

7.5.2 Pavement Structural Survey

A total of 80 points were examined at the left hand side of every route in order to conduct physical measurement and visual inspection of the pavement. Cutting was done at an average interval of 1,500 m at 8 routes with the exception of Old Kigogo Road, and all of the streets in area 9. Inspection points are presented in Appendix 7.3.3.

The roads in the city of Dar es Salaam have two types of surface courses, asphaltic concrete layer and bituminous surface treatment layer, both of which are hot mix type pavements.

Hot mix type asphaltic concrete surface, which is a relatively high cost pavement compared to other types, has been observed in arterial roads, such as Morogoro Road and Uhulu Road. Most of the roads in the city, however, are constructed with low cost pavement, bituminous surface treatment surface. They are further classified into two types, namely single bituminous surface (SBST) and double bituminous surface treatment (DBST).

Pavement structure consists of soil or an aggregate subbase on a subgrade of selected materials, crushed stone base course and bituminous surface. Subbase materials, however, were not distinguishable from the base materials since they are similar and of the same size.

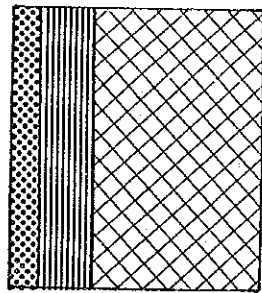
Typical pavement structures constructed on roads in the city are presented in Fig. 7.5. The type of surface and thickness of each layer depends on the classification of road. In the case of Kilwa Road which is designated as an arterial road/trunk road linking Dar es Salaam with Kibiti, the base course materials are comprised of a lime stabilized soil.

Inspection results on pavement thickness are presented in Appendix 7.3.4. On the basis of the measurements taken at the site, an effective depth of pavement by road is estimated for the purpose of overlay design, as shown in Table 7.7.

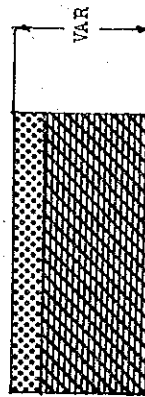
Fig. 7.5 Typical Pavement Structure by Road

Arterial and Collector Roads

Port Access
Length 15.6km

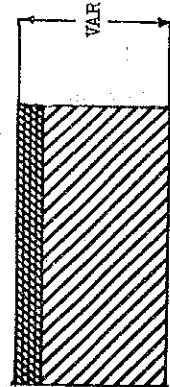


Kilwa Road
7.1km-Boundary DEM
City L. 4.9km

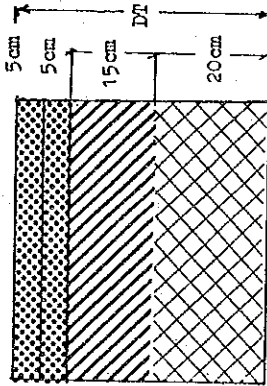


Area Streets

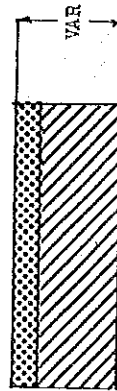
Central Area Street



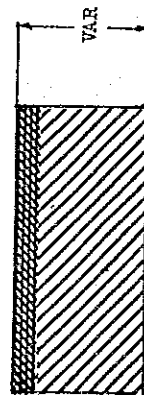
Morogoro Road
(U.W.T J.C-Magomeni J.C)
Length 2.7km



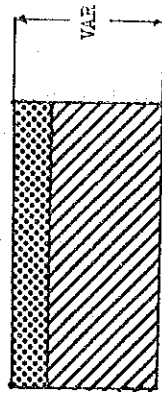
New Kigogo Road
L. 1.6km



Change/once Area Streets



Morogoro Road
(Magomeni J.C - Ubungo J.C)
Length 6.5km



Explanatory Notes.



Hot Asphalt Mix for Binder and Surface Course.



Bituminous Stabilization Base



Lime Stabilization Base



Bitumen Surface Treatment.



Base Course.



Sub Base Course (Crusher-run)

D.T Design thickness.

VAR - Variable Pavement Thickness

Table 7.7 Effective Depth of Pavement

Name of Road	Depth of Sub/Base Courses (cm)	Depth of Surface Course (cm)	Effective Depth of Pavement (cm)
<u>Group 1: Arterial/Collector Roads</u>			
1. Old Bagamoyo Road	12	0	12
2. Old Kigogo Road	0	0	8
3. Shekilango Road	10	0	10
4. Morocco/New Kigogo/	12	3	15
5. Kinondoni Street	10	2	12
6. Morogoro Road up to Ubungo	15	7	22
Ubungo - 3km TRM	10	4	14
7. Uhuru Road	12	4	16
8. Gerezani/Bandari Roads	10	4	14
9. Kilwa Road	10	4	14
10. Chang'ombe Road	12	1.5	13
<u>Group 2: Area Roads</u>			
A. Oysterbay Residential Area			
Laibon and Bongoyo Sts.	11	2.5	13.5
Naile Sallasies St.	12	3.0	15.0
Toure Drive	12	2.5	14.5
B. Mwinjuma Road			
	9	2	11
C. Magomeni Commercial Area			
	10	4	14
D. Central Area			
	20	2.5	22.5
E. Kariakoo Commercial Area			
	10	0	10
F. Chang,'mbe Area			
	20	2	22
G. Temeke Area incl.Mbagalla I			
	20	3.5	23.5
H. Ilala Commercial and Residnetial Area			
	20	2	22.0

7.5.3 Quarry Site Survey

A quarry site survey was conducted at the following quarries to observe the general condition of quarry operations and sites.

- Kunduchi Area Quarries
(M/S Stone and Concrete Products Limited, and MECCO Kunduchi)
- Msolwa Quarry near Chalinze
(MECCO Msolwa)
- Mikese Quarries near Morogoro
(Mikese MOCW quarry, Wade Adam's Maseyu quarry, C.G. Tensen Mikese quarry and Kajima quarry)

The location of each quarry is presented in Appendix 7.3.5 and the following are general observations made by the Study Team:

- Kunduchi Quarry Aggregates;
Most of the aggregates are mixed with a red clay soil during the production process, which may have a negative influence on the construction of pavement during the rainy season. Some aggregates are not suitable for the wearing course materials, so that the adaptability for pavement surface should be checked carefully before use.
The quarry sites are located 20 km north from Dar es Salaam so that transportation cost is likely to be cheaper than that of other quarries.
- Msolwa and Mikese Quarry Aggregates;
These materials have a high specific gravity and a low water absorption value compared to Kunduchi aggregates. Materials are suitable for both pavement base and surface courses. The problem, however, is the long distance between the quarry sites and Dar es Salaam City (150 km to 175 km approx.) which results in higher transportation cost and lower capacity of daily output of pavement construction.

7.6 Identification of Problems and Issues on the Existing Roads

The following are the main problems and issues which have been identified by the Study Team through study and field investigations on the existing roads in Dar es Salaam City.

(1) Pavement Condition of Roads in the City

A PSI survey was conducted on all arterial and collector roads and a section local roads which have been proposed by DCC as priority roads to identify the deterioration level of pavement of each road.

The survey revealed that almost 80 % of roads have deteriorated seriously to the level where overlay or reconstruction measures are required as shown below:

Roads Subject to the Study	Total Length	Road Length Required for		
		Maintenance	Overlay	Reconstruction
Arterial Roads	148.5	52.5	81.3	14.7
Collector Roads	65.5	11.6	22.3	31.6
Local Roads	91.2	0.0	32.3	58.9
Total	305.2 km	64.1 km	135.9 km	105.2 km
	(100.0%)	(21.0%)	(44.5%)	(34.5%)

The above table shows that the pavement on collector and local roads has deteriorated more seriously than that of arterial roads.

The excessive damaged of these roads has been caused mainly because of the following reasons:

- Increase of overloaded heavy vehicles
- Poor maintenance of roadside and storm drainage structures
- Unsuitable materials used in pavement structures
- Inadequate pavement design and construction
- Small maintenence capacity due to shortage of funds and equipment which has accelerated yearly damages on pavement

(2) Situation of Road Congestion

Congestion levels on the existing roads was examined applying the congestion ratio (C.R.) on the basis of road inventory and present traffic volume counted by the Study Team.

The study revealed that the following five (5) roads have very high levels of C.R. over 1.5 which identifies them as being heavily congested throughout the day. These roads urgently require improvement measures through widening from 2 to 4 lanes.

<u>Congested Roads</u>	<u>C.R.</u>	<u>Length</u>	<u>Section</u>
1. Uhuru Road	1.91	0.9 km	From Msinbazi to New Kigogo Rd.
2. Sokoine Road	1.88	0.8 km	Central Area
3. Morogoro Road	1.68	4.8 km	From Morocco to Port Access
4. Bagamoyo Road	1.60	3.0 km	From Upanga to Morocco Road
5. Upanga Road	1.52	1.8 km	Tanganika Mtr. to Selender Br.

(3) Improvement of Intersections

The intersections controlled by roundabouts have become overloaded in the central area due to an increase of traffic in recent years. The following two (2) intersections should be upgraded to signal controlled intersections in order to meet the peak flows:

- Tanganyika Motor Roundabout at Upanga Road
- Junction at Uhulu and Mwinzima Roads

Another three(3) roundabouts in the city center area may also be in need of improvement, however, they must be improved simultaneously along with traffic devices, parking lots and bus bays so as to maximize the effect of investments.

(4) Provision of Bus Bay

Due to the inappropriate location of bus stops and insufficient numbers of bus bays for passengers, main roads often experience serious traffic congestion in the morning and evening peak hours. In order to improve the situation, bus bays with sufficient space should be provided at appropriate locations, particularly on the following roads where daily traffic

volume have exceeded 10,000 per day: (See Fig. 7.6)

- Uhuru Road (Msimbazi Junction - 4 lanes Section)
- Morogoro Road (Morocco Junction - Port Access Junction)
- Morocco Road (New Bagamoyo Junction - Morogoro Junction)
- New Bagamoyo Road (Slender Br. - Mpakani Junction)

(5) Roadside and Storm Drainage Structures

Lack of proper maintenance of roadside drainage is one of the major causes of pavement deterioration. Since pavement durability is greatly affected by water, maintenance of drainage structures is essential for extending pavement life.

Most of the roads located in the urban areas are properly served by lined channel or underground piped drainage systems, with the exception of the roads which have been constructed without development plans. All the entrances of gullies should be cleared of soil and debris by routine maintenance to ensure the discharge of surface water and to minimize troubles for road users.

Many sections of roads had been blocked and damaged by floodings which frequently occurred during this years rainy season. These floodings have been caused mainly by poor drainage maintenance. The programme of renewal and improvement on storm drainage systems is expected to be implemented as soon as possible.

(6) Other Issues

- Road Inventory

The inventories of the city roads are not available in the office of City Council. Since the inventories provide basic information about engineering and traffic characteristics of the city roads, they would be essential reference sources for subsequent engineering and maintenance work.

- Design Criteria

Design criteria for city roads is also not unavailable in the City Council. The basic design features to be applied for

urban roads, such as design speed, axle load limits, width of carriageway and shoulder etc. are essential not only for the design but also for the maintenance of the existing roads.(6)

7.7 Roads Selected for Further Study

The Study Team has selected the roads with a total length of 200 km approx. for further improvement in terms of short, middle and long plans. Selection was made taking into consideration the following factors:

- Pavement deterioration;
A average PSI value of a road less than 2.5 which equals the level at which a road requires improvement by either overlay or reconstruction.
- Road Congestion;
A congestion Ratio of a road more than 1.5 which equals the level at which a road requires improvement by widening.
- Priority Roads Proposed by DCC;
Roads are considered to be important from the view point of social and economic activities.

If any of the above factors apply to a road, it will be identified as one which requires further study.

Based on the above criteria, 116.6 km over 35 arterial and collector roads and 88.7 km over 129 local roads in 8 areas are selected for further study as shown in Table 7.8.

Table 7.8 Roads Selected for Further Study

Name of Roads	Subject Roads Total Length	Priority Roads Proposed by DCC	Pavement Deterio. Ave. PSI less 2.5	Congest. Ratio C.R>1.0	Roads Selected for Further Sdy.
1. Arterial Roads					
1-1 <u>New Bagamoyo</u>	35.0	13.0			23.0
- Up to Wazo H.	(23.0)	-	1.97	1.64**	(23.0)
- Beyond Wazo H.	(13.0)	(13.0)*	1.27	-	-
1-2 <u>Morocco</u>	3.5	3.5	2.03	1.02	3.5
1-3 <u>Kinondoni</u>	1.7	0.7	2.43	-	0.7
1-4 <u>Morogoro</u>	33.0	9.5			9.5
- Up to TRM 4.5km	(9.5)	(9.5)	2.19	1.68**	(9.5)
- Other Section	(23.5)	-	2.38	-	-
1-5 <u>United Nat.</u>	2.0	-	(2.85)	-	-
1-6 <u>UWT</u>	1.9	-	(3.25)	-	-
1-7 <u>Port Access</u>	15.6	-	(3.85)	-	-
1-8 <u>Bandari</u>	2.2	2.2	2.07	1.27	2.2
1-9 <u>Kilwa</u>	15.7	8.6			8.6
- Up to 8.6km	(8.6)	(8.6)	2.19	-	(8.6)
- Beyond 8.6km	7.1	-	2.32	-	-
1-10 <u>Uhuru</u>	5.0	2.8	2.41	1.91**	2.8
1-11 <u>Msimbazi /5</u>	1.6	1.6	2.10	1.30	1.6
1-12 <u>Mpakani</u>	3.9	-	2.06	-	-
1-13 <u>Upanga</u>	1.8	-	(2.80)	1.52**	1.8
1-14 <u>Pugu</u>	17.4	-	(3.64)	-	-
1-15-1 <u>Nkurumah /4</u>	0.3	0.3	1.80	-	0.3
1-15-2 <u>Samora</u>	0.8	-	2.20	1.07	-
1-15-3 <u>Sokoine /4</u>	0.8	0.8	2.45	1.88**	0.8
1-15-4 <u>Gerezani</u>	1.2	1.2	2.00	1.29	1.2
1-15-5 <u>Kivukoni /4</u>	1.0	1.0	2.20	1.20	1.0
1-15-6 <u>Maktaba /4</u>	0.9	0.9	2.00	1.26	0.9
1-15-7 <u>Ohio /4</u>	1.0	1.0	2.34	-	1.0
1-15-8 <u>Ocean /4</u>	3.2	3.2	2.46	-	3.2
Sub-total (1)	148.5km	50.3km			62.1km
2. Collector Roads					
2-1 <u>Old Bagamoyo</u>	8.2	8.2	1.19	-	8.2
2-2 <u>Haile Sall. /1</u>	5.0	5.0	1.50	-	5.0
2-3 <u>Toure Drive /1</u>	5.6	5.6	2.26	-	5.6
2-4 <u>Bongoyo /1</u>	0.8	0.8	2.40	-	0.8
2-5 <u>Shekilango</u>	3.8	3.8	1.50	-	3.8

2-6	<u>Kondo</u> /3	1.2	1.2	2.20	-	1.2
2-7	<u>Mwinjuma</u> /2	2.4	2.4	1.14	-	2.4
2-8	<u>Makanya</u>	5.0	5.0*	0.57	-	5.0
2-9	<u>University</u>	3.8	-	2.07	-	-
2-10	<u>Kigogo C-1</u>	1.3	2.0*	2.47	-	2.0
2-11	<u>Kigogo C-2</u>	1.8	-	0.00	-	-
2-12	<u>Kigogo C-3</u>	1.9	-	0.00	-	-
2-13	<u>Old Kogogo</u>	6.8	6.8	0.38	-	6.8
2-14	<u>Kagera</u> /3	2.0	2.0	1.60	-	2.0
2-15	<u>Mikumi</u>	1.1	1.1*	1.25	-	1.1
2-16	<u>New Kigogo</u>	2.7	2.7	2.16	1.13	2.7
2-17	<u>Chango'mbe</u>	4.6	4.6	(2.68)	1.21	4.6
2-18	<u>Temeke</u>	1.9	1.9	(2.65)	-	1.9
2-19	<u>Mbagala I</u>	1.4	1.4	1.07	-	1.4
2-20	<u>Mbagala II</u>	2.2	-	2.35	-	-
2-21	<u>Mahunda</u>	2.0	-	1.30	-	-
	Sub-total (2)	65.5km	54.5km			54.5km
3. Local Roads (Area Roads Proposed by DCC)						
A.	<u>Oyster Bay Area</u>	8.1	8.1	1.5-2.5	-	8.1
B.	<u>Mwunijuma Area</u>	-	-	-	-	-
C.	<u>Magomeni Area</u>	-	-	-	-	-
D.	<u>Central Area</u> /4	10.3	10.3	1.5-2.5	1.0-1.5	10.3
E.	<u>Kariakoo Area</u> /5	30.0	30.0	0.0-1.5	-	30.0
F.	<u>Chango'mbe Area</u>	14.6	14.6	0.0-1.5	-	14.6
G.	<u>Temeke Area</u>	13.9	13.9	1.5-2.5	-	13.9
H.	<u>Ilala Area</u>	10.3	10.3	0.0-1.5	-	10.3
I.	<u>Other Important Rds.</u>					
-	<u>Shaurimoyo</u>	1.0	1.0*	0.0-1.5	-	-
-	<u>Manxese L-1</u>	1.5	1.5*	0.0-1.5	-	-
-	<u>Mwinjuma L-1</u>	1.5	1.5*	0.0-1.5	-	1.5
	Sub-total (3)	91.2km	91.2km			88.7km
	Total	<u>305.2km</u>	<u>196.0km</u>			<u>205.3km</u>

Note:

- (1) The roads with /1 to /5 are located in the areas proposed by DCC as follows:
/1; Oyster Bay Area, /2; Mwinjuma Area, /3; Magomeni Area /4; Central Area, /5; Kariakoo Area
- (2) Roads with * are additionally proposed by DCC.
- (3) Roads with ** requires improvement by widening to 4-lane.
- (4) Roads with underline are selected by the Study Team for further study with a total length of 200 km approx.



Fig.7.6 Proposed Location of Bus Bays

CHAPTER 8 EXISTING ROAD MAINTENANCE AND OPERATION SYSTEM

8.1 Present Road Maintenance Conditions

The road network of Dar es Salaam City consists of 1,150km in total, of which 450 km are asphalt roads and 700 km are gravel and earth roads. Presently, most of these roads have deteriorated to the extent that normal routine maintenance is no longer cost effective.

The excessive damage of Dar es Salaam City roads has been caused due to the following principal factors.

- (1) Long time lack of proper and timely maintenance.
- (2) Inadequacy of funds available each year for roads maintenance, rehabilitation and reconstruction.
- (3) Lack of equipment and plants for road maintenance and construction.
- (4) Higher rate of city growth in all aspects as compared to the ability of the City Authority to provide the required infrastructure.

It may be said that trunk roads are generally fair in road maintenance except the city center sites which are rather idle in maintenance. Surface of the asphalt pavement streets are deteriorated to a gravel one and not flat for a long distance, of which pavement crossfalls are mostly worn out lowering carriage way surface than that of the shoulders.

Defects of the asphalt pavement, neglect of the surface drainage, clogging of drain pipes and undredging ditches and unhauling the sand heaped on the streets are seen in many places in the centre area of DSM.

Outside of the city center in urban, called suburban, there are Districts, Divisions and Wards including Temeke, Chang'ombe, Ilala, Magomeni, Kinondoni, Kariakoo and Kusunu, etc. which show good arrangement of the streets and houses,

however, the maintenance of their streets have long been neglected.

On general streets, there are fair conditions in road maintenance with side drains protected by concrete plates or masonry walls but pavement edges are damaged in many places which are due to lack of curb stone or pavement stopper along them. Many potholes are seen on the street surface.

8.2 Present Maintenance System

8.2.1 Road Maintenance Programme

As to the road maintenance in DSM City, the Trunk Road Maintenance Unit (TRM) of the Ministry of Communications and Works is carrying out the maintenance of the trunk road, out of which the city center sections are maintained by Dar es Salaam City Council (DCC).

According to the DCC Integrated Programme, 1988/89-1992/93, about 89 km of asphaltting, 131 km of graveling, and 80 km of rehabilitation were intended to be done by the City Council, however, the first year programme had not been done, which are due to inadequacy of funds available for road maintenance and rehabilitation.

In accordance with the maintenance results of TRM, routine works of grass cutting, drainage cleaning and repairing of the signal pole have been carried out but the periodical work as improving and repairing were deferred until when equipment and spare parts be procured to be used.

Referring to the actual road maintenance length conducted in the past five years, regarding which New Kigogo road, 2 km long, has been constructed in Magomeni area by DCC and improvement of the Morogoro road and construction of Selender bridge have been done by a financial assistance of the Japanese Government.

Future road maintenance programme, which was worked out in the DSM City Council Integrated Programme (1988-93), however, seems likely difficult to carry out successfully, under existing condition.

Daily production of road maintenance work per meter by unit, which are very small because of the lack of resources of budget, materials, and manpower to be available. According to a recent TRM monthly record, about 90,000 m² of vegetation control, 22,000 m² of road cleaning and 4,500 m² of curb cleaning have been carried out in a month under its routine maintenance works, employing a total of 120 labourers.

8.2.2 Budgetary Allocation and Expenditure

The maintenance expenditure of DCC was not much comparing to the total recurrent expenditure. The ratio is as shown in Table 8.1.

Table 8.1 Road Maintenance Expenditure for 5 years

	(Unit: Thousand Tsh)				
	<u>1983/84</u>	<u>1984/85</u>	<u>1985/86</u>	<u>1986/87</u>	<u>1987/88</u>
Salaries	(18,427)	2,064	10,544	14,953	12,769
Equipment	1,010	1,012	6,899	9,259	5,457
Material	1,780	3,338	12,609	13,609	13,122
Administ	1,962	381	6,265	4,168	1,852
Total	(23,179)	6,795	36,317	42,341	33,198
Total Recurrent Expenditure, DCC Maintenance/		357,923	335,722	437,614	501,635
Total, Reccur. Ex.		1.8%	10.8%	9.6%	6.6%

Note: The figures in () is for the whole Engineering Dept.
Separate data for road is not available in 1983/84.

8.2.3 Organization of Maintenance Office

The road maintenance activity has been carried out by the Road Section of the Engineering Department of the City Council. The Road Section has two divisions which are Road Maintenance Division and the Road Design, Planning and Construction Division which are shown in Fig. 8.1, and has four maintenance depots in the districts of the city, as the field activity offices, on the other hand as a repair shop of the equipments, vehicles and plants.

There is the DCC Main Depot which has to practice the maintenance/repairing of all equipment/vehicles from other sections as Building, Fire Control, Electrical and other sections of all Department of DCC, because the Main Depot is belong to the Mechanical Work Shop Section of the Engineering Department of DCC.

8.2.4 Jurisdiction of Each Maintenance Units

The four maintenance depots are located in respective districts in DSM as the field maintenance offices of the Road Section. Each depot, however, is very small in scale and have no adequate equipment/vehicles for the maintenance of the long distance roads of more than 600 km of urban and 500 km of suburbarn road in DSM.

The space of DCC Main Depot along the Pugu road at Chang'ombe has been occupied with a lot of vehicle scraps and irreparable equipment/plants, so there is no space even to clean the vehicle for inspection and furthermore, the facilities are seen to be uneffective in their arrangement.

At present, the main work of the Depot is to supply fuel to the vehicles from other DCC sections, whereas new idea for the construction of a work-shop shall be worked out for an increasing equipment/vehicles to be maintained.

CITY COUNCIL OF DAR ES SALAAM

ORGANIZATION CHART OF THE
ENGINEERING DEPARTMENT

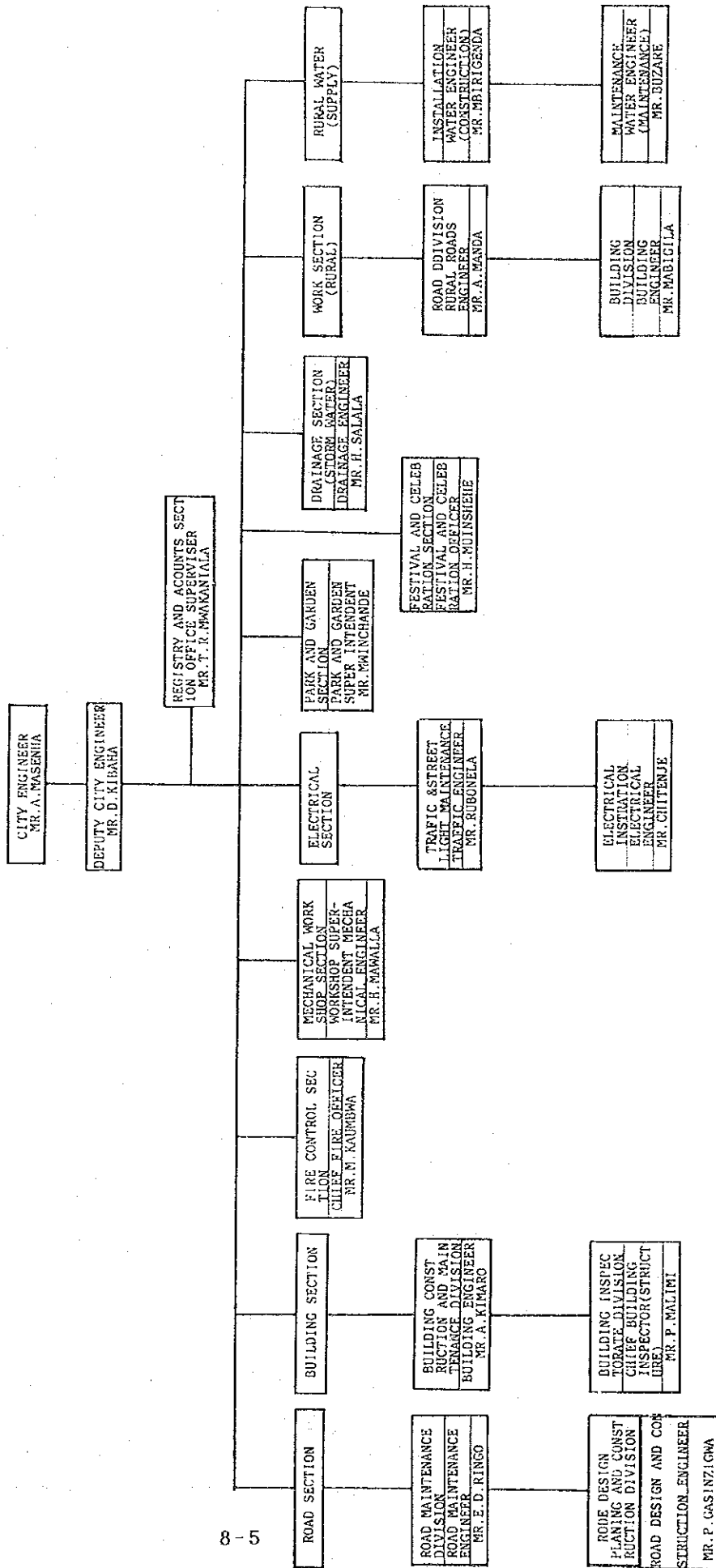


Fig. 8.1 : Organization Chart of Engineering Department of DCC

There are Pugu road, Port access road Maintenance Unit of which organization chart are shown in Fig. 8.2 and TRM Coast Region under the Ministry of Communications and Works for the maintenance of the trunk roads, and they have been well equipped, so the maintenance of the trunk roads are rather good but Kilwa road.

8.3 Present Road Maintenance Operation

8.3.1 Maintenance Activity

There are following categories in the road maintenance works:

Routine maintenance: required continuously on every roads as grass cutting, drain clearing, recutting ditches, culvert maintenance, road sign maintenance.

Periodic maintenance: regravelling, repairing rut dragging, grading, potholes, patching, repairing edges, sealing cracks, surface dressing.

Instead of the works of drainage, sand hauling, filling potholes and restoring scoured surface, routine maintenance works have been carried out on the major roads.

8.3.2 Workmanship of Maintenance Activities

Maintenance activities are carrying out inadequate method, the results of the works seems likely unfair, though the works being carried out by a local contractor are rather good. The local contractors will be fully available for the road maintenance works.

According to the inventory studies over the Main Depot, almost all equipment/vehicles have long been out of work, and there seems no possibility of repairing them because of lack of spare parts, materials and mostly have become scrap.

8.3.3 Availability of Materials

Because materials required for construction are mostly imported from abroad, the Government of Tanzania allows to supply fuels/lubrication comparatively fairly in DSM, but other materials as machinery, spare parts for equipment are rather restricted.

Cement; which is being manufactured with 1,250,000 tons of yearly productive capacity, and a production of 356,000 tons (1985), 473,000 tons (1986), are reported respectively (JETRO) and there is Tanzania Portland Cement Factory Co., Ltd at Wazo Hill about 23 km north of DSM.

Asphalt; which is imported from abroad and an oil refinery plant (Italy) is to be opened next year, so local asphalt will be available for the use of road maintenance and asphalt mix is manufactured at the plant of Mwananchi Engineering & Construction Co., Ltd in DSM.

Gravelling material, limestone; which is obtained from Kunduch Beach about 22 km north of DSM.

Aggregate; which is obtained from Morogoro area, about 140km north of DSM.

8.3.4 Capacity of Local Contractors

The construction contractors in Tanzania are requested to be registered to the Ministry as an approved contractor. There are about 36 companies as class one, which is for the projects exceeding Tsh 120,000,000/ for only one project.

These contractors will be fully available for the road maintenance works.

8.4 Present Workshop and Equipment.

This survey was conducted to examine the adequacy of road maintenance equipment and workshop and to identify the existing problems on the equipment and workshop.

8.4.1 Workshop Organization/Facilities

(1) Main Depot.

Main depot is situated along Pugu road within the Dar es Salaam City centre (See Appendix 8-1-1). The function of this depot is to maintain all the equipment and vehicles belong to the Engineering Department and other Department of DCC.

a) Building

The present buildings of the main depot were built 40 years ago by the British Government and its layout is shown in Appendix 8-2-1.

b) Organization chart of the main depot

The main depot consists of the following sections as heavy duty vehicle, tractor and earth moving equipment, premix plant, land rover, light duty vehicle, tyre shop, motor-cycle, health Mwananyamala, fire, engine room, machine shop, service, auto-electric, welding, panel beating/spray painting and office machines section as shown in Fig. 8.3, Table 8.2 and Appendix 8-1-3.

Heavy duty vehicle section is intended for repairing lorries above 3 tons. Tractor and earth moving equipment section is intended for repair construction equipment such as bulldozer, wheel loader, road roller and power train. Pre-mix plant section is intended for repairing asphalt mixture, mixabatch.

Table 8.2 Facilities of the Main Depot

<u>No.</u>	<u>Name of Block</u>	<u>Sq.m</u>	<u>Description</u>
1.	Administ. Block	175	1. Record & switch board room 2. Depot Superintendent room 3. Engineers room 4. Transport Officer room 5. Administ. Officers room
2.	Gate house	7	1. Watchman
3.	Elect. Dispensary	825	1.
4.	Heavy duty work shop and motor cycle	480	1. Tyre gage, Auto Electric, Motor cycle shop 2. Like scrap workshop
5.	Store & greasing.	300	1. Keeping some material and spareparts
6.	Land rover garage	700	1. Keeping scrap land rover.
7.	Heavy plant workshop	450	1. Crowded with scraps
8.	Petrol, Diesel Tank Stand	75	1. Petrol super 13000 lts Regular 4500 lts
9.	Panel beating spray painting weldingshop	150	1. Ark welding set 1 Gas welding set 1

The workshop is headed by the Depot Superintendent, under him there is an assistant executive engineer (mechanical) and the two are overseeing 16 sections.

c) Present facilities and tools at main depot

There are very few facilities in the main depot and shortage of workshop tools as shown in Appendix 8-2-5. For example, the depot does not have enough box sets for each section and special tool such as hydraulic press for final drive system, help puller front hub and rear hub.

(4) Arrangement of Facility

The fuel stands are poorly arranged (see Appendix 8-2-1). The arrangement is causing a queue during fuelling of vehicle and equipment.

Table 8.3 List of present facilities in main depot

<u>No</u>	<u>Name of Facilities</u>	<u>Total No.</u>	<u>Location</u>	<u>Working</u>	<u>Not Working</u>	<u>Remark</u>
1	Air compressor	4	Tyre shop	1		
			Heavy duty			
			Workshop	1	1	/1
			Preyshop	1		
2	Fuel Stand	3				
	- Diesel 13000		Main depot	1	-	/1
	- Sup. Gas. 13000		ditto	1	-	/1
	- Regular 4500		ditto	1	-	/1
3	Centre Lather Machine	1	Engine shop	1	-	/1

Note /1: The facilities require repair.

(2) Road maintenance division and its relationship with the main Depot

The relationship between main depot and site depot is that all the operators and mechanics are dispatched from the main depot to site depots.

a) Site depot (see Appendix 8-2-4)

There are four construction site depots namely, Ilala garden, Kisutu, Kigogo road and Temek. These depots are directly under the road maintenance engineer.

-Ilala garden depot: The depot is located along Uhuru road some 4km from main depot. The depot consists of one tool store, two good-win batch mix machine and manual tools such as shovels, forks and hoes. There are three mechanics who are supposed to undertake minor repairs of machines on site. The operators and mechanics are under the main depot.

-Kisutu depot: The depot is located at the junction of Ally Khan and Olimpia Street some 6 km from main depot. The depot consists of administration block and a few manual tools like shovels fork and hoes.

All the manpower allocated to that depot with an exception of a few clerks and watchman are engaged in road maintenance works. They are supposed to collect the pre-mix asphalt from the Ilala garden depot.

Temeke depot: The depot is located along Temeke road, some 8 km from the main depot. The depot consists of one administration block and a handful of manual tools. All the manpower except a few watchman are engaged in road maintenance work in Temeke district. They are supposed to collect their pre-mix asphalt from Ilala garden depot

Kigogo depot: The depot is situated along Kigogo road, some 10 km from main depot. The depot consists of one administration office and few manual tools. All the staff allocated to this depot with an exception of a few clerks and watchman are engaged in road maintenance works in Kinondoni district. They are supposed to receive their supplies of asphalt from Ilala garden depot.

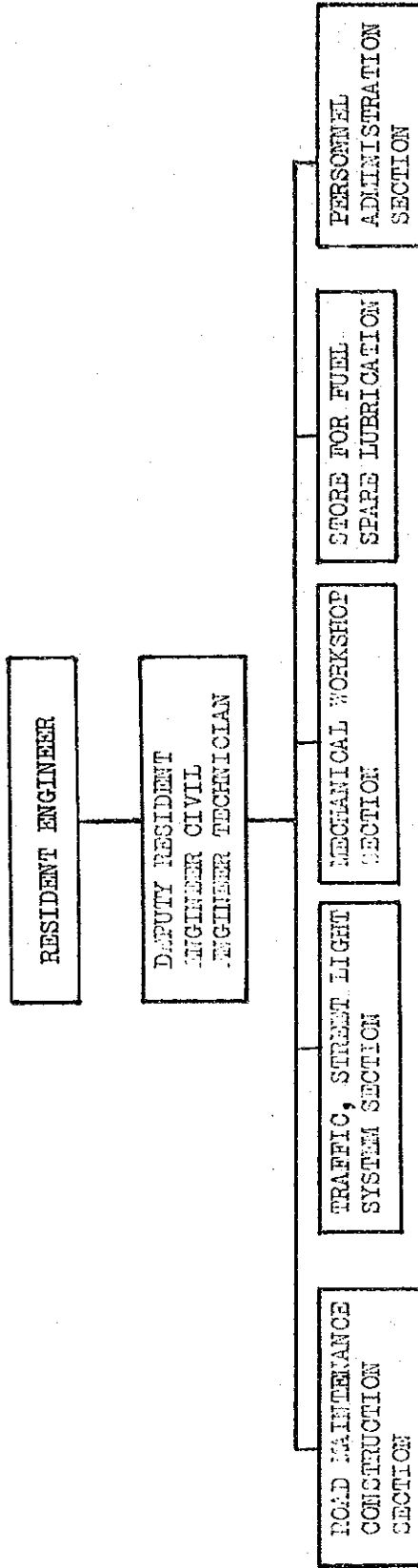
(3) The Port Access/Pugu road Maintenance Unit

This depot is situated along the Pugu road. The function of this depot is to undertake repair of the maintenance equipment to be used for Pugu and Port Access road, including repair of light system such as bulbs and poles.

They operate a small garage for minor repair on equipment and vehicle for the Ministry of Communications and Works. The unit does not have enough workshop equipment and sufficient manpower.

There is no direct relation between this depot (Maintenance Unit) and the main depot of DCC. Fig. 8.2 shows the organization chart of Port Access/Pugu Road Depot.

Fig. 8.2 Organization Chart of Port Access/Pugu Road Depots



CIVIL ENGINEER	1	WORKSHOP	1	SUPPLIES OFFICER	1	OFFICE SUPERVISOR	1
SENIOR CONSTRUCTION FOR MAN	1	ELECTRICAL FOREMAN	1	MECHANICS	4	STORE ATTENDANT	1
TECHNICIAN, ROAD CONSTRUCTION	1	TECHNICIAN ELECTR. ELECTR. LABOURS	6	AUTO ELECTRIC	2	FUEL LUBRICA:	1
HEADMAN	2		4				
SKILLED LABOURERS	40						
UN SKILLED LABOURERS	60						
DRIVERS	5						
OPERATORS	2						
TOTAL	112		11		7		3
							14

8.4.2 Staff organization.

(1) Number of mechanics and operators in main depot

There are four mechanics who are fully engaged in repairing road maintenance equipment, locating in the pre-mix section.

There are fifteen mechanics in tractor and earth moving equipment section and twenty mechanics in the heavy section. They are repairing road maintenance equipment and other general repair.

Two operators are for batch mixer, two for steel rollers, three for motor graders and two for wheel loader. These makes a total of 9 operators. There are fourteen drivers for Isuzu tipper.

(2) Technical level in main depot

a) Mechanic

Level of mechanic is not sufficient, for example, they does not know "How to properly fix propeller shafts" and How to properly fix construction tyre for wheel loader and wheel tyre tractor.

The number of qualified mechanics is very few in the organization. There are no technicians of grade I, II and III. There are only 14 technicians with grade IV. The rests are just assistant technicians and apprentices.

b) Operators

They do not know:

- how to carry out inspection before and after work
- daily check
- how to loading tipper

For example, KOMATSU wheel loader loading up to 11 ton dump truck, cycle time is 8 min. This is very low level.

c) Employment and training

There are two categories of mechanics and operators, category one are those, whose salary scale is below MS.3 (i.e less than Tsh 3,065/ per month, and category two are those who are above MS2 (i.e more than Tsh 3,065/ per month).

For employment of mechanics and operators in category two, permission from the local government service commission should be sought. This commission is responsible for staffing and training of skilled manpower in all the councils in Tanzania.

Most operators and mechanics in main depot are below MS. 3 scale, and the employment of this category staff does not require any permission from the local government service commission.

Training of mechanics and operators whose scales are below MS3 is supposed to be arranged by DCC through the training officer. Presently there is no clear and defined training system for mechanics and operators.

8.4.3 Spare Parts/Storage System

The spare parts supply and storage are under the city store officer in the city finance department. (see Fig. 8.3)

When an equipment is damaged and spare part is needed for replacement, the depot superintendent will write a requisition for spares to the city store officer.

8.4.4 Equipment for Road Maintenance.

a) Number of equipment

Road maintenance in DCC has 24 construction equipment units, one steel roller is working but other equipment do not work, and only 14 tippers are working. This shows great shortage of equipment.

Shortage of funds have always hindered DCC' desire to replace old equipment, most of which are beyond their economic lives.

b) Type of equipment

Road maintenance division of DCC have kinds of equipment, these are loading, dig and excavator, road maintenance plant and tipper. About 50% of tippers are out of order, and 95% of the four other kinds of construction equipment are out of order.

c) Suitability of road maintenance equipment

Equipment owned by DCC are generally unsuitable for road maintenance, and some necessary small equipments such as plate compacter, small heater and water tank truck are not there. The list and conditions of these equipment are presented in Appendix 8-2-2 and Appendix 8-2-3.

8.5 Identification of Existing Problems

The following are existing problems and issues identified by the Study Team from the survey on the road maintenance and operation.

a) Organization of Main Depot

Main depot has two controlling personnel, namely Depot Superintendent and Assistant executive engineer. It may be difficult for them to control all the sections (16 sections) of Main Depot. (Refer to Appendix 8-1-3)

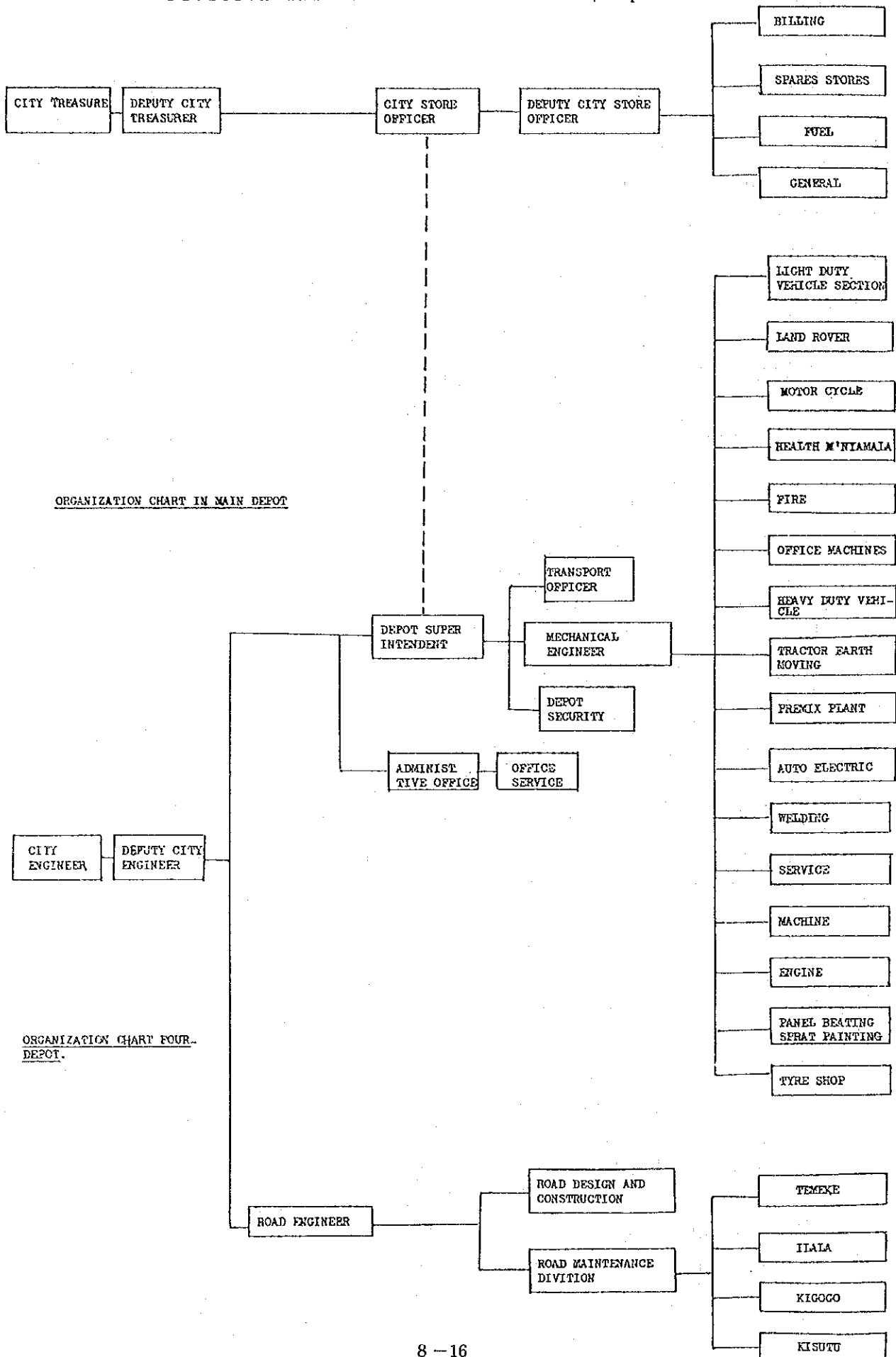
Lack of mechanical and electrical inspectors is also problem for maintenance of equipment.

b) Relationship between main depot and site depot

No direct relationship between site depots and the main depot is existing.

The only relationship is that so long as all the mechanics and operators are under control of the main depot, they

Fig. 8.3 Organization Chart of Road Maintenance Division and its Related Division/Department



are time to time dispatched to road maintenance division to carry out some jobs whenever required.

c) Instruction System

Depot superintendent gives instructions directly to section foreman. In this case it seems that there is no need of having a mechanical engineer, this is wrong.

Generally instruction system at the main depot is very poor and disorganized. For example, presently, equipment coming for maintenance are never inspected before and after maintenance. Job orders and job cards are never technically prepared and therefore very incomprehensive.

d) Position of manpower

DCC have many staffs in its mechanical, maintenance section but most of them are unskilled. The section is staffed by very junior mechanics and operators.

e) Facilities of working for road maintenance

There is one depot for each district, but they do not have workshop and they only keep manual hand tools. The four depots will have to be re-established, and maintained in close proximity to the main depot to have a minor repair on equipment.

f) Regular maintenance system

DCC main depot is yet to establish regular maintenance system and also the main depot will have to establish maintenance control system such as:

- Numbering system for new equipment.
- Registration system for new equipment.
- Maintenance schedule for all equipment.
- Emergency system for accident and urgent situation.

g) Equipment operation system

Technical level of mechanics in the maintenance section is very poor and there is a great shortage of skilled mechanics and operators.

There are three kinds of manuals, such as operation manual, workshop or repair manual and maintenance or operation manual. But the Depot should keep these manuals in their respective section and the workshop does not have any manual as well as parts catalog.

h) Recommendation

Through this investigation and analysis, a lot of unbalance for the type and numbers of the equipment, vehicles, machines, and facilities including manpower for the present road maintenance works have been observed.

For an exclusive use for the road maintenance, a new main depot should be established urgently. Procurement of machine, equipment and vehicles for the road maintenance works and assignment of manpower will also be planned in relation with the forthcoming maintenance and construction works.

The new main depot will be supported with technical guidances of the contractor who will construct the main depot together with urgent maintenance works such as filling of all potholes and resealing surfaces on the existing roads.

CHAPTER 9 IMPROVEMENT OF ROAD MAINTENANCE SYSTEM

9.1 General

While the DCC has made every effort to improve/repair the deteriorated roads, restoration to the initial road condition appears difficult. As a result of the study in Dar es Salaam, it is recommended by the Study Team that the road maintenance system should be revised, including the construction of a new main depot to increase the road maintenance capacity.

The construction of a road maintenance depot and the provision of maintenance equipment, technical assistance, training program and preliminary cost estimation were worked out from the short and medium/long-term viewpoints.

Bitumen patching for pot-holes and routine maintenance work were analysed as the most necessary maintenance categories, based on which the necessary equipment, materials and staff were known.

Throughout the analysis, it was assumed that the maintenance efforts provided during the activity period would be the "normal" necessary to preserve the roads in their initial conditions.

9.2 Maintenance Methodology and Procedure

9.2.1 Definition of Maintenance Activities

In consideration of the defective conditions of the DCC's roads, the activities to be covered under routine, periodic and urgent maintenance are as follows.

Routine Maintenance: Required continuously on every road as road furniture installation, bush cleaning, ditch cleaning, gravel patching, dragging, pot-hole patching and grading.

Periodic Maintenance: Regravelling, repairing rut dragging, repairing edges, resealing cracks, surface dressing.

Urgent Maintenance: Needed to deal with emergencies and problems calling for immediate action when a road is blocked.

The first step is to define individual activities that can be measured and related separately to resource requirements on a consistent basis. Several activities were analysed under the designated routine maintenance for the short term plan (1990-1994). This provided the basic framework for the development of the programme.

From the medium (1995-1999), long term (2000 after) plan, periodic maintenance will be undertaken step by step in accordance with the establishment of New Maintenance System in DCC.

9.2.2 Standards (Level of Maintenance)

For each maintenance activity, standards were developed to estimate the amount of each kind of work required during the each stage. Assumptions were made regarding frequency and cycles utilized for the planning and programming of various activities. The standards were expressed in terms of annual number of unit of work.

The following are some examples of standards that were developed on the basis of past experience.

a) Experience shows that average effective life of a bitumen sealed road with ADT of 1000 or more is 4 years.

b) Past experience indicated that 150 liters of bitumen spraying is required every day for patching 30 m² of bitumen surface. Consequently a realistic standard would be 5 liters per sq.m of bitumen surface. (details are shown in Appendix 3.1)

9.2.3 Programming

Dar es Salaam City is served by 1,146km of the existing road network system consisting of a hierarchy of arterial, collector and local roads. It consists of 451km of paved roads and 595km of unpaved roads, a total of 1,146km.

The length of road network to be improved/repaired under this project will be estimated about some 100km in short term period, whereas the length of the roads subject to the maintenance system is estimated at about 350km of paved roads.

The amount to be performed under this programming is as follows.

In accordance with the result of maintenance inventory survey, the average PSI value of the arterial roads allow us to develop a required maintenance ratio of 1.0% area for the total road area of 350km long for the short term plan.

<u>Classification</u>	<u>Length</u>	<u>Paved area</u>
Arterial Road	149.5km	1,458.120 sq.m
Collector Road	56.5km	373.978 sq.m
Local Road	145.0km	923.614 sq.m
<u>Total</u>	<u>350.0km</u>	<u>2,775.712 sq.m</u>

The above figures are taken or induced from the results of the inventory surveys.

A total area to be performed maintenance is estimated at 27,550sq.m (2,755.712sq.m x 0.01)

Requirement units are based on an average output of 30 m² /day, 6 hours work /day, 200 days work /year are estimated respectively with the assumption of 3 years term.

$$27,550 / (@30 \times 200 \times 3) = 1.5 \text{ (units)}$$

Therefore, it is proposed that there will be 2 units for carrying out bitumen patching (for pot holes) in short term period.

9.2.4 Proposed Maintenance Activities

As the results of the investigation of the existing road maintenance system and analysis of the problems relating to the roads, it is suggested that following plans are to be carried out under the project .

a) Urgent Pavement Repair of the major roads from a viewpoint of minimum social requirement in Dar es Salaam.

b) To establish a Road Maintenance System including a new road maintenance depot which will be under the jurisdiction of the Road Section of the Engineering Department of DCC.

c) To define the policy for implementation of maintenance programme and monitoring system in a new Road Maintenance Division of the Road Section of the Engineering Department of DCC.

d) To establish a new workshop in a new road maintenance depot.

e) As to urgent pavement repair, the DCC's road maintenance potential seems to be low to carry out it by force account at this moment, accordingly the work will be carried out by a contractor. While the work it will become a responsibility of the contractor to training some DCC' technicians so that the works will be performed by the force account with the provision of enough equipment and skill staffs.

Contents of the urgent pavement repair will be given precisely in Chapter 10.

The remaining b),c) and d) are described as follows.

Regarding to define the policy for implementation, generally it will be necessary to define the future course of the organization and it will be reflected to the scope of works and budgetary consideration.

The road maintenance activities through all the DCC roads in DSM will be carried out under this road maintenance system and implementation of maintenance/repair and procurement of materials, staff and both technical, administrative training as well as monitoring will be performed under the system.

In addition the existing workshop in the Main Depot seemed to be inadequate to carry out road maintenance works satisfactorily, whereas a new main depot is expected to be built with workshop function.

9.3 Requirement for Bitumen Patching Maintenance

In order to repair the pot-holes urgently on the road, an urgent pavement repair will be carried out by a contract work for short period.

After establishing the new maintenance depot with adequate equipment/vehicles for the use of road maintenance, subsequently the bitumen patching on the roads in DSM will be carried out by the maintenance fleet.

Disintegration of bitumenous pavement is the breaking up of a pavement into small, loose fragments. This includes the dislodging of aggregate partials. Pavement repair is made by cutting out to solid material on both sides and bottom and filling it with new base and surface material.

In accordance with the afore-mentioned paragraph 9.2 Methodology and Procedures, there would be required 2 units of maintenance groups. Required maintenance sources as equipment, material and man-power are estimated as follows on the basis of an average output of 30 m2 per day, of which calculations are mentioned in Appendix 9.2.

Summary of Requirement

<u>Description</u>	<u>No.</u>
(a) <u>Machinery</u>	
Tipper Truck (7tons)	3
LWB Truck (7tons)	1
Vib. Roller (2tons)	2
Bitumen Sprayer	2
Compressor (3.0cu.m)	1
As.cutter	2
Supervisory Vehicle (Pick-up)	2
Motor Cycle	2
Walk Talkies	4
Two-way Radio	2
(b) <u>Material</u>	
Chippings	600 cu.m
Bitumen	60,000 liters
Diesel	64,000 -do-
Oil/lubrication	1,000 -do-
Other miscellaneous	Is
(c) <u>Staffs</u>	
Inspector	1
Foreman	2
Drivers/Operators	8
Helpers	8
Labourers	10

9.4 Requirement of Routine Maintenance

Activities to be covered under routine maintenance include:

- a) Road Furniture Installation includes installation of direction post, sign and road markers, etc.
- b) Bush cleaning is carried out within the road reserve in order to improve visibility and increase the warning time when encountering traffic.
- c) Ditch Cleaning is done manually and involves excavation back to original invert level of ditches which have become silted up during rain. This work is usually carried out in conjunction with culvert cleaning.
- d) Culvert Cleaning involves the removal of soil deposited in culverts.
- e) Gravel Patching involves the replacement of gravel in worn and eroded area of surface and shoulder of gravel and earth roads.
- f) Dragging is carried out in dry seasons and involves the periodic dragging of gravel and earth roads with branches of trees between gradings to delay the development of corrugations, ruts and potholes.
- g) Grading Grading is the most expensive routine maintenance activity. Light grading is carried out when the road surface is dry and preferably, heavy grading is done after rain. In determining the frequency of grading, taking into account traffic and surface type, grading will be two times a year.

In parallel with the operation of grader, load roller will take part in the compaction work. A roller operation will not be neglected so as to maintain the earth or gravel roads stable flat and to avoid being scoring with track

wheels passing on.

In dry season, water tanker will be used for spraying water on the roads being improving with grader and rollers for the purpose of earth consolidation.

The computational procedures for providing requirement equipment and vehicles are given in Appendix 9-3 respectively and following are the summary of requirement for routine maintenance work.

Summary of Requirement

<u>Description</u>	<u>No.</u>
(a) <u>Machinery</u>	
Tipper Truck (7tons)	1
LWB Truck (7tons)	1
Water Tanker (6K.l)	2
Supervisory Vehicle (pickup)	2
Motor Grader (2.8m)	1
Excavator (0.4cu.m)	1
Dumpers (2tons)	2
(b) <u>Material</u>	
Diesel	61,000 liters
Gasoline	18,000 -do-
Other miscellaneous	ls
(c) <u>Staffs</u>	
Inspector	1
Foreman	1
Drivers/Operators	9
Helpers	9
Laboures	16

9.5 Proposed Organization of Road Maintenance System

9.5.1 Establishment of Road Maintenance Unit

Proposed new road maintenance system expecting properly maintained city roads shall be established urgently in the Engineering Department of DCC which is shown in Fig.9.1.

This proposed road maintenance system will be consisting of one new Maintenance Unit and two other Unit of Road Planning Unit and Road Design and Construction Unit under the Department of DCC.

The function of each proposed Unit and depot under new road maintenance system is stated as follows;

a) Road Maintenance Unit

- to evaluate existing road conditions by using a new road monitoring system intending for a prompt repair of road defects.
- to prepare road maintenance programme and other technical categories.

b) Main Road Dept

- to perform routine and periodic maintenance for DCC roads
- to perform future improvement works of overlay and reconstruction of pavement, etc.
- to train mechanics and operators and other technical staff.
- to train administrative and supervise staff for maintenance works

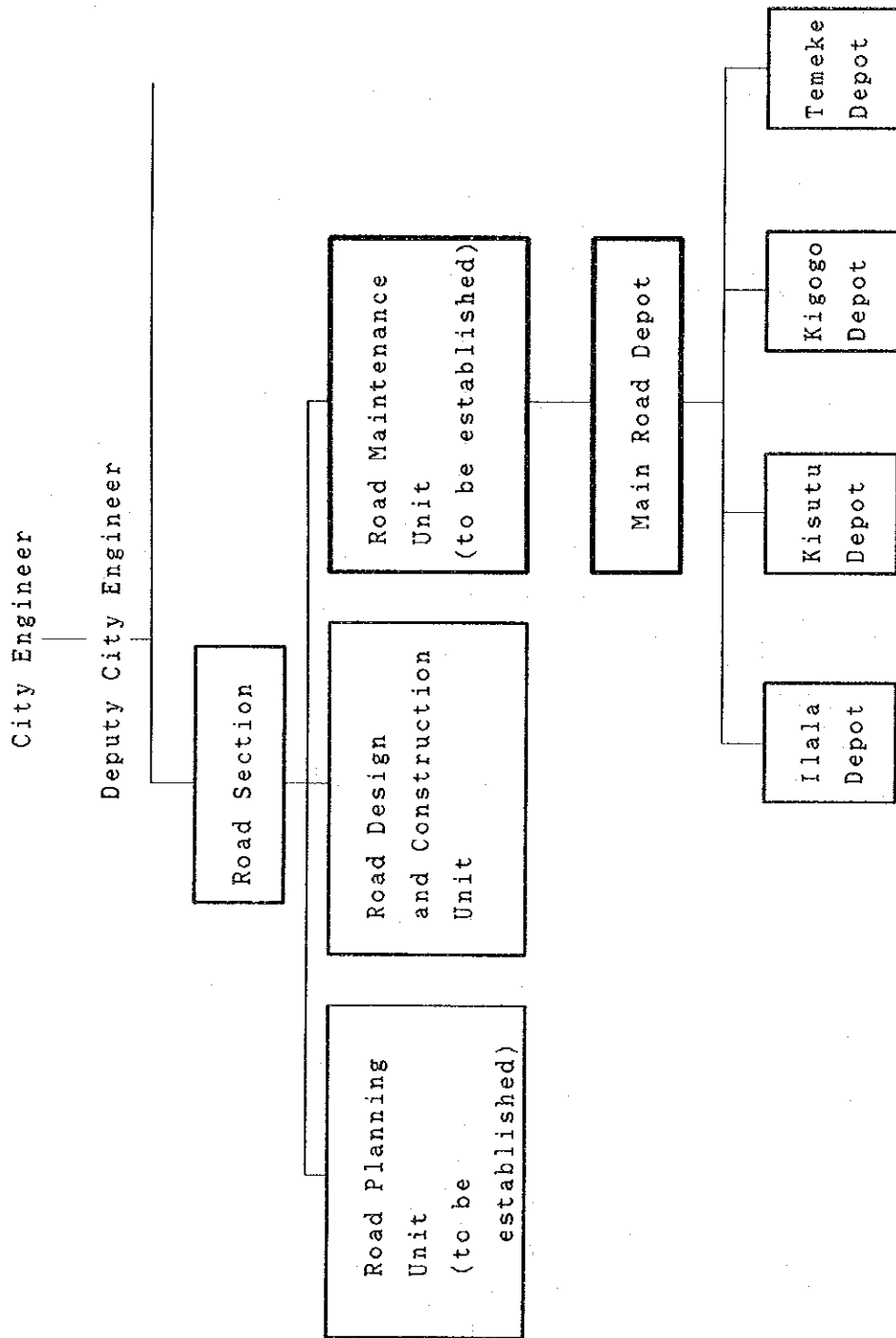


Fig. 9.1 Proposed Road Maintenance System

c) Sub-Depots

- to perform road monitoring
- to perform maintenance under the Main Depot
- to keep equipment, materials and staff for routine maintenance
- to strengthen its capacity to maintain the roads in accordance with the increase of the traffics on the roads.

9.5.2 Proposed Organization and Main Staff of Main Road Depot

In order to implement required road maintenance works, it is necessary to establish Main Road Depot which has functions to store proper equipment for road maintenance, to procure adequate quantity of road maintenance material, to implement maintenance works and to repair all equipment required for road maintenance work.

Therefore, New Main Road Depot should have following four sections with necessary staff shown in Fig.9.2.

- Road Maintenance Section
- Mechanical Workshop Section
- Material Store Section
- Personnel Administration Section

The responsibility of main staff of the Main Depot is stated as follows.

a) Resident Engineer

The Resident Engineer reports to DCC's City Engineer and has the responsibility and authority to undertake the following:

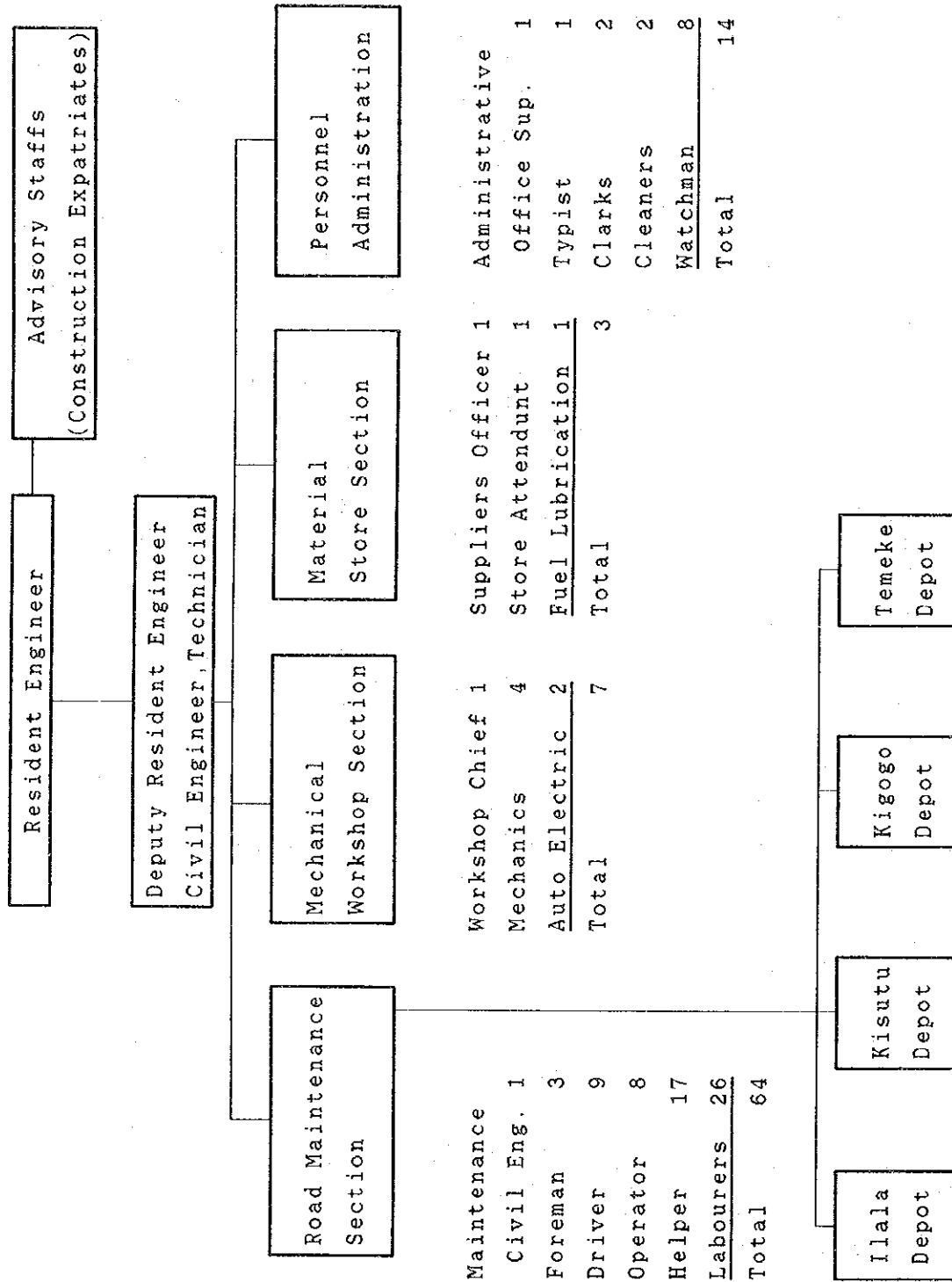


Fig. 9.2 Organization Chart of the Proposed Main Depot

- Direct, through subordinates, all branches ' operation. Develop the Depots' work programs and budget estimates, for DCC approval.
- Develop with DCC approval, depot policies and operating procedures , including performance standards, design and construction specifications.
- Evaluate and award engineering and maintenance proposals relating to DCC operations.
- Coordinate road-related matters with other ministries that involue DCC participation.
- Exercise management control on work performance and expenditures consistent with MOCW/DCC policies. The position requires a senior engineer with at least five years of highway experience plus at least five years of government administration in a responsible management position.

b) Maintenance Engineer

The Maintenance engineer is directly responsible to City Engineer. In this position, the Maintenance Engineer has the responsibility for the following:

- Preparing proposed annual work programs and budget estimates for all road maintenance works including contraction works expecting Medium/Long term.
- Developing for the Resident Engineer's approval standards relating to work performance and maintenance service levels.
- Maintaining an updated road feature inventory.
- In cooperation with the training officer, identifying training needs of the road maintenance staff.
- Maintaining close contact with DCC Road Maintenance Division engineers and provide management support as needed.

This vital depot position requires a graduate civil engineer, ideally, the maintenance engineer should have five years of responsible experience in road and equipment maintenance including two years of on-site field

engineering. Given current scarcity of available qualified staff, practical experience and related training will need to run during a technical assistance program.

c) Supply Officer

The Supply Officer reports directly to the Depot Resident Engineer. In this position the Supply Officer is responsible for the following tasks:

- Directing materials supply operations in the main Depot and in outlying facilities on site as required.
- Establishing and implementing operating procedures consistent with good workshop practice in such areas as materials sampling, testing and reporting results.
- Developing appropriate specifications for road and bridges construction/maintenance materials available in Tanzania.

This position requires a graduate civil or mechanical engineer. Ideally, the Supply Officer should have three to five years of field and storing experience. Given the current scarcity of available qualified staff, practical experience and related training will need to begin during a technical assistance program.

d) Office Supervisor

The Office Supervisor reports directly to the Resident Engineer. Responsibilities of the Office Supervisor include the following:

- Directing the on-going administration of all main depot accounting functions.
- Advising the Resident Engineer in all organizational, administrative, cost accountancy, and budgetary matters.
- Assisting other Main Depot supervisory and clerical staff in field level implementation and on-going administration of accounting procedures and management systems.

This position requires a person with a minimum of five years experience in government budgeting, accounting and office administration. The ideal candidate should be a qualified cost-accountant.

e) Workshop Chief

Workshop Chief would be responsible for directing all operations in his respective workshop, including preventive and corrective maintenance and spare parts control.

This position requires senior technicians qualified in the operation and maintenance of both light and heavy equipment. He should have several years of experience in workshop administration, including spare parts management and stock control.

Considering above mentioned responsibilities of the staff, proper arrangement of this staff is difficult in DCC and the operator, foreman and labour who are engaging in existing road maintenance work of DCC will be shift to the new Main Depot.

Therefore, such consideration should be necessary as follows;

- Invitation of operation and administration expert of road maintenance from MOCW,
- or to receive the technical assistance from other countries for operation and administration of road maintenance.
- or to send and train trainee to TRM of MOCW.

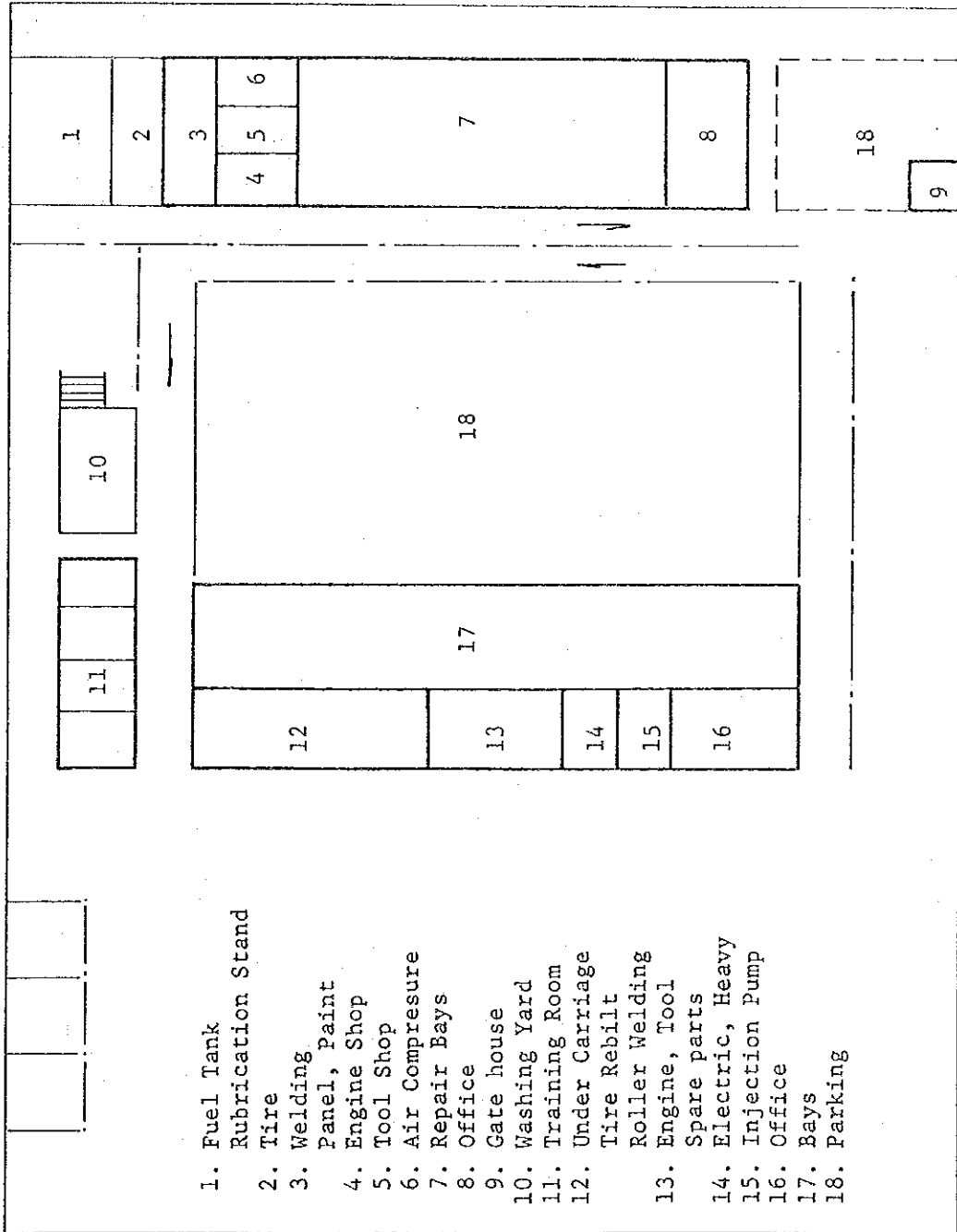
9.5.3. Layout plan of Main Road Depot

Considering the function of the proposed Main Depot, following buildings have been listed up as essential for the operation of the Main Depot. The required floor spaces of these buildings and the layout plan of the Main Depot have been made as shown in Table 9.1 and Fig 9.3 respectively.

In the course of estimation of the required floor space, the future extension of the Main Depot has been also considered that the future required personnel of about 160 persons and the average repair and maintenance ratio of 30% less of the required equipment and vehicle will be the subject to the medium and long-term plan.

<u>Building</u>	<u>Operations</u>
Administrative Office	- Administration - Planning - Budget, etc
Store	- Spare Parts - Fuel - General
Mechanical Workshop	- Body Repair - Tyre Repair - Auto Electric - Panel Beating - Spray Painting - Welding
Road Maintenance Section	- Tipper Group Activities - Motor Grader Group Activities - Roller Group Activities - Arrangement of Plant and Tools
Training Room	- Road Maintenance - Mechanical Maintenance - Auto Electric and Heavy Electric maintenance and Inspection

Fig. 9.3 Lay out of Existing Main Depot



110M

140M

Table 9.1 Estimation for construction of the new
Main Depot/Sub Depot

Description		Estimation (as of June 1989)
A. Main Depot		
1. Earth Grading	15,400sq.m @ 300Tsh/sq.m	= 4,620,000Tsh
2. Floor Concrete	7,650sq.m @ 3,000Tsh/sq.m	=22,950,000Tsh
3. Building	1,840sq.m @50,000Tsh/sq.m	=92,000,000Tsh
Store	590sq.m	
Repair Shop	550sq.m	
Office	290sq.m	
Wash yard	160sq.m	
Training Room	250sq.m	
Fence	500m @ 2,000Tsh	=1,000,000Tsh
Gate		= 500,000Tsh
Electricity(L.S)		=2,000,000Tsh
Water Supply(L.S)		=2,000,000Tsh
Miscellaneous(L.S)		=6,930,000Tsh
	Total	130,000,000Tsh
B. Sub Depot		
1. Earth Grading	1500*4sq.m @ 300Tsh/sq.m	= 1,800,000Tsh
2. Building	150*4sq.m @40,000Tsh/sq.m	=24,000,000Tsh
	Total	=25,800,000Tsh
	Grand Total	155,800,000Tsh

9.6 Manpower and Training

In accordance with the proposed revamping of the road maintenance system including the establishment of a new Road Main Depot of the DCC' Road Section, and providing for forthcoming the Medium and Long term works, staffskills need to be developed to a level consistent with responsible position.

9.6.1 Manpower

The manpower requirement of the Short, Medium and Long Term period of the Study have been identified in the preceding clause. Appendix 9-4 "Summary of Main Staff and Materials" indicates the number of categorised staff required for those periods.

9.6.2 Training

Training and education to strengthen the technical knowledge of how to maintain/repair roads and machinery and to run the new system including administration of the organization, procurement of the materials, store-keeping and their fiscal budgetary preparation are needed.

The proposed organization are consisting four sections, so the staff assigned to each section shall be trained for filling its maintenance potential in the Main Road Depot.

The training programme for each section will be as follows.

(1) Personnel Administration Section

<u>Title of Course</u>	<u>Participants</u>	<u>Course Contents/Other Remarks</u>
Management Seminar	All Management Staff, Mechanics and Inspectors	Basic management principles, Techniques, and applications for those persons.

(continued)

Basic Super- vision course	Admini.Super- visor, Workshop Chief Inspector Foreman	Principles of work assignment, delegation, monitoring, control and principles of on-job train- ing.
Training in Personnel, Appraisal and Review Methods	All staff with Supervisory Responsibili- ties	Objective is to train the participants to evaluate the performance with the individual
Annual work program Review	All Management Staff Engineer Supply Officer	Annual session covering DCC's road maintenance management problems and management techn- ques to review and discuss the annual work program.

(2) Material Store Section

<u>Course</u>	<u>Participant</u>	<u>Course Contents/Other Remarks</u>
Store house and Equip- ment Main- tenance Management	Consultant's counterparts and store attendants	Store maintenance course given regularly by the experts.
Job Sche- duling, and Control	Selected perso- nel from DCC	Short course on scheduling and monitoring job order followed by on-job training.
Accountants Record Keeping	DCC accountants clerks and Admini.Officers	Short course on basic account- ing using costing materials provided by Roas/Equipment Maintenance expert

(3) Mechanical Work Section

<u>Course</u>	<u>Participants</u>	<u>Course Contents/Other Remarks</u>
Equipment Operators	All light vehicle and equipment operators	Instruction in proper equipment operation and inspection; principles of preventive maintenance; recognition of problems
Helper on-job Training	All helper and Apprentice	Principles and practice of use of simple hand held shop equipment.
Shop Technician skill up-grading	Selected Technician in the workshop	Practical, primarily on job-training with a minimum of necessary theory for up-grading skill.
Record and Road Equipment Maintenance	All vehicle and equipment operators	The objective is to verify that operators know how to operate their equipment properly; can keep accurate vehicle logs and know when to call a mechanic.

(4) Road Maintenance System Section

<u>Course</u>	<u>Participants</u>	<u>Course Contents/Other Remarks</u>
Training/ Production Brigade Operations	Foremen and road crews performing routine road maintenance	Pilot program, joint training and actual productive road maintenance performed under supervision of foremen trained in on-job teaching, including discussion as to the "why" of operations.
Road and Equipment Maintenance Management Course	All Management Staff	Basic principles of road and Equipment maintenance, management, including techniques for implementation and supervision of maintenance.

For the training programme remarked above, some adequate number of specialist, trainers or instructors would be required, for which, DCC will seek for the inland experts including foreign experts in MOCW or other authorities.

9.6.3 Foreign Technical Specialists as Instructors

In consideration of the scarcity of adequate inland trainers some foreign technical specialists would be invited to the proposed maintenance depot.

Following two training expatriates consisting of one construction engineer and one mechanical engineer shall be assigned to the proposed system for about two years.

(1) Construction Engineer

The construction engineer shall assist the resident engineer in identifying a general work plan for a strengthen of the road maintenance efficiency of the DCC. The proposed scope of work includes:

- a) Work programm, setting out method, management and operation of construction equipment, labour force requirement, arrangement of construction materials, quality control, expenditure control of works and cash flow planning consisting with the most efficient allocation of resources.
- b) Superintendence of the works in progress in accordance with the technical specifications.
- c) Establishment of a training program based on the manpower requirement and implementation of an effective on-the-job training.

The position requires a senior engineer graduated civil engineering course with at least 5 years of responsible experience in road maintenance and/or construction of bitu-

minous, gravel and earth roads.

(2) Mechanical Engineer

The mechanical engineer shall assist the resident engineer in maintaining the construction equipments and workshop facilities. The proposed scope of work includes:

- a) Review on the construction equipments and workshop facilities and planning of the equipment services, maintenance/repair system and arrangement of workshop facilities.
- b) Establishment of maintenance manual of equipment/vehicle for washing or cleaning, inspection, issue repair specifications and completion inspection etc.
- c) Establishment of routine maintenance system in field and depot for daily check of the vehicles/equipments by driver and operator group.
- d) Establishment of a training system for maintenance staff as drivers, operators and mechanics, that is class room training for a proper maintenance and daily, weekly and monthly inspection for each equipments.

The position requires a senior engineer qualified in the operation and maintenance of both light and heavy equipment. He should have several years of experience in workshop administration including spare parts management and stock control.

9.7 Recommendation for Proposed Road Maintenance System

Establishment of a road maintenance system, building of a new Main Depot and procurement of the equipment and machinery for the new Main Depot have been identified and proposed in this chapter.

In reviewing with the request of the equipment list prepared by the DCC (see Appendix 9-6), required equipments of road maintenance for the short, medium and long-term plan have been analysed taking into consideration future strengthen of road maintenance potential in order. (see Table 9.2)

However, in addition to these requirements, there will be necessary a series of works and problems to be undertaken by DCC or other authorities concerned as follows :

(1) For the building of the new Main Depot, there will require the provision of land area where will be some 15,400. m² wide as shown in Fig.9.3 and from a view point of accessibility it shall be located along some arterial road.

(2) In order to run the new road maintenance system effectively, there will be necessary a provision of budgetary fund of expenditures as mainly itemized follows :

(a)Office expenditures;

- Fuel and light expense
- Water and electric supply expenses
- Employees' traffic expenses
- Office facilities, furniture expenses
- Miscellaneous expenses

(b)Salaries and Wages for staff and employees

(c)Fuel/Oil consumption cost

As to (a) to (c), Summaries of annual budget required are as follows.

<u>Item</u>	<u>Cost/Year (Thousand Tsh)</u>
(a) office Expenditures	= 1,400
(b) Salaries and wages for Staff and Employee	= 3,600
(c) Fuel/Oil Consumption cost	=17,700
(Details are shown in Appendix 9-5.)	

(3) In order to assign mechanics, technicians, store staffs and administrative staffs for the new Main Depot, DCC shall take necessary actions regarding the personnel transposition from other organization in DCC and ask MOCW for transference of personnel, if necessary.

(4) It is recommended that Central Government shall subsidize DCC for securing fiscal fund for the new Road main Depot.

(5) In the history of cooperation between Tanzania and Japan, many specialists have been dispatched and engaged in the improvement of technic, socio-economic and mental culture at responsible positions in MOCW or other authorities, therefore, it is recommended that those specialists or successors shall be assigned for the new system in appreciation of these results and experiences.

Table 9.2 Required Equipment Summary

Equipment	Unit rate (us.\$)	Short Term		Medium/Long Term	
		Q'ty	Amount	Q'ty	Amount
<u>Road maintenance</u>					
Tipper Truck (7tons)	48,000	4	192,000	5	240,000
LWB Truck (7tons)	50,000	2	100,000	2	100,000
Vib. Roller (2tons)	17,000	2	34,000	2	34,000
Bitumen Sprayer	3,000	2	6,000	2	6,000
Water Tanker (6Kl)	32,000	2	64,000	-	-
Motor Grader (2.8m)	79,000	1	79,000	3	237,000
Excavator (0.4 cu.m)	85,000	1	85,000	1	85,000
Road Sweeper (7.9ton)	28,000	-	-	2	56,000
Supervisory Vehicle (pick-up)	19,000	4	76,000	5	95,000
As. Cutter (5.8Kg)	20,000	2	40,000	2	40,000
Dumper (2tons)	18,000	2	36,000	2	36,000
Motor Cycle	3,000	2	6,000	-	-
Road Marking Set	13,000	1	13,000	2	26,000
Compressor (3cu.m)	24,000	1	24,000	-	-
Walk Talkies	1,000	4	4,000	-	-
Two-way Radio	3,000	2	6,000	-	-
Sub total			765,000		955,000
			(Tsh. 110,000,000)		(Tsh. 137,000,000)
<u>Main Depot</u>					
Double pick-up (3.5tons)	33,000	1	33,000	-	-
Tipper Truck (7tons)	48,000	1	48,000	-	-
Welding Machine	2,000	1	2,000	1	2,000
Generator (8KVA)	7,000	2	14,000	-	-
Compressor (3cu.m)	24,000	1	24,000	1	24,000
Overhead Crane	62,000	1	62,000	-	-
Chain Bluck	1,000	3	3,000	-	-
Fuel Pump	1,000	3	3,000	-	-
Fuel Dispenser	24,000	1	24,000	-	-
Tool Box	2,000	5	10,000	-	-
Motor Cycle	3,000	2	6,000	4	12,000
Fuel Tank (2Kl)	36,000	1	36,000	-	-
Walk Talkies	1,000	-	-	2	2,000
Other Tool	32,000	1	32,000	-	-
Steel Wheeled Roller (8t)	50,000	-	-	1	50,000
Pneumatic Tired Roller (8t)	50,000	-	-	1	50,000
Dump Truck (10t)	70,000	-	-	5	350,000
Bulldozer (D7/Ripper)	215,000	-	-	1	215,000
As.Finisher (3.6m)	75,000	-	-	1	75,000
Excavator (2.2cu.m)	150,000	-	-	1	150,000
Sub total			297,000		930,000
			(Tsh. 43,000,000)		(Tsh. 134,000,000)
Total			1,062,000		1,885,000
			(Tsh. 153,000,000)		(Tsh. 271,000,000)

CHAPTER 10 IDENTIFICATION OF NECESSARY IMPROVEMENT

10.1 General

Taking into consideration the present situation of pavement deterioration and traffic congestions of the existing roads and the political priority given by the government of Tanzania, priority roads with a total length of 205 km approx. were selected by the Study Team in Chapter 7.

The improvement measures required for each section of the roads are identified through study and analysis of the data and information collected through the field surveys.

Preliminary engineering study and cost estimate with an accuracy equivalent to the level of preliminary feasibility study are carried out in this chapter on the basis of the improvement measures identified above.

10.2 Identification of Necessary Improvement

10.2.1 Classification of Necessary Improvement

The necessary improvements dealt with in this study are broadly classified into three categories, namely Category A "Improvement of Road Structures", Category B "Urgent Repair of Pot-holes" and Category C "Improvement of Maintenance System".

Each category consists of the following improvement items:

(1) Category A: "Improvement of Road Structures"

A-1 Overlay

A-2 Reconstruction of Pavement

A-3 Widening from 2 to 4 Lanes

A-4 Rehabilitation/Improvement of Drainage Structures

- A-5 Provision of Bus Bays
- A-6 Improvement of Intersections

(2) Category B: "Urgent Repair of Pot-holes"

- B-1 Urgent Repair of Pot-holes

(3) Category C: "Improvement of Road Maintenance System"

- C-1 Construction of Road Maintenance Depots
- C-2 Provision of Road Maintenance Equipment
- C-3 Technical Assistant and Training Programme

10.2.2 Category A "Improvement of Road Structures"

Improvement measures necessary for each road have been identified on the basis of information and data collected through road inventory surveys, pavement surveys, drainage surveys and road maintenance surveys.

The following are the results of improvement measures identified for each road:

[A-1] & [A-2]

Overlay and Reconstruction of Pavements:

Sections to be reconstructed and improved with overlay were identified using the Present Serviceability Index (PSI) of the pavement of the existing road. The results of PSI value obtained through the field survey are presented in Appendix 10-1-1 and shown in Fig. 10.1. The criteria for determining overlay and reconstruction are as follows:

- Overlay section : PSI value between 2.5 and 1.5
- Reconstruction section: PSI value less than 1.5

[A-3] Widening from 2 to 4 Lanes:

Roads with more than a 1.5 congestion ratio will be improved by widening from 2 to 4 lanes. Implementation of widening will be determined by taking into consideration the increase of traffic demand as well as road network requirements of Dar es Salaam City. The following five (5) radial roads

were determined to be in need of widening as soon as possible.

- Uhule Road from Msinbazi Road Junction up to the end of 2 lanes, L=0.9 km
- Sokoine Road, L=0.8 km
- Morogoro Road from Morocco Road Junction to Port Access Junction, L=4.8 km
- Bagamoyo Road from Selender Bridge to Morocco Road Junction, L=3.0 km
- Upanga Road from Tanganika Motor Junction to Selender Bridge, L=1.8 km

Roads with more than a 1.0 congestion ratio will need to be widened after about 5 to 10 years.

[A-4] Rehabilitation/Improvement of Drainage Structures

Box and pipe culverts will be provided where roads are flooded during the rainy season due to inadequate location or low capacity of existing culverts.

[A-5] Provision of Bus Bays

Bus bays will be furnished on roads where the daily traffic volume has exceeded 10,000 per day to improve traffic congestion. Bus bays will be furnished on the following congested roads as shown in Fig. 7.6.

- Uhule Road,
- Morogoro Road,
- Morocco Road,
- New Bagamoyo Road

[A-6] Improvement of Intersections

The following five(5) intersections controlled by roundabouts must be upgraded to signal-controlled intersections to meet traffic flows during peak hours:

- Tanganika Motor Roundabout at Upanga Road,
- Roundabout intersection at Uhulu and Msimbazi Roads,
- Other three (3) roundabouts in the Central Area.

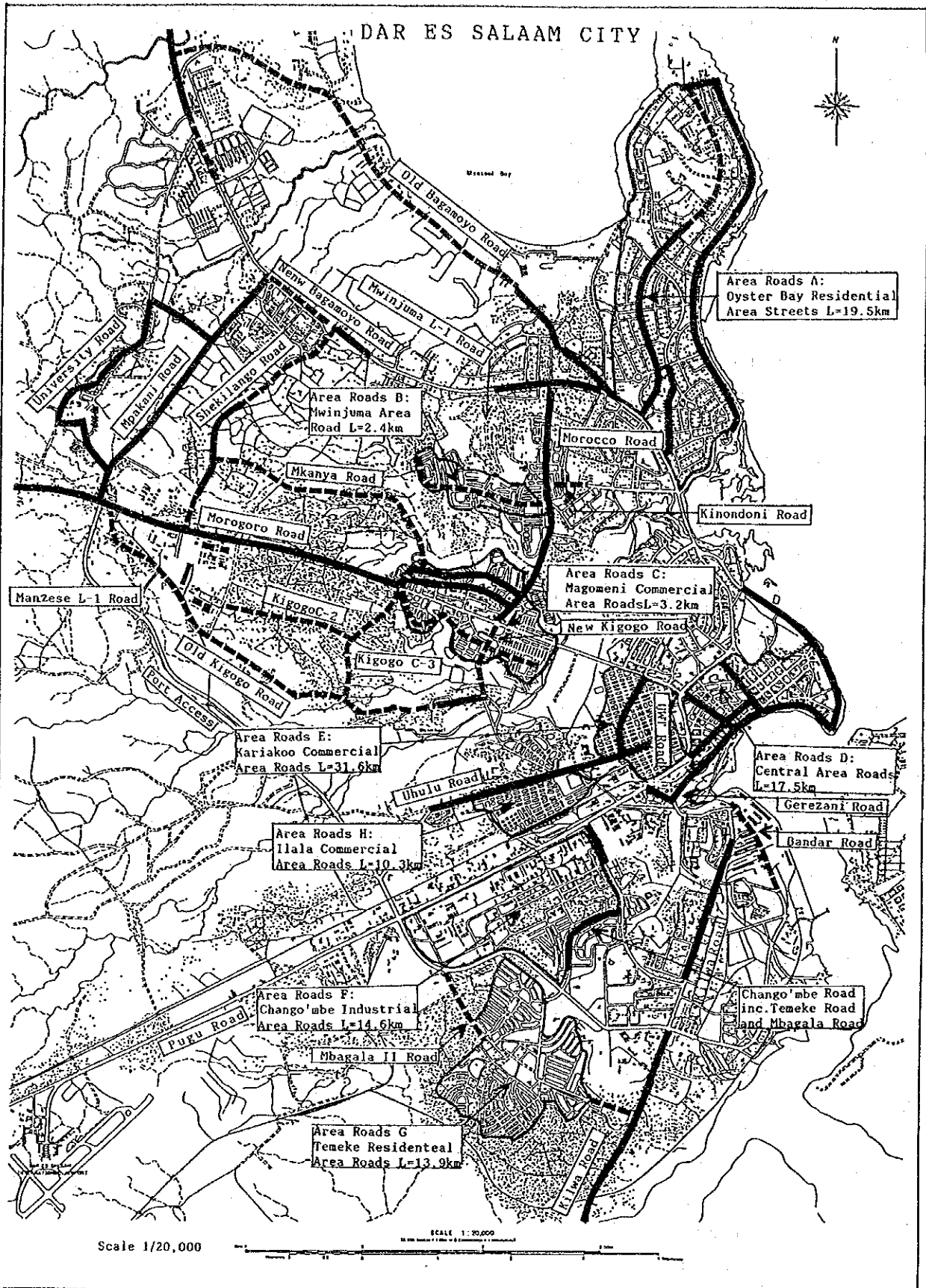





Fig.10.1 Pavement Rehabilitation
by Road

Overlay Section 

Reconstruction 

Section and Areas 

10.2.3 Category B: Urgent Repair of Pot-holes

[B-1] Urgent Repair of Pot-holes

In order to minimize the damage on vehicles and to improve traffic flow and safety, urgent repair of pot-holes will be conducted as a temporary measure on all city roads which have deteriorated seriously. The number of pot-holes are tentatively estimated on the basis of PSI value for the purpose of preliminary evaluation.

The determination of actual locations and numbers requiring repair work will be made by DCC or a consulting engineer on behalf of the Government of Tanzania before starting the construction work.

10.2.4 Category C: Improvement of Road Maintenance System

[C-1] Construction of Road Maintenance Depots

Newly constructed road maintenance depots including workshops are proposed so as to strengthen the capacity of road maintenance for city roads as shown below:

- 1 no. of main road maintenance depot
- 4 nos. of site road maintenance depots

[C-2] Provision of Maintenance Equipment

Road maintenance equipment including spare parts and materials will be provided along with the implementation schedule of road improvement under Category A.

[C-3] Technical Assistance and Training Programme

Training of engineers and improvement of technical and administrative skills related to road maintenance may necessitate the introduction of experts from advanced countries.

A training programme will be prepared emphasizing implementation for the construction of road maintenance depots as well as the provision of maintenance equipment.

10.2.5 Summary of Improvement Measures

Improvement measures identified for each road through the study outlined in the previous paragraph were summarized taking into consideration the following factors:

(1) [Category A] and [Category B]

Improvement measures identified on each road were reviewed employing the criteria mentioned below so as to prevent the double investment of improvement measures;

- Improvement measures of overaly or reconstruction of pavement should not be conducted for the road sections where widening of the existing road was proposed in this study.
- Provision of bus bays, renewal and improvement of drainage structures and improvement of roundabout intersections should be implemented in conjunction with the construction of improvement measures of the related roads.
- Urgent repair of pot-holes on the existing roads should be conducted regardless of the implementation of improvement measures under Category A taking into account the seriously deteriorated condition of pavement which may cause heavy traffic accidents and damages to vehicles.

Based on the above analysis, improvement measures were determined for each road, the summary of which is presented in Table 10.1.

(2) [Category C]

Improvement measures of Road Maintenance System under Category C are summarized in Table 10.2.

Table 10.1 Summary of Improvement Measures by Road (Categories A and B)

Name of Roads	Categories A										Categories B	
	Total Section of		A-1	A-2	A-3	A-4	A-5	A-6	B-1		Urgent Repair of Pol-hallies (nos.)	
	Length	Maintenance level	Overlay (km)	Recon-struction (km)	Widening (km)	Drainage Structures (km)	Bus Bays Type-A (nos.)	Improvement of Intersection Type-B (nos.)	Urgent Repair of Pol-hallies (km)			
I. Arterial Roads												
1-1 New bagamoyo												
-Up to Mpakani J.	8.0	2.0	2.0	1.0	3.0	1.2	6	14	-	-	8.0	250
-Beyond Mpakani J.	15.0	3.0	8.0	4.0	-	-	-	-	-	-	15.0	830
1-2 Morocco	3.5	-	3.5	-	-	-	4	8	-	-	3.5	175
1-3 Kinondoni	0.7	0.2	-	0.5	-	-	-	-	-	-	0.7	52
1-4 Morogoro												
-Up to Port Ac. J.	4.8	-	-	-	4.8	-	6	10	-	-	4.8	48
-Beyond Port Ac. J.	4.7	-	4.7	-	-	-	-	-	-	-	4.7	47
1-8 Bandari	2.2	1.0	-	1.2	-	0.3	-	-	-	-	2.2	130
1-9 Kilwa												
-Up to 8.6km	8.6	2.6	5.5	0.5	-	1.0	-	-	-	-	8.6	351
1-10 Uhuru	2.8	-	1.9	-	0.9	-	2	10	1	-	2.8	140
1-11 Msimbazi	1.6	0.6	1.0	-	-	-	-	-	-	-	1.6	56
1-13 Upanga	1.8	-	-	-	1.8	0.3	-	-	1	-	1.8	18
1-15-1 Nkrumah	0.3	-	0.3	-	-	-	-	-	-	-	0.3	15
1-15-3 Sokoine	0.8	-	-	-	0.8	-	-	-	-	-	0.8	8
1-15-4 Cerezani	1.2	-	1.2	-	-	-	-	-	-	-	1.2	60
1-15-5 Kivukoni	1.0	-	1.0	-	-	-	-	-	-	-	1.0	50
1-15-6 Maktaba	0.9	-	0.9	-	-	-	-	-	-	3	0.9	45
1-15-7 Ohio	1.0	-	1.0	-	-	0.4	-	-	-	-	1.0	50
1-15-8 Ocean	3.2	-	3.2	-	-	-	-	-	-	-	3.2	160
sub-total	62.1km	9.4km	34.2km	7.2km	11.3km	3.2km	18nos.	42nos.	2nos.	5nos.	52.1km	2485nos.

Name of Roads	Categories A										Categories B		
	Total Section of		A-1	A-2	A-3	A-4	A-5	A-6	B-1		Urgent Repair of	Pot-holes	
	Length	Maintenance level	Overlay	Recon-struction	Widening	Drainage Structures	Bus Bays	Improvement of Intersection	Urgent	Repair of			
(km)	(km)	(km)	(km)	(km)	(km)	(nos.)	(nos.)	(nos.)	(nos.)	(km)	(sq. m)		
2. Collector Roads													
2-1 Old Bagamoyo	8.2	-	2.0	6.2	-	1.8	-	-	-	-	8.2	720	
2-2 Haile Sellasie	5.0	-	3.0	2.0	-	-	-	-	-	-	5.0	350	
2-3 Toure Drive	5.6	-	5.6	-	-	-	-	-	-	-	5.6	280	
2-4 Bongoyo	0.8	-	0.8	-	-	-	-	-	-	-	0.8	40	
2-5 Shekilango	3.8	-	2.0	1.8	-	1.9	-	-	-	-	3.8	280	
2-6 Kondea	1.2	-	1.2	-	-	-	-	-	-	-	1.2	60	
2-7 Mwinjuma	2.4	-	-	2.4	-	2.4	-	-	-	-	2.4	240	
2-8 Makanya	5.0	-	1.5	3.5	-	1.2	-	-	-	-	5.0	425	
2-10 Kisogo C-1	2.0	1.0	-	1.0	-	1.0	-	-	-	-	2.0	110	
2-13 Old Kigogo	6.8	-	1.0	5.8	-	-	-	-	-	-	6.8	630	
2-14 Kagera	2.0	1.0	-	1.0	-	-	-	-	-	-	2.0	110	
2-15 Mikumi	1.1	-	-	1.1	-	-	-	-	-	-	1.1	110	
2-16 New Kigogo	2.7	1.5	-	1.2	-	-	-	-	-	-	2.7	135	
2-17 Chango'mbe	4.6	3.0	1.6	-	-	-	-	-	-	-	4.6	110	
2-18 Temeke	1.9	1.9	-	-	-	-	-	-	-	-	1.9	19	
2-19 Mbagala I	1.4	0.4	-	1.0	-	-	-	-	-	-	1.4	104	
sub-total	54.5km	8.8km	18.7km	27.0km	-	8.3km	-	-	-	-	54.5km	3723nos.	
3. Local Roads (Area Roads Proposed by DCC)													
A Oyster Bay Area	8.1	-	-	8.1	-	-	-	-	-	-	8.1	810	
D Central Area	10.3	-	-	10.3	-	-	-	-	-	-	10.3	1030	
E Kariakoo Area	30.0	-	-	30.0	-	-	-	-	-	-	30.0	3000	
F Chango' mbc Area	14.6	-	-	14.0	-	-	-	-	-	-	14.6	1460	
G Temeke Area	13.9	-	-	13.9	-	-	-	-	-	-	13.9	1390	
H Ilala Area	10.3	-	-	10.3	-	-	-	-	-	-	10.3	1030	
I. Other Important Rd.													
-Mwinjuma L-1	1.5	-	-	1.5	-	-	-	-	-	-	1.5	150	
sub-total	88.7km	-	-	88.7km	-	-	-	-	-	-	88.7km	8840nos.	
Total	205.3km	18.2km	52.9km	122.9km	11.3km	21.9km	18nos.	42nos	2nos.	3nos	205.3km	15048nos.	

Table 10.2 Improvement Measures of Road Maintenance System under Category C

Measures	Short term				Medium/Long term			
	(Pa)	(R)	(W)	total	(P)	(R)	(W)	total
<u>Establishment of Road Maintenance Depot</u>								
Main Depot				1				
Site Depot							4Nos.	4
<u>Procurement of Equipment/Machine</u>								
7 ton Tipper trucks	3	1	1	5	2	3		5
LWB Lorries with crane	1	1		2	2			2
Moter Grader		1		1		3		3
Vehicles(pick up)	2	2		4	2	2	1	5
Bitumen sprayers	2			2	2			2
2 tons vib.Rollers	2			2	2			2
2 tons Dumpers		2		2	2			2
Excavater(0.4 cum)		1		1	1			1
Road Sweeper							2	2
Moter cycles	2		2	4		4		4
Asphalt cutters	2			2		2		2
Road marking sets		1		1		2		2
Steel wheeled Roller(8t)							1	1
Pneumatic Tyred Roller(8t)							1	1
Bulldozer(7 ton with ripper)							1	1
Watter Tanker (6Kl)		2		2				
Compressor(3.5 cum)	1		1	2		1		1
Double Cabin pick-up(3.5ton)			1	1				
Welding Machines			1	1			1	1
Overhead Crane			1	1				
Generators(8 kVA)			2	2				
Chain BLocks			3	3				
Fuel Pumps			3	3				
Fuel Tank (20Kl)			1	1				
Fuel Dispenser			1	1				
Tool Boxes			5	5				
Other Tool			1	1				
Walk Talkies	4			4	2			2
Two-way Radio	2			2				
Dump Trucks(10 ton)							5	5
Excavater(2.2cu.m)							1	1
As.Finishor							1	1
<u>Technical Assistance and Training</u>								
Technical Assistance for administration or supervision of maintenance works					1	expert		
Training for mechnics and operator					1	expert		

Abbreviation: Pa=Patching Maintenance Work
R =Routine Maintenance Work
P =Periodic Maintenance Work
W =Work shop

10.3 Preliminary Engineering Plan

A preliminary engineering plan was studied with an accuracy equivalent to the pre-feasibility study level as shown below:

10.3.1 Design Criteria and Standards

At present, there is no authorized road design standard. However, MOCW plans to finalize the "Road Design Standards" prepared for submission to the 2nd SATCC Meeting of the "Group of Experts on Road Infrastructure" in July 1984 and is expected to be completed soon according to the MOCW officials. Therefore, the Study Team has decided to use the Road Standards for this project.

It is noted that the above Road Design Manual was prepared for use on rural roads under the jurisdiction of MOCW, but not for urban roads. Therefore, if there are any items which are not applicable to urban roads, either Japan Road Standards or AASHTO's Design Standard will be applied taking local conditions into account with the approval of MOCW.

10.3.2 Improvement Plan of Roadway

Horizontal and vertical alignments of the roads proposed for renewal and improvement are generally suitable for the Road Design Standard. Therefore no major improvement work on alignments were considered for the proposed roads.

Minor adjustments in horizontal and vertical alignments may be necessary, particularly in improving curves and sight distance. However, these improvement measures will be considered in the subsequent feasibility study stage but not in this preliminary design stage.

Carriageway and road formation widths were checked through field surveys and road inventory data shown in Appendix 7-1-1. Improvement of cross sections of existing pavements should conform to road standards applied for each road classification.

10.3.3 Improvement Plan of Pavement

Overlay and reconstruction of pavements will be done on the existing pavement in principle without major improvement of carriageway.

The following is the design method of improvement measures proposed for each road:

(1) Overlay Design

To strengthen the distressed asphalt pavements, various kinds of methods of overlay design have been developed by different organizations. Those methods can be broadly classified into two groups as follows:

(i) Design method by pavement component analysis

- Asphalt Institute Method
- Japan Road Associations Method

(ii) Design method with the use of pavement deflection

- Transport and Road Research Laboratory Method
- AASHTO Guide,
- California Method, etc.

In this study, the design method by pavement component analysis developed by the Asphalt Institute in 1977 was employed.

For the determination of overlay and reconstruction thickness, traffic data were analyzed on the basis of "Traffic Demand Forecast" presented in Chapter 5. The following is the design method used for the determination of overlay thickness:

a. Initial Daily Traffic (IDT) and Growth Rate

Using the traffic count made by the Study Team in 1989, the expected average daily number of vehicles was estimated in both directions for the first year after the improvement of the road, sometime in 1994. This is referred roads the Initial Daily Traffic (IDT), the summary of which is presented in Appendix 10-2-1.

Future traffic volume by vehicle type was forecasted based on the traffic volume in 1991 using the following growth rates (1989 - 2000):

* Car & Light goods	3 %
* Bus	10 %
* Truck	2 %
Total	4 %

b. Percentage of Heavy Traffic

Since loads imposed by passenger cars and light vehicles do not contribute significantly to the structural damage of the road pavement, medium and heavy trucks and buses, two-axle six-tire vehicles or larger, were included in the analyses.

c. Average Gross Mass of Heavy Vehicles

Average Gross mass of heavy vehicles was estimated on the basis of weight study data as shown in Appendix 10-2-2 and was developed using the traffic data obtained by the Study Team.

The result of the estimated of average gross mass is presented below:

- Heavy Good Vehicles -- 18 ton
- Medium Good Vehicles and Buses -- 10 ton

d. Single-axle Load

Mixed traffic must be converted to the equivalent of a 8,200 kg (18,000 lb) single axle road.

e. Initial Traffic Number

Initial Traffic Number(ITN) was obtained using the analysis chart as shown in Appendix 10-2-3 on the basis of the number of heavy vehicles, average gross mass and single-axle road.

f. Design Period

Design periods employed for determining thickness of overlay and reconstruction are 10 and 20 years respectively.

g. Adjustment Factor for the Design Period

Adjustment factors for the design period and estimated annual traffic growth rate will be determined using Appendix 10-2-4.

h. Design Traffic Number (DTN)

The DTN is the average daily number equivalent to a 8,200 kg (18,000 lb) single-axle load applied for the selected design period. The figures of Design Traffic Number(DTN) were calculated as shown in Appendix 10-4-5.

i. Full-depth Asphalt Pavement Thickness

Using the appropriate Thickness Design Chart as shown in Appendix 10-2-6, the full-depth asphalt pavement thickness (T) was obtained.

j. Effective Thickness of the Existing Pavement

Pavement structural components of the existing roads were evaluated so as to obtain the representative Effective Thickness (Te) on each proposed road. To determine Te, each layer of the exiting pavement must be converted to the equivalent thickness of asphalt concrete using the Conversion Factor as shown in Appendix 10-2-7. The results of the calculation of effective thickness are given in Appendix 10-2-8.

k. Thickness of Overlay

The required thickness of asphalt concrete overlay is equal to $T - T_e$. Using this method, overlay thickness computation was carried out for all proposed roads. The results of thickness computation are shown in Appendix 10-2-9.

(2) Design of Pavement Reconstruction

Pavement design in Tanzania has been carried out employing either AASHTO Standards or TRRL's Road Note 31. In this Study, however, The Asphalt Institute Design Method, USA, has been applied for the design of pavement reconstruction, since overlay design has been conducted using design method by pavement component analysis developed by the Asphalt Institute, USA, as stated above. Design method of pavement reconstruction is the same as overlay design.

- (3) **Overlay and Reconstruction Thickness by Road**
- Calculation of overlay and reconstruction thickness of pavement was conducted for each road using the estimated bearing capacity (CBR) obtained through field survey and data collected. Table 10.3 shows the results of calculation.

10.3.4 Improvement Plan of Drainage

To maintain city roads under all-weather conditions as well as to extend pavement life, perfection of drainage facilities is an indispensable factor.

The field survey revealed that many sections of roads have been blocked and damaged by floodings which frequently occur during the rainy season due to lack of proper maintenance of roadside drainage and insufficient capacity of storm drainage systems provided along the roads.

Roadside drainage structures and cross drainage located in flooded areas will be reconstructed or provided to improve the capacity of drainage structures.

It is noted however that reconstruction or renewal of storm drainage systems using major rivers and their tributaries have been excluded from the study for the following reasons:

- (a) Improvement of storm drainage systems is considered to be outside the scope of the study,
- (b) Improvement will entail a considerable amount of work and expense,
- (c) The Ministry of Lands, Natural Resources and Tourism is planning to implement renewal and emergency maintenance work for these facilities.

- Pipe culvert

Pipe culvert with a minimum of 100 cm in diameter will be provided considering easy maintenance. These culverts will

be provided at flooded areas and widening sections where the existing cross drainage will be damaged due to construction of widening work. The average interval of pipe culvert was 100 m approx.

10.3.5 Improvement Plan of Bridges

Bridges on the existing roads are mostly steel girder and concrete bridges, although wooden bridges can be found in some sections. However, most bridges on the roads selected for further study (205 km approx.) satisfy design loading and carriage-way width.

Only a few old bridges constructed with one lane and judged from visual inspection to have insufficient bearing capacity will be reconstructed to 2 lanes.

The types of bridges were selected taking the river width and river bed conditions into account as shown below:

<u>Span Length (m)</u>	<u>Type of Bridge</u>
- Span length less than 10 m	RC - Slab Bridge
- Span Length 10 m - 20 m	H - beam Steel Bridge
- Span Length more than 20 m	Steel Girder Bridge

A typical cross section is presented in Appendix 10-2-10.

Table 10.3 Calculation of Overlay and Reconstruction Thickness of Pavement

Link No.	Name of Roads	Road Length (km)	Estimated CSR	Design Period		Design Traffic Number (DTN)	Full-depth Thick (TA) Overlay Recon. (2014)	Effective Thickness (Te) (mm)	Overlay Leng. (km)	Reconstruction Leng. Type (km)			
				Val. (mm)	Year (Year)						Overlay Recon. (2004)	Thick (TA) Overlay Recon. (2014)	
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩-⑪				
I. Arterial Roads													
1-1	New bagamoyo												
	-Up to Mpakani J.	8.0	8	10	20	284	180	200	110	2.0	100	1.0	B
	-Beyond Mpakani J.	15.0	8	10	20	118	180	200	110	8.0	80	4.0	B
1-2	Morocco	3.5	8	10	20	138	180	-	100	3.5	80	-	-
1-3	Kinondoni	0.7	8	10	20	43	-	180	-	-	-	0.5	A
1-4	Morogoro												
	-Up to Port Ac. J.	4.8	8	10	20	514	-	220	-	-	-	-	-
	-Beyond Port Ac. J.	4.7	8	10	20	103	-	-	-	4.7	80	-	-
1-8	Bandari	2.2	10	10	20	280	-	200	-	-	-	1.2	B
1-9	Kilwa												
	-Up to 8.6km	8.6	10	10	20	283	180	200	100	5.5	80	0.5	B
1-10	Uhuru	2.8	10	10	20	220	180	-	90	1.9	70	-	-
1-11	Msimbazi	1.6	10	10	20	327	180	-	140	1.0	40	-	-
1-13	Upanga	1.8	10	10	20	284	-	200	-	-	-	-	-
1-15-1	Nkrumah	0.3	10	10	20	0	100	-	130	0.3	25	-	-
1-15-3	Sokoine	0.8	10	10	20	244	-	200	-	-	-	-	-
1-15-4	Gerezani	1.2	10	10	20	273	-	-	-	1.2	40	-	-
1-15-5	Kivukoni	1.0	10	10	20	66	160	-	130	1.0	40	-	-
1-15-6	Maktaba	0.9	10	10	20	44	160	-	130	0.9	40	-	-
1-15-7	Ohio	1.0	10	10	20	8	-	-	-	1.0	25	-	-
1-15-8	Ocean	3.2	10	10	20	0	100	-	130	3.2	25	-	-
sub-total		62.1km								34.2km		7.2km	

Link No.	Name of Roads	Road		Estimated Design Period		Design Traffic		Full-depth		Effective		Overlay		Reconstruction	
		Length (km)	CBR Val.	Overlay Recon. (Year)	Number (DTN)	Thick (TA)	Thick (TA)	Thickness (Te)	Leng. (km)	Thick (mm)	Leng. (km)	Thick (mm)	Leng. (km)	Type	
															①
2. Collector Roads															
2-1	Old Bagamoyo	8.2	8	10	20	61	152	180	200	120	2.0	50	6.2	B	
2-2	Haile Sellsie	5.0	12	10	20	103	232	150	180	80	3.0	60	2.0	A	
2-3	Toure Drive	5.6	12	10	20	7	23	100	-	110	5.6	25	-	-	
2-4	Bongoyo	0.8	12	10	20	7	23	100	-	110	0.8	25	-	-	
2-5	Shekilango	3.8	8	10	20	57	128	170	200	70	2.0	90	1.8	B	
2-6	Kondoa	1.2	8	10	20	0	0	100	-	70	1.2	25	-	-	
2-7	Mwinjuma	2.4	8	10	20	104	270	-	200	-	-	-	2.4	B	
2-8	Makanya	5.0	8	10	20	4	8	100	100	70	1.5	25	3.5	C	
2-10	Kigogo-1	2.0	8	10	20	18	40	-	180	-	-	-	1.0	A	
2-13	Old Kigogo	6.8	8	10	20	57	173	180	200	110	1.0	70	5.8	B	
2-14	Kagera	2.0	8	10	20	27	57	-	180	-	-	-	1.0	A	
2-15	Mikumi	1.1	8	10	20	6	12	-	100	-	-	-	1.1	A	
2-16	New Kigogo	2.7	8	10	20	64	171	-	200	-	-	-	1.2	B	
2-17	Chango'mbe	4.6	10	10	20	257	609	160	-	120	1.6	40	-	-	
2-18	Temeke	1.9	10	10	20	102	301	-	-	-	-	-	-	-	
2-19	Mbagala I	1.4	10	10	20	58	179	-	180	-	-	-	1.0	A	
	sub-total	54.5km									18.7km		27.0km		
3. Local Roads (Area Roads Proposed by DCC)															
A.	Oyster Bay Area	8.1	12	10	20	7	23	-	100	-	-	-	8.1	C	
D.	Central Area	10.3	8	10	20	8	16	-	100	-	-	-	10.3	C	
E.	Kariakoo Area	30.0	8	10	20	27	57	-	180	-	-	-	30.0	A	
F.	Chango'mbe Area	14.6	10	10	20	58	179	-	180	-	-	-	14.0	A	
G.	Temeke Area	13.9	10	10	20	58	179	-	180	-	-	-	13.9	A	
H.	Ilala Area	10.3	10	10	20	6	12	-	100	-	-	-	10.3	C	
I.	Other Important Rd.														
	-Mwinjuma	1.5	8	10	20	0	0	-	100	-	-	-	1.5	C	
	sub-total	88.7km											88.7km		
	Total	205.3km									52.9km		122.9km		

10.4 Preliminary Quantities and Cost Estimation

10.4.1 Preliminary Work Quantities for Each Road

(1) Categories A: Improvement of Road Structures

Unit work quantities of improvement measures were calculated on the basis of the typical cross sections shown in Fig. 10.2 obtained through the preliminary design performed in the previous paragraph.

Each improvement measure consists of the following major work items and unit quantities estimated for each improvement measures are given in Appendix 10-3-1.

- Embankment including clearing/grubbing, excavation of common materials at borrow pit, hauling with average distance of 10 km and compaction
- Selected materials for improved subgrade
- Crusher run aggregate (subbase course)
- Selected crushed stone (base course)
- Asphalt concrete (plant mix)
- Tuck coat for overlay
- Prime coat for reconstruction
- Soil aggregate shoulder
- Pipe culvert
- RC bridge including super- and sub-structures
- H-Beam bridge including super- and sub-structures
- Girder bridge including super- and sub-structures
- Miscellaneous work including side ditch, slope protection, guide post, guide rails, traffic sign, lighting facilities, etc.

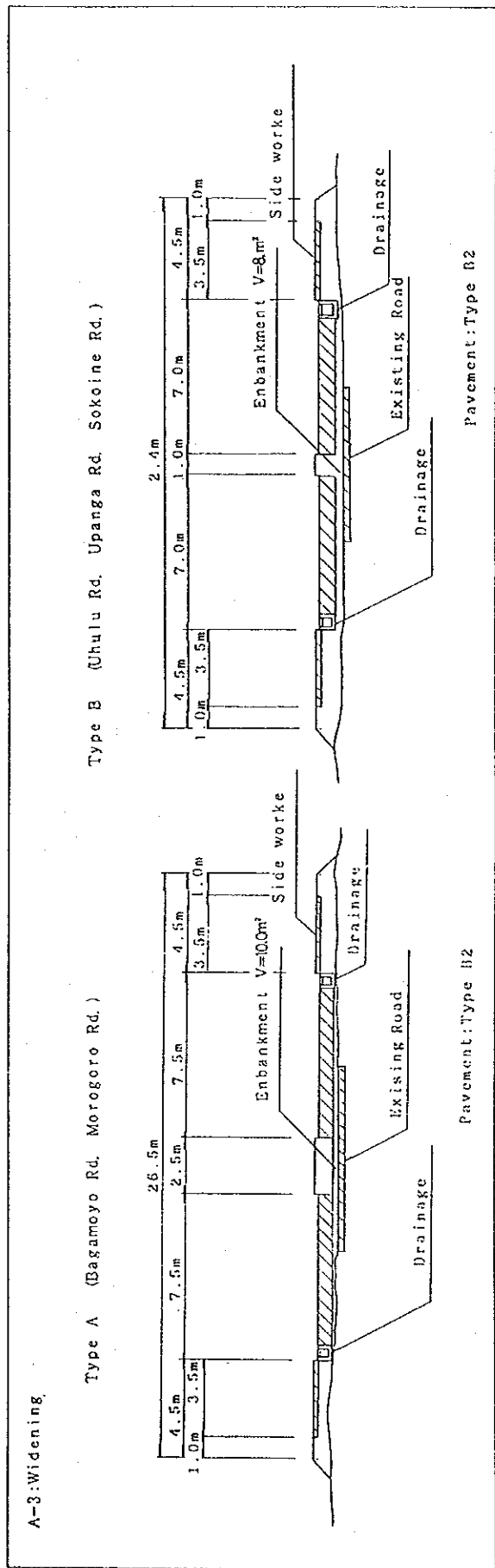
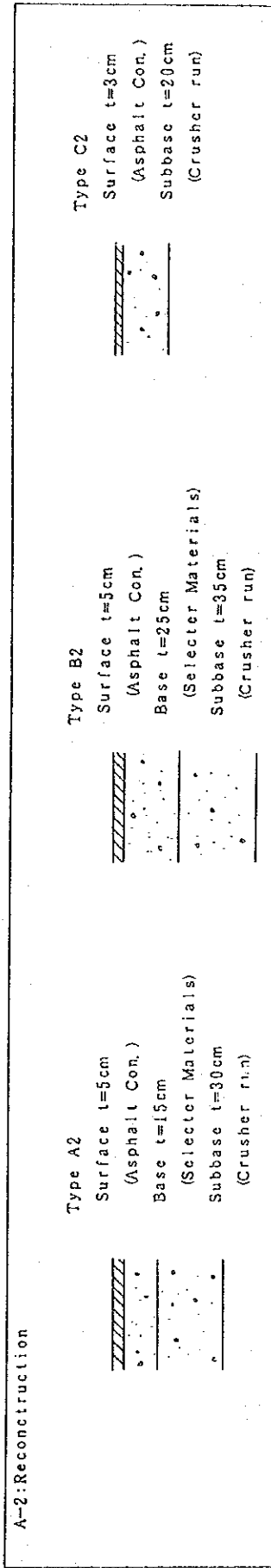
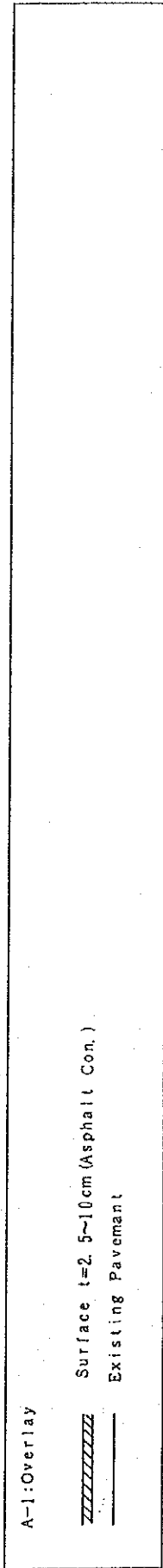
The land acquisition attributable to the improvement measures was not considered in this stage since the right-of-way width resolved by the government is generally sufficient enough for these improvement work.

(2) Category B: Urgent Repair of Pot-Holes

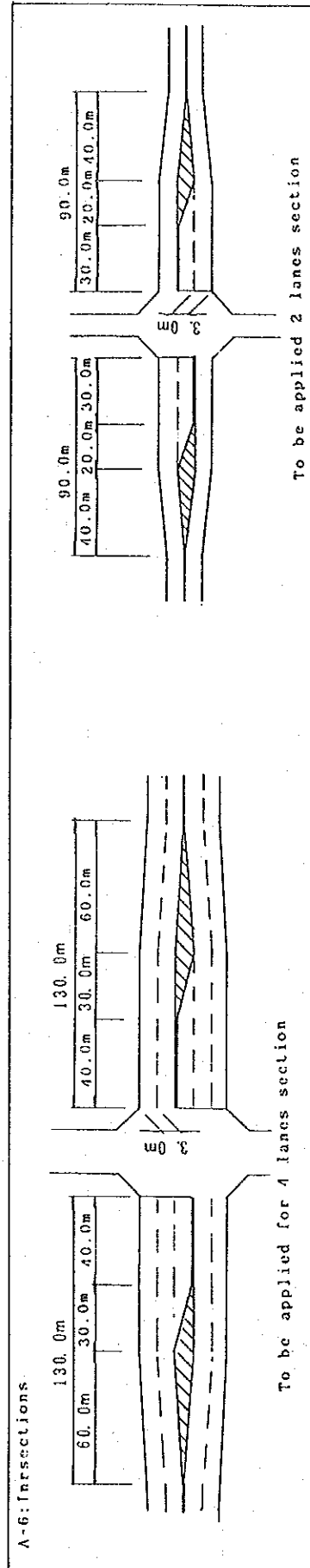
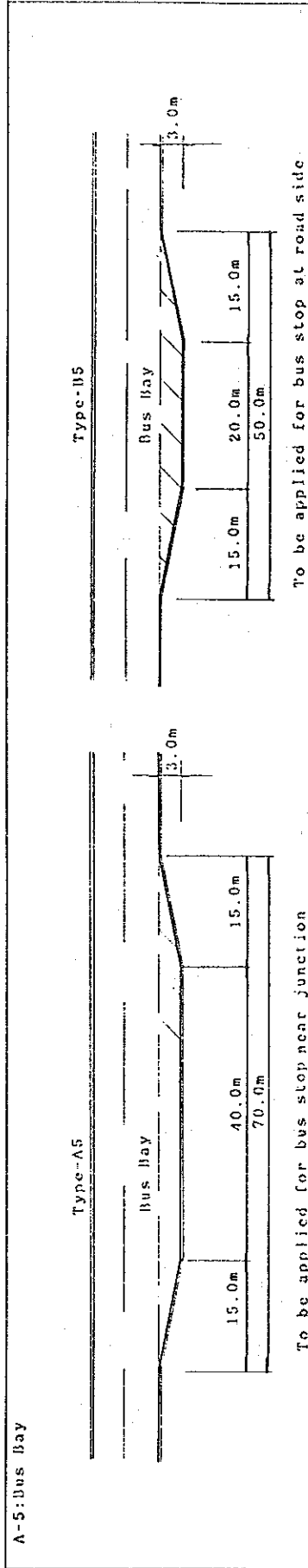
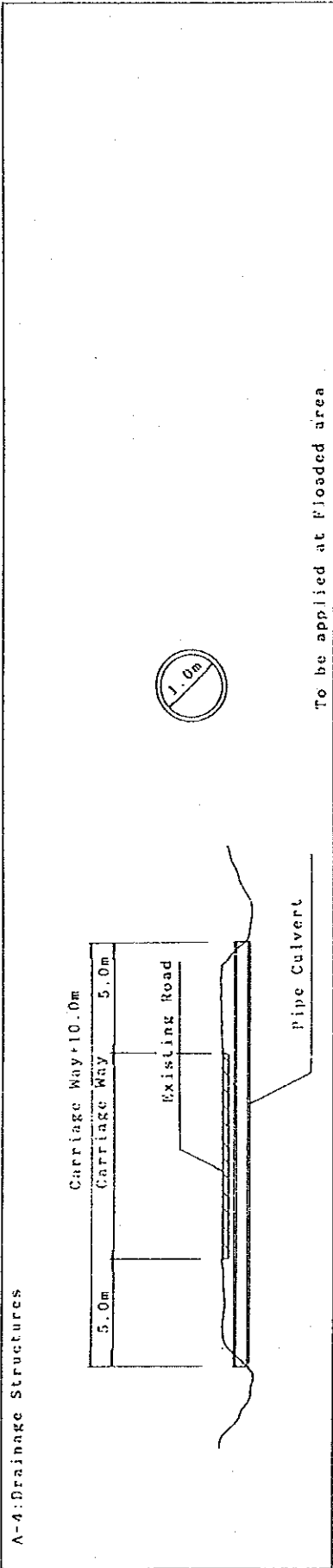
Quantities of pot-holes are estimated assuming the number of and areas of pot-holes per 100 meter of arterial road based

Fig 10.2 Type of Improvement Measures

(Category A: Road Improvement)



(Category A: Road Improvement)



on the data obtained during the PSI survey as shown in Appendix 10-3-2. The work involved in repairing pot-holes is as follows:

- Removal of unnecessary soil and debris
- Selected crushed stone for base course
- Prime coat
- Asphalt concrete

(2) Category C

Quantities of road maintenance depot and maintenance equipment to be provided under Category C were estimated taking into consideration the following items:

- a. Type of pavement (earth, gravel and asphalt)
- b. Budget allocated for road maintenance
- c. Amount of maintenance to be done per month or year
- d. Capability of worker and operator
- e. Workable day per month or year

Required quantities of road maintenance depots and equipment are presented in Tables 9.1 and 9.2 respectively in Chapter 9.

10.4.2 Preliminary Cost Estimate for Each Road

(1) Category A: Improvement of Road Structures" and Category B "Urgent Repair of Pot-holes"

For the purpose of preliminary evaluation, the unit rates used in this study were developed from recent cost data and the bid prices on projects similar to the roads proposed in the study. The unit rates for major work items are shown in Appendix 10-3-3.

Based on the above unit rates, the unit cost of each improvement measure was calculated by applying these unit rates to the estimated unit quantities obtained in the previous paragraph. The results are shown in Appendix 10-3-4. The cost of miscellaneous work was estimated at 10 % of the total cost of major work items.

The preliminary cost of improvement measures was estimated by applying these unit costs to the estimated quantities of improvement measures on each road. The results of the calculation are shown in Appendix 10-3-5 and summaries of the preliminary costs of Categories A and B are presented in Tables 10.4 and 10.5 respectively.

(2) Category C "Improvement of Road Maintenance System"

Preliminary cost estimate was made for Improvement of Road Maintenance System to be provided under Category C as shown in Table 10.6.

Table 10.4 Summary of Preliminary Cost for Category A

Name of Roads	Selected Roads Total Length (km)	Preliminary Cost Estimate (Tsh. *1000)	Unit Cost Per km (Tsh. *1000)	Remark
1. Arterial Roads				
1-1 New bagamoyo				
-Up to Mpakani J.	8.0	607.770	75.970	
-Beyond Mpakani J.	15.0	293.880	19.590	
1-2 Morocco	3.5	64.520	18.430	
1-3 Kinondoni	0.7	18.410	26.300	
1-4 Morogoro				
-Up to Port Ac. J.	4.8	809.100	168.570	
-Beyond Port Ac. J.	4.7	60.400	12.860	
1-8 Bandari	2.2	55.900	25.410	
1-9 Kilwa				
-Up to 8.6km	8.6	116.690	13.570	
1-10 Uhuru	2.8	190.850	68.160	
- (Widening)	2.8	(427.310)	152.610	
1-11 Msimbazi	1.6	14.350	8.970	
1-13 Upanga	1.8	279.240	155.130	
1-15-1 Nkrumah	0.3	8.740	29.130	
1-15-3 Sokoine	0.8	122.090	152.610	
1-15-4 Gerezani	1.2	13.450	11.210	
1-15-5 Kivukoni	1.0	5.610	5.610	
1-15-6 Maktaba	0.9	26.000	28.890	
1-15-7 Ohio	1.0	12.210	12.210	
1-15-8 Ocean	3.2	16.540	5.170	
sub-total	62.1km	2,715,750		
2. Collector Roads				
2-1 Old Bagamoyo	8.2	332.170	40.510	
2-2 Haile Sellasie	5.0	95.750	19.150	
2-3 Toure Drive	5.6	26.880	4.800	
2-4 Bongoyo	0.8	3.840	4.800	
2-5 Shekilango	3.8	126.800	33.370	
2-6 Kondoa	1.2	6.650	5.540	
2-7 Mwinjuma	2.4	134.210	55.920	
2-8 Makanya	5.0	79.030	15.810	
2-10 KigogoC-1	2.0	31.920	15.960	
2-13 Old Kigogo	6.8	287.510	42.280	
2-14 Kagera	2.0	36.830	18.420	
2-15 Mikumi	1.1	40.510	36.830	
2-16 New Kigogo	2.7	52.160	19.320	
2-17 Chango'mbe	4.6	12.560	2.730	
2-18 Temeke	1.9	-	-	
2-19 Mbagala 1	1.4	29.460	21.040	
sub-total	54.5km	1,296,280		
3. Local Roads (Area Roads Proposed by DCC)				
A. Oyster Bay Area	8.1	102.060	12.600	
D. Central Area	10.3	181.690	17.640	
E. Kariakoo Area	30.0	883.800	29.460	
F. Chango'mbe Area	14.6	501.800	34.370	
G. Temeke Area	13.9	477.740	34.370	
H. Ilala Area	10.3	168.710	16.380	
I. Other Important Rd.				
-Mwinjuma	1.5	26.460	17.640	
sub-total	88.7	2,342,260		
Total	205.3km	6,354,290		

Table 10.5 Summary of Preliminary Cost for Category B

Name of Roads	Selected Roads Total Length (km)	Preliminary Cost Estimate (Tsh. *1000)	Unit Cost Per km (Tsh. *1000)	Remark
1. Arterial Roads				
1-1 New bagamoyo				
-Up to Mpakani J.	3.0	3,110	1,040	
-Beyond Mpakani J.	20.0	10,330	520	
1-2 Morocco	3.5	2,180	620	
1-3 Kinondoni	0.7	650	930	
1-4 Morogoro				
-Up to Port Ac. J.	3.5	600	170	
-Beyond Port Ac. J.	6.0	580	100	
1-8 Bandari	2.2	1,620	740	
1-9 Kilwa				
-Up to 8.6km	8.6	4,370	510	
1-10 Uhuru	2.8	1,740	610	
- (Widening)	2.8	(1,740)	610	
1-11 Msimbazi	1.6	700	440	
1-13 Upanga	1.8	220	120	
1-15-1 Nkrumah	0.3	190	630	
1-15-3 Sokoine	0.8	100	130	
1-15-4 Gerezani	1.2	750	630	
1-15-5 Kivukoni	1.0	620	620	
1-15-6 Maktaba	0.9	560	620	
1-15-7 Ohio	1.0	620	620	
1-15-8 Ocean	3.2	1,990	620	
sub-total	62.1km	30,930		
2. Collector Roads				
2-1 Old Bagamoyo	8.2	8,960	1,090	
2-2 Haile Sellasie	5.0	4,350	870	
2-3 Toure Drive	5.6	3,480	620	
2-4 Bongoyo	0.8	500	630	
2-5 Shekilango	3.8	3,480	920	
2-6 Kondoia	1.2	750	630	
2-7 Mwinjuma	2.4	2,990	1,250	
2-8 Makanya	5.0	5,290	1,060	
2-10 KigogoC-1	2.0	1,370	690	
2-13 Old Kigogo	6.8	7,840	1,150	
2-14 Kagera	2.0	1,370	690	
2-15 Mikumi	1.1	1,370	1,250	
2-16 New Kigogo	2.7	1,680	620	
2-17 Chango' mbe	4.6	1,370	300	
2-18 Temeke	1.9	240	130	
2-19 Mbagala 1	1.4	1,290	920	
sub-total	54.5km	46,330		
3. Local Roads (Area Roads Proposed by DCC)				
A Oyster Bay Area	8.1	10,080	1,240	
D Central Area	10.3	12,810	1,240	
E Kariakoo Area	30.0	37,320	1,240	
F Chango' mbe Area	14.6	18,160	1,240	
G Temeke Area	13.9	16,920	1,220	
H Ilala Area	10.3	12,810	1,240	
I Other Important Rd.				
-Mwinjuma	1.5	1,870	1,250	
sub-total	88.7	109,970		
Total	205.3km	187,230		

Table 10.6 Summary of Preliminary Cost for for Category C
 "Improvement of Road Maintenance System"

unit: 000T.shs

Improvement Measures	Short Term	Mrdium/Long Term	Total
<u>Establishment of Road Maintenance Depot</u>			222,800
- 1 No. of Main Depot	Area:15,400sq.m	—	15,400sq.m
	Building:1,840sq.m	—	1,840sq.m
	Const. Cost:130,000	—	130,000
	Workshop Equipment: 43,000	24,000	67,000
- 4 Nos of Sub Depot	—	Area:1,500x4sq.m	6,000sq.m
	—	Bilding:150sq.mx4	600sq.m
	—	Const. Cost:25,800	25,800
<u>Procurement of Plant and Equipment</u>			381,000
- Procurement of Equipment for Routine Maintenance	110,000	—	110,000
- Procurement of Equipment for Periodic and Major Improvement Work	—	271,000	271,000
<u>Technical Assistance and Training</u>			
- Technical Assistance for administration or supervision of maintenance works	one expert	—	one expert
- Training for mechanica and operators	one expert	—	one expert
Total	283,000	320,800	603,800

CHAPTER 11 FORMULATION OF IMPLEMENTATION PLAN AND SELECTION OF HIGH PRIORITY PROJECTS

11.1 General

As stated in Chapter 10, the improvement measures to be conducted in the study are divided into three main categories with sub-work items as follow:

- * Category A "Improvement of Road Structures"
 - Overlay of Pavement
 - Reconstruction of Pavement
 - Widening from 2 to 4 lanes
 - Rehabilitation/Improvement of Drainage Structures
 - Provision of Bus Bays
 - Improvement of Intersections

- * Category B "Urgent Repair of Pot-holes"

- * Category C "Improvement of Road Maintenance System".
 - Construction of Road Maintenance Depot
 - Provision of Maintenance Equipment
 - Technical Assistance and Training Programme

Implementation of each category is divided into three phases in terms of short, middle and long-term plans taking into consideration the priority and urgency engineering and socio-economy as well as the policy of the Tanzanian Government with in the following target years:

- Short-term Plan (1990 - 1994)
- Middle-term Plan (1995 - 1999)
- Long-term Plan (2000 -)

11.2. Evaluation of Proposed Roads under Category A

11.2.1 Criteria for Priority Order

Determination of priority or urgency given to the proposed roads (205 km) selected under Category A has been made primarily according to the degree of pavement deterioration and traffic congestion existing on the roads. However, also taken into account were the socio-economic impact of the proposed roads on their surrounding areas and the priority given by the Tanzanian government.

Items considered for the evaluation consist of three major categories of criteria, namely (1) Engineering Perspectives, (2) Socio-economic Perspectives and (3) Government Priority.

Each category is further divided into sub-categories shown below:

(1) Engineering Perspectives

1-a Deterioration of Pavement

The level of deterioration was judged according to the results taken from the PSI (Present Serviceability Index) survey.

1-b Traffic Congestion

The level of congestion was determined using C.R (Congestion Ratio) obtained through analysis of traffic capacity.

1-c Present Traffic Volume

Volume of ADT (Average Daily Traffic) on each road was estimated on the basis of the traffic count survey.

(2) Transport Network/Socio-Economic Perspectives

2-a Road Classification

The function or importance of a road is judged in accordance with road classifications, namely Arterial, Collector and Local roads.

2-b Landuse Pattern

The degree of impact on surrounding areas depends on the land-use situation along the proposed roads. The land-use pattern was classified into Commercial/Industrial, Residential and Agricultural/Less developed areas. Criteria of classification is given in Appendix 11-1-1.

2-c Development Potential

The impact of the proposed roads is estimated taking into consideration the existing development plans on the areas influenced along the roads. Degree of impact was estimated in accordance with the criteria shown in Appendix 11-1-2.

(3) Priority of Government

Priority given by the Tanzanian government to each road was considered in evaluating of proposed roads.

11.2.2 Ranking and Evaluation of the Proposed Roads

On the basis of the criteria evaluated in paragraph 11.2.1, quantification for each proposed road was conducted.

Primary data used for quantification were collected through field survey on road inventory, pavement condition, traffic count and OD survey, analysis of traffic congestion, road network, land-use pattern, and socio-economy.

In this Study, arbitral weight method was employed in evaluating major criteria and sub-criteria taking into consideration the magnitude of impact as well as the degree of pavement deterioration and congestion level of the existing roads.

The marks assigned to each item are given in Table 11.1.

Scores provided to each road for sub-criterion are summed up according to each category and a total evaluation score is obtained for each road.

Table 11.1 Criteria for Selection of High Priority Roads (100km)

<u>Items of Evaluation</u>	<u>Mark</u>	<u>Remarks</u>
A. <u>Engineering View Points (60)</u>		
A-1. Deterioration Level of Pavement	<u>30</u>	
- Very Bad (PSI Value:0.0 - 1.5)	30	Reconstruction
- Bad (PSI Value:1.5 - 2.5)	15	Overlay
- Fair/Good(PSI Value:2.5 - 5.0)	0	Maintenance
A-2. Present Traffic Congestion	<u>20</u>	
- Heavily Congested (C.R>1.5)	20	Widening
- Congested (1.0≤C.R≤1.5)	10	Imprv. required
- Ordinary(C.R<1.0) (C.R; Congestion Rate)	0	No improvement
A-3. Present Traffic Volume	<u>10</u>	
- ADT more than 10,000	10	
- 1,000 ≤ ADT ≤ 10,000	5	
- ADT less than 1,000	0	
B. <u>Transport Network/Socio-Economic View Points (30)</u>		
B-1. Function of Road	<u>10</u>	
- Arterial/Collector Roads	10	
- Main/Important Local Roads	5	
- Other Minor Roads	0	
B-2. Existing Landuse Pattern	<u>10</u>	
- Commercial/Industrial Areas	10	
- Residential Areas	5	
- Agriculture/Less Developed Areas	0	
B-3. Future Development Potential	<u>10</u>	
- Commercial/Industrial Areas	10	
- Residential Areas	5	
- Agriculture/Less Developed Areas	0	
C. <u>Policy of Government (10)</u>		
- Priority roads proposed by Gov.	<u>10</u>	
- Other roads	0	
Total	<u>100</u>	

The result of scores obtained for each road are presented in Table 11.2.

In ranking the proposed roads according to the criteria established in the previous paragraph, this study employed a group ranking method as follows:

- Rank A: Roads whose scores are higher than the average value
- Rank B: Roads whose scores fall in between the average value and 2/3 of the average
- Rank C: Roads whose scores are lower than 2/3 of the average value

As a result, the roads with a total length of 103 km fell into Rank A as shown in Table 11.3. These are deemed to have priority from the view point of engineering and socio-economy as well as high priority roads among the selected roads of 205 km.

11.2.3 Issue of New Bagamoyo/Upanga Roads

Among the roads classified in Rank A, New Bagamoyo and Upanga Roads were not proposed by DCC as the priority project in this study because of the commitment of Italian Government for its construction.

The government of Tanzania, however, changed their stands recently and decided to exclude a portion of the road from Tanganika Roundabout to Mapakani Road Junction (9,8 km) from the list of proposal sent to Italian government taking into consideration the result of evaluation made by the Study Team for these roads with the highest priority on the implementation.

Under such a situation, the government of Tanzania requested to include the said sections into this Study as the highest priority projects to be implemented in the short-term plan, for which Japanese side finally agreed.

Table 11.2 Scores Obtained by Each Criteria
(Improvement of Road Structures)

Link No.	Name of Roads	Road Length (km)	Scores Obtained by Each Criteria							Total (100)	
			Engineering View Points			Transpot/Socio Poli- Economy cy					
			A-1 (30)	A-2 (20)	A-3 (10)	B-1 (10)	B-2 (10)	B-3 (10)	C-1 (10)		
1. Arterial Roads											
1-1	New Bagamoyo	23.0									
-	Up to Mpakani J.	(8.0)	15	20	10	10	5	10	10		80
-	Up to Wazo Hill	(15.0)	15	10	10	10	5	10	10		70
1-2	Morocco	3.5	15	10	10	10	5	0	10		65
1-3	Kinondoni	0.7	30	10	10	10	5	0	10		75
1-4	Morogoro	9.5									
-	Up to Ring Rd.	(5.0)	15	20	10	10	10	0	10		75
-	Up to TRM 4.5km	(4.5)	15	0	10	10	0	10	10		55
1-8	Bandari	2.2	15	10	10	10	10	10	10		75
1-9	Kilwa										
-	Up to 8.6km	8.6	15	0	10	10	5	10	10		60
1-10	Uhuru	2.8	15	20	10	10	5	0	10		70
1-11	Msimbazi	1.6	15	10	10	10	10	0	10		65
1-13	Upanga	1.8	15	20	10	10	10	10	10		85
1-15-1	Nkrumah	0.3	15	10	10	10	10	0	10		65
1-15-3	Sokoine	0.8	15	10	10	10	10	0	10		65
1-15-4	Gerezani	1.2	15	10	10	10	10	10	10		75
1-15-5	Kivukoni	1.0	15	0	10	10	10	0	10		55
1-15-6	Maktaba	0.9	15	10	10	10	10	0	10		65
1-15-7	Ohio	1.0	15	10	10	10	10	0	10		65
1-15-8	Ocean	3.2	15	0	10	10	5	0	10		50
	Sub-total (1)	62.1km									1.190
											Ave. = 1,190/18 = 67.5
2. Collector Roads											
2-1	Old Bagamoyo	8.2	30	0	5	10	5	10	10		70
2-2	Haile Sellasie	5.0	30	0	5	10	5	10	10		70
2-3	Toure Drive	5.6	15	0	5	10	5	10	10		55
2-4	Bongoyo	0.8	15	0	5	10	5	10	10		55
2-5	Shekilango	3.8	30	0	5	10	5	0	10		60
2-6	Kondoa	1.2	15	0	5	10	5	10	10		55
2-7	Mwinjuma	2.4	30	0	5	10	5	0	10		60
2-8	Makanya	5.0	30	0	5	10	5	10	10		70
2-10	Kigogo C-1	2.0	15	0	0	10	10	10	10		55
2-13	Old Kigogo	6.8	30	0	5	10	5	10	10		70
2-14	Kagera	2.0	15	0	0	10	5	0	10		40
2-15	Mikumi	1.1	30	0	0	10	5	10	10		65
2-16	New Kigogo	2.7	15	10	10	10	5	0	10		60
2-17	Chango'mbe	4.6	15	10	10	10	10	10	10		75
2-18	Temeke	1.9	0	0	5	10	5	10	10		40
2-19	Mbagala I	1.4	30	0	5	10	5	10	10		70
	Sub-total (2)	54.5km									980
											Ave. = 980/16 = 61.3
3. Local Roads (Area Roads Proposed by DCC)											
A.	Oyster Bay Area	8.1	15	0	5	0	5	10	10		45
D.	Central Area	10.3	15	10	5	5	10	10	10		65
C.	Kariakoo Area	30.0	30	10	5	5	10	0	10		70
F.	Chango'mbe Area	14.6	30	0	5	5	10	10	10		70
G.	Temeke Area	13.9	15	0	5	0	5	0	10		35
H.	Ilala Area	10.3	30	0	5	0	5	0	10		50
I.	Mwinjuma L-1	1.5	30	0	5	0	5	0	10		50
	Sub-total (3)	88.7km									385
											Ave. = 385/7 = 55.0
	Total	205.3km									Average = 2.580/41 = 62.9

Table 11.3 Ranking of Project Roads
(Improvement of Road Structures)

Link No.	Name of Roads	Road Length (km)	Total Score (S)	Ranking of Project Roads		
				Rank A Ave.<S (km)	Rank B 2/3Ave<S<Ave (km)	Rank C S<2/3Ave. (km)
<u>1. Arterial Roads</u>						
1-1	New Bagamoyo	23.0				
-	Up to Mpakani J.	(8.0)	80	8.0		
-	Up to Wazo Hill	(15.0)	70		15.0	
1-2	Morocco	3.5	65	3.5		
1-3	Kinondoni	0.7	75	0.7		
1-4	Morogoro	9.5				
-	Up to Ring Rd.	5.0	75	5.0		
-	Up to TRM	4.5km	55		4.5	
1-8	Bandari	2.2	75	2.2		
1-9	Kilwa					
-	Up to 8.6km	8.6	60		8.6	
1-10	Uhuru	2.8	70	2.8		
1-11	Msimbazi	1.6	65	1.6		
1-13	Upanga	1.8	85	1.8		
1-15-1	Nkrumah	0.3	65	0.3		
1-15-3	Sokoine	0.8	65	0.8		
1-15-4	Gerezani	1.2	75	1.2		
1-15-5	Kivukoni	1.0	55		1.0	
1-15-6	Maktaba	0.9	65	0.9		
1-15-7	Ohio	1.0	65	1.0		
1-15-8	Ocean	3.2	50		3.2	
Sub-total (1)		62.1km	1,215	29.8km	32.3km	0.0km
<u>2. Collector Roads</u>						
2-1	Old Bagamoyo	8.2	70	8.2		
2-2	Haile Sellasie	5.0	70	5.0		
2-3	Toure Drive	5.6	55		5.6	
2-4	Bongoyo	0.8	55		0.8	
2-5	Shekilango	3.8	70	3.8		
2-6	Kondoa	1.2	55		1.2	
2-7	Mwinjuma	2.4	60		2.4	
2-8	Makanya	5.0	70	5.0		
2-10	Kigogo C-1	2.0	55		2.0	
2-13	Old Kigogo	6.8	70	6.8		
2-14	Kagera	2.0	40			2.0
2-15	Mikumi	1.1	65	1.1		
2-16	New Kigogo	2.7	60		2.7	
2-17	Chango'mbe	4.6	75	4.6		
2-18	Temeke	1.9	40			1.9
2-19	Mbagala I	1.4	70	1.4		
Sub-total (2)		54.5km	980	35.9km	14.7km	3.9km
<u>3. Local Roads (Area Roads Proposed by DCC)</u>						
A.	Oyster Bay Area	8.1	45		8.1	
D.	Central Area	10.3	65	10.3		
E.	Kariakoo Area	30.0	70	30.0		
F.	Chango'mbe Area	14.6	70	14.6		
G.	Temeke Area	13.9	35			13.9
H.	Ilala Area	10.3	50		10.3	
I.	Mwinjuma L-1	1.5	50		1.5	
Sub-total (3)		88.7km	385	54.9km	19.9km	13.9km
Total		205.3km	2,580	120.6km	66.9km	17.8km

Note: Average Value = $2,580/41 = 62.9$
2/3 Ave. Value = $62.9 \times 2/3 = 42.0$

11.2.4 Package of Proposed Roads

The proposed roads classified in Rank A were grouped into packages taking into consideration the ease of construction during the implementation stage.

Package of proposed roads was made on the basis of the following criteria:

- Road network requirement to ensure better and efficient connection in the regional road network, including reinforcement of accessibility from local roads to collector or arterial roads and linkage between rural areas and urban areas.
- Socio-economic requirements needed to improve road systems in the areas in view of the stimulation of economic activities as well as the minimum requirement of infrastructures.

Proposed roads were grouped into 13 nos. of packages.

11.2.5 Evaluation of Proposed Roads Packaged

In determining the ranking of proposed roads packaged in the above, the same group ranking method as the method of ranking for proposed roads in paragraph 11.2.2 was employed as shown below:

- Rank A: Packages whose scores are higher than the average value
- Rank B: Packages whose scores are lower than the average value

Table 11.4 shows the result of the score obtained by each package and as the result, the following 6 packages with a total length of 103.4 km were selected to be Rank A.

Table 11.4 Ranking of Packaged Roads
(Improvement of Road Structures)

Package No.	Link No.	Name of Roads	Road Length (km)	Total Score	Ave. Score (S)	Ranking of Package	
						Rank A Ave. < S	Rank B S < Ave.
P-1		<u>Morogoro Ext. 1</u>	5.0	75	75	5.0	-
	1-4-1	Up to Port Access	5.0	75			
P-2		<u>New Bagamoyo Group</u>	9.8	165	83	9.8	-
	1-13	Upanga	1.8	85			
	1-1-1	New Bagamoyo up to Mpakani Junc.	8.0	80			
P-3	1-9	<u>Kilwa Road</u>	8.6	60	60	-	8.6
P-4		<u>Oyster Bay Group</u>	27.7	295	59	-	27.7
	Area A.	Oyster Bay Area	8.1	45			
	2-2	Haile Sellasie	5.0	70			
	2-3	Toure Drive	5.6	55			
	2-4	Bongoyo	0.8	55			
	2-1	Old Bagamoyo	8.2	70			
P-5		<u>Mwinjuma Group</u>	16.9	390	65	16.9	-
	Area B.	Mwinjuma	2.4	60			
	I	Mwinjuma L-1	1.5	50			
	1-2	Morocco	3.5	65			
	1-3	Kinondoni	0.7	75			
	2-5	Shekilango	3.8	70			
	2-8	Makanya	5.0	70			
P-6		<u>Kigogo Group</u>	15.8	345	58	-	15.8
	2-1	Old Kigogo	6.8	70			
	2-6	Kondoa	1.2	55			
	2-14	Kagera	2.0	40			
	2-15	Mikumi	1.1	65			
	2-10	Kigogo C-1	2.0	55			
	2-16	New Kigogo	2.7	60			
P-7		<u>Central Group</u>	20.9	565	63	20.9	-
	Area C.	Central Area	10.3	65			
	1-8	Bandari	2.2	75			
	1-15-1	Nkrumah	0.3	65			
	1-15-2	Sokoine	0.8	65			
	1-15-4	Gerezani	1.2	65			
	1-15-5	Kivukoni	1.0	50			
	1-15-6	Maktaba	0.9	65			
	1-15-7	Ohio	1.0	65			
	1-15-8	Ocean	3.2	50			
P-8		<u>Kariakoo Group</u>	31.6	135	68	31.6	-
	Area E.	Kariakoo Area	30.0	70			
	1-11	Msimbazi	1.6	650			
P-9		<u>Chango'mbe Group</u>	19.2	145	73	19.2	-
	Area F.	Chango'mbe Area	14.6	75			
	2-17	Chango'mbe	4.6	70			
P-10		<u>Temeke Group</u>	17.2	145	48	-	17.2
	Area G.	Temeke Area	13.9	35			
	2-18	Temeke	1.9	40			
	2-19	Mbagala I	1.4	70			
P-11		<u>Ilala Group</u>	13.1	60	60	-	13.1
	Area H.	Ilala Area	10.3	50			
	1-10	Uhuru Road	2.8	70			
P-12		<u>Morogoro Ext. 2</u>	4.5	60	60	-	4.5
	1-4-2	Up to TRM 4.5	4.5	60			
P-13		<u>Bagamoyo Road from Mpakani to Wazo Hill</u>	15.0	(70)		(15.0)	-
	1-1-2	Mpakani to Wazo Hill					
	Total		205.3km	2,580		103.4km	86.9km

Note: Bagamoyo Road from Mpakani Road junction up to Wazo Hill was deleted from the subject of the Study because of the commitment of Italian Government.

Priority Order of Packages Evaluated in Rank A

Priority Order	Package No.	Name of Package	Project Length
(1)	P-2	New Bagamoyo Group	9.8 km
(2)	P-1	Morogoro Road	5.0 km
(3)	P-9	Chango'mbe Group	19.2 km
(4)	P-8	Kariakoo Group	31.6 km
(5)	P-5	Mwinjuma Group	16.9 km
(6)	P-7	Central Group	20.9 km
Total			103.4 km

Detailed of each package with preliminary cost are presented in Table 11.5.

11.3 Evaluation of Urgent Repair of Pot-holes under Category B

Pot-holes have increased to such an extent on the pavement of existing roads which causes serious damages on the vehicles and traffic accidents. The Study Team therefore recommends to repair these pot-holes immediately from the view point of the safety of public.

11.4 Evaluation of Proposed Maintenance Systems under Category C

Improvement measures on road maintenance system under Category C consists of three major work items; (1) Establishment of Road Maintenance Depots, (2) Procurement of Plants and Equipment and (3) Technical Assistance and Training Programme.

Each improvement measures is further divided into the sub-work units as shown below:

- (1) Establishment of Road Maintenance Depots
 - 1 no. of Main Depot
 - 4 no. of Site Depots

Table 11.5 Priority Package of Road under Category A

<u>Rank</u>	<u>Package</u>	<u>Name of Packages</u>	<u>Project</u>	<u>Approx.</u>	<u>Link</u>
<u>ing</u>	<u>No.</u>	<u>and Roads</u>	<u>Length</u>	<u>Cost</u>	<u>No.</u>
			(km)	(Tsh. M)	
1	P-2	<u>New Bagamoyo Group</u>	<u>9.8</u>	890	
		- Upanga Road	(1.8)		1-13
		- New Bagamoyo Road	(8.0)		1-1-1
2	P-1	<u>Morogoro Ext. 1</u>	<u>5.0</u>	810	1-4-1
		- Up to Port Access			
3	P-9	<u>Chango'mbe Group</u>	<u>19.2</u>	510	
		- Chango'mbe Area Roads	(14.6)		Area F
		- Chango'mbe Road	(4.6)		2-17
4	P-8	<u>Kariakoo Group</u>	<u>31.6</u>	900	
		- Kariakoo Area Roads	(30.0)		Area E
		- Msimbazi	(1.6)		1-11
5	P-5	<u>Mwinjuma Group</u>	<u>16.9</u>	450	
		- Mwinjuma	(2.4)		Area B
		- Mwinjuma L-1	(1.5)		L-1
		- Morocco	(3.5)		1-2
		- Kinondoni	(0.7)		1-3
		- Shekilango	(3.8)		2-5
		- Makanya	(5.0)		2-8
6	P-7	<u>Central Group</u>	<u>20.9</u>	440	
		- Central Area	(10.3)		Area C
		- Bandari	(2.2)		1-8
		- Nkrumah	(0.3)		1-15-1
		- Sokoine	(0.8)		1-15-2
		- Gerezani	(1.2)		1-15-4
		- Kivukoni	(1.0)		1-15-5
		- Maktaba	(0.9)		1-15-6
		- Ohio	(1.0)		1-15-7
		- Ocean	(3.2)		1-15-8
Total			103.4 km	4,000	

(2) Procurement of Plants and Equipment

- Procurement of equipment required for daily and routine maintenance work
- Procurement of plants and equipment required for major improvement work including overlay and reconstruction of pavements

(3) Technical Assistance and Training

- Technical assistance for administration or supervision of maintenance work
- Training for mechanics and operators

In determining the order of priority for the above work, the Study Team employed the following criteria:

* Establishment of Road Maintenance Depots

The begin with a main depot should be established for road maintenance in Dar es Salaam taking into consideration the difficulty in allocating the local budget for operating maintenance depots.

Another 4 site depots should be built at the later stage after bringing-up the administrators, engineers and technicians including operators and mechanics through on-the-job-training of maintenance which to be undertaken at the main depot.

* Procurement of Plants and Equipment

Type and numbers of plants and equipment should be determined taking into account the kind of work involved for maintenance as well as the volume of work to be done per month.

The Study Team suggestes to first procure the type of equipment required for dailly and routine maintenance work. Heavy equipment to be used for overlay and reconstruction of pavement, such as crushing plants, aspahlt finishers, vibration rollers, bulldozers, etc. should be procured at a later stage after the road maintenance teams are substantially organized.

* Technical Assistance and Training Programme

In order to operate and administer the maintenance depots smoothly and without problems, it is recommended that technical assistance from other countries advanced in road maintenance technology, be received immediately after establishing the main depot.

A training programme for engineers and technicians should be implemented in conjunction with the Technical Assistance Programme.

Summary of evaluation results was presented in Table 11.6.

Table 11.6 Priority of Improvement Measures for Road Maintenance under Category C

Improvement Measures	Rank A	Rank B
<u>1. Establishment of Road Maintenance Depot</u>		
- 1 No. of Construction of Maintenance Depot	o	-
- 4 Nos of Strengthen of Site Depots	-	o
<u>2. Procurement of Plant and Equipment</u>		
- Procurement of Equipment for Daily and Routine Maintenance Works	o	-
- Procurement of Plant and Equipment for Major Improvement Works	-	o
<u>3. Technical Assistance and Training</u>		
- Technical Assistance for administration and supervision of maintenance works	one expert	-
- Training for mechanic and operators	one expert	-

11.5 Formulation of Implementation Plan

11.5.1 General

The projects proposed in Categories A, B and C were classified into short, middle and long-term plans with the target year as shown below in accordance with the Scope of Works on the basis of the evaluation made for each improvement measures in sub-clause 11.2 through 11.4

- Short-term Plan : 1990 - 1994
- Middle-term Plan : 1995 - 1999
- Long-term Plan : 2000 - 2005

The implementation plan of projects in each category was formulated taking into consideration the project costs required, ease of construction, construction period, expected impacts to the influenced areas, policy of the government, etc. as follows:

11.5.2 Short-term Plan

(1) Category A: Improvement of Road Structures

Six (6) packages of road projects obtained the scores in Rank A are judged to be urgent works which are to be implemented in the short-term plan as follows:

- New Bagamoyo Road/Upanga Road, 9.8 km
- Morogoro Road, 5.0 km
- Chang'ombe Area Roads, 19.2 km
- Kariakoo Area Roads, 31.6 km
- Mwinjima Area Roads, 16.9 km
- Central Area Roads, 20.9 km

(2) Category B: Urgent Repair of Pot-holes

This improvement measure was proposed as the urgent measures so that it should be implemented in the short-term plan.
(205 km)

(3) Category C: Improvement of Maintenance System

DCC will be responsible for the maintenance after completion of the improvement under the Category A. DCC is, therefore,

required to establish proper road maintenance system before taking over the project roads. Thus, construction of new main depot and procurement of maintenance equipment proposed in the Category C should be implemented at the early stage of the short-term plan.

It is noted that the equipment to be provided in this stage shall be the light equipment to be used for daily and routine maintenance.

11.5.3 Middle-term Plan

In the middle-term plan, it is recommended to implement the remaining priority roads classified into Rank B of Category A as shown below. The procurement of heavy equipment to be used for overlay and reconstruction shall also be implemented in the middle-term plan.

(1) Category A: Improvement of Road Structures

Overlay and reconstruction of the following area roads:

- Ilala Area Group, 13.1 km
- Oyster Bay Area Roads, 27.7 km
- Kigogo Area Roads, 15.8 km
- Temeke Area Roads, 17.2 km

In addition to the above, the following arterial roads should be improved:

- Kilwa Road (Overlay), 8.6 km
- Morogoro Road from Port Access Junction to TRM (Overlay and Reconstruction), 4.5 km
- Central Ring Road consisting of Ohio, Sokoine, Gerezani and Bandari Roads (Widening from 2 to 4 lanes), 5.2 km

(2) Category C: Improvement of Maintenance System

- Procurement of equipment required for overlay and reconstruction of the roads

11.5.4 Long-term Plan

As stated in the Chapter 5, strengthening of Middle Ring Road as well as the improvement of intersections by grade separation are essential for the future road network system in Dar es Salaam. The Study Team therefore recommends to implement the following measures:

(1) Category A: Improvement of Road Structures

- Improvement of Middle Ring Road (P-14) consisting of;
(Total Length: 10.8 km, Total Cost: Tsh. 26,000 million)
 - a. Widening of Morocco, New Kigogo and Chang'ombe Roads from 2 to 4-lane and provision of grade separated interchange at Morogoro and Uhulu Roads,
(Length: 10.8 km, Cost: Tsh. 1,500 million)
 - b. Construction of missing link in between New Kigogo and Chang'ombe by elevated structures with grade separated interchange at Pugu Road,
(Length: 1.0 km, Cost: Tsh. 800 million)
 - c. Direct connection of Middle Ring Road with Port by Extension of Chang'ombe Road up to Port Access.
(Length: 2.5 km, Cost: Tsh. 300 million)

- Improvement of Intersections by grade separation (P-15) at the following: (Total Cost: Tsh. 500 million)
 - a. Intersection at Pugu Road/Port Access
 - b. Intersection at Pugu Road/Msimbazi Road

11.5.5 Summary of Implementation Plan and High Priority Projects

The implementation of short, middle and long-term plans as mentioned above was summarized in Table 11.7 and Fig.11.1.

Fig. 11.2 shows the tentative schedule of each improvement measures with an annual budget required.

The projects selected in the short-term plan were determined to be high priority projects under this study for subsequent preliminary engineering design in Chapter 12.

Table 11.7 Summary of Implementation Plan

Improvement Measures	Quantity	Fund Re- quirement (Tsh.xMill)
1. Short Term Plan		
<u>Category A: Improvement of Road Structures</u>		
P-2 Widening of New Bagamoyo Group	9.8	890
- Upanga Road	(1.8)	
- New Bagamoyo up to Mpakani Junction	(8.0)	
P-1 Widening of Morogoro up to Port Access	5.0	810
P-9 Improvement of Chango'mbe Group	19.2	510
- Chango'mbe Area Roads	(14.6)	
- Chango'mbe Road	(4.6)	
P-8 Improvement of Kariakoo Group	31.6	900
- Kariakoo Area Roads	(30.0)	
- Msimbazi Road	(1.6)	
P-5 Improvement of Mwinjuma Group	16.9	450
- Mwinjuma Area Roads	(2.4)	
- Mwinjuma L-1 Road	(1.5)	
- Morocco Road	(3.5)	
- Kinondoni Road	(0.7)	
- Shekilango Road	(3.8)	
- Makanya Road	(5.0)	
P-7 Improvement of Central Group	20.9	440
- Central Area Roads	(10.3)	
- Bandari Street	(2.2)	
- Nkrumah Street	(0.3)	
- Sokoine Drive	(0.8)	
- Gerezani Street	(1.2)	
- Kivukoni Street	(1.0)	
- Maktaba Street	(0.9)	
- Ohio Street	(1.0)	
- Ocean Drive	(3.2)	
Sub-total (A)	103.4 km	4,000
<u>Category B: Urgent Repair of Pot-holes</u>		
U-1 Urgent Repair of Pot-holes	Sub-total (B)	205.9 km 190
<u>Category C: Improvement of Maintenance Systems</u>		
M-1 Construction of Main Depot	1 no.	170
M-2 Provision of Equipment (Phase I)	Sum	110
M-3 Technical Assistance/Training	T/A	-
Sub-total (C)		280
Total of Short-term Plan (A+B+C)		Tsh. 4,470
2. Middle Term Plan		
<u>Category A: Improvement of Road Structures</u>		
P-3 Improvement of Kilwa Road	8.6	120
P-11 Improvement of Ilala Area Roads	13.1	600
- Ilala Area Road	(10.3)	
- Uhuru Road	(2.8)	
P-4 Improvement of Oyster Bay Group	27.7	550
- Oyster Bay Area Roads	(8.1)	
- Haile Sellasie	(5.0)	
- Toure Drive	(5.6)	
- Bongoyo Street	(0.8)	
- Old Bagamoyo Road	(8.1)	
P-6 Improvement of Kigogo Group	15.8	460
- Old Kigogo Road	(6.8)	
- Kondoia Street	(1.2)	
- Kagera Street	(2.0)	
- Mikumi Street	(1.1)	
- Kigogo C-1	(2.0)	
- New Kigogo Road	(2.7)	
P-10 Improvement of Temeke Group	17.2	510
- Temeke Area Roads	(13.9)	
- Temeke Road	(1.9)	
- Mbagala I Road	(1.4)	
P-13 Improv. of Morogoro Beyond Port Access	4.5	60
P-14 Improv. of Central Ring Road (Widning)	5.2	780
Sub-total (A)	110.2 km	3,080
<u>Category C: Improvement of Maintenance Systems</u>		
M-4 Construction of Site Depots	4 nos.	50
M-5 Provision of Equipment (Phase II)	Sum	270
Sub-total (C)		320
Total of Middle-term Plan (A+C)		Tsh. 3,400
3. Long Term Plan		
<u>Category A: Improvement of Road Structures</u>		
P-15 Improvement of Middle Ring Roads	14.3	2,600
P-16 Improv. of 2 Intersections by grade separation		500
Sub-total (A)	14.3 km	3,100
Total of Long-term Plan (A)		Tsh. 3,100

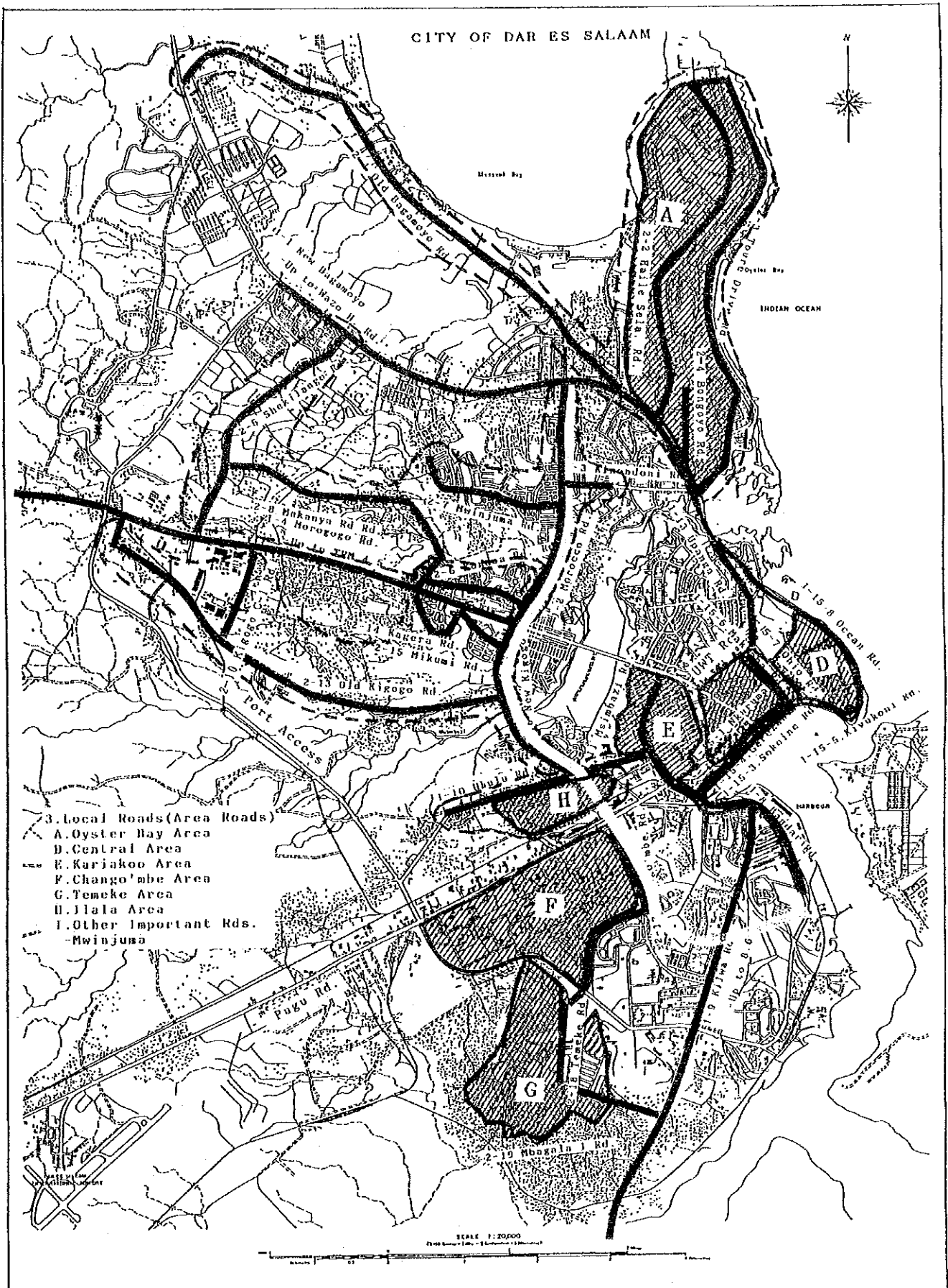





Fig. 11-1 Summary of Implementation Plan

Short Term 
 Medium Term 
 Long Term 

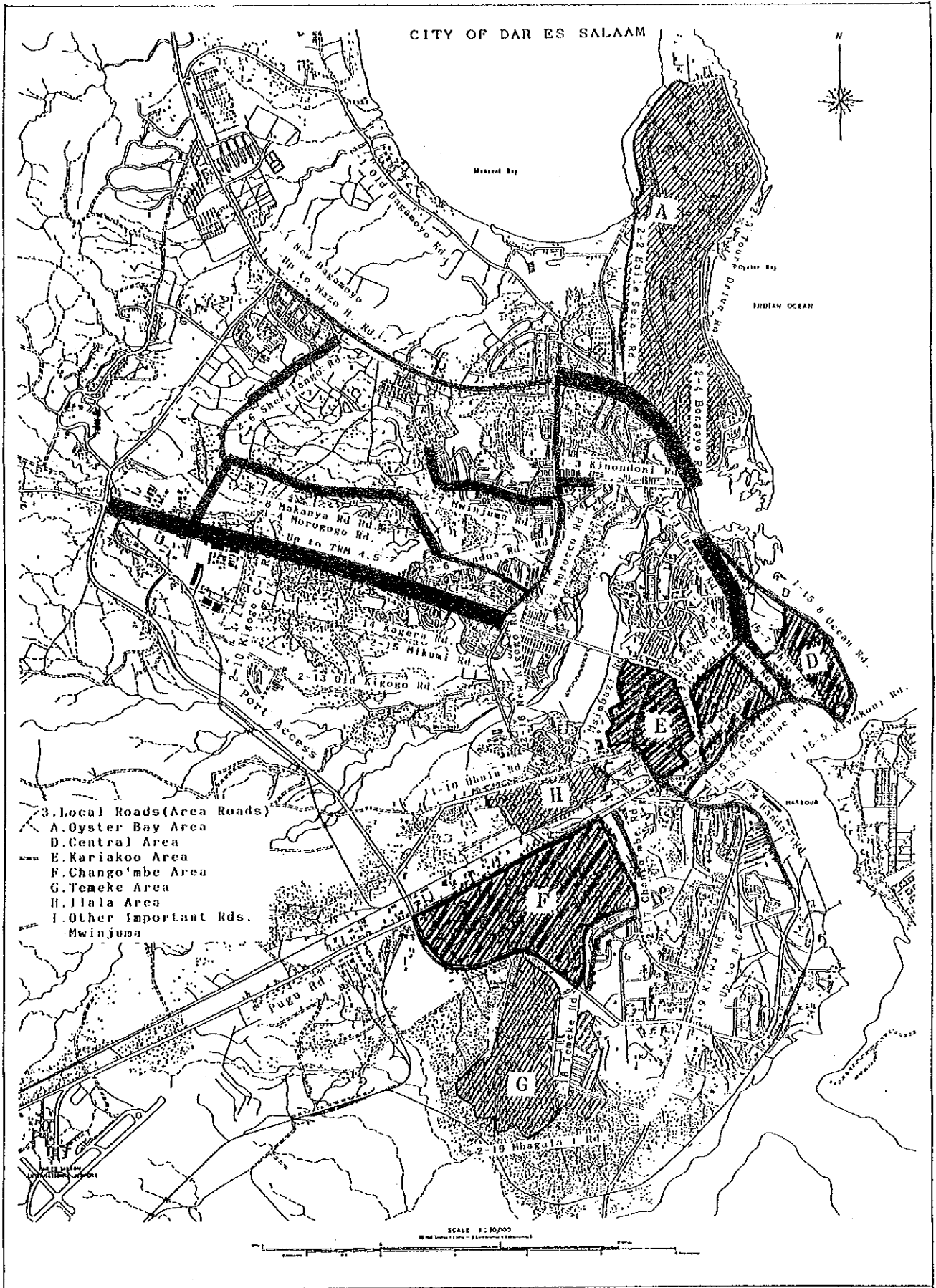


Fig. 11-3

High Priority Projects of Short Term Plan

- Deerlay
- Reconstruction
- Area
- Widening

CHAPTER 12 PRELIMINARY ENGINEERING DESIGN FOR THE HIGH PRIORITY PROJECTS

12.1 General

Supplemental field surveys were carried out along the high priority project roads selected in the previous chapter.

On the basis of the data and information obtained through the supplemental field surveys, the preliminary engineering design was conducted using the existing topographical maps with a scale of 1/2,500.

12.2 Supplemental Field Surveys

The supplemental surveys conducted by the Study Team are the following items:

- Topographical survey
- Utilities survey
- Traffic survey on area roads
- Intersection traffic movement
- Pavement structural component survey
- Road inventory and drainage survey

12.2.1 Topographical Survey

The existing topographical maps (Photo. dated March, 1982) with a scale of 1/2,500 are available in the Survey Department and covers the whole area of Dar es Salaam City.

In order to obtain the data and information required for subsequent preliminary engineering design, supplemental topographical survey was conducted by the Study Team. The survey was

made along the widening sections of the projects, namely Morogoro, Upanga and New Bagamoyo Roads, to identify the major changes in topographical conditions as well as to check the buildings and houses which are irregularly occupied in the right-of-way.

Topographical maps with a scale of 1/500 have been prepared by the Study Team for the design of major intersections of Tanganyika Motor Roundabout, Morocco Junction and Port Access Junction which are proposed to be improved to the signal controlled intersections.

Cross sectional survey was carried out with an interval of 50m along the widening sections to estimate the required volume of earthwork.

Bench mark (BM) maps with an elevation were collected from the Land Survey Department, however, most of the bench marks shown in the maps were already interfered or demolished by road and building constructions so that no bench marks were confirmed in and near the proposed project sites.

Effective width of existing roadway of Upanga Road was measured carefully by the Study Team so that the proposed widening measure would not interfere with the lands or lots occupied by the embassies of other countries.

12.2.2 Utilities Survey

Utilities survey was conducted along the widening sections of Morogoro, Upanga and New Bagamoyo Roads to identify the existing utilities which might be affected by the construction of the Project and relocated to the suitable place during or before construction.

Utilities maps showing the approximate location with dimension of underground utilities were also collected from the government and agency concerned.

(1) Water Main (National Urban Water Authority)

There are water mains with a diameter of 18' to 58' laid along Morogoro and Upanga/New Bagamoyo Roads. Pumping station is located near the junction of New Bagamoyo/Mpakani.

Since water mains are laid mostly beneath 2 m in depth, they would not be affected by the road construction with the exception of the hydrants which are located alongside roads and protected with concrete walls. These hydrants might be necessary to be replaced or protected properly so as not interfere with the road improvement projects.

(2) Telephone Underground Cable and Lines (POSTA)

Underground telephone cables exist along Morogoro Road and Upanga/New Bagamoyo Roads.

The improvement of tele-communication system (Phase 1) in Dar es Salaam City is being undertaken by the study team of JICA and the installation of new telephone cable will be started soon according to the officials concerned. This phase 1 project will cover the eastern area of Dar es Salaam including Central and Oysterbay areas so that new telephone cables to be laid along Upanga Road might be affected by widening of Upanga Road.

The location of new cable should be determined taking into consideration the proposed widening projects of Upanga Road.

(3) Electric Wire and Pole (TANESCO)

There are existing high tension lines (H.T Line) installed along the project roads which should be replaced to proper location so as not interfere with the construction of the project roads.

(4) Sewerage and Sanitary Pipes (DSSD)

Pipe culverts being used for sewerage and sanitary are located along the roads and joined with the existing roadside drainage system. These pipes should not be disturbed and be maintained as they are, special care should be given during the construction of the project.

12.2.3 Supplementary Traffic Survey on Area Roads

Supplementary traffic survey was conducted on area roads selected as the high priority project, namely Chang'ombe, Kariakoo, Mwinjima and Central Areas, to obtain necessary traffic data and information required for estimating the projected future traffic volume which will be used for the calculation of project benefits.

Traffic by type of vehicle was counted for 10 hours from 7 a.m. to 5 p.m. at the following representative area roads: (See Fig.12.1)

- Central Area :- Aggery Street
 - Zanaki Street
 - Libya Street
- Kariakoo Area :- Kongo Street
 - Mkunguni Street
 - Shikuku Street
- Chang'ombe Area :- Mbozi Road
 - Changa Street
- Mwinjuma Area :- Makanya Road

The results of survey on each area road are presented in Appendix 12.1.

Since it is impossible to conduct the traffic survey on all the existing roads in the Area during in this short time survey, the representative ADT on each Area have been developed on the basis of 10 hour traffic volume obtained the above, for estimation of projected future traffic in the area using the following formula:

$$ADT = T_{12} \times K \times 1/W$$

$$\text{where, } T_{12} = T_{10} + 2(T_{24} - T_{12})/12$$

$$T_{24}/T_{10} = 6K/(7-K)$$

$$T_{10} = 10\text{hrs day-time traffic volume}$$

$$K = \text{Daily/day-time traffic ratio}$$

$$W = \text{Weekly variation ratio}$$

The results of ADT calculated and existing representative tra

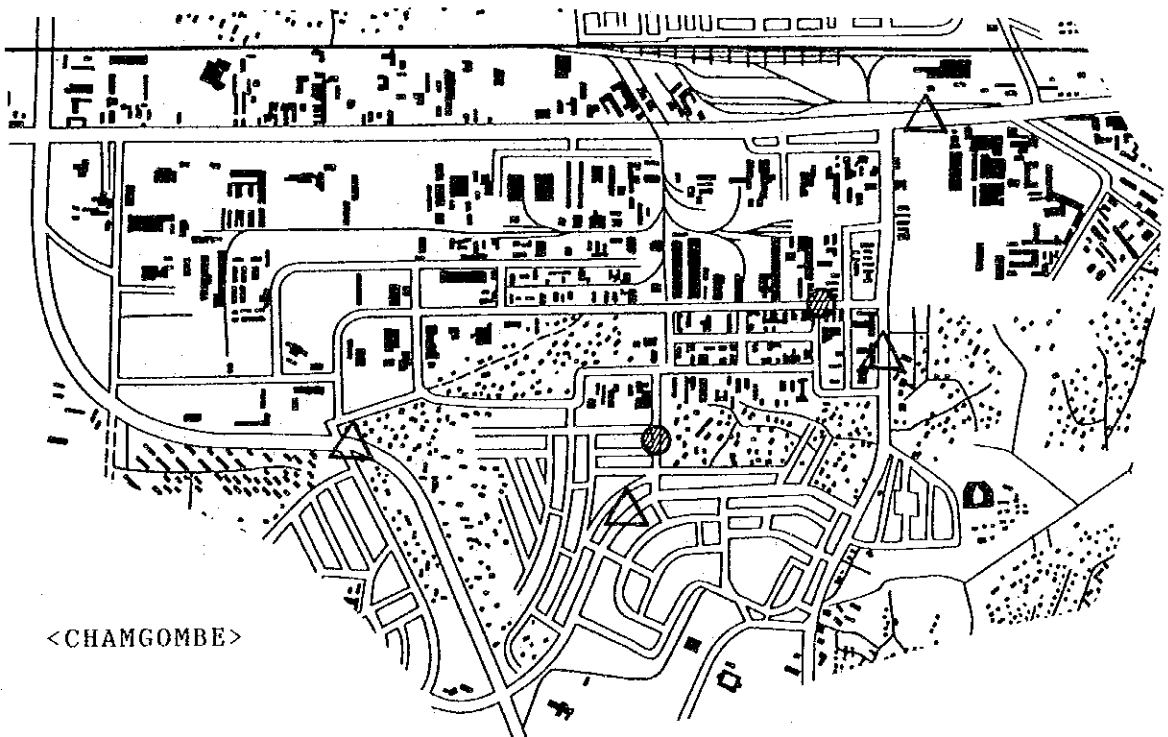
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Key:

◐ = Supplementary Traffic Survey Station

△ = Traffic Survey Stations Conducted on May 1989



<CHAMGOMBE>

Fig.12.1 Location Maps of Traffic Survey on Area Roads

Table 12-1 Calculation of ADT on each Local Road

Area name	Central Area			Kariakoo Area			Chang'ombe Area	Mwinji ma A.	
road name	Aggery street	Zanaki street	Libya street	Kongo street	Mkunguni street	Shikuku street	Mbozi road	Changa street	Mkanya road
Date	Nov.21, (tus)	-do-	-do-	-do-	Nov.22 (wed)	-do-	-do-	-do-	Dec.4 (mon)
<u>Observation value</u>									
1.Car	1298	3297	2585	346	1931	268	1553	753	105
2.Light G.	633	1279	1109	204	964	197	1124	423	82
3.Medium G.	121	146	137	41	174	64	572	126	43
4.Heavy G.	3	-	12	9	2	4	102	33	6
5.Bus	70	152	134	43	139	47	109	41	5
Total	2125	4874	3979	643	3210	580	3460	1376	241
<u>Daily/day-time Ratio</u>									
1.Car	1.39	do	do	do	do	do	do	do	do
2.Light G.	1.27	do	do	do	do	do	do	do	do
3.Medium G.	1.37	do	do	do	do	do	do	do	do
4.Heavy G.	1.06	do	do	do	do	do	do	do	do
5.Bus	1.32	do	do	do	do	do	do	do	do
<u>Weekly Variation Ratio</u>									
1.Car	1.00	do	do	do	1.00	do	do	do	1.00
2.Light G.	1.02	do	do	do	0.97	do	do	do	1.02
3.Medium G.	1.17	do	do	do	1.07	do	do	do	1.17
4.Heavy G.	0.72	do	do	do	0.92	do	do	do	0.72
5.Bus	1.04	do	do	do	0.86	do	do	do	1.04
<u>ADT value</u>									
1.Car	1804	4583	3593	481	2684	373	2159	1046	146
2.Light G.	820	1657	1437	264	1188	243	1385	521	106
3.Medium G.	194	234	220	66	255	94	838	185	69
4.Heavy G.	2	-	9	7	2	4	99	32	5
5.Bus	96	209	184	59	158	53	124	47	7
Total	2916	6683	5443	877	4287	767	4605	1831	333

Table 12-2 Existing Representative Traffic on Area Road

Area name	Road name	leng.	ADT in number					Total
			1.Car, taxi	2.light goods	3.Medium goods	4.Heavy goods	5.Bus	
Central area	Ohio St.	1.0km	8,771	2,585	343	43	993	12,735
	Maktaba St.	0.9	9,898	3,766	246	52	1,672	15,634
	Samora Ave.	0.8	9,159	3,148	111	23	294	12,735
	Morogoro Rd.	0.9	7,332	3,126	150	18	378	11,001
	Sokoine Dri.	0.8	10,990	4,442	812	42	2,155	18,441
	Aggerly St.	0.4	1,804	820	194	2	96	2,916
	Zanaki St.	0.9	4,583	1,657	234	-	209	6,683
Libya St.	0.5	3,593	1,437	220	9	184	5,443	
Average								
weighted	Arterial/collector		9,181	3,377	327	36	1,090	14,011
ADT/km	Local road		3,690	1,410	221	6	177	5,504
Kariakoo area	Uhuru St.	0.6	8,726	3,520	599	88	1,403	14,336
	Uhuru St.	0.6	9,202	5,348	1,372	177	2,606	18,705
	Msimbazi St.	1.6	6,242	2,756	966	49	3,419	13,432
	Kongo St.	1.1	481	264	66	7	59	877
	Mkunguni St.	0.9	2,684	1,188	255	2	158	4,287
	Shikuku St.	0.5	373	243	94	4	53	767
Average								
weighted	Arterial/collector		7,409	3,475	974	85	2,813	14,750
ADT/km	Local road		1,252	592	140	5	93	2,082
Chang'ombe area	Chang. Rd.	1.4	6,519	3,514	1,020	176	1,149	12,719
	Chang. Rd.	1.5	3,466	1,518	645	56	1,600	7,285
	Mbozi Rd.	0.5	2,159	1,385	838	99	124	4,605
	Chamga St.	1.0	1,046	521	185	32	47	1,831
Average								
weighted	Arterial/collector		4,940	2,482	826	114	1,547	9,909
ADT/km	Local road		1,417	809	403	54	72	2,755
Mwinjuma	Morocco Rd.	3.5	6,782	1,867	882	104	561	10,191
	Kinondoni Rd.	0.7	6,308	2,238	366	17	1,386	10,315
	Shekilango Rd.	3.8	1,046	521	185	32	47	1,831
	Mwinjuma area Rd.	2.4	6,050	771	350	33	351	7,555
	Makanya Rd.	5.0	146	106	69	5	7	333
Average								
weighted	Arterial/collector		5,502	1,461	574	90	461	8,088
ADT/km	Local road		203	317	158	14	117	809

traffic in each Area were as shown in Table 12. 1 and Table 12.2 respectively.

12.2.4 Intersection Traffic Movement

Intersection traffic counting was conducted to obtain the volume and characteristics of traffic flow of each major intersection which will be used for the estimation of traffic capacity and design of proposed intersections.

(1) Survey

The survey was conducted at eleven (11) points on the priority roads as shown below:

- Bagamoyo Road :- Morocco Rd. Intersection
 - Old Bagamoyo Rd. Intersection
 - Hail Sellasie Rd. Intersection
 - Kinondoni Rd. Intersection
- Upanga/UWT road:- UN Rd. Intersection
 - Ocean Rd. Intersection
 - Tanganyika Motor Roundabout
 - Maktaba Street Intersection
- Morogoro road :- Port Access Rd. Intersection
 - Shekilango Rd. Intersection
 - New Kigogo Rd. Intersection

Classified traffic counting was carried out on each selected intersections during the peak hours from 7:00 am to 9:00 am and 3:00 pm to 5:00 pm.

The results of survey and its summary are shown in Appendix 12.2 and Table 12.3.

(2) Traffic Capacity Analysis on Proposed Road Junctions

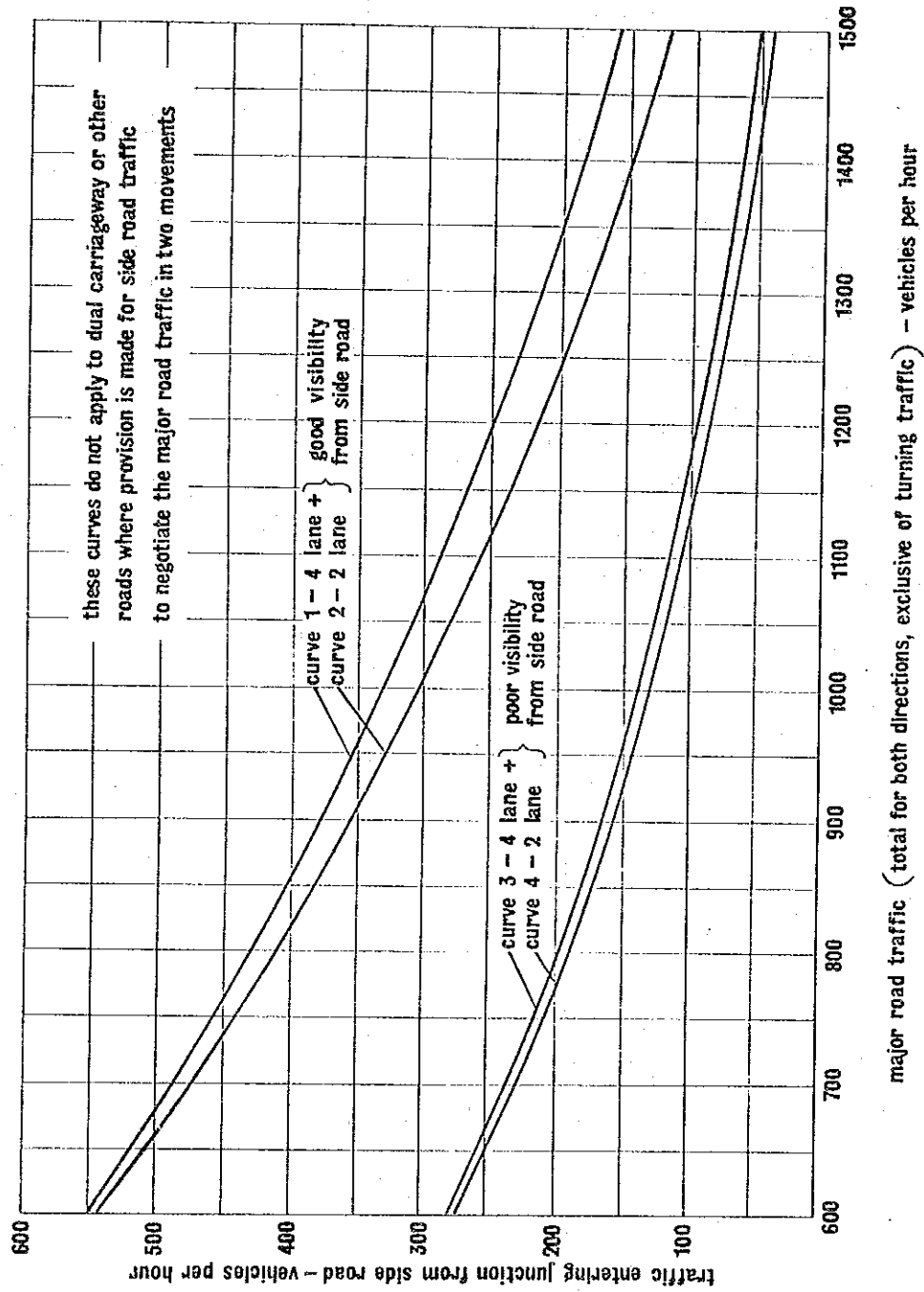
The design manual, "Roads in Urban/Rural Area" published by the TRRL in UK was applied for the estimation of the traffic capacity on proposed intersections.

Fig. 12.2 shows the chart to be used for analysing the traffic capacity on priority roads.

Table 12-3 Summary of Intersection Traffic Counting

Main Rd	Name of Intersec.	Intersec. Type	Peak Hour Traffic			Capacity in case of Priority Int. (entering traffic from side roads)
			Main road All traffic	Through traffic	Side road Entrance traffic	
Bagamoyo road						
-	Morocco Rd Inter.	Priority T Inter.	1,150	854	321	380
-	Old Bagamoyo Rd. Inter.	Priority T Inter.	1,812	1,498	490	120 <u>1/</u>
-	Hail Sellasie Rd. Inter.	Priority T Inter.	1,545	1,299	285	180 <u>1/</u>
-	Kinondoni Rd. Inter.	Signal Controlled	2,149	1,701	1,492	- <u>1/</u>
Upanga road						
-	Ocean Rd. Inter.	Signal Controlled	2,625	1,424	287	180 <u>1/</u>
-	UN Rd. Inter.	Signal Controlled	3,156	2,303	672	- <u>1/</u>
-	Tanganyika Motor Roundabout	Roundabout	1,662	629	767	530 <u>1/</u>
UWT Street						
-	Maktaba St. Inter.	Priority T Inter.	1,919	1,327	407	210 <u>1/</u>
Morogoro road						
-	Port Access Rd. Inter. (signal broken)	Priority	1,019	500	870	650 <u>1/</u>
-	Shekilango Rd. Inter.	Priority	934	684	240	480
-	New Kigogo Rd. Inter.	Signal Controlled	1,577	1,264	564	200 <u>1/</u>

1/ over saturated intersection in case of Priority Junction.



Source : Roads in Urban Areas, Scottish Development Department, Ministry of Transport, U.K.

Fig. 12.2 Capacity of Priority Intersection