LUSAKA CITY COUNCIL
THE REPUBLIC OF ZAMBIA

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT AND MAINTENANCE OF LUSAKA CITY ROADS IN THE REPUBLIC OF ZAMBIA

DECEMBER, 1995

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.
IN ASSOCIATION WITH
JAPAN ENGINEERING COUNSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Zambia, the Government of Japan decided to conduct a basic design study on the Project for Improvement and Maintenance of Lusaka City Roads and entrusted the study to the Japan International Cooperation Agency (JICA).

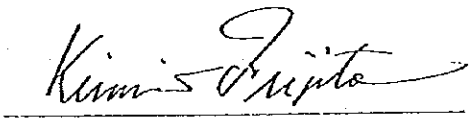
JICA sent to Zambia a study team from May 26 to July 4, 1995.

The team held discussions with the officials concerned of the Government of Zambia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Zambia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned to the Government of the Republic of Zambia for their close cooperation extended to the teams.

December, 1995



Kimio Fujita
President
Japan International Cooperation Agency

December, 1995

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement and Maintenance of Lusaka City Roads in the Republic of Zambia.

This study was conducted by Nippon Koei Co., Ltd. in association with Japan Engineering Consultant Co., Ltd., under a contract to JICA, during the period from May 19, 1995 to December 25, 1995. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Zambia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

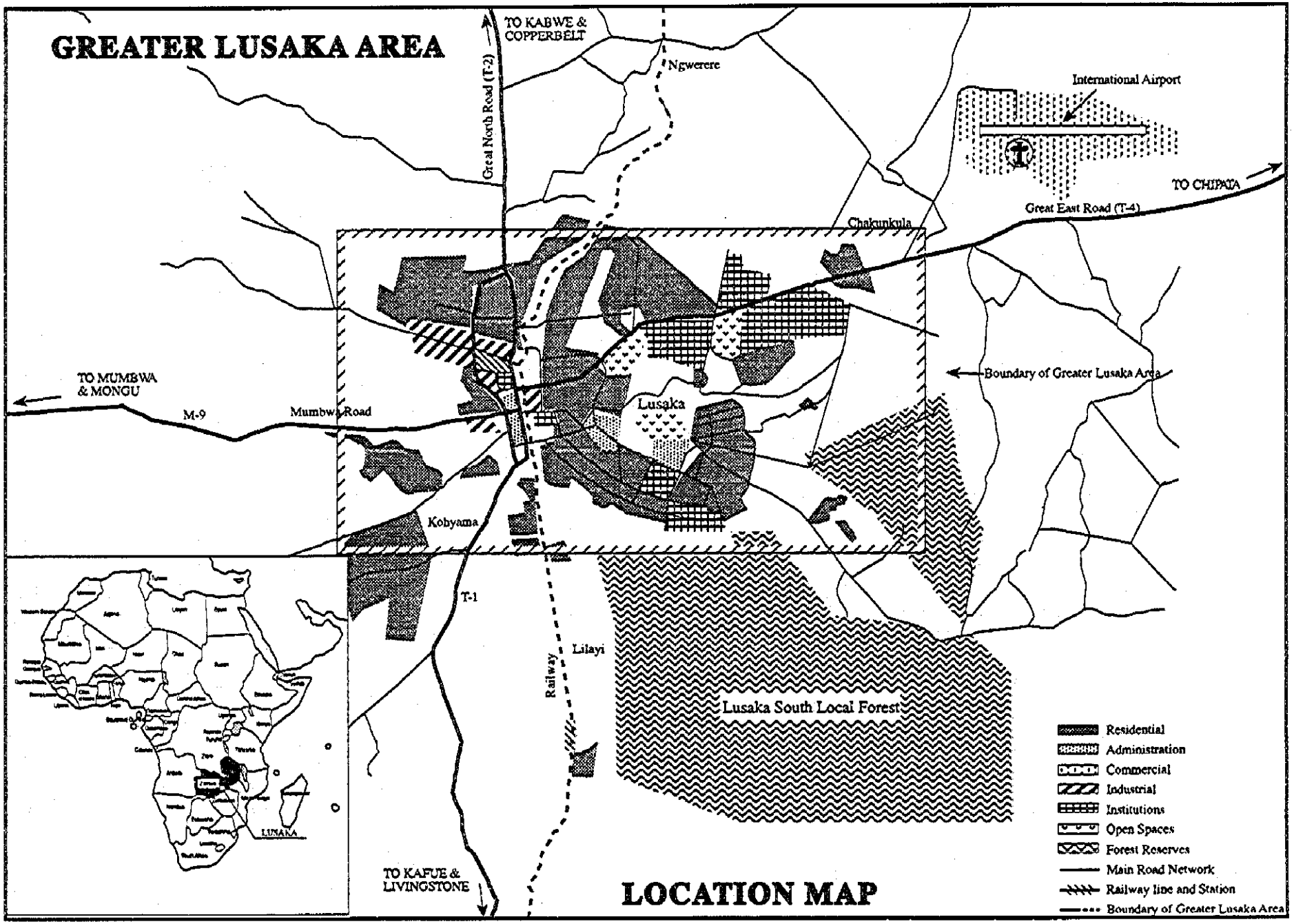
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

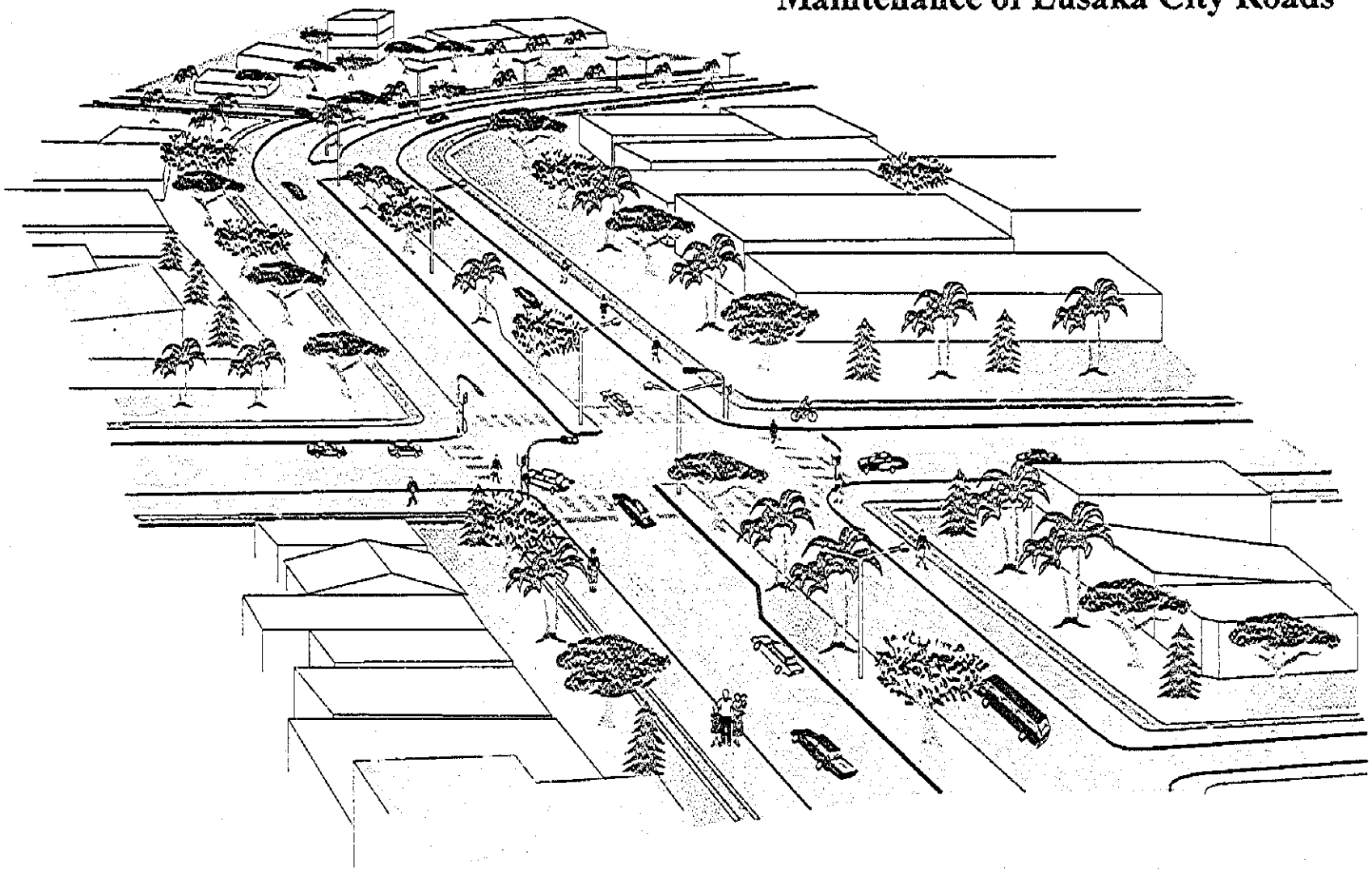
Hiroki Shinkai

Project Manager,
Basic design study team on
The Project for Improvement and
Maintenance of Lusaka City Roads

Nippon Koei Co., Ltd.
in association with
Japan Engineering Consultants Co., Ltd.


GREATER LUSAKA AREA
TO KABWE & COPPERBELT
Great North Road (T-2)
Ngwerere
International Airport
TO CHIPATA
Great East Road (T-4)
Chakunkula
TO MUMBWA & MONGU
M-9
Mumbwa Road
Lusaka
Boundary of Greater Lusaka Area
Kobyama
T-1
Railway
Lilayi
Lusaka South Local Forest
LUSAKA
TO KAFUE & LIVINGSTONE
LOCATION MAP
Residential
Administration
Commercial
Industrial
Institutions
Open Spaces
Forest Reserves
Main Road Network
Railway line and Station
Boundary of Greater Lusaka Area

The Project for Improvement And Maintenance of Lusaka City Roads



Widening Plan of Lumumba Road

Abbreviations

AADT	: Annual Average Daily Traffic
AASHTO	: American Association of State Highway and Transportation
AC	: Ashpalt Concrete
ADT	: Average Daily Traffic
A/P	: Authoorization to Pay
DBST	: Double Bituminous Surface Treatment
ESA	: Equivalent Standard Axles
E/N	: Excahnge of Notes
GDP	: Gross Domestic Product
GRP	: Gross Regional Product
IRR	: Internal Rate of Return
JICA	: Japan International Cooperation Agency
p.c.u.	: Passenger car unit
PSI	: Present Serviceability Index
P/Q	: Pre-qualification
SBST	: Single Bituminous Surface Treatment

CONTENTS

Chapter 1 Background of the Project

Since the nation's independence in 1964, the Zambian Government has adopted six (6) of Socio-economic Development Plans. The Zambian Government adopted Structural Adjustment Reform Plan during 1983 - 1985 with the recommendation from IMF and IBRD. However, the inflation during the implementation of the plan forced the Government to give up the plan in the midway, and the Government launched New Economic Development Plan instead. The plan was again replaced by Renewed Structural Adjust Plan in 1989. In the Renewed Structural Adjustment Plan, high priority was placed on transport sector, especially on the road subsector, where great emphasis was placed on the enhancement of service standard of the existing roads.

During 1992 - 93, Technical Assistance for Transport Engineering was provided by IDA. In the meanwhile, the Zambian Government carried out nation-wide road inventory survey (visual survey) to prepare comprehensive road improvement plan and concluded that the road rehabilitation in the city of Lusaka is most urgent.

The City of Lusaka has a population of 1.03 million in 1992 and annual average population growth rate during the last 10 years is estimated at 6.2%. The total road length of the city is about 1,600 km, of which about 850 km or 53% of the total is paved by bituminous surface dressing method and the rest of 750 km is of laterite. Most of the paved roads were built in more than 20 years ago and cannot cope with the growing traffic, of which the share of the heavy vehicles is extremely high. Large traffic volume on the roads in the city, combined with the insufficient road maintenance work due to shortage of the fund and to the incapability of section in charge, has aggravated the road condition greatly. It is anticipated that further deterioration of the roads in the city will hamper the socio-economic activities of the city, should no proper road improvement plan be introduced at present.

The Zambian Government, with the above background, has requested the Japanese Government to assist their urgent road improvement project under the Japan's Grant Aid Program. The content of the Request by the Zambian Government is described below:

(1) Rehabilitation and Improvement of Road

Rehabilitation and improvement of roads in Lusaka city, with total length of about 160 km (R.W. 6 m : 126.9 km, 12 m : 32.4 km) . The undertaking consists of rehabilitation and improvement of roads, including shoulders, drainages, sidewalks, and other road facilities.

(2) Supply of Plant and Equipment:

To supply following plants and equipments:

Hot-mix asphalt plant (1), Wheel loader (1), Dump-truck (8), Paver (1), Pneumatic Roller (1), Steel Roller (1), Manual vibrating roller (2), Generator (1), Motor grader (2), Workshop with equipment (1), Laboratory with equipment (1), Spare parts(1)

Chapter 2 Contents of the Project

2.1 Objectives of the Project

The Lusaka City, the capital city of the Republic of Zambia, has a road network of over 1,600 km comprising of 850 km of bituminous surface dressing and 750 km of laterite roads. Due to the recent steady economic growth, Lusaka City has shown the remarkable increase in number of traffic and large-sized vehicles.

However, the road network system, which forms the basic frame of the urban transportation in the City, has been deteriorated remarkably due to the inferiority of pavement structure (composed of the bituminous surface dressing) as well as the constraint of road maintenance funds in the past, which resulted in the deterioration of roads to the level where normal routine maintenance including the repair for pot-holes is no longer cost effective. These deteriorated roads have now become serious effect on the social and economic activities in the City.

The Project aims at the improvement of road network system in the City as well as the road maintenance system of the City Council through the rehabilitation of the pavement and procurement of maintenance equipment, in order to improve the living conditions of Lusaka people as well as to enhance the economic and social activities.

2.2 Basic Concept of the Project

The basic concept of the Project is, (1) to improve the existing city roads having the permanent asphaltic concerte, which have been deteriorated due to the strucutural defect of the surface treatment, and (2) to improve the road maintenance system City Council through the procurement of the maitenance equipment which will be utilized for daily and routine maintenance of the existing road.

2.3 Basic Design

2.3.1 Design Conditions

(1) Natural Conditions

In zambia, rainy seasons starts in November and ends in march, and Jue to Septembr forms dry season. Annual rainfall is rather small as 800 to 900 mm, however, in rainy season, monthly rainfall volume reaches as much as 230 mm,

causing the road submerged and pavement heavily damaged. It is reported pavement rehabilitation work is ordinarily undertaken during the dry seasn.

(2) Construction Conditions

The electricity in Lusaka City is transported by transmission line from the Kariba Dam on Zambezi River located at the border between Zambia and Zinbabwe and therefore no shortage of the electiric supply is expected in the City. No water shorgtage is also expected.

Since Zambia is land rocked country, the export and import goods are transported through either, Tanzania, Mozanbeequ or South Africa. The most reliable international route is the one through the South Africa.

From July 1, 1995 this year, the new tax system, namely valuable added tax (VAT), is introduced in Zambia. This tax will be charged on goods only so far but not on food and services.

Rock materials to be used for pavement and concrete will be obtained from the government qauury located in south at a distance 50 km away form Lusaka City, and sand materials from the Kafe River deposit.

Soil/sand materials to be used for road embankment is available free of charge at the deposit owened by the City Council which is located in south 5 km from the city center.

(3) Local Contractor and Local Materials

There are very few local contractors who have a sufficient equipment and a techinical experience for carrying out the heavy construction project. The construction plan therefore should be prepared taking into consideration the limited capability of the local contractors.

Cement and fuel are available at the market in Lusaka City. Deisel oil can be purchased on the basis of bulk directly from the international oil companies in Lusaka City.

Construction equipment shall be imported from South Africa. Ordinary equipment, such as dump truck and 4 wheel vehicles, can be obtained through lease company, however, they are very expensive and not reliable.

(4) Construction Period

The selected priority roads are classified into two groups taking into account the function and characteristics of each road, landuse pattern around the roadside, traffic volume, etc.

2.3.2 Selection of Priority Roads

The City Council has requested to the Japanese Government the improvement of 51 routes over 160 km approx. in their original request, however, the widening of Lumumba Road and Great North Road were additionally requested during the field survey of the Basic Design.

The proposed roads, therefore, has been reviewed to meet the requirement of scheme of Japanese Grant Aid and the selection of priority roads has been made taking into consideration the required costs for the improvement of each road. The improvement measures proposed by the City Council were also reviewed based on the road and pavement survey.

The priority roads have been selected on the basis of the criteria established by the Study Team. Items of evaluation in the criteria consist of 6 items as shown in Table 2-1. The scores for each evaluation item provided to each road are summed up and a total evaluation score is obtained for each road. In the study, the roads whose score are higher than 65 points were determined to be high priority project and 22 routes over 65 km approx. have been selected as high priority roads. The evaluation result is presented in Table 2-2 and the location of these high priority roads are shown in Fig. 2-1.

The selected priority roads are further categorized into two groups taking into account the function and characteristics of road, landuse pattern around the roadside, traffic volume, etc. as shown below:

(a) Access to the Compounds (12 routes over 30.8 km)

These roads are connected with the compounds in the city where middle class people are living and used to be the bus routes. The priority roads and its related compounds are shown as follows:

S.No.	Route No.	Name of Road	Length (km)	Road Classification	Lane Number
1	22	Los Angels Road	3.4	Class IC	2
2	25	Manali/Kaunda Road	3.5	Class IC	2
3	37	Mandevu Chipata Road	3.6	Class IC	2
4	38	Chawama/John Howard	4.5	Class IC	2
5	64	Mutandwa Road	1.7	Class IC	2
6	66	Lukanga Road	1.6	Class IC	2
7	75	Mtendere Route	1.6	Class IC	2
8	102	Zambezi Road	1.7	Class IC	2
9	104	Garden Road	2.0	Class IC	2
10	33	Palm Drive	3.2	Class IC	2
11	89	Commonwealth Avenue	2.9	Class IC	2
12	122	Antelope Avenue	1.1	Class IC	2
		Total	30.8		

(b) Major Arterial Roads in the City

The roads consist of major road running through the economic and industrial areas and arterial roads forming the major road network in the City as shown below:

S.No.	Route No.	Name of Road	Length (km)	Road Classification	Lane Number
1	4	Cairo Road	1.8	Class IA	6
2	5	Freedomway	1.6	Class IB	4
3	7	Kalambo Road	0.7	Class IC	4
4	9	Kalundwe Road	0.8	Class IC	4
5	8	Lumumba Road	7.2	Class IA	(4)/*
6	20	Mubwa Road	3.7	Class IC	2
7	24	Chilumbulu Road	7.2	Class IB	2
8	26	Kalingalinga Road	2.5	Class IC	2
9	27	Alick Nkata Road	4.3	Class IC	2
10	35	Katima Mulilo Road	4.6	Class IB	2
		Total	34.4		

* Widening will be made under the Project

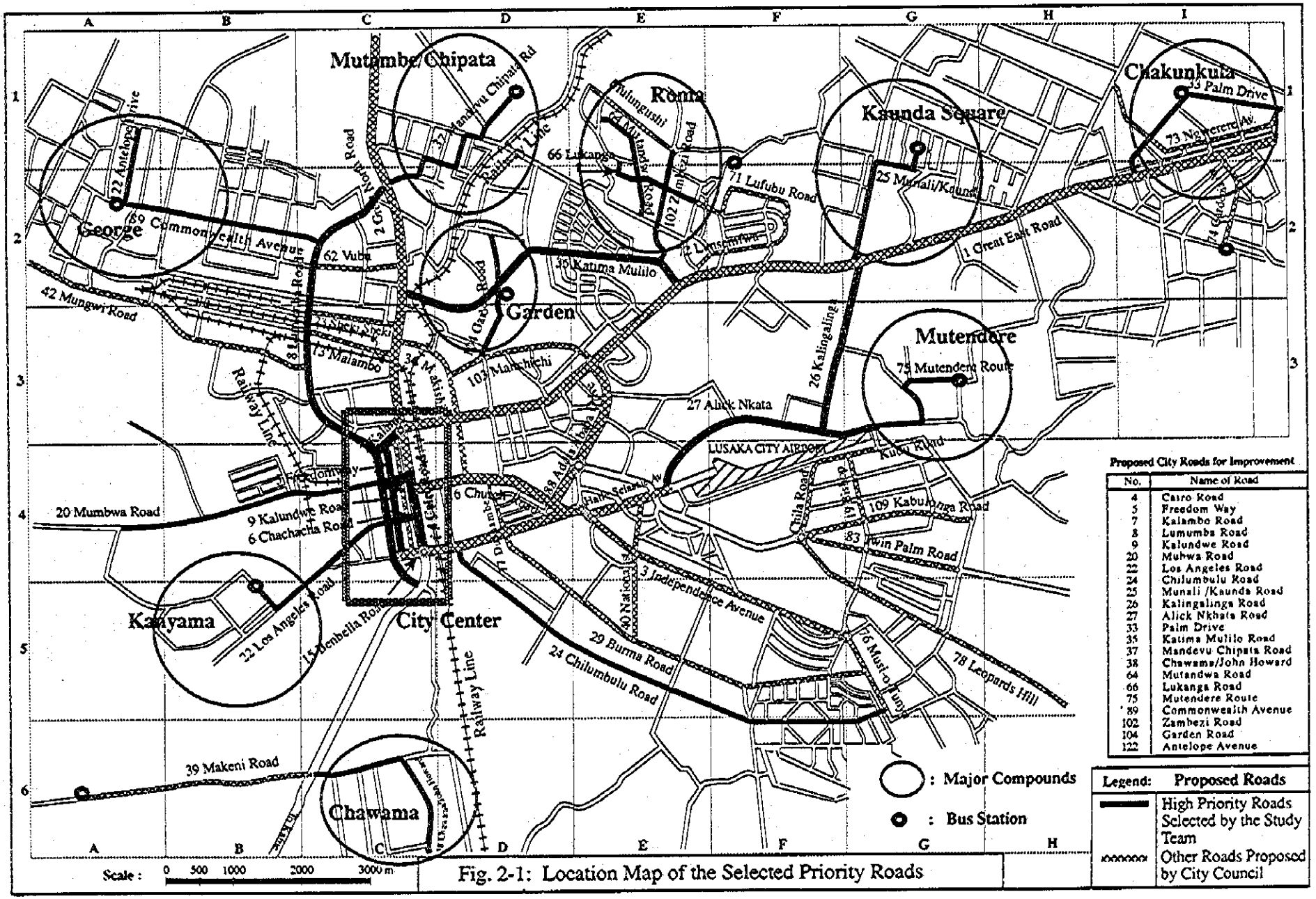
Note: Class IA; Arterial Road having 7.3 m width of carriageway
Class IB; Arterial Road having 6.7 m width of carriageway
Class IB; Arterial Road having 6.1m width of carriageway
(Source: Road Design Mannual prepared by the Road Department, The Ministry of Works and Supply)

Table 2-1: Criteria for Section of Priority Roads

	Items of Evaluation	Mark	Remarks
1.	Engineering View Points	(40)	
1-1	Deterioration Level of Pavement		
	- Very Bad (PSI Value: 0.0 - 1.5)	20	Reconstruction
	- Bad (PSI Value: 1.5 - 2.5)	10	Overlay
	- Fair/Good (PSI Value 2.5 - 5.0)	0	Maintenance
1-2	Present Traffic Volume		
	- ADT more than 5,000	20	
	- 2,500 ≤ ADT ≤ 5,000	10	
	- ADT less than 2,500	0	
2.	Socio-Economic View Points	(20)	
2-1	Function of Road		
	- Arterial Roads	10	
	- Collector Roads	5	
	- Feeder Roads	0	
2-2	Landuse Pattern		
	- Densely Populated Area	10	
	- Populated Area	5	
	- Less Developed Area	0	
3.	Improvement of Basic Human Need	(20)	
	- Large Impact on Basic Human Need	20	
	- Medium impact on Basic Human Need	10	
	- Less Impact on Basic Human Need	0	
4.	Development Policy of Lusaka City Council	(20)	
	- High Priority	20	
	- Priority	10	
	- Others	0	
	Total	100	

Table 2-2 Selection of Priority Roads

Route No.	ROAD NAME	Length	Width	Items of Evaluation						Marks	Priority Order	High Priority Roads (HPR)
				1-1: Deterioration of Pavement	1-2: Daily Traffic Volume	2-1: Functin of Road	2-2: Landuse Pattern	3: Improvemnt of Basic Human Need	4: Developmen t Policy of Lusaka City			
		(m)	(m)									
1	Great East Road	14.0	12.0	0	20	10	0	10	20	60		
2	Great North Road	5.0	12.0	0	20	10	0	10	10	50		
3	Independance Ave	6.0	12.0	0	20	10	0	0	10	40		
4	Cairo Road	1.8	12.0	10	20	10	10	10	10	70	3	HPR
5	Freedomway	1.6	12.0	10	20	10	10	10	20	80	1	HPR
6	Chachacha Road	1.7	6.0	0	20	5	10	10	10	55		
7	Kalambo Road	0.7	12.0	10	20	10	10	10	20	80	1	HPR
8	Lumumba Road	7.2	6.0	10	20	10	10	10	20	80	1	HPR
9	Kalundwe Road	0.8	6.0	10	20	5	10	10	20	75	2	HPR
13	Malambo Road	1.7	6.0	0	10	5	5	0	10	30		
15	Benbella Road	0.8	12.0	0	20	10	10	0	10	50		
16	Church Road	2.5	12.0	0	20	10	5	0	10	45		
19	Bishop Road	1.0	6.0	10	10	5	5	10	10	50		
20	Mubwa Road	3.7	6.0	10	10	10	10	10	20	70	3	HPR
22	Los Angels Road	3.4	6.0	20	10	5	5	20	20	80	1	HPR
23	Sheki Sheki Road	1.3	6.0	0	10	5	5	10	10	40		
24	Chilumbulu Road	7.2	6.0	10	20	10	10	10	20	80	1	HPR
25	Manah/Kaunda Road	3.5	6.0	20	10	0	10	20	20	80	1	HPR
26	Kalingalinga Road	2.5	6.0	10	20	10	5	10	20	75	2	HPR
27	Alick Nkata Road	4.3	6.0	20	10	10	5	10	20	75	2	HPR
29	Burma Road	6.0	6.0	0	20	10	5	0	10	45		
33	Palm Drive	3.2	6.0	20	0	0	5	20	20	65	4	HPR
35	Katima Mulilo Road	4.6	6.0	10	10	10	5	10	20	65	4	HPR
36	Makishi Road	2.5	6.0	0	10	5	5	10	10	40		
37	Mandevu Chipata Rd	3.6	6.0	20	10	0	10	20	20	80	1	HPR
38	Chawama/John Howard	4.5	6.0	20	10	0	10	20	20	80	1	HPR
39	Makeni Road	4.5	6.0	10	0	10	5	0	10	35		
40	UN/Nationalist Road	2.5	6.0	0	10	5	0	0	10	25		
42	Mungwi Road	4.7	6.0	10	10	5	5	10	10	50		
62	Yubu Road	1.3	6.0	0	10	5	0	0	10	25		
64	Mutandwa Road	1.7	6.0	20	0	0	5	20	20	65	4	HPR
66	Lukanga Road	1.6	6.0	20	0	0	5	20	20	65	4	HPR
67	Mulungushi Road	1.6	6.0	10	0	0	5	10	10	35		
71	Lufubu Road	1.8	6.0	10	0	0	0	10	10	30		
72	Lunsemfwa Road	1.3	6.0	10	0	0	0	10	10	30		
73	Ngwerere Avenue	3.2	6.0	20	0	0	0	10	10	40		
74	Gardenia Avenue	1.5	6.0	0	0	0	0	10	10	20		
75	Mtendere Route	1.6	6.0	20	10	5	5	20	20	80	1	HPR
76	Musi-o-Tunya	1.3	6.0	10	10	5	5	10	10	50		
77	Dushambe Road	1.0	6.0	0	10	5	5	10	10	40		
78	Leopards Hill	15.0	6.0	0	10	5	0	0	10	25		
83	Twin Palm Road	2.3	6.0	10	10	0	0	0	10	30		
88	Addis Ababa Drive	2.5	6.0	0	20	10	5	10	10	55		
89	Commonwealth Avenue	2.9	6.0	10	10	5	5	20	20	70	3	HPR
102	Zamberi Road	1.7	6.0	20	0	5	10	10	20	65	4	HPR
103	Manchinchi Road	2.3	6.0	10	10	5	5	0	10	40		
104	Garden Road	2.0	6.0	10	20	5	5	20	20	80	1	HPR
109	Kabulonga Road	2.5	6.0	10	0	5	5	0	10	30		
122	Antelope Avenue	1.1	6.0	10	10	5	10	20	20	75	2	HPR
	Kudu Road	1.3	6.0	10	0	0	0	10	10	30		
	Chila Road	1.0	6.0	10	0	5	5	10	10	40		
	Total	159.3				High Priority Roads Selected for the Project						65.2



Proposed City Roads for Improvement

No.	Name of Road
4	Cairo Road
5	Freedom Way
7	Kalambo Road
8	Lumumba Road
9	Kalundwe Road
20	Mubwa Road
22	Los Angeles Road
24	Chilumbulu Road
25	Munali /Kaunda Road
26	Kalingalinga Road
27	Alick Nkhata Road
33	Palm Drive
35	Katima Mulilo Road
37	Mandevu Chipata Road
38	Chawama/John Howard
64	Mutandwa Road
66	Lukanga Road
75	Mutendere Route
89	Commonwealth Avenue
102	Zambezi Road
104	Garden Road
122	Antelope Avenue

Legend:	Proposed Roads
▬▬	High Priority Roads Selected by the Study Team
×××××××	Other Roads Proposed by City Council

Fig. 2-1: Location Map of the Selected Priority Roads

(ii) Proposed Improvement Measures

(a) Widening of Lumumba Road

In addition to the request by the City Council for the improvement of roads consisting of overlay and reconstruction of pavement, the widening of Lumumba Road and Great East Road were newly requested by the City Council during the field survey. The possibility for widening of these roads were studied taking into consideration the related higher master plan, traffic volume, situation of landuse and acquisition, under ground public facilities, etc..

As the result, it was concluded that Great East Road should not be included in the project due to lack in urgency in terms of traffic volume, however, the widening of Lumumba Road is acceptable and reasonable because of the following reasons:

[Relation to the higher master plan]

There is the higher master plan entitled "Lusaka City Urban Development Plan" prepared in 1975, in which Lumumba road was planned as the most important roads with 8 traffic lanes forming the basic frame of road network in the city in 2000. This plan seems to be unrealistic at the moment due to remarkable change in economic conditions in the past 10 years, however, the importance of Lumumba Road seems to be unchanged because of that the landuse pattern in Lusaka City has been developed in line with this master plan.

[Traffic Volume]

As the result of traffic survey, the widening of Lumumba Road can be justified because of the following facts:

- The road is passing through the industrial and business areas where heavy traffic is generated, and carrying large number of vehicles. ADT 17,000 was counted at the section near the central market, which is far beyond the capacity of 2 lane Lumumba Road (12,000 - 13,000 ADT).

- Traffic congestion during the peak hour is serious and the situation is getting worse due to increase in traffic volume as well as the shortage of intersection capacity. Congestion ratio is estimated to be

in the range between 1.25 - 1.50 which indicates the chronic traffic congestion in day time.

- High proportion of large-sized heavy trucks (almost 20%) was observed because of that Lumumba Road is functioned as the by-pass to the Great North Road, which causes the decrease of the traffic capacity of Lumumba Road.

[Land Acquisition and Compensation]

No land acquisition and compensation will be required for widening of Lumumba Road since the existing right-of-way is reserved by the City Council having 30 to 50 m width which is sufficient enough for widening work.

[Under Ground Public Utilities and Electric Line]

Water main, sewerage pipe, telephone cable are laid beneath the existing footways at 1.5 m approx. along the Lumumba Road. The utilities survey, which was carried out jointly with the agencies concerned, revealed that the widening of road can be done without any relocation of these under ground utilities by designing the alignment properly.

(b) Review on the Improvement Measures proposed by the Council

The patching works was excluded from the original scope of the improvement measures component of the project because of the reason that the work is relatively simple which may not meet the requirement of Japan's Grant Aid Scheme.

Improvement measures to be applied for the priority roads consist of pavement overlay and reconstruction including the rehabilitation of shoulder, side ditch and drainage facilities, sidewalk, bus station and related facilities.

The project roads, which are located in the low ground and submerged during the rainy season, shall be embanked to 0.5 m to 1.0 m in order to minimize the influence of water on the pavement structure.

(c) Selection of Maintenance Equipment

The request on the maintenance equipment made by the City Council was not accepted by the Japanese side because of the following reasons:

(i) The proposed equipment are categorized to be large-sized heavy equipment of which maintenance and operation might be complicated and difficult for the City Council, and price of these equipment are also expensive under the Japanese Grant Aid Scheme.

(ii) Strengthening of direct force for the road maintenance is contrary to the privatization of IDA's maintenance policy. (This policy was already accepted by the City Council and adopted for the heavy maintenance work by employing the local contractor.)

The City Council withdrew their original request, however, submitted to the Japanese side the revised proposal on the maintenance equipment during the field survey. The new proposal was prepared based on the estimation required for routine maintenance including patching work, cleaning and improvement of drainage system and urgent repairs caused by the accidents.

The revised maintenance equipment was planned to strengthen the road maintenance capacity by increasing the working depots double from 3 units to 6 units. This case, however, might need double funds for road maintenance at present. On the contrary, the present maintenance system has not been working in full swing due to constraint the maintenance funds in the past. Rapid expansion of the maintenance units may cause various troubles and hindrance on the operation of maintenance work.

Therefore, it is recommended that the maintenance equipment to be supplied under the project shall be the one which requires for the recovery and improvement of the existing maintenance depots, but not for strengthening of the maintenance capacity. The type of maintenance equipment to be procured under this project shall be selected and estimated based on the above understanding.

Table 2-3 Revised Maintenance Equipment Requested by Lusaka City

No.	Items	Specifications	Q'ty Requested
1.	Motor grader	2.7 m wide	1
2.	Front-end loader	0.4 m3	1
3.	Backhoe	0.1 m3	1
4.	Rollers (hand)	600 kg	2
5.	Tipper trucks	6 ton	4
6.	Plate compactors	50 - 60 kg.	6
7	Bitumen sprayers	30 lit/min	4
8.	Concrete mixer	0.2 m3	1
9.	Pick-ups (tonner)	1 ton	5
10.	Bitumen cutters	-	3
11.	Light truck-mounted crane	5 ton	2
12.	Hand breaker	1.3 m3/min.	1
13.	Road blowers		2
14.	Spare Parts (25%)		
15	Tool boxes	large size	1
16.	Tool boxes	small size	3
17.	Tractors	27 H.P.	2

Therefore, it is recommended that the maintenance equipment to be supplied under the project shall be the one which requires for the recovery and improvement of the existing maintenance depots, but not for strengthening of the maintenance capacity. The type of maintenance equipment to be procured under this project shall be selected and estimated based on the above understanding.

(i) Required Equipment for Maintenance Work

Three (3) type of maintenance works are considered for estimation of maintenance equipment as follows:

- Repair of pot holes
- Repair of deteriorated pavement on a small scale
- Cleaning and repair of drainage facilities

Required equipment for each work is estimated as shown below:

Repair of Pot Hole/Deteriorated Pavement on the Small Scale

Work Items	Equipment	Q'ty/unit
* Transport of labour	Pickup (1 ton)	1
* Transport of equipment	Truck (2 ton)	1
* Transport of materials	Truck (2 ton)	1
* Cutting of pavement	Concrete cutter (30cm)	1
* Breaking of pavement	Breaker (30 kg) Compressor	1 1
* Spreading and Compacting	Rammer (60-90kg)	2
* Bitumen spray	Asphalt sprayer(200lit.)	1

Cleaning and Repair of Drainage Facilities

*Transport of labor	Pickup (1 ton)	1
*Transport of materials	Truck (2 ton)	1
*Excavation and Loading	Back hoe (0.1 m3)	1
*Breaking of hard rock	Breaker (30 kg) Compressor	1 1
*Transport of Removed Pavement	Truck (2 ton)	1
*Concrete Lining	Concrete mixer (0.2 m3)	1

Others

* Loading of materials/equipment	Truck with crane (4 ton)	1

(ii) Selection of Maintenance Equipment

The existing working units for maintenance work are as shown below:

-	No of unit in charge of patching work	3 units
-	No of unit in charge of drainage work	2 units
	Total	5 units

The maintenance equipment required for the routine maintenance are estimated on the basis of existing five (5) working units as shown in Table 2-4.

Table 2-4 Estimation of Maintenance Equipment to be Supplemented

Name of Equipment	Patching Work (3 parties)	Cleaning and Repair of Drainage (2 parties)	Estimated Equipment No. (Total)	Equipment Available in Lusaka City	Required Equipment to be Supplemented
Pick up truck	3	2	5	(2) /1	3
Truck	3	2	5	(2) /2	3
Dump truck	3		3	3	-
Concrete Cutter	3		3		3
Concrete breaker	1 for 5 parties		1		1
Compressor	1 for 5 parties		1		1
Motor grader	1		1	3	-
Vibration Roller	1		1		1
Tampa, Ranma	6		6	3	3
Asphalt sprayer	3		3		3
Backhoe		1	1		1
Concrete Mixer		1	1		1
Truck with crane	1 for 5 parties		1		1

/1 : Tractor will be utilized for this work.

/2 : A part of dump truck will be diverted to this work

The followings are the list of maintenance equipment to be procured under the project:

Type of Equipment	Specifications	Qty Requested	Q'ty to be procured under the Project
(1) Pick up truck	1 ton	5 nos.	3 nos.
(2) Truck	4 ton	4 nos.	3 nos.
(3) Concrete cutter	30 cm	3 nos.	3 nos.
(4) Concrete breaker	30 kg	1 no.	1 no.
(5) Compressor	for Breaker	-	1 no.
(6) Vibration roller	600 kg	2 nos.	1 no
(7) Tampa or Ranma	60 -90 kg	6 nos.	3 nos.
(8) Asphalt Spray	200 lit./drum	4 nos.	3 nos.
(9) Backhoe	0.1 m3	1 no.	1 no.
(10) Concrete mixer	0.2 m3	1 no.	1 no.
(11) Truck with crane	4 ton	2 nos.	1 no.
(12) Spare parts		1 set	1 set
(13) Tools		1 set	1 set
(14) Motor grader	2.7 m wide	1 no.	-
(15) Front loader	0.4 m3	1 no.	-
(16) Tractor	27 HP	2 nos.	-
(17) Road blower	-	2 nos.	-

2.3.3 Basic Design

(1) Project Features

The project is classified into two categories, namely improvement of road and procurement of maintenance equipment. The category of road improvement is further divided into two groups from the view point of the function of road as well as the implementation purpose as shown below:

(i) Improvement of Roads

Group 1: Urgent Repair of Access to the Compounds

(12 routes over 28 km approx.)

[Improvement measures]

Type 1;	Pavement overlay with improvement of sidewalk	0.8 km
Type 2;	Pavement overlay with improvement of shoulder/drainage	12.0 km
Type 3;	Reconstruction of pavement with improvement of shoulder/drainage	15.4 km
Type 4;	Widening	0.0 km
	Total (i)	28.2 km

Group 2: Improvement of Arterial Roads

(10 routes over 33 km)

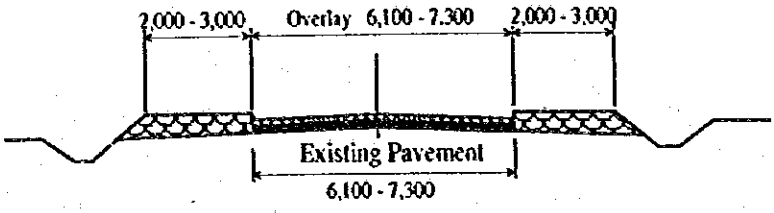
[Improvement measures]

Type 1;	Pavement overlay with improvement of sidewalk	5.4 km
Type 2;	Pavement overlay with improvement of shoulder/drainage	16.6 km
Type 3;	Reconstruction of pavement with improvement of shoulder/drainage	4.0 km
Type 4;	Widening	7.2 km
	Total (ii)	23.2 km

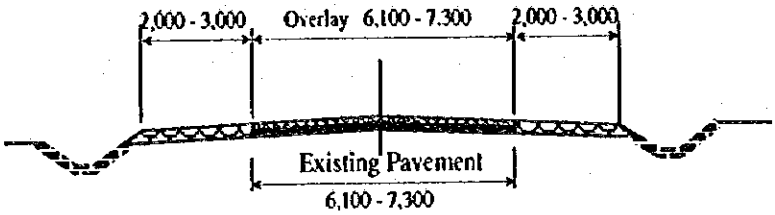
(ii) Procurement of Maintenance Equipment

(a)	Maintenance equipment for patching wok	8 kinds and 18 nos.
(b)	Maintenance equipment for drainage work	2 kinds and 2 nos.

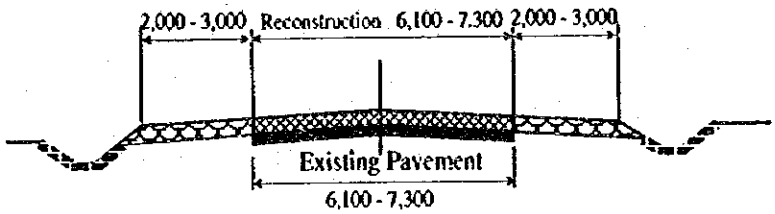
Typical cross section of each improvement measures are presented in Fig. 22-2.



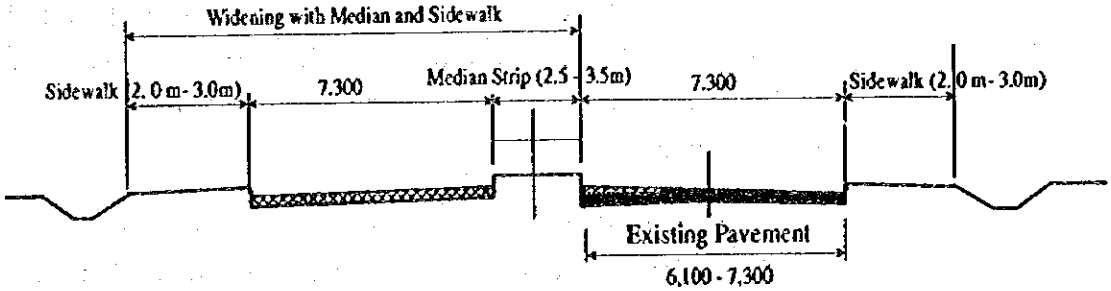
Type 1: Overlay with Sidewalk Improvment



Type 2: Overlay with Shoulder &Drainage Improvment



Type 3: Reconstruction of Pavement
including Shoulder & Drainage Improvement



Type 4: Widening of Existing Road to 4Lanes

Fig. 2-2: Typical Cross Section of Improvement measures

(2) Concept of Basic Design

The improvement measures proposed for the project roads are either pavement overlay or reconstruction of pavement with minor shoulder and drainage improvement, so that no major change on the alignment and carriageway width would be required for the proposed roads with the exception of Lumumba Road.

In addition, the project roads are mostly running through the city and developed areas with relatively flat terrain, which may not require major change on vertical alignment.

Based on the above understandings, the basic design will be carried out taking into consideration the following policy:

(i) Access to the Major Compounds

Improvement shall be made on the pavement and its related facilities on the basis of present road conditions in principle, and no major change on the carriageway width as well as the road alignment shall be made, with the exception of the embankment sections where the vertical alignment will be raised by 1.0 m approx. taking into account the drainage issue. No design speed shall apply for the design of existing road improvement.

(ii) Major City Roads with the exception of Lumumba Road

Same as the above.

(iii) Lumumba Road

Since the Lumumba Road is the major arterial road in the city with high road classification, widening of the road shall be designed properly in accordance with the design standards specified in the "Manual of the Highway Design Standards", prepared by the Road Department , Ministry of Works and Supply.

Design speed shall be determined at 40 km/hr taking into account the landuse pattern along the road side as well as the numbers of major intersections to be crossed which are controlled by traffic signal. Fig. 2-3 shows the widening method of the Lumunba Road.

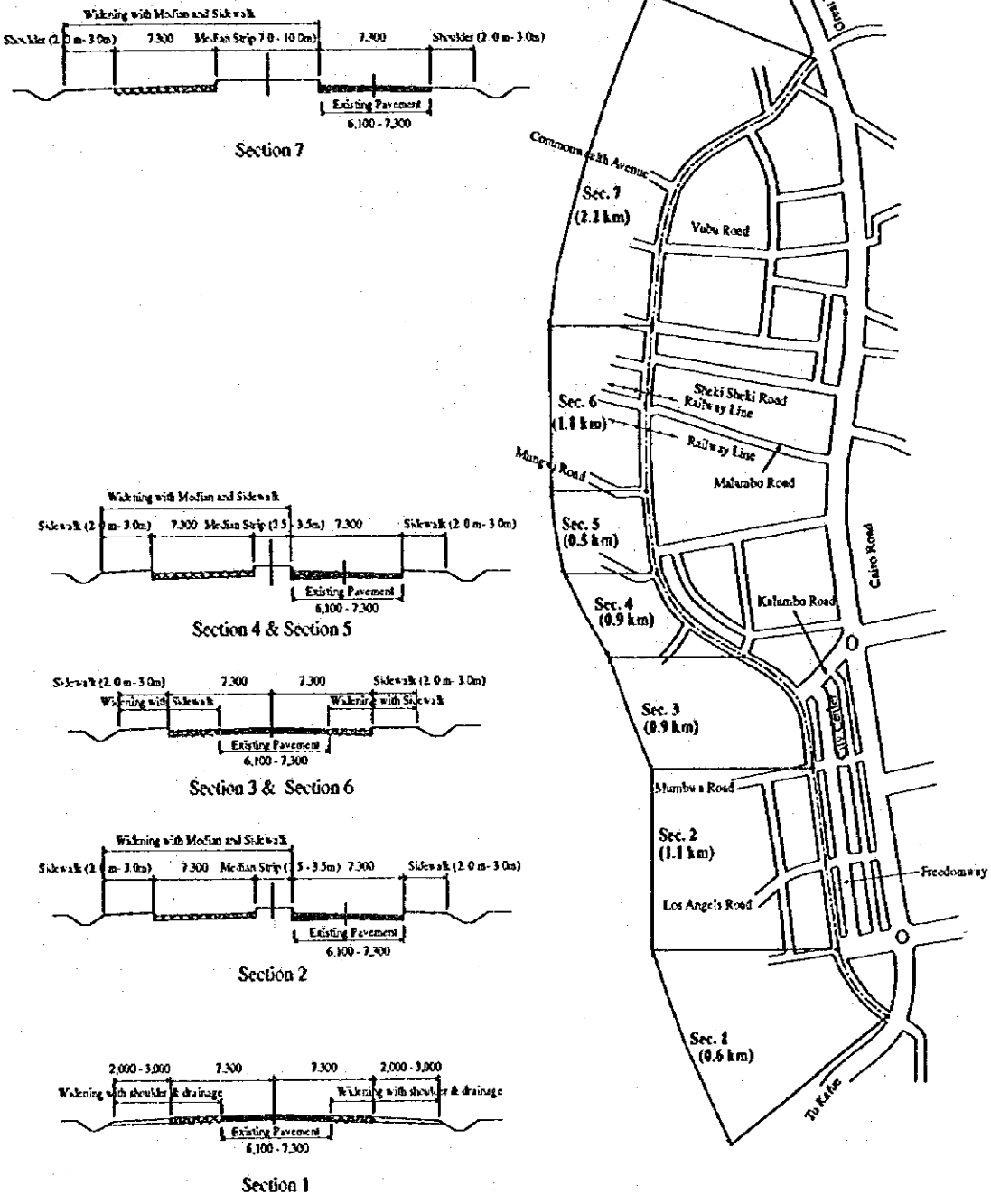


Fig. 2-3 Widening Method of Lumumba Road

(3) Design Criteria

"Manual of the Highway Design Standards", prepared by the Road Department, Ministry of Works and Supply, is applied for the project roads. For the design criteria not covered by the above standards, either Japan Road Standards or AASHTO's Design Standards is adopted for the Basic Design.

Table 2-6 shows the detailed standards for widening of Lumumba Road and Table 2-7 shows the geometric design standards to be applied for each project road:

Table 2-6 Geometric Standards to be applied for Lumumba Road

Designs Speed	40 kg/hr
Minimum Radius	120 m
Maximum Grade	7.0%
Carriageway Width	7.3 m x 2
Median Strip	2.0 - 10.0 m
Sidewalk	3.0 m

(4) Typical Cross Sections

The typical cross sections for each improvement measure are presented in Fig. 2-4. Thickness of surface, base course and sub base course shall depend on the traffic volume, strengthening of subsoil and existing pavement structures on each road.

Widening method of Lumumba Road has been studied in order to minimize the relocation and protection of existing public utilities and under ground facilities by widening of road.

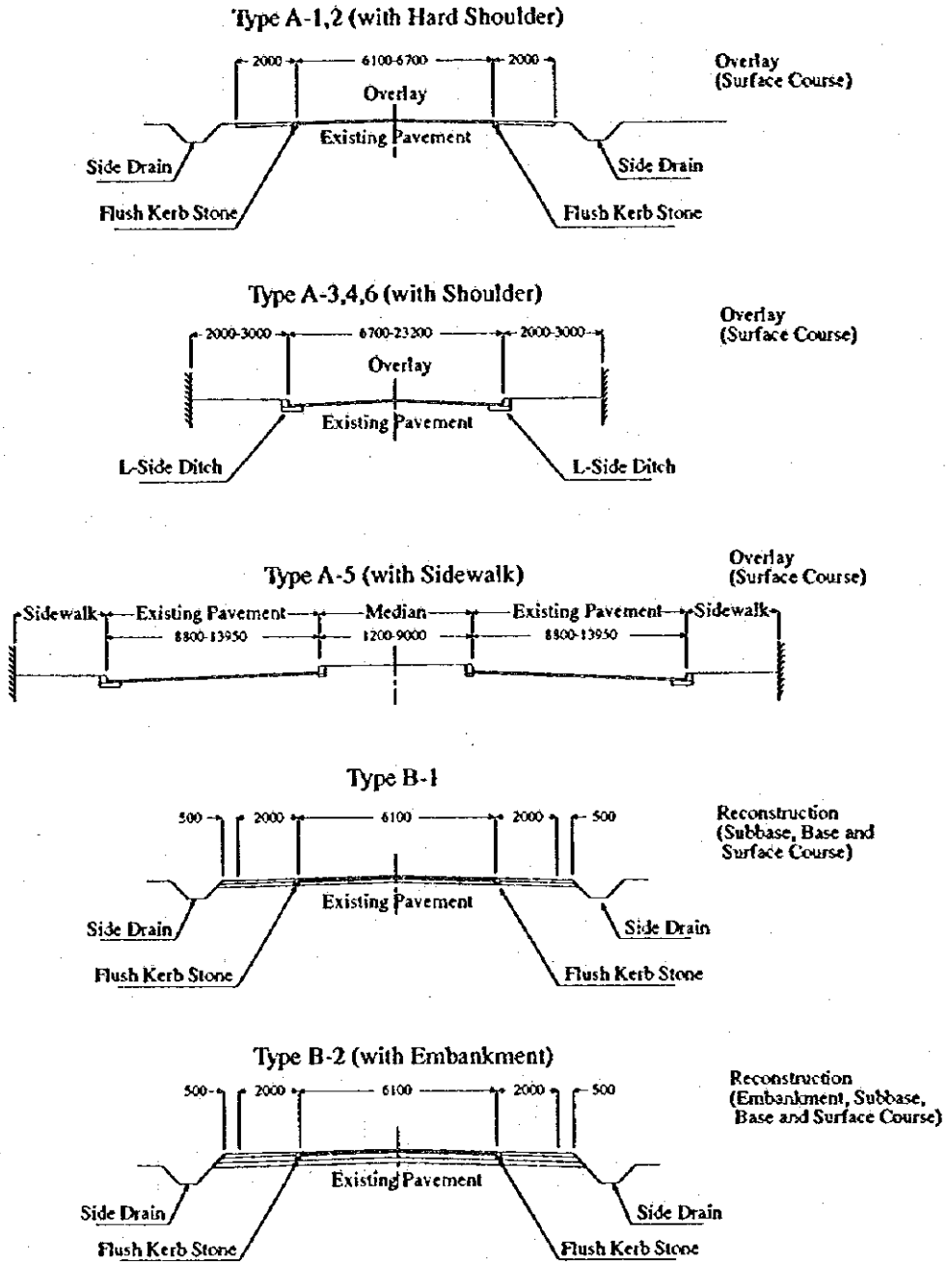
(5) Pavement Design

The pavement design is conducted in accordance with "Pavement Design Guide" prepared by the Department of Roads, the Ministry of Works and Housing. As for the pavement overlay, the design was conducted in accordance with the pavement component analysis developed by the Asphalt Institute, USA in 1977. Design life of the pavement shall be 10 years for overlay and 20 years for reconstruction of pavement.

Table 2-7: Design Criteria to be Applied for Each Road

	Route No.	Name of Road	Length (km)	Road Classification	Lane Number	Design Speed (km/hr)	Pavement Width (m)	Section to be Improved (km)	Shoulder Width (mini. 2 m) Soft Shoulder (km)	Shoulder Width (mini. 2 m) Hard Shoulder (km)	Median Strip (m)	Sidewalk(SW) 3.0 m & Walkway(WW) 2.0 m (km)	Bus Station No.	Drainage Left (km)	Drainage Right (km)	Typical Cross Sections
(1) Group 1: Urgent Repair of Access to the Major Compounds																
1	22	Los Angels Road	3.4	Class IC	2	Not applicable	2 x 6.1	4.3	-	4.3	-	-	1	4.3	4.3	Type 1 & Type 2 & Type 3
2	25	Manali/Kaunda Road	3.5	Class IC	2	Not applicable	2 x 6.1	2.4	-	2.4	-	-	1	2.4	2.4	Type 2 & Type 3
3	37	Mandevu Chipata Rd	3.6	Class IC	2	Not applicable	2 x 6.1	3.6	-	3.6	-	-	1	3.6	3.6	Type 3
4	38	Chawama/John Howard	4.5	Class IC	2	Not applicable	2 x 6.1	4.0	-	4.0	-	-	1	4.0	4.0	Type 3
5	64	Mutandwa Road	1.7	Class IC	2	Not applicable	2 x 6.1	1.7	1.7	-	-	-	-	1.7	1.7	Type 2 & Type 3
6	66	Lukanga Road	1.6	Class IC	2	Not applicable	2 x 6.1	1.6	1.6	-	-	-	-	1.6	1.6	Type 2 & Type 3
7	75	Mtendere Route	1.6	Class IC	2	Not applicable	2 x 6.1	1.6	-	1.6	-	-	-	1.6	1.6	Type 2 & Type 3
8	102	Zambezi Road	1.7	Class IC	2	Not applicable	2 x 6.1	1.7	1.7	-	-	-	-	1.7	1.7	Type 2 & Type 3
9	104	Garden Road	2.0	Class IC	2	Not applicable	2 x 6.1	2.0	-	2.0	-	-	1	2.0	2.0	Type 2
10	33	Palm Drive	3.2	Class IC	2	Not applicable	2 x 6.1	1.8	-	1.8	-	-	1	1.8	1.8	Type 3
11	89	Commonwealth Avenue	2.9	Class IC	2	Not applicable	2 x 6.1	2.9	-	2.9	-	-	1	2.9	2.9	Type 2
12	122	Antelope Avenue	1.1	Class IC	2	Not applicable	2 x 6.1	1.1	-	1.1	-	-	-	1.1	1.1	Type 2
		Total	30.8					28.7	5.0	23.7			7	28.7	28.7	
(2) Group 2: Improvement of Major City Roads																
13	4	Cairo Road	1.8	Class IA	6	Not applicable	6 x 7.3	1.0	-	-	-	1.0 km (existed)	-	-	-	Type 1
14	5	Freedomway	1.6	Class IB	4	Not applicable	4 x 6.7	1.6	-	-	-	1.6 km (existed)	-	-	-	Type 1
15	7	Kalambo Road	0.7	Class IC	4	Not applicable	4 x 6.1	0.7	-	-	-	0.7 km (existed)	-	-	-	Type 1
16	9	Kalundwe Road	0.8	Class IC	4	Not applicable	4 x 6.1	0.8	-	-	-	0.8 km (existed)	-	-	-	Type 1
17	8	Lumumba Road	7.2	Class IA	(4)/*	40 km/hr	4 x 7.3	7.2	2.2	0.6	2.0 - 10.0	SW 4.4	1	7.2	7.2	Type 4
18	20	Mumbwa Road	3.7	Class IC	2	Not applicable	2 x 6.1	3.7	2.2	-	-	SW 1.2	-	2.0	2.0	Type 2 & Type 3
19	24	Chilumbulu Road	7.2	Class IB	2	Not applicable	2 x 6.7	6.8	5.5	-	-	SW 1.2 & WW 5.5	-	7.2	7.2	Type 1 & Type 2
20	26	Kalingalinga Road	2.5	Class IC	2	Not applicable	2 x 6.1	2.5	2.5	-	-	-	-	2.5	2.5	Type 2
21	27	Alick Nkata Road	4.3	Class IC	2	Not applicable	2 x 6.1	4.3	4.3	-	-	-	-	4.3	4.3	Type 2
22	35	Katima Mulilo Road	4.6	Class IB	2	Not applicable	2 x 6.7	4.6	4.6	-	-	-	-	4.6	4.6	Type 2
		Total	34.4					33.2	21.3	0.6		12.4	1	27.8	27.8	
		Grand Total	65.2					61.9	26.3	24.3		12.4	8	56.5	56.5	

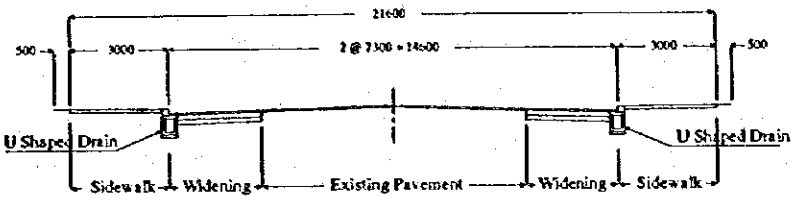
/* : Lumumba Road is planned to be widened to 4 lane.



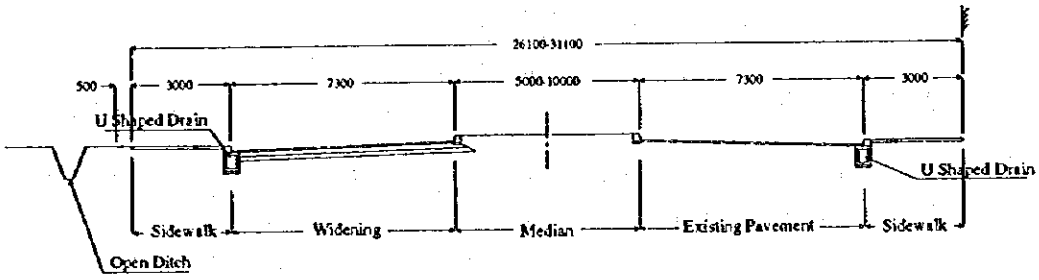
-All dimensions are in Millimeter

Fig. 2-4: Typical Cross Sections to be Applied for the Proposed Roads (1)

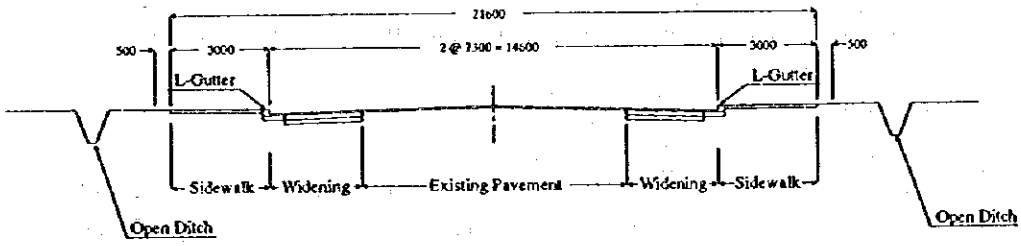
Type C-1



Type C-2



Type C-3



- All dimensions are in Millimeter

Fig. 2-4: Typical Cross Sections to be Applied for the Proposed Roads (2)

The pavement design will be carried out based on the data on traffic, subsoil conditions and materials to be used for pavement. The type of pavement structure has been determined taking into account the availability of aggregates in terms of production, quality and prices as follows:

- Surface course : Pre-mixes asphalt concrete
- Base course : Mechanically stabilized gravel, 2 inch - dust, with CBR value more than 30 %
- Sub-base course : Crusher run, 3 inch - dust, with CBR value more than 15 %

The calculation result of pavement thickness for overlay and re-construction are presented in Table 2-8 and 2-9 respectively. Proposed pavement structure for re-construction is presented in Table 2-10.

(6) Drainage Design

Drainage facilities are the one of the important structures to keep the road in safe condition for traffic and to extend the life of road structure, especially pavement. Annual rainfall is rather small at 800 - 900 mm, however, in rainy season, monthly rainfall volume reaches as much as 230 mm, which has caused roads submerged and pavement heavily damaged.

Storm drainage shall be fully taken into consideration and in such a road section that is likely to submerged in rainy season, vertical alignment shall be raised by 1.0 m approx. to protect the pavement from the underground water:

(7) Shoulder and Sidewalk Design

The project road connecting the compound is utilized as the commuting routes for the resident in compound, so that many people are walking on the shoulder of the road. Therefore, the shoulder of these roads shall be paved by the SBST in order to secure the ease of passing through for the pedestrian.

(9) Shoulder Design

5.5 km long existing sidewalk along the Chilumbulu Road will be improved by the pavement of SBST.

Table 2-8 Thickness Design for Overlay Pavement

Proposed Roads	Traffic Survey Point	Initial Daily Traffic Volume in 1997: Medium Goods Vehicles (nos.)	Heavy Goods Vehicles (nos.)	Medium Buses (nos.)	Heavy Buses (nos.)	Total (nos.) Average gross mass (t)	One way Initial Daily Traffic Volume (nos.)	Initial Traffic Number (Chart-1) (nos.)	Adjustment Factor for Initial Traffic Nos.	Design Traffic Number in 2007 (nos.)	CBR (%)	Full depth Pavement Thickness (Ta) (Chart-2) (mm)	Existing Pavement Thickness: Surface (mm)	Existing Pavement Thickness: Base (mm)	Conversion Factor: Surface	Conversion Factor: Base	Effecve Thickness of Existing Pavement (To) (mm)	Required Thickness of Overlay (mm)	Proposed Overlay Thickness (mm)	Overlay Type
		15.6	29.0	4.0	17.5	s	b=a/2	c	d	e=c*c		f					g	h=f-g		
Phase I																				
22 Los Angels Road	P-3	61 (8%)	38 (5%)	558 (78%)	61 (8%)	718 (7.46)	359	110	0.76	84	25	120	20	250	0.6	0.3	87	33	40	Ov-2
25 Munali/Kaunda Road	P-13	43 (6%)	0 (0%)	646 (92%)	17 (2%)	706 (5.03)	353	70	0.76	53	25	115	20	300	0.6	0.3	102	13	30	Ov-1
37 Mandevu Chipata Road	P-7	105 (15%)	0 (0%)	524 (77%)	52 (8%)	681 (6.82)	341	80	0.76	61	25	110	20	200	0.6	0.3	72	38	40	Ov-2
38 Chawama/John Howard	P-4	85 (10%)	13 (2%)	727 (85%)	33 (4%)	858 (6.05)	429	90	0.76	68	8	180	20	450	0.6	0.3	147	33	40	Ov-2
64 Mutandwa Road	D-7(25%)	86 (68%)	14 (11%)	24 (19%)	4 (3%)	127 (14.91)	63	50	0.76	38	15	130	20	300	0.6	0.3	102	28	30	Ov-1
66 Lukanga Road	D-7(25%)	86 (68%)	14 (11%)	24 (19%)	4 (3%)	127 (14.91)	63	50	0.76	38	15	130	20	300	0.6	0.3	102	28	30	Ov-1
75 Mtendere Route	P-12(50%)	86 (55%)	6 (2%)	159 (59%)	19 (7%)	270 (9.20)	135	50	0.76	38	18	125	20	250	0.6	0.3	87	38	40	Ov-2
102 Zambezi Road	D-7(50%)	172 (68%)	27 (11%)	48 (19%)	8 (3%)	254 (14.91)	127	100	0.76	76	15	135	20	300	0.6	0.3	102	33	40	Ov-2
104 Garden Road	P-8(50%)	98 (18%)	13 (2%)	386 (73%)	33 (6%)	530 (7.66)	265	70	0.76	53	19	130	20	300	0.6	0.3	102	28	30	Ov-1
33 Palm Drive	P-13(50%)	22 (6%)	0 (0%)	323 (92%)	9 (2%)	353 (5.05)	177	30	0.76	23	25	105	20	250	0.6	0.3	87	18	30	Ov-1
89 Commonwealth Avenue	P-1	162 (15%)	0 (0%)	1,099 (79%)	136 (10%)	1,397 (6.66)	699	160	0.76	125	25	125	20	250	0.6	0.3	87	38	40	Ov-2
122 Antelope Avenue	P-1(35%)	57 (12%)	0 (0%)	385 (79%)	48 (10%)	489 (6.66)	244	60	0.76	46	25	105	20	250	0.6	0.3	87	18	30	Ov-1
Phase II																				
4 Cairo Road	D-2	607 (44%)	51 (4%)	564 (41%)	162 (12%)	1,384 (11.39)	692	400	0.76	304	25	135	20	300	0.6	0.3	102	33	40	Ov-2
5 Freedomway	D-4	424 (18%)	52 (2%)	1,869 (78%)	50 (2%)	2,395 (6.88)	1,198	320	0.76	243	25	135	20	300	0.6	0.3	102	33	40	Ov-2
7 Kalambo Road	D-4	424 (18%)	52 (2%)	1,869 (78%)	50 (2%)	2,395 (6.88)	1,198	320	0.76	243	25	135	20	300	0.6	0.3	102	33	40	Ov-2
9 Kaundwe Road	P-5	275 (22%)	52 (4%)	890 (71%)	39 (3%)	1,256 (7.99)	628	220	0.76	167	25	130	20	300	0.6	0.3	102	28	30	Ov-1
8 Lumumba Road	D-5	1,008 (35%)	321 (11%)	1,359 (48%)	173 (6%)	2,861 (11.71)	1,431	900	0.76	684	25	140	20	300	0.6	0.3	102	38	40	Ov-2
20 Mumbwa Road	D-6	308 (58%)	131 (24%)	82 (15%)	14 (3%)	535 (17.15)	268	260	0.76	198	25	130	20	300	0.6	0.3	102	28	30	Ov-1
24 Chilumbulu Road	P-9	118 (8%)	118 (8%)	1,257 (81%)	52 (3%)	1,545 (7.25)	773	250	0.76	190	25	130	20	300	0.6	0.3	102	28	30	Ov-1
26 Kalingalinga Road	P-13	43 (6%)	0 (0%)	646 (92%)	17 (2%)	706 (5.03)	353	70	0.76	53	18	130	20	300	0.6	0.3	102	28	30	Ov-1
27 Alick Nkata Road	P-11	368 (55%)	56 (4%)	978 (67%)	48 (3%)	1,450 (8.36)	725	300	0.76	228	18	150	20	350	0.6	0.3	117	33	40	Ov-2
35 Katima Mulilo Road	D-7	343 (68%)	54 (11%)	95 (19%)	15 (3%)	507 (14.91)	254	200	0.76	152	19	140	20	300	0.6	0.3	102	38	40	Ov-2

NOTE: Weigth of Vehicles

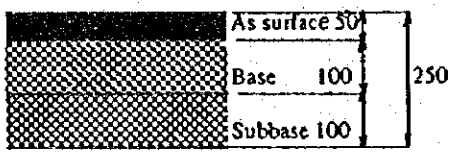
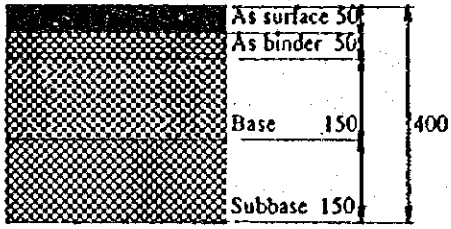
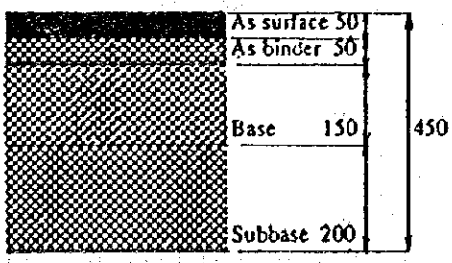
	Full	Empty	Average
Medium Goods Vehicles	19.7t	11.5t	15.6t
Heavy Goods Vehicles	49.0t	10.0t	29.0t
Medium Buses	5.0t	3.0t	4.0t
Heavy Buses	19.7t	15.2t	17.5t

Table 2-9 Thickness Design for Re-construction Pavement

		Traffic Survey Point	Initial Daily Traffic Volume in 1997					Initial Daily Traffic Volume one way in 1997				Equivalence Factor				Td	Average Growth Rate 20 years	DT	Traffic Class	Subgrade Materials Classification	Pavement Type	Embankment Subgrade Material Classification	Pavement Type Embankment Section
			Medium Goods Vehicles (nos.)	Heavy Goods Vehicles (nos.)	Medium Buses (nos.)	Heavy Buses (nos.)	Total (nos.)	79%	34%	60%	77%	Medium Goods Vehicles	Heavy Goods Vehicles	Medium Buses	Heavy Buses								
	Phase I		19.7	49.0	5.0	19.7																	
22	Los Angels Road	P-3	61	38	558	61	718	24	6	167	23	2	6	0.00	1	55	9.1%	1.04E+06	T3	S4	Type-2	S2	Type-2
25	Manali/Kaunda Road	P-13	43	0	646	17	706	17	0	194	7	2	6	0.00	1	20	9.1%	3.82E+05	T4	S5	Type-1	S2	Type-1
37	Mandevu Chipata Rd	P-7	105	0	524	52	681	41	0	157	20	2	6	0.00	1	51	9.1%	9.72E+05	T3	S4	Type-2	S2	Type-2
38	Chawama/John Howard	P-4	85	13	727	33	858	34	2	218	13	2	6	0.00	1	47	9.1%	8.79E+05	T3	S2	Type-2	S2	Type-2
64	Mutandwa Road	P-13	43	0	646	17	706	17	0	194	7	2	6	0.00	1	20	9.1%	3.83E+05	T4	S3	Type-1	S2	Type-1
66	Lukanga Road	P-13	43	0	646	17	706	17	0	194	7	2	6	0.00	1	20	9.1%	3.83E+05	T4	S3	Type-1	S2	Type-1
75	Mtendere Route	P-12	171	12	318	37	538	68	2	95	14	2	6	0.00	1	81	9.1%	1.53E+06	T3	S4	Type-2	S2	Type-2
102	Zambezi Road	P-13	43	0	646	17	706	17	0	194	7	2	6	0.00	1	20	9.1%	3.83E+05	T4	S3	Type-1	S2	Type-1
33	Palm Drive	P-13	43	0	646	17	706	17	0	194	7	2	6	0.00	1	20	9.1%	3.83E+05	T4	S5	Type-1	S2	Type-1
	Phase II							0	0	0	0	2	6	0.00	1	0	9.1%						
8	Lumumba Road	D-5	1,008	321	1,359	173	2,861	398	55	408	67	2	6	0.00	1	595	9.1%	1.12E+07	T1	S4	Type-3		
20	Mumbwa Road	D-6	305	131	82	14	532	122	22	25	5	2	6	0.00	1	191	9.1%	3.61E+06	T2	S4	Type-3	S2	Type-3
27	Alick Nkata Road	P-11	368	26	978	48	1,420	145	10	293	18	2	6	0.00	1	183	9.1%	3.46E+06	T2	S4	Type-2		

	Full	Empty	Average	Average/Full
* Medium Good Vehicles	19.7t	11.5t	15.6t	79%
* Heavy Good Vehicles	49.0t	10.0t	29.0t	34%
* Medium Bus	5.0t	3.0t	4.0t	60%
* Heavy Bus	19.7t	15.2t	17.5t	77%

Table 2-10 Proposed Pavement Structure for Re-construction Pavement

Countermeasure	Pavement Type	Total Thickness	Pavement Structure	Proposed Roads
Overlay	Ov-1	3cm		25 Munari/Kaunda Road 64 Mutandwa Road 66 Lukanga Road 104 Garden Road 122 Antelope Avenue 9 Kalundwe Road 20 Mumbwa Road 24 Chilumbulu Road 26 Kalingalinga Road
	Ov-2	4cm		22 Los Angels Road 75 Mtendere Road 102 Zambezi Road 4 Cairo Road 5 Freedomway 7 Kalambo Road 8 Lumumba Road 27 Alick Nkata Road 35 Katima Mulio road
Reconstruction and New Construction	Re-1	25cm	 Surface cource (Asphalt pre-mixed) t=5 cm Base cource (Mechanical stabilized crushed stone,CBR 30) t=10cm Subbase cource (Crusher run,CBR 30) t=10cm DSN=42.5>30.6-------OK	25 Manali/Kaunda Road 64 Mutandwa Road 66 Lukanga Road 102 Zambezi Road 33 Palm Drive
	Re-2	40cm	 Surface cource (Asphalt pre-mixed) t=5 cm Binder cource (Asphalt pre-mixed) t=5 cm Base cource (Mechanical stabilized crushed stone,CBR 30) t=15cm Subbase cource (Crusher run,CBR 30) t=15cm DSN=72.5>65.4------OK	38 Chawama/John Howard 27 Alick Nkata Road 22 Los Angels Rd 37 Mandevu Chipata Road 75 Mtendere Route
	Re-3	45cm	 Surface cource (Asphalt pre-mixed) t=5 cm Binder cource (Asphalt pre-mixed) t=5 cm Base cource (Mechanical stabilized crushed stone,CBR 30) t=15cm Subbase cource (Crusher run,CBR 30) t=20cm DSN=78.0>75.3------OK	8 Lumumba Road 20 Mumbwa Road

(10) Related Structure Design

(i) Bus Stations

The roads to be connected with the compound are used as the main bus routes for the resident in the compound. At every end of the road to the compound, there is the bus station for turning and waiting for the passenger. These bus stations shall also be paved as same structure as the road improvement.

(ii) New Bus Terminal near the Intersection with Kalambo Road

New bus terminal will be constructed along the Lumumba Road near the intersection of Kalambo Road. The land required for the new bus terminal is already reserved by the City Council for realization. The access to this bus terminal will be connected with the Lumumba Road and Mubwa Road, so that additional lane for turning to the new bus terminal shall be considered in the design of either the widening of Lumumba Road or Mubwa Road.

(iii) New Market along Los Angels Road

New market is under construction along with Los Angels Road near the intersection of Lumumba Road. The new market is supposed to be completed in September 1995 this year, however, a large numbers of kiosks, which are now engaging in business on the existing sidewalks of Lumumba Road, will be moved to the new market after completion of the new market, which may cause the traffic congestion near the intersection of Lumumba Road.

In order to relief the anticipated traffic jam on the Los Angels Road, the first 500 m of Los Angels Road shall be provided with the right turning lane on the road.

(11) Road Facilities Design

(i) Street Light

Existing street lights installed along the existing road shall be re-constructed in accordance with the widening of Lumbumba Road to 4 lanes, in order to facilitate the safe of the traffic movement and pedestrians. Lighting columns should be installed within the median strip

or sidewalk with a interval ranging from 40 m to 50 m depending on the road side conditions.

(ii) Traffic Light

Traffic lights shall be equipped at major intersections, under the judgment of necessity based on traffic volume on the priority road and the volume flowing from the non-priority intersecting road in a peak condition.

In widening plan of Lumumba Road to 4 lanes, examination were made at every intersections. At four intersections, 12-hour traffic volume of Lumumba Road and respective intersection roads are as follows; by multiplying 10% of peak hour ratio, the traffic volume without traffic lights were obtained to examine the necessity of traffic light equipping:

	12-hour Traffic Volume	
Intersection	Intersection Road	Lumumba Road
Los Angels Road	4,500 (450)	19,515 (1,951)
Katanga Road	1,000 (100)	10,863 (1,086)
Commonwealth Ave.	4,687 (470)	10,863 (1,086)
Great North Road	5,073 (510)	10,863 (1,086)

Remark: ( ): Peak-hour traffic volume

By applying Fig 2-5, the following were concluded:

Intersection	Intersection Capacity	Judgment
Los Angels Road	Not Enough	Traffic Light to be Equipped
Katanga Road	Enough	*)
Commonwealth Ave.	Not Enough	Traffic Light to be Equipped
Great North Road	Not Enough	- do -

Remark: *): At Katanga Road Intersection road occupancy by big-size trailers are prominent, hindering smooth traffic flows. For securing traffic flow and safety, traffic lights be equipped.

Fig. 2-6 shows the proposed traffic lights to be installed along the Lumumba Road, and the type of traffic light are summarized below:

(a) Replacement by new one in accordance with the widening of Lumumba Road ---------- 4 places

(Cross Type ; Kafue Road)

(T Type ; Kumungwi Road, Kalambo Road and Mubwa Road)

(b) Necessity of traffic light newly ---------- 4 places

(Cross Type ; Great North Road and Los Angels Road)

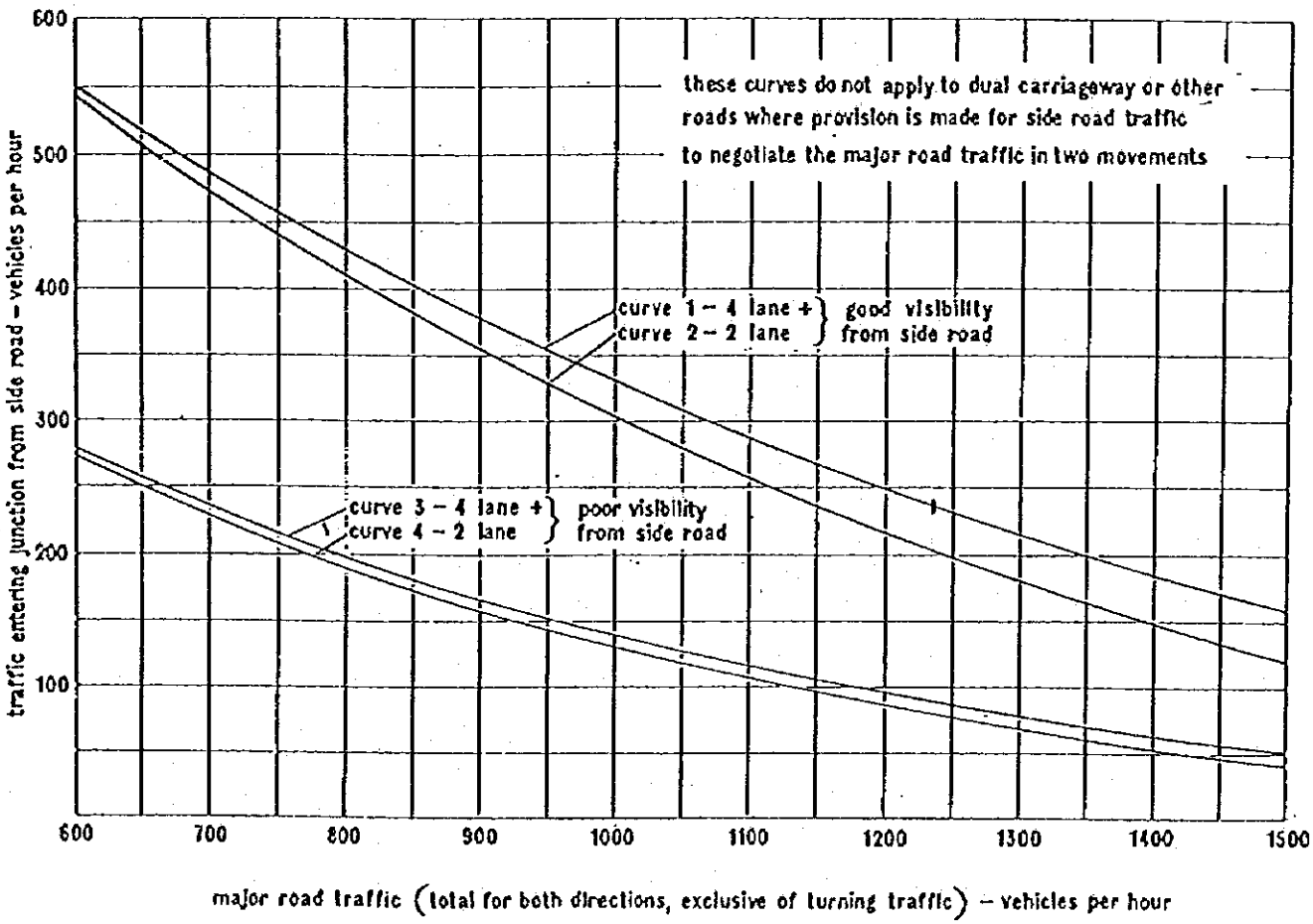
(T Type ; Commonwealth Ave. and Katanga Road)

(iii) Road marking

Road marking will be used not only to define traffic lanes but also to guide vehicles at junction and indicate the position of stop and waiting lanes. To maintain the smooth and safe flows in the city roads, road marking shall be provided.

(v) Tree Planting

There are grown-up trees planted on sidewalk along Lumumba Road, which should be retained as they are as much as possible so as to keep better environment. The tree will also be planted in the median strip to shade the light of traffic coming from the opposite direction.



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

Fig 2-5 Traffic Capacity of Priority Intersections

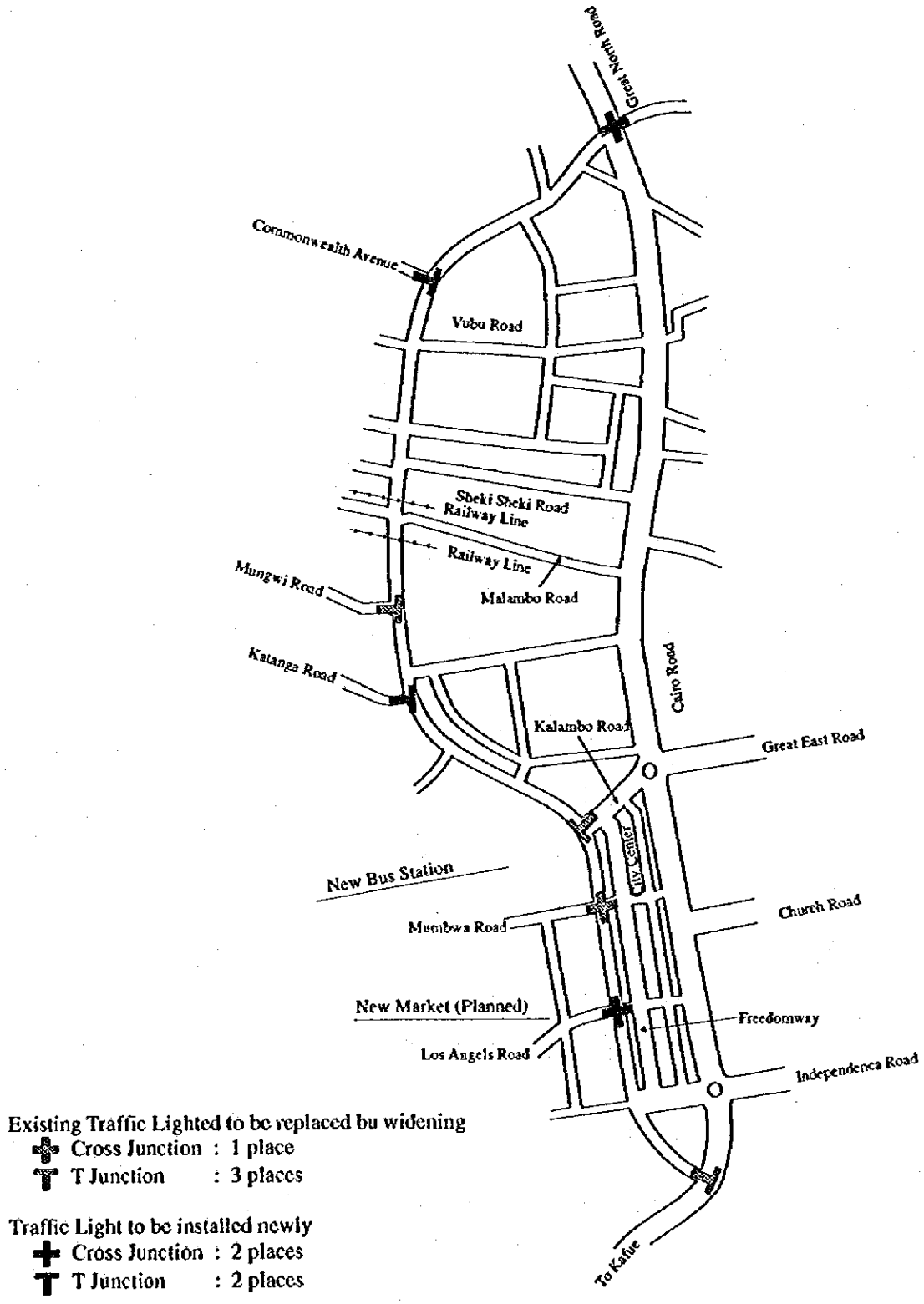


Fig. 2-6 Traffic Lights to be Installed along the Lumumba Road

(11) Relocation/Protection of Public Utilities Design and Railway Crossing

The existing utilities which might be affected by the widening of the project road should be protected and relocated properly as show in Fig. 2-7. The utilities should be designed taking into account the operation and maintenance for the services after open to the traffic so that it may not hinder traffic and accelerate the deterioration of road structures.

Water mains and telephone cable laid along the Lumumba Road are located at more than 10 m from the existing pavement edge and beneath the existing sidewalk at 1.0 m in depth approx.. Therefore, it was judged that the widening of Lumumba Road can be done without interference to these underground utilities.

In some sections of Lumumba Road, electric wires and poles will be affected by the widening work. These electric line should be replaced by new one at the cost of the City Council.

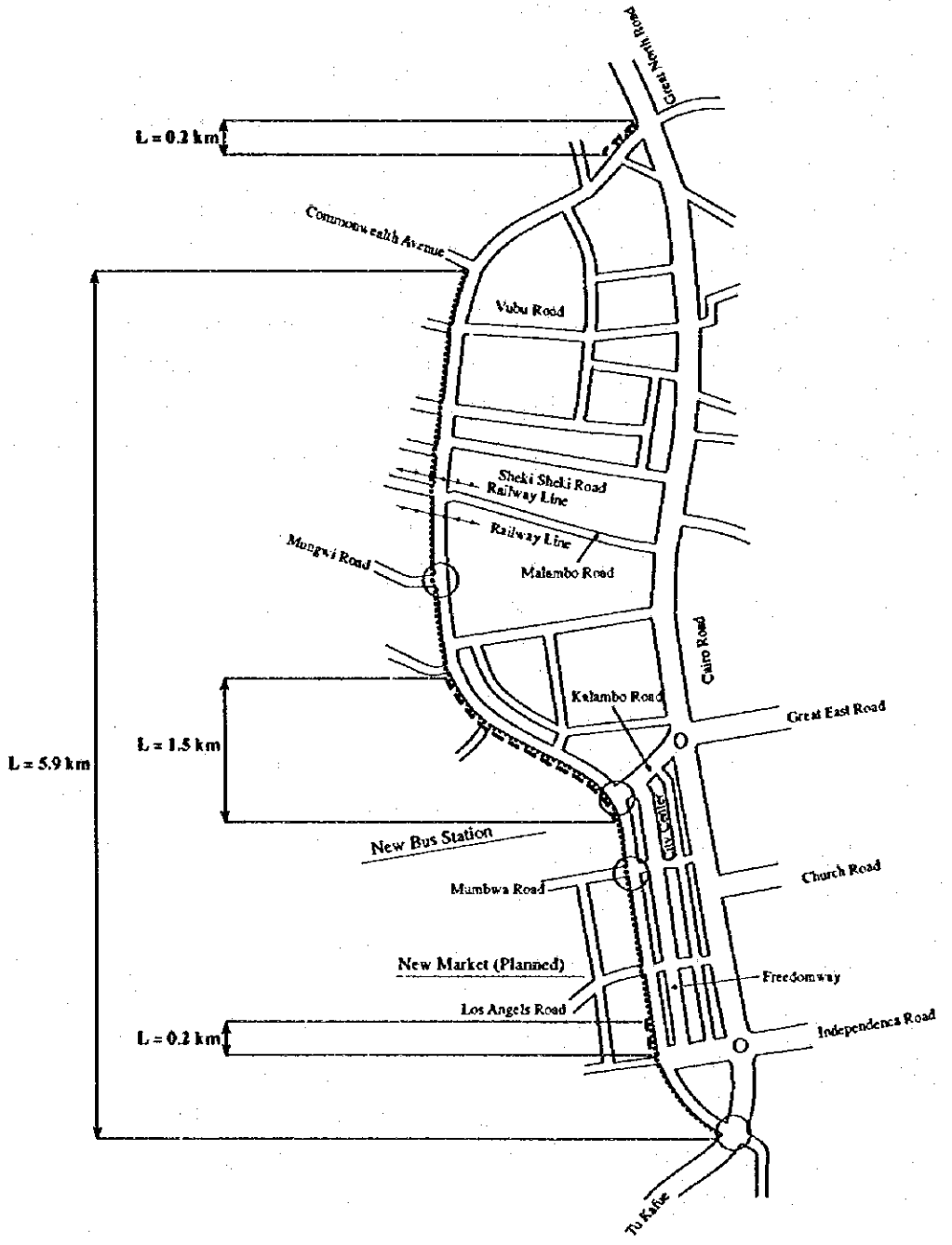
Lumumba Road crosses the railway line at two places. The widening of road at the railway crossing will be done using the striped steel plates. Existing crossing gates and alarms shall be relocated in accordance with the widening plan and used as they are. The widening shall be conducted properly so as not to obstruct the railway operation.

(12) Buildings /Houses to be removed

No buildings and houses will be removed due to widening of Lumumba Roads since the existing right-of-way width reserved for the Lumumba Road is 30 m to 50 m which is sufficient enough for the widening to 4 lanes. However, there are many kiosks irregularly occupied the sidewalk along the Lumumba Road near the city center. The government of Zambia should demolish these kiosks prior to the commencement of the project.

(13) Work Quantities

Work quantities was calculated on the basis of design drawings and Summary of major works is presented in Table 2-11.



Quantities of Public Utilities to be replaced

Public Utilities	Unit
Street light pole :	73
Electric pole :	32
Traffic light :	8

— — Section of Electric Poles to be repalced

..... Section of Street Light Poles to be replaced

◯ Traffic Light to be replaced

Fig. 2-7: Existing Street Lights and Traffic Lights Affect by the Widening of Lumumba Road

Table 2-11 Summary of Major Work Quantities

No.	Work Item	Unit	Quantity
1	Removal of Existing Pavement	m2	55,387
2	Waste Excavation (Common)	m3	81,704
3	Waste Excavation (Hard Rock)	m3	53,104
4	Embankment	m3	76,229
5	Pipe Culvert (Dim. 30 cm - 100 cm, 90° Foundation)	m	3,280
6	Pipe Culvert (Dim. 60 cm - 100 cm, 360° Foundation)	m	1,805
7	L Type Side Ditch (400 x 300 & 400 x 400)	m	10,000
8	U Type Side Ditch (400 x 300)	m	4,400
9	Catch Pit Type A (400 x 300)	no.	698
10	Repair of Existing Open Channel	m	33,100
11	Open Channel (0.6 Base - 1.7 Height)	m	11,130
12	Manhole	no.	49
13	Outlet of Pipe Culvert (D600)	no.	239
14	Preparation of Subgrade	m2	433,887
15	Subbase Course	m3	43,180
16	Base Course	m3	59,761
17	Double Bituminous Surface Treatment (DBST)	m2	192,000
18	Preparation of Overlay	m2	363,082
19	Asphalt Surface Course t = 5 cm	m2	183,026
20	Asphalt Binder Course t = 5 cm	m2	150,122
21	Overlay (t = 3 cm)	m2	180,246
22	Overlay (t = 4 cm)	m2	182,836
23	Tuck Coat	m2	500,884
24	Prime Coat	m2	183,026
25	Sidewalk	m2	118,824
26	Flush Curb at Pavement Edge	m	98,600
27	Stone Curb at Medium Strip	m	9,420
28	Street Light	no.	288
29	Traffic Light	place	8
30	Lane Marking	m2	13,335
31	Roof of Bus Stop	place	4
32	Stripped Steel Plate	set	1

(14) Drawings

Basic design drawings are presented in Appendix A and the list of drawings are as shown below:

	Items of Drawings	Drawing No.
(i)	Location map	No. 1
(ii)	Typical Cross Sections	No. 2 - No.8
(iii)	Group 1: Urgent Repair of Access to the Compounds	No. 9 - No.26
(iv)	Group 2: Improvement of Arterial Roads	
	- Lumumba Road	No. 27 - No.46
	- Other arterial Roads	No. 47 - No.52
(v)	Bus station	No. 53
(vi)	Drainage Facilities	No. 54 - No.58
(vii)	Road Facilities	No. 59
(viii)	Relocation of Public Utilities	No. 60 - No.62
(ix)	Miscellaneous Work	No. 63

Chapter 3 Implementation Plan

3.1 Implementation Plan

3.1.1 Implementation Concept

(1) Implementation Method and Plan

The implementation plan has been studied assuming that the project will be executed under the grant aid from the Japanese Government and made taking the following conditions into consideration:

(i) The City Council will be the executing agency and appoint the project manager who is responsible for the administration and management of the project.

(ii) A Japanese consultant, recommended by JICA and entrusted by the City Council after contract signing, will carry out the detailed design, tendering in cooperating with a client in selecting a contractor and supervision for the project.

(iii) A Japanese contractor, after contract signing, will undertake the construction work and procure the maintenance equipment under the project.

(iv) The City Council shall provide a contractor the temporary site free of charge for the contractor's base camp near the project site.

(v) Prior to commencement of the work, the City Council shall replace or protect the public utilities including the water main, telephone cable, power line, etc., which might be affected by the construction of road. The street light and traffic lights will be reconstructed by a contractor under the project.

(vi) The City Council is responsible for coordinating all construction related matters with the residence and agencies concerned and solving troubles and problems which may raised during the construction of the project.

(vii) The project site shall be given by the City Council in accordance with the construction schedule submitted by a contractor at the commencement of

project. A contractor is responsible for maintenance of the sites until handing over the completed section or route to the City Council.

(viii) A contractor shall hand over route by route to the City Council upon completion of the work. The City Council shall undertake the maintenance work after handing-over of each route.

(ix) The City Council is responsible for providing the facilities so as to keep the maintenance equipment in good condition.

(x) The construction schedule will be prepared assuming that the rainfall will not affect the critical work of the project including earthwork and pavement, since the rainfall will last for a whole day even in the rainy season.

(2) Necessity of Experts

Since the pavement work is the critical in the project, proper operation for asphalt plant is essential for successful completion of the project. It is therefore recommended that a qualified expert will be despatched from Japan for the purpose of operation and maintenance of asphalt plant.

In addition, in order to improve the maintenance work in terms of quality and output, the expert who has a well experience on the pavement maintenance, especially repairing of pavement by patching work, will be despatched to provide the staff of City Council the on-the-job training for repairing work using the maintenance equipment to be procured under the project.

3.1.2 Implementation Conditions

For the implementation of the project, the following conditions are taken into consideration:

(1) Traffic management on the existing roads during the construction

The project roads are mostly 6.1 m to 7.1 m wide 2 lanes road which may require the traffic management during the construction of pavement and overlay. One side construction for these 2 lanes roads opening one-way traffic might be difficult since these roads mostly requires embankment by 1.0 m approx. for the drainage purpose.

Therefore, temporary diversion with a traffic signal devices will be provided during the construction of these 2 lanes roads. A part-time traffic suspension would be unavoidable during the construction of the compound roads due to difficulty of provision of temporary detour. Night work will also be done, if necessary.

(2) Procurement of construction equipment and materials

Construction equipment and materials are imported from South Africa and mostly available in Lusaka City. Therefore, construction equipment and materials to be used for the project, with the exception of particular one, should be planned to be purchased either in the local market in Zambia or procured from South Africa as far as possible .

3.1.3 Scope of Works

(1) Undertakings of Japanese

(i) Improvement of Road Facilities

- To carry out the detailed design and tender in selecting the contractor
- To undertake the improvement of roads described in Paragraph 1.3.2
- To improve the drainage facilities up to the connection with the existing storm drainage system.

(ii) Procurement of Equipment and Materials

- To procure the maintenance equipment described in the paragraph 1.3.3 and transport them up to the store yard of City Council

(2) Undertakings of Zambian Government

(i) Road Facilities

- To relocate and protect of water main, electricity wire, telephone cable, street lighting, traffic signal
- To appoint the project manager and staff for the project, and provide the office, transportation and to ensure the project running cost for the project.

(ii) Maintenance equipment

- To arrange the store room or yard to keep the maintenance equipment to be procured under the project.
- To operate and maintain the equipment

3.1.4 Construction Supervision

Immediately after signing the Exchange of Notes (E/N), the contract for engineering consulting services should be signed. The services will cover the detailed design, cost estimation, preparation of tender/contract documents, tendering and construction supervision.

The required Japanese staff and their responsibilities are described below:

(i) Team Leader

Responsible for all aspects of the consulting services during the detailed design and construction stage

(ii) Road Engineer

Responsible for the detailed design of roads including the supplementary traffic survey for intersection design

(iii) Road Design Engineer

Responsible for the detailed design of road structures including the drainage structures, sidewalks, walkway, intersections, bus stops, etc.

(iv) Facilities Engineer

Responsible for the detailed design of street lighting, traffic sign and railway crossing

(v) Construction Planner/Cost Estimate

Responsible for the preparation of detailed implementation plan including the review on project costs made in the basic design stage

(vi) Contract Specialist

Responsible for the preparation of tender, contract and related documents during the detailed design

(vii) Survey Engineer

Responsible for the topographic survey including the centerline survey, cross sectional survey and plain table survey during the detailed design.

(viii) Soil and Materials Engineer

Responsible for the supplementary pavement survey including pavement structure and subsoil investigation during the detailed design

(ix) Resident Engineer

As the resident engineer in Lusaka City, responsible for supervising the construction work

(x) Materials Engineer

Responsible for the quality control for the materials to be used for the road structures during the construction

3.1.5 Procurement Plan

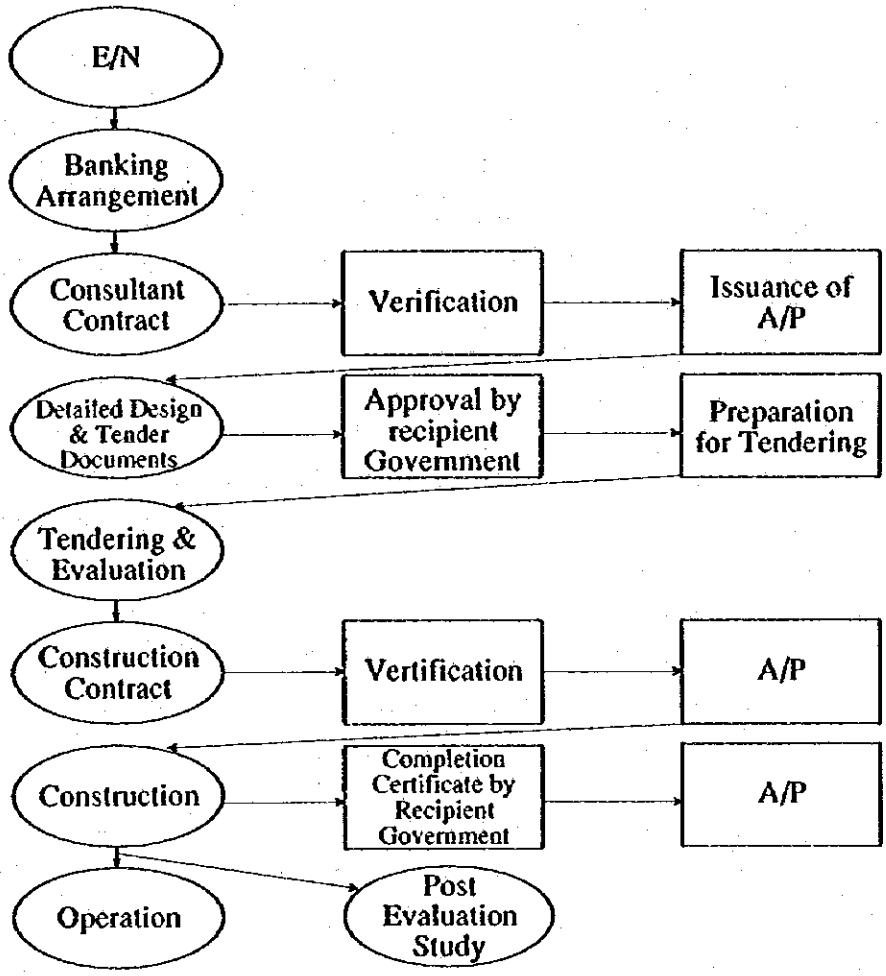
The construction materials to be used for the project are mostly available in Lusaka, with the exception of street lighting, traffic signal and railway crossing facilities which will be procured via a Zimbabwe from South Africa during the construction stage.

Table 3-1 Procurement of Construction Materials

Description	Procured from Zambia	Procured from South Africa	Procured from Japan
Cement	O		
Water-reduced agent	O		
Straight Asphalt	O		
Asphalt Emulsion	O		
Crusher run	O		
Sand	O		
Plywood	O		
Wooden	O		
Gasoline	O		
Light Oil	O		
Heavy Oil	O		
Traffic Light		O	
Street Light		O	

3.1.6 Implementation Schedule

The implementation schedule for the detailed design and construction was prepared taking into consideration the procedure of the Japanese Grant Aid System as shown in Fig 3-1 below:



Note (1) E/N : Exchange of Note
(2) A/P : Authorization to Pay

Fig 3-1 Procedure of Japanese Grant Aid Program

Each phase is broadly divided into three stages as shown below:

1 stage: Contract with the consultant and the detailed design

After signing the contract with the selected a Japanese consulting firm, the detailed design will be carried out by the consultant including the preparation of the tender/contract documents, drawings and cost estimate. The direct contract system will be applied to procure the consultant.

2 stage: Pre qualification, Tendering and Contract with the Contractor

After discussion with and approval by JICA pertaining to evaluation of the items for the pre qualification (P/Q) of tenderers for the construction work, the P/Q activities will be carried out in Japan by the consultant on behalf of the Government of Zambia to select the qualified tenderers.

In the tendering operation, the principle of general competitive bidding will be applied to select a Japanese contractor for the construction work. Evaluation of the tenders and selection of the contractor will be performed in Japan by representatives of the Government of Zambia and the Consultant in the presence of JICA officials. Negotiation with the selected contractor and signing of the contract will be also be done in Japan. The direct contract system currently in use will be applied to obtain the Contractor.

Parallel to the signing of the contract, the Government of Zambia will conclude a banking arrangement with an authorized foreign exchange bank in Japan to open accounts for the purpose of receiving the funds granted by the Government of Japan, and making payment to the Japanese consultant and contractor. This banking arrangement will serve as the basis for the Government of Zambia to issue the Authorization to Pay (A/P) that is indispensable for use by the Japanese consultant as well as for use by the Japanese contractor who will have to obtain export licenses for equipment and materials.

Such banking arrangement will also be used to receive payments as stipulated in the contract terms and should be concluded within one month after the signing of the E/N. It is noted that the Japanese consultant and contractor will able to carry out their responsibilities only after receiving the verified contract and A/P.

The next step is a verification to be conducted by the Government of Zambia. Verification means examine whether the contents of contracts conform to the provisions of the E/N, which is requisite for the contract to be effective.

3 stage: Construction work

The construction work will basically consist of two phases as follows:

(i) Phase 1 : Urgent repair of the access to the compounds, 12 routes over 30.8 km

- 12 months required for construction period

(ii) Phase 2 : Improvement of the arterial roads in the city, 10 routes over 30 km, and procurement of the maintenance equipment.

- 16 months required for construction period

The project is planned to be implemented in two (2) phases as shown below:

(1) Phase 1: Urgent repair of access to the Compounds (12 routes over 30.8 km)

(2) Phase 2: Improvement of arterial roads in the City (10 routes over 34.4 km)

The Phase 1 requires 4 months for the detailed design and 12 months for the construction. As for the Phase 2, 5 months is required for the detailed design and 16 months for construction. Fig. 3-2 shows the implementation schedule of Phase 1 and Phase 2.

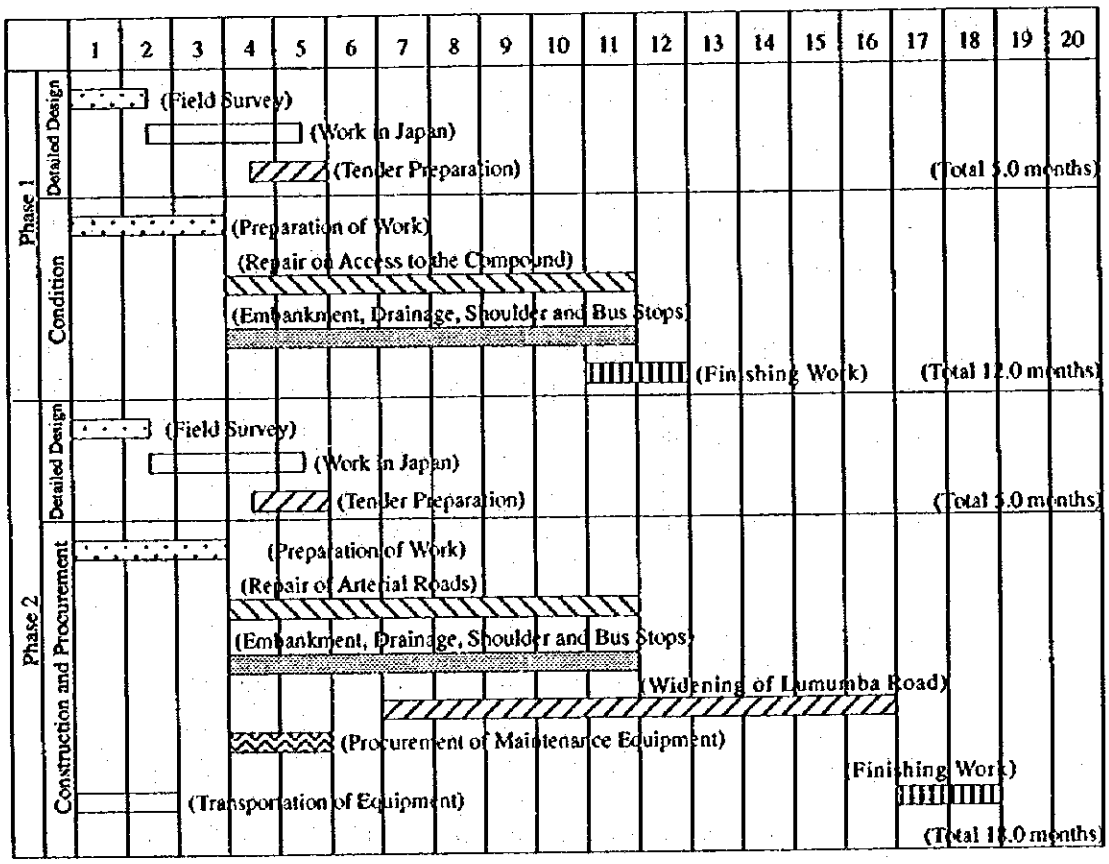


Fig 3-2 Overall Implementation Schedule

3.1.7 Obligation of Recipient Country

For the implementation of the project, the Government of Zambia will undertake the following:

(1) Undertakings required for Construction Works

- Land acquisition,
- Land lease for temporary works, if any
- House compensation and their removal
- Relocation and protection of the existing utilities which might be affected by the construction of the roads

(2) Administration work

- To furnish data necessary for the detailed design and construction supervision
- To bear commission for the banking services based on the Banking Arrangement
- To ensure prompt unloading and customs clearance at the port of disembarkation in Zambia for the equipment, materials and vehicles required for the project
- To ensure tax exemption for the consultant and the contractor engaged in the project
- To issue visa, traffic certificate and other certificates necessary for the execution of the project to the consultant and the contractor
- To ensure contractual payments to the consultants and the contractor
- To bear expenses required for the proper and effective maintenance after completion of the project
- To bear all the expenses necessary for the execution of the project other than those to be borne by the grant aid.

(3) The expenditure to be borne by Zambian Government

In connection with the implementation of the project, the following expenditures was estimated:

Replacement of Public Utilities	Unit	Quantity	Cost (Unit: 1,000 kw)
(1) Electric wire along the Lumumba Road (location 1)			
Pole	nos.	81	65,000
Wire	m	3,430	5,000
(2) Electric wire along the Lumumba Road (location 2)			
Pole	nos.	8	6,500
Wire	m	260	4,000
Total			80,500

3.2 Operation and Maitenance Plan

Operation cost and maintenance cost required before and after completion of the project is estimated as follows:

Annual Funds Required (KW Miilion)

	Present (1994)	After Procurement of maintenance equipment	Increased Ratio
Administration cost including Salary for the Staff for Road Dept.	213	213	0%
Maintenance Work and Operation	252	336	30% up
Total of Road Sector	465	549	20 % up

(1) Administration cost shall cover the operation and running costs of road maintenance offices including the salary and these cost would not be changed wheather the project is implemented or not because of that these are the fixed cost.

(2) The cost for the maintenance work and operation would be increased by supply of maintenance equipments, of which amount is estimated as shown below:

[Fuel Costs]

	Q'ty	House power	Fuel Consuption per lit/hour/Hp/No.	Fuel Consuption per lit/hour
Pick up Truck	3	85	0.035	8.9
Truck	3	253	0.039	29.6
Vibration Roller	1	28	0.109	3.1
Backhoe	1	120	0.129	15.5
Truck with crane	1	94	0.071	6.7
Total				63.8 lit/hour

Working hour : 6 hour/day x 50% = 3.0 hour/day

Operation cost : 64 lit/hour x Kw 262/lit x 3.0 hour/day x 25 day/month x 12month = Kw 15 million/year ..... (1)

[Labour cost]

50 man/day x Kw 1,500/day x 25 day/month x 12 month = Kw 22.5 million/year ..... (2)

[Materials cost]

Gravel 10 ton/day x Kw 8,000/ton x 25 day/month x 12 month = Kw 24.0 million/year

Asphalt 0.5 ton/day x Kw 150,000/ton x 25 day/month x 12 month = Kw 22.5 million/year

Total Kw 46.5 million/year ..... (3)

Total Increased Cost of Maintenance Works ; (1) + (2) + (3)

- KW15.0(m)+KW 22.5(m)+ KW 46.5(m) = KW 84 million

The increased maintenance cost amounting Kw 84 million per year accounts for about 30% of the annual budget allocated to the road maintenance in Lusaka City Council. We understand that the increase of maintenance cot would be endured by re-allocation their budget.

Chapter 4 Project Evaluation and Recommendation

4.1 Project Effect

The Project aims at the improvement of major roads in Lusaka city. The total length of the roads to be improved by the Project is about 65 km over 22 roads. The project is expected to achieve the various social and economic effects as described below:

(1) Improvement of Basic Human Need through the Improvement of Access to the Compounds

It is expected that major bus routes in the city will be improved through the overlay and reconstruction of pavement of access to the compounds. It will shorten the commuting hour of inhabitants of over 200 to 300 thousands in the compounds and secure the transport route which have been impassable frequently due to inadequate drainage facilities during the rainy season. The project also improve the environment of the compounds by reducing the dust which have caused by the passage of vehicles on the gravel road.

(2) Enhancement of Economic and Social Activities in the City by Improvement of Arterial Roads in the City

The pavement condition of arterial roads in the city are mostly in bad due to lack of maintenance of pavement. These roads will be improved by the overlay and reconstruction of pavement which will contribute to the traffic movement remarkably resulting in the saving of running cost and traveling time. The Lumumba Road, running in parallel with Great North Road, is one the most important arterial road carrying heavy traffic with more than 17,000 vehicle per day. The congestion of Lumumba Road will be reduced and solved by the widening to 4 lanes road, which will enhance the economic and social activities in the Central Area of Lusaka City.

The road network system in the city will be connected with each other and strengthened efficiently through the improvement of arterial roads and access to the compounds, which will contribute not only to the improvement of economic and social activities but also to the improvement of basic human need of the people in the city.

4.2 Recommendations

The project aims at improvement of major bus routes to the compounds as well as arterial roads in the Lusaka City covering 65 km approx. over 22 routs, however, there are still many routes left in poor and bad condition. These roads should be maintained by the City Council properly utilizing the maintenance equipment which will be provided under this project.

It is noted that the maintenance work should be transferred from the direct force of City Council to the private sector in the long term in line with the road maintenance policy of IDA. The heavy or major improvement work shall be undertaken through the employment of general contractor so that the road maintenance equipment to be provided under the project are the one which are used for the daily or routine maintenance work. In this regard, the City Council is advised to establish the road maintenance system on the basis of private sector as soon as possible and prepare the concrete implementation program of road maintenance for the city road.