3	3.9	5	4.56
PSI180	Gayaza Road	5.9	3	2.8	4.7	3.42
PSI190	Kira Road	5.3	2	3.6	5	4.12
PSI200	Masaka Road	9.6	2	2.5	4.9	3.71
PSI210	Lugogo By-Pass	2.4	2	4.7	5	4.88
PSI220	Kitante Road	3.4	3	3.7	4.5	4.1
PSI230A	Mulago Hill Road	0.5	3	4.3	4.6	4.5
PSI250	Natete Road	3.6	3	1.1	3.7	2.36
PSI260	Luwum Street / Namirembe Road	2	2	3.6	4.5	3.98
PSI275	Balintuma Road - Nakulabye	1.7	2	4.5	5	4.77
PSI277	Makerere Hill Road	1.8	4	4.4	4.9	4.66
PSI280	Ring Road Mengo	3.6	2	0.7	1.4	0.95
PSI290	Mengo Hill Road	0.85	2	3.6	4	3.8
PSI310	Kampala Road	2.5	3	3.9	4.9	4.39
PSI330	South St / Bombo Rd. / Wandegeya R@	3.2	3	3	4.1	3.58
PSI350	Katwe Road	1.5	2	3.3	3.8	3.52
Total		98.55				3.77

Note Range of scores includes both pavement variability and observer variations

5. Longitudinal or transverse cracking

6. Alligator cracking

7. Pot-hole

8. Pumping

9. Bleeding

10. Shoving/edge depression

11. Edge spalling

12. Ravelling

13. Corrugations/deformations

14. Bumps

15. Trenching

Table 4.11 presents the results of the pavement condition survey in summary. The range of scores embraces both variations between different 1 km lengths within a section and variations between different observers. A detailed check of the results shows that different observers are reasonably consistent when rating the same subsection of road.

4.1.6 Matrix Building

The roadside interview data (4.1.2) and the traffic count data (4.1.3) were combined to produce base year (1997) trip matrices for use by the traffic model.

Expansion of the interviews was applied in an orthodox manner, expansion factors being computed for each hour and vehicle type. This procedure ensured that peak period trips were properly represented (with a fixed number of interviewers, it is quite common for sampling rates to drop during the peaks). The controlling counts were the 12-hour observed counts factored down to allow for the lower volume of traffic encountered at weekends; the details of calculating these factors are given in sub-section 4.1.3 (1).

The base year (1997) matrix building process had many stages, as follows:

(1) For each RSI site and direction, three matrices were built from the expanded interviews:

Private vehicles	:	motorcycles, cars, pick-ups and miscellaneous
Heavy vehicles	:	2-axle trucks, 3+axle trucks
Public transport vehicles	:	minibuses and buses

(2) Three inbound (to Kampala) cordon matrices were created by summing the inbound matrices at the cordon stations J1 to J8.

(3) Three outbound (from Kampala) cordon matrices were created by summing the outbound matrices at the cordon stations J1 to J8.

(4) Three two-way cordon matrices were created by combining the inbound and outbound cordon matrices, care being taken not to double count the through (external to external) movements. These matrices did not contain trips internal to the cordon.

(5) The three matrices were converted to passenger car units per hour (pcus/hr) using the following pcu equivalents:

Private vehicle	:	1.1 pcus
Heavy vehicle	:	2.0 pcus
Public transport vehicle	:	1.3 pcus

(6) An initial estimate of internal trips in pcus/hr was made by creating a unit matrix and Furnessing it to row and column totals which were proportional to the internal zone trip ends of the cordon pcus/hr matrix.

(7) The cordon matrix and the trial internal matrix were added to form a test matrix in pcus/hr. This was assigned to the base year network and assigned flows were compared to observed flows (converted to pcus/hr). The trial internal matrix was adjusted up or down and the assignment repeated until the sum of the assigned flows and the sum of the observed flows were approximately equal. This was taken as an indication that the number of trips in the internal matrix was approximately correct. Also at this stage, trips between zones 451

and 452 (both external to site J8 on Ggaba Road) were patched in to match the traffic count taken at site C12.

(8) The base year network and the prior (test) matrix were input to an ME2 (maximum entropy matrix estimation process) designed to improve the test matrix. The base year network model was also improved on a trial and error basis by modifying link capacities. This process was iterative, involving a cycle of 4 computer programs, namely network build - assign prior matrix - matrix estimation - assign improved matrix. Throughout, the cross cordon OD movements, being observed, were frozen.

(9) At this point, the improved pcus/hr matrix was reasonably good, and so too were the modelled routes, but the information obtained at the internal sites J9 and J10 had not yet been used. A select link assignment was run in order to obtain the origins and destinations of trips modelled as passing through sites J9 and J10. These were compared with the corresponding observed pcus/hr matrix for sited J9 and J10 combined. Those OD movements indicated by the model as being fully observed at the J9/J10 screenline were patched into the improved matrix (replacing the previous values). The resultant matrix was then fed back into the ME2 process.

Steps (7) to (9) involved a degree of complexity, but were necessary to obtain a good internal matrix, albeit only in pcus/hr. Given the need, in an urban area, to use a capacity restrained assignment technique, there was no way to establish separate internal matrices for the three vehicle classes.

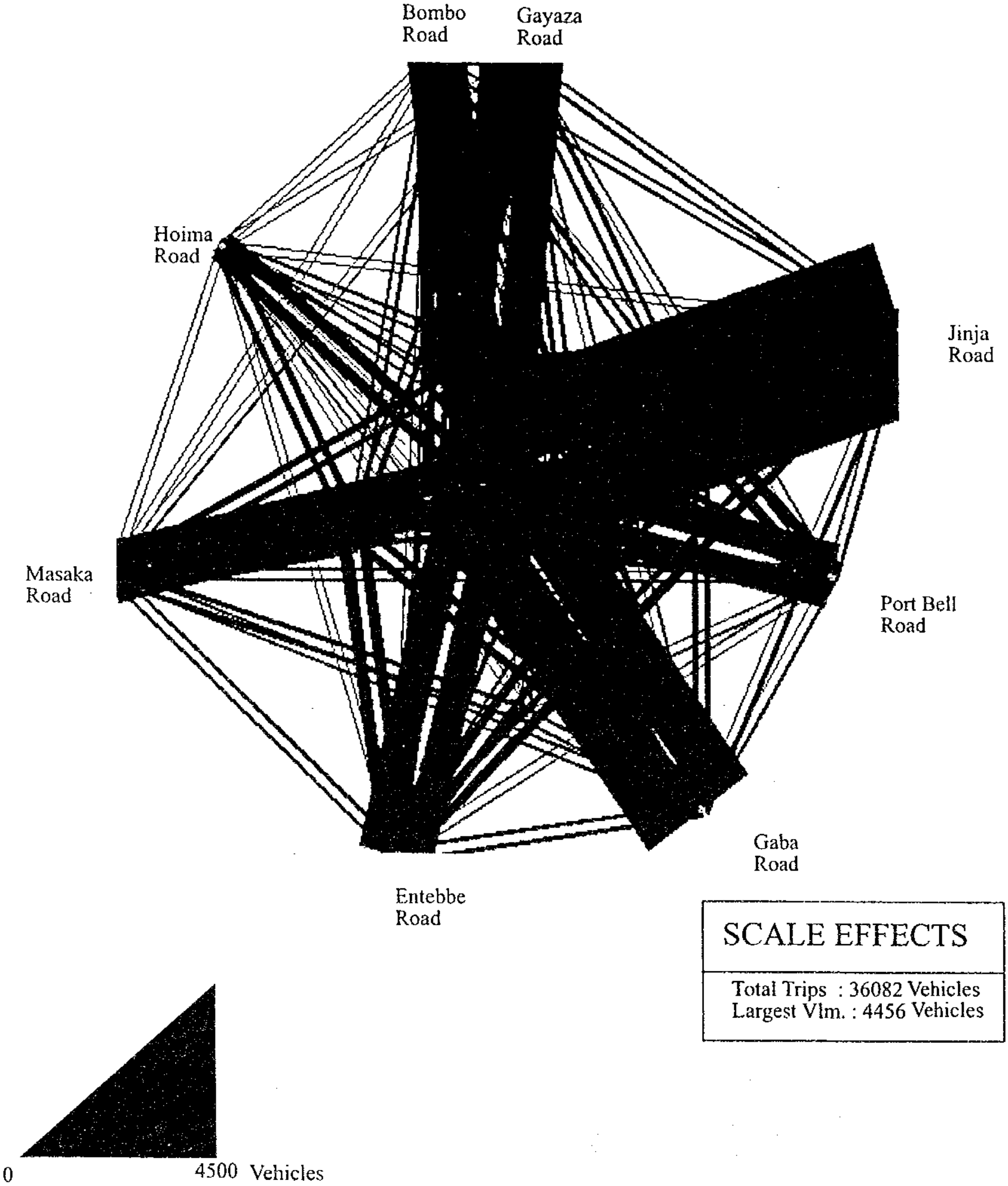


Fig 4.4 (1) TRAFFIC DESIRE LINES AT THE CORDON, 1997
- PRIVATE VEHICLES -

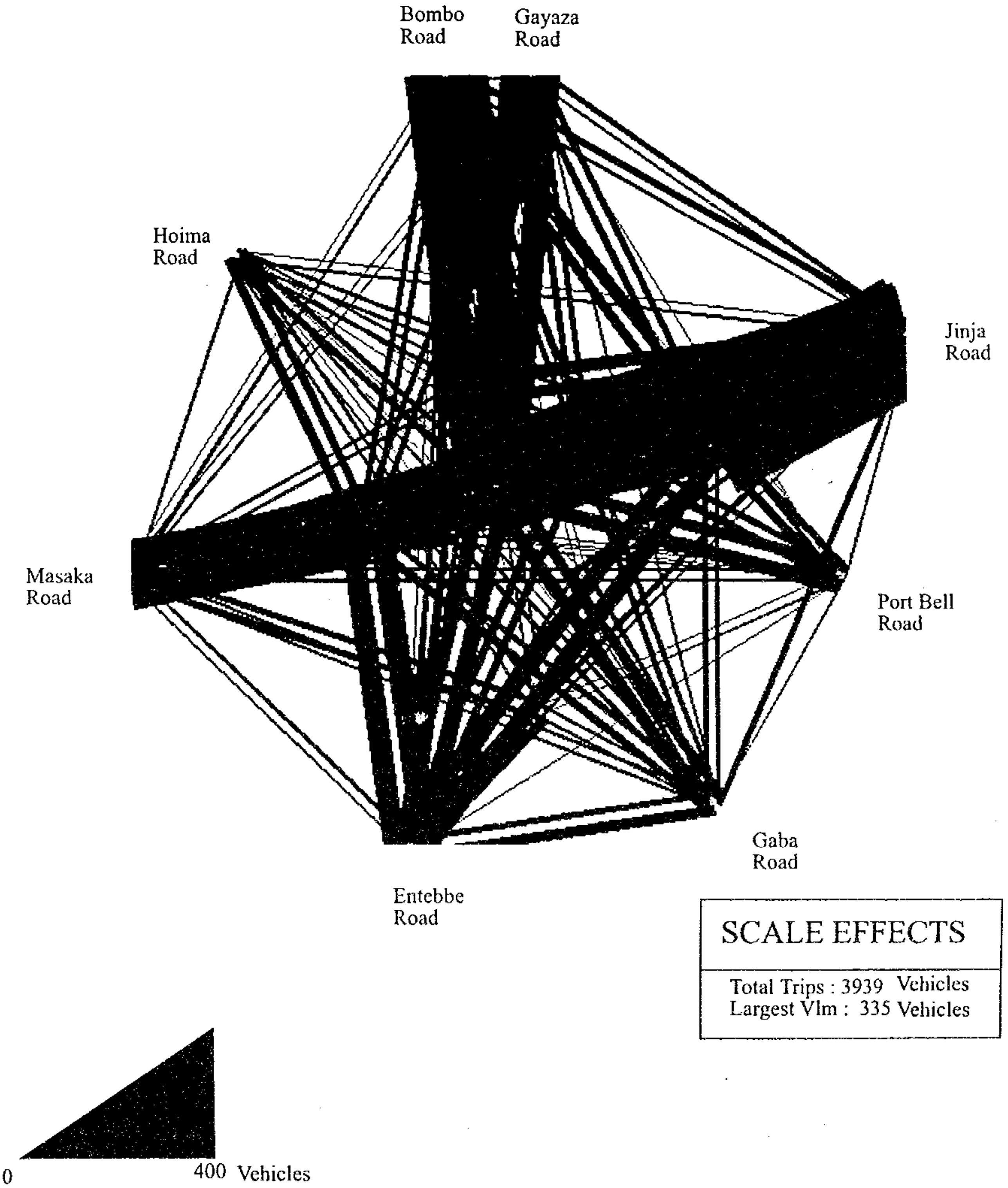


Fig 4.4 (2) TRAFFIC DESIRE LINES AT THE CORDON, 1997
- HEAVY VEHICLES -

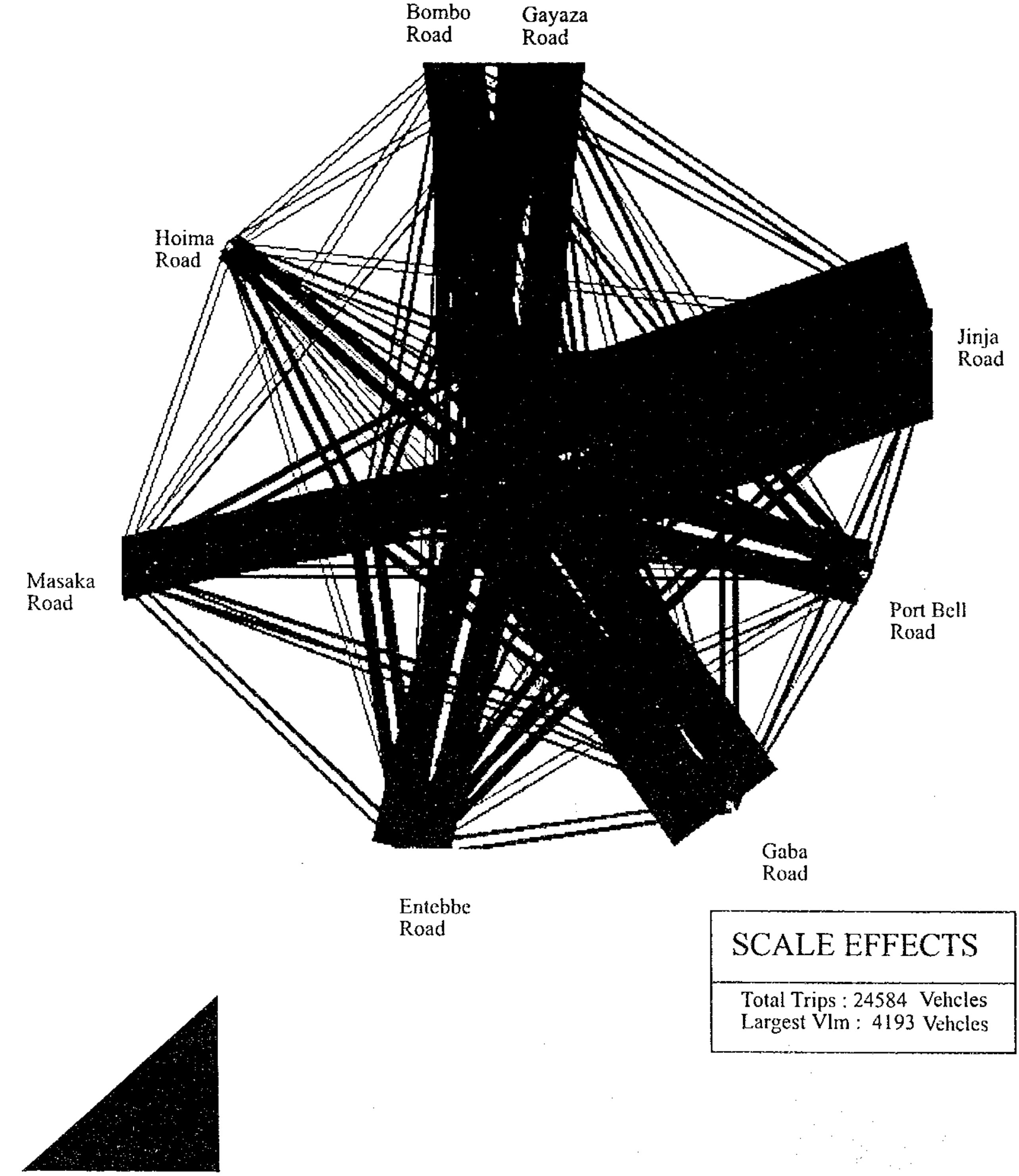


Fig 4.4 (3) TRAFFIC DESIRE LINES AT THE CORDON, 1997
- PUBLIC VEHICLE -

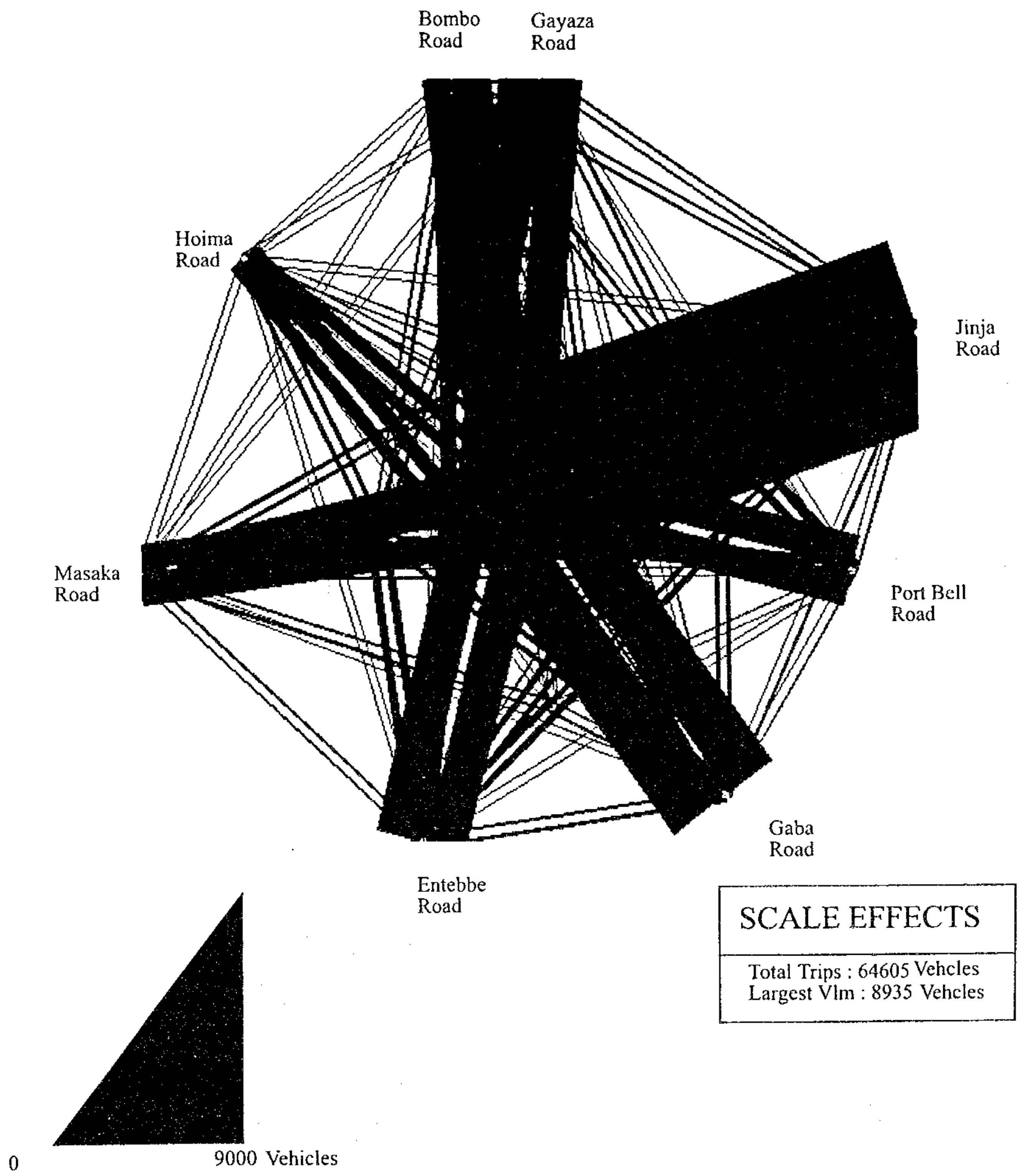


Fig 4.4 (4) TRAFFIC DESIRE LINES AT THE CORDON, 1997
- ALL VEHICLES -

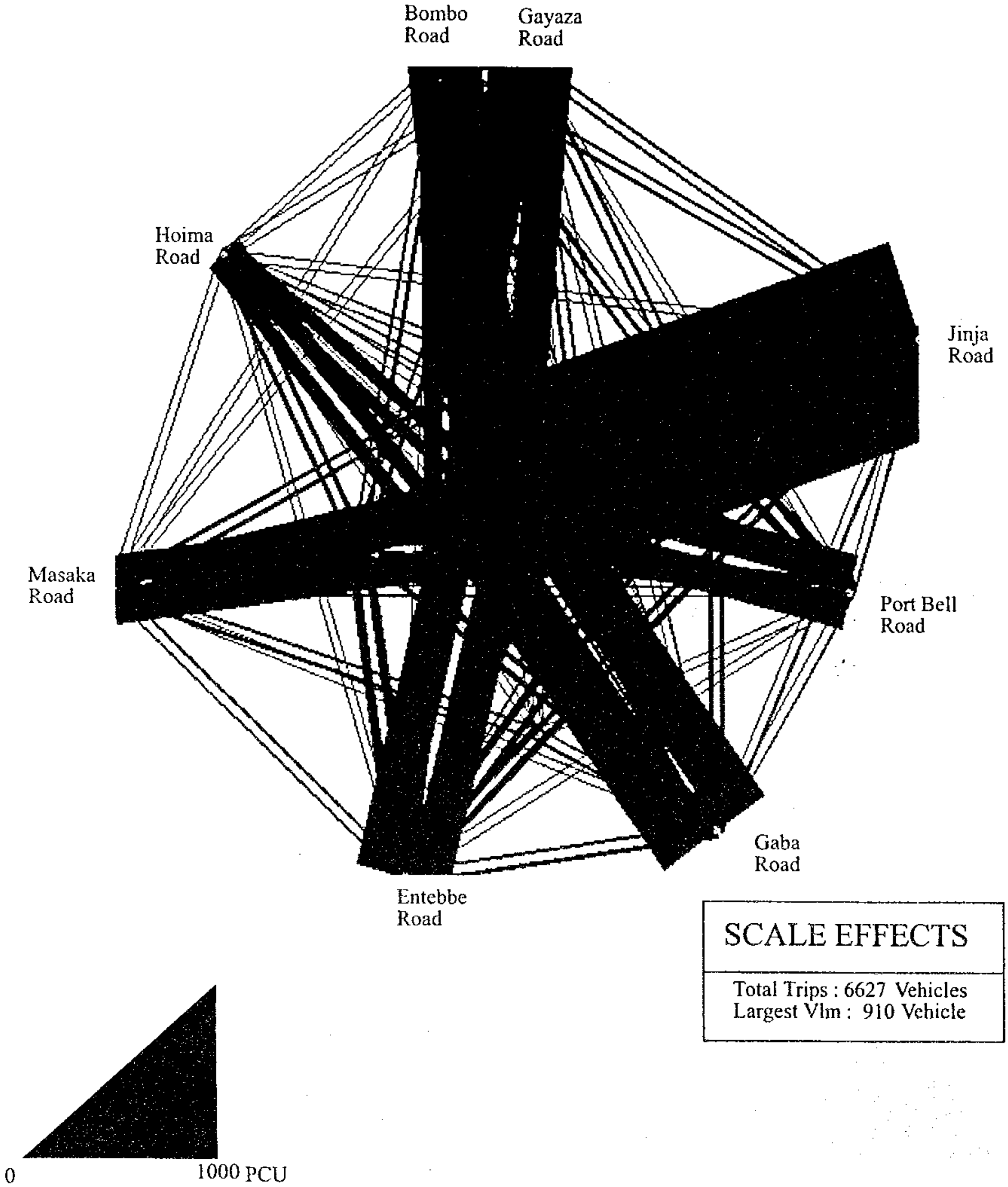


Fig 4.4 (5) TRAFFIC DESIRE LINES AT THE CORDON, 1997
- PCU/HOUR -

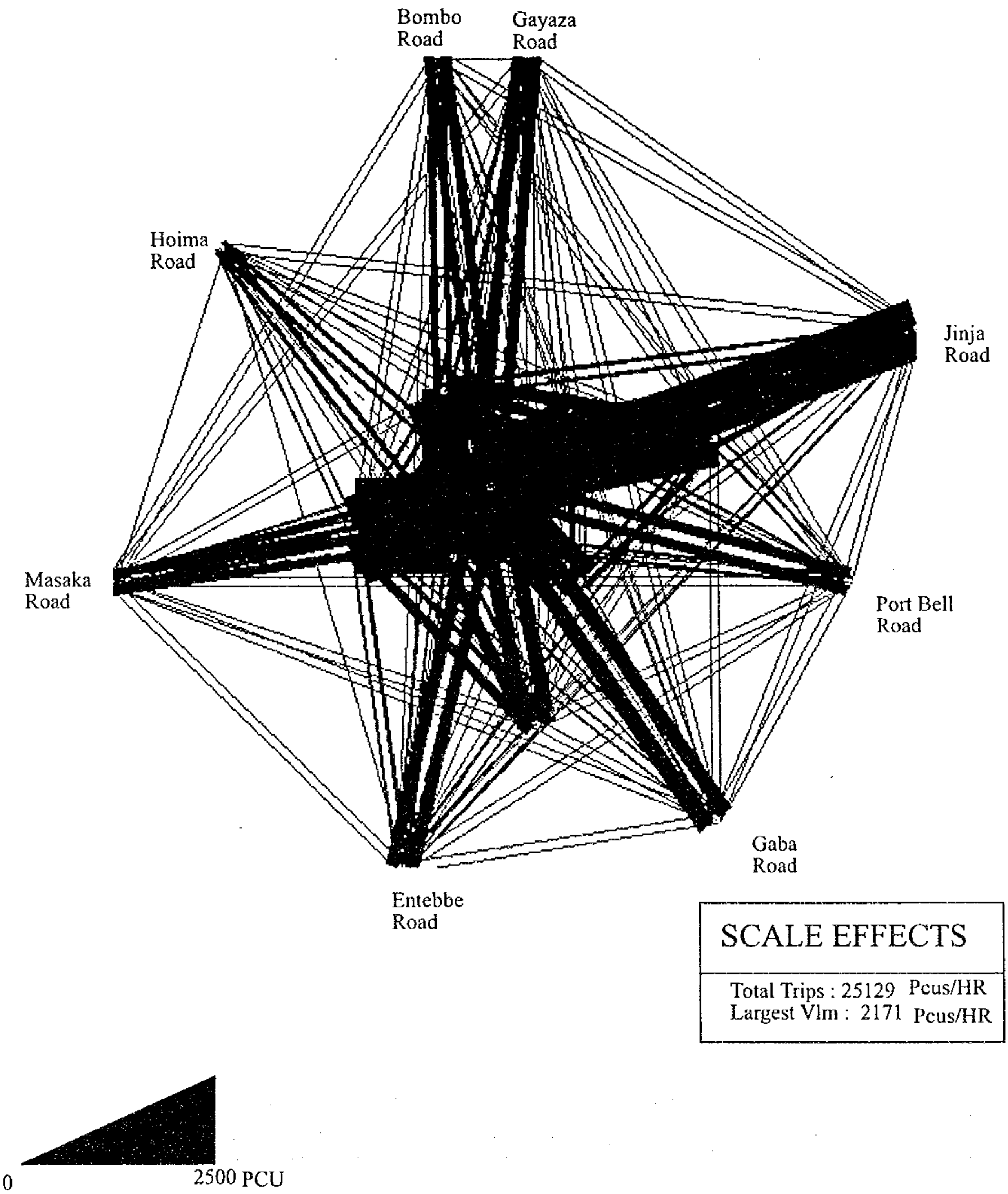


Fig 4.5 PCUS/HOUR 1997 SECTOR MATRIX

4.2 Characteristics of Traffic in the Study Area

The characteristics of traffic in the Study Area are known from general observations by the Study Team members, from the results of the surveys undertaken and from other data sources.

4.2.1 Vehicle Composition

The total number of each vehicle type observed at the 29 12-hour weekday traffic count sites was:

Bicycle	59,279	14.6%	-
Motorcycle and scooter	21,245	5.2%	6.1%
Passenger car and four wheel drive vehicle	152,558	37.5%	43.8%
Taxi/minibus (Matatu)	105,642	25.9%	30.4%
Bus	1,619	0.4%	0.5%
Pick-up truck	49,059	12.0%	14.1%
Truck 2-axles	14,309	3.5%	4.1%
Truck 3-axles or more	2,770	0.7%	0.8%
Other - tractor, road roller etc.	696	0.2%	0.2%
		100.0%	100.0%

Bicycle	59,279	14.6%	-
Private vehicles	223,558	54.9%	64.3%
Heavy vehicles	17,079	4.2%	4.9%
Public transport vehicles	107,261	26.3%	30.8%
		100.0%	100.0%

The percentage contributions of each vehicle type, to total traffic and to motorised traffic, are given alongside. It can be seen that the dominant modes are bicycles, cars, matatus and pick-up trucks.

Overall, the percentage of heavy vehicles is very low and is skewed towards the smaller 2-axle trucks. This is explained by the nature of Uganda's economy and by the fact that pick-up trucks, which the Study Team consider to be predominately private vehicles, also play a role in the transport of goods. The percentage of heavy vehicles is lower still when the lower weekend flows are taken into account.

The corresponding data for just the roadside interview cordon sites (C1 to C8) are :

Bicycle	17,408	20.3%	-
Motorcycle and scooter	4,027	4.7%	5.9%
Passenger car and four wheel drive vehicle	24,938	29.0%	36.4%
Taxi/minibus (Matatu)	24,716	28.8%	36.1%
Bus	331	0.4%	0.5%
Pick-up truck	9,807	11.4%	14.3%
Truck 2-axles	3,835	4.5%	5.6%
Truck 3-axles	765	0.9%	1.1%
Other - tractor, road roller etc.	128	0.1%	0.2%
		100.0%	100.0%

Bicycle	17,408	20.3%	-
Private vehicles	38,900	45.3%	56.7%
Heavy vehicles	4,600	5.4%	6.7%
Public transport vehicles	25,047	29.1%	36.6%
		100.0%	100.0%

At the cordon, along the commuter routes, public transport has a greater share. Also, the goods traffic using Jinja Road and serving the industrial areas contributes to the slightly greater share of heavy vehicles.

4.2.2 Vehicle Occupancy and Person Trips

The principle use of the traffic surveys has been to collect information relating to vehicle counts and vehicle journeys. However, the effect of the different vehicle occupancies should be borne in mind. Average occupancies for private, heavy and public transport vehicles are respectively 2.36, 2.78 and 11.17 people (including the driver). Therefore, approximately 30% of people travel by private transport and 70% by public transport.

4.2.3 Axle loads

The axle load survey has revealed that the vehicles with the greatest number of axles, i.e. the larger vehicles, appear to be overloaded, although there is a possible doubt about the measurement method when two axles are in close proximity. This being the case, a small proportion of vehicles may be causing most of the damage to the existing roads. The Study Team will stipulate carefully the required maximum axle weights for the roads that they design.

4.2.4 Capacities and Saturation Flows

Observations and the calibration of the base year traffic model have both revealed that quantities measuring the traffic operational performance, namely capacity and saturation flow, are significantly lower in Uganda than in developed nations. There are a number of reasons for this, as listed below, many of which can be reduced over time given suitable investment and enforcement. Essentially, road space is not being used efficiently.

- wrong type of junction control
- ill disciplined behaviour at road junctions
- give way to the right at roundabouts not applied
- cyclists and pedestrians too close to motorised traffic
- commercial activities too close to the road
- stop on demand by matatus
- insufficient bus stops
- irregularity of road width due to poor planning or pavement edge spalling
- disruptive effects of potholes
- too much on street parking
- poor circulation near matatu parks
- insufficient number and locations of matatu parks
- lack of traffic management in the central areas

CHAPTER 5

FUTURE TRAFFIC DEMAND FORECAST

5 FUTURE TRAFFIC DEMAND FORECAST

5.1 Future Socio-economic Framework

5.1.1 Population Projection

In the population projection, the applied rates of increase were as follows:

- Uganda : 2.5% per annum up to the year 2015
- Kampala City : 4.6% per annum up to the year 2005
  4.5% per annum during 2005 - 2015

The following is the rationale of the respective rates adopted:

1) For the whole Ugandan population, the Statistics Dept. assumed in its projection the increase rates; 3.5% per annum up to the year 1996, 2.9% per annum up to the year 2005, and 2.8% per annum up to the year 2015. This projected population is used in such publications as the "10-year Road Sector Development Programme", as officially authorized figures. These assumptions, however, were judged to be exaggerated because of the fact that the past population growth registered 2.6% per annum during 1969 to 1980 and 2.5% per annum during 1980 to 1991 and growth rates have been decreasing. According to the World Bank Statistics, 1984 - 1993, the neighbouring countries have different population growth rates; namely, Kenya: 3.1%, Zaire: 3.3%, Rwanda: 2.8%, Tanzania: 3.2%, and Sudan: 2.7%. If the country characteristics are considered, the past growth rate of 2.5% is appropriate to apply in Uganda up to the year 2020. Whilst a constant growth rate has been adopted, it might implicitly contain the reduction factor. Thus, the Ugandan population projection has been made on a conservative basis.

2) With reference to Kampala City population, the prevailing projections can be found in the "Kampala Urban Study, 1994". It forecasts, based on the 1991 Census figure of 774,241, that Kampala City's population will grow to 1,209,931 in the year 2000 and to 1,556,793 in 2004. The projections have been made by applying the different population growth rates peculiar to each ward/parish of Kampala City; the total population is the aggregate of the ward-by-ward projections. The resultant rates of increase are 5.1% per annum during 1991 to 2000 and 6.5% per annum for the years 2000 to 2004.

Other population projections are available in the "10-year Road Sector Development Programme" (growth rate: 5.0% up to 1995) and in the "First Urban Project" (growth rate: 5.2% up to 1995), but these are not extended to the year 2000. Under the circumstances, most notice has been taken of the projection methodology of the "Kampala Urban Study, 1994". Considering the past performance of the City's population growth (3.0% per annum in 1968 - 80 and 4.9% per annum in 1980 - 91), the rates of increase derived in the "Kampala Urban Study" are exaggerated, especially for the period from 2000 to 2004. However, the methodology itself, the aggregation of ward/parish projections, was judged reasonable and was followed. In the "Kampala Urban Study", ward/parish area characteristics have been minutely analyzed to discover what additional population they can absorb and the respective rates of increase be determined.

The Study Team has applied an annual population increase of 40,130 (the modified value of the "First Urban Project") to Kampala City population from 1991 to 1997. The resultant average annual growth rate of population is 4.6%, which was used up to 2005. From 2006 onwards, a slightly reduced rate of 4.5% per annum was adopted up to 2020, taking into account limits to urban population growth in the city area.

3) Application to individual wards

The "Kampala Urban Study, 1994" assumes a rate of population growth between 2.0% and 6.5% in each ward/parish inside Kampala City. The low rate of 2.0% is applied to the built-up areas mostly located around the CBD, while high rates are applied to the prospective development areas such as the planned sub-centres and the suburban fringes. Well-balanced urban development has been aimed at, as part of the structure plan targeted for the year 2004. Population projections carried out in the "Kampala Urban Study" take, therefore, full account of the socio-economic characteristics of each area. The area's capacity to accommodate additional population is reflected in the applied rates of population increase.

The tables below show the population projection results, for both Uganda and Kampala City.

Uganda

Unit: thousand

Year	Population	Applied Growth Rate (%)
1991	16,671.7	(Base Year)
1997	19,334.4	2.5
2005	23,557.0	2.5
2015	30,155.0	2.5
2020	34,117.6	2.5

Kampala City

Unit: thousand

Year	Population	Applied Growth Rate (%)
1991	774.2	(Base Year)
1997	1,015.0	4.6
2005	1,454.5	4.6
2015	2,258.8	4.5
2020	2,814.9	4.5

5.1.2 Forecasts of Economic Activity and Income Level

The government is expecting the economic growth during FY1996/97 to FY1998/99 to be 5.5% in real terms. In the light of the past achievement in the economic growth (1986 - 1995: 6.7%; 1990 - 1995: 6.9%, 1993 - 1994: 10.1%, 1994 - 1995: 8.7%), this target is realistic but cautious. The Study Team assumes the Ugandan economy will grow at a rate of 6.2% per annum for the coming 8 years, should the favorable socio-economic conditions be maintained, reducing to 4.6% after 2005.

The per capita GDP will continue to grow at a rate of 3.6% per annum in line with the above economic growth over the coming 8 years, reducing to 2.0% thereafter. Coinciding with the per capita GDP, the income level of the country population as well as Kampala City residents will increase. However, the fact that Kampala City residents have more than double the income level of the country population is not expected to change.

5.1.3 Forecasts of Employment

It was assumed that the employment volume is subordinate to the total population in the area. Total Ugandan employment is equal to the working population as stated in Chapter 2, which is 37.7% of the total population. In the case of Kampala City the employment ratio to the total population has been modified, taking into account the commuter movement from the neighboring areas. The ratio applied in Kampala City was 40.0%.

Employment volumes in Uganda and Kampala City were obtained from the projected population multiplied by the respective ratios, as shown below.

Unit: thousand

Year	Uganda	Kampala City
1997	7,289.1	406.0
2005	8,881.0	581.8
2015	11,368.4	903.5

5.1.4 Breakdown by Traffic Zone

The projected population and forecasted employment were allocated to each traffic zone, to formulate planning data for the traffic demand forecast. The present situation is indicated for the year 1997, while future forecasts are shown in 2005 and 2015. Allocation of population and employment was made in accordance with the area characteristics and the land use classification inside the traffic zone.

Tables 5.1 to 5.3 present the planning data thus formulated within the future socio-economic framework. The features relative to these planning data are illustrated in Figs. 5.1 (a), (b), (c) and Figs. 5.2 (a), (b), (c), only for Kampala City inner traffic zones.

Table 5.1 Planning Data for Kampala City Inner Traffic Zones, 1997

Unit: thousand

Zone Code	Area (ha)	Population	Employment		
			Agriculture	Industry	Commerce/Services
010	227.0	10.2	-	-	4.6
011	47.4	3.9	-	-	8.7
012	54.5	11.6	-	2.6	10.5
013	133.3	3.9	-	8.9	8.5
020	470.6	13.9	0.6	-	3.5
021	165.2	1.2	-	22.2	-
030	171.7	30.9	0.2	0.7	2.7
040	182.4	38.3	0.2	6.7	1.5
050	112.4	24.0	1.0	0.2	2.0
110	116.2	21.2	0.7	5.5	0.6
111	372.7	58.2	1.4	0.3	2.5
112	1,150.3	21.1	14.8	-	-
120	329.1	30.1	3.6	7.9	2.0
130	373.3	62.7	1.4	-	3.7
210	462.5	8.3	4.5	3.4	1.4
211	96.5	13.9	0.2	15.6	3.8
212	366.2	20.9	0.5	7.7	0.9
213	260.0	9.2	2.5	7.7	-
214	416.0	13.0	3.1	3.4	3.1
215	510.0	15.4	5.0	0.5	4.6
310	353.9	37.2	0.9	0.3	3.2
311	292.1	43.8	1.4	2.3	9.4
320	269.8	52.3	-	-	5.4
322	1,400.9	29.0	20.6	1.1	4.2
410	200.7	26.0	-	2.0	4.0
411	386.3	19.1	0.5	2.0	1.9
412	819.3	30.4	5.0	7.8	7.4
420	481.9	36.3	2.3	1.4	5.8
421	1,122.2	71.4	8.3	0.8	3.4
430	191.0	25.4	0.2	0.6	5.1
431	795.8	31.2	8.8	-	-
451	792.8	29.7	8.8	-	-
452	934.3	21.6	12.6	-	-
461	1,232.6	53.2	6.0	5.1	4.6
462	833.3	40.1	6.1	18.8	6.3
471	1,496.1	37.8	18.4	1.1	4.5

Source: Study Team

Table 5.2 Planning Data for Kampala City Inner Traffic Zones, 2005

Unit: thousand

Zone Code	Population	Employment		
		Agriculture	Industry	Commerce/Services
010	11.9	-	-	5.3
011	4.6	-	-	10.2
012	13.5	-	3.0	12.3
013	4.6	-	10.0	10.0
020	16.3	0.5	-	4.1
021	1.4	-	22.6	-
030	36.2	0.2	0.6	3.6
040	44.9	0.2	14.5	2.8
050	35.5	0.7	0.3	3.8
110	31.2	0.5	10.1	1.4
111	89.3	1.0	0.5	5.8
112	32.4	14.0	15.0	6.5
120	35.2	3.1	10.9	5.3
130	96.2	1.3	-	9.7
210	12.7	4.3	5.2	2.1
211	21.3	0.2	20.4	5.8
212	32.1	0.5	8.5	2.4
213	14.1	2.4	8.5	4.1
214	19.2	2.9	5.0	5.6
215	18.0	4.3	0.6	5.4
310	49.8	0.7	0.4	6.2
311	64.7	1.3	4.9	14.9
320	71.6	-	-	8.4
322	44.5	19.5	3.2	8.4
410	35.6	-	3.0	7.0
411	26.1	0.4	3.8	3.7
412	46.7	4.8	9.4	12.4
420	49.7	1.7	1.9	8.9
421	109.6	7.8	1.2	6.2
430	37.5	0.1	0.9	9.5
431	47.9	8.3	-	2.5
451	45.9	8.3	1.8	5.0
452	29.6	12.1	-	6.3
461	78.6	5.7	9.4	7.8
462	61.5	5.8	27.3	6.7
471	58.0	17.4	16.9	11.9

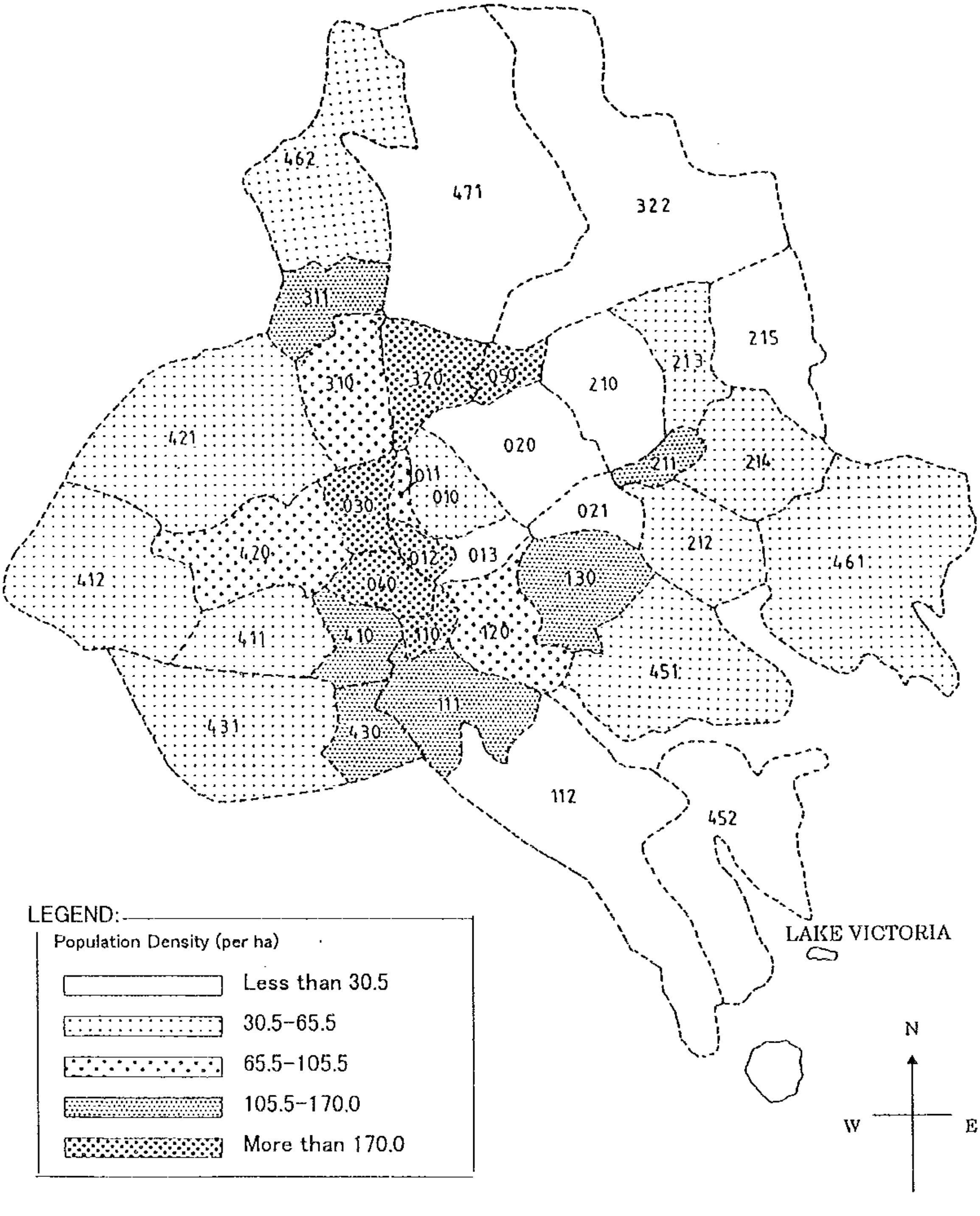
Source: Study Team

Table 5.3 Planning Data for Kampala City Inner Traffic Zones, 2015

Unit: thousand

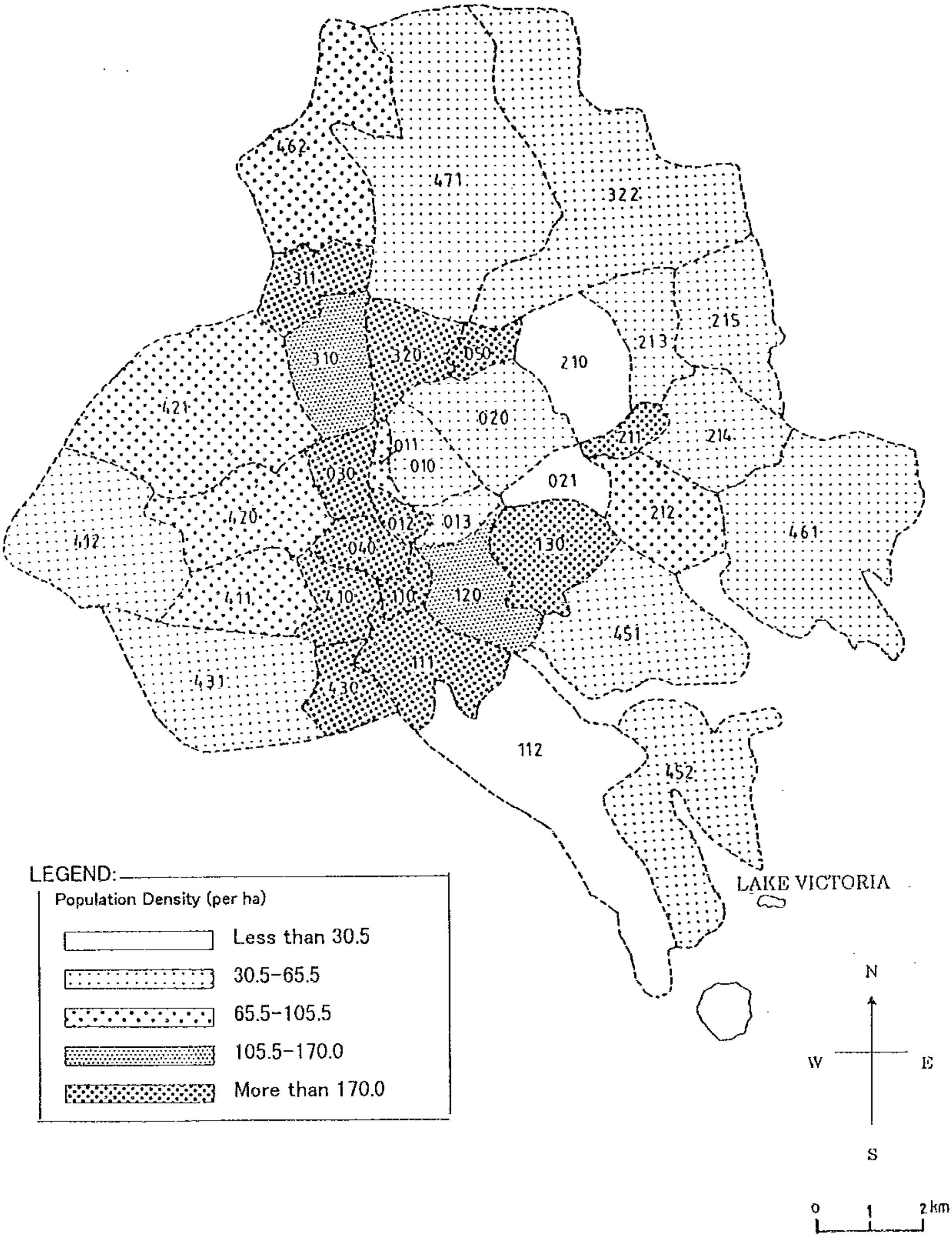
Zone Code	Population	Employment		
		Agriculture	Industry	Commerce/Services
010	13.1	-	-	5.8
011	5.1	-	-	11.3
012	14.9	-	3.3	13.6
013	5.1	-	11.8	11.0
020	18.0	0.5	-	4.5
021	1.5	-	22.6	-
030	48.6	0.2	3.8	9.6
040	60.3	0.2	19.5	7.6
050	43.3	0.6	1.9	9.2
110	46.2	0.4	15.0	4.2
111	152.5	0.9	3.2	15.7
112	58.0	13.2	26.9	13.6
120	52.1	2.1	16.1	7.8
130	164.3	1.2	2.3	21.5
210	21.7	4.1	8.9	8.6
211	26.0	0.1	24.9	12.1
212	54.8	0.4	14.5	9.1
213	24.1	2.2	14.5	9.5
214	32.8	2.8	10.8	11.1
215	26.6	4.1	3.9	11.0
310	73.7	0.7	3.6	11.7
311	95.8	1.2	8.1	25.0
320	106.0	-	0.7	13.9
322	79.7	18.4	8.7	17.5
410	52.7	-	4.4	15.3
411	38.6	0.4	5.6	9.1
412	69.1	4.6	16.9	23.4
420	73.6	1.5	5.8	15.7
421	196.3	7.3	5.1	13.6
430	55.5	0.1	4.3	16.5
431	78.0	7.9	3.0	6.1
451	74.8	7.9	5.9	9.6
452	48.2	9.4	5.5	13.7
461	128.0	4.4	15.3	14.2
462	105.1	4.4	28.5	13.4
471	108.9	12.4	28.8	20.3

Source: Study Team



THE FEASIBILITY STUDY OF
IMPROVEMENT OF TRUNK ROAD
AT KAMPALA URBAN INTERFACE

Fig.5.1(a) Population Density, 1997



THE FEASIBILITY STUDY OF
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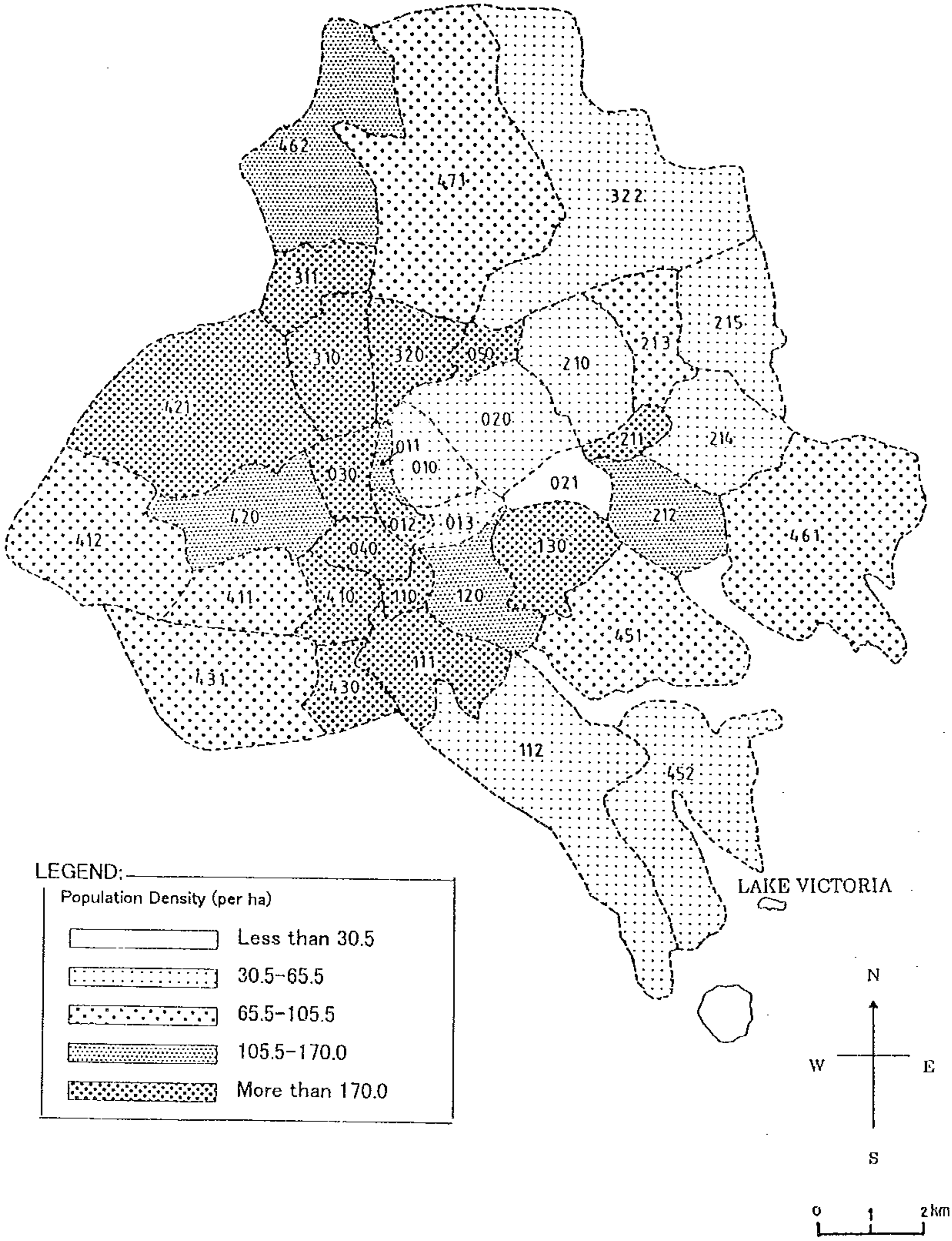
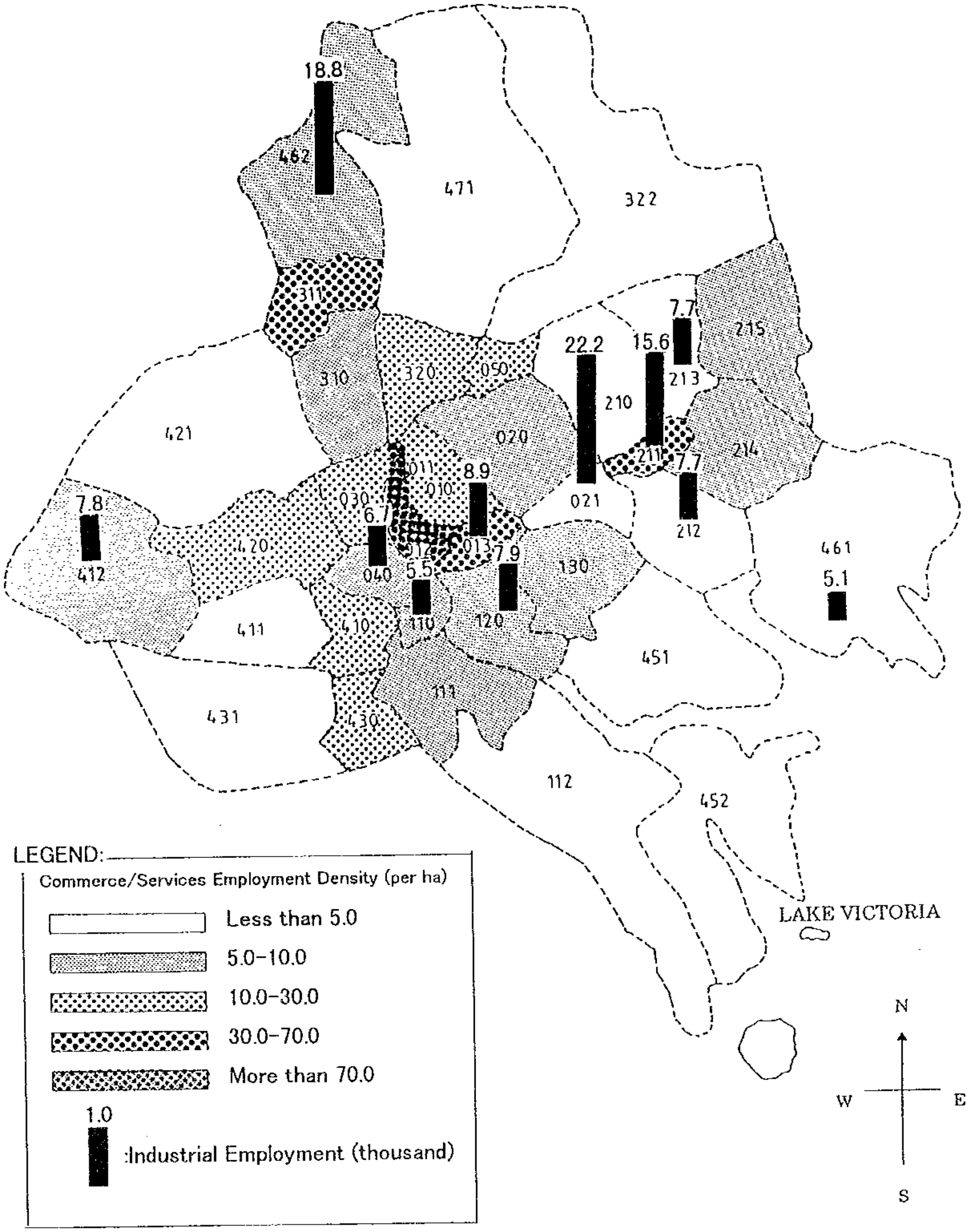
Fig.5.1(b) Population Density, 2005



THE FEASIBILITY STUDY OF IMPROVEMENT OF TRUNK ROAD AT KAMPALA URBAN INTERFACE

Fig.5.1(c) Population Density, 2015



THE FEASIBILITY STUDY OF
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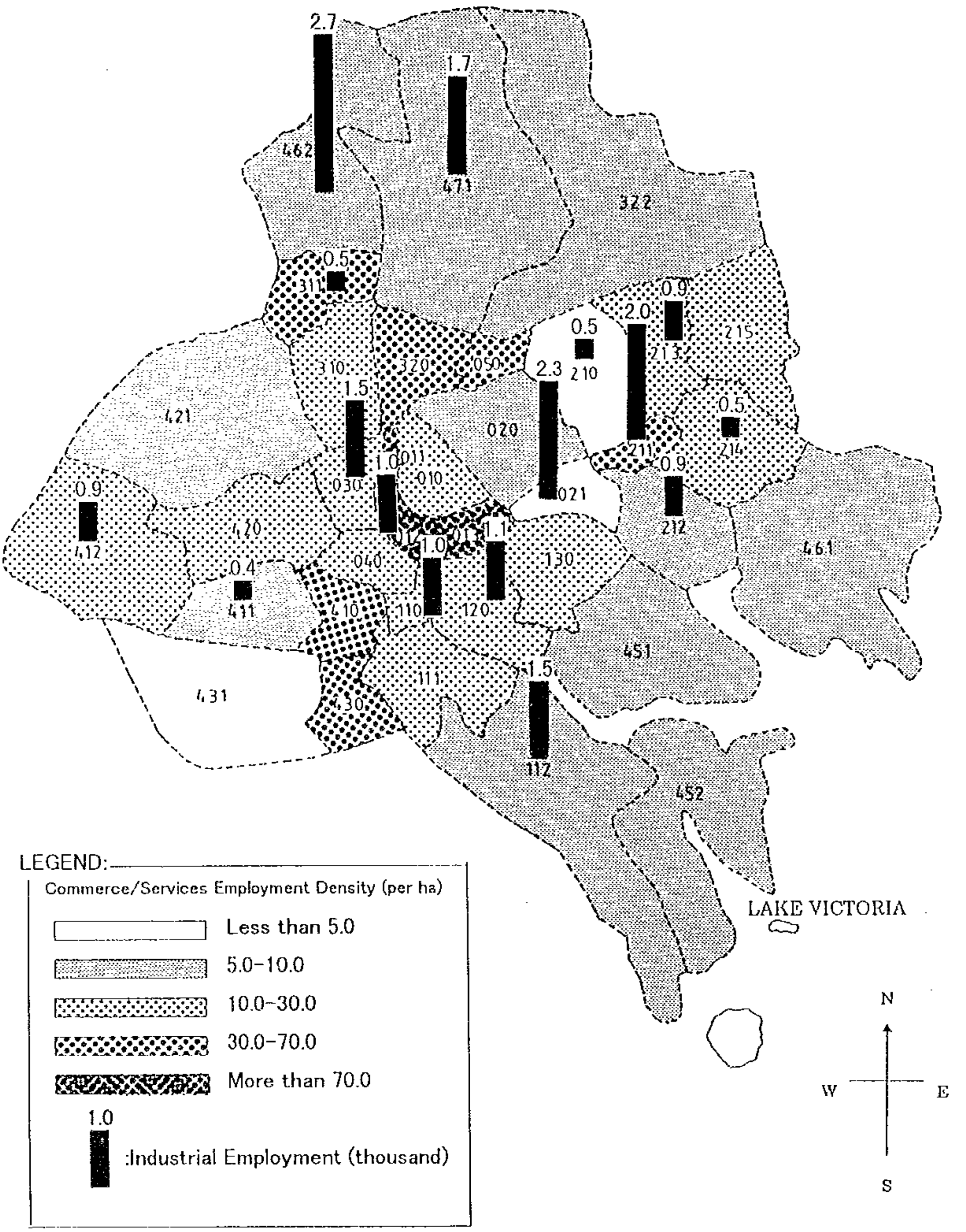
Fig.5.2(a) Industrial Employment Volume and Commercial/Services Employment Density, 1997.



THE FEASIBILITY STUDY OF
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Fig.5.2(b) Industrial Employment Volume and Commercial/Services Employment Density, 2005.

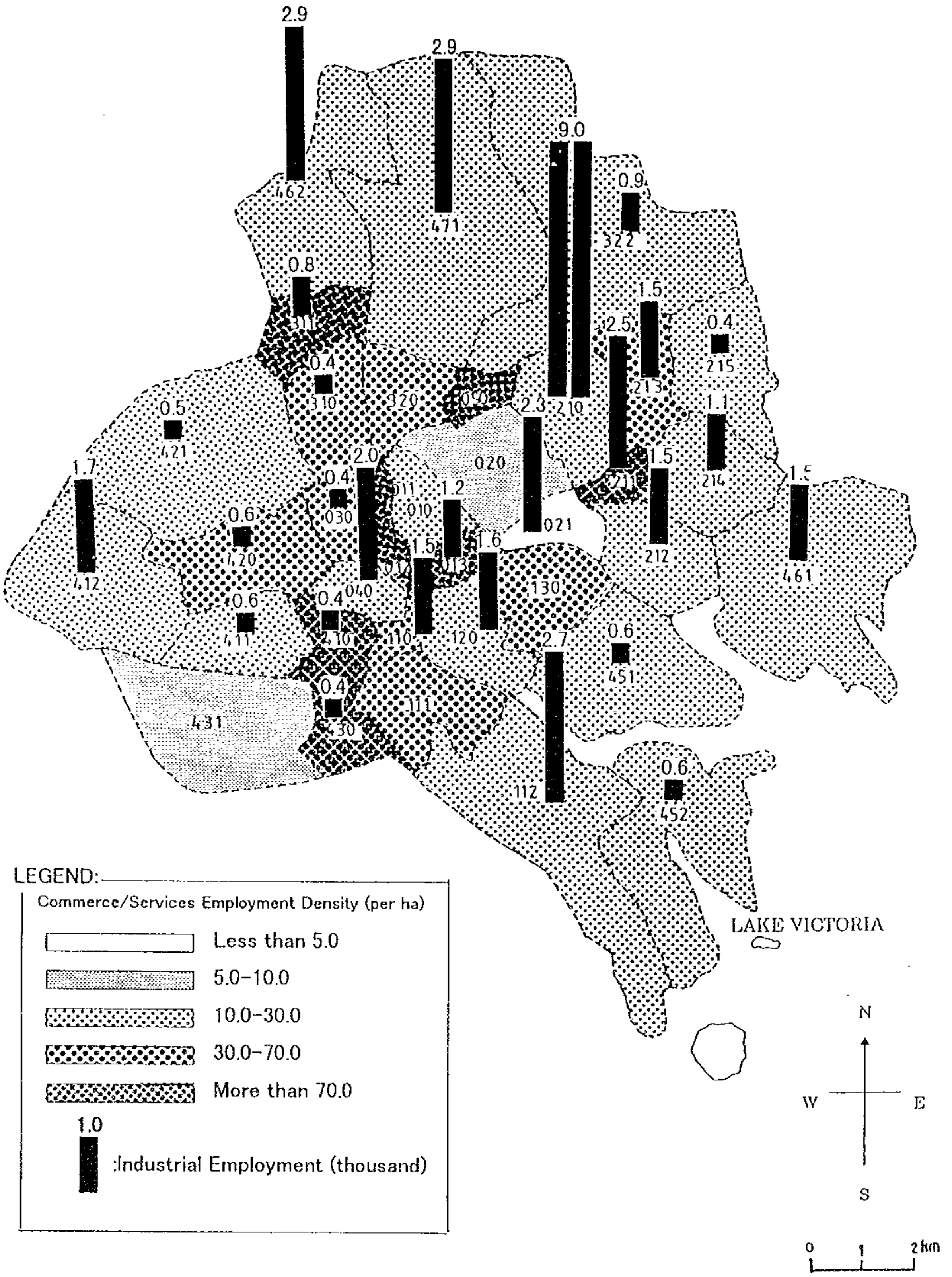

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Fig.5.2(c) Industrial Employment Volume and Commercial/Services Employment Density, 2015.

5.2 Generating/Attracting Traffic (Trip Ends)

5.2.1 Outline Methodology

The growth of trip ends relative to those of the base year matrices was driven by forecast population and land use changes and their predicted effects on employment of various types, and by a forecast of macro-economic growth. Trip end growth was forecast for 2 years, 3 broad categories and 3 types of zone, as follows :

- future years 2005 and 2015
- private, heavy and public transport vehicles
- zones inside the roadside interview cordon (010 to 431)
- zones outside the cordon but inside Kampala City (451 to 471)
- zones outside Kampala City (500 to 703)

The method involved explaining the observed 1997 (base year) trip ends for each vehicle category in terms of population and employment effects, then using the fitted relationships and zonal forecasts of population and employment to predict future changes in those trip ends. An additional factor was the anticipated response of people to economic growth and higher incomes; this can affect travel mode choice considerably. Details of the main steps now follow.

5.2.2 Explaining Base Year Demand

Because our traffic model and trip ends relate to an average hour of an average 12-hour day, the matrices are nearly symmetric and for all practical purposes the trips from a zone and the trips to the same zone are influenced by population and employment in a similar manner. The influences of population and employment vary from zone to zone according to the activities being carried out in the zones.

The trip ends of the observed 1997 matrices were explained in terms of the available estimates of population and employment, the latter subdivided into employment related to agricultural, industrial and commercial land uses. This was implemented in a spreadsheet by allocating weighting factors to population and to each of the 3 employment types, and thus building up a score for each zone. The weighting factors were adjusted until the zonal scores were approximately proportional to the observed trip ends. Separate weighting factors were established for each of the 3 vehicle categories and 3 types of zone. The subdivision into 3 types of zone was necessary for the following reasons :

- for the internal zones, the observed trip ends are partial, relating only to cordon crossing movements; the cordon is a line through the roadside interview stations J1 to J8.

- for the zones external to the cordon but internal to Kampala City, the observed trip ends include cordon crossing movements to and from internal zones plus some through (external to external) movements.

- for the zones outside Kampala city, the situation is similar but only population data was available to explain the observed trip ends.

5.2.3 Forecasting Future Trip Ends

The weighting factors established in explaining the base year trip ends were applied to the forecast population and employment for each zone to produce the trip end forecasts for 2005 and 2015. Overall, the population of Kampala is forecast to grow at 4.5% per annum between 1997 and 2015, with total employment increasing proportionately, but with a swing away from agricultural employment towards industry and commerce. Also, population is forecast to increase at a faster rate in the outlying areas of Kampala than in the centre.

Additional factors related to economic growth were applied. The forecast increases in GDP per capita are 3.6% per annum between 1997 and 2005, reducing to 2% between 2005 and 2015. Private vehicle trips per capita were assumed to increase at faster rates, 5.5% between 1997 and 2005, and 3% thereafter. Heavy goods vehicle trips per capita were assumed to rise in line with economic growth. Public transport trips per capita were assumed not to respond to economic growth; indeed in many countries there has been a negative effect as people switch to private transport. The response to economic growth was not applied to zones 011, 012 and 013 in central Kampala, on the grounds that there are natural constraints on vehicle trip growth in these highly concentrated downtown areas.

The forecast growth in purely internal trips (which for the base year 1997 were estimated, not observed) was in line with the forecast growth in internal to external and external to internal trips.

5.3 Future Vehicle OD Matrices

5.3.1 Technique and Results

For both future years, the above procedures gave estimates of trip end growth relative to 1997 for:

- the private vehicle 12-hour cordon matrix
- the heavy vehicle 12-hour cordon matrix
- the public transport vehicle 12-hour cordon matrix
- the internal pcus/hr matrix

A "Frater" technique, in which the input (1997) matrix rows and columns are iteratively adjusted to match the forecast trip ends, was applied to each of the 4 matrices in turn. This process is mathematically convergent and yields an output matrix that complies with the specified row and column (trip end) totals to whatever level of precision is specified. The procedure for combining the 4 matrices to produce a full pcus/hr matrix was the same as that used in forming the 1997 pcus/hr matrix.

Table 5.4 shows the total number of trips in the cordon matrices and in the full matrices for years 1997, 2005 and 2015, together with the growth factors relative to 1997. The overall forecast pcus/hr growth relative to 1997 was 1.69 for year 2005 and 3.14 for 2015, corresponding to compound growth rates of 6.8% per annum between 1997 and 2005 and 6.4% per annum between 2005 and 2015. These are high growth rates but not as high as the 10% experienced over the past decade.

In order to illustrate the geographical variation in trip end growth and the distribution of trips, 16 sectors formed by grouping zones were defined. Table 5.5 contains the definitions of these sectors. Sectors 1 to 8 are internal to the cordon, sectors 9 to 16 external. The trips in pcus/hr from each of these sectors in 1997, 2005 and 2015 are shown in Table 5.6. Forecast trip end growth is low in central Kampala (sector 1), straddles the average in central eastern and central western Kampala (sectors 2 and 3) and is high in outer Kampala (sectors 4 to 8). Outside the cordon, forecast growth is below average except in those external sectors (10,15 and 16) containing zones which lie within Kampala city.

The forecast distribution of trips is shown in the sector to sector pcus/hr desire line diagrams for 2005 (Figure 5.3) and 2015 (Figure 5.4). These are automatically scaled by a computer program, so information regarding the scaling effects is provided on the diagrams. These diagrams are complemented by Tables 5.7 and 5.8, containing pcus/hr matrices for years 2005 and 2015 respectively.

5.3.2 The Nature of the Forecast

This is a demand forecast; only for central Kampala has there been any attempt to take account of limitations to growth in vehicular travel.

The Study Team are aware that demand can not always be met in an urban area and resolved to comment on the supply situation after undertaking future year assignments using the traffic model. The model is able to supply information on levels of congestion. The Study Team's task is to produce a practical improvement plan for parts of the Kampala highway network. If the forecast vehicular demand (particularly for year 2015) is too high for any practical plan, then the Study Team will design for a lower level of demand and comment on the shortfall in supply. This will stop short of an urban transportation study.

Table 5.4 Total Trips in Matrices

Matrix Type	Year 1997 Trips	Year 2005 Trips	Year 2005 Growth	Year 2015 Trips	Year 2015 Growth
Cordon Matrices					
Private Vehicles 12-hour day	36082	69792	1.93	137371	3.81
Heavy Vehicles 12-hour day	3939	6985	1.77	13189	3.35
Public Transport 12-hour day	24584	32089	1.31	51328	2.09
All Vehicles 12-hour day	64605	108866	1.69	201888	3.12
Pcus/hr 1.1 / 2.0 / 1.3	6627	11038	1.67	20351	3.07
Full Matrix					
Pcus/hr 1.1 / 2.0 / 1.3	25129	42536	1.69	78964	3.14

Table 5.5 Definition of Sectors

Sector Number	Sector Description	Places Included	Zones Included
1	Central Kampala	Nakasero, Nakivubo, Civic Centre	010, 011, 012, 013
2	East Central Kampala	Kololo, Industrial Area, Kamwokya	020, 021, 050
3	West Central Kampala	Kagugube, Bukosa, Old Kampala, Kisenyi, Mengo	030, 040
4	Southern Kampala	Katwe, Kibuye, Makindye, Luwafa, Likuli, Salaam	110, 111, 112
5	South-East Kampala	Nsambya, Kibuli, Kabalagala, Wabigalo, Kisugu	120, 130
6	Eastern Kampala	Naguru, Nakawa, Kiswa, Bugolobi, Ntinda, Mbuya, Kyambogo, Banda, ITEK, Nabisunsa, UPK, Upper Estate	210, 211, 212, 213, 214, 215
7	Northern Kampala	Bwaise, Mulago, Wandegaya, Bukoto, Kiwatule, Kyanja	310, 311, 320, 322
8	Western Kampala	Ndeeba, Rubaga, Busega, Natete, Namirembe, Lungujja, Kasubi, Lubya, Nakulabye, Najanankumbi, mutundwe, Kabowe	410, 411, 412, 420, 421, 430, 431
9	Jinja Road approach	Mpigi-Kyaddondo(part), Eastern Uganda, Kenya	502, 510, 550, 700
10	Port Bell Road approach	Mutungo, Luzira, Luzira Prison, Butabika	461
11	Entebbe Road approach	Mpigi-Busiro(part), Entebbe	500
12	Masaka Road approach	Mpigi-Gombo,Butembala,Mowokota,Busiro(part), South_Western Uganda, Western Uganda, Zaire, Tanzania, Rwanda	501, 503, 520, 530, 701, 702
13	Hoima Road approach	Mpigi-Busiro(part),Kyaddondo(part)	504, 505
14	Bombo Road approach	Kawempe, Kazo, Mpigi-Kyaddondo(part), North-Western Uganda, Northern Uganda, Sudan	462, 506, 540, 541, 560, 703
15	Gayaza Road approach	Kyebando, Kikaya, Kanyanya, Mpererwe, Kamamboga, Mpigi-Kyaddondo(part)	471, 507
16	Gaba Road approach	Bukasa, Kansanga, Gaba, Buziga	451, 452

Table 5.6 **Sector Trip Ends (Pcus/hr)**

Sector Number	Year 1997	Year 2005		Year 2015	
	Trips	Trips	Growth	Trips	Growth
1	9420	11438	1.21	13175	1.40
2	1578	2624	1.66	4113	2.61
3	3227	5759	1.78	12465	3.86
4	863	2139	2.48	4937	5.72
5	683	1519	2.22	3304	4.84
6	1416	3022	2.13	7187	5.08
7	1717	4039	2.35	9067	5.28
8	2256	5120	2.27	11862	5.26
9	901	1377	1.53	2324	2.58
10	297	584	1.97	1177	3.96
11	437	767	1.76	1344	3.08
12	409	703	1.72	1181	2.89
13	189	257	1.36	424	2.24
14	392	647	1.65	1120	2.86
15	381	788	2.07	1648	4.33
16	964	1754	1.82	3637	3.77

Table 5.7 Sector to Sector Pcus/hr Matrix for 2005

Origin Sector	Destination Sector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2481	837	1103	545	534	1430	1213	1355	498	211	246	87	58	160	258	422
2	1142	190	92	5	118	251	519	60	87	39	29	22	7	12	22	28
3	1400	62	627	164	34	104	1001	1525	171	77	29	195	85	124	103	57
4	427	5	597	355	0	0	35	553	27	14	53	29	7	10	4	24
5	524	263	89	0	21	223	252	0	38	10	13	11	2	6	8	59
6	583	500	45	2	350	692	313	14	216	94	56	48	9	24	38	38
7	1142	331	746	18	135	725	249	187	99	23	41	30	14	88	175	34
8	969	23	2253	278	0	23	225	806	115	36	89	148	44	18	35	58
9	439	78	157	21	31	197	81	100	0	35	62	41	1	35	37	60
10	195	38	73	12	9	94	21	34	24	0	15	8	0	18	9	35
11	275	35	32	60	14	70	49	102	30	19	0	19	1	9	6	47
12	92	23	188	30	11	52	32	157	36	8	32	0	2	3	4	34
13	59	7	94	7	2	8	13	43	5	4	3	5	0	1	1	4
14	205	18	146	14	8	34	123	26	18	7	17	7	1	1	4	18
15	260	22	112	3	8	39	172	35	22	14	17	15	2	39	0	28
16	506	38	70	29	71	52	43	77	13	14	56	15	7	10	4	750

Table 5.8 Sector to Sector Pcus/hr Matrix for 2015

Origin Sector	Destination Sector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1632	728	1192	891	655	2195	1800	1852	466	307	251	71	38	114	377	607
2	1197	281	199	16	294	480	1122	170	110	67	36	25	9	15	39	50
3	1504	127	1778	419	116	414	2207	3813	477	162	140	344	171	335	222	238
4	580	14	1377	1079	0	1	134	1355	64	40	117	61	14	23	10	70
5	698	559	304	1	56	643	725	1	74	26	24	19	4	10	24	137
6	809	1018	138	8	970	2049	924	42	472	253	113	94	20	52	116	110
7	1872	601	1354	68	379	2378	748	529	206	52	77	52	28	171	461	88
8	1487	50	5158	691	0	91	716	2424	261	99	185	296	94	38	98	174
9	379	93	412	47	57	413	161	212	0	71	120	64	2	45	100	149
10	263	63	139	35	23	251	46	89	60	0	29	13	0	32	27	106
11	267	44	138	132	26	144	96	215	55	39	0	33	3	17	15	120
12	74	26	315	61	19	101	57	310	55	18	56	0	4	4	9	73
13	37	9	175	12	4	20	27	94	8	9	7	9	0	3	2	9
14	155	24	347	33	15	77	258	57	32	19	31	10	3	1	13	44
15	357	37	219	8	21	117	437	94	48	40	35	40	5	107	0	84
16	718	71	270	88	168	160	120	235	33	48	136	34	21	24	10	1500

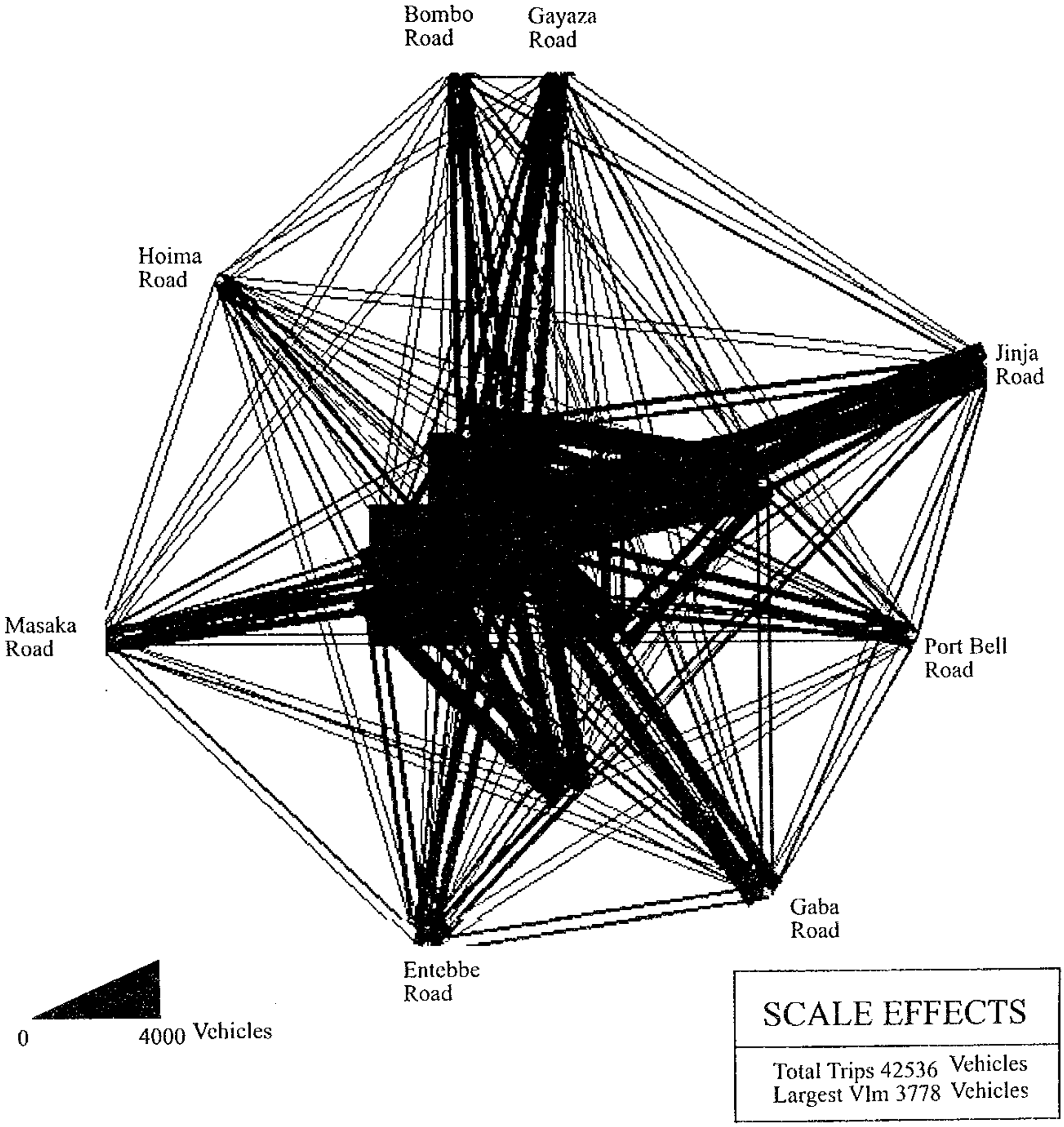


Fig 5.3 PCUS/HR 2005 SECTOR MATRIX

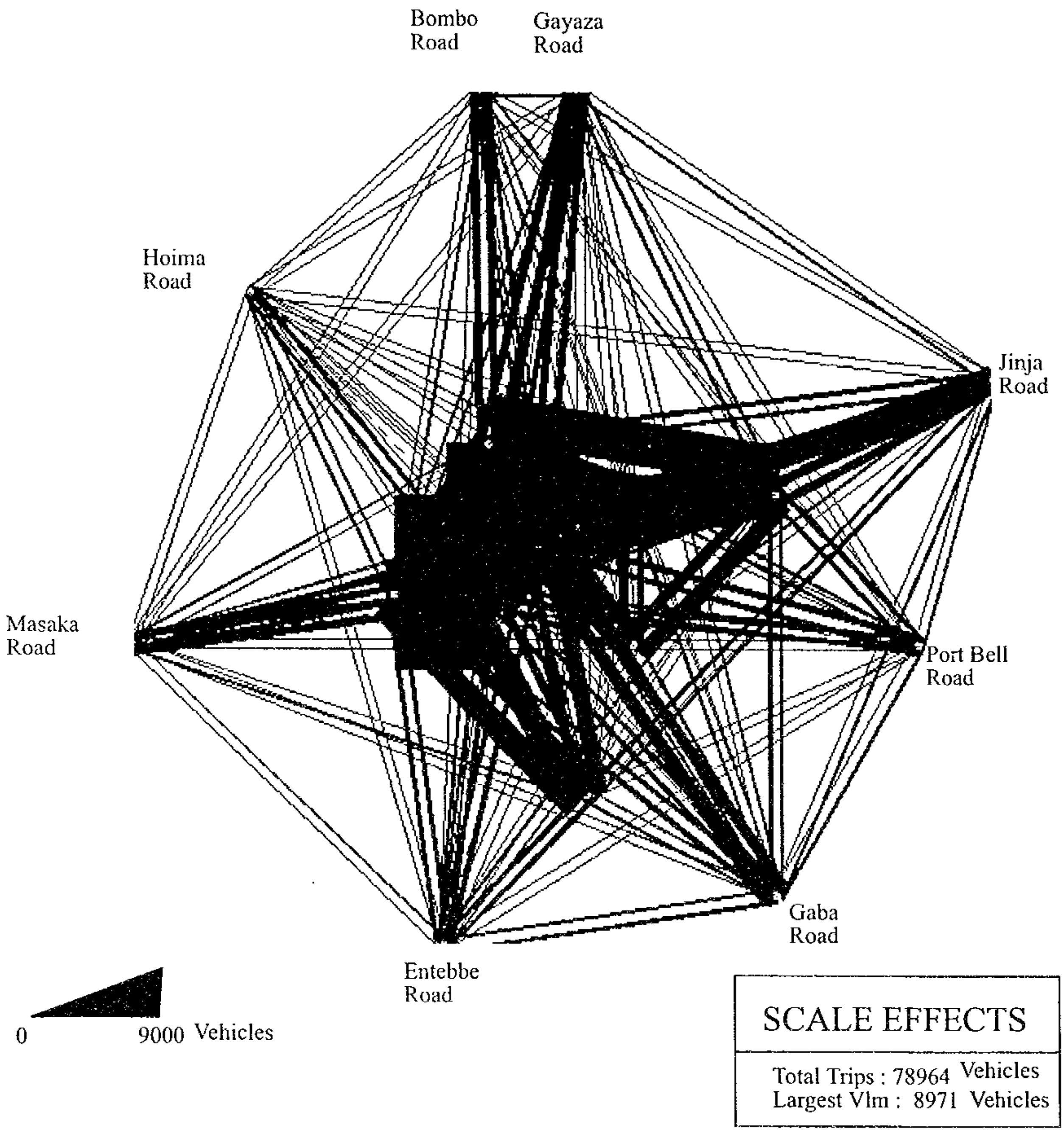


Fig 5.4 PCUS/HR 2015 SECTOR MATRIX

CHAPTER 6

FORMULATION OF ROAD DEVELOPMENT CONCEPT

6. FORMULATION OF ROAD DEVELOPMENT CONCEPT

6.1 Present Road Traffic Issues

The nature of the traffic in the Study Area is such that the existing transport infrastructure cannot provide sufficient services to road users and communities situated near roads. This has resulted in inefficiency in urban transport and deterioration of urban amenities.

Apart from network effects, individual roads are providing a minimum level of service to their users, although it is anticipated that these roads will be saturated in the near future if the present high rate of traffic increase continues. Road improvement works to upgrade the existing capacity of the individual roads are requested.

It is noted that the road network in the study area is not well organized. The road network is mainly composed of a number of radial roads which converge in the city centre. There is no circular road or by-pass to reduce the concentration of traffic in one area of the city.

Most of the junctions in the study area are roundabouts with low capacity. Traffic congestion at these junctions is chronic and is causing a "bottleneck" in urban traffic flow. Enhancement of junction capacity is one of the most urgent issues to streamline urban traffic flow in the area.

In addition , there are some traffic problems which originate in the mismanagement of the past road improvement and maintenance works. This is illustrated by the poor provision of sidewalks and drainage systems, even on newly improved roads.

The present road issues identified by the Study Team are shown in Fig. 6.1 while Table 6.1 describes the factors behind present traffic issues in terms of problems and probable measures to be undertaken.

Table 6.1 Present Road Traffic Issues

Present Traffic Issues	Factor behind Present Road Traffic Issues	Probable Measures to be Undertaken
- Inefficiency in Road Transport	A. Factors related to Road Infrastructure 1. Physical Factors (1) Concentration of radial roads into city centre (2) Lack of ring shaped arterial road surrounding downtown core. (3) Lack of bypass road for through traffic (East-West, North-South corridors) (4) Under - capacity of intersections (5) Insufficient road linkage (6) Defective road infrastructure (7) Low geometric design (8) Poor provision of road facilities (drainage, sidewalks, road furniture) (9) Unbalanced road network as against the pattern of traffic demands	- Upgrade of bottleneck intersection, signalization, grade-separation, improvement of geometry - Improvement of linkage roads - Improvement of carriageways (rehabilitation, reconstruction, partial repair) - Improvement of road facilities/ furniture - Widening of road/ increasing number of lanes - Introduction of circular roads/ bypasses
- Disregard of Traffic Safety	2. Management /Public Transport related Factors (1) Intrusion of pedestrians onto carriage way (2) Passage of heavy vehicles in the city centre and residential areas (3) Increase in roadside parking (4) No control on roadside loading and unloading (5) Concentration of public transport (mini buses) in the city centre. (6) Substandard service level of public transport.	- Designation of crossing points - Installation of pelican crossing - Regulation of heavy vehicle passage - Installation of parking places - Designation of on/off loading places - Construction of bus bays - Reorganization of private bus companies
- Degradation of RoadsideEnvironment	B. Factors related to traffic demand (1) Extension of urban land use (2) Heterogeneous population increase (3) Sharp increase in vehicle ownership (4) Concentration of urban facilities in one area of the city	- Road development consistent with land use plan. - Introduction of functional hierarchy of roads - Decentralization of urban facilities
	C. Administrative/Legislative/Institutional Factors (1) Partial enforcement of traffic regulation (through traffic, one-way, vehicle loading, vehicle inspection, environmental protection) (2) Poor traffic behaviour (driver, pedestrian, activities in nearby communities).	- Strict enforcement of traffic regulation and control - Revision of traffic related laws - Introduction of legal measures to protect the environment

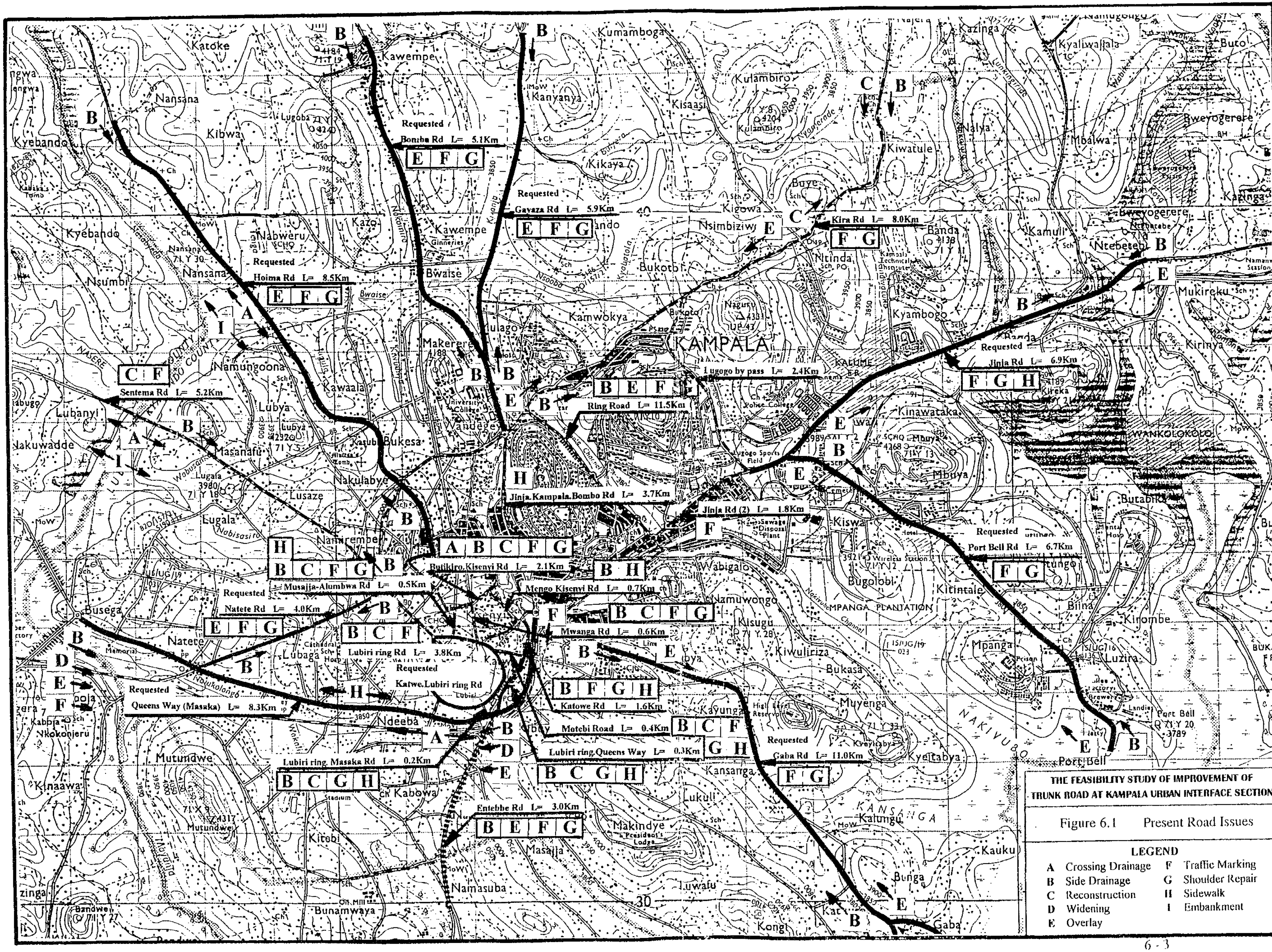


Figure 6.1 Present Road Issues

6.2 Prospect of Future Road Development

6.2.1 Basic Stance for the Formulation of the Future Road Development Plan

With the recognition of present road traffic issues, the emphasis of future road development planning was placed more on the aspect of improvement of existing infrastructure than on new construction, in which cost effective road development proposals are being sought, taking account of such negative effects usually brought about by "big plans" as burdens on the environment and human life, and the financial condition of the Ugandan government.

In this context, it is quite important that benefits from the road improvement undertaking should be distributed equally among all the components of society, and such biased road development proposals as those of the past, which were designed only for vehicle users or for industrial purposes should be reconsidered.

From the above stance, targets of future road development were set out as follows:

- Road development aiming at enhancement of road user benefit
- Road development aiming at enhancement of safety/environmental condition of roads

6.2.2 Road Development Aiming at Enhancement of Road User Benefit.

The above target will be attained by adopting the following measures;

- Improvement of existing bottleneck points in urban traffic flow.
- Enhancement of road capacity through rehabilitation, construction and widening of the existing roads.
- Introduction of new road network to divert traffic from certain congested road sections

The above concepts are explained below:

(1) Improvement of existing bottleneck points in urban traffic flow

The bottleneck points in urban traffic, which mainly consist of low capacity rotary junctions and certain road sections rendered impassable due to inundation during the rainy season and other reasons, will be improved. The bottleneck points to be improved will be identified on the basis of the following criteria:

- Effects on urban traffic flow brought about by the improvement work
- Effects on reduction of traffic accidents
- Impact on surrounding land use and environment
- Contribution to Basic Human Need (BHN)
- Project cost
- Implementability

(2) Enhancement of road capacity through improvement of linehaul

The roads to be improved will be selected on the basis of following criteria:

- Present serviceability
- Vehicle/capacity ratio (present, future)
- Functional role in urban traffic flow
- Economic impact to be brought about by the improvement work.

Selection of the type of improvement work will be carried out taking the following factors into consideration:

- Size of project costs
- Implementability in terms of land acquisition and relocation of residents
- Consensus among participants including residents

(3) Introduction of new road links to divert traffic concentrated in one area

This measure includes construction of circular roads and bypasses. These roads would reduce congestion on certain road sections via diversion of through traffic.

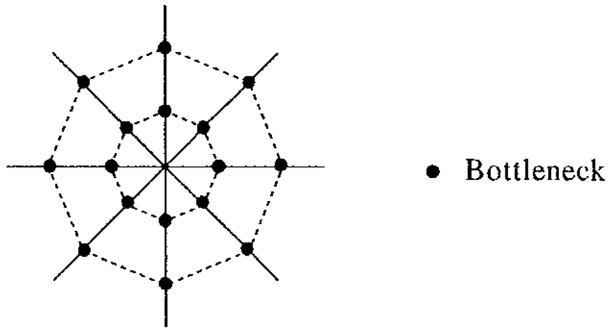
The probable new links will be selected taking the following factors into consideration.

- Consistency with on-going and previously proposed road development schemes

- Effects on urban traffic flow brought about by the realization of new links
- Degree of congestion level to be expected at certain existing road sections
- Functional role in urban traffic flow
- Size of project costs
- Implementability in terms of land acquisition and relocation of residents
- Consensus by participants including residents

The above road development concepts are illustrated in Fig. 6.2.

Strengthening of Junctions



Eradication of Critical Points of Traffic

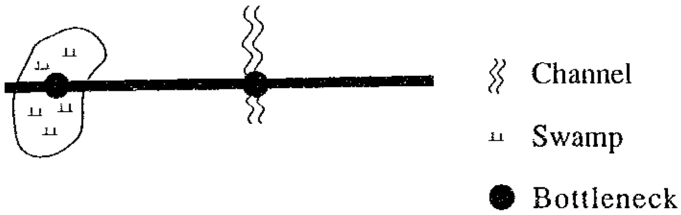
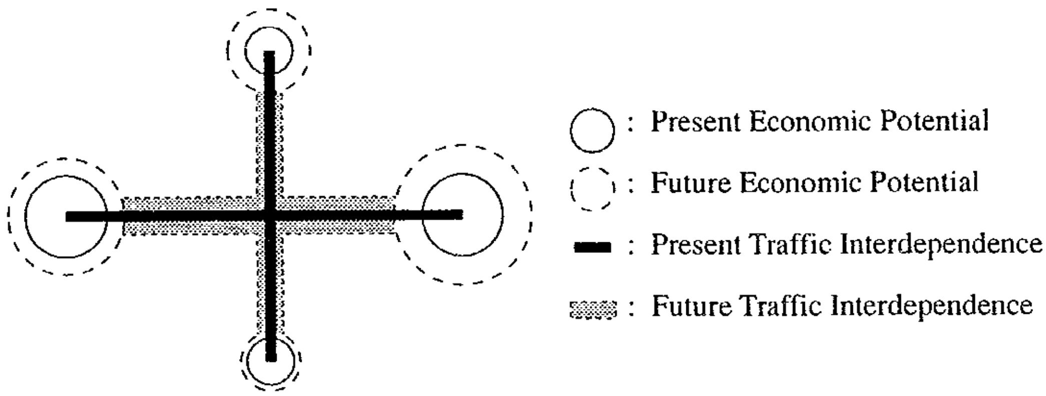


Figure 6.2 (1) Road Development Concept
- Improvement of Existing Bottleneck Points -

Strengthening of Urban Corridors (A)



Strengthening of Urban Corridors (B)

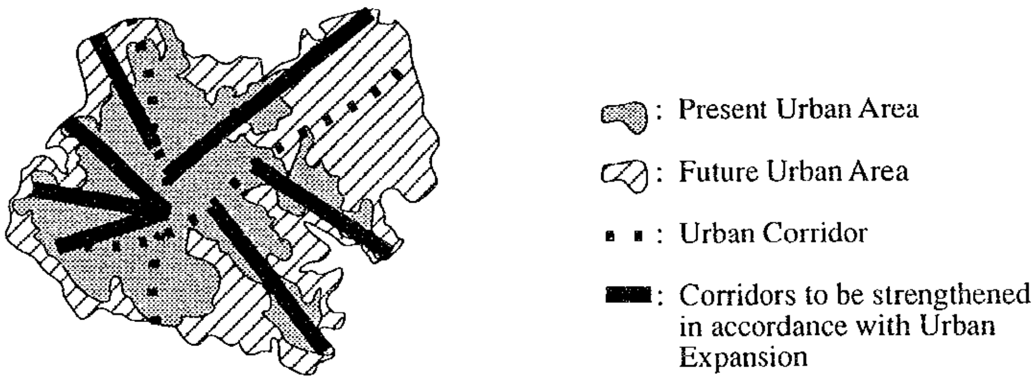
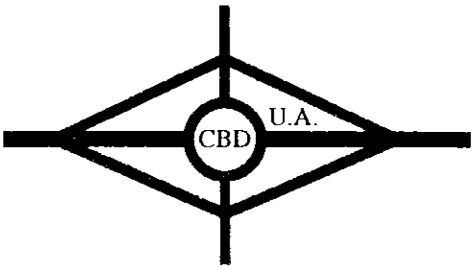


Figure 6.2 (2) Road Development Concept
- Enhancement of Linehaul Capacities -

Diversion of Traffic Concentration



CBD: Central Business District

U.A.: Urban Area

Figure 6.2 (3) Road Development Concept
- Diversion of Traffic Concentration -

6.2.3 Road Development aiming at Enhancement of Safety/ Environmental Condition of Roads.

The above target will be attained adopting some supplemental works of installation of traffic furniture and facilities on critical road sections.

The development concept in this context consists of the following two subjects:

- Enhancement of road safety level
- Protection of roadside environment

(1) Enhancement of road safety level

The road sections or critical points on certain roads where safety measures are to be introduced will be determined among the accident prone zones (black spots) as identified in Fig 5.4 and defective road sections described in the road inventory survey.

The measures to be undertaken will be selected among the following candidates:

- Improvement of sidewalks
- Improvement of road shoulders
- Installation of road crossing facilities
- Installation of bus bays
- Installation of traffic signs/markings
- Others

(2) Protection of roadside environment

The road sections or points where environmental protection measures are to be introduced will be selected among the places of environmentally vulnerable zones which are identified in Annex B.

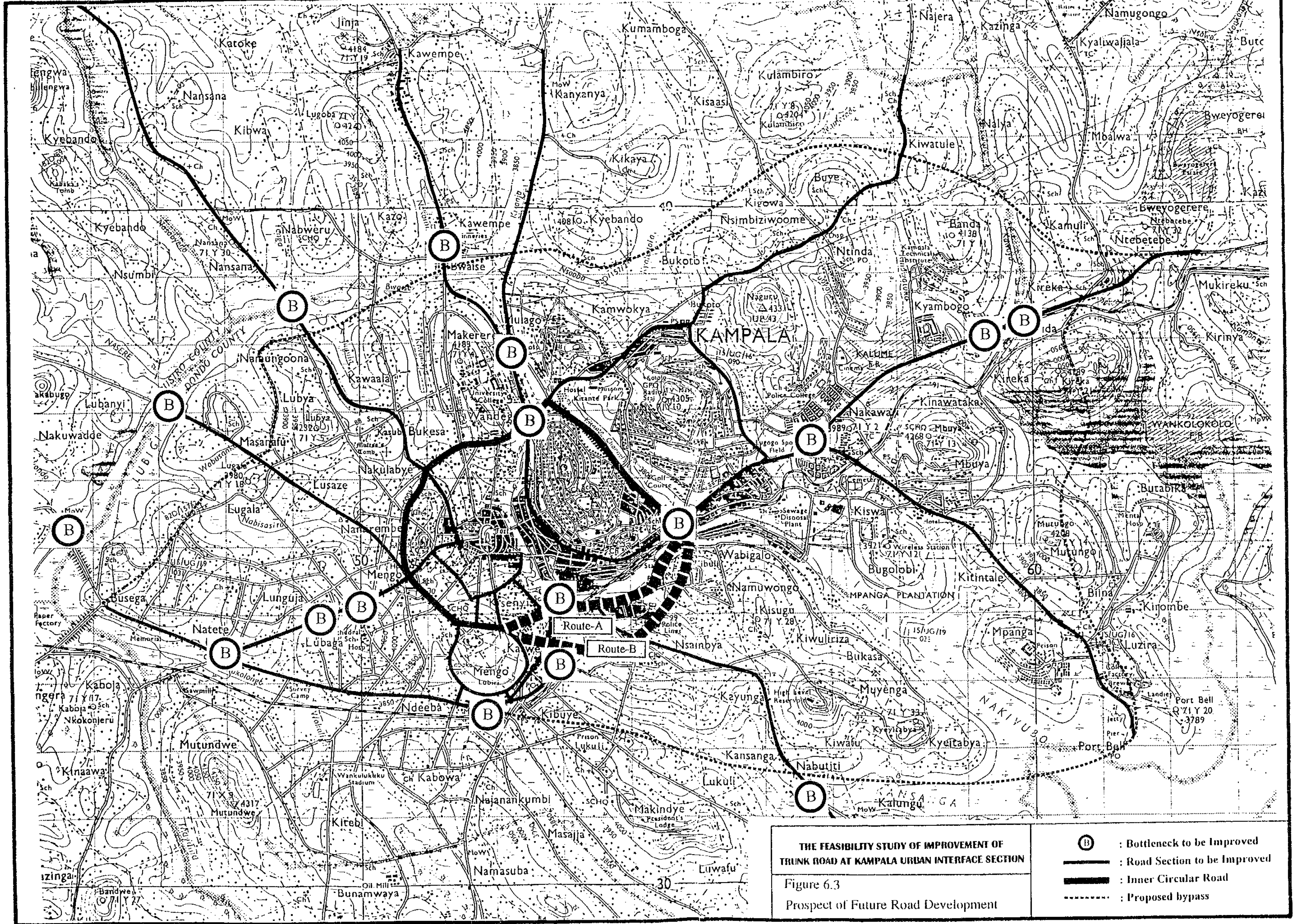
The measures to be undertaken will be selected among the following candidate methods:

- Improvement of roadside drainage
- Introduction of anti-pollution measures

- Introduction of noise reduction measures

- Others

The prospects of future road development are presented in Fig 6.3.



THE FEASIBILITY STUDY OF IMPROVEMENT OF TRUNK ROAD AT KAMPALA URBAN INTERFACE SECTION

Figure 6.3

Prospect of Future Road Development