Table 3.1 Type of Vehicle Classified

Type of Vehicle	Objective
1. Car, Taxi	Passenger Car, Land Rover, Land Cruser
2. Light Goods Veh.	Pick-up, Delivery Van
3. Medium goods Veh.	under 3 accel's goods vehicle
4. Heavy goods Veh.	more than 3 accel's goods vehicle
5. Bus	Mini and Large size bus

3.3 Traffic Count Survey and Analysis

3.3.1 Results of Traffic Volume Counted

The result of actual traffic volume counted on each survey station is shown in Table 3.2.

3.3.2 Calculation of ADT and Congestion Ratio

(1) ADT Calculation Formula

Traffic data, as a result of observation values obtained from the Traffic Count Survey, was to be converted into Average Annual Daily Traffic (AADT) after making adjust-ments to cope with daily, weekly, and seasonal variations. However no data was available, explaining a seasonal variation in DCC. Therefore Average Daily Traffic (ADT) was calculated without a seasonal variation factor.

The daily/day-time traffic ratio on Morogoro Road was calculated and is shown in Table 3.3. This ratio was applied to the other roads for the calculation of ADT.

The weekly variation ratio on Morogoro Road was calculated with the results taken from the 6 weekday count. Sunday has been excluded, as is shown in Table 3.4, as the traffic volume on this day drops to less than 29% of weekday traffic, and a ratio excluding Sunday would benefit road planning more than one which included Sunday.

Table 3.2 Result of Actual Traffic Volume Counted

Station No.	RoadName	Lane	12hr Trffic count (both direction) Car	Light goods	Medium goods	Heavy goods	Bus	Total
1	Ocean Road	2	7009	2379	118	89	246	9841
2	Upanga Road	2	8414	3265	552	46	831	13108
3	UnitedNationRd	2	4566	2148	208	12	340	7284
4	Uhuru Street	2	7185	4306	986	220	2113	14810
5	Pugu Road	4	13722	8993	1579	318	2184	26796
6	Bandari Street	2	5615	2129	961	151	646	9502
7	Moroco Road	2	5049	1479	648	85	467	7728
8	Morogoro Road	2	5960	3339	968	130	2703	13100
9	Port Access Rd	4	3455	3296	1618	466	698	9533
10	-ditto-	4	2510	1592	1216	471	425	6214
11	Kilwa Road	2	1228	1109	854	159	471	3821
12	Samora'Avenue	2	3593	179	62	4	39	3877
13	Ohio Street	2	6660	2152	307	27	814	9960
14	Maktaba Street	2	7498	3137	220	34	1387	12276
15	Samora Avenue	2	6939	2620	100	15	243	9917
16	Morogoro Road	2	5599	2469	122	15	260	8465
17	UWT Street	4	10026	4212	548	117	844	15747
18	Gerezani Str	2	8608	3571	578	52	1741	14550
19	Uhuru Street	2	6611	2933	537	54	1155	11290
20	Morogoro Road	4	9903	4159	687	356	3262	18367
21	Msimbazi Str	2	4862	2214	688	60	2790	10614
22	Gerezani Str	2	4694	2744	1127	271	538	9374
23	Bagamoyo Road	2	9424	4146	454	314	280	14618
24	HaileselasieRd	2	3730	1298	248	93	142	5511
25	Old BagamoyoRd	2	3019	1443	238	39	105	4844
26	Konondoni Road	2	4807	1770	298	14	929	7818
27	Mwinjuma Road	2	2433	619	247	41	288	3628
28	Bagamoyo Road	2	4273	2532	474	614	585	8478
29	Toure Drive	2	3429	283	141	5	16	3874
30	Shekilango Rd	2	3162	787	355	58	160	4522
31	Mpakani Road	2	1716	1404	817	149	348	4434
32	Mobibo Road	2	584	367	165	16	212	1344
33	Old Kigogo Rd	2	755	612	148	4	299	1818
34	Pugu Road	4	5549	3970	1370	190	1332	12411
35	Chang'ombe Rd	2	4964	2778	831	152	1010	9735
36	Chang'ombe Rd	2	2865	1200	526	47	1073	5711
37	Mbagala Road	2	1336	725	463	43	782	3349
38	Port Acces Rd	4	1061	1010	926	926	561	4484
39	New Kigogo Rd	2	3161	1784	385	698	472	6500

Table 3.3 Daily/day-time Ratio

STATION NO. 20
DATE: 12-05-1989

DIRECTION	UP-DIRECTION				DOWN-DIRECTION				BOTH-DIRECTION			
ITEM TYPE OF VEHICLE	VOLUME DAY-TIME	VOLUME NIGHT-TIME	VOLUME 24hrs	RATIO	VOLUME DAY-TIME	VOLUME NIGHT-TIME	VOLUME 24hrs	RATIO	VOLUME DAY-TIME	VOLUME NIGHT-TIME	VOLUME 24hrs	RATIO
Car, Taxi	5287	1493	6780	1.28	4793	1718	6511	1.34	10080	3211	13291	1.32
light goods Vehicle	1966	428	2394	1.22	2025	456	2481	1.23	3991	884	4875	1.22
Medium goods Vehicle	242	83	325	1.34	312	85	397	1.27	554	168	722	1.30
Heavy goods Vehicle	330	21	351	1.06	310	9	319	1.03	640	30	670	1.05
Bus	1741	303	2044	1.17	1558	564	2122	1.36	3299	867	4166	1.26
TOTAL No. Average	9566	2328	11894	1.24	8998	2832	11830	1.31	18564	5160	23724	1.28

Table 3.4 Weekly Variation Ratio of Day-time Traffic

SECTION:NO. 20
1) Excluding Sunday

DIRECTION	TYPE OF VEHICLE	DAY-TIME TRAFFIC (PCU)								WEEKLY VARIATION RATIO						
		SUNDAY	MONDAY	TUESDAY	WED-DAY	THUR-DAY	FRI-DAY	SAT-DAY	AVERAGE[1]	SUNDAY	MONDAY	TUESDAY	WED-DAY	THUR-DAY	FRI-DAY	SAT-DAY
UP	Car, Taxi	2936	4840	4990	5031	5279	5287	4629	5009	0.59	0.97	0.97	1.00	1.05	1.06	0.92
	light-goods	1473	2218	2081	1956	2002	1966	2111	2096	0.72	1.08	1.01	0.95	0.97	0.96	1.03
	Medium-goods	314	518	680	634	542	484	560	570	0.55	0.91	1.19	1.11	0.95	0.85	0.98
	Heavy-goods	351	894	702	627	822	990	615	775	0.45	1.15	0.91	0.81	1.06	1.28	0.79
	Bus	4303	4353	4863	3388	5544	5223	5352	4787	0.90	0.91	1.02	0.71	1.16	1.09	1.12
	TOTAL	9382	12823	13316	11636	14189	13950	13267	13197	0.71	0.97	1.00	0.88	1.08	1.06	1.01
DOWN	Car, Taxi	3118	5014	4913	4804	4411	4793	4985	4753	0.66	0.05	1.03	1.01	0.93	1.01	0.94
	light-goods	1348	1980	2078	1986	1950	2025	2047	2011	0.67	0.98	1.03	0.99	0.97	1.01	1.02
	Medium-goods	262	530	694	614	582	624	562	601	0.44	0.88	1.15	1.02	0.97	1.04	0.94
	Heavy-goods	417	975	366	762	510	930	687	705	0.59	1.38	0.52	1.02	0.72	1.32	0.97
	Bus	4125	4059	4923	4758	4719	4774	5070	4701	0.88	0.86	1.05	1.01	1.00	0.99	1.08
	TOTAL	9270	12558	12974	12924	12172	13046	12951	12771	0.73	0.98	1.02	1.01	0.95	1.02	1.01

ADT calculation formula is :

ADT=TxKx1/W where

T:12 hr day-time traffic volume(pcu)

K:Daily/daytime traffic ratio

W:Weekly variation ratio

Traffic volume in passenger car unit (p.c.u.) was calculated based on the following convertion rate:

- Car,taxi and ligtht goods vehicle=1.0 p.c.u.
- medium goods vehicle =2.0 p.c.u.
- heavy goods vehicle and bus =3.0 p.c.u.

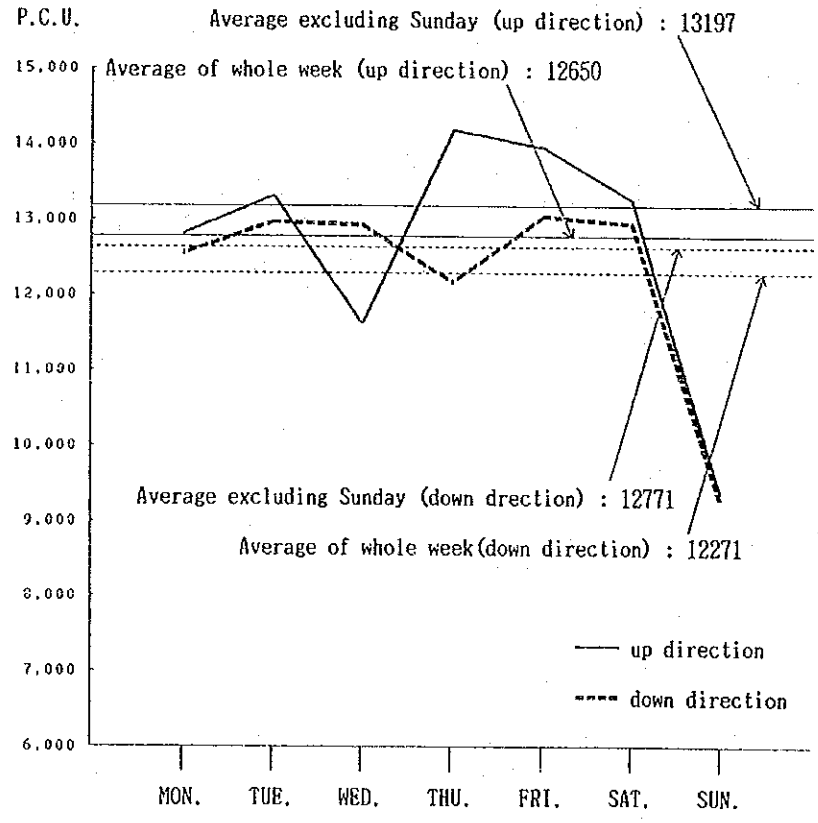


Fig. 3.4 Weekly Variation of Day-time Traffic

(2) Results of ADT calculation and Congestion Ratio

The estimated ADT of each survey station is shown in Table 3.5 and detailed calculations are given in Appendix 3-5.

Table 3.5 Present Traffic Volume(A.D.T) and Congestion Ratio on each Survey Station

Station No.	RoadName	Lane	Classification	12hr Trffic Volume Counted	12hr Traffic Volume (p.c.u.)	ADT (p.c.u.)	Congestion Ratio
1	Ocean Road	2	A	9841	10629	13680	0.76
2	Upanga Road	2	A	13108	15410	20410	1.52
3	UnitedNationRd	2	A	7274	8186	10690	0.62
4	Uhuru Street	2	A	14810	20464	25642	1.91
5	Pugu Road	4	A	26791	33379	42640	0.81
6	Bandari Street	2	A	11433	14854	18683	1.27
7	Moroco Road	2	A	7728	9480	12408	1.02
8	Morogoro Road	2	A	13100	19734	24719	1.68
9	Port Access Rd	4	A	9533	13479	16689	0.28
10	-ditto-	4	A	6214	9222	11854	0.20
11	Kilwa Road	2	A	3821	5935	7636	0.36
12	Samora Avenue	2	A	3877	3125	5258	0.42
13	Ohio Street	2	A	9960	11949	15169	1.12
14	Maktaba Street	2	A	12276	15338	19329	1.26
15	Samora Avenue	2	A	9917	10533	13480	1.07
16	Morogoro Road	2	A	8465	9137	11947	1.01
17	UWT Street	4	A	15747	18217	23693	0.39
18	Gerezani Str	2	A	14550	18714	23646	1.88
19	Uhuru Street	2	A	11290	14257	17917	1.34
20	Morogoro Road	4	A	18367	26290	33097	0.63
21	Msimbazi Str	2	A	10614	17002	21333	1.30
22	Gerezani Str	2	A	9374	12119	15241	1.17
23	Bagamoyo Road	2	A	14618	16260	21312	1.64
24	HaileselasieRd	2	C	5511	6229	8109	0.71
25	Old BagamoyoRd	2	C	4844	5370	6817	0.55
26	Konondoni Road	2	A	7818	10002	13485	0.83
27	Mwinjuma Road	2	C	3628	4533	8674	0.85
28	Bagamoyo Road	2	A	8478	11350	13629	0.50
29	Toure Drive	2	C	3874	4048	5292	0.46
30	Shekilango Rd	2	C	4522	5313	6982	0.66
31	Mpakani Road	2	A	4434	6245	7735	0.34
32	Mobibo Road	2	C	1344	1965	2510	0.22
33	Old Kigogo Rd	2	C	1818	2572	3482	0.30
34	Pugu Road	4	A	12411	16825	20907	0.40
35	Chang'ombe Rd	2	C	9735	12890	17072	1.21
36	Chang'ombe Rd	2	C	5711	8477	11244	0.80
37	Mbagala Road	2	C	3349	5462	6837	0.59
38	Port Acces Rd	4	A	3784	6284	8171	0.14
39	New Kigogo Rd	2	C	6500	9195	11889	1.13

A: Arterial Road
C: Collector Road

The congestion ratio of each road was calculated by dividing ADT by traffic capacity. This was calculated on each road following the method outlined in the Manual on Geometric Design of Highways in Japan as shown in Appendix 3-6.

The traffic volume of sections other than that of survey stations was estimated based on the analysis of the results of the traffic survey along with a supplementary evaluation given by the Study Team and local staff.

The results yieled from the ADT calculations and the con-gestion ratio on the study road are shown in Fig.3.5 and Fig.3.6. Fig.3.5 makes clear that almost all of the arterial roads sustain more than 10,000 p.c.u./day traffic. Furthermore the radial arterial roads, such as Bagamoyo Road, Morogoro Road, Pugu Road, Uhuru Street, and the roads in the City-Center, such as U.W.T. Road and Sokoine Drive sustain over 20,000 p.c.u./day traffic.

Table 3.6 Summary of Existing ADT on the Classified Roads

Road class	lane No.	ADT(p.c.u./day) Max.	Min.	Ave.
Arterial Road:	4 lane	42,640	8,171	22,440
	2 lane	25,642	7,636	15,485
Collector Road:	2 lane	17,072	2,510	8,064

Referring to Fig.3.6, it can be concluded that roads which experience a high congestion ratio over 1.5 are Bagamoyo Road, Morogoro Road, Uhuru Street, Upanga Road and

Sokoine Drive, while Morocco Road, New kigogo Road, Chang'-ombe Road, Msimbazi Street, Gerezani Street, Bandari Street and some streets within the City Center, are experiencing a congestion ratio of more than 1.0.

Table 3.7 Summary of Existing Congestion Ratio on the Classified Roads

Road class	lane No.	Congestion Ratio(per day) Max.	Min.	Ave.
Arterial Road:	4 lane	0.81	0.14	0.41
	2 lane	1.91	0.34	1.08
Collector Road:	2 lane	1.21	0.22	0.68

The following classification is applied for the understanding of the congestion level in Japan, according to the "Traffic Capacity of Roads".

Congestion ratio less than 1.0:

Traffic can run smoothly without road congestion throughout the 12 hours of daytime. There are also no traffic jams or delays in the traffic flow.

Congestion ratio 1.0 - 1.25:

There is a time zone of 1-2 hours (peak time) in which there is a possibility of road congestion, during the 12 hours of daytime, and a very small possibility that congestion may continue for many hours.

Congestion ratio 1.25 - 1.5:

Congested condition, from congestion at peak time to continuous daytime congestion.

Congestion ratio over 1.5:

Road traffic shows a chronically congested situation.

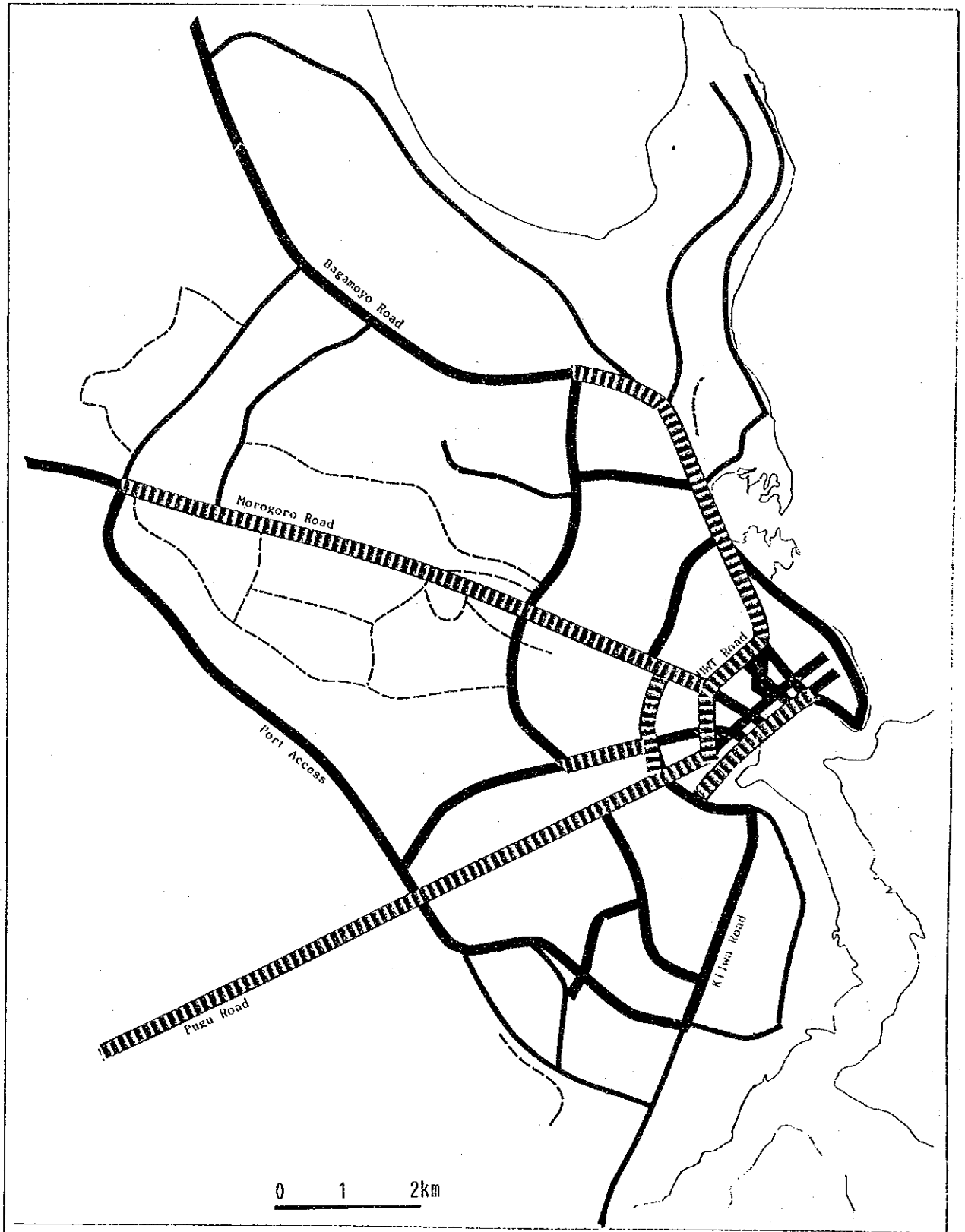


Fig. 3.5 Present Traffic Volume

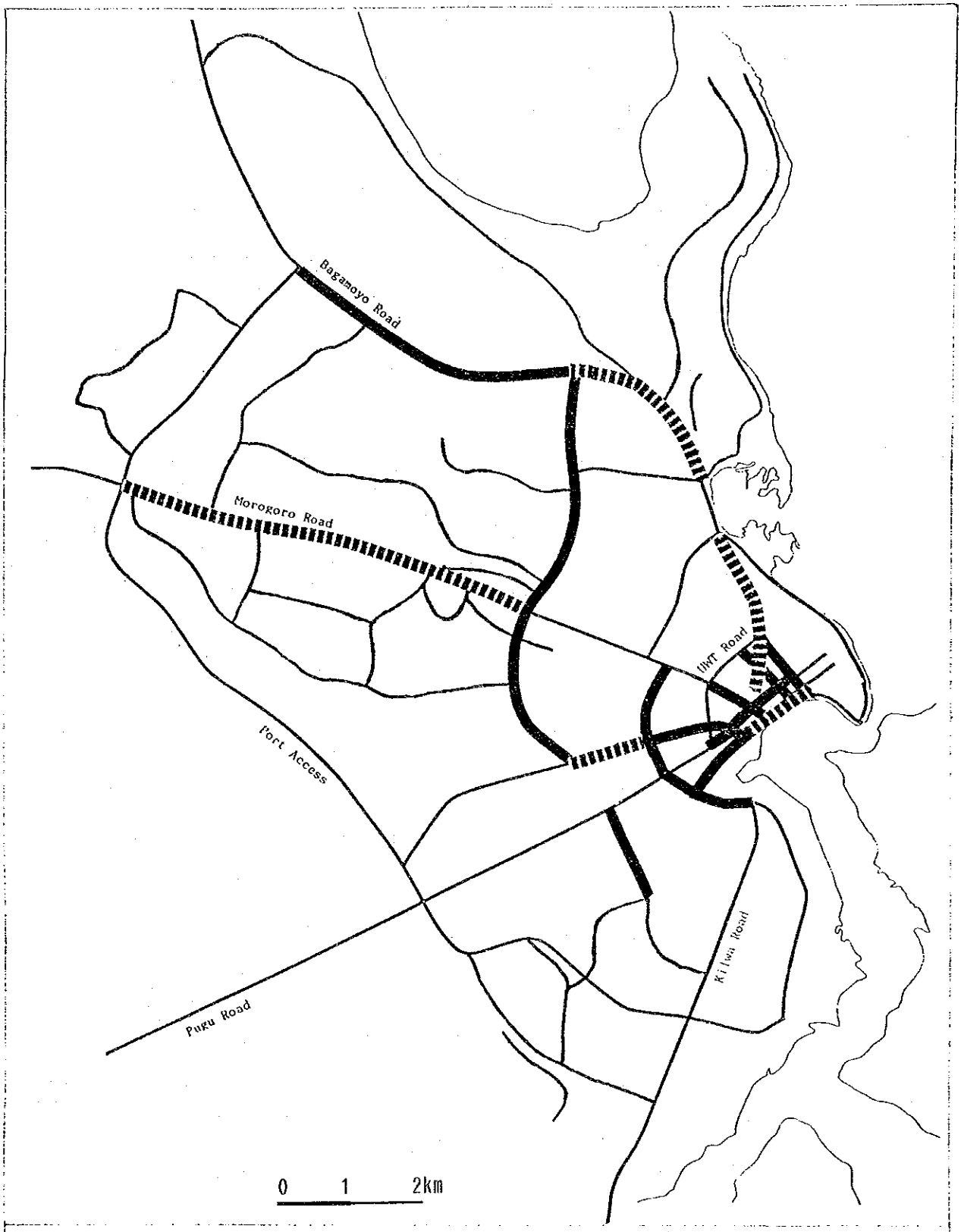


Fig. 3.6 Present congestion Ratio

1.5≦ X
1.0≦ X <1.5
X <1.0
X: Congestion Ratio

3.3.3 Variation of Hourly Traffic Volume

The 24 hours traffic survey was conducted on Morogoro Road and the results are given in Fig.3.7. The survey shows that the features of the hourly variations of traffic volume in one day are as follows:

- Peak hour time in the morning is around 7-8 a.m. and in the evening around 5-6 p.m.

- Peak hour traffic in the morning is greater than that in the evening

- Traffic volume after 12 p.m.is very small.

The hourly variation of 12hr traffic volume classified the typical diverse patterns according to the characteristics of road function and land-use patterns, as shown in Fig. 3.8.

3.3.4 Historical Trends of Traffic Volume

The analysis of historical trends of traffic volume on the Inner Cordon-line is essential for the understanding of existing and future traffic potential.

Tables 3.8 shows the Study Team's count of 12hr. traffic volume on the Inner Cordon-line in 1989 as well as the former 12hr. traffic volume rate presented in the Basic Design Study Report of the Morogoro Road Improvement Project,taken in 1984, JICA.

As a result, it was discovered that the average annual growth rate for all vehicles is 1.9% in the period between 1982 and 1989.

If this rate is to continue for 10 years, future traffic volume will be 1.25 times higher than that of the present.

Fig. 3.7 Hourly Traffic Variation (24hr)

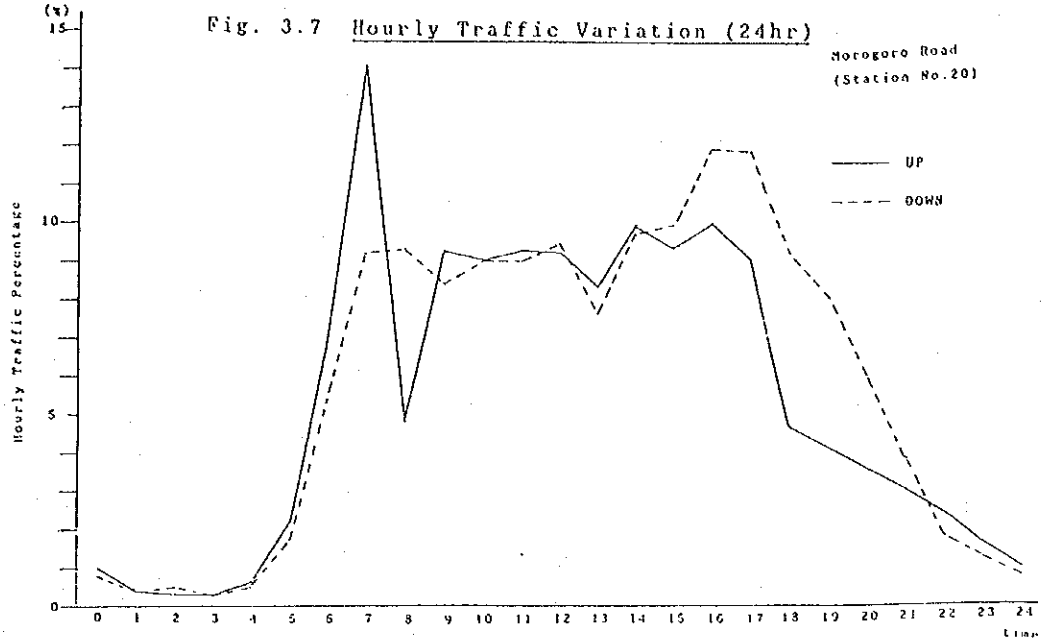


Fig. 3.8 Hourly Traffic Variation (12hr)

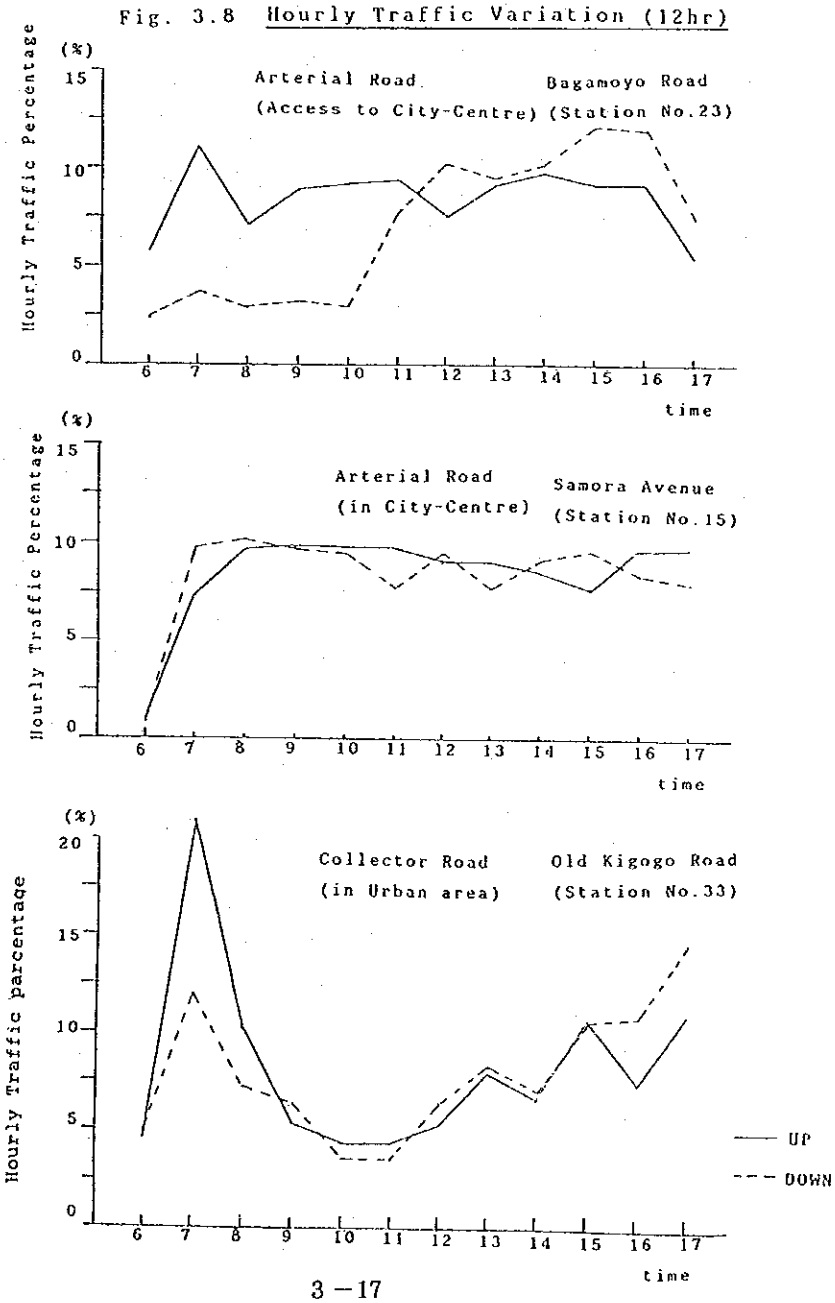


Table 3.8 Historical Trend of 12 hr. Traffic Volume on Inner Cordon-line

year	Type of Vehicle	12hrs. Traffic of Inner Cordon-line: Bagamoyo Road	Morogoro Road	Uhuru Road	Pugu Road	Kiliwa Road	Total
1982	-Car,Light goods	18,915	11,050	9,441	27,014	7,258	73,678
1/	-Buses	502	1,590	812	1,095	672	4,671
	-Trucks	1,087	1,279	1,251	2,721	992	7,331
	Total	20,504	13,919	11,505	30,830	8,922	85,680
1989	-Car,Light goods	23,859	14,062	11,491	22,715	9,118	81,245
2/	-Buses	1,264	3,262	2,113	2,184	879	9,702
	-Trucks	1,187	1,043	1,206	1,897	1,436	6,761
	Total	26,310	18,367	14,810	26,796	11,433	97,716
Average Annual Growth Rate(%) (1982-1989)							
	-Car,Light goods	3.4	3.5	-0.9		3.3	1.4
	-Buses	14.1	10.8	12.3		3.9	11.0
	-Trucks	1.3	-2.9	-3.5		5.4	-1.1
	Total	3.6	4.0	-0.2		3.6	1.9

Data: 1/ The Basic Design Study Report on the Morogoro Road Improvement Project,1984,JICA

2/ The Study Team, 1989, JICA

3.4 Roadside O-D Survey

The following contains an analysis of some typical data taken during the Roadside O-D Survey and reference to road-use characteristics is supplied below.

3.4.1 Sampling rate

The survey was conducted by interview method for 12 hours continuously from 6 a.m. to 6 p.m. The average total of the sampling rate was 13.0 % and the sampling rate for each station is shown in Table 3.9.

Table 3.9 Sampling Rate of O-D Survey

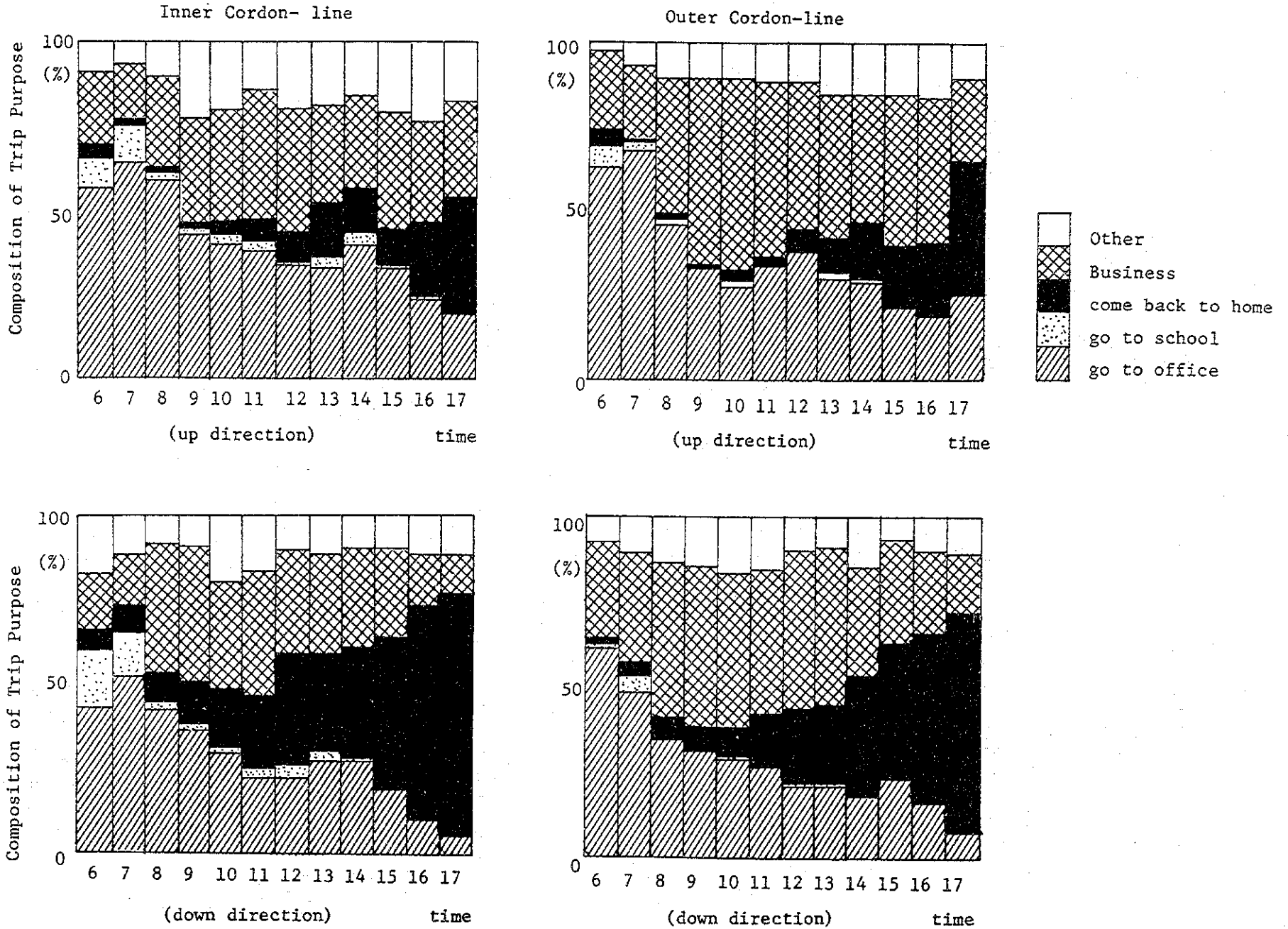
Station	Road Name	No. of Samples	Sample Rate(%)
1	Ocean Road	1,437	14.8
2	Upanga Road	1,580	12.2
3	United Nation Rd.	1,445	19.8
4.	Uhuru Road	1,763	11.9
5	Pugu Road	1,443	5.4
6	Bandari Street	1,580	13.8
7	Morocco Road	1,305	16.9
8	Morogoro Road	1,375	10.8
9	Port Access Road	1,549	16.2
10	Port Access Road	1,389	22.4
11	Kiliwa Road	1,143	30.5
	Total	15,998	13.0

3.4.2 Composition of Travel-purpose

Fig 3.9 shows the composition of road-use purpose for total traffic movement on the Inner Cordon-line and Outer Cordon-line.

Travel to work composed the main purpose of road-use during the morning peak hour from 7:00-8:00 a.m. This occupied 64 % of all road-use. In the evening peak hour from 17:00-18:00 p.m. commuting home from work was the major purpose

Fig.3.9 Composition of Travel-Purpose



of drivers which occupied 65% of all road-use on the Inner and Outer Cordon-line.

3.5 Running Speed Survey

3.5.1 Method of Running Speed Survey

In general, a vehicle running speed will decrease in accordance with increasing traffic density on roads and traffic jams will occur when the density reaches a critical level.

It is necessary to accumulate a considerable amount of data regarding this traffic phenomenon. Therefore, a large scale vehicle velocity survey is needed in order to plot the relation between average vehicle velocity and traffic volume linking the different traffic capacities of all roads classified.

In order to analyse the relation between the congestion ratio (= Traffic volume /Capacity) and vehicle velocity of each classified road including pavement conditions discribed by the PSI value two methods of surveying running speed were conducted as follows.

1) A spot speed survey was conducted by measuring the speed of passing vehicles at certain sections.

2) The traveling speed survey was conducted by measuring the traveling time on certain links by vehicle.

3.5.2 Analysis of Running Speed Survey

The relation between the congestion ratio and velocity has been established for arterial and collector roads according to surface conditions based on the analysis of the data obtained by two Running Speed Surveys.

Fig 3.10 shows the K-V formula (congestion ratio and velocity formula) for 2 lanes and dual carriageway roads and 3 types of K-V formula for 2 lanes roads are classified using PSI data of road surface conditions.

The classification of the surface condition establishes that a road with a good surface condition has more than 2.5 PSI value, a road with a poor surface condition has between 1.5 to 2.5 PSI value and a road with a bad surface condition has less than 1.5 PSI value. The detailed data of the running speed survey is shown in Appendix 3-8.

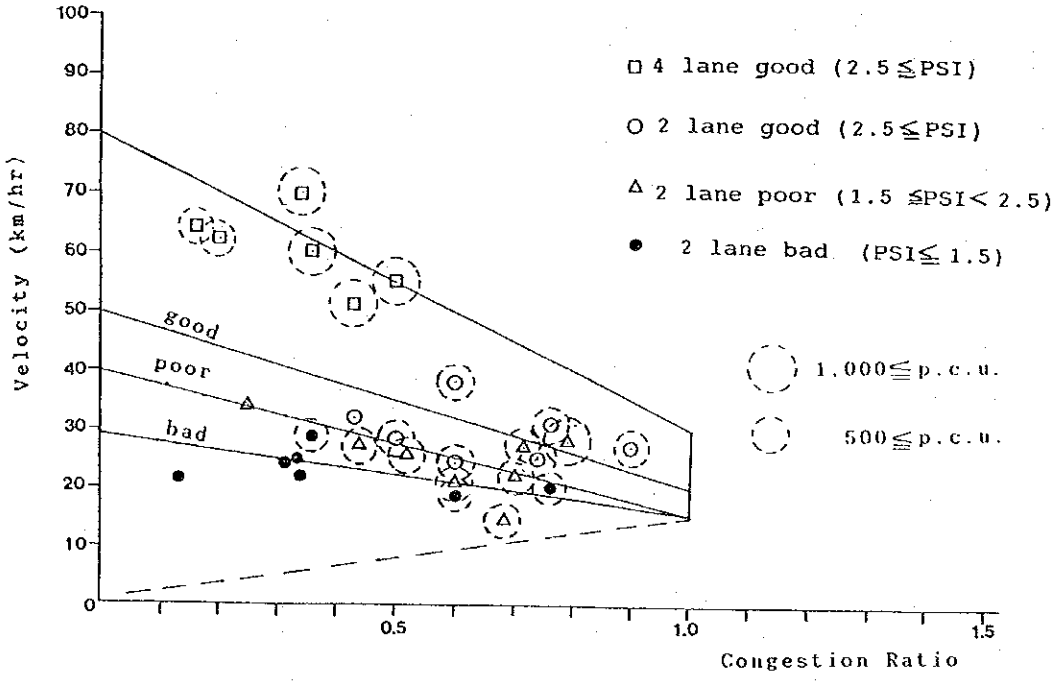


Fig. 3.10 Result of Running Speed Survey (K-V Curve)

3.6 Analysis of Existing Traffic Problems

The following highlights the existing traffic problems identified through the analysis of the data obtained from the traffic survey.

(1) Congestion on the arterial roads:

The congestion ratio of almost all the radial arterial roads with 2 lanes is more than 1.0 and high congestion ratios of more than 1.5 are counted on the important roads, such as Bagamoyo Road, Morogoro Road, Uhuru Road and Upanga Road.

The ring roads such as Morocco Road, Msimbazi Road, Gerezani Street and Bandari Street also shows a congestion ratio of more than 1.0.

(2) Congestion on all streets in the City-Center:

The congestion ratio of all streets in the City-Center is more than 1.0. In particular, Sokoine Drive shows a high-er ratio of over 1.5 due to lack of traffic capacity on the roads and intersections.

(3) Traffic restriction by surface conditions on almost all roads

Results taken from the Running Speed Survey, confirm that traffic restriction has occured on almost all roads with bad surface conditions and vehicle running speed is limited to less than 30 km/hr on bad surface roads with less than 1.5 of PSI value.

(4) Lack of proper Bus-stop facilities

Bus transport is an extremely important urban transport mode for public transport. However, very few adequate bus-stops are provided on arterial roads.

Moreover the stopping of buses creates traffic jams because of inadequate bus stops on the major roads during peak traffic hours. Therefore it is necessary to construct proper bus bays for the purpose of contributing to smooth traffic management during peak hours.

(5) Lack of Traffic Data:

There is very little traffic data available at DCC. Therefore it is difficult to analyze and identify traffic problems quantitatively for traffic engineers and planners.

In order to solve the above mentioned problem, the following improvements will be necessary:

a) Improvement of Capacity on the Arterial Roads:

The widening of congested radial arterial roads with a congestion ratio of more than 1.5 is urgently neened. Other roads showing a congestion ratio over 1.0 need to be widened within about 10 years, if the future traffic growth is assumed to be greater than 1.9% per annum.

Specifically, it will be necessary to consider the establishment of a new Ring Road composeing Morocco road, New Kigogo Road, Chang'ombe Road and new link connecting to Port Access Road in order to reduce traffic congestion on Uhuru Road and Msimbazi Street especialy, thus forming a desirable road network in Dares Salaam.

b) Improvement of Intersections in the City-Center:

There are several round-about intersections in the City-Center which contribute to the increasing rate of traffic jams. Therefore it is necessary to introduce signal control systems replacing round-about control for all traffic movements due to the limitation of space for the widening of streets in the City-Center.

c) Improvement of Road Surface Condition:

In order to solve the serious traffic restrictions caursed by the deterioration of road surface condition, the repair of bad surface conditions especially on the congested roads will be necessary.

d) Provision of Bus-Bays on Congested Roads:

It is necessary to construct Bus-Bays for smooth traffic movement on congested roads.

e) Establishment of Traffic Monitoring System in DCC:

The introduction of a Traffic Monitoring System along with the repair of facilities is need to solve the traffic problems in Dar es Salaam. Therefore the establishment of the following periodical Traffic Monitoring System in DCC is recommended.

- Annual Traffic Counting on the major arterial and collector roads.
- Origin and Destination Survey on the major arterial and collector roads for each decade.

CHAPTER 4 FUTURE FRAMEWORK

4.1 Review of Authorized Plans

In order to estimate the future traffic volume on the Dar es Salaam Road Network, the future economic frame was analyzed based on the following three authorized plans regarding the development of Dar es Salaam.

-Economic Recovery Programme
-Dar es Salaam Master Plan
-City Council Integrated Programme

These three authorized plans were reviewed prior to analysing the future economic frame.

4.1.1 Economic Recovery Programme

(1) Background

The economic recovery of Tanzania which began in 1976 following the 1973/74 oil shock was not sustained past 1983 (see Table 2.6). In this period, Tanzania experienced its worst economic crisis since Independence in 1961 with production steadily declining in all major sectors leading to a decrease in the per capita income.

The Goverment of Tanzania determined to undertake the necessary measures to reverse the decline in standard of living and production capacity and sought the support of the donor community in its efforts to undertake a programme of economic recovery.

(2) Objectives of the Economic Recovery Programme

The major objectives of the Programme are as follows.

-to increase the output of food and export crops
-to rehabilitate the physical infrastructure to support direct production activities
-to increase capacity utilization in industry
-to restore internal and external balances

In order to realize the objectives of the Programme, the key macro-economic policies are as follows.

-Producers Prices
-Exchange Rate
-Trade Regime
-Fiscal and Budgetary Policy
-Money and Credit
-External Aid
-Financial Requirements for Economic Recovery

(3) Sector Priorities and Minimum Import Requirements

To support the implementation of the Economic Recovery Programme, the Government's control is necessary to the local resource allocation and the foreign exchage resource allocation.

The foreign exchange requirement of the Economic Recovery Programme was estimated sector by sector in the three general categories of investment, rehabilitation and recurrent accounting, for 25%, 12% and 63% respectivelyof the total.

The Investment Programme consists of the foreign cost component (a) public sector projects included in the development budget and (b) a minimum number of new projects relating to activities of exceptionally high priority.

The considerable amount of the component of the Investment Programme are provided to the section of transportation, energy and agriculture.

The Rehabilitation Programme consists mainly of the foreign component of key infrastructure and productive structures such as energy, manufacturing transportation and agriculture.

The Recurrent Requrirements had been deriverd to stimulate productive activity in priority areas, to relieve bottlnecks in transportation, and to provide essential social services.

Table 4.1 Minimum Import Requirements (million $)

	1986/87	1987/88	1988/89
Investment/Rehabilitation	443.2	417.5	407.5
- Agriculture	62.2	79.8	86.4
- Transportation and Communications	106.9	124.5	76.2
- Energy and Water	112.2	100.2	65.9
- Mining	67.5	21.8	40.6
- Construction	14.3	16.5	17.7
- Community Services	11.0	9.4	9.2
- Others	37.8	30.2	28.5
Recurrent	762.6	812.7	892.9
- Food Imports	40.9	36.8	33.1
- Agriculture	91.9	105.1	122.7
- Transport and Communications	100.7	111.1	114.0
- Energy and Water	190.5	210.5	240.5
- Manufacturing	148.7	151.7	157.7
- Mining	13.2	14.3	21.1
- Construction	47.5	45.8	49.1
- Community Services	65.6	67.8	70.1
- Others	63.6	69.6	84.6
Grand Total	1,205.8	1,230.2	1,300.4

4.1.2 Dar es Salaam Master Plan

(1) Objectives

The primary objective of the Master Plan was the provision of a development programme for the urban and surrounding region of Dar es Salaam. A further objective was to incorporate, where possible, recent planning projects and development programmes. In regard to the service component, the objective was to establish a programme providing, adequate water, sewage, drainage, solid waste and electrical facilities to all existing and proposed developments at a minimum cost.

(2) Strategies

The frame work of the Master Plan was based on the population projections using available data upto the year 1978. The future population was projected to 2,461,000 people by the year 1999 within the future urban area. Also the employment projection had been done and shown in the Table 4.2 below.

Table 4.2 Population and Employment Projections of Dar es Salaam in the Master Plan

	Existing 1978	Future 1999
Population	843,090	2,461,000
Employment	129,100	418,300
- Manufacturing	37,410	148,200
- Commerce	14,000	71,000
- Public Service & Utilities	33,000	82,800
- Transport & Communications	26,000	78,100
- Construction	16,000	32,600
- Mining	90	100
- Agriculture	2,600	5,500

The plan called for an overall reduction in the population density and improvement in the level of services available.

The City was planned in three development stages according to population growth.

- stage 1 : to accommodate 1.3 million people in 1984
- stage 2 : to accommodate 1.6 million people in 1989
- stage 3 : to accommodate 2.5 million people in 1999

Land use and public service facility plans were established and por each development stage and Fig. 4.1 shows the future land use plan for final stage 3.

(3) Five Year Development Programme

The Five Year Development Programme for stage 1 deals specifically with priority projects requiring early implementation in the Master Plan to provide for growth in an orderly and convenient manner.

The priority projects in the public services sector include water supply and distribution, sewage collection and disposal,electrily supply and distribution and transportation.

In the transportation sector, 13 priority projects were identified and only three projects, i.e. Selender Bridge Widening, Morocco Road Extension to Kigogo and Morogoro Road Widening, have been completed.

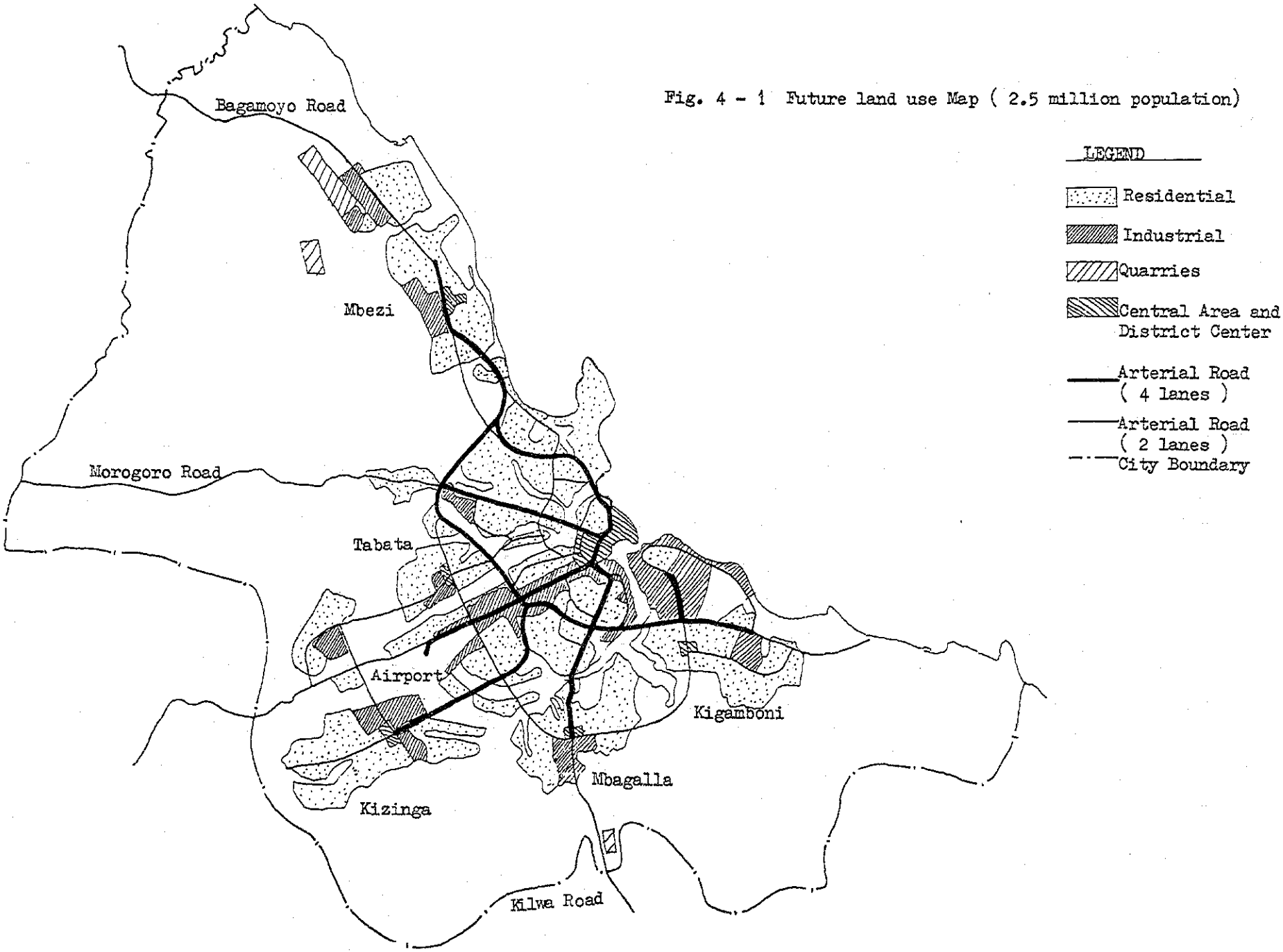


Fig. 4 - 1 Future land use Map (2.5 million population)

4.1.3 City Council Integrated Programme

(1) Objective of the Programme

Based on the future population projection for 1999 given in the Master Plan, the City Council assumed that the city population will continue to grow to reach 2,461,000 in Dar es Salaam by 1999.

In order to increase the provision of essential services to the population as well as to rehabilitate those services which had deteriorated due to the lack of funds, the City Council prepared the Integrated Programme in 1987.

The objective of this Programme is to seek assistance in terms of financial aid, plants and equipment, expertise and training in the different sectors of the Dar es Salaam City Council so as to facilitate more balanced development in the City and to improve the present critical road and sanitation situation.

(2) The Integrated Programme

In order to realize the above-mentioned city services, the following sectors considered to require urgent redevelopment and rehabilitation.

Urgent Sector

Public Work Sector	Proposed Cost (million $)
-Rehabilitation of Roads	42.1
-Rehabilitation of the Storm Water Drainage	4.0
-Street and Traffic Lights Redevelopment	1.6
-Rehabilitation of the Fire Brigade	0.6
-Rehabilitation and redevelopment of City Parks and Gardens.	0.7

Public Health Sector	
-Disposal of refuse and waste	2.9
-Construction of three New District Hospitals	13.8
Rural Water Supply	
-Construction of shallow wells and Provision of piped water to village.	0.8
Green Belt Development	
-Provision of farm inputs and equipment	7.0
Land Planning and Development	
-Provision of Survey Equipments	6.1
Grand Total	80.5

The progress of the proposed Integrated Programme is very limited and only Chole Road is under Rehabilitation.

4.2 Analysis of Future Framework

4.2.1 Methodology

As a result of the review of the Master Plan and the City Council Integrated Programme, the future population and employment for the year 1999 were estimated in the Master Plan based on historical data available up to 1978.

Therefore, updating and current trend analysis of the future population and employment should be necessary, and the distribution of future population and employment by the traffic zones identified in Appendix 3-1, is also necessary for the estimation of future traffic generation by the traffic zones.

The distribution of the future population and employment by the traffic zones has been down in hermony with on the future land use prospect provided by the City Planning Department.

4.2.2 Future Population and Employment Projection

(1) Future Population Projection

The annual population growth rate of Dar es Salaam has been decreasing from 7.8% during 1967-1978 to 4.8% during 1978-1988 because of the introduction of industrial decentralization and the establishment of the Dar es Salaam Master Plan (see Table 4.3).

Based on the current population growth rate of 4.8% a year, the future population of Dar es Salaam City/Region is estimated to be 2,389,000 in 2000 as follows.

$$1,360,850 \times 1.048^{12} = 2,389,000$$

While the population projection of the Master Plan was estimated to be 2,461,000 by the year 1999.

But the difference between these two assumptions is only 3% as follows:

2,461,000/2,389,000=1.03

Considering the small difference between two assumptions above mentioned and authority of the Master Plan therefore, the target population for 1999 established in the Master Plan was applied as the future population in 2000 for this study.

Table 4.3 Future Population in Dar es Salaam

	Year	Population Projection in the Master Plan	Population Projection in the Study
Existing	1978	843,090	843,090
	1988	-	1,360,850
Future	1989	1,642,000	-
	1999	2,461,000	-
	2000	-	2,461,000

(2) Future Employment Projection

Refering to the current trend and structural analysis of the existing employment of Dar es Salaam, total number of employment is assumed 231,300 in 1988 and the employment/ population ratio was 18% in 1966 and 17% in 1988.

Following the procedure of the population projection, the total number of future employment in 2000 will be considered as the same level of the employment in 1999 projected in the Master Plan(see Table 4.4).

The estimated member of future employment by sector in 1999 in the Master Plan Study was applied as the value of future employment by sector in 2000 for the Study according to the industrialization and progress of the employment structure shown in Table 4.4.

4.2.3 Distribution of Future Population and Employment

(1) Methodology

The data of the 1988 census population by word and the 1988 registration record of enterprise by word are only available for the analysis of the existing distribution of population and employment for each traffic zone.

Therefore, the existing employment by traffic zone for the two sectors of industry and commerce was estimated using the existing proportion of the registered enterprises for traffic zones.

(2) Future Land-Use Prospect

Fig. 4.2 shows the future land-use prospect for 2000 prepared by the Study Team based on the information of the Future Land-use Prospect from the City Planning Department of DCC and these features are as follows:

a) For the development and extension of the proposed new development area, such as Kigamboni and Kizinga, it will be pointed that the proposed development of those two areas will be very difficult to complete by 2000 due to lack of fund for the costly investment of infrastructure such as New Road and Rail Crossing to Kigamboni, New Arterial Road to Kizinga and other infrastructures to those area.

Table 4.4 Future Employment in Dar es Salaam

	Employment and Structure by sector					
	1966	1979	1982	1983	1988(1)	2000(2)
1. Manufacturing	13,219	37,410	46,025	47,279	64,800	148,200
	(22.4)	(29.0)	(25.6)	(26.0)	(28.0)	(35.4)
2. Commerce	6,937	14,000	26,093	27,096	37,000	71,000
	(11.7)	(10.8)	(14.5)	(14.9)	(16.0)	(17.0)
3. Public Service	16,529	33,000	61,067	61,348	74,200	82,800
and Utilities	(28.0)	(25.6)	(34.0)	(33.7)	(32.0)	(19.8)
4. Transport and	11,655	26,000	38,168	38,736	46,300	78,100
Communications	(19.7)	(20.1)	(21.3)	(21.3)	(20.0)	(18.7)
5. Construction	10,028	16,000	6,162	5,620	6,900	32,600
	(17.0)	(12.4)	(3.4)	(3.1)	(3.0)	(7.8)
6. Mining	49	90	463	460	500	100
	(0.1)	(0.1)	(0.3)	(0.3)	(0.2)	(-)
7. Agriculture	653	2,600	1,580	1,495	1,600	5,500
	(1.1)	(2.1)	(0.9)	(0.8)	(0.8)	(1.3)
Total Employment	59,070	129,100	179,558	182,034	231,300	418,300
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Total Employment/Population	18%	15%	18%	17%	17%	17%
Population	332,000	883,600	1,017,000	1,065,800	1,360,850	2,461,000

Source: The Dar es Salaam Master Plan and Date from Central Statistical Bureau.

(1): Figures are estimated useing existing statistics by the Study Team.

(2): Future Employment are established in the Master Plan.

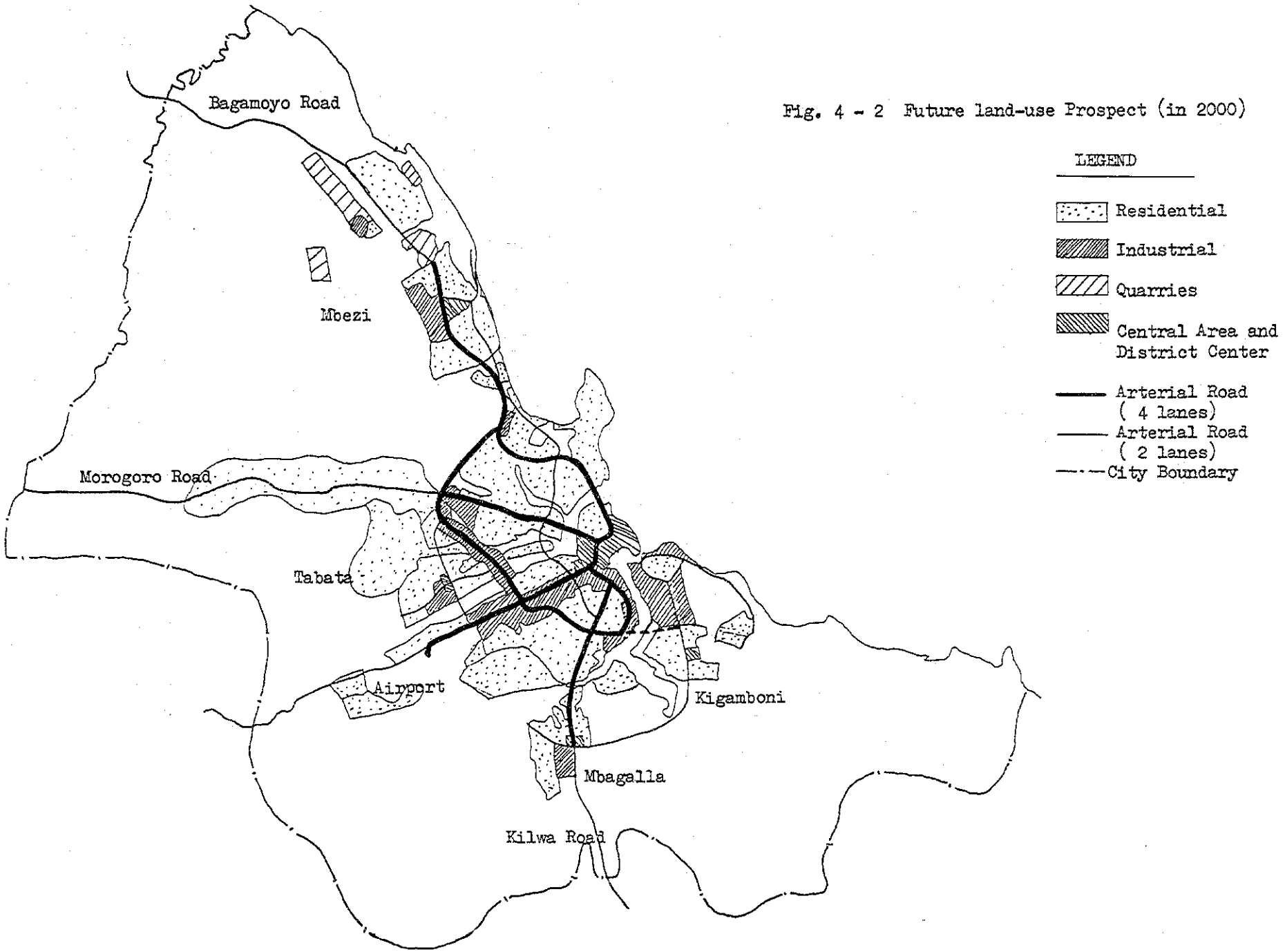


Fig. 4 - 2 Future land-use Prospect (in 2000)

Therefore, it will be generally reasonable to use the land-use map of the Interim Plan in the Master Plan for the future land-use prospect in 2000 except the New Road and Rail Crossing to Kigamboni

b) Considering the progress and existing development of industrial area along the Port Access Road, these land-use will be suitable for the trunk road function of the Port Access Road.

c) New residential development will be considerable to the area of west extension along Morogoro Road and Tabata area and north extension along Bagamoyo Road.

(3) Future Population Distribution

Existing population and historical trend by word are given from the 1978 and 1988 census data and shown in Appendix 4-1.

Future population distribution in 2000 has been calculated based on the present increasing rate of census population by each word between 1978 and 1988. Although some words were estimated with the population density of more than 200 people per hectare in 2000. Therefore these growth rates were tapered off toward a marginal density of population according to the basic concept on land-use and population distribution in the Master Plan (see Appendix 4-1).

As the results of the estimation and adjustment, Table 4.5 shows the existing and future distribution of population by zone.

(4) Future Employment Distribution

The industrial employment is consisting of the employment of manufacturing, construction and harbour, while the commercial employment is consisting the employment of commerce, public service & utilities and transport & communications.

Future Industrial Employment

The zonal distribution of the total increasing employment for manufacturing sector from 1988 to 2000 were conducted according to the registration data of the proposing or on-going industries provided from the Ministry of Commerce and Industry, while the other industrial employment in 2000 was distributed to each zone according to the zonal potential of the industrial employment seeAppendix 4-2).

Table 4.5 shows the existing and future distribution of Industrial employment estimated by traffic zone and Fig. 4.3 shows the higher increasing area of industrial employment than the total average increasing rate of industrial employment from 1988 to 2000 and these zones are assumed as an industrial area in the future land-use prospect.

Future Commercial Employment

For the estimation of future commercial employment by zone, the increasing rate of population by zone from 1988 to 2000 was applied as the increasing rate of commercial employment, except the city center zone.

The increasing potential of commercial employment for the city center will not be influenced by its own increasing rate of population, but directly influenced by the total increasing rate of population of Dar es Salaam(see Appendix 4-3).

Table 4.5 shows the existing and future commercial employment estimated by traffic zone and Fig. 4.4 shows the higher increasing area of commercial employment than the total average increasing rate of commercial employment from 1988 to 2000.

Table 4.5 Summary of Frame work by Traffic Zone

Zone No.	Zone Name	Ward	Population 1988	Population 2000	(1) Industrial Employ. 1988	(1) Industrial Employ. 2000	(2) Commercial Employ. 1988	(2) Commercial Employ. 2000
1.	City Center	Mchafukoge, Kisutu	16,904	16,000	7,600	9,800	19,400	26,200
2.	Kariako	Kariako, Jangwani	27,889	29,000	9,000	11,600	21,300	28,600
3.	Kivukoni	Kivukoni	5,372	5,000	900	1,200	5,800	7,800
4.	Upanga	Upanga East, WEST	20,827	23,000	1,600	4,000	3,500	2,900
5.	Gerezani	Mchikichini, Gerezani	22,527	23,000	6,100	9,800	11,000	14,800
6.	Ilala	Ilala	35,048	39,000	3,200	5,100	7,900	10,700
7.	Keko	Keko	42,868	50,000	12,900	37,900	4,400	4,100
8.	Miburani	Miburani	72,892	82,000	2,600	3,300	7,200	6,000
9.	Kurashini	Kurashini	26,776	45,000	18,800	26,100	3,100	3,900
10.	Buguruni	Buguruni	48,247	72,000	1,600	5,000	8,500	9,500
11.	Kigogo	Kigogo	21,222	28,000	500	600	1,500	1,500
12.	Magomeni: Mzimuni,Ndugumbi,Magomeni		73,665	83,000	3,200	4,100	8,700	11,700
13.	Kinondoni	Kinondoni	42,387	63,000	200	300	1,400	1,600
14.	Mwananyamala	Mwananyamala	72,508	103,000	800	1,000	1,900	2,000
15.	Mburahati	Mburahati	53,911	51,000	200	300	1,900	2,500
16.	Tandele	Tandele	58,413	63,000	200	300	1,100	1,500
17.	Manzese	Manszese	54,499	113,000	2,500	3,200	2,300	12,800
18.	Mabibo	Mabibo	45,963	75,000	700	4,700	2,400	2,900
19.	Msasani	Msasani	51,293	106,000	900	4,100	2,100	3,200
20.	Kawe	Kawe	44,085	114,000	400	3,400	700	1,300
21.	Ubungo	Ubungo	46,980	122,000	2,000	11,200	1,800	3,200
22.	Tabata	Tabata	18,465	153,000	700	4,700	1,300	8,500
23.	Vingunguti	Vingunguti	33,690	63,000	-	3,900	-	2,800
24.	Kipawa	Kipawa	36,910	104,000	3,700	19,300	3.300	6,300
25.	Ukonga	Ukonga	45,203	117,000	1,100	4,300	4,200	7,700
26.	Temeke	Temeke	91,144	111,000	5,600	11,000	14,500	13,200
27.	Mtoni	Mtoni	39,417	48,000	800	1,000	3,400	3,100
28.	Mbagala: Mbagala,Yombovituk,Chamazi		78,350	238,000	600	2,700	4,300	9,700
29.	Vijimkweni: Vijimkweni,Kibada,Twangoma		12,212	20,000	-	-	-	-
30.	Kigamboni	Kiganboni	26,078	39,000	500	1,600	1,700	1,900
31.	Kunduchi: Kunduchi,Mbuweni,Bunju		34,897	69,000	100	2,000	200	300
32.	Kibanba	Kibanba,Gobe	21,504	51,000	300	400	600	1,000
33.	Pugu:	Pugu,Kinyerezi,Msongola	22,625	105,000	-	1,000	300	1,000
34.	Kisarawe:Kisarawe,Somangira,Kimbiji		16,016	38,000	-	-	-	-
	Total		1,360,850	2,461,000	89,200	198,300	157,500	214,400

(1):Including Harbor Employment, (2):Including Public Service, Utilities, Transport and Communication

Fig. 4.3 Future Expansion Area of Industrial Employment.

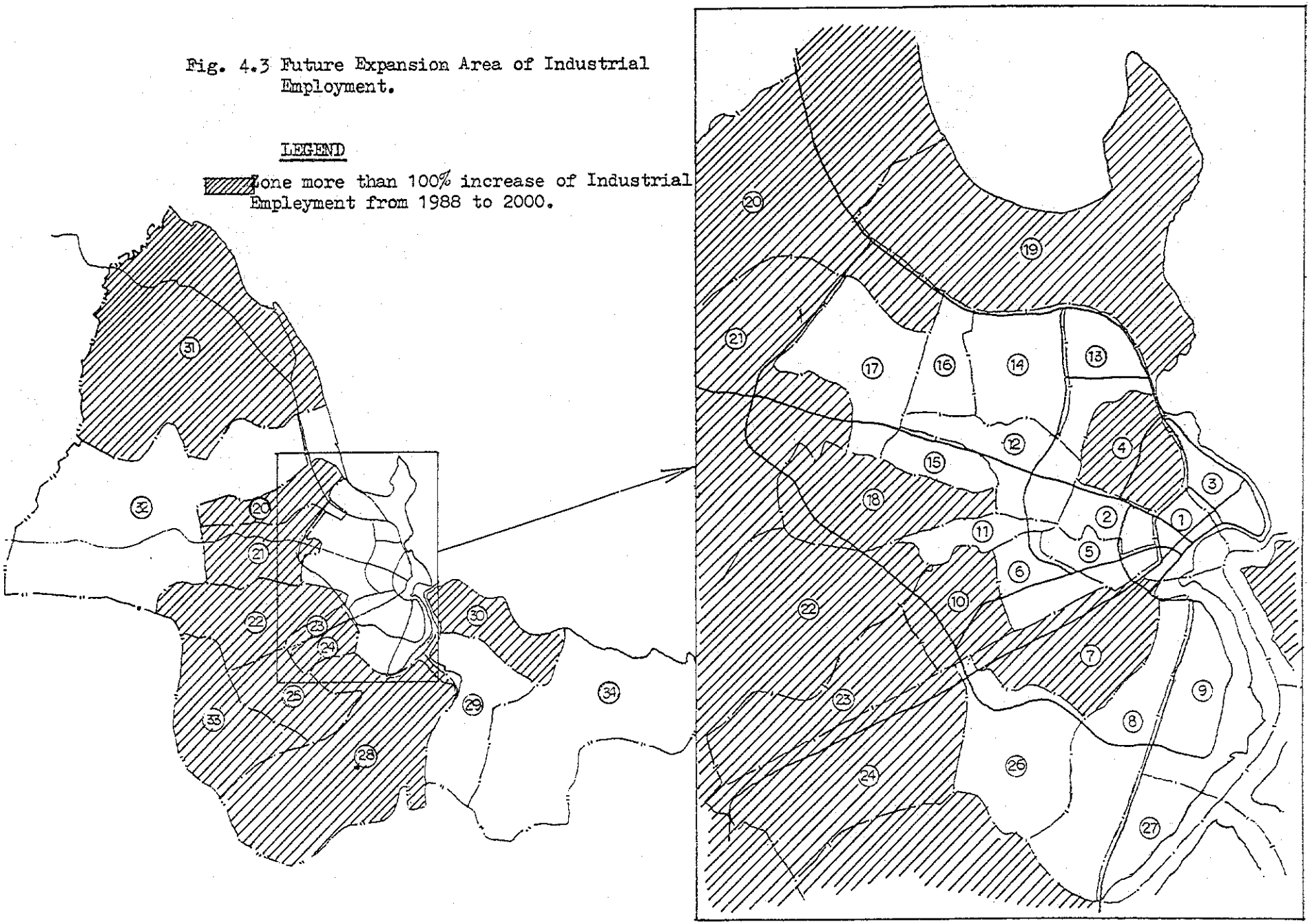
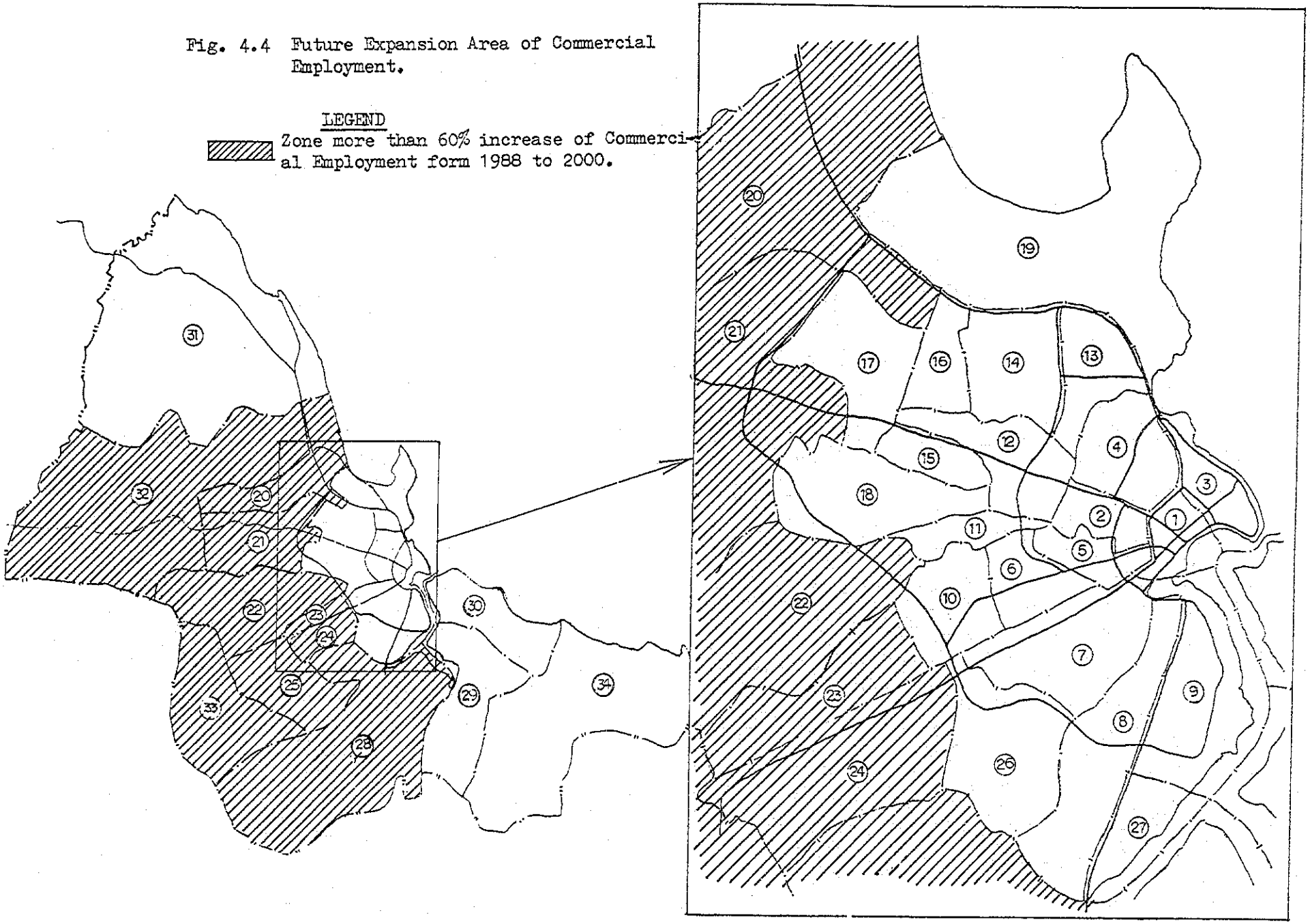


Fig. 4.4 Future Expansion Area of Commercial Employment.

LEGEND

Zone more than 60% increase of Commercial Employment form 1988 to 2000.



4.3 Transport Projection

(1) Transport Projection in the Master Plan

As a result of the review of the Master Plan, it was established that the number of motor vehicles in Dar es Salaam will increase from 24,600 vehicles in 1978 to 49,000 vehicles by 1999 with an average annual growth rate of 3.3%. This projection assumes that motor vehicle import restrictions will stay in effect. Furthermore, there was another assumption that if the restrictions are lifted in 1979, the number of motor vehicles will increase to 76,000 vehicles by 1999 with an average annual growth rate of 5.5%.

After two assumptions the Master Plan conducted that average car ownership rates are expected to decrease and the importance of private cars as a means of transport will consequently decrease. Table 4.6 shows the result of the assumption of the future number of motor vehicles and Table 4.7 shows the present and future transportation system by mode at morning peak hour projected in the Master Plan.

Table 4.6 Future Projection of Vehicles in the Master Plan

Year	No of Vehicle	Average Growth Rate	Population	No of Vehicles per 1000 Population
1967	15,500	-	356,286	44
1978	24,600	4.3%	843,090	29
1999	49,000	3.3%	2,461,000	20

Table 4.7 Transportation System by Mode at Morning Peak Hour Proposed in the Master Plan

Mode	Present(1978)	Future(1999)
Walk	52	36
Public Transit	13	24
Employer Transit	12	13
Private Vehicles	16	12
Bicycles & Motorcycles	6	15
Total	100%	100%

(2) Historical Trend of the Traffic Volume

In the course of the traffic survey, the Traffic Cordon-lines were established to analyse the magnitude of traffic movement between city centre and surrounding area shown in Fig. 3.3.

Table 3.8 shows the 12hrs traffic volume on the Inner Cordon-line in 1989 counted by the Study Team and also shows the former 12hrs traffic volume on the Cordon-line presented in the Basic Design Study Report for the Morogoro Road Improvement Project, 1984 by JICA. As the results, it well be found that the total average annual growth rate of Cordon-line movement was 1.9%, 1.4% increase per annum for car and light goods vehicles, 11% increase per annum for buses, and 1.1% decrease per annum for trucks.

(3) Traffic Projection for the Study

Table 4.8 shows the comparison of growth rate of actual 12hrs traffic on Cordon-line, population, GDP and other data.

The annual growth rate of total traffic on the Cordon-line was 1.9% from 1982 to 1989 while the annual growth rate of GDP and population forDar es Salaam was 2.0% from 1977 to 1987 and 4.8% from 1978 to 1988 respectively.

On the other hand it will be pointed that the recent progress of the economic recovery is remarkable and the annual growth rate of GDP and motor vehicles on roads provided by the National Insurance Company was 3.5% and 3.6% between 1984 and 1987 respectively.

Considering the recent progress of economic recovery and the future growth rate of population of Dar es Salaam, the future annual economic growth by 2000 will be assumed as about 4% in accordance with the projection of GDP annual growth rate of 4-5% by 1993 in the New Five Year Development Plan.

Thus the average annual growth rate of traffic on the Cordon-line will be around 4% for total traffic, 3% for cars and light goods vehicles, 10% for buses and 2% for trucks respectively, according to the relations between GDP, population growth and traffic movement growth.

Comparing the average annual growth rate of vehicle projection of 3-5% to 1999 in the Master Plan, it will be reasonable that the above assumption of the average annual growth rate of 4% to 2000 will be adequate for the future total growth rate of traffic movement in the Study Area.

Table 4.8 Comparison of Traffic and Socio-Economic Growth

Item		Existing Average Growth Rate	Existing Period	Future Average Growth Rate	Future Period
12hrs Traffic on the Inner Cordon Line	Cars & Light goods	1.4		4	
	Buses	11.0	1982-89	10	1989-2000
	Trucks	-1.1		2	
	Total	1.9		4	
Motor Vehicles on Roads		-0.7	1980-87		
		(3.6)	(1984-87)		
Population	Dar es Salaam	4.8	1978-88	5.0	1988-2000
	Tanzania	2.8	1978-88		
GDP	Tanzania	2.0	1977-87		
		(3.5)	(1984-87)	4	1989-2000

* figures in parenthesis show recent progress.

CHAPTER 5 TRAFFIC DEMAND FORECAST

5.1 General

This chapter includes an estimation of future traffic demand (for the year 2000) based on the Traffic Survey data obtained in May 1989 and the preparation of proposed future road network. Table.5.1 shows the major work items.

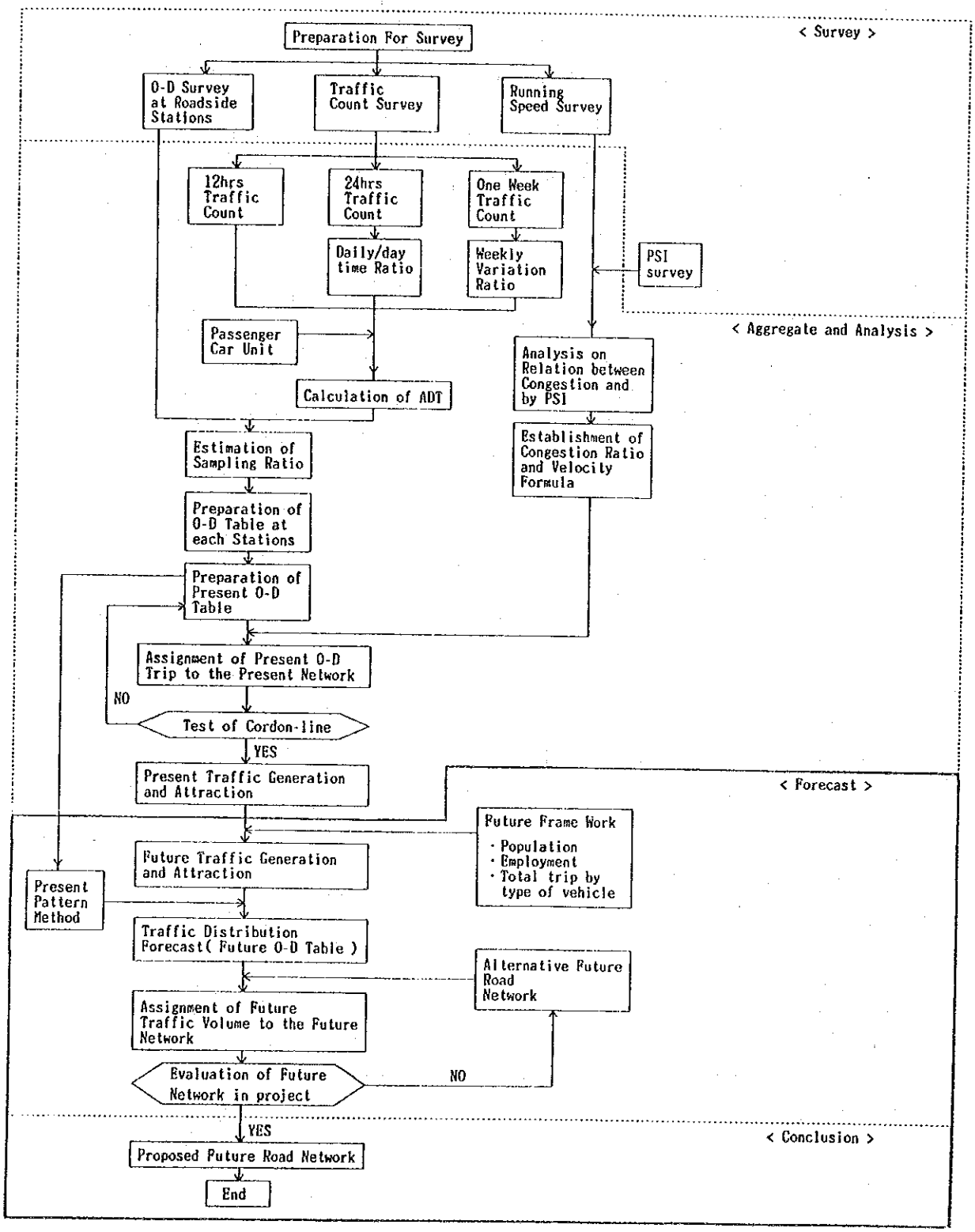
Table.5.1 Major Work Items of Traffic Demand Forecast

Work Item	Contents
Traffic Generation and Attraction	The first step of the Traffic Demand Forecast is to estimate generation and attraction by each zone.
Traffic distribution	The second step of the Traffic Demand Forecast is to estmate future traffic distribution between each zones.
Traffic Assignment	The third step of the Traffic Demand Forecast is to estimate traffic volume by each link. This result will be taken into consideration when conducting an analysis and identification of road improvement measures.
Proposed future road network	Based on the results of the forecast , a desirable future road network will be proposed for short, middle and long term plans.

5.2 Forecast Procedure

Fig 5.1 shows the procedure of future demand forecast from the work of the traffic survey to the proposed future road network.

Fig.5.1 The Flow Chart of Traffic Demand Forecast



5.3 Traffic Generation and Attraction

5.3.1 Estimation Method

In order to estimate future traffic generation and attraction by zone, population indexes related to generation or attraction volume by road-use purpose were used as shown in Table 5.2.

The present O-D table measuring road use was obtained from roadside O-D survey. These, however, did not include all of the generated and attracted road-usage in each zone: particularly intra-zone usage. Therefore the table is somewhat inaccurate and does not serve well as a basis for estimating all the traffic volume As it was difficult to make a mathematical model for the estimation of total traffic generation and attraction.

Table 5.2 Population Index of Road-use Generation/Attraction by Trip Purpose

Trip Purpose	Generation /Attraction	Population Index
commuting to office	Generation	Night time
	Attraction	Working place
commuting to school	Generation	Night time
	Attraction	Night time
Returning home	Generation	Working place
	Attraction	Night time
Business	Generation	Working place
	Attraction	Working place
Others	Generation	Working place
	Attraction	Working place

A total control growth rate of future generation and attraction was obtained from the growth rate of traffic volume by type of vehicle estimated from historical trend data and the perspective for socio-economic growth as shown in Table5.3.

The process of estimating future generation and attraction by each zone is as follows.

The process of estimating generation and attraction

Step	Contents
1	Calculation of total future traffic generation/attraction by each type of vehicle using present traffic generation/attraction and the growth rate shown in Table 5.3.
2	Calculation of increasing traffic generation/attraction by each type of vehicle from present to future.
3	Calculation of increasing traffic generation/attraction by each purpose using the present composition of each purpose by each type of vehicle.
4	Calculation of future population index by each zone as shown in Table 5.2.
5	Calculation of increasing population index by each zone from present to future.
6	Calculation of increasing traffic generation/attraction by each zone obtained from dividing increasing traffic generation(calculated from step 3) by increasing population index (calculated from step 5).
7	Caluculation of future traffic generation/attraction by each zone by adding present volume.

Table 5.3 Growth Rate of Controlled Total by Type of Vehicle

Type of Vehicle	1989 - 2000
Car,Taxi	4 %
Light Goods Vehicle	4 %
Medium Goods Vehicle	2 %
Heavy Goods Vehicle	2 %
Bus	10 %
Weighted Total Average:	4.3 %

Note: Figures are average annual growth rates.

5.3.2 Future Traffic Generation and Attraction

Table 5.4 shows the generation and attraction volumes by each zone for the year 2000.

According to the results, the generation and attraction volume in the city of Dar es Salaam was estimated as 366,157 tripends/day(for the year 2000) up from 268,687 tripends/day(for the year 1989). The growth rate was estimated at 1.36 times for the total tripends of Car, Taxi, Light Goods, Medium Goods and Heavy Goods Vehicle.

The characteristic of generation and attraction by zone is shown in Fig.5.2 and in Fig.5.3 and summarized as follows:

a) A zone having a greater part of traffic volume is the City-Center zone as this has about 53,000 tripends/day at present and about 57,000 tripends/day are estimated in future.

b) Zones having a considerable volume of more than 20,000 tripends/day in future are Keko, Msasani, Kariakoo, and Ubungo zones.

c) The above zones and zones surrounding the City-Centre have a rather low volume, and the growth rate(2000/1989) is lower than the other zones, as the urban area is expanding extensively and the suburban area is estimated to be a rapidly increasing area.

Fig.5.2 Future Traffic Generation and Attraction Volume

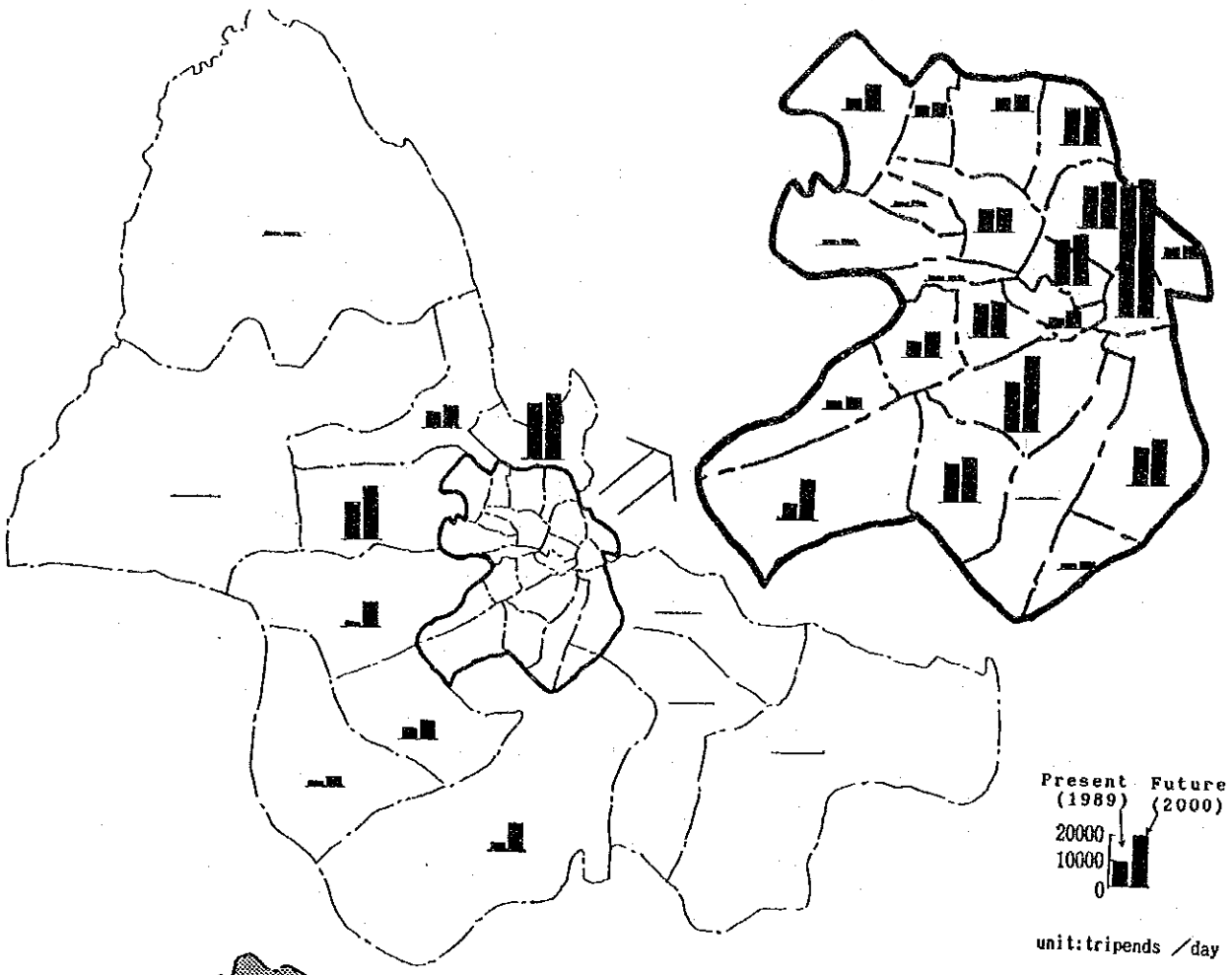


Fig.5.3 Future Traffic Growth Rate(2000/1989)

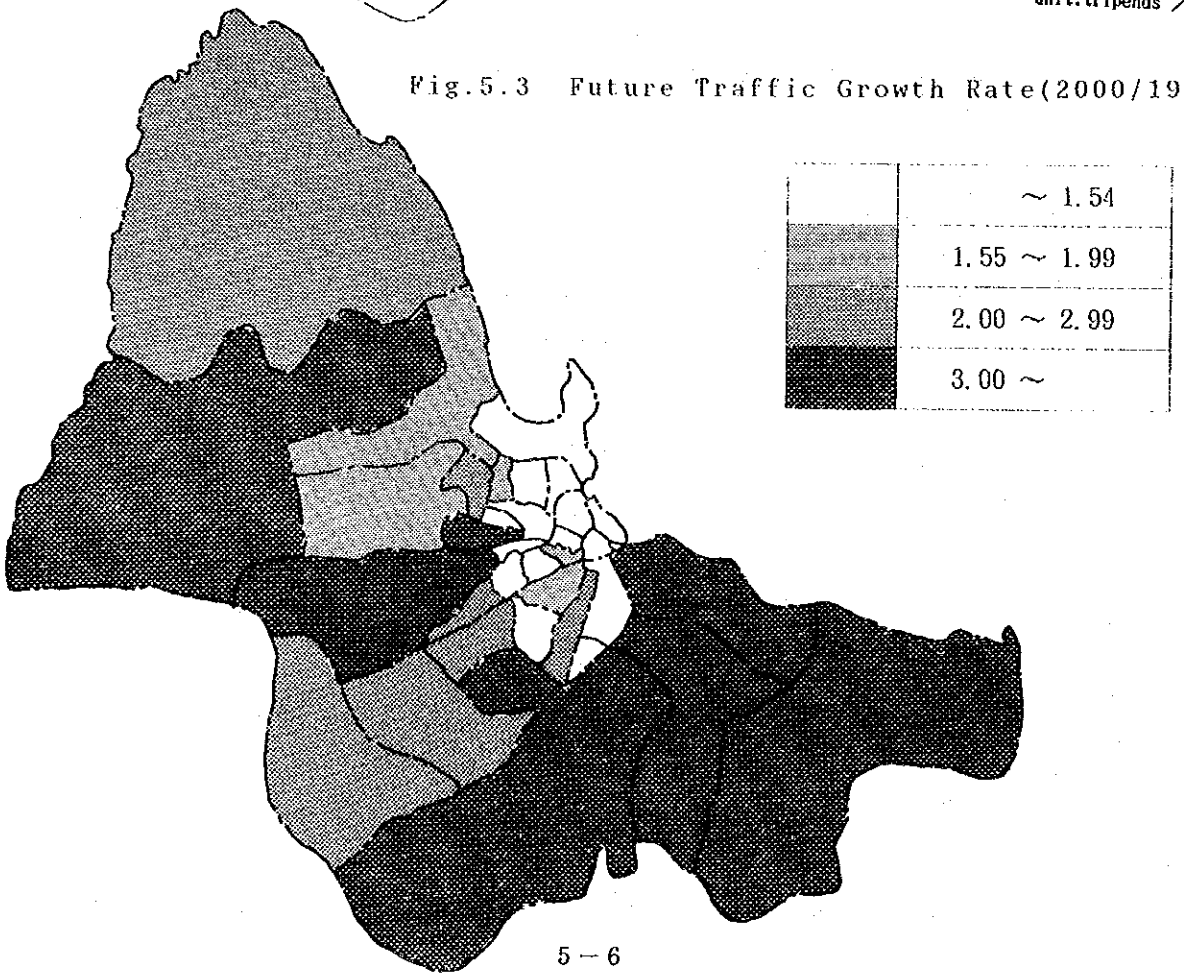


Table 5.4 Traffic Generation and Attraction Volumes at the Present and in Future

(unit:tripends/day)

Zone		Present (1989)	Future (2000)	Growth Rate (2000/1989)
In City	1	53,016	63,336	1.19
	2	17,223	24,017	1.39
	3	3,536	5,064	1.43
	4	16,773	19,798	1.18
	5	4,121	8,061	1.96
	6	12,915	16,655	1.29
	7	19,697	33,341	1.69
	8	213	483	2.27
	9	14,383	20,393	1.42
	10	6,396	9,848	1.54
	11	1,436	1,806	1.26
	12	8,319	11,311	1.36
	13	14,634	17,046	1.16
	14	5,164	6,760	1.31
	15	897	1,287	1.43
	16	386	751	1.95
	17	4,782	12,049	2.52
	18	925	3,973	4.30
	19	22,159	28,397	1.28
	20	5,450	9,838	1.81
	21	15,144	24,135	1.59
	22	2,004	10,923	5.45
	23	2,810	7,114	2.53
	24	6,532	17,520	2.68
	25	4,094	9,854	2.41
	26	15,164	19,642	1.30
	27	2,410	3,014	1.25
	28	4,420	18,268	4.13
	29	35	161	4.60
	30	218	1,518	6.96
	31	1,614	3,670	2.27
	32	66	555	8.41
	33	1,664	4,839	2.91
	34	87	536	6.16
Sub Total		268,687	415,963	1.55
Out of City		2,911	4,271	1.47
Total		271,598	420,234	1.55

Note:Total of Car,Taxi,Light Goods,Medium Goods,and Heavy Goods and except inner zone trip

5.4 Traffic Distribution

5.4.1 Estimation Method

For the estimation of future traffic distribution, the present method was basically applied in accordance with the Frater method, since a new large scale regional development project will not be promoted until the year 2000.

Taking into consideration the future completion of the on-going Kibiti-Lindi Road Project which is located in the southern coastal region of Dar es Salaam along Kiliwa Road we can see that its developmental effect will be more than triple that of vehicle running speed on the road on an average from 20 to 60 Km/hr. It is possible, therefore to estimate that the future additional development traffic on the OD pair-trips generated from zone 28 and from the southern zones will increase about $(60/20)^{1/3} = 1.442$ times from existing OD trips.

5.4.2 Future Traffic Distribution

The results obtained from the estimation of the future O-D table and present O-D table are shown in Appendix 5-1 and 5-2.

The present traffic movement in Dar es Salaam tends to be concentrated in the City-Centre with basicaly 19.5% of all road-use located there and this pattern will be maintained to almost the same extent in the future, with its degree of concentration estimated to decrease only slightly to 15.3% in the future. Travel between the city of Dar es Salaam its outskirts is light and the present ratio of road-use of 1.1% will be sustained in future. Fig. 5.4 shows the characteristic of the distribution pattern in surrounding Dar es Salaam.

And Fig.5.5 shows the line desired of all trips at present and in future. Future desired traffic lines by vehicle type are shown in Appendix 5-3 - 5-6.

Fig.5.4 Basic Traffic Movement at Present and in Future

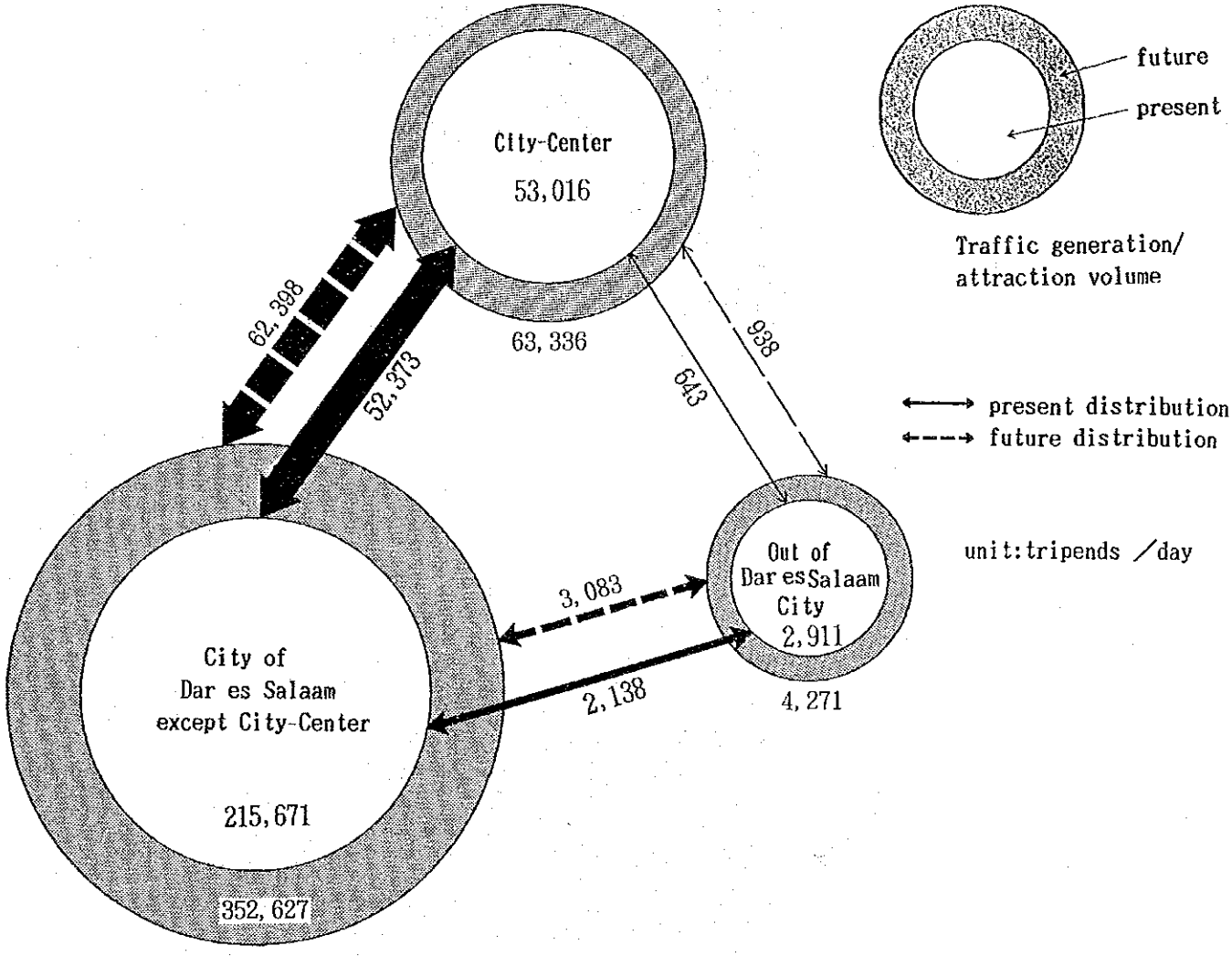


Fig.5.5 Disire Line Traffic at Present and in Future

5.5 Traffic Assignment

5.5.1 Traffic Assignment Method

The traffic assignment method used in this study was an actual traffic movement method which employed the K-V formula(Congestion and Velocity Formula), as this method simulates the present traffic volume better than other methods as shown Table 5.5.

Fig 5.6 shows the detailed procedure that the traffic assignment method adopted.

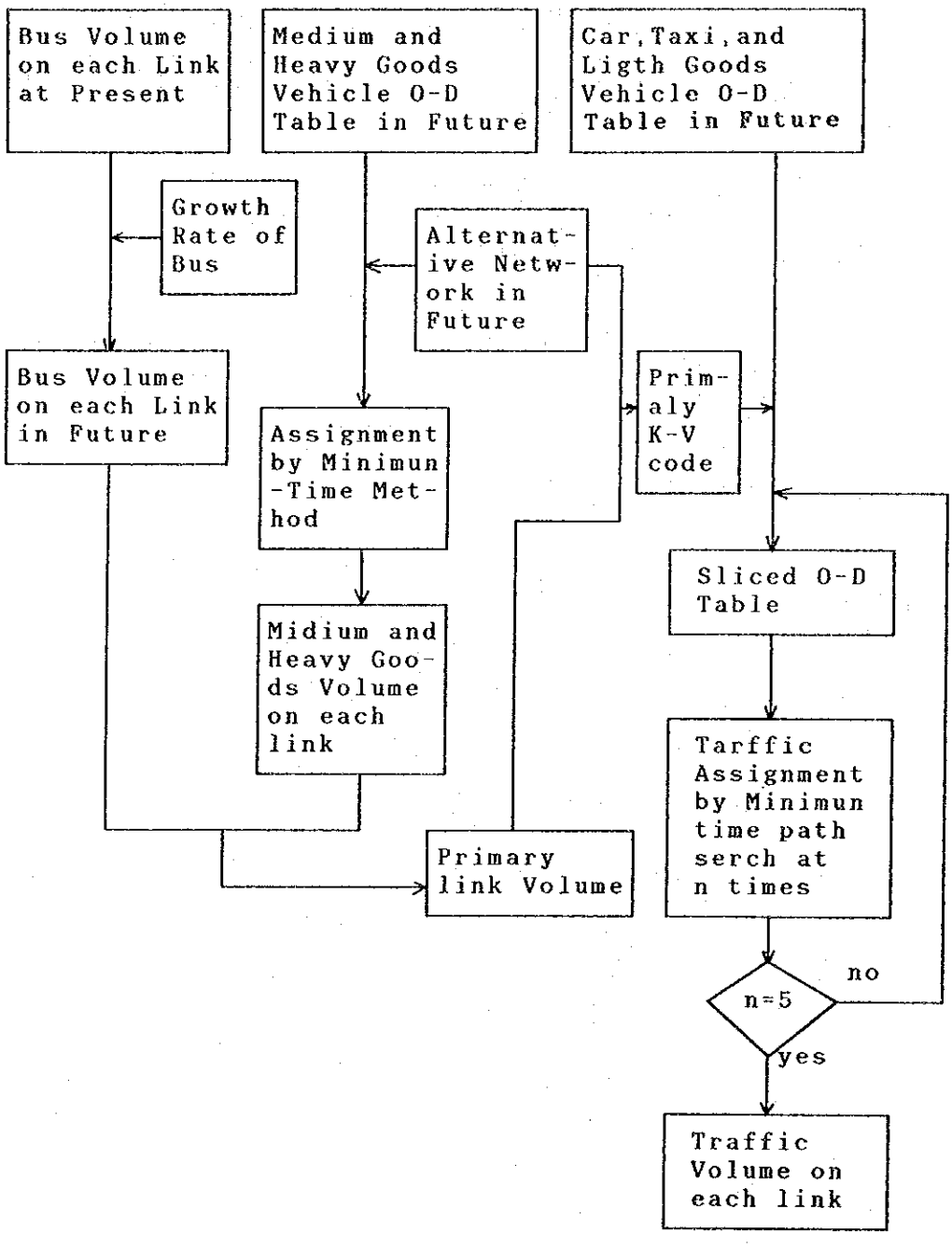
Table 5.5
Comparison of three methods on reappearance of the Present Traffic Movement in Dar es Salam Road Network

Method	Degree of Reappearance: Observed-estimated (until:100pcu/day) Average	Observed-estimated (until:100pcu/day) Standard Deviation	Observed/Estimated (%) Average	Observed/Estimated (%) Standard Deviation
a.Minimum-Distance Path Assignment	63.7	54.8	93.2	71.3
b.Minimum-Time Path Assignment	71.8	74.1	96.1	78.2
c.Actual Assignment Using K-V Formula with Equal Devision of O-D Table	44.2	40.6	98.7	43.9

Note: Above results were calculated at 39 stations at which a traffic counting survey was conducted in May, 1989.

K-V formula was established through the analysis of the results of the running speed survey conducted in May, 1989.

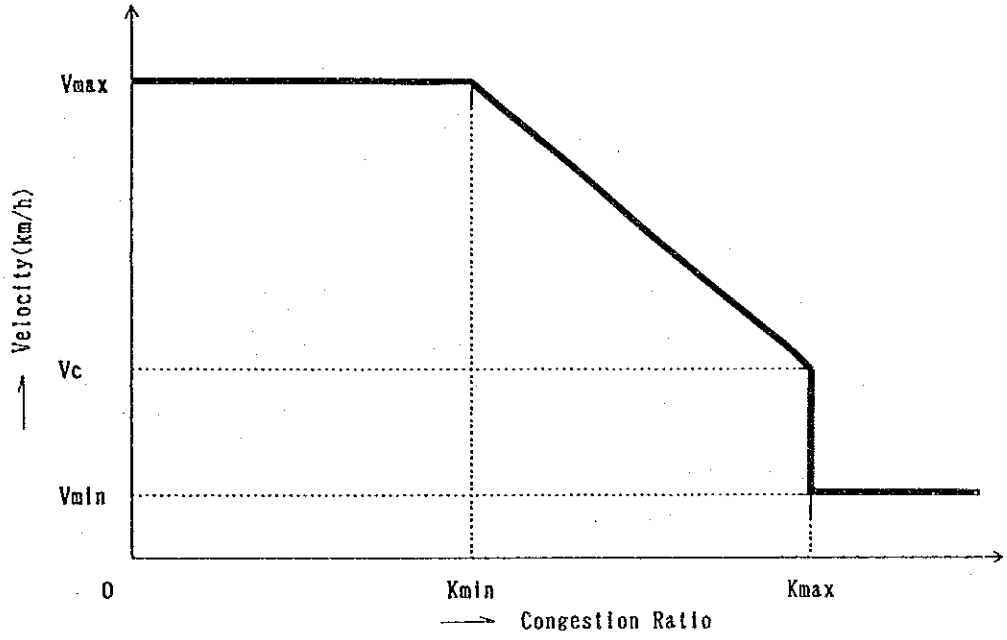
Fig.5.6 Detailed Work Flow of Traffic Assigment
(Actual Assignment method using K-V Formula
with Equal Division of OD Table)



Vehicle velocity was basically influenced by road pavement condition represented by the PSI value and traffic congestion.

In this study, four equations of K-V formula were established as shown Fig.5.7.

Fig. 5.7 K-V Formula for Traffic Assignment



Code	Vmax	Vc	Vmin	Kmin	Kmax	
1	30	20	5	0.5	1.0	
2	40	20	5	0.5	1.0	
3	50	20	5	0.5	1.0	
4	80	30	5	0.5	1.0	
9	10	10	10	0.5	1.0	Access Link

< K-V Code applied >

Area	Collector Road			Arterial Road(2 lane)			4 lane
	bad	poor	good	bad	poor	good	
in CBD	1	2	3	1	2	3	3
out of CBD	1	2	3	1	2	3	4

*bad condition road : PSI<1.5
*poor condition road: 1.5≤PSI<2.5
*good condition : 2.5≤PSI

5.5.2 Establishment of Alternative Network Plan

The main traffic problem identified in the previous chapter existing in Dar es Salaam was the heavy traffic congestion on radial arterial roads and all streets in the City-Centre.In order to solve this existing traffic congestion on the road network and to prepare for future traffic increase, alternative road networks are established in accordanace with the estimated results of existing and future traffic congestion on the existing road network shown in Fig. 3.6 and 5.12.

- To begin with, in order to solve the existing congestion on the arterial roads, an alternative network of Type A plans to widen the exisiting congested radial arterial roads with over 1.5 of the existing traffic congestion ratio.

- Following, in order to solve the congestion problem in the City-Centre, an alternative network of Type B which plans the widenning of circulation roads in the City-Centre and other congested roads is added to the alternative network of Type A.

- Finally, for the desired road network on which almost all links will have a congestion ratio of less than 1.0 an alternative network of Type C is planned in order to establish a new Middle Ring road in addition to the alternative network of Type B.

The above mentioned alternatives are shown in Fig.5.7-5.11 and traffic capacity of each network is shown in Appendix 5-7.

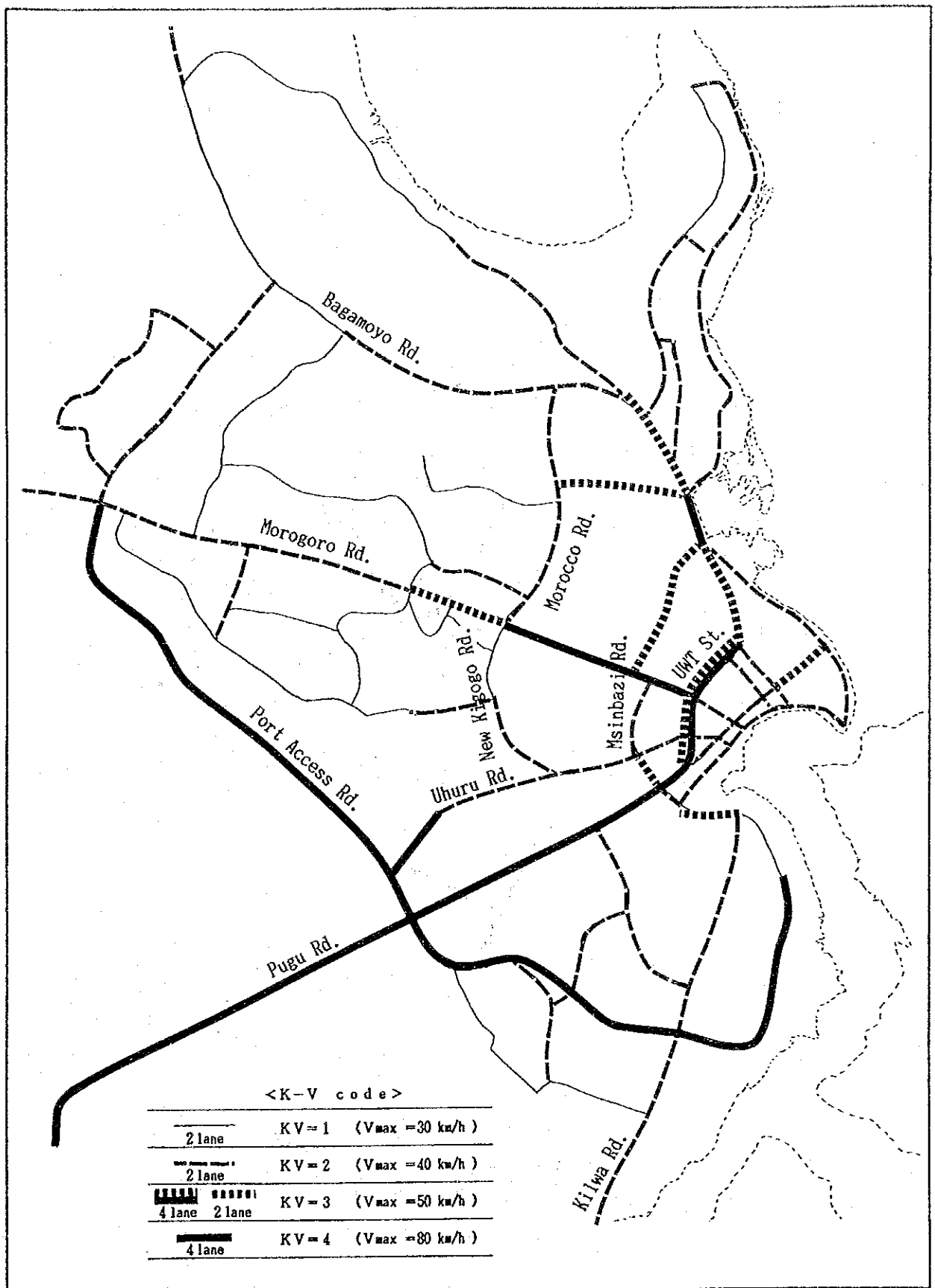


Fig.5.8 Alternative Network (Present Network)

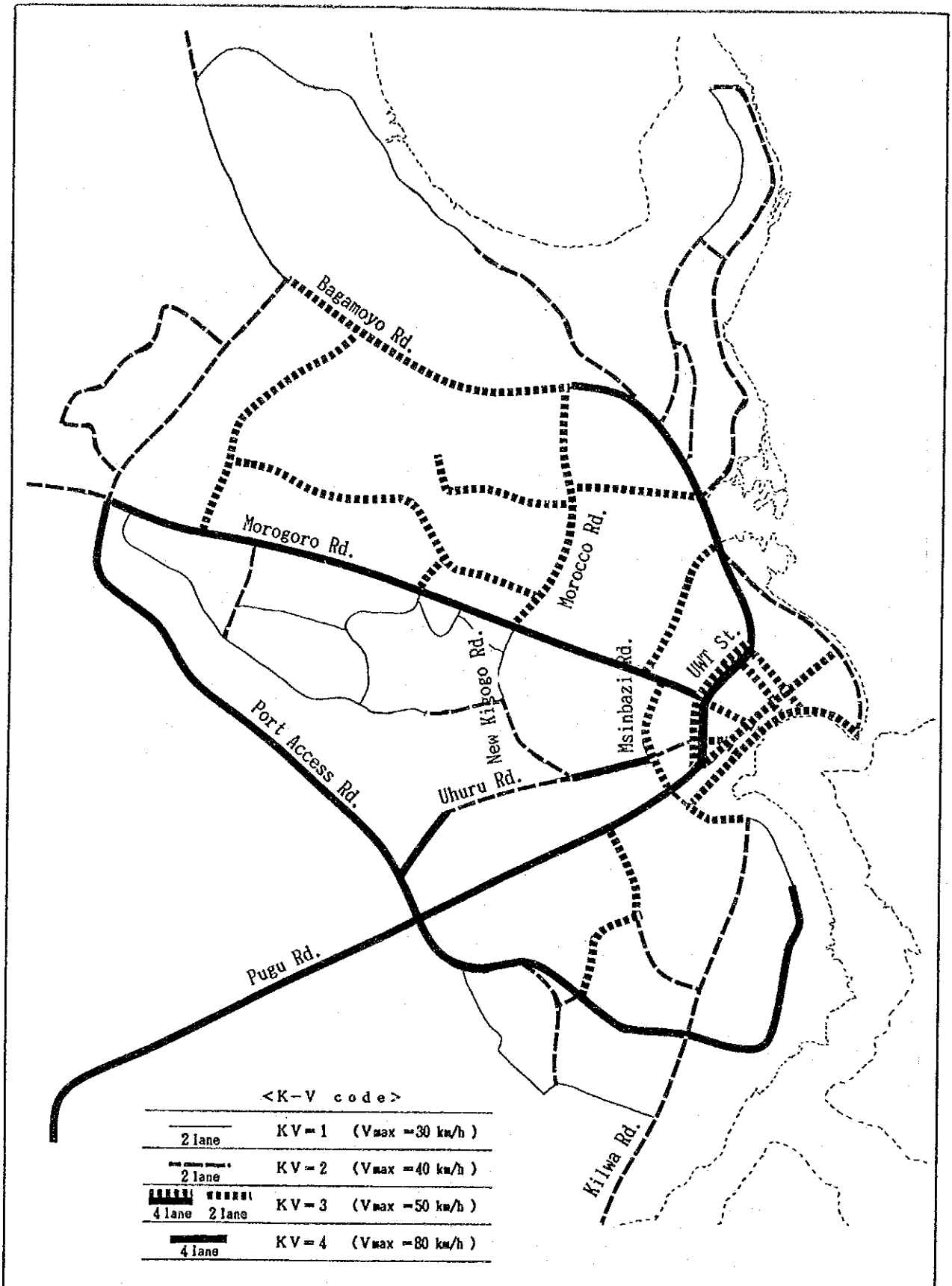


Fig.5.9 Alternative Network (Type A)

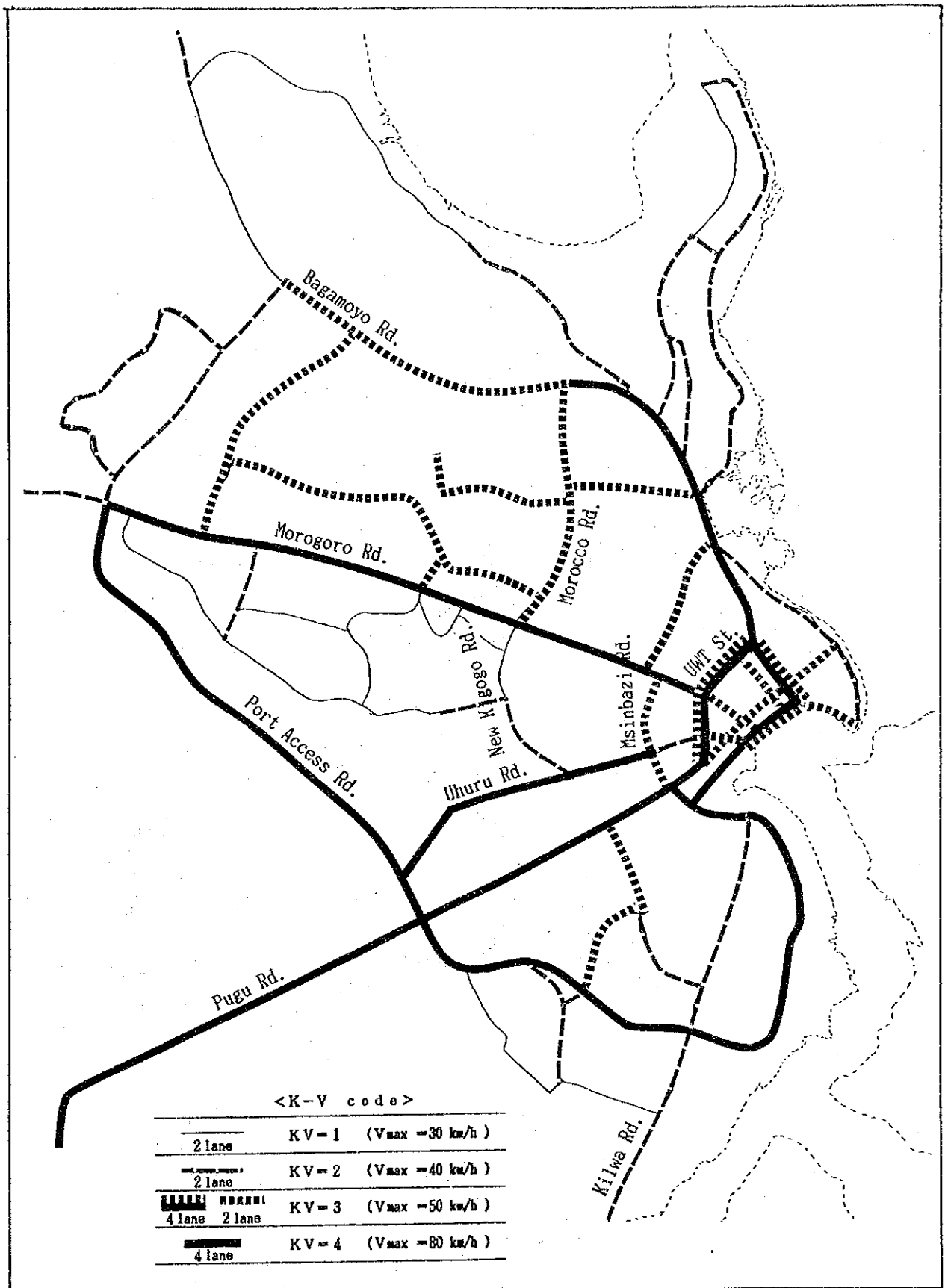


Fig.5.10 Alternative Network (Type B)

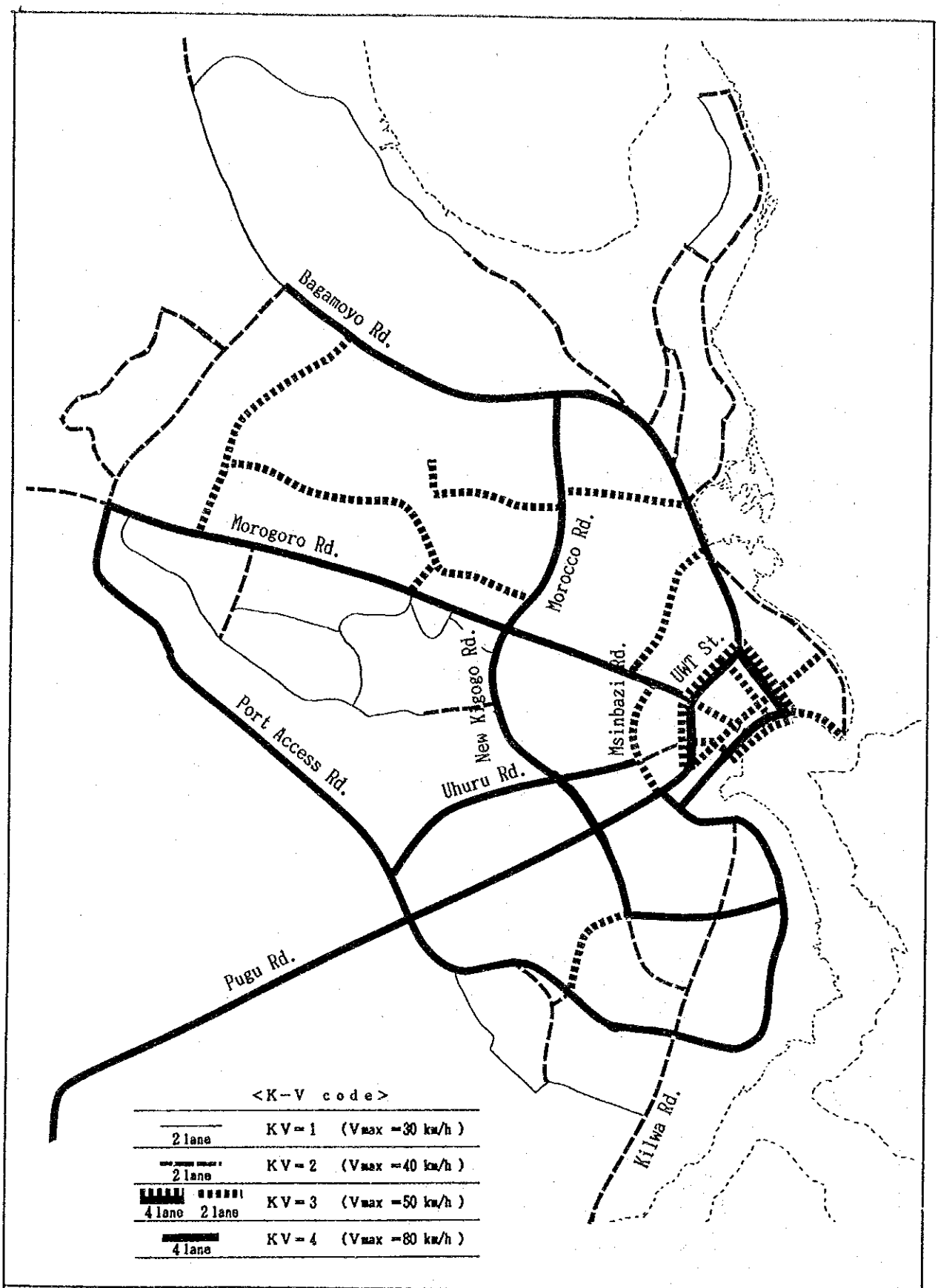


Fig.5.11 Alternative Network (Type C)

5.5.3 Traffic Assignment

The results of traffic assignment on alternative road networks with future traffic demand(future O-D table) are shown in Fig.5.12-5.15 and a summary of these results is given in Table 5.6.

Future traffic congestion on the existing network has been estimated using future OD table and traffic asignment method as shown in Fig.5.12. In accordance with the increase of future traffic demend, heavily congested links with a congestion ratio of 1.5 are expected to be widespread throughout the urban area. Therefore it will be difficult to secure smooth traffic movement of the existing network without any improvement made to existing congested roads.

After evaluating these results, it has been concluded that alternative A is the only effective solution to the problem of heavy congestion on the present congested links, and for future demand, the total average congestion level of all links in Dar es Salaam is estimated at 0.877 less than 1.0. But there will remain some congested links with over 1.5 congestion ratio in the future traffic demand.(see Fig. 5.13)

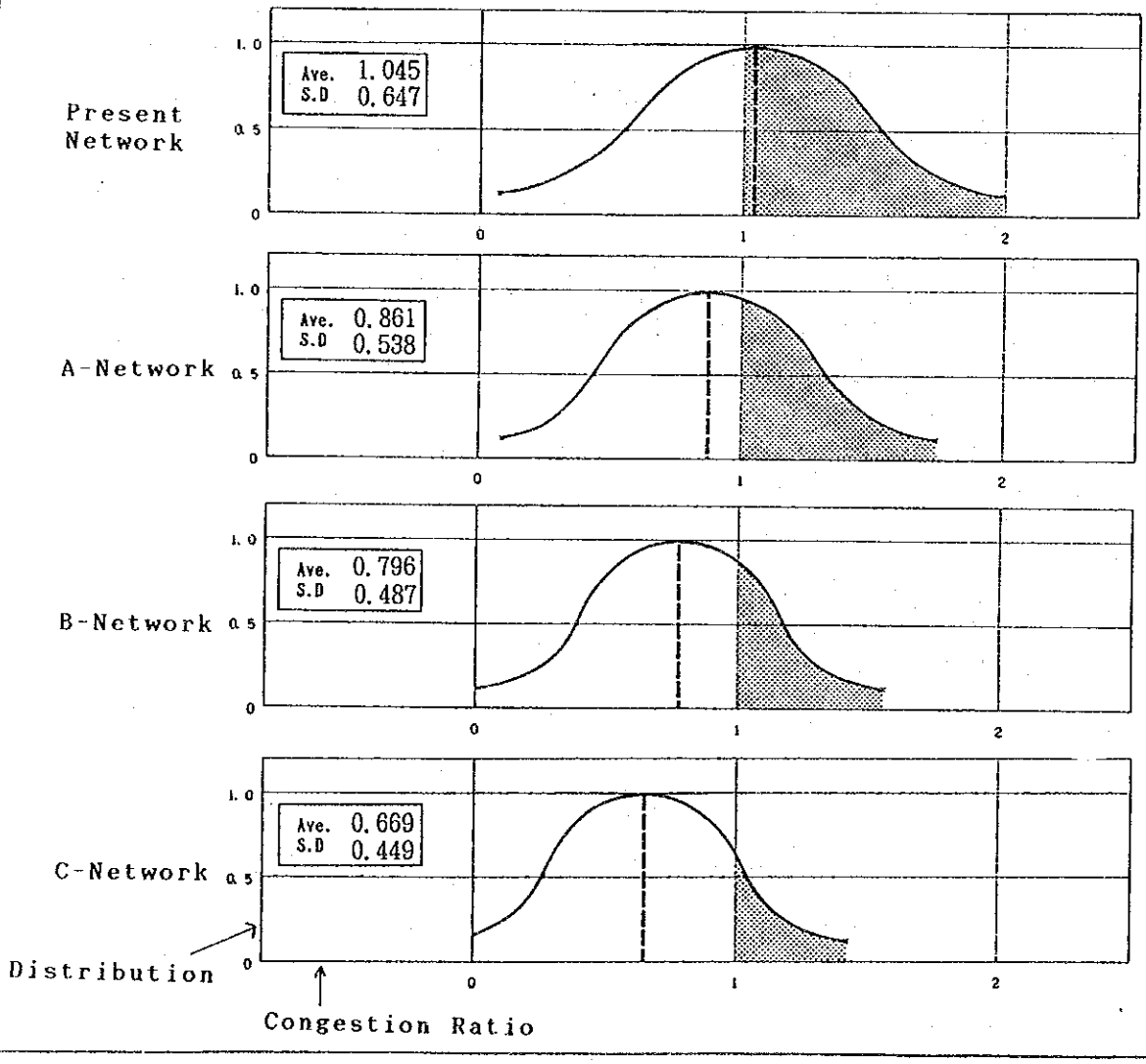
Alternative B is effective for future traffic demand because all links are estimated with less than 1.5 of congestion ratio.(see Fig.5.14)

Alternative C is the desired network for future traffic demand because almost all links are estimated with a congestion ratio of less than 1.0 (see Fig.5.15)

Table 5.6 Summary of the Traffic Assignment on the Alternative Networks with Future Traffic Demand

Alternative name	Congestion Ratio Average	Congestion Ratio Standard Deviation	Average Velocity (=Vehicle*distance/ Vehicle*hour :km/h)
Present	1.045	0.647	33.8
A-Network	0.861	0.538	38.4
B-Network	0.796	0.487	44.1
C-Network	0.669	0.449	50.3

* Average and standard deviation of congestion ratio was caluculated with the weigth by link distance.



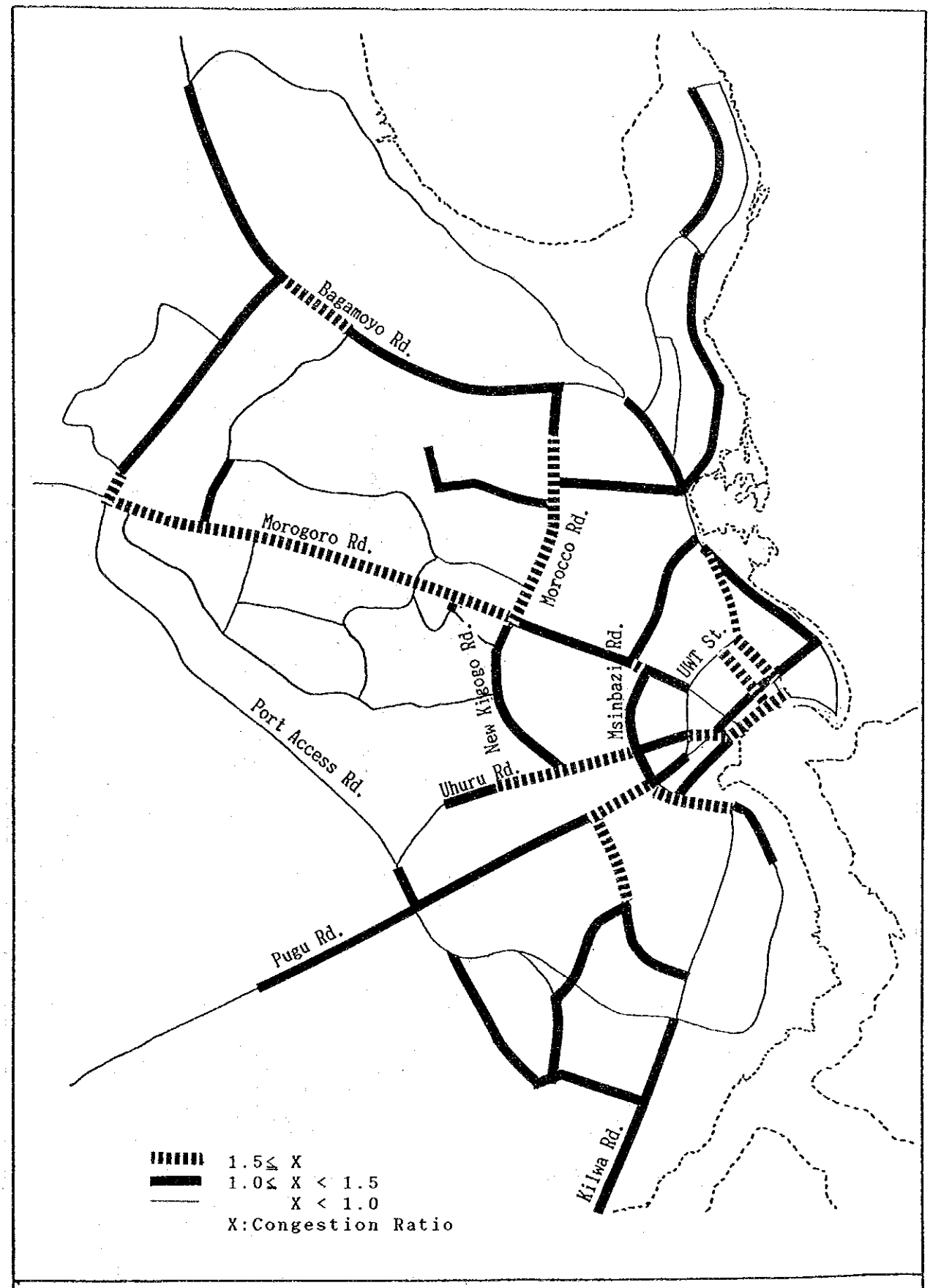


Fig.5.12 Future Traffic Congestion of Present Network

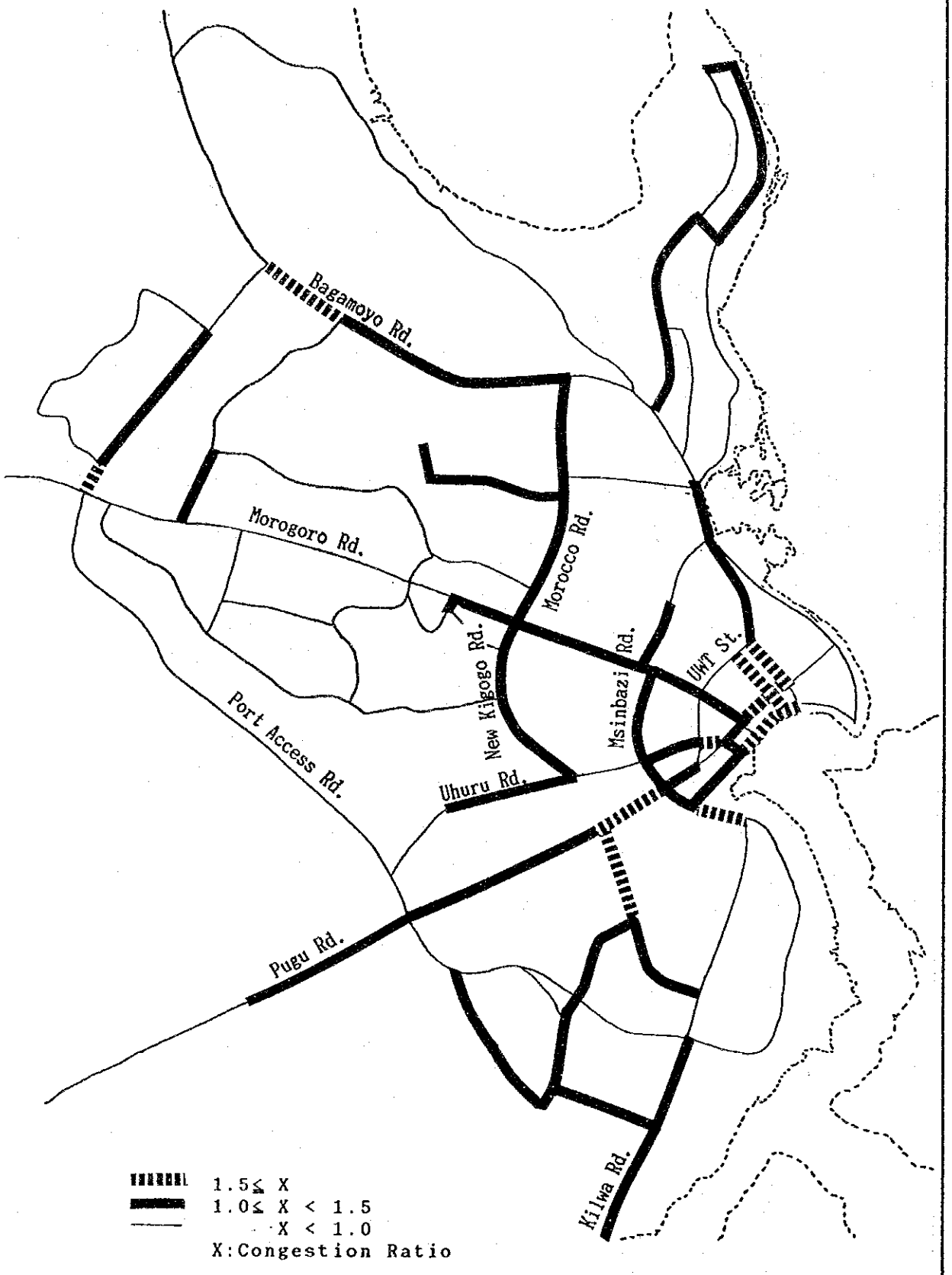


Fig.5.13 Future Traffic Congestion of Alternative Network A

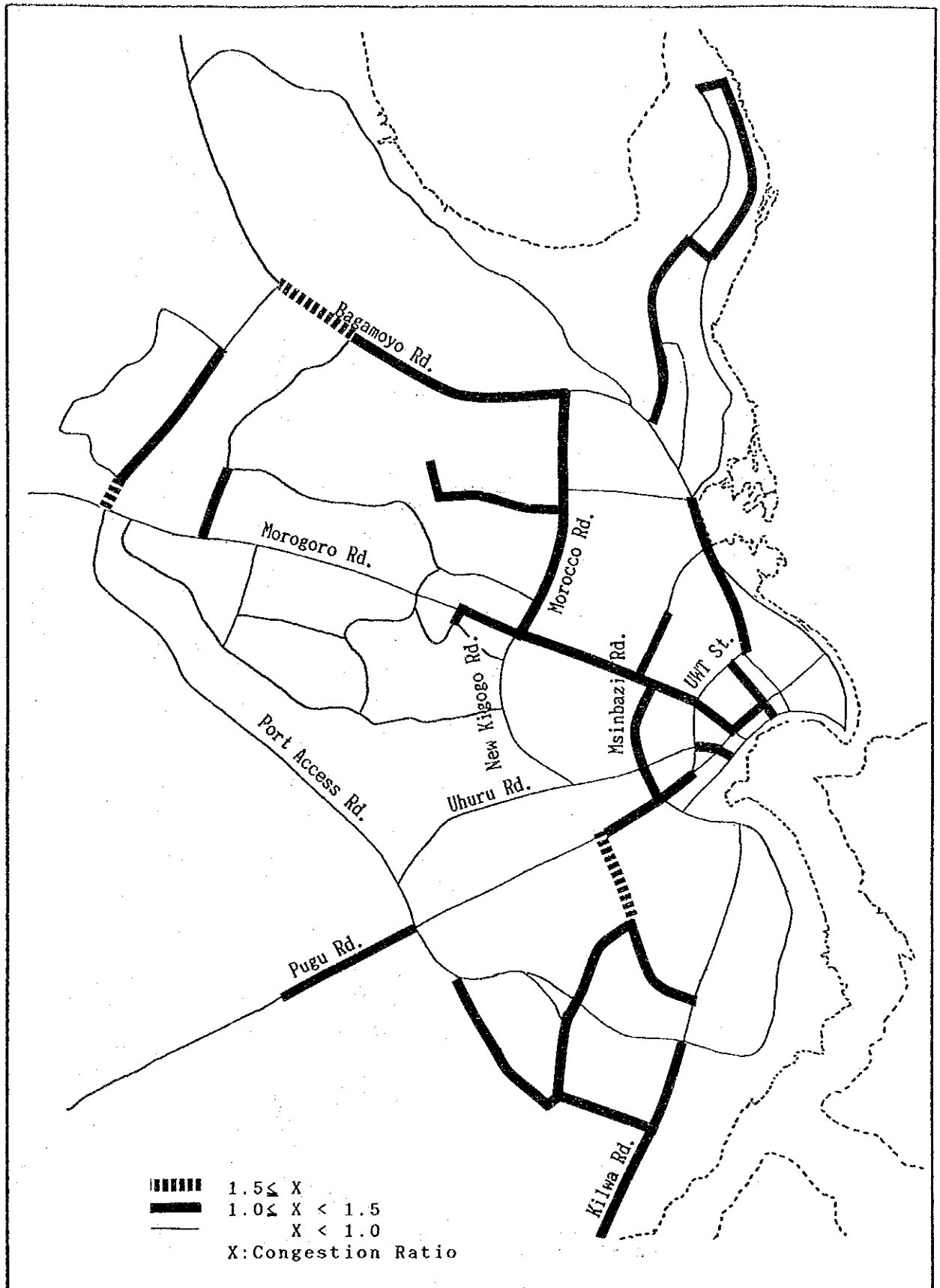


Fig.5.14 Future Traffic Congestion of Alternative Network B

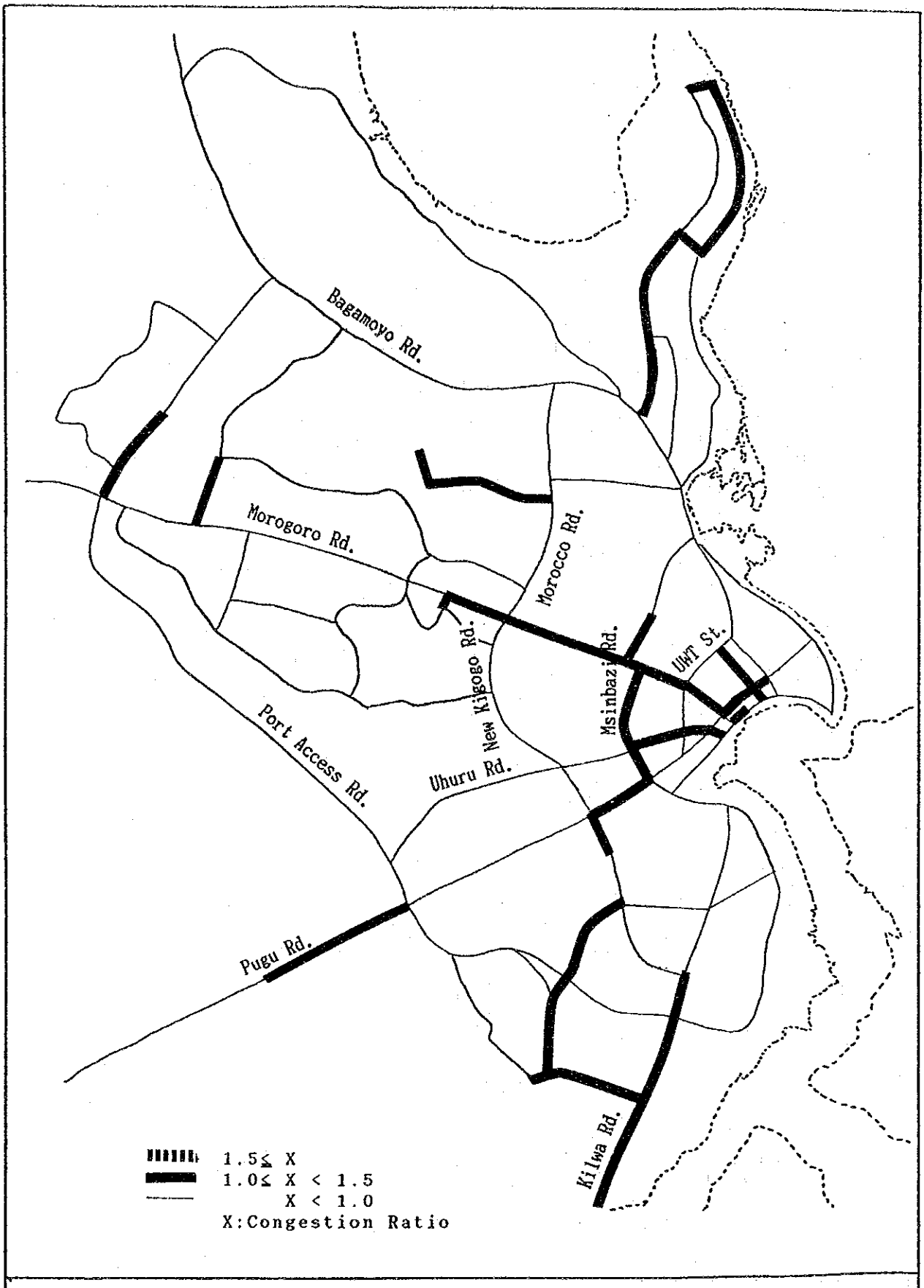


Fig.5 15 Future Traffic Congestion of Alternative Network C

5.6 Proposed Future Road Network

5.6.1 Basic Policy for Establishing Future Road Network

Traffic demand in Dar es Salaam is increasing yearly in accordance with the economic growth of Tanzania. The future traffic growth rate between the years 1989 to 2000 was estimated at 4.3% per annum. Whis the existing level of road network poor some links are showing a congestion ratio of more than 1.5. Therefore if road facilities are not repaired, it is estimated that future traffic congestion will reach an unbearable level with a congestion ration of over 1.5 on all roads in the urban area and an average congestion ratio of all the links is estimated 1.037.

In order to support the economic activities and to realize smooth traffic movement, it is necessary to expand the road capacity in conjunction with increasing traffic demand. Based on the results of the future traffic forecast, a basic policy for establishing the future road network was prepared and organized into 3 stages as shown balow.

Implementation Plan(target year)	Target of Achievement
-Short term plan (1990 - 1994)	Improvement of present congested roads on which congestion occurs at a ration over 1.5, particularly on radial arterial roads.
-Middle term plan (1995 - 1999)	Improvement of the roads on which congestion will reach more than 1.5 in 2000 particularly on the streets in City-Centre
-Long term plan (2000 -)	Improvement of the roads on which the congestion ratio will reach between 1.0 to 1.5 in 2000 particularly on the new Middle Ring Road.

5.6.2 Proposed Future Road Network

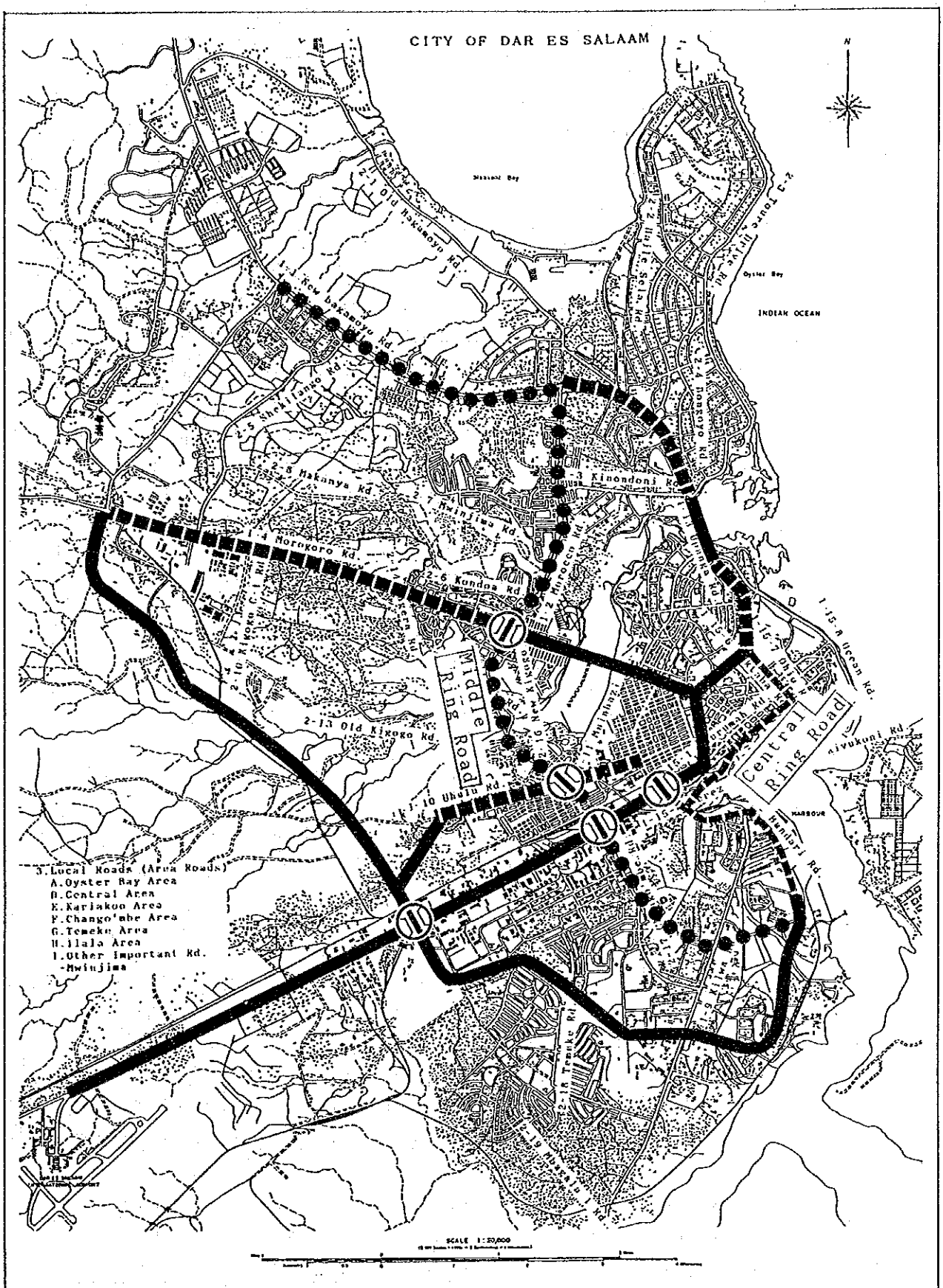
Fig 5.6 shows the proposed future road network which is to be improved under the short, medium and long-term plans and the basic policy established for the future road network.

(1) Widenning of Arterial Roads

Proposed roads to be widen from 2 to 4 lanes during each implementation period are listed in Table 5.7.

Table 5.7 Proposed Future Road Network to be widen from 2 lanes to 4 lanes

Implementation Plan	Road Name
Short Term Plan	Strengthening of Radial Arterial Roads
	-Upanga Rd. (from UWT St. to U.N. Rd.)
	-Bagamoyo Rd.(from Selender Bri.to Morocco Rd)
	-Morogoro Rd.(from Morocco Rd. to Port Access)
	-Uhuru Rd. (from Msimbazi St. to Nursery Sch)
Middle Term Plan	Strengthening of City-Centre Streets (Establishment of Central Ring Road)
	-Sokoine Drive(from Post Office to Gerezani St.)
	-Gerezani St.(from Pugu Rd. to Sokoine Drive)
	-Bandari St. (from Gerezani St. to Port Access)
	-Ohio St. (from Upanga Rd. to Sokoine Drive)
Long Term Plan	Establishment of New Middle Ring Road
	-Morocco Rd. — New Midle Ring Road
	-New Kigogo Rd. and its extension — New Midle Ring Road
	-Changombe Rd.(from Pugu Rd. to Port Access Rd.) — New Midle Ring Road
	-Bagamoyo Rd.(from Morocco Rd. to Mpakani Rd.)



Present 4 lane

Short Term 4 lane

Middle Term 4 lane

Long Term 4 lane

Grade Separation in Long-Term

Fig.5.16 Proposed Future Road Network

From the view point of formulation and construction the widening of radial arterial roads such as Uhuru Road should be a component of the shot-term plan and the widening of Changombe Road will be implemented as one part of the New Middle Ring Road in the long-term plan.

(2) Introduction of Grade Separation

To safely considering the establishment of the future trunk road network for the long term period and smooth traffic management of the future heavy traffic demand in Dar es Salaam, the introduction of a grade separated intersection (Grade Separation) will be considered for the intersections crossing between dual carriagway roads of which the future traffic volume will exceed the capacity of signal controlled intersections.

The capacity calculation formula of signal controlled intersections between dual carriagway is as follows:
(see Appendix 5-10 for detailed calculation method)

$$C_S = (C_A + C_B)/2 \times 0.9 \times 1/P \times K$$

Where, C_S : Traffic Capacity of signal controlled intersection (vehicle/day)
C_A : Saturation Flow Rate of enterance A road
C_B : Saturation Flow Rate of enterance B road
P : Peak hour traffic rate (10%)
K : Congestion Rate (1.5)

each entrance road has the following Saturation Flow Rate:

lane	Ideal Saturation Rate	Adjustment factor heavy vehicle	Right turn vehicle	Left turn vehicle	Saturation Flow Rate
Through traffic	2000x2	(15%) 0.91	1.00	1.00	3640
Right-turn	1800	0.91	1.00	1.00	500
Left-turn	1800	0,91	1.00	0.80	1310
					5450

Therefore,

C_S = (5450+5450)/2 x 0.9 x 1/10% x 1.5 = 73,575

say 75,000(veh/day)

Refers to the result of the future traffic volume on the future trunk road network as is shown in Appendix 5-8,(4-1), future traffic demand on the following important intersections will be in excess of the capacity of signal controlled intersections.

Therefore, the introduction of grade separation to the following intersections will be recommenden under the Long Term Plan.

a) Intersection between New Middle Ring Road and Pugu road
b) Intersection between New Middle Ring Road and Uhuru road
c) Intersection between New Middle Ring road and Morogoro R
d) Intersection between Pugu Road and Port Access Road
e) Intersection between Pugu Road and Msinbazi Road

Regarding the above grade-separation of a) to c) on the New Middle Ring Road, it will be proposed that a type of grade-separation be recommended so that the New Middle Ring Road be constructed over the crossing roads for the following reasons:

- to respect the future trunk road network under construction untill the middle-term period and to minimize the additional improvement cost for the grade-separation.
- not to disturb the through traffic on the future trunk road network during the construction period of grade-separation.

Another proposed type of grade-separation for the above d) and e) on Pugu Road will be recommended so that the crossing roads,i.e. Port Access Road and Musinbazi Road, will cross above Pugu Road. This is due to the geographical condition of the proposed location and to prevent disturbing the through traffic on the principal Pugu Road which connects the City Center and the airport.

CHAPTER 6 IDENTIFICATION OF ROAD NETWORK

6.1 Existing Roads in Dar es Salaam City

6.1.1 Existing Road System in Dar es Salaam

Roads within Dar es Salaam are developed on a radial system of four (4) major roads which forcus on the Central Area of Dar es Salaam. The radial roads are identified as follows:

- Bagamoyo Road including Upanga Road
- Morogoro Road
- Pugu Road
- Kilwa Road

There are three (3) circumferential roads connecting each radial road outside the Central Area as follows:

- Port Access (outer ring road)
- Morocco Road - New Kigogo Road (middle ring road)
- UWT Street (inner ring road

Pugu Road, Port Access Road, UWT Road and a part of Morogoro Road are the 4 lanes paved roads with a high design standard, while the others are 2 lanes paved roads.

6.1.2 Classification of City Roads

The Dar es Salaam City is served by 1,150 km of the exisiting road network system consisiting of a hierarchey of arterial, coll -ector and local roads as shown in Fig. 6.1.

The function of roads connected to each hierarchy are as follows:

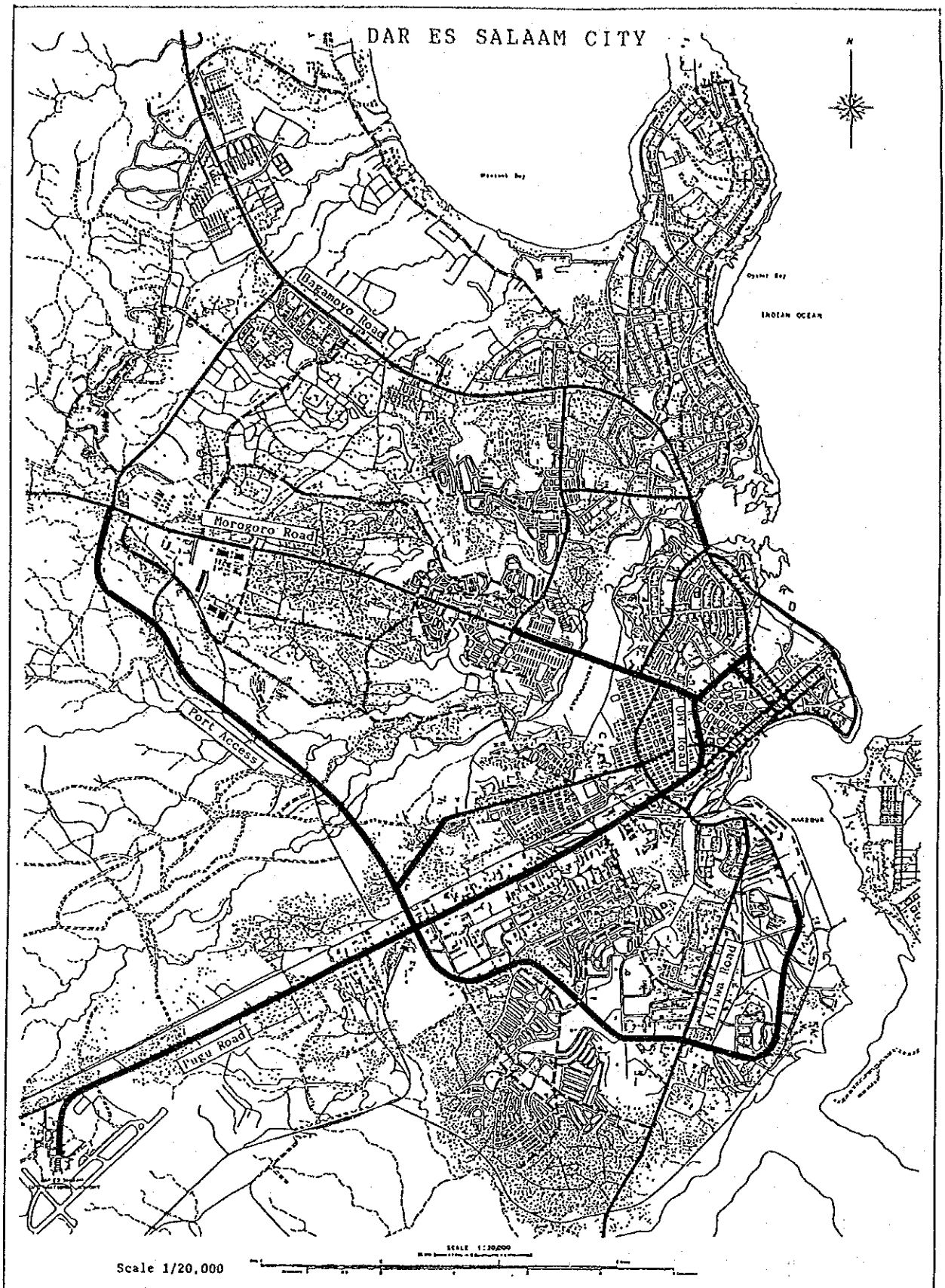


Fig.6.1 Existing Classified Road System in Dar es Salaam

Arterial Roads
4 lanes paved roads:
2 lanes paved roads:
Collector Roads
2 Lanes paved roads:
2 Lanes unpaved roads:
Local Roads
Key plan not applicable

(1) Arterial roads:

Arterial roads form the primary network for the city as a whole and provide access to the national trunk system. All longer-distance traffic movements to, from and within the city should be passed through on these roads.

(2) Collector roads:

Collector roads distribute traffic within the residential, industrial and principal business districts of the city. They form the link between the arterial roads and the local roads and provide circulation within the environmen-tal areas.

(3) Local roads:

Local roads distribute the traffic within the environmental areas. They provide access to the individual buildings and land within the environmental areas.

The existing roads in Dar es Salaam as classified by the above hierarchey are presented in the Appendix 6-1 and summarized below:

Table 6.1 Summary of Existing Classified Roads

Classification	Total Length(km)	
1. Arterial Roads	148	(13%)
4-lane paved roads	35	
2-lane paved roads	113	
2. Collector Roads	65	(6%)
2-lane paved roads	52	
2-lane unpaved roads	13	
3. Local Roads	933	(81%)
2-lane paved roads	251	
Minor unpaved roads	682	
Total	1,146	(100%)
Paved roads	451	(39%)
Unpaved roads	695	(61%)

6.1.3 Jurisdiction of Roads

The City of Dar es Salaam is responsible for the maintenance of all roads in the city with the exception of the following roads, Pugu Road, Morogoro Road, Port Access and Kilwa Road which are jointly maintained by the DCC and MOCW in accordance with the government regulation. The cost of equipment and materials to be used for maintenance of these roads are born by the MOCW while staff and labour cost are born by the DCC.

The improvement and construction including rehabilitation and upgrading for roads other than arterial roads are the responsibility of DCC, while the arterail roads are MOCW.

Table 6.2 showes the summary of jurisdiction of city roads:

Table 6.2 Jurisdiction of City Roads

	Maintenance	Improvement/ Construction
1. Arterail Roads	DCC	MOCW
Major roads/*	DCC/MOCW J.V	MOCW
2. Collector Roads	DCC	DCC
3. Local Roads	DCC	DCC

Note: Major roads include Pugu Road, Morogoro Road, Port Access and Kilwa Road.

6.2 Proposed Roads in Dar es Salaam Master Plan

The Five Years Development Programme (1979 - 1984), a part of document of Dar es Salaam Master Plan, was prepared a working doc-ument dealing with the projects that must be implemented during the first five years of the Master Plan period. In the report, eight (8) road projects were selected as priority projects to be implemented in the first five year.

The present situation on the roads proposed in the Master Plan Study are presented in Appendix 6-2. Out of the projects proposed in the Master Plan, the following roads were selected out and included into the priority roads for rehabilitation and improvement under this study:

- Upanga Road
- Gerezani, Bandari and Kilwa Roads
- Bagamoyo Road

6.3 Priority Roads Proposed by DCC

The Five Year Integrated Programme (1989 - 1993) was formu-lated by DCC in October, 1987. The objective of the programme is to seek an assistance in terms of financial aid, plants and equip-ment, expertise and training in the different sectors of the Dar es Salaam City Council so as to facilitate a more balanced deve-lopment trend within the city (the urban and semi-urban areas).

In its preparation, the priority of the national policy has placed on the rehabilitation and maintenance of the existing roads and completion of on-going projects.

In line with the government policy of the Integrated Progra-mme, DCC has selected the priority roads with a total length of 170 kmapprox. and requested to include these roads in the Study as shown in Table 6.3 which was confirmed by both DCC and the Study Team mutually in the Minutes of Meeting signed on March 21, 1989.

The priority roads shown in Fig 6.2 consist of the following

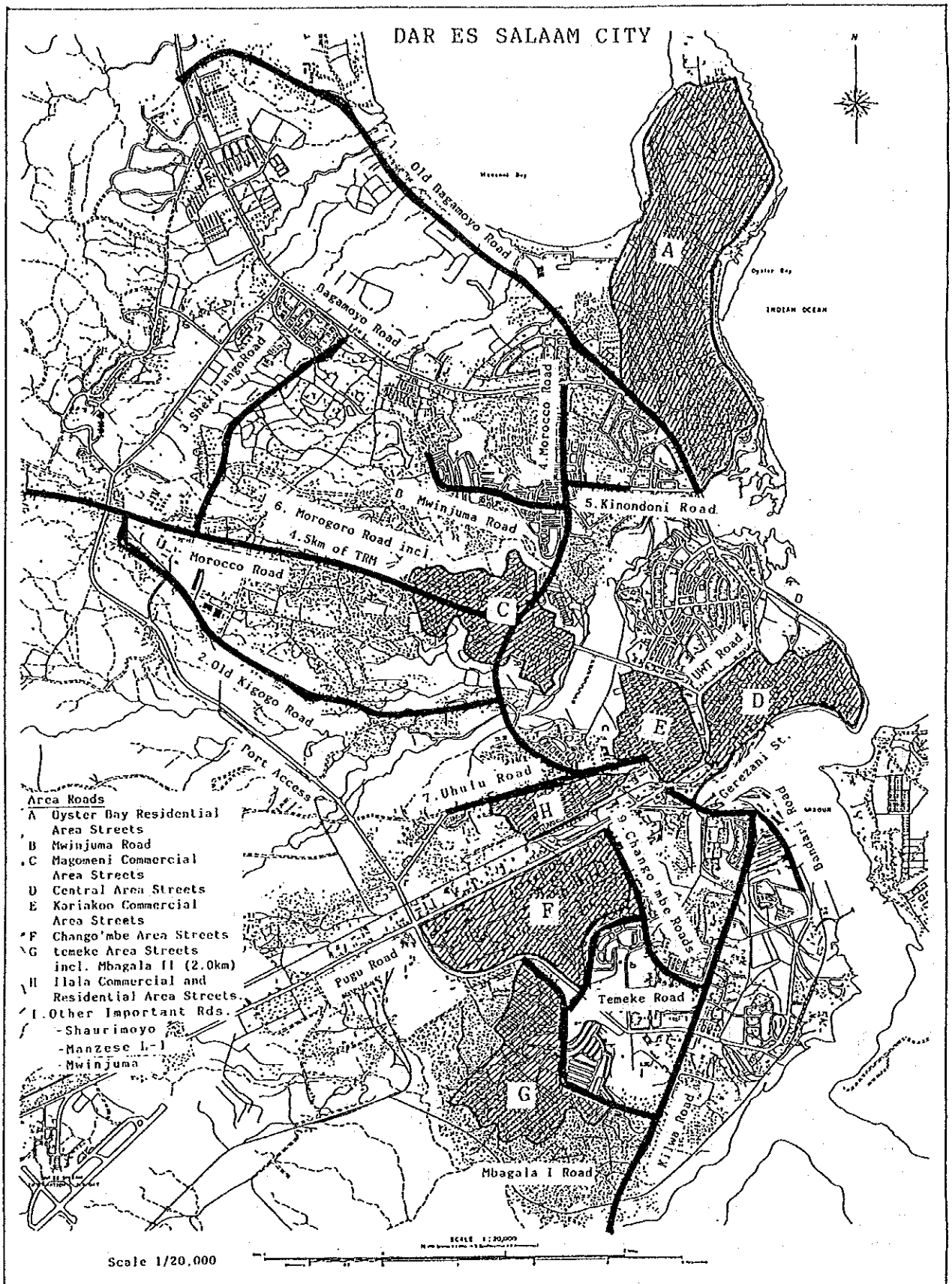


Fig.6.2 Priority Roads Proposed By DCC

Arterial/Collector Roads:

Local Roads (Area Roads) / Other Important Rds.

Table 6.3 Priority Roads Proposed by DCC

No.	Name of Roads	Length Measured by St.Tm.	Length Estimated by DCC	Road Classification
Group 1: Arterial and Collector Roads				
1.	Old Bagamoyo Road	8.2	(8.4)	Collector road
2.	Old Kigogo Road	6.8	(6.0)	Collector road
3	Shekilango Road	3.8	(4.4)	Collector road
4	Morocco Road through Kigogo to Uhuru Roads	6.2	(6.8)	Arterial road
5	Kinondoni Street	0.7	(0.7)	Arterial road
6	Morogoro Road incl. 4.5 km of TRM	9.5	(8.0)	Arterial road
7	Uhuru Road	2.8	(2.3)	Arterial road
8	Gerezani St.(1.2km) incl. Bandari Road(2.2km) & Kilwa Raod(8.6km)	12.0	(12.0)	Arterial road
9	Chang'ombe Roads incl. Temeke Road(1.9km) & Mbagala I Road (1.4km)	7.9	(8.0)	Collector road
	Total of Group 1 :	57.9 km	(56.6 km)	
Group 2: Area Roads				
A	Oyster Bay Residential Area Streets	19.5	(19.0)	Incl. 3 collec. roads.(12.1km)
B	Mwinjuma Road	2.4	(2.4)	Collector road
C	Magomeni Area Streets	3.2	(3.2)	2 collc. roads
D	Central Area Streets	17.5	(16.9)	Incl. 5 arterial roads.(7.2km)
E	Kariakoo Commercial Area Streets	31.6	(31.4)	
F	Chang'ombe Area Streets	14.6	(14.6)	
G	Temeke Area Streets incl. Mbagala II (2.0km)	13.9	(13.0)	
H	Ilala Commercial and Residential Area Streets.	10.3	(10.3)	
	Total of Group 2 :	113.0 km	(110.8 km)	
	Grand Total :	170.9 km	(167.4 km)	

two groups of which details are presented in Appendix 6-3.

Group 1: Arterial/Collector Roads	57.9 km
Group 2: Area Roads/Streets.	113.0 km
Total	170.9 km

In addition to the roads proposed above, DCC requested that the following equally important roads/streets also be considered in the study:

(1)	New Bagamoyo Road: Wazo Hill to Mpiji River Bridge	13.0 km
(2)	Makanya Street : Magomeni to Shekilango Road	5.0 km
(3)	Shaurimoyo Road : Ilala Area	1.0 km
(4)	Mikumi Street : Magomeni Area	1.1 km
(5)	Kigogo C-1 (Morogoro to National Inst. of Transport	2.0 km
(6)	Menxese L-1 (Manxese to Tandale Market Area)	1.5 km
(7)	Mwinjuma L-1 (Mwinjuma to New Bagamoyo Road)	1.5 km
	Total	25.1 km

The length of roads proposed by DCC totals 196.0 km.

6.4 Roads Subject to the Study

Identification of the existing roads was conducted on the basis of existing road inventories, road maps and technical supplement data of the Dar es Salaam Master Plan.

Among the city roads with a total length of 1,146 km, all arterial roads and collector roads with a length of 214 Km over 44 routes were included in the roads subject to the Study.

Among the local roads consisting of 933 km, 251 km are one or 2 lanes paved roads located in urban and sub-urban areas and remaining 682 km are minor un-paved roads in the rural areas or feeder/access to the individual residential neighborhoods. These minor local roads however are mostly not engineered roads so that they are excluded from the study. Therefore the local roads included into the Study are only engineered local roads with a priority given by the DCC as shown in Table 6.3.

As the result, roads to be subject to the study totals to 305 km as follows:

- All Arterial Roads in the City (23 routes) (23 routes)	148.5 km
- All Collector Roads in the City (21 routes) (21 routes)	65.5 km
- Local Roads in 8 Areas Proposed by DCC /1 (128 routes)	91.2 km
Total	305.2 km

Note /1: Arterial and collector roads located in the areas are excluded from the area roads so as to prevent duplication.

CHAPTER 7 ENGINEERING SURVEY AND ANALYSIS

7.1 General

An engineering survey was conducted to identify the actual conditions of the existing roads and to collect necessary information required for the subsequent preliminary design.

The following surveys and analyses were conducted by the Study Team together with their counterpart personnel provided by DCC and MOCW:

- Road inventory survey
- Drainage survey
- Pavement surface condition survey
- Pavement structural survey

7.2 Road Inventory Survey

7.2.1 Road Inventory Survey

Road inventory survey was conducted on all the roads subject to the study which are idnetified by the Study Team in the preceeding chater. The total length of routes surveyed was 305 km.

The survey was carried out on the identified 23 routes over 148 km of arterial, 21 routes over 66 km of collector roads, and 128 routes over 91 km of local roads in 8 areas with an accuracy of pre-feasibility study level.

Prior to the survey, desk studies were conducted based on topographical maps with a scale of 1/20,000 and 1/5,000. However these maps did not cover the entire city.

The major items collected during the survey were as shown below:

- Terrain condition and landuse pattern along the road,
- Length and width of carriageway and shoulder,
- Type and condition of pavement,
- Road crossing structures including bridges, flyovers, boxes and pipe culverts, etc.,
- Adequacey for both horizontal and vertical alignments,
- Type of intersection, roundabout/signal controlled,
- Necessity of provision of road side drainage structures.
- Submerged sections caused by floods.

The road inventories are presented in Appendix 7-1-1. The details will be attatched to the drawings and prepared in a subsequent preliminary design.

Followings are some general observations made by the Study Team on the existing roads in Dar es Salaam City:

(1) Alignment and Width of Roads

The alignment of roads located within the circle of Port Access are generally good owing to the surrounding the flat terrain. Beyond the circle the roads have relatively steep vertical alignment due to rolling terrain.

Most of the roads have sufficient width of carriageway and shoulder depending on its classification and traffic volume.

(2) Intersections

There are some intersections controlled by roundabouts in the Central Area. Most of them, however, have become over-loaded due to the increase of traffic volume in recent years which frequently causes traffic congestion in the area. The improvement of these intersections may require the implementation of traffic signals so that traffic will be able to flow smoothly during peak hours. Traffic jams are found at the following roundabout intersections:

- Tanganika Motors Roundabout at Upanga Road
- Junction at Uhulu and Mwinzima Roads

- Clocktower Roundabout at Samora Street
- Askari Monument Roundabout at Maktaba Street
- Gerezani - Bandari Roundabout

(3) Pavement

Most major and important roads in the city are paved with bituminous materials. These roads, however, have seriously deteriorated due to a long absence of proper maintenace. Details are analysed in the succeeding paragraphes.

(4) Bridge

Bridge structures located within urban areas are generally healthy, however, some bridges located in sub-urban and rural areas are found to be in poor or bad condition due to erosion and corrosion. The following bridges are in particularly serious condition:

- River bridge on Bagamoyo Road at 25 km point from DSM
- River bridge on Bagamoyo Road at 28 km point from DSM

(5) Land Acquisition Situation

With the exception of the roads in the Central Area, land acquisition will not be difficult for most of the roads in the project area. Right-of-way width reserved for each road is generally sufficient and this will enable the government to widen the roads according to the increase of traffic. However, some of these roads are illegally occupied by low-grade houses and buildings which must be dismantled as soon as possible.

(6) Shortage of Bus Bay

Bus services are the major means of transport for commuters in Dar es Salaam. These bus operations, however, interfere seriously with traffic flow due to their inappropriate locations and shortage of bus bays. Additional bus bays are urgently needed for some roads in order to improve traffic congestion. This is especially true in the case of the following roads:

- Morocco Road, Morogoro Road, Uhulu Road and Bagamoyo Road

7.2.2 Identification of Congested Roads

To identify the possibility of widening existing roads, the degree of congestion was examined for each road on the basis of road inventory and traffic data collected by the Study Team through field surveys.

Congestion Ratio (C.R.) by road was obtained through analysis on traffic capacity and daily traffic volume, the summary of which was presented in Chapter 3.

The following criteria were established for identifying road congestion:

Table 7.1 Criteria of Road Congestion

C.R. exceeding 1.5; Roads are heavily congested throughout the day and urgent improvement measures by widening are required.

1.0 < C.R. < 1.5 ; Roads are congested during morning, afternoon and evening peak hours and improvment by signal controlled intersections, provision of traffic devices and bus bays are required.

C.R. below 1.0 ; Roads are not congested and normal maintenance work is required.

5 links over 11.3 km are identified as roads which require urgent improvement by widening as shown in Table 7.2.

Another 6 links over 15.5 km and roads in the Central Area 17.5 km long are identified as the roads which require improvement of intersections, provision of bus bays and traffic devices.

Table 7.2 Links Identified as Congested Road

Lank.	Name of Links	Link Length	Congest. Ratio	Remarks
A.	Roads required for widening:			
1	Uhuru Road	0.9	1.91	Msimbazi - New Kigogo
2	Sokoine(City) Drive	0.8	1.88	Central Area
3	Morogoro Road	4.8	1.68	Morocco - Port Access
4	Bagamoyo Road	3.0	1.64	Upanga - Morocco
5	Upanga Road	1.8	1.52	Tanganika Motor - Selender Bridge.
	Sub Total (1)	11.3 km		
B.	Roads required for improvement by intersection, provision of bus bays and traffic devices:			
1	Msimbazi Road	1.6	1.30	
2	Gerezani Street	1.2	1.29	
3	Bandari Road	2.2	1.27	
4	Chango'mbe Road	4.4	1.21	
5	New Kigogo Road	2.6	1.13	
6	Morocco Road	3.5	1.02	
	City Center	17.5	1.00 - 1.50	
7 -	Maktaba/Azikiwe Str.	(0.9)	1.26	
8 -	Kivukoni Front	(1.0)	1.20	
9 -	Samora Avenue	(0.8)	1.07	
	Sub Total (2)	33.0 km		
	Total (1)+(2)	44.3 km		

7.3 Drainage Survey

The drainage survey was conducted to observe the existing condition of roadside drainage systems, placing emphasis on maintenance of the drainage structures, storm drainage systems including outlet watercourses, and nature and extent of floodings.

The survey was carried out during the rainy season in the Dar es Salaam area which begins in late March and ends in June.

7.3.1 Storm Drainage System

The existing urban area of Dar es Salaam City is served by a storm drainage system which consists of major waterways, secondary waterways and a local drainage system. The existing major rivers are identified as major waterways with their tributaries regarded as secondary waterways as shown in Fig. 7.1.

The urban area of the city is served by the local drainage system which is comprised of piped sections fed by roadside channels and open ditches and which drains into the sea through several outlets.

The sub-urban areas are served by local roadside ditches which have been constructed to drain only the road surfaces with little consideration given to the effect of runoff from adjacent areas. Many other areas have no conventional drainage system, allowing runoff to collect or seep into the ground.

The project on rehabilitation and emergency maintenance work for Dar es Salaam stormwater, sewage and sanitation was planned by the Ministry of Lands, Natural Resources and Tourism in 1984. The scope of the proposed project in the above plans mainly covers the cleaning of sedimentation and debris in channels, culverts and gullies for the following areas:

- City Center, Temeke Outfall Channel, Msimbazi Channel System, and Regent Estate Channels and Kijitonyama River.

Until now , however, these projects have not been implemented due to financial difficulty in the Tanzanian Government.

Fig.7.1 Existing Storm Drainage System

7.3.2 Roadside Drainage

The roadside drainage system in urban areas, such as Central Area, Kariakoo commercial area, Chango'mbe industrial area, Ilala area, Oysterbay area, etc. are generally served by small lined channels and underground piped systems.

As for the arterial and collector roads which have been recently constructed, ditch drainage is provided along the road. The drainage is usually grass-lined and occasionally concrete or asphalt-lined and directed to local waterways.

There is no apparent roadside drainage system in most of the old residential and rural areas of the city. The road surface water is either absorbed into the plots by seepage through the soil or ponding occurs with eventual slow percolation and/or evaporation.

The drainage system of these roads is generally in poor working condition due to the lack of or improper drainage maintenance work in the past.

During this rainy season, the Study Team observed much flooding which occured on the roads and created serious difficulties for both public traffic and pedestrians. Fig. 7.2 shows the location of flooded areas which have often affected the city roads.

Surface water on the roads in the urban area is normally collected by means of gullies and discharged through a piped drainage system. However, most of the gullies laid under carriageways are not working well against storm water due to the blocking of gratings by soil and debris which must be cleared by routine maintenance.

The following general observations were made by the Study Team on the roadside drainage structures of the city roads;

(1) Roads in the urban areas:
- blocking of gully entrances by debris, soil and vegetation:
- silting in the bottom of channels, piped sections, and

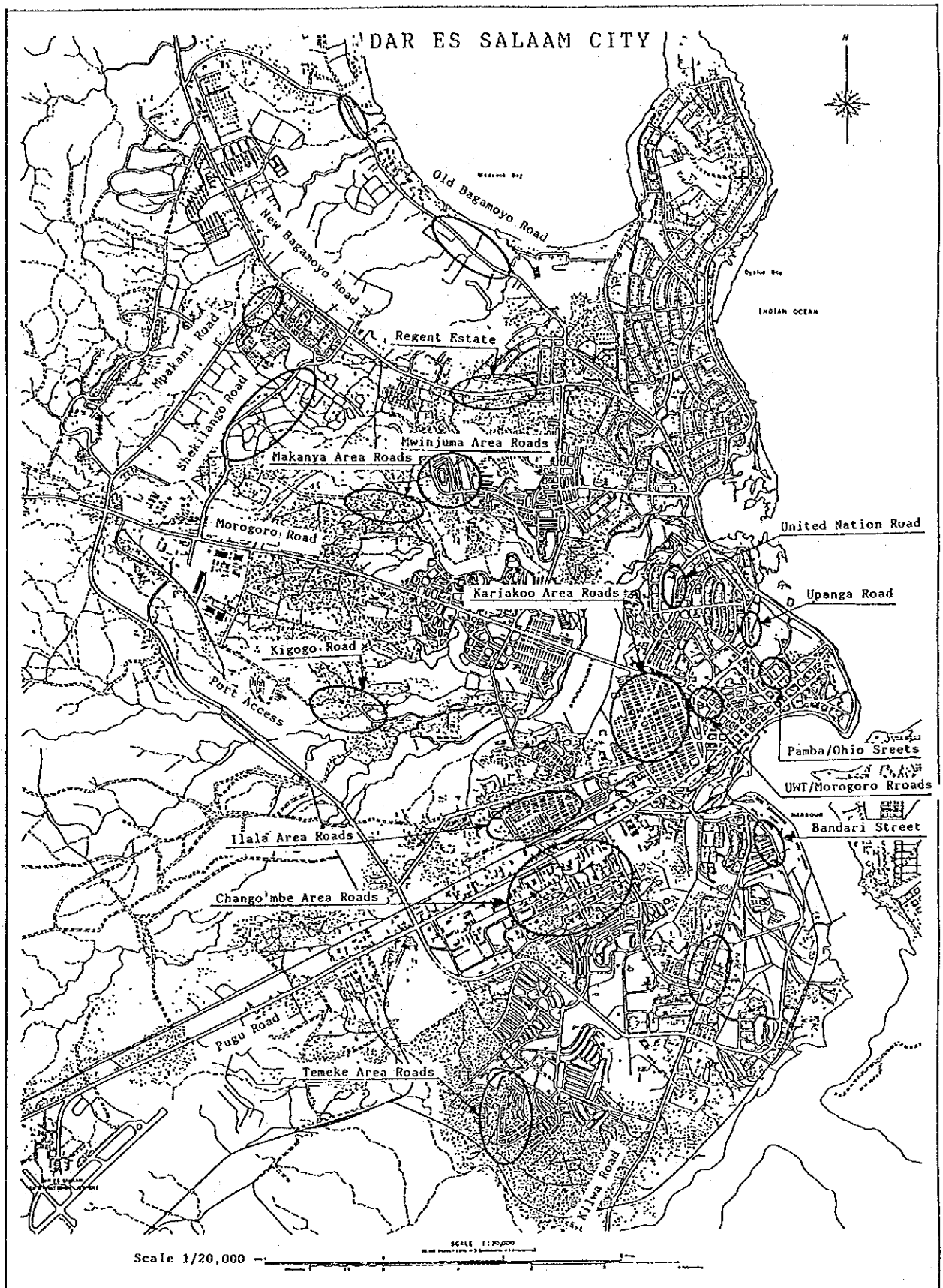


Fig.7.2 Flooded Areas Observed During Rainy Season

Flooded Areas.

culverts
- erosion of shoulders and side slopes;

(2) Roads in the sub-urban and rural areas:
- blocking of ditch drainage by debris, soil and vegetation:
- silting in the bottom of channels, piped sections and culverts:
- erosion of the bottom of side drains in soils or on steep gradients;
- erosion of shoulders and side slopes;
- erosion at culverts outfalls and at foundation of bridge piers and abutments.

The survey results given for existing conditions of roadside drainagealong the major roads and area roads proposed by DCC are presented in Appendix 7-1-3.

7.4 Pavement Surface Condition Survey

The pavement surface condition survey was conducted in order to identify the existing conditions of road surfaces and to determine which sections need improvement along with the countermeasures.

7.4.1 Method of Pavement Surface Condition Survey

The surface conditions of existing roads were evaluated by means of the Present Serviceability Index (PSI) method using visual assessment which was developed in accordance with the Manual Series No.17, "Asphalt Overlays and Pavement Rehabilitation", published by the Asphalt Insititute, U.S.A.

The PSI method of visual assessment is suitable for a road project where a large number of road sections are to be evaluated in a short time.

There is another method of measuring the PSI value by mechanical means, however, it was not recommended for this study, since the deterioration of the exisiting roads in the city has largely exceeded the level of an accurate evaluation by means of mechanical inspection.

The PSI survey was conducted for all arterial and collector roads and local roads which were proposed by DCC as the area roads with a total length of 305 km. Other local roads have not been inspected since most of them are unengineered or have deteriorated completely to the level of gravel roads.

Data for PSI was obtained by visual inspection of the rating group composed of five persons, all of whom fully understand the purpose of the pavement rating method. The assignment of rating classes with respect to the actual surface conditions were understood among the raters prior to the start of the survey through trial practices. Ratings from zero (0) to five (5) are assigned to each section, with higher numbers indicating more satisfaction and lower ratings indicating poor surface conditions.

7.4.2 Analysis of PSI Survey Data

The detailed method of PSI survey, the rating items on pavement conditions and the rating form used for the survey are presented in the Appendices 7-2-1 through 7-2-3. Based on the data obtained through PSI survey, the pavement condition of each road was identified by the following critera:

Table 7.3 Criteria of Pavement Deterioration

PSI Value	Conditions of Pavement	Countermeasures to be taken
0.0 < PSI < 1.5	Very Bad	Reconstruction
1.5 < PSI < 2.5	Bad	Overlay
2.5 < PSI < 5.0	Poor/Fair	Maintenance

The rating obtained through survey were analysed and average rating points and ranges were calculated. The resluts of PSI survey are illustrated in Fig. 7.3 of which detailed are presented in Appendix 7-2-4.

Table 7.4 showes the summary of road classified by the level of PSI value together with necessary countermeasures.

Table 7.4 Road Section by PSI Value

PSI Value	Road Conditions	Length of Roads: Arter. Roads	Collec. Roads	Local Roads	Total (km)	Countermeasures to be taken
0.0 - 1.5	Very Bad	14.7 (9.8%)	31.6 (48.2%)	58.9 (64.6%)	105.2 (34.5%)	Reconst-ruction
1.5 - 2.5	Bad	81.3 (54.7%)	22.3 (34.0%)	32.3 (35.4%)	135.9 (44.5%)	Overlay
2.5 - 5.0	Poor/Fair	52.5 (35.3%)	11.6 (17.7%)	0.0 (0.0%)	64.1 (21.0%)	Maintenance
Total		148.5 (100.0%)	65.5 (100.0%)	91.2 (100.0%)	305.2 (100.0%)	

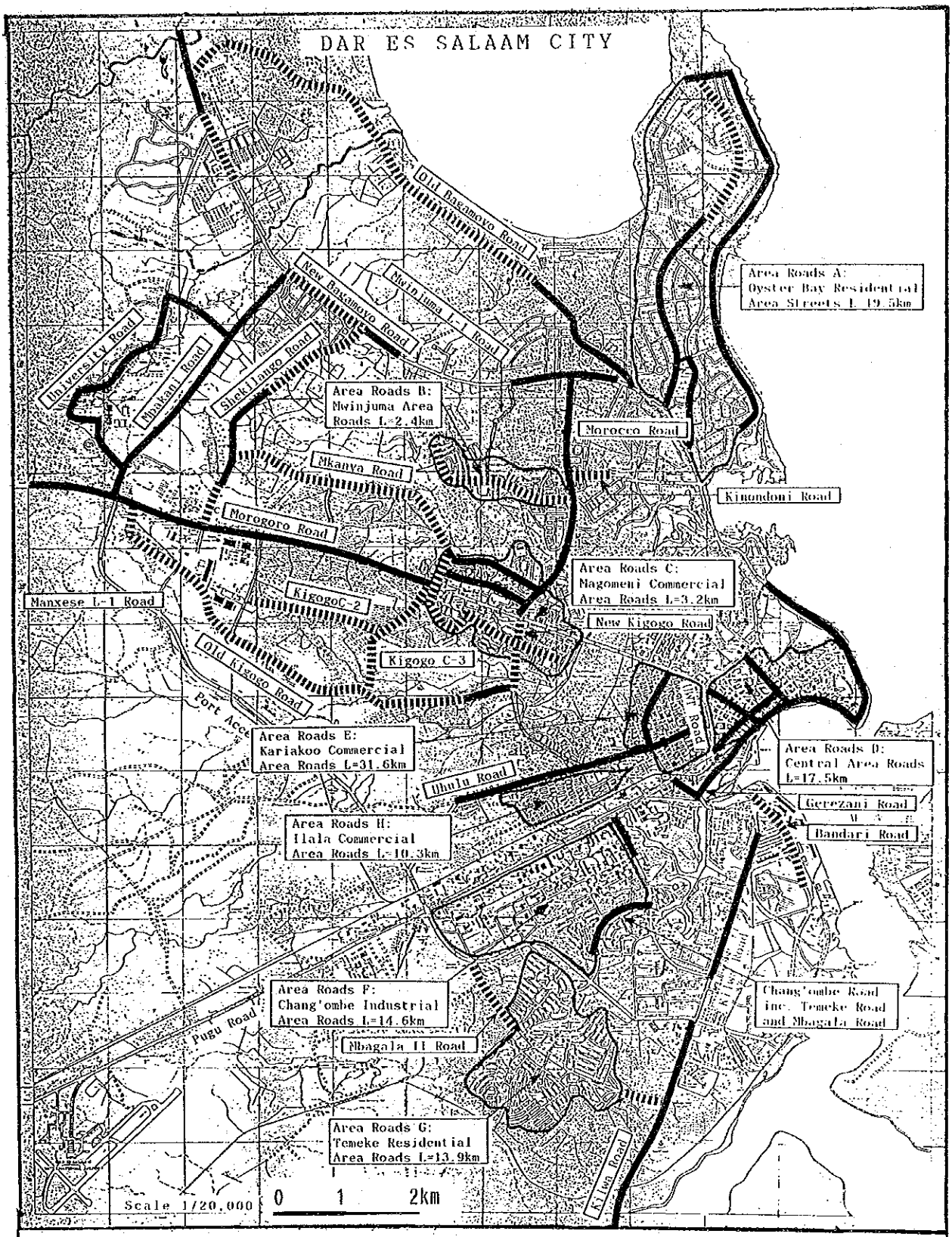


Fig 7.3 Results of PSI Survey on Arterial/ Collector Roads

7.5 Pavement Structural Survey

Pavement structural survey was conducted to identify the existing pavement structures and examine the adequacy of the pavement structures for current and future use.

The survey consists of the following:

- Subsoil Materials Investigations
- Pavement Structures Survey

7.5.1 Sub-soil Survey

The soil of this area can be characterized as beach ridge sand along the roads, sand clay and silt mash along the beach, and swampy clays along the Msinbazi River as shown in Fig. 7.4. Msasani Peninsula has a raised reef composed of limestone soil. The remaining area of Dar es Salaam, is comprised of superficial white buff sand. This type of soil covers 75% of the entire city.

A total of 30 bore holes were done by hand auger on selected points along the roads as shown in Appendix 7-3-1. The Laboratory tests done were soil classifcation and CBR tests. Tests were doneat the Central Materials Laboratory of the Ministry of Communications and Works. Test results are shown in Appendix 7-3-2, together with reference data of other projects conducted around the project areas in the past.

On the basis of field investigations and laboratory test results, subsoil materials have been classified into five (5) groups as shown in Table 7.5.

CBR value by road was estimated on the basis of 30 nos. of laboratory test results, AASHTO unified soil classification, and the previous test results conducted in other road projects carried out in the areas, such as Morogogo Road Project in 1985, and Pugu Road Project in 1974. Table 7.6 showes the result based on the estimation of CBR value by road which varies from 8 to 12 %.

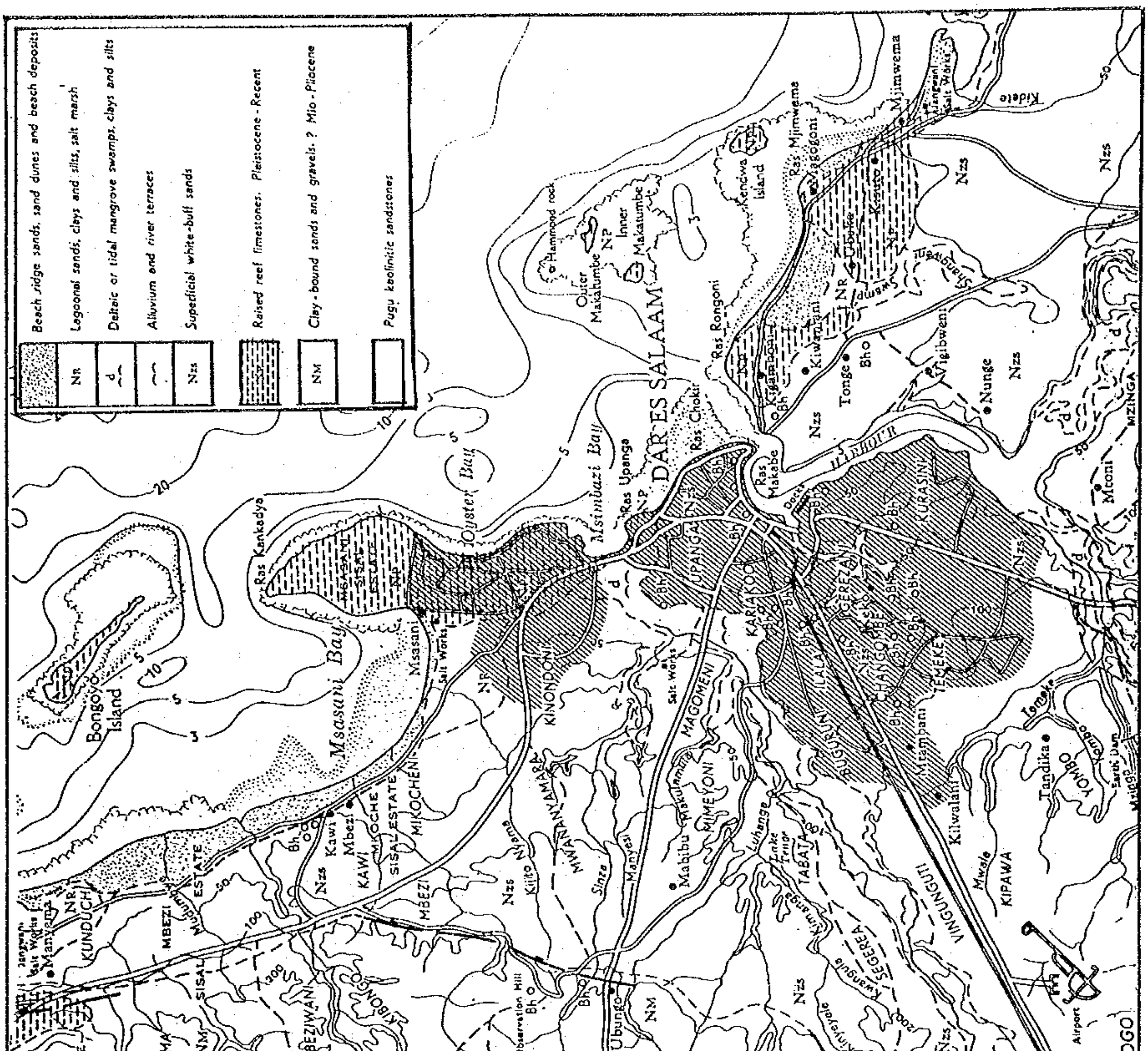


Fig.7.4 Geology of Dar es Salaam Area

Table 7.5 Characteristics of Subsoil Materials

	Soil Group	AASHTO Unified Classificatn	L.L. (%)	MDD (t/c.m)	Estimated CBR (%)
1	Silt clayey sand	A-2-6	26 - 39	1.9 - 2.4	10
2	Clayey silts lime/ plastic clayey sand	A-2-7	38 - 41	1.9 - 2.3	8
3	Calcareous fine sand	A-3	non plastic	1.8 - 1.9	10
4	Gravel sands	A-1-a A-1-b	non plastic	1.8 - 2.3	12 -30
5	Silt clay materilas	A-4	25	2.2	8

Table 7.6 Estimted CBR value by Road

Name of Road	Length (km)	Nos. of Soil Test	Estimated CBR Value
Group 1: Arterial/Collector Roads			
1. Old Bagamoyo Road	8.2	3	8
2. Old Kigogo Road	6.8	2	8
3. Shekilango Road	3.8	3	8
4. Morocco/New Kigogo/	6.2	3	8
5. Kinondoni Street		1	8
6 Morogoro Road up to Ubungo	6.5	1	8
Ubungo - 3km TRM	3.0	1	6
7. Uhuru Road	2.8	1	10
8. Gerezani/Bandari Roads	7.1	2	10
9. Kilwa Road	4.9	2	6
10. Chang'ombe Road	7.9	2	10
Group 2: Area Roads			
A. Oysterbay Residential Area	19.5	2	12
B. Mwinjuma Road	2.4	1	10
C. Magomeni Commercial Area	3.2	2	8
D. Central Area	17.5	1	10
E. Kariakoo Commercial Area	31.6	1	10
F. Chang,'mbe Area	14.6	2	10
G. Temeke Area incl.Mbagalla I	13.9	1	10
H. Ilala Commercial and Residnetial Area	10.3	1	10