Ministry of Local Government and Housing
The Republic of Zambia
Livingstone City Council

No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
IMPROVEMENT OF LIVINGSTONE CITY ROADS
IN
THE REPUBLIC OF ZAMBIA

MAY 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CONSTRUCTION PROJECT CONSULTANTS, INC.

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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 of Livingstone City Roads and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Zambia a study team two times from September 27th to October 24th, 2007 and from November 4th to December 8th, 2007.

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 of the Government of the Republic of Zambia for their close cooperation extended to the teams.

May 2008

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

May 2008

LETTER OF TRANSMITTAL

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

This study was conducted by Construction Project Consultants, Inc., under a contract to JICA, during the period from September, 2007 to May, 2008. 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,

Tetsumi Masui
Project Manager,
Basic Design Study Team on
the Project for Improvement of
Livingstone City Roads
Construction Project Consultants, Inc.

SUMMARY

SUMMARY

(1) Country Profile

The Republic of Zambia (hereinafter referred to as "Zambia") is a landlocked country located in south-central Africa with a population of approximately 11.9 million (2006), a national land area of 753,000 km^2, which is approximately twice the size of Japan. Most of its territory is comprised of highlands 1,000 to 1,350 meters above sea level. Livingstone, the site of the project, is located in a southern province of Zambia bordering Zimbabwe. The site has many hills ranging from 880 to 970 meters above sea level and includes Victoria Falls along an international boundary, which is listed as a world heritage site. The annual mean temperature is 23.4C° (2002 to 2006) which does not fluctuate very much throughout the year. Although rainfall is concentrated between November and March, the annual average precipitation has been relatively low at approximately 560mm (approximately 1/3 that of Tokyo) over the past five years (2002 to 2006).

Due to the progress of the rapid economic liberalization in the 1990s, Zambia has become one of the most advanced nations in view of economic deregulation in southern Africa. On the other hand, economic growth in the first half of the 1990s was weak due to the long slump in international prices for copper, such that gross domestic product (GDP) continued negative growth. Since then, the Zambian economy has continued to show favorable growth due to the implementation of a privatization of large-scale copper mines which began in 2000, a rise in international copper prices since the end of 2003, the promotion of an industrial diversification policy including agriculture and tourism implemented by the Government of the Republic of Zambia (hereinafter referred to as "GRZ"), and debt relief through the Heavily Indebted Poor Countries (HIPC) Initiative since 2005. GDP growth has maintained a level of 5.0% since 2003 and was 6.0 % in 2006. The gross national income (GNI) in Zambia is 7.5 billion US dollars (2006) and the GNI per capita is 630 US dollars (2006).

(2) Background, Details and Outline of the Requested Project

Roads within the transportation sector play an important role in transporting goods including international logistics and passengers in Zambia and are the basis of economic growth. The 5th National Five-Year Plan (2006 to 2010) also pointed out the importance of establishing a road traffic network for economic growth including agriculture and tourism and there is a pressing need for further improvement.

For nationwide road development, the GRZ established the National Road Board (NRB) which is composed of the Ministry of Works and Supply (hereinafter referred to as "MWS") which has jurisdiction over the road sector and the Ministry of Local Government and Housing (MLGH) in the

central government, representatives from the private sector and other governmental authorities, which launched the Road Sector Investment Program (ROADSIP) in 1997. It was decided that the first phase of the program would be implemented over five years from 1998 to 2002 and the second phase would be implemented over ten years from 2004 to 2013. In the second phase of the program, the development of major urban roads is regarded to be the most important issue for revitalizing the economy in key local cities which supports local economic recovery and social services. The target Mosi O'Tunya Road, which is a part of the major road (T1) (of T1 road, a name of the part of Livingstone area), is a major trunk road located at the junction of the route to South Africa by way of Zimbabwe from Lusaka, the capital of Zambia, and the route to South Africa by way of Botswana. The road is regarded to be an important transit route for principal physical distribution in Zambia. Accordingly, the road is included in the major trunk roads development plan of the Road Sector Investment Program (ROADSIP) II.

The targeted twenty one (21) routes (33.5km) requested by Zambia (July 2006) are located in Livingstone and the above-mentioned Mosi O'Tunya Road is also included in the requested target roads.

As for the present condition of the requested roads, full-scale pavement repair was conducted on T1 Road between 1970 and 1975 and road surface was improved in 1994 through random paving (low cost pavement). Twenty (20) other municipal routes have been improved since independence in October 1964. In the breakdown, 48% of the roads with a total extension of 165km or more are randomly paved; whereas the remaining 52% are unpaved laterite roads. As a consequence, the present major roads including Mosi O'Tunya Road in the city have deteriorated severely due to an increase in heavy vehicles accompanying the recent international truck roads network development. In addition, incidental road facilities such as sidewalks and drainage systems are also severely damaged and are hindering economic growth in a city where tourism is a key industry.

After due consideration of the current situation, the GRZ made a request for Japanese Grand Aid for necessary funding to improve roads based on the realization that smooth passage of vehicles in the city is essential not only for social and economic development of the city but also for that of the nation.

In due consideration of the above, the Government of Japan decided to carry out a Basic Design Study on the requested twenty one (21) routes (33.5km) after examining the appropriateness of the project components and the scope as a Japanese Grand Aid Scheme.

(3) Outline of the Study Findings and Project Components

In response to this decision, the Japan International Cooperation Agency (JICA) implemented a field survey divided into two parts. In the first field survey, the actual conditions of the requested 21 routes

were confirmed and the routes were narrowed down. In the second field survey, an appropriate basic design was prepared as the Grand Aid Scheme, a project plan was formulated and the project cost was estimated. In particular, the first Basic Design Study Team was dispatched from September 27 to October 16, 2007 to hold discussions with the concerned parties in Zambia and to reaffirm the background and components of the request. The narrowing down of the requested 21 routes in the study was also examined. As a result of the route selection and evaluation, only Mosi O'Tunya Road (13.01km) of the 21 routes was selected for the requested Japanese assistance. Although the other 20 routes were recognized to be important, they are excluded because they do not meet the requirement of JICA's Grant Aid Scheme in term of urgency and relevance; it is difficult to realize immediate efficiency due to less traffic volume and relatively shorter length of municipal roads. The second Basic Design Study Team was dispatched from November 4 to December 8, 2007 in order to explain and discuss the results with the Zambian side and then to obtain the consent of the recipient side. In the second field survey, the actual condition of the road targeted under the project, natural conditions, and the project site conditions including traffic volume and road design standards in Zambia were researched. After returning to Japan, the appropriate project components were reviewed based on the findings of the survey and a Basic Design was prepared. The Draft Report Explanation Team was dispatched from March 13 to March 23, 2008 in order to discuss and confirm the components of the Basic Design and the obligations of the Zambian side in accordance with a draft final report, and consent was obtained.

Detailed study on the project site revealed that the entire road surface had deteriorated, and vertical or transversal cracks and pot holes were observed. In addition, the ends of pavement were severely damaged and deteriorated and some break lines between the road shoulders and roadways had been sagged to the extent that the separation between vehicles and pedestrians is difficult. Furthermore, the old road drainage systems improved prior to independence were obsolete and damaged, and problems such as water pooling along roadways and shoulders during raining were confirmed.

As design policy, the Zambian standard road type IB (for urban district) and IC (districts other than urban districts) have been adopted. The road alignment in principle shall trace the existing roads not to relocate roadside houses or public facilities whenever possible. In the pavement plan, a load which would bear both the existing traffic and the future traffic were examined and reflected in the design. Effective utilization of existing road drainage facilities as much as possible was planned. Particularly for road traversing culverts, replacement of damaged concrete pipes and corroded corrugated metal pipes and storage drums with new concrete pipes was planned. With respect to ancillary facilities, although the Zambian side made an additional request for installation of "street lights", "benches", "cycling tracks" and "traffic signals" in the second field survey, as the result of the examination, benches and traffic lights were excluded from the scope of Japanese assistance. A suggestion was made to use new road shoulders for cycling tracks and install street lights at necessary

sections from the viewpoint of vehicle and pedestrian traffic safety and public peace and order at night. In addition, ancillary facilities such as roadside, road surface division lines, pedestrian crossings, bumps, guard fences and road signs were also planned.

The above-mentioned Project planning is outlined in the following table.

Outline of the Project

Item		Description
Target Section		13.01km (between the entrance of Livingstone and Victoria Falls Bridge)
Pavement Structure	Surface Course Construction	Asphalt concrete surface course, 5 cm (main line)
		Double bituminous surface treatment: DBST (road shoulders)
		Single bituminous surface treatment: SBST (sidewalks)
	Base Course Construction	Base course, 10cm (mechanically stabilized crushed stone)
		Sub-base course, 12 to 40cm (crasher-run stone)
Road Width Structure		IB 2-lane:11.70m (3.35m roadway×2, 2.5m shoulder×2)
		IC 4-lane:18.20m (3.05m roadway×4, 2.0m shoulder×2, 2.0m median strip)
		IC 2-lane:10.10m (3.05m roadway×2, 2.0m shoulder×2)
Road Drainage Facilities		U-shaped gutters : 3,235m (concrete, open/covered) Soil gutters : 3,440m Road traversing culverts : 468m (φ600 to φ1,000mm) Inlet construction : 15 locations Spillway construction : 16 locations Catch pit construction : 46 locations
Ancillary Facilities		Roadside construction : 10,181m Road surface division lines : 35,700m (center and side lines) Pedestrian crossings : 29 locations Bumps : 10 locations (speed and land strip) Guard fences : 53 locations Road signs : 50 locations Street light installation : 62 units installed along the distance of about 3.1km (49 one-light type units, 13 two-light type units)
Other Facilities		Repair of 106m guardrail at the existing 2 bridges (88m Maramba Bridge、18m Kabila Bridge)

(4) Project Period and Estimated Project Cost

In case the Project is implemented, the detailed design will take 5 months and the construction will take 13 months. The Project will be implemented in accordance with the Japan's Grant Aid scheme and the cost will be determined before concluding the Exchange of Notes (E/N) for the Project.

(5) Verifying the Relevance of the Project

By implementing the Project, the conditions of Mosi O'Tunya Road in Livingston City will be improved, and safe and smooth traffic flow will be ensured. It is therefore expected to benefit 104,000 citizens in Livingstone and 600,000 tourists.

[Direct Effects]

1) By improving traffic efficiency through better travel performance and securing smooth traffic flow, the average speed for safe travel between the start and end points (except for urban areas) will be increased from the current 30km/h to 50km/h. The average travel speed between urban areas will be increased from 20km/h to 40km/h.

2) By improving road shoulders, sidewalks and street lights, it will become possible to separate pedestrians and bicycles from vehicles. By installing street lights, various measures including night safety will also be assured. The accident rate will therefore be reduced so as to contribute to improvement in safety of the relevant road at night and during daytime hours.

[Indirect Effects]

1) By functioning as a major international trunk road, physical distribution and personnel exchange will be promoted and will contribute to the revitalization of social and economic activities.

2) By improving the convenience for tourists through better accessibility to tourism facilities, it will contribute to the tourism industry, which is a key industry in the city.

As mentioned earlier, through the implementation of the Project, smooth and safe urban traffic flow will be ensured, and contribute to the development of the tourism industry, a key industry in the city, revitalization of regional social and economic activities and promotion of an improvement in living conditions for local residents. Therefore, implementation of the Project under the Japanese Grant Aid Scheme has been considered to be significant.

The implementing agency of the Project is the Livingstone City Council (hereinafter referred to as

"LCC"). Requirements to be undertaken by the Zambian side include the relocation of existing utilities (electricity, water supply and sewer systems, etc.), removal and relocation of existing street lights, lead-in wire to new street lights to be installed, and securement of a temporary yard lot. Expenses necessary to implement the requirements will be borne by the Ministry of Local Government and Housing (MLGH), which is the competent governmental authority.

With regard to major necessary maintenance work after the completion of the target road construction under the Project such as cleaning and repair of roads and drainage facilities, the necessary expenses shall be borne by LCC, the implementing agency.

The Zambian side is required to deal with the following issues related to the Project.

1) In order to reinforce the road maintenance system and build managerial skills, engineers should be continuously secured and human resources should be trained.

2) A long-term maintenance system should be established and a maintenance budget should be secured based on it.

3) Overloaded vehicles, which are a biggest contributor to road damage (especially for pavement), should be regulated, and a regulating system should be established, reinforced and implemented thoroughly.

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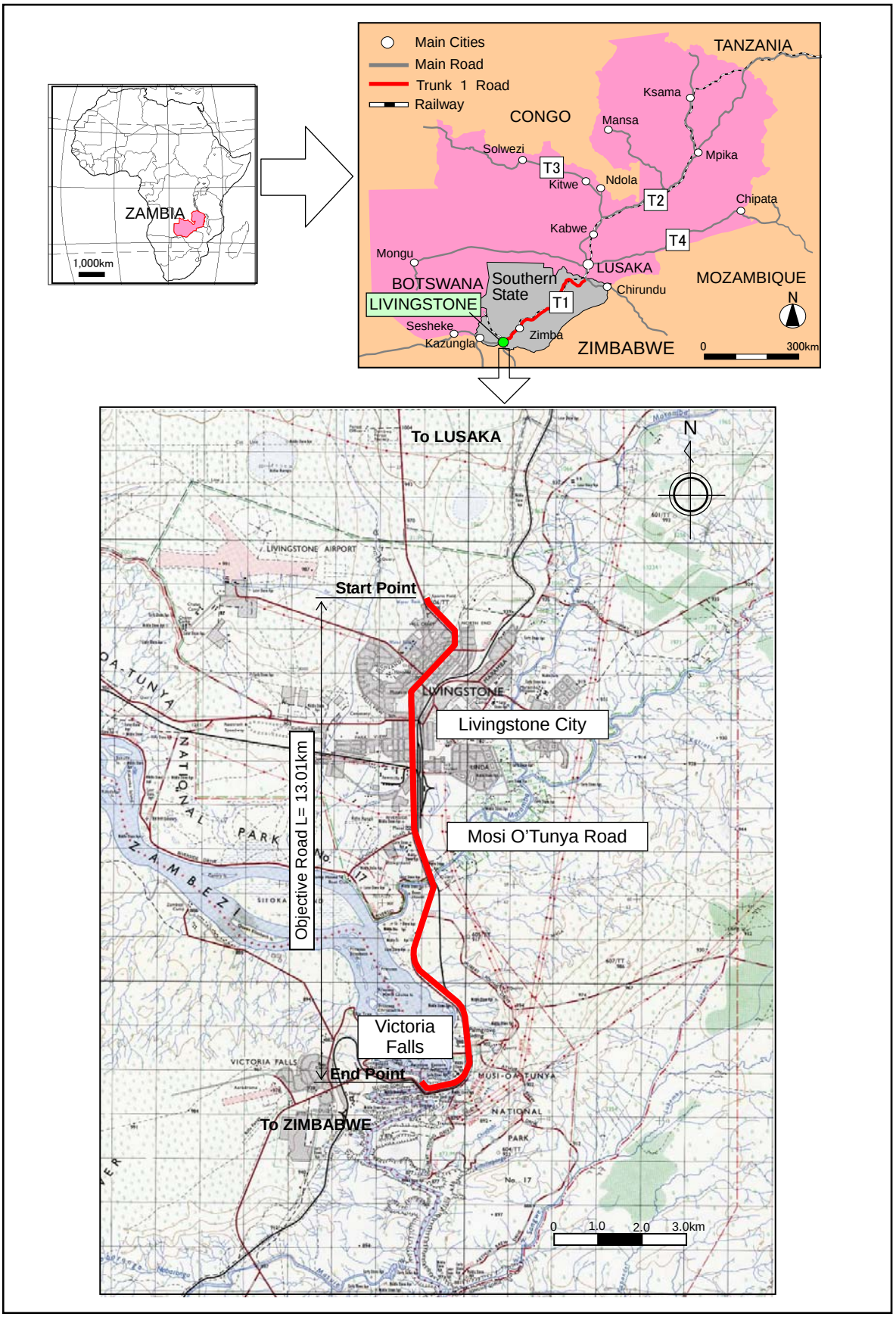

LOCATION MAP

（Town area center）

（From a town area to an end point）

PERSPECTIVE

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

General

AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
AFDB	:	African Development Bank
A/P	:	Authorization to Pay
B/A	:	Banking Arrangement
CBR	:	California Bearing Ratio
DBST	:	Double Bitumen Surface Treatment
DCP	:	Dual-Mass Dynamic Cone Electrometer
ECZ	:	Environmental Council of Zambia
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
E/N	:	Exchange of Note
EPB	:	Environment Project Brief (Environmental Project Brief)
EU	:	European Union
GDP	:	Gross Domestic Product
GNI	:	Gross National Income
IEE	:	Initial Environmental Examination
JICA	:	Japan International Cooperation Agency
LCC	:	Livingstone City Council
M/D	:	Minutes of Discussion
MLGH	:	Ministry of Local Government and Housing
MOFNP	:	Ministry of Finance and National Planning
MOHA	:	Ministry of Home Affaire
MOTENR	:	Ministry of Tourism, Environment and Natural Resources
MWS	:	Ministry of Works and Supply
NHCC	:	National Heritage Conservation Commission
NRFA	:	National Road Fund Agency
O&M	:	Operation and Maintenance
RDA	:	Roads Development Agency
ROW	:	Right of Way
RTSA	:	Road Transport & Safety Agency
SATCC	:	Southern Africa Transport and Communications Commission
SBST	:	Single Bitumen Surface Treatment
SEED	:	Support to the Economic Expansion and Diversification
WB	:	World Bank

ZAMTEL	:	Zambia Telecommunications Limited
ZAWA	:	Zambia Wildlife Authority
ZESCO	:	Zambian Electricity Supply Corporation
ZNTB	:	Zambia National Tourist Board
ZRL	:	Zambia Railways Limited

CHAPTER 1

BACKGROUND OF THE PROJECT

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1-1 Background of the Requested Japanese Assistance

Zambia has attempted to recover from a previous economic slump and is endeavoring to develop a highly potential agricultural sector and to revitalize various industries through tourism or by encouraging trade and investment. In recent years, economic growth has risen to a level of 6.0% thanks to a rise in international copper prices, which is the state's biggest source of revenue.

Under such circumstances, in order to systematically develop its infrastructure Zambia is improving its road network through the creation of the "5th National Five-Year Plan (2006 to 2010)". However, due to chronic budgetary deficits the implementation of road development often relies on overseas aid.

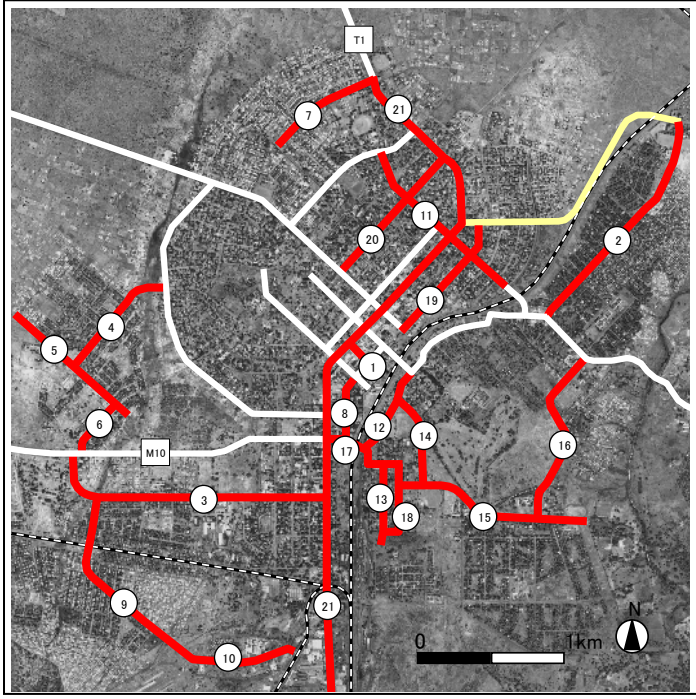
Livingstone, the project site, is located in the southern province approximately 500km away from Lusaka, the capital of Zambia, and is a tourist city situated on the doorstep of the world heritage site Victoria Falls, and many tourists are expected to visit the city before and after the FIFA World Cup to be held in 2010 in South Africa.

The target road in the city was improved after independence in October 1964. Of roads with a total length of 165km or longer, random paving through bituminous surface treatment has been applied to approximately 80km, while the remaining 85km remain un-paved (laterite). Since the later half of the 1970s, except for some roads, most of the roads have not had full-scale repaired for 40 years due to a decrease in the road sector budget.

As a consequence, major roads in the city including the target Mosi O'Tunya Road have been severely damaged due to an increase in the use of heavy vehicles associated with the recent international trunk roads network development at present. In addition, ancillary facilities such as sidewalks or drainage systems have been damaged considerably, which has become a factor in hindering economic growth and the key industry in the city, tourism.

After considering the situation, the GRZ made a request for Japanese Grand Aid for necessary funding to improve the proposed 21 routes (33.5km) based on the realization that the smooth flow of traffic is important, not only for the city, but also for social and economic development. The requested routes are listed as follows.

List of Roads Requested (21 routes)



Road No.	Road Name	Length (m)	Width (m)
1	Kapondo Street	300	7.0
2	Kaunda Road	1,700	7.0
3	Kafubu Road	2,000	7.0
4	Lenda Road	900	6.1
5	Botswana Road	1,100	6.1
6	Chipata Road	400	7.0
7	Nafumba Road	800	7.0
8	Mikambo Road	300	6.1
9	Sambono Road	1,500	7.0
10	Balewa Road	800	7.0
11	Obote Road	1,300	7.0
12	Tanzania Road	700	6.1
13	Nyansa Road	800	6.1
14	Chipembi Road	700	6.1
15	Siambelele Road	1,400	7.0
16	Linda Road	1,300	7.0
17	Nakatindi Road	600	7.0
18	Ngoma Road	500	6.1
19	Chimwemwe Way	1,100	6.1
20	Nehru Way	1,100	6.1
21	Mosio O'tunya Road	14,200	7.0-14.0
Total of Road Length		33,500	-

In response to the request, the Government of Japan dispatched the first Basic Design Study Team from September 27 to October 24, 2007 in order to examine the priority of the roads requested (21 routes) and routes subject to the study. Subsequently, the second Basic Design Study Team was dispatched from November 4 to December 8, 2007 in order to explain the results of the route selection to the Zambian side. It was confirmed and agreed that only one route, Mosi O'Tunya Road, would be subject to the requested Japanese assistance. Afterwards, the field survey began for Mosi O'Tunya Road. After returning to Japan, a Basic Design was prepared based on the findings of the field survey and a draft final report compilation of the requested components was prepared. The Draft Report Explanation Team was dispatched to Zambia from March 13 to 23, 2008 for an explanation and discussions. Consent was therefore obtained from the Zambian side.

The above-mentioned field survey was implemented in two parts and the first and second surveys and specific contents were compiled as follows.

【First Field Survey】

Survey Period	September 27 to October 24, 2007
Scope of Survey	Proposed 21 routes (33.5km)
Objective of the First Field Survey	
• To collect data necessary to select routes highly appropriate for the Grant Aid Scheme	
Description of the First Field Survey	
- The following field surveys were conducted to all proposed 21 routes. • Survey of existing road surface conditions, drainage systems and other ancillary facilities, survey of road usage, survey of periphery conditions - Through a hearing research from the competent governmental agency, implementing agency and other concerned governmental organs, the following matters were conducted. • Confirmation of the implementing system (including maintenance), confirmation of the future plan, confirmation of procedures for environmental and social considerations	
First Field Survey Findings	
After returning to Japan, as the result of evaluating the data collected from viewpoint of "urgency", "necessity" and "relevance", only one route, Mosi O'Tunya Road, was selected as the target.	

【Second Field Survey】

Survey Period	November 4 to December 8, 2007
Scope of Survey	Mosi O'Tunya Road (14.2km)
Objective of the Second Field Survey	
• To explain to and to get consent from the Zambian side the result of the first field survey that only Mosi O'Tunya Road was subject to the requested Japanese assistance. • To collect data and information necessary to formulate a basic design, project cost estimate and work schedule through the detailed survey.	
Description of the Second Field Survey	
- The first field survey findings and the result of the analysis after returning to Japan were explained to the Zambian side. It was agreed that only Mosi O'Tunya Road would be subject to the requested Japanese assistance. - The following surveys on the target section were conducted • Survey on natural conditions (location survey and survey on the existing road structure), traffic volume, axle loads, presence of relocation or removal of utilities - Through a hearing research from the competent governmental agency, implementing agency and other concerned governmental organs, the following matters were conducted. • Reconfirmation of the implementing system (including maintenance and its budgetary step), reconfirmation of procedures for environmental and social considerations and concerned governmental organs necessary for coordination - Data necessary to formulate a project cost estimate and work schedule.	
Response to additional request at the time of the second field survey	
In addition to the above-mentioned surveys originally planned, a survey on the following components that were additionally requested by the Zambian side in the second field survey was conducted in order to examine its relevance as requested Japanese assistance and data was collected. • "Street lights", "benches", "cycle tracks" and "traffic signals"	
First Field Survey Findings	
The findings are compiled in the Basic Design Study Report.	

1-2 Natural Conditions

(1) Climate

The target site experiences a tropical climate and is roughly divided into three seasons. There is a cool dry season between March and August, a hot dry season between September and mid November and a hot rainy season from the end of November to February. Although rainfall is concentrated between November and March, annual precipitation over the past 5 years (2002 to 2006) was approximately 560mm (about 1/3 the average of Tokyo), which is relatively small. Precipitation readings recorded at the Livingstone International Airport Observatory are shown in Table 1-1.

Table 1-1 Monthly Rainfall at the Project Site (2002 to 2006)

Unit: mm

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Average Rainfall	132.1	94.9	92.2	12.4	0	0	0	0	0.9	22.5	41.8	164.9	562.4

Source: Livingstone International Airport Observatory

The monthly mean maximum and minimum temperatures at the Livingstone International Airport Observatory are shown in Table 1-2.

Table 1-2 Monthly Mean Temperature at the Project Site (2002 to 2006)

Unit: °C

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mean Temperature	Max.	31.5	30.9	30.8	30.4	28.6	27.6	26.6	30.1	32.4	33.9	34.6	31.3
	Min.	19.6	19.4	18.7	15.5	11.6	9.4	8.5	12.1	16.4	19.8	20.6	21.1

Source: Livingstone International Airport Observatory

(2) Topography

The project site is located in a hilly zone 880 to 970 meters above sea level. Although there are ground surface inclinations running east to west (perpendicular to the target route) as well as south to north, both angles of inclinations are rather gradual thus no special consideration is required when preparing the design. The average gradient at the target route is approximately 0.7% and the maximum gradient is approximately 4.7 %, which is mild with few ups and downs.

(3) Implementation of Natural Condition Survey

3-1) Surveying

In order to grasp the geographical data necessary for road design, construction plan and cost estimation, surveying was carried out for a total 13.01km of Mosi O'Tunya Road (T1) for approximately one month from November 7, 2007 by a commissioned local contractor.

The findings of the surveying are described as follows.

Geographical Surveying Contents

Item	Description
Coverage	a) Control point surveying : Target section 13.01km, 11 locations
	b) Geographical surveying : 13.01km, 66.0ha, cross-sectional surveying at intervals of 20m (50m average width)
	c) Differential leveling : Target section 13.01km
Measured Item	Road center, pavement edges, slope faces, road occupancy widths, buildings, house, bridges, culverts and other drainage systems and structures, public facilities, electric poles, telephone poles, water supply systems, public and private boundary lines, trees, ponds and river edges, etc.

3-2) Existing Road Structure Survey

In order to plan for appropriate repair section for the target sections, road damage and deterioration conditions were examined through direct management and local commissioning from November 7 to 21, 2007. The contents of the survey are described as follows.

1) Road Surface Visual Observation, Test Pit, DCP Survey (Dynamic Penetration Test)

Existing Road Structure Survey Contents

Item	Description
Surface Visual Observation Test Pit DCP Survey (Dynamic Penetration Test)	13.01km section 13 locations (right and left staged locations) , 0.5 to 1.0m deep 68 locations (right and left staged locations), maximum 1.0mdeep
Laboratory Test (Base Course, Sub-grade)	10 base course samples, 5 sub-grade samples

2) Survey Findings

With respect to the survey findings, each survey is outlined as follows and each material is attached in Appendix 5-3 the findings of the survey on natural conditions in the end of the Report.

a) Road Surface Visual Observation

Based on visual observations implemented during the survey, the total loss of pavement was not apparent. However, partial vertical or transversal cracks, pavement deterioration and depletion of pavement ends could be observed.

b) Test Pit Survey Findings

The observation results of the test pit implemented at 1km intervals throughout the target route are described in the following table.

Table 1-3 Results of Existing Road Structure Observation

Km	0+000 - 4+400	4+400 - 13+100
Surface Course	Random paving (20 - 40mm)	Random paving (40 - 90mm)
Base Course	Crushed stone (100 - 150mm)	Cement stabilized crushed stone (80 - 150mm)
Sub-base Course	Crushed-stone contained laterite material (120 - 150mm)	Crushed-stone contained laterite material (140 - 500mm)
Sub-grade	Clayey sand	Clayey sand, gravelly soil
Remarks	• About 100mm thick asphalt pavement is applied directly on top of compacted sand stratum mainly in urban areas. • The existing sub-grade is 15 or more.	• About 20mm thick old random paving was observed beneath the sub-base course. In this section, surface course and base course are headed up on the former pavement. The heading up height is about 300mm. • The existing sub-grade CBR is over 15. There are some sections over CBR30 and partially CBR7.

As a special remark, on the sub-base course between 4km+400 and 13km+010 at the railway intersection, it was observed that the thickness of sub-base course varied depending on the location. This is probably due to the fact that both the surface and base courses became rutted and longitudinal alignment damaged before improvements were made.

Sampling in Test Pit Survey

c) DCP Survey Findings

A dual-mass dynamic cone penetrometer (DCP) test was conducted on the target road. DCT test result is attached in Appendix 5-3 the findings of the results of the Natural conditions survey in the end of the Report. When comparing pavement damage in the DCP results and visual observation, the routes with low DCP value nearly correspond to the

DCP Survey

routes with pavement damage. In addition, when comparing the longitudinal alignment in the planned route, the routes with low altitude, in other words, spots where water pools easily, the routes with pavement damage visually observed and routes with low DCP value correspond. Pavement damage is therefore judged to be the result of poor drainage.

1-3 Environmental and Social Considerations

(1) System, Procedures and Permit (Approval) for Environmental and Social Considerations

1) Environmental and Social Considerations System

The Ministry of Tourism, Environment and Natural Resources (hereinafter referred to as "MOTENR") is in charge of environmental administration in Zambia.

An agency responsible for promotion of the environmental management, environmental regulation, examination of an Environmental Impact Assessment (hereinafter referred to as "EIA") and environmental awareness, etc. is the Environmental Council of Zambia (hereinafter referred to as "ECZ"), which is independent of MOTENR, and also has a branch office in Livingstone where the project site is located.

Implementation of an EIA was established in 1997 in accordance with the Environmental Protection and Pollution Control Act enacted in 1990. Its aim is to prevent negative environmental and social effects by assessing the environmental and social impact prior to the implementation of a project.

The relevant project is categorized as a "road" sector project obligatory to EIA procedures in conformity with the environmental assessment regulations of 1997 and therefore, in the case of locating in an area other than a urban district and a total extension of 10km or more, or in the case of locating in a natural park or hunting area and total extension of 1km or more, requires submission of an EIA.

2) Process from Procedures for EIA to Environmental Permit

Procedures for an EIA commence when a project undertaker submits an application to the Environmental Council of Zambia (hereinafter referred to as "ECZ"). An EIA is divided into two stages: an Environment Project Brief (hereinafter referred to as "EPB") and an Environment Impact Statement (hereinafter referred to as "EIS"). The former is equivalent to an Initial Environmental Examination (hereinafter referred to as "IEE"); whereas, the later is equivalent to a full assessment.

When a project undertaker who intents to implement construction work submits an EPB to the ECZ, whether or not a further EIS is necessary is decided through an examination. The EIA for the project site was approved by the ECZ in November 2004 as part of the road improvement program between Zimba and Livingstone (terminal point of the Project), which was financed by the EU. However, in

accordance with the ECZ regulations, the provision that "if a project does not commence within three years, the procedures for re-registration are necessary" was applied, so it expired in December 2007.

Under such circumstances, it was confirmed that the EIA for the Project was required to submit an EPB again in order to obtain an environmental permit. The process until the acquisition of an environmental permit with respect to the Project is described as follows.

Process until Acquisition of Environmental Permit

Procedures	Responsible Agency
1. Preparation of draft EPB	MLGH
2. Submission of draft EPB to ECZ	MLGH
3. Submission of ECZ's comments on draft EPB	ECZ
4. Submission of EPB to ECZ	MLGH
5. Issuance of environmental decision (permit)	ECZ

As the result of submitting an EPB again and examination, through the judgment of the ECZ, it was recognized that the Project falls under routes approved by the EU project and the construction scale and description did not change. An environmental permit (environmental approval) was therefore issued by the ECZ dated on December 26, 2007. The permit was confirmed in the Minutes of Discussions at the time of explaining the basic design. (Refer to Appendix 4 and the Minutes of Discussion <M/D> in the end of the Report)

3) Relationship among ZAWA, NHCC and ECZ

Agencies that should coordinate their efforts during environmental considerations include the following two organs in addition to the ECZ.

a) Zambia Wildlife Authority (hereinafter referred to as "ZAWA")

It is necessary to coordinate with ZAWA, which is the organ with jurisdiction over the national park the project site passes by.

b) National Heritage Conservation Commission (hereinafter referred to as "NHCC")

Since Victoria Falls, a world heritage, is located on the outskirts of the terminal point under the Project, it is therefore necessary to discuss with NHCC over which organ is to have jurisdiction.

ECZ, ZAWA and NHCC are all sub-organizations of MOTENR. With respect to environmental issues, if a project relates to the jurisdiction of ZAWA or NHCC, discussions with both organs is necessary and should be compiled by ECZ. In a similar manner, for the Project confirmation from both organs was received with ECA acting as a liaison, and the environmental permit was issued.

The relationship between these organs and the ECZ is shown in the following figure.

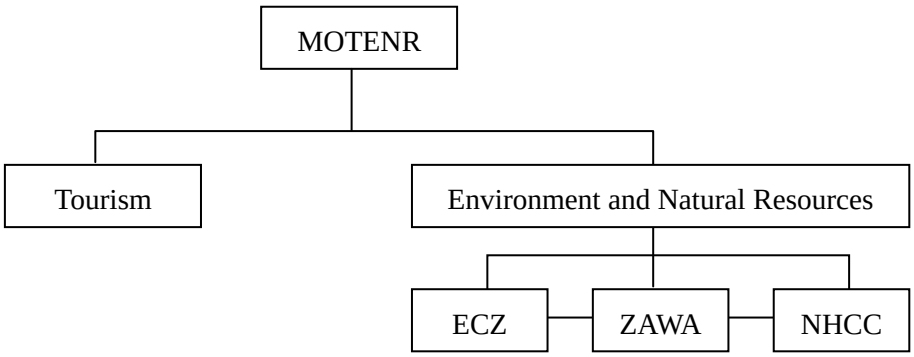


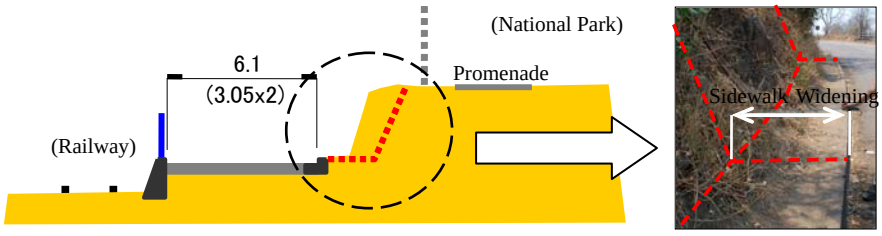
Figure 1-1 Correlation Chart between ECZ and ZAWA and NHCC

(2) On-Site Confirmation of Squatters, Shops and Involuntary Settlement

In the Study it was confirmed that there were no squatters and shops and involuntary settlements along the proposed road.

(3) Cut Associated with Sidewalk Widening in the Vicinity of the Terminal Point in the National Park

The National Heritage Conservation Commission (NHCC) and LCC witnessed the actual site and a written permit was issued by the NHCC. (Refer to confirmation letter from the concerned governmental agencies in Appendix 5-2 at the end of the Report)



Sidewalk Widening Plan

(4) Tree Clearing

Two locations in the target section may require tree felling: the transition (smoothing) area from 2-lanes to 4-lanes and repair site for a T-shaped road with M10. It was confirmed that this tree felling

would be single clearing and would have no impact on the surrounding environment. LCC, which is the owner of the stand of trees, witnessed the actual site and a written permit for tree felling was issued. (Refer to confirmation letter from the concerned governmental agencies in Appendix 5-2 at the end of the Report)

(5) Procedures for Installation of Road Drainage Systems in the Nature Reserve

It is possible to avoid or lessen the impact on the environment by utilizing the existing drainage channels for road drainage systems in the nature reserve. The utilization of existing drain flow ends was witnessed by NHCC and LCC at the actual sites and a written permit was issued by NHCC. (Refer to confirmation letter from the concerned governmental agencies in Appendix 5-2 at the end of the Report)

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

(1) Overall Goal and Project Purpose

Transportation infrastructure development is the lifeline of exports and imports in the Republic of Zambia (hereinafter referred to as "Zambia"), a land-locked country, and is the key to economic growth. At the present time, the transportation infrastructure in Zambia includes roads, railways and airways. However, the cost of airways is high and they are mainly designed for tourism; whereas, the railways are unreliable due to various problems and delays or irregular services resulting from administrative problems. Therefore, the primary transportation infrastructure is roads. In the transportation sector, roads play a vital role in both international and domestic transportation of goods and passengers and are the basis of economic growth.

The 5th National Five-Year Plan (2006 to 2010) also mentions the importance of establishing a road traffic network for economic growth including agriculture and tourism, and rapid development is in an immediate need.

For nationwide road development, the Government of the Republic of Zambia (hereinafter referred to as "GRZ") established the National Road Board (NRB) which is composed of the Ministry of Works and Supply (hereinafter referred to as "MWS") which has jurisdiction over the road sector and the Ministry of Local Government and Housing (MLGH) in the central government, representatives from the private sector and other governmental authorities and launched the Road Sector Investment Program (ROADSIP) in 1997. It was decided that the first phase of the program would be implemented over five years from 1998 to 2002 and the second phase would be implemented over ten years from 2004 to 2013. In the second phase of the program, the development of major urban roads is regarded to be the most important issue for revitalizing the economy in key local cities which support local economic recovery and social services.

Since the target road Mosi O'Tunya Road (T1) under the Project is located within Livingstone, Zambia and is located at the junction of the route to South Africa by way of Zimbabwe from Lusaka, the capital of Zambia, and the route to South Africa by way of Botswana, the road is regarded to be an important way station for principal physical distribution routes in Zambia. Consequently, it is included in the major trunk roads development plan of the Road Sector Investment Program (ROADSIP) II.

The aim of the project is “the realization of smooth traffic in Mosi O’Tunya Road”. By accomplishing this, the project ultimately aims at “socio-economic development in Zambia through the revitalization of physical distribution in Livingstone”.

(2) Outline of the Project

To accomplish the above-mentioned goal, the Project will involve 13.01km of road improvement along Mosi O’Tunya Road under the Project for Improvement of Livingstone City Roads.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policies

1) Requested Japanese Assistance

In July 2006, Zambia requested the improvement of 21 routes (33.5km) including Mosi O’Tunya Road which is a major trunk road. The details and reasons for the selection of scope of the requested Japanese assistance are described as follows.

The first field survey in the Study confirmed the request for the rehabilitation of 21 proposed routes (33.5km). From the results of the findings of the first field survey, Mosi O’Tunya Road (13.01km) was selected from among the 21 routes as the target road based on an examination of urgency, necessity and relevance. The results of the first field survey was explained to GRZ in the second field survey, and it was confirmed and agreed by GRZ that Japanese assistance would be extended only to the improvement of Mosi O’Tunya Road.

The evaluation results in selecting Mosi O’Tunya Road are described as follows.

- Urgency : The improvement for the section from the junction at T2 to Zimba has been completed. It has been decided that T1 road (between Zimba and Livingstone) also will be improved by the European Union (hereinafter referred to as “EU”) and bidding for construction work is scheduled in 2008. In addition, M10 road (connecting to Botswana and to Namibia) has already been improved through German funding. However, Mosi O’Tunya where damages and deteriorations can be observed on the pavement does not have an improvement plan for near future, and is concerned to be a bottleneck of the international road network if it is remained untouched. So its urgency is recognized.

- Necessity : It is important for Zambia, a landlocked country, to secure a traffic route leading to ports. In particular, improvement to sections of this road, a route connecting South Africa and Lusaka, the nation's capital, is considered necessary.
- Relevance : When considering the increase in the future traffic volume of heavy vehicles to be generated at T1 and the quality of the circumjacent roads that have been constructed and/or improved, high quality of road engineering is being requested. It is therefore of sufficient relevance.

The evaluations of 20 routes other than Mosi O'Tunya Road are described as follows.

- Urgency : The urgency of the routes was evaluated on the basis whether the civil life and community activities will be critically affected or not if the routes remained untouched. The results show that there are few routes that will fall under this category.
- Necessity : The necessity of the routes were evaluated on the basis whether the local industries and considerable numbers of residents will receive benefits by the road improvement or not. However, it is recognized that the connections between each road and local industries are weak and the necessity is low.
- Relevance : Traffic congestion that may hinder daily traffic on roads in the city does not exist and the level of improvement required for city roads through the present self funds of the Roads Development Agency (RDA) is regarded to be relevant. Therefore, the relevance for the Japanese assistance cannot be recognized.

As described above, one route, Mosi O'Tunya Road was selected from the viewpoint of the urgency, necessity and relevance.

In the second field survey, the results of the selection of routes were explained to the Zambian side and it was confirmed and agreed that only one route Mosi O'Tunya Road would be applicable for assistance.

Furthermore, in the second field survey, the additional request for 1) street lights, 2) benches, 3) cycling track and 4) traffic signals was listed. The results of examination on the request and the reasons are explained as follows.

a) Street Lights:

[Request]

Street lights will be installed in a 5.8km section from the starting point to Sichanga Street (km5+800).

[Examination Result]

Construction of new street lights along a 3.1km section between Airport Road (km2+200) and a supermarket (km5+280) in front of Sichanga Street is planned.

[Reason]

Cooperation with the ongoing Support to Economic Expansion and Diversification (SEED) project financed by World Bank, the necessity and urgency from the viewpoint of traffic safety and public peace due to the heavy traffic flow and pedestrians at night along this section was recognized. In addition, it was confirmed that the budget for electricity charges and maintenance cost have been well secured, so its relevance could be recognized.

b. Benches:

[Request]

It was requested that benches would be arranged generally until the vicinity of Akapelwa Street (km2+350) to M10 (km3+268).

[Examination Result]

This request was excluded from the requested Japanese assistance.

[Reason]

The Zambian side is judged to be able to sufficiently bear the cost for benches. So the necessity to bear the cost through the Japanese Grand Aid could not be found.

c. Cycling Track:

[Request]

It was requested that a cycling track be installed on one-side along an approximate 8km section between the vicinity of the supermarket (km5+000) and the terminal point (km13+010).

[Examination Result]

This request was excluded from the requested Japanese assistance. New shoulders (2m wide) will be improved using a double bituminous surface treatment (DBST). It is therefore possible to substitute the shoulder as a cycle path.

[Reason]

At the present time, since there were few tourists and residents who utilize bicycles, the necessity and relevance to improve the road for cycle path could not be found out.

d. Traffic signals:

[Request]

With regard to the installation of request for traffic lights, a particular location for installation was not designated.

[Examination Result]

This request was excluded from the requested Japanese assistance.

[Reason]

In accordance with the Southern Africa Transport and Communications) criteria, if the daily traffic volume and the daily number of pedestrians exceed 24,000 units and 9,600 persons respectively, control with a traffic light is necessary. However, in this Study, only about 10,000 units were counted at M10, which is considered to have a large traffic volume, so it was confirmed that a traffic signal would not be necessary.

2) Basic Policy

In order to contribute to the implementation of the major trunk road network improvement plan formulated by the Zambian side to address the present conditions that safety or smooth traffic has been hindered due to the deteriorated roads, it is aimed to improve Mosi O'Tunya Road as a part of the plan. The Project will be planned in accordance with the following principles in due consideration of the request of the Government of Zambia and the results of the field survey and discussions.

a) Design Criteria

In designing roads under the Project, the Recommendations on Road Design Standards Geometric Design of Rural Roads were mainly applied. In due consideration of the Southern Africa Transport and Communications Commission (SATCC) standards widely adopted in the South African nations and the American Association of State Highway and Transportation Officials (AASHTO) standards, the Japanese Road Structure Ordinance was examined and applied when necessary.

b) Road Standards

For road standards, road types IB (between urban districts) and IC (between other districts) of the Zambian design standards in the similar manner as existing roads were applied and examined. For alignment, in principle the existing roads were traced to avoid relocation of roadside houses or public facilities. By considering the rolling landscape of the target section and the fact that it runs through an urban district and national park, 60km/h was applied to design speed in accordance with the Zambian

road design standards. Based on this, 125m and 8.0% were selected for the minimum plane curve radius and the maximum gradient respectively.

c) Pavement Plan

Since a design load necessary for a pavement plan was examined based on the field survey on a traffic volume, a pavement design period will be 10 years. With respect to a pavement improvement method, in principle an overlay method would be applied by removing the existing pavement and utilizing the existing base course as a sub-base course. Accordingly, the pavement improvement would be roughly classified into three patterns.

i) To lay a base course (10cm) and asphalt mixed surface course (5cm) on the existing roadbed.

ii) To remove the existing surface course and base course and to lay new sub-base course (25 to 30cm), base course (10cm) and asphalt mixed surface course (5cm) on the sections in the urban district where the present road height is to be observed.

iii) To lay asphalt mixed surface (5cm) between sections of the existing concrete pavement.

d) Road Drainage System Plan

It was planned to utilize existing road drainage facilities effectively as much as possible. However, new gutters and traversing culverts were scheduled based on the flow calculation. U-shaped gutters, soil gutters, traversing culverts, inlet and spillway construction and catch pit construction would be major structures to be improved. Especially for traversing culverts, it was planned to replace broken concrete pipes, corroded corrugated metal pipes and storage drums with concrete pipes. In addition, for road gutters, it was planned to arrange concrete gutters in the urban district and soil gutters at cut and plain locations in the national park.

e) Ancillary Facility Plan

Although the Zambian side made an additional request for “street lights”, “benches”, “cycle tracks” and “traffic signals” in the second field survey, as the result of examination, it was suggested to exclude benches and traffic signals from the requested Japanese assistance and to substitute new road shoulders to be constructed for cycle paths. It was also planned to arrange street lights at necessary locations from the viewpoint of traffic safety, public peace and order at night for vehicles and pedestrians in the urban district. In addition, roadside construction, road surface division lines, pedestrian crossings, bumps, guard fences and road signs were scheduled as ancillary facilities.

f) Other

The repair of missing guardrails of the existing two bridges (Maramba and Kabila Bridges) was scheduled.

(2) Consideration to Natural Conditions

1) Meteorological Conditions

Although there are no special meteorological concerns with the design, the conditions shall be effectively utilized and reflected in the construction plan, road drainage facility planning in due consideration of the existence of the rainy season and rainfall.

- Although the project site is located in the southern district which belongs to a tropical zone, the district comprised of highlands of approximately 1,000m above sea level and therefore has a relatively moderate climate.
- The annual precipitation at the project site is approximately 560mm (approximately 1/3 of the Japanese average).
- With respect to temperature, although there is a hot dry season between September and December, it is warm throughout the year so it is quite comfortable. The temperature does not drop in the mornings and evenings.

2) Other Natural Conditions

The findings of the survey obtained in the Study listed below shall be reflected in the road improvement plan, the pavement plan and the drainage plan.

- Survey of the existing road conditions:

  Road surface observation through a direct management system and reassignment (re-commissioning), test pit, dual mass dynamic cone penetrometer (DCP) test

- Topographical survey:

  Investigation through reassignment

- Survey of the existing road drainage conditions:

  Field exploration through a direct management system

(3) Consideration to Social and Economic Conditions

1) Target Road Property

The starting point of the target road will be at the water tower, a landmark at the entrance of the town, situated at the north side of an urbanized area. Subsequently, the target road will enter into a residential area, pass through a business zone at the town center, and pass approximately 6km through Mosi O'Tunya National Park by way of a new suburban subdivision and then reach to the World Heritage Site of Victoria Falls (international boundary). There is a bridge at the border, which was originally constructed as a railway bridge in 1905 and the road was added later in 1930. It still serves as a railway/road bridge and plays an important role in the route for exporting mineral resources from Zambia. The district has tourism resources such as Victoria Falls, safaris etc.

The following table is a list outlining the design policy regarding the social characteristics of the target roads.

Table 2-1 Target Road Property

	Target Road Property	Matters to Examined in the Design
1	Urban Road passing through core local city with history	In the case of smoothing (widening) from 2 lanes to 4 lanes and upgrading M10 intersection, special attention should be paid to road design in order to protect roadside trees forming a part of the landscape as much as possible.
2	Road passing through the national park	Environmental consideration should be given to the design and the construction. The components discussed and coordinated with ZAWA and with the administrator of national parks should be reflected in the design.
3	Road connecting to international boundary	Coordination with various authorities during the design and implementation stages is essential. Since large-sized vehicles that cross the international boundary can be observed and gives damages to various nearby facilities (park fences and road shoulders), road design should include measures to protect facilities from large vehicles after completion.
4	Roads with tourism resources such as the World Heritage Site (Victoria Falls)	Components permitted through discussion and coordination with the National Heritage Conservation Commission (NHCC) should be reflected in the design, specifically, plans to install foot path at the terminal point adjacent to the World Heritage Site and road drainage considerations.
5	Important T1 road as lifeline of Zambia, a land-locked country	The road plan will take into consideration present and future traffic volume. The most suitable pavement shall be designed by taking traffic characteristics such as overloaded large-sized vehicles into consideration.

(4) Consideration to Construction Conditions

1) General policy on construction work

For construction-related procedures necessary to the implementation, there are no formalities for obtaining a license and approval from city halls or police, etc. other than those who have jurisdiction

over a client like Japan. In particular, the project owners have complete responsibility and authority over road use permits, etc. necessary for road construction. However, the Japanese contractors (builders) and the Consultant shall notify the city hall and police of the transporting route of equipment and materials and operation times, etc. in order to ensure safety during the construction work.

Notable legislation related to implementing a construction work includes the Labor Standards Law which was revised in 1997, and the minimum wage was also revised in 2006. Workers shall be employed in accordance with the said laws.

2) Policy concerning procurement of construction materials

As major construction materials such as aggregate, bituminous materials, cement, reinforcing bars for roads, aggregate for concrete and lumbers are locally available in Zambia, they shall be procured in Zambia.

3) Policy concerning procurement of construction machinery

As it is possible to lease construction machinery owned by local contractors, construction machinery shall be procured in Zambia.

(5) Consideration to Effective Use of Local Firms

Though there are local contractors who can undertake road construction works, they are insufficient both in experience and quality. However, as there seems no problem to use them as subcontractors of Japanese contractors, effective use of local firms is encouraged.

(6) Consideration to Capability of Implementing Agency for Operation and Maintenance

The competent governmental authority of the Project is the Ministry of Local Government and Housing (MLGH) and the implementing agency is the Livingstone City Council (LCC).

With respect to road projects, the scope of work for each agency is specified in the Traffic Act of 2002. According to the Traffic Act of 2002, the Road Development Agency (RDA) carries out planning, management and adjustment of the national road network; whereas, each city council is responsible for planned urban roads under the guidance of the RDA.

However, in 2006 the RDA became an official administrative and the network has not been operated as prescribed in the Traffic Act. They are therefore in a transitional stage between the former and new organizations.

The administrative body for road maintenance in Livingstone is shown in the following figure. In 2006 the road and drainage maintenance cost was 775 million ZK (¥23 million) and in 2007 it was 1,021 million ZK (approximately ¥31 million), which is nearly 9% of the total municipal budget.

Street lights as lighting systems are scheduled under the Project. The electricity charges and maintenance expenses necessary for the street lights in the SEED project to be completed by the end of 2008 and those under the Project are budgeted in each 3-year plan respectively. Moreover, 197 million Kwacha (approximately ¥5.95 million) in 2008 and 70 million Kwacha (approximately ¥2.1 million) is the scheduled budget for electricity charges and maintenance cost respectively.

As described earlier, although a maintenance for the Project can be sufficiently dealt with, as design policy, roads and new road drainage facilities shall be easily maintained by man power; whereas, specifications such as galvanized processing is applied to steel materials including supports, etc. shall be designed for easy maintenance.

Table 2-2 Annual Budget of LCC, Zambia

(Unit: 1,000 Kwacha)

FY / Item	2004	2005	2006	2007
Overall LCC Budget	8,962,063	7,487,917	8,712,143	11,349,104
Technical Services Department Budget	2,803,098	2,084,719	2,503,989	3,696,364
Road Maintenance Cost	100,000	774,943	774,943	1,021,062

(7) Policies regarding the Scale and Contents of the Subject Facilities

1) Road Design Standards

On the target road T1 (Mosi O'Tunya Road), improvements to the section from the intersection of T2 Road to Zimba has been already been completed. The design for the section between Zimba and border has been completed by EU fund and approved. However, the tender was failed and the section Zimba-Livingstone is being currently reviewed. Since the design for city roads in the center of Livingston has been completed through the Support to Economic Expansion and Diversification (SEED) Project financed by the World Bank, construction work on some sections has already begun. Road standards and design criteria on the route to be improved will be applied in accordance with the following criteria and compatibility with the sections improved on T1 and roads improved through the SEED Project (roads, sidewalks, road drainage and street light improvement).

a) SATCC : Southern Africa Transport and Communications Commission:

b) Road Standard Design in Zambia : Recommendations on Road Design Standards Geometric Design of Rural Roads

c) Road Structure Ordinance : Explanation and Application of the Road Structure Ordinance, Japan Road Association

Design conditions to be applied to the design are shown in following table.

Table 2-3 Road Design Conditions

Item		Unit	Design Value
Design speed		(km/h)	60
Number of lanes		lane	2,4
Lane width		m	6.7 (Road type IB) 6.1 (Road type IC)
Maximum gradient		%	8.0
Minimum superelevation		%	6.0
Filling slope			1:1.5 - 2.0
Cut slope	Hard Rock		1:0.5
	Decomposed Rock		1:0.75
	Other		1:1.0 - 1.5
Pavement design period		year	10

The road width shall be based on the Zambian standard road design and the cross structure by road type is shown below.

Table 2-4 Cross Structure by Road Type in Road Standard Design in Zambia

Road Type	Lane	Lane Width	Carriage way Width	Border Line	Shoulder Width	Median	Road Width	Right of Way
I	4	3.5	2×7.4	0.2	3.0	3.0	23.8	2×60
IA	2	3.65	7.3	-	3.0	-	13.3	100
IB	2	3.35	6.7	-	2.5	-	12.0	100
IC	2	3.05	6.1	-	2.0	-	10.1	100
II	2	3.05	6.1	-	1.5	-	9.1	100
III	1	5.5(min)	5.5(min)	-	1.0	-	7.5	100

Source: Recommendations on Road Design Standard, Geometric Design, 1994

2) Pavement Deign Standards

The present conditions shall be effectively utilized in pavement design as much as possible in order to ensure the necessary functions of trunk roads. In conformity with the American Association of State Highway and Transportation Officials (AASHTO) asphalt pavement design methods as shown in Figure 2-1, structural design shall be based on the design conditions shown in Table 2-5.

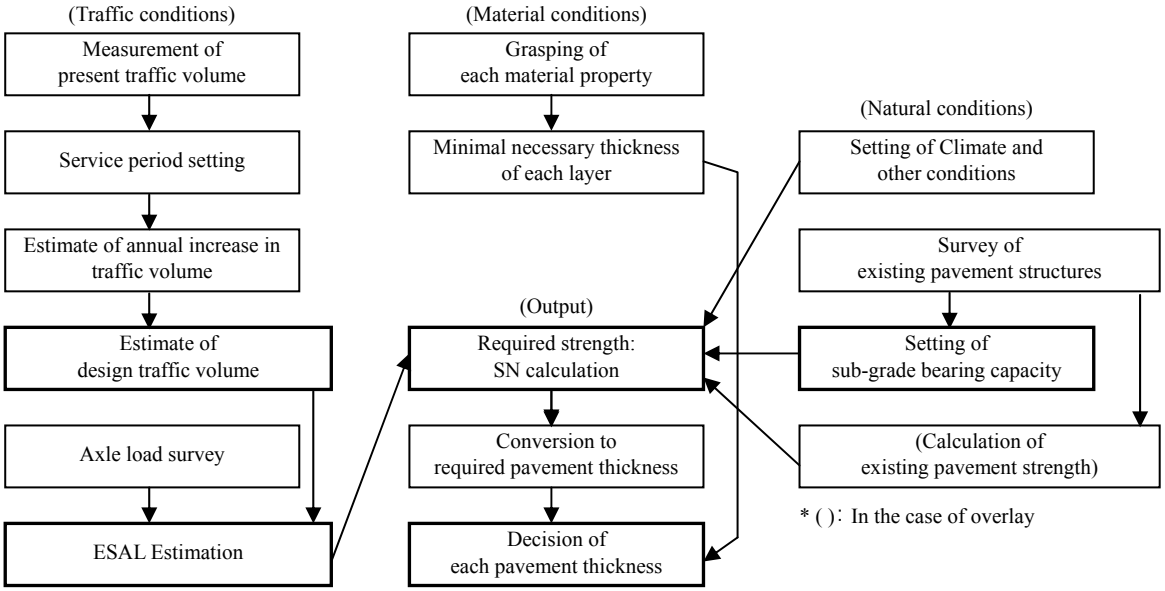


Figure 2-1 AASHTO Asphalt Pavement Design Methods

Table 2-5 AASHTO Pavement Design Conditions

Item		Design Value
Design axle load	KM.0+000-4+400	ESAL 7.9×10^6
	KM.4+400-13+010	ESAL 3.3×10^6
Reliability (R)		90%
	ZR	-1.282
	SO	0.35
Serviceability criteria	PO	4.0
	Pt	2.0
Sub-grade stability factor	MR=1500×CBR	CBR15 or more
Pavement layer coefficient	Asphalt concrete	0.44
	Granular base course	0.14 (Mechanically stabilized crushed stone)
	Granular sub-base course	0.13 (Crusher run)
Drainage coefficient	Granular base course	1.0
	Granular sub-base course	1.0

3) Drainage Design Criteria

In road drainage facilities design, as the drainage design shall be based on drainage conditions of existing facilities and rainfall conditions, the present drainage facilities shall be effectively utilized as much as possible. In the case of new drainage facilities or effective use or replacement of the existing facilities, aquifer conditions on the road surface or drainage conditions from the neighboring areas shall be grasped and the size of a facility shall be determined through drainage calculations, in such case the rainfall intensity is shown in Table 2-6 in conformity with the route designed by EU (between Zimba and Livingstone).

Table 2-6 Drainage Design Conditions

Type of Drainage Facility	Return Period of Rainfall	Rainfall Intensity
Gutters, open channel	3 years	61.8 (mm/h)
Culverts, closed conduit	5 years	71.3 (mm/h)

The rational method and Manning method shall be applied to the calculation of rain runoff and the calculation of road drainage facility sizes respectively.

(8) Policy on Construction Method and Schedule

An entire project implementation plan shall be created in due consideration of the following factors by examining the implementation and process plan mainly for road construction work while taking construction scale and contents into consideration and after establishing the division between construction work and execution-related matters.

1) Surface finishing of the asphalt pavement will be a critical path, as rainfall will adversely affect it. Therefore, the pavement work should be implemented before the rainy season (November to February).

2) Relocation of public utilities, which is expected to be taken by the recipient side (electrical lines, water supply and sewerage system, manholes) and the removal of existing street lights, etc. should be completed by the commencement of construction work.

2-2-2 Basic Plan

2-2-2-1 Overall Plan

As shown in "2-2-1 Design Policy in Basic Design of the Requested Japanese Assistance", the Project will include the improvement of Mosi O'Tunya Road (13.01km), road drainage systems and incidental road facilities. Horizontal alignment and longitudinal alignment of the existing road due to be improved under the Project shall not be changed radically from that of the existing road. The plan in accordance with design policy is outlined as follows.

Table 2-7 Facility Plan Overview

Item		Description
Target Section		13.01km (between the entrance of Livingstone and Victoria Falls Bridge)
Pavement Structure	Surface Course Construction	Asphalt concrete surface course, 5 cm (main line)
		Single bituminous surface treatment : SBST (road shoulders)
		Double bituminous surface treatment : DBST (sidewalks)
	Base Course Construction	Base course, 10cm (mechanically stabilized crushed stone)
		Sub-base course, 12 to 40cm (crasher-run stone)
Road Width Structure (Cross Sections)		IB 2-lane : 11.70m (3.35m roadway×2, 2.5m shoulder×2)
		IC 4-lane : 18.20m (3.05m roadway×4, 2.0m shoulder×2, 2.0m median strip)
		IC 2-lane : 10.10m (3.05m roadway×2, 2.0m shoulder×2)
Road Drainage Facilities		U-shaped gutters : 3,235 m (concrete, open type with cover) Soil gutters : 3,440m Road traversing culverts : 468m (φ600 to φ1,000mm) Inlet construction : 15 locations Spillway construction : 16 locations Catch pit construction : 46 locations
Ancillary Facilities		Roadside construction : 10,181m Road surface division lines : 35,700m (center and side lines) Pedestrian crossings : 29 locations Bumps : 10 locations (speed and land strip) Guard fences : 53 locations Road signs : 50 locations Street light installation : 62 units installed along the distance of about 3.1km (49 one-light type units, 13 two-light type units)
Other Facilities		Repair of 106m guardrail at the existing 2 bridges (88m Maramba Bridge, 18m Kabila Bridge)

2-2-2-2 Facilities Plan

(1) Road Geometric Design

In accordance with the road standards and design criteria, it was determined that the following road geometric designs conform to the Zambian road design standards and road ordinances.

Table 2-8 Decided Road Geometric Design Standards

Item	Urban District (Road Type IB)	Other (Road Type IC)	Applicable Criteria
Roadway Width (m)	3.25	3.05	Zambian Road Design Standards
Shoulder Width (m)	2.50 (0.50)	2.00 (0.50)	Ditto
Sidewalk Width (m)	2.0, Existing Sidewalk Width	2.0, Sidewalk Width	
Design Speed (km/h)	60		Zambian Road Design Standards
Min. Plane Curve Radius (m)	125		Ditto
Min. Plane Curve Length (m)	100		Ditto
Min. Vertical Curve Radius/ Vertical Curve at Crest (m)	2,000		Ditto
Min. Vertical Curve Radius/ Vertical Curve at Sag (m)	1,600		Ditto
Min. Vertical Curve Length (m)	80		Ditto
Max. Gradient (%)	8.0		Ditto
Standard Super-elevation (%)	2.5		Ditto
Min. Smoothing Length of Super-elevation & Widening (m)	50		Road Ordinances

Zambian Road Design Standards : Recommendations on Road Design Standards Geometric Design of Rural Roads

Road Structure Ordinance : Explanation and Application of the Road Ordinances, Japan Road Association

Classification of road type for IB and IC was shown in Figure 2-2 in conformity with cross sections of the existing road.

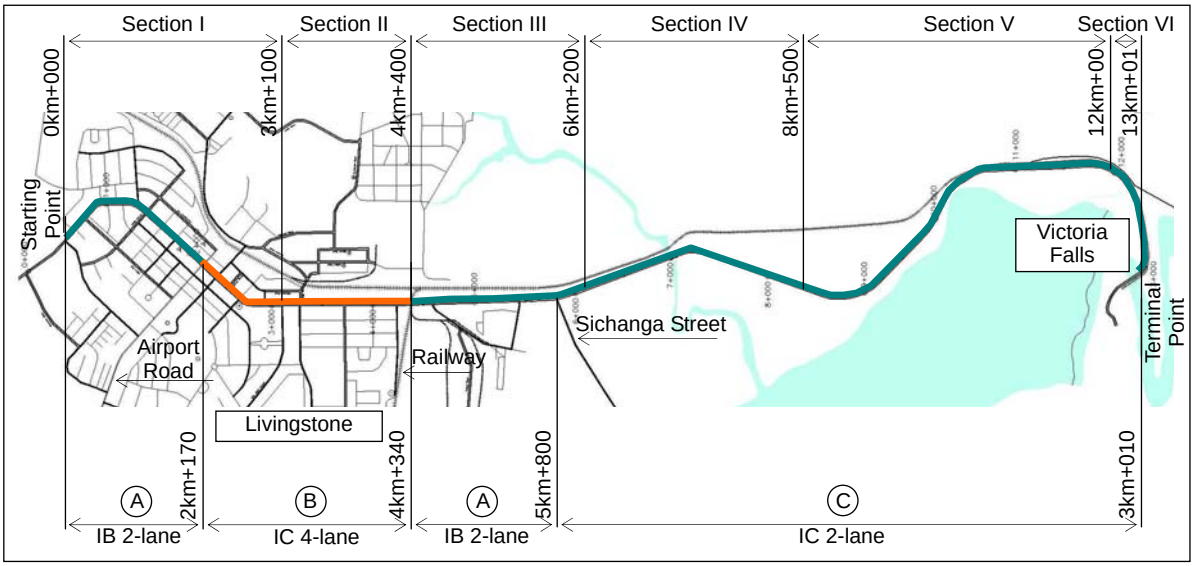


Figure 2-2 Route Division through Existing Pavement (Upper Section) and Road Standards (Lower Section)

(2) Sectional Structure

The standard cross-section plan based on the design policy and road geometric design is shown in the following figure.

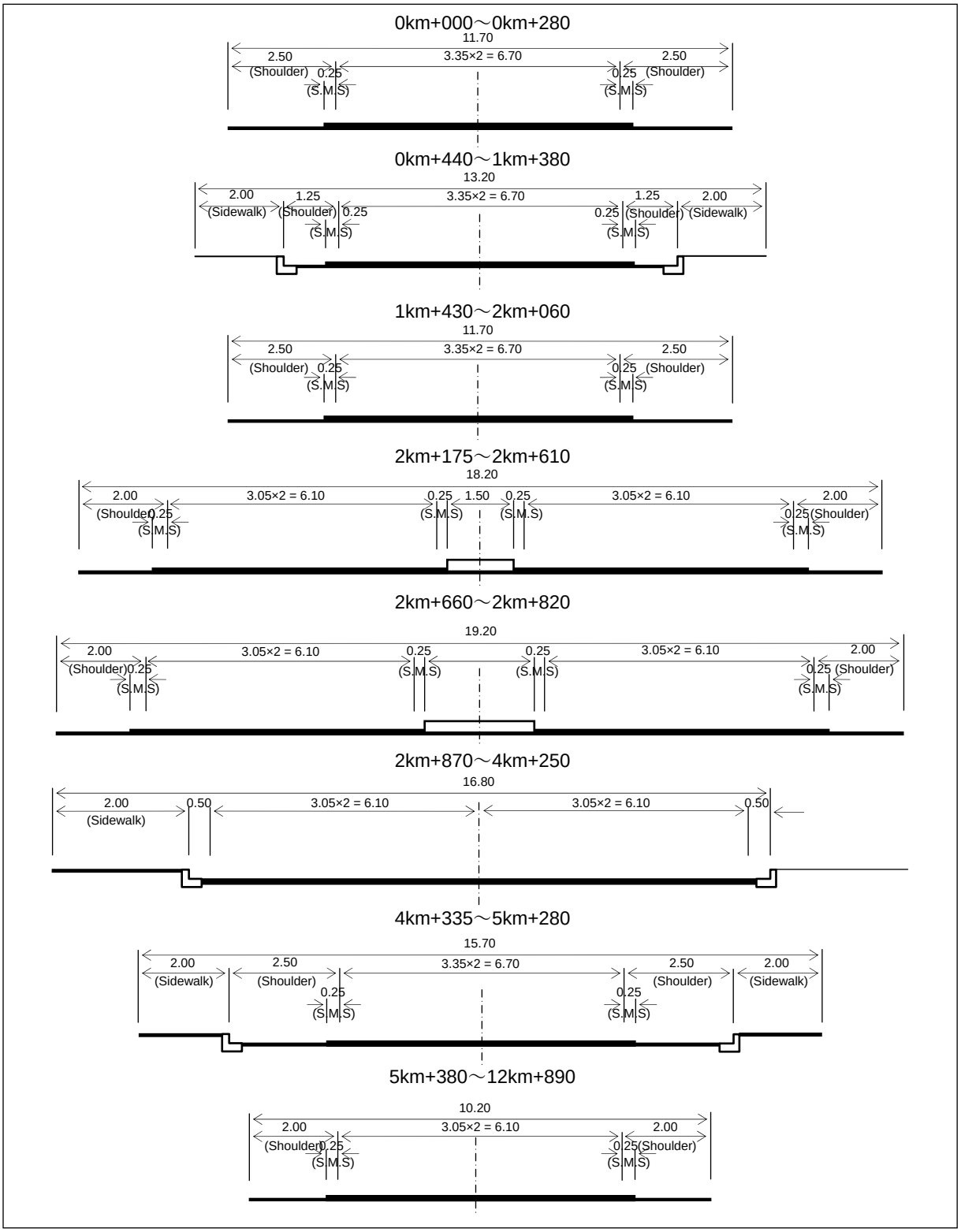


Figure 2-3 Standard Cross Section

(3) Horizontal Alignment

By following the horizontal alignment of the present road, horizontal road alignment was determined by adding linear elements in accordance with the road geometric design standards. Table 2-9 and Table 2-10 show horizontal alignment and smoothing of widening of roadway respectively.

Table 2-9 Horizontal Alignment

No.	Survey point at the starting point	Survey point at the terminal point	Curve length (m)	Horizontal Curve
1	KM.0+42.105	KM.0+270.719	228.614	600
2	KM.0+867.475	KM.0+965.905	98.430	125
3	KM.1+236.954	KM.1+362.454	125.500	160
4	KM.2+539.531	KM.2+587.994	48.462	1000
5	KM.2+677.813	KM.2+809.540	131.727	160
6	KM.2+918.337	KM.2+949.574	31.237	1000
7	KM.4+439.874	KM.4+466.745	26.871	1000
8	KM.5+500.81	KM.6+254.480	753.67	2500
9	KM.7+113.928	KM.7+342.304	228.376	350
10	KM.8+556.941	KM.9+188.480	631.539	580
11	KM.9+796.596	KM.9+944.285	147.689	500
12	KM.10+710.707	KM.11+595.381	884.674	580
13	KM.11+595.381	KM.12+475.467	880.086	580
14	KM.12+870.653	KM.13+008.718	138.065	135

Table 2-10 Smoothing of Widening

No.	Survey point at the starting point	Survey point at the terminal point	Distance (m)	Smoothing Rate
1	KM.0+280.0	KM.0+440.0	160	1/125
2	KM.1+380.0	KM.1+430.0	50	1/40
3	KM.2+060.0	KM.2+175.0	115	1/30
4	KM.2+610.0	KM.2+660.0	50	1/50
5	KM.2+820.0	KM.2+870.0	50	1/30
6	KM.4+250.0	KM.4+335.0	85	1/30
7	KM.5+280.0	KM.5+380.0	100	1/125

(4) Longitudinal Alignment

By observing the height between the section heading up to new pavement (asphalt mixed surface course ＋ base course) and the present surface height, longitudinal road alignment shall be determined by adding linear elements in accordance with road geometric design standards. The existing asphalt pavement shall be removed to ensure the quality of the pavement.

(5) Pavement Design

In accordance with the road design standards and design criteria, the geometrical road structure of existing pavement conditions was divided into 6 sections.

In accordance with the basic flexible pavement formula of the American Association of State Highway and Transportation Officials (AASHTO), the results of a paving index (SN) for each section divided into 6 sections are shown in Table 2-11. In addition a location map showing the division of sections is shown in Figure 2-2.

Table 2-11 Required Pavement Structure Index (SN) by Section

Section / Condition	I	II	III	IV	V	VI
Cumulative 18kip Equivalent Single Axle Load(W18)	ESAL 7.9×10^6		ESAL 3.3×10^6			
Standard Deviation (Z0)	-1.282					
Standard Error (S0)	0.35					
Present Serviceability Index (ΔPSI=P0-Pt)	4.0-2.0=2.0					
Sub-grade Soil Resilience Coefficient (MR)	30,000	22,500	22,500	45,000	30,000	45,000
CBR	20	15	15	30	20	30
Required Pavement Structure Index (SN)	2.69	2.98	2.60	2.01	2.34	2.01

Section I : Km0+000 - 3+100 II : Km3+100 - 4+400
III : Km4+400 - 6+200 IV : Km6+200 - 8+500
V : Km8+500 - 12+000 VI : Km12+000 – 13+010

1) Pavement Structure Design

The required strength is called the structure index (SN) and can be obtained through the following basic formula:

$$\log_{10}W_{18} = Z_R * S_0 + 9.36*\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\frac{\Delta PSI}{(4.2-1.5)}}{0.4+\frac{1094}{(SN+1)^{5.19}}} + 2.32*\log_{10}M_R - 8.07$$

Here,

W18 : Number of wheel sets passing converted into 18kip for the service period
ZR : Reliability coefficient
S_0 : Overall standard deviation
M_R : Sub-grade soil resilient modulus = CBR × 1500
ΔPSI : Lowered portion of serviceability index (Ex. If initial value: Po=4.2 and final value: Pt=2.5, Po-Pt=1.7)

2) Design Period

The design period shall be ten years.

3) Design Traffic Volume

With respect to future accumulated traffic volume, the following value is a conversion of axle load 18Kips (8.2ton) based on the results of the 24-hour traffic volume survey conducted at the time of B/D study in November 2007.

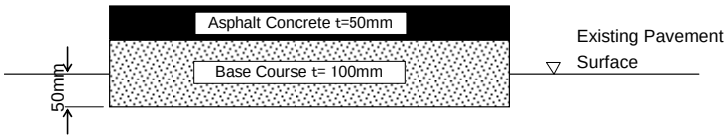
0+000 - 4+400 (Railway intersection) : ESAL 7.9×10^6
4+400 - 13+010 : ESAL 3.3×10^6

4) Pavement improvement method

a) Repair (a)

This is applied in the case of removing the existing pavement and utilizing the existing base course as a sub-base course.

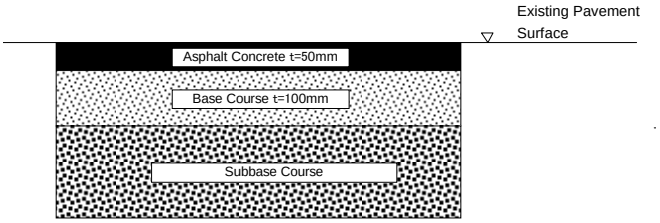
After removing the existing asphalt mixed surface course, asphalt mixed surface course layer and base course are laid on the existing base course.



b) Repair (b)

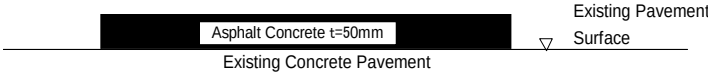
This is applied in the case of replacing the existing pavement.

After removing the existing pavement in order to observe the present road height, asphalt mixed surface course and base course are laid.



c) Repair (c)

This is applied in the case of placing asphalt mixed surface course on the existing concrete pavement.



5) Calculation of required pavement thickness

Pavement structure in each section is shown in the following table.

Table 2-12 Pavement Structure by Section

Pavement Design Section	Section	Section Distance (km)	Existing Pavement Type*1	Recyclable existing surface course /pavement thickness	Planned pavement thickness (m)			Execution type
					Surface・Base	Base course	Sub-base course	
					0.44*2	0.14*2	0.13*2	
I	0+000 - 2+220	0.22	D/B/SB	0.30	0.05	0.10	0.25	(b)
	0+000 - 2+200	2.2	D/B/SB	0.30	0.05	0.10	0.25	(a)
	2+200 - 3+100	0.9	D/B/SB	0.30	0.05	0.10	0.25	(b)
II	3+100 - 4+400	1.3	S/B/SB	0.35	0.05	0.10	0.30	(b)
III	4+400 - 6+200	1.8	S/B/SB	0.30	0.05	0.10	0.24	(a)
IV	6+200 - 8+500	2.3	S/B/SB	0.35	0.05	0.10	0.12	(a)
V	8+500 - 12+000	3.5	S/B/SB	0.30	0.05	0.10	0.19	(a)
VI	12+000 - 12+900	0.30	S/B/SB	0.20	0.05	0.10	0.12	(a)
	12+300 - 12+890	0.59	S/B/SB	0.20	0.05	0.10	0.12	(b)
	12+890 - 12+900	0.01	S/B/SB	0.20	0.05	0.10	0.12	(a)
	12+900 - 13+010	0.11	Con/B/SB	0.20	0.05	0.10	0.12	(c)

*1 : D=DBST, B=Base, SB= Sub-base, Con=Concrete
*2 : Pavement layer coefficient

2-2-2-3 Road Drainage System Plan

(1) Road Drainage Facility Plan

In accordance with the road Standards and design Criteria, road drainage facilities were determined as follows. Although the existing road drainage facilities are utilized effectively as much as possible, the sizes of new gutters and traversing pipes (culverts) that are planned shall be based on the flow calculation.

1) Planned rainfall intensity I

The following design rainfall intensity shown in “Table 2-6 Drainage Design Conditions” shall be applied.

Gutters, open channel : 61.8 mm/h (3-year return period of rainfall)
Culverts, closed conduit : 71.3 mm/h (5-year return period of rainfall)

2) Calculation of Rain Runoff

With respect to the calculation of runoff, a discharge basin diagram is shown in "Engineering Data". Runoff at the check points (drain flow ends and channel junctions) was calculated based on the following rational formula.

$Q=(1/3.6\times10^{6})\times C\times I\times a$

Q : Runoff (m^3/s)

C : Runoff coefficient (Road surface • slope: 0.8, Residential area: 0.5)

I : Rainfall intensity (mm/h)

a : Catchment area (m^3)

3) Calculation of Road Drainage Facility Size

The size of gutters and drainage pipes was calculated based on the Manning method.

$V=1/n\times R(2/3)\times i(1/2)$

V : Mean velocity (m/s)

n : Roughness coefficient
(Concrete gutter:0.015, Concrete pipe:0.015, stone-masonry gutter : 0.03)

R : Hydraulic mean depth (mm/h)
(Cross-sectional area of flow/length of wet perimeter)

i : Channel gradient

The displacement capacity at the check points shall be calculated based on the following formula and the results shall be shown in the "Engineering Data".

$Q=A\times V$

Q : Displacement (m^3/s)

A : Cross-sectional area of flow (m^2)

V : Mean velocity (m/s)

(2) Road Traversing Culvert Plan

The existing culverts traversing roads shall be utilized effectively as much as possible in a similar manner as other road drainage facilities. Of the existing culverts, damaged concrete pipes, corroded corrugated metal pipes and storage drums were replaced with new concrete pipes. In addition, the sizes of existing and new culverts were determined by checking their displacement in accordance with "(1) Road Drainage Facility Plan".

It has been discussed and agreed upon with GRZ that the size of new road traversing culvert shall be Φ600 and Φ900 by checking the displacement.

A list of the road traversing culverts to be improved in the project is shown in the following table.

Table 2-13 Culvert List

No.	Title	Station	Existing Pipe	Culvert Pipe			Catch Pit, Inlet/Spillway					
							Catch Pit			Inlet/Spillway		
				Use	Renew	New	Use	Renew	New	Use	Renew	New
1	P- 40	KM. 0 + 450	----			concrete φ600			○			
2	P- 1	KM. 0 + 580	Concrete φ350	○				○				
3	P- 36	KM. 0 + 645	Concrete φ350	○				○				
4	P- 2	KM. 0 + 805	Concrete φ350	○				○				
5	P- 3	KM. 0 + 890	Concrete φ350	○				○				
6	P- 4	KM. 1 + 85	Concrete φ350	○				○				
7	P- 5	KM. 1 + 245	Concrete φ350	○				○				
8	B- 1	KM. 1 + 420	Box H900, W900	○						○		
9	P- 6	KM. 1 + 625	Concrete, Corrugated Metal φ600	○	concrete φ600						○	
10	P- 7	KM. 1 + 805	Concrete, Corrugated Metal φ600	○	concrete φ600						○	
11	P- 8	KM. 1 + 980	Concrete, Corrugated Metal φ600	Designed by SEED Project								
12	P- 9	KM. 2 + 160	Concrete, Metal Drum φ600		concrete φ900						○	
13	P- 10	KM. 2 + 345	Concrete, Metal Drum φ600		concrete φ900						○	
14	P- 41	KM. 2 + 495	----			concrete φ600			○			
15	P- 42	KM. 2 + 620	----			concrete φ600			○			
16	P- 43	KM. 2 + 620	----			concrete φ600			○			
17	P- 44	KM. 2 + 650	----			concrete φ600			○			
18	P- 11	KM. 2 + 650	Corrugated Metal φ1,000		concrete φ1,000						○	
19	P- 45	KM. 2 + 840	----			concrete φ600						○
20	P- 46	KM. 2 + 915	----			concrete φ600						○
21	P- 12	KM. 3 + 250	Concrete φ600	○				○				
22	P- 37	KM. 3 + 645	Concrete φ600	○				○				
23	P- 47	KM. 3 + 690	Metal Drum φ600		concrete φ600						○	
24	P- 13	KM. 3 + 880	Concrete φ600	○				○		○		
25	P- 38	KM. 4 + 175	Concrete φ600×2	○							○	
26	P- 48	KM. 4 + 205	----			concrete φ600			○			
27	P- 49	KM. 4 + 450	Corrugated Metal φ900		concrete φ900						○	
28	P- 50	KM. 4 + 850	Corrugated Metal φ900		concrete φ900						○	
29	P- 14	KM. 5 + 170	Concrete φ600	○						○		
30	P- 15	KM. 5 + 245	Concrete φ600	○						○		
31	P- 16	KM. 5 + 550	Concrete φ600	○						○		
32	P- 17	KM. 6 + 270	Concrete φ600	○						○		
33	P- 18	KM. 7 + 160	Concrete φ600	○						○		
34	P- 30	KM. 7 + 530	Concrete φ600×2	○						○		
35	P- 31	KM. 7 + 790	Concrete φ600	○						○		
36	P- 19	KM. 8 + 970	Concrete φ600×2	○						○		
37	P- 20	KM. 9 + 260	Concrete φ600×2	○						○		
38	P- 32	KM. 9 + 520	Concrete φ600	○						○		
39	P- 21	KM. 9 + 620	Concrete φ600	○						○		
40	B- 2	KM. 10 + 10	Box H1,200×W1,800	○						○		
41	P- 22	KM. 10 + 140	Concrete φ600	○						○		
42	P- 23	KM. 10 + 310	Concrete φ1,500×2 Box. H1,150×W1,750×2	○						○		
43	P- 33	KM. 10 + 620	Corrugated Metal φ600	○						○		
44	P- 24	KM. 10 + 710	Corrugated Metal φ1,500	○						○		
45	P- 25	KM. 10 + 840	Corrugated Metal φ600	○						○		
46	P- 26	KM. 11 + 70	Corrugated Metal φ600	○						○		
47	P- 27	KM. 11 + 190	Corrugated Metal φ600	○						○		
48	P- 28	KM. 11 + 620	Corrugated Metal φ600	○						○		
49	P- 29	KM. 11 + 670	Corrugated Metal φ600	○						○		
50	P- 34	KM. 11 + 860	Corrugated Metal φ600	○						○		
51	P- 35	KM. 12 + 10	Corrugated Metal φ600	○						○		

(3) Road Gutter Plan

Concrete road gutters are planned in the urban area section; whereas, soil gutter drainage work is planned for cutting and plain parts in the national park section.

A list of road gutters is shown in Table 2-14.

Table 2-14 Road Gutter List

Type		Left-side Gutter	Median Gutter	Right-side Gutter
Concrete U-shaped gutter	New	KM.0+450 - KM.0+450	-	KM.0+450 - KM.0+450
Existing gutter	-	-	-	KM.0+450 - KM.1+420
Existing gutter	-	KM.1+440 - KM.1+980	-	KM.1+440 - KM.2+340
Concrete U-shaped gutter	Replace	KM.2+000 - KM.2+620	-	-
Concrete U-shaped gutter	New	-	KM.2+180 - KM.2+620	-
Existing gutter	-	KM.2+740 - KM.2+840	-	-
Existing stone masonry ditch	Repair	-	-	KM.2+740 - KM.3+960
Existing stone masonry ditch	Replace	-	-	KM.3+980 - KM.4+200
Existing stone masonry ditch	Repair	KM.4+340 - KM.5+300	-	-
Existing gutter	-	-	-	KM.4+340 - KM.5+800
Soil gutter	New	Cut and plain parts in the national park section		

Note) Left-side and right side indicated refers to left and right from the starting point to the terminal point.

2-2-2-4 Incidental Road Construction Work Plan

(1) Installation to Connecting Road

At the junction of Mosi O'Tunya road (hereinafter referred to as the "Road") and a connecting road, there is heading up spot due to road improvement. In order to even the faulting at this junction, road occupancy width was smoothed (25m at one side). Asphalt concrete pavement shall be applied to major connecting roads in similar manner as the carriageway of the Road; whereas, a double bituminous surface treatment (D.B.S.T) shall be applied to other connecting roads.

Figure 2-4 demonstrates the installation method for the Road and connecting roads. Connecting roads to be asphalt concrete pavement are shown in Table 2-15.

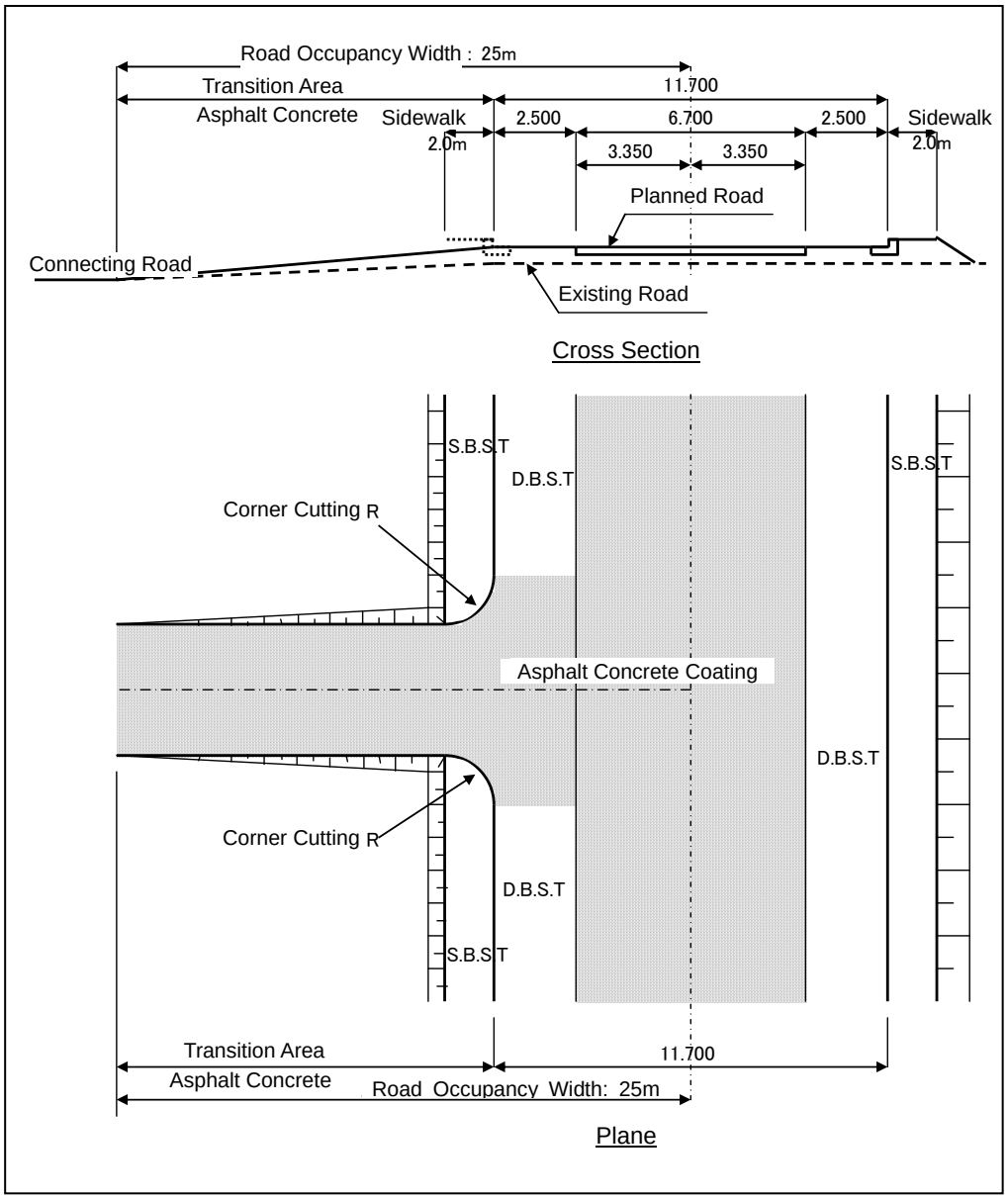


Figure 2-4 Installation to Connecting Road

Table 2-15 Connecting Roads Paved with Asphalt Concrete

No.	Connecting Road	Station
1	Katete Avenue	KM. 1 + 310
2	M10	KM. 3 + 268
3	Kafubu Road	KM. 3 + 705

(2) Sidewalk Cutting

The sidewalks include access to residential areas and access to connecting roads. Pedestrians and vehicle driving-ins were taken into consideration by cutting curb stones down for easy access to the

residential district and connecting roads. The following figure shows the installation method between THE ROAD and connecting roads.

Sidewalk access –A : Method of accessing residential district

Sidewalk access –B : Method of accessing connecting roads

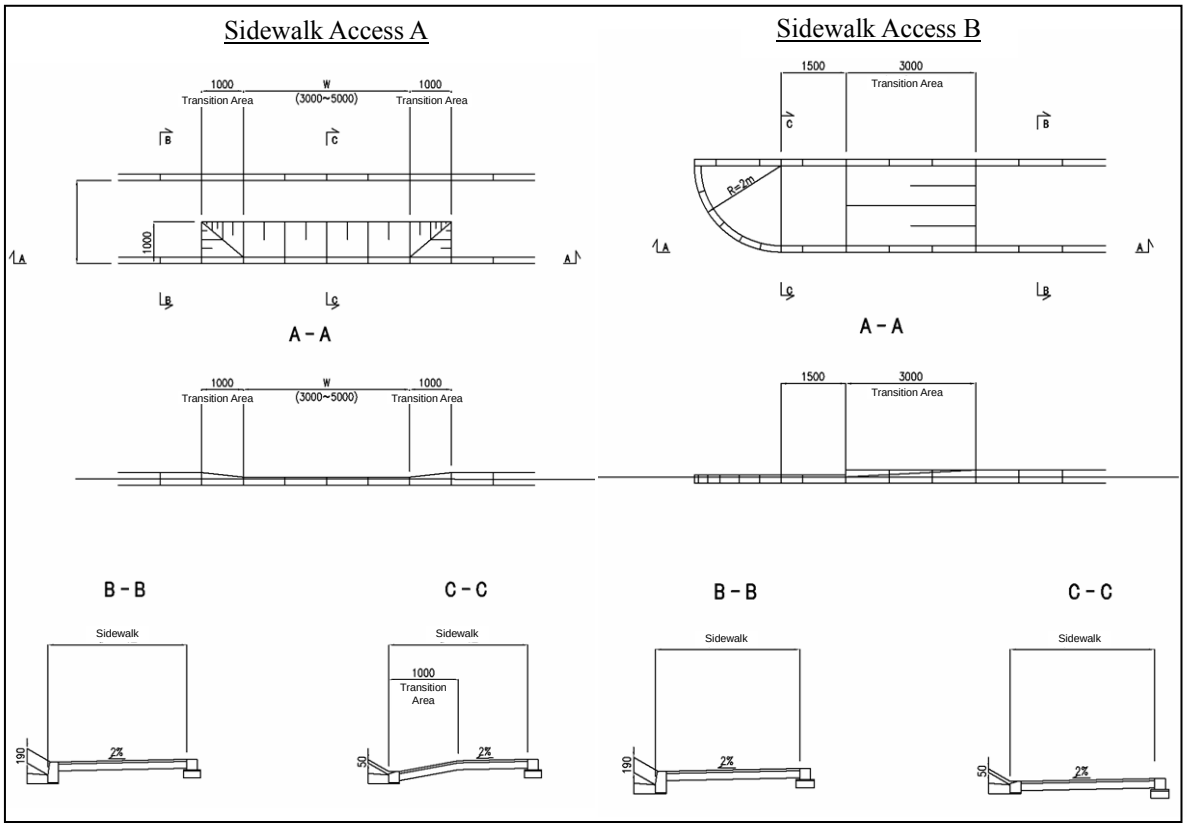
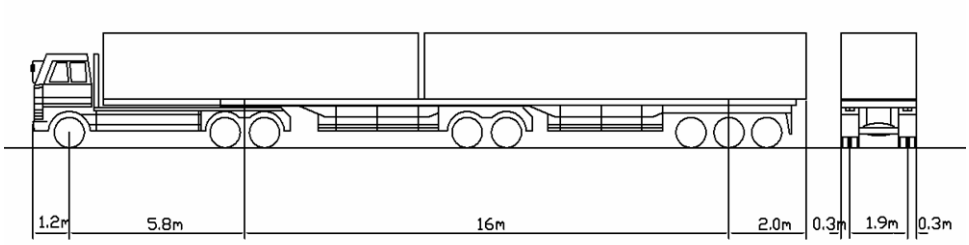


Figure 2-5 Sidewalk Cutting Diagram

(3) Intersection Plan between the T1Road and M10

At the intersection between the Road and M10 the volume of large-sized vehicles such as semi-trailers and pedestrians is high due to the presence of public facilities such as schools, kindergartens and churches throughout the vicinity. Taking semi-trailers and pedestrians into consideration an intersection was planned. Since the intersection shall conform to road ordinances, a radius large enough for an 8-axel semi-trailer (largest semi-trailers passing through site) shown in Figure 2-6 to easily turn shall be applied. Figure 2-7 shows the scheme drawing of the intersection between the Road and M10.



Source: Road Ordinances: Explanation and Application of Road Ordinances, Japan Road Association

Figure 2-6 8-axel Semi -trailer

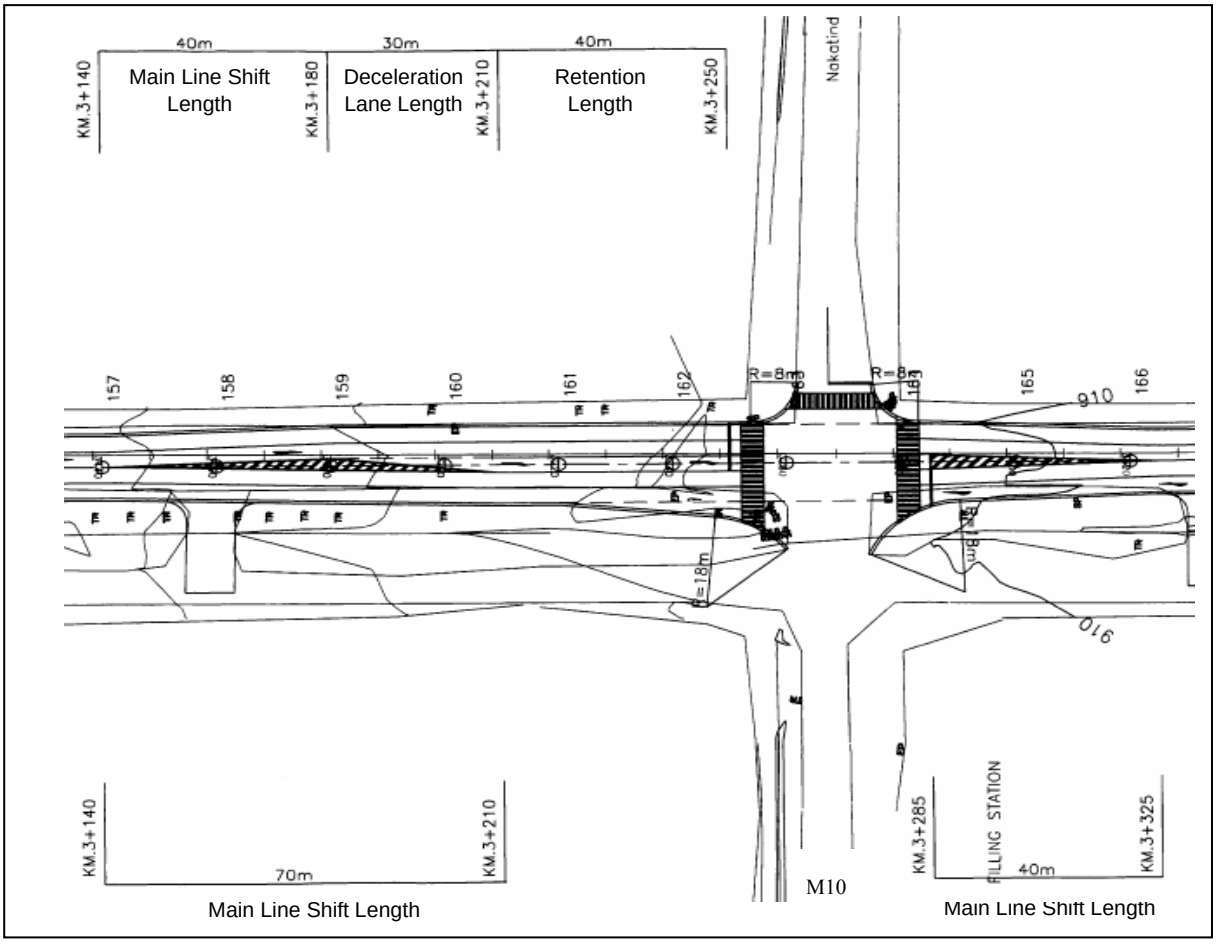


Figure 2-7 Intersection Scheme Drawing

- Added Lane Width
  3.0m
- Retention Length
  25m (8-axel semi-trailer) ＋12m (Large-sized vehicle) ＋ allowance =40m
- Deceleration Lane Length
  Minimum value : 30m

Calculated value : (60×3.0)/6=30m

Adopted value : 30m

- Main Line Shift Length

Minimum value : 40m

Calculated value : (60×1.5)/3=30m

Adopted value : 40m

(4) Parking Lots

Since the section from the vicinity of the airport road to the front of Livingstone Museum is a municipal center where public and commercial facilities are concentrated and it is bustling with people throughout the day, many people use parking lots. In the present parking lots the pavement has separated completely and road surfaces are uneven, reducing drainage effectiveness.

To improve the parking lots, the unevenness of the base course was reduced and a double bituminous surface treatment (DBST) was applied.

Parking lot planning is shown in Figure 2-8.

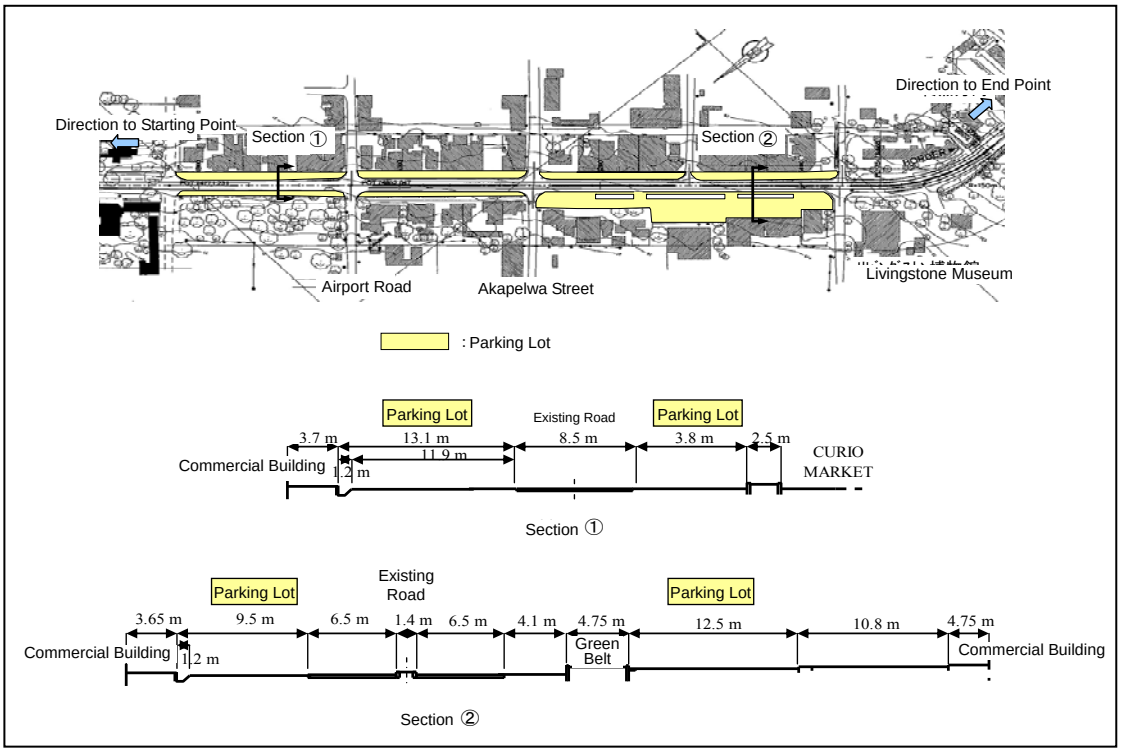


Figure 2-8 Parking Lot Planning

(5) Sidewalks

The existing sidewalks are installed in the urban area from Obote Road to Railway Intersection. Since sidewalk width and pavement structure vary depending on the section, the width ranges from

approximately 2m to 4m and the pavement structure includes asphalt and interlocking types. In addition, asphalt has peeled off or the base course is uneven along some sidewalks. Plans and designs were made for the existing pavement improvement work and for the new pavement construction work.

Sidewalk plan is listed in the table below.

Table 2-16 Sidewalk Plan List

Type		Left-side Sidewalk	Right-side Sidewalk
Sidewalk (2m)	New Construction	KM.0+440 - KM.1+420	KM.0+440 - KM.1+420
Existing Sidewalk	Repair	KM.1+440 - KM.4+340	KM.1+440 - KM.2+840
Existing Sidewalk	-	-	KM.2+860 - KM.3+700
Sidewalk (2m)	New Construction	-	KM.3+710 - KM.4+340
Sidewalk (2m)	New Construction	KM.3+710 - KM.4+340	KM.3+710 - KM.4+340
Sidewalk (1m)	New Construction	-	KM.12+540- KM.13+010

Note) Left-side and right side indicated refers to left and right from the starting point to the terminal point.

The minimum width of new sidewalks shall secure 2.0m to enable easy access and to allow pedestrians to run over or as a close approach to roadways. However, the sidewalk width in the vicinity of the international border shall be 1.0m for geographical reasons.

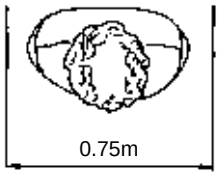


Figure 2-9 Pedestrian Occupancy Width

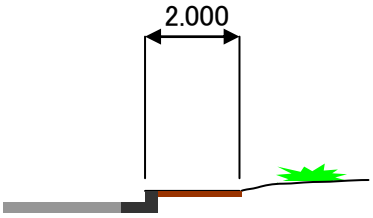


Figure 2-10 Standard Sidewalk Width

(6) Traffic Safety Facilities

Only regulatory and warning signs necessary for traffic safety shall be applied as traffic markings and the installation method shall be a road-side design.

As for road markings, centerlines (white), edge lines (yellow) and stop lines have been installed. Centerlines and edge lines were installed along all routes; whereas, stop lines were installed at the Road and the connecting road that crosses the Road.

Pedestrian crossings were installed at each major connecting road. For the purpose of reducing vehicle speed, speed humps and rumble strips were installed. Table 2-17, Table 2-18, Table 2-19 shows the planned pedestrian crossing locations, hump locations and traffic road signs respectively.

Table 2-17 Planned Pedestrian Crossing Locations

No.	Survey Point	Location
1	KM.0+465	Mushili Way
2	KM.1+310	Katete Avenue
3	KM.1+462	Obote Avenue
4	KM.1+634	Kashitu Road
5	KM.1+810	Mose Street
6	KM.1+990	Nwela Street
7	KM.2+169	Airport Road
8	KM.2+350	Akapelwa Street
9	KM.2+507	Kapondo Street
10	KM.2+658	Mutelo Street
11	KM.2+292	Senanga Road
12	KM.3+268	M10
13	KM.3+705	Kafubu Road
14	KM.3+975	Nsansa Road
15	KM.4+218	Chishimba Falls Road
16	KM.5+040	
17	KM.5+120	

Table 2-18 Planned Hump Locations

No.	Rumble Strip Hump
1	0km+280 to100m
2	0km+800 to 100m
3	1km+370 to 100m
4	3km+200 to 100m
5	3km+330 to 100m
6	5km+000 to 100m

Table 2-19 Traffic Road Signs

Traffic Road Signs	Signs	Location
Control Signs	STOP	Mushili Way Nehru Way Katete Avenue Obote Avenue Kashitu Road Mose Street Akapelwa Street Kapondo Street M10 Kafubu Road Nsansa Road
Prohibition Signs	SPEED LIMIT	Starting Point Urban Area National Park
Advance Warning Signs	PEDESTRIAN CROSSING	Table 2-16
	RAILWAY CROSSING	KM.4+340
	HUMPS	Table 2-18
	NARROW BRIDGE	Maramba Bridge Kabila Bridge
	BEND TO RIGHT	R=125,160,350,500,580,600
	BEND TO LEFT	R=125,160,350,500,580,600

(7) Lighting Facilities (Street Lights)

Mosi O'Tunya Road located in an urban area and near the center of Livingstone is both 4-lanes and 2-lanes and is a daily service road crowded with tourists. Street lights are therefore necessary from the viewpoint of traffic safety and public peace for pedestrians and vehicles at night.

The findings from an examination under the Project are as follows (Refer to 2-2-3 Basic Design Drawings for a detailed layout).

However, the height of street light fittings and light spacing shall be 12.0m and 50m respectively.

Table 2-20 Street Lights

Section (km)	Street Light Type		Arrangement
	Single	Double	
a. Airport Road (km2+169) - Senanga Road (km2+840)	5	13	Center
b. Senanga Road (km2+840) - Chishimba Falls Road (km4+218)	24	0	One side
c. Chishimba Falls Road (km4+218) - km5+280	20	0	One side
Total	49	13	

Note) a. 4-lane with median strip, b. 4-lane without median strip, c. 2-lane

2-2-3 Basic Design Drawings

The basic design drawings are as listed below. General location map, plans, vertical sections, cross sections and general structure drawings, etc. are listed in Appendixl 5-6.

Table 2-21 List of Basic Design Drawings

Drawing No.	Description	No. of Drawings
ZL BD A-1	INDEX OF DRAWINGS	1
ZL BD B-1	PROJECT LOCATION MAP	1
ZL BD B-2	LAYOUT MAP	1
ZL BD C-1	TYPICAL CROSS SECTION FOR 2-LANE SECTION	1
ZL BD C-2	TYPICAL CROSS SECTION FOR 4-LANE SECTION	1
ZL BD D-1 to D-20	PLAN AND PROFILE (1/20) - (20/20)	20
ZL BD E-1	DRAINAGE U-DRAIN	1
ZL BD E-2	DRAINAGE CONCRETE PIPE	1
ZL BD E-3	DRAINAGE CATCH PIT	1
ZL BD F-1	INCIDENTAL WORKS-1 (WALKWAY ACCES)	1
ZL BD F-3	INCIDENTAL WORKS-2 (KERBSTONE)	1
ZL BD F-3	INCIDENTAL WORKS-3 (STRUCTURES)	1
ZL BD F-4	INCIDENTAL WORKS-4 ROAD MARKING)	1
ZL BD F-5	INCIDENTAL WORKS-5 (JUNCTION LAYOUT AND MARKING)	1
ZL BD F-6	INCIDENTAL WORKS-6 (HUMPS)	1
ZL BD F-7	INCIDENTAL WORKS-7 (STREET LIGHT)	1
ZL BD G-1	MAJOR JUNCTION DETAIL (M10 JUNCTION)	1
TOTAL		36

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project will be implemented in accordance with the scheme of Japan's Grant Aid. Accordingly, the following points must be taken into consideration as implementation policy:

1) Local engineers, workers, equipment and materials shall be utilized as much as possible for their contribution to the creation of employment opportunities, promotion of technology transfer and vitalization of the local economy.

2) Temporary work for road construction shall be planned by assuring efficient materials delivery and efficient equipment operation. Accordingly, the local topographic, geological features, etc. shall be well grasped and reflected in the temporary work plan.

3) A realistic execution scheme shall be formulated in due consideration of rainfall patterns, time requirement for equipment and materials procurement, proper working methods, etc.

4) Since it is difficult to plan detours in urban districts at the project site, proper scheduling of alternating one lane traffic patterns and processing of field work shall be drawn up in order to avoid any excessive hindrance to the current traffic flow.

2-2-4-2 Implementing Conditions

The following points shall be considered during the implementation phase of the Project:

(1) Compliance with labor standards

The constructor shall observe currently applicable laws and regulations of Zambia related to construction, pay serious attention to appropriate working conditions and practices related to employment, prevent disputes with workers and ensure safety.

(2) Environmental conservation during the Project Period

The constructor shall conduct and supervise construction work while paying attention to environmental protection which was granted in the “construction permit” as a premise for the permit. In addition, the constructor shall be responsible for environmental preservation by taking measures against dust, turbid water, etc. which may arise from waste disposal, surplus soil disposal, filling, paving, etc. related to removal of the existing structures (longitudinal and crosswise traversing drainage structures).

(3) Necessity of communicating means at the site

The planned road is classified as an urban road where traffic congestion occurs in the mornings and evenings, buses travel back and forth along routes and where local residents come and go during the day. Minimum communicating equipment required for establishing a system of communication and management under such a situation shall be taken into consideration in order to ensure safety for general traffic, the neighboring residents and related construction personnel during construction as well as in an emergency situation.

(4) Insuring Traffic Safety

Special attention shall be given to traffic safety due to the fact that the project site includes the urban area. Accordingly, traffic safety personnel (in pairs) shall be posted day and night at the construction sites in order to ensure the safety of passing vehicles and residents.

(5) Schedule Adjustment

Progress of work by Zambia shall be adequately confirmed and adjusted.

2-2-4-3 Scope of Work

In case the Project is implemented, works to be taken by both Japanese and Zambian governments are outlined as follows.

(1) Scope of Work by Japan

1) Construction Work

Improvement work for existing roads of a total length of 13.01km along the target section.

- Earth work, pavement of roadways and sidewalks, shoulder pavement work, intersection construction and necessary temporary construction work.
- Construction of cross drainage and drainage ditches and temporary construction work necessary for incidental construction work.
- Installation of temporary facilities (such as base camp, office, lodging house and storage).

2) Procurement of Equipment and Materials

Procurement of construction materials and equipment for construction of roads and structures described in 2-2-4-6: “Procurement Plan”.

3) Safety Measures

Safety management and measures related to the execution of construction work.

4) Consultancy Services

Preparation of detailed design, tender and agreement documents, assistance of tender procedures, and work supervision.

(2) Scope of Work by Zambia

1) Acquisition of construction permit

A construction permit related to the Project conducted by the Ministry of Local Government and Housing (MLGH), which is the Zambian implementing agency, shall be obtained prior to bidding by contractors.

2) Land expropriation and compensation

Land expropriation necessary for the Project is listed below.

- To secure land necessary for building facilities described in the "work execution plan" such as a base camp and borrow pit , as well as to secure disposal sites for waste and surplus soil to be discharged from construction work.
- Security of temporary yards (camp yard and office, lot for asphalt plant).

3) Relocation of Public Facilities, etc.

- Relocation of obstacles (such as removal of street lights, adjustment of water and sewer pipes and manholes).
- Installation of lead-in wiring for street lights (installation work for leading in of electric lines until new street lights to be constructed).

4) Others

- Assistance for Japanese and third-country persons (other than Zambian) who are involved in the implementation of the Project to facilitate entry and stay, etc. in Zambia shall be made.
- Customs duties, domestic taxes and other surcharges imposed by the Zambian government shall be exempted or refunded.
- By appointing counterparts, means of transportation and expenses for personnel shall be ensured.

2-2-4-4 Consultant Supervision

(1) Consultancy Services

To implement the Project, the conclusion of the Exchange of Notes (E/N) with respect to the grant aid signed between both the Governments of Japan and Zambia is a prerequisite. After signing of the E/N, based on a written recommendation issued by JICA, and in accordance with the scope and procedure of the Japanese Grant Aid scheme, the Consultant will conclude a consultancy agreement with the Ministry of Local Government and Housing (MLGH), which is the implementing agency for the Government of Zambia. Following the conclusion of the agreement, the Consultant will carry out a detailed design, assistance toward the tender process and supervision of construction work. Hereinafter, major services included in the consultancy agreement are described.

1) Tender Documents Stage (Detailed Design Stage)

Based on the Basic Design Study Report, the Consultant will prepare a detailed design for each facility and tender documents. The following documents will be prepared in order to obtain approval from the Ministry of Local Government and Housing (MLGH).

a. Design documents,
b. Design drawings, and
c. Tender documents.

2) Tender Stage

The Ministry of Local Government and Housing (MLGH) will select Japanese-national contractors by means of open bidding with the assistance of the Consultant. Representatives from the Government of Zambia who participate in the tender and construction contract should possess the authority to approve related contracts and who are able to judge technical matters. The tender assisting services of the Consultant at the tender stage are described below.

a. Public announcement of PQ (pre-qualification),
b. Pre-qualification,
c. Bidding and evaluation of bids, and
d. Contract conclusion.

(2) Personnel Plan for Consultancy Services

Assignment of consulting personnel and their duties at each stage of detailed design and construction bidding shall be as follows.

1) Preparation of detailed design and tender documents

A design team organized under the chief consultant shall prepare detailed designs.

In addition, the detailed design preparation will include tender documents. In due consideration of the Project to be conducted through the Japanese Grant Aid, the following points should be taken into account in the case of preparing tender documents.

- Forms for tender instructions and written contracts, etc. shall conform to the guidelines of the Japanese Grant Aid.
- Technical specifications shall be prepared in due consideration of technical specifications on the Zambian side so as to sufficiently ensure quality.
- The personnel who is fully familiar with design contents relating to a basic design study and detailed design shall take the initiative in the preparation of tender documents.

2) Implementation system for tender assistance

Persons exclusively in charge shall be assigned to ensure that tendering progresses smoothly.

(3) Work Supervision System, etc. (Onsite Supervision System by the Consultant)

1) Work supervision

After the conclusion of the consultancy agreement, the Consultant will issue the commencement of work to contractors and start work supervision. Furthermore, during the work supervision, the Consultant shall report on the construction progress directly to MLGH and other agencies and shall inform contractors of work progress, carry out services with respect to quality, safety and payments, and provide remedies and recommendations on construction work. In addition, the Consultant shall submit a monthly report to the Japanese Embassy in Lusaka, the capital, and the JICA Zambian office.

2) Implementation organization for work supervision

Assignment plan of consulting staff and their duties in the work supervision are described as follows.

- **Work supervision** (such as commencement and completion of construction work):

An engineer shall be responsible for coordinating construction work and administrating and managing stationed supervisors. At the start and halfway point of construction, he/she will be dispatched to the actual site in order to fulfill an onsite supervisory system and takeover after the completion of the facilities. Furthermore, an engineer shall be dispatched to the actual site at need during the progress of the construction work in order to provide advice or to witness various inspections.

- **Resident Engineer for Construction Supervision** (Japanese):

An engineer shall be stationed and carry out general schedule supervision and safety control at the actual site. Since the Project will be implemented in accordance with Japanese Grant Aid, an implementation schedule shall be prepared at the detailed design stage in due consideration of this. Based on the schedule, supervision shall be made so that the Project is implemented as scheduled.

- **Work supervision** (pavement engineer) (Japanese)**:**

An engineer shall witness pavement work from pilot execution to completion of pavement work and shall provide guidance and supervision to contractors.

- **Local Employee** (road engineer):

A local engineer shall assist the stationed Japanese supervisor and carry out quality control, schedule management and safety control.

2-2-4-5 Quality Control Plan

A laboratory shall be provided at the base camp for carrying out concrete quality testing. Technical staff shall be assigned to the laboratory so that the needs for quality control at the site can be satisfied. Major items for a quality control plan associated with the construction under the Project are shown in the Table 2-22:

Table 2-22 Quality Control Items

Item			Test Method	Test Frequency
Base (Crushed Stone)	Mixed materials		Liquid limit, plasticity index	Each time of mixing
			Gain size distribution (mixture)	
			Aggregate strength test (TFV)	
			Aggregate density test	
			Max. dry bulk density (compaction test)	
	Laying		Density test (degree of compaction)	Designated frequency
Prime coat, tack coat	Materials	Bituminous material	Quality certificate	For each material type
			Storage and spraying temperature	Each time of delivery
Asphalt	Materials	Bituminous material	Quality certificate, composition analysis table	For each material
		Aggregate	Gain size distribution (mixture)	For each delivery, once / month
			Coefficient of water absorption	For each material type
			Aggregate strength test (TFV)	
	Mixing test		Stability	Each time of mixing
			Flow value	
			Percentage of air voids	
			Voids of mineral aggregate	
			Tensile strength (indirect)	
			Residual stability	
			Design asphalt content	
	Paving		Mixing temperature	As required
			Laying temperature	Each time of transport
			Sampling, Marshall stability test	Approx. once / day
Concrete	Materials	Cement	Quality certificate, results of chemical & physical test	For each material type
		Water	Results of composition test	For each material type
		Admixture	Quality certificate, composition analysis table	For each material type
		Fine aggregate	Specific gravity under oven dry condition	For each time of changing material
			Grain size distribution, fineness modulus	
			Rate of clay agglomerate and soft fine pieces	
		Coarse aggregate	Specific gravity under oven dry condition	For each time of changing material
			Gain size distribution (mixture)	
	At mixing test		Compressive strength test (cubic specimen)	Each time of mixing
	At placing		Slump test (concrete)	For each placing
			Air content	For each placing
			Temperature	For each placing
	Strength		Compressive strength test (7^{th}, 28^{th})	Designated frequency
Reinforcing bars	Materials		Quality certificate, results of tensile test	For each lot

2-2-4-6 Procurement Plan

(1) Procurement Conditions of Construction Materials

Policy concerning procurement of construction materials is described as follows.

1) Locally produced materials shall be procured as much as possible.

2) If imported goods are constantly being distributed on the market in the relevant country, they shall be procured.

3) Materials which are difficult to procure locally shall be procured form Japan or a third country. The procurement source will be determined in due consideration of price, quality and delivery date, etc.

Most of the major materials such as bituminous materials, aggregates for pavement, concrete materials and wood materials are either produced in Zambia or imported and are therefore available.

Procurement sources for major construction materials are shown in the table below.

Table 2-23 Procurement Sources for Major Construction Materials

Material Name	Procurement Source			Remarks
	Local	Japan	Third Country	
Aggregate for pavement	○			Locally produced
Asphalt materials	○			Imported from South Africa
Cement	○			Ditto
Reinforcing bars	○			Ditto
Aggregate for concrete	○			Locally produced
Shaped steel	○			Imported from South Africa
Concrete pipe (Diameter : 600 - 1,200mm)	○			Ditto
Vinyl chloride pipe (50 - 200mm)	○			Ditto
Crushed stone	○			Locally produced
Wood materials (plywood, square timber, plate)	○			Ditto
Fuel	○			Imported from Saudi Arabia
Lubricants	○			Imported from South Africa
Paints	○			Ditto

(2) Construction Machinery

Policy concerning procurement of construction machinery is described as follows.

1) Construction machinery owned by local constructors shall be leased.

2) If construction machinery is difficult to procure, it shall be procured from Japan or a third country. The procurement source will be determined in due consideration of a transportation cost and leasing fees.

From the results of the field survey, construction machinery to be utilized for construction work are available in Zambia. The procurement source for major construction machinery is shown in Table 2-24.

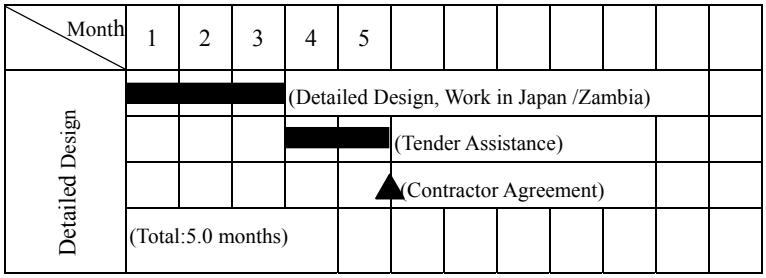
Table 2-24 Procurement Sources of Major Construction Machinery

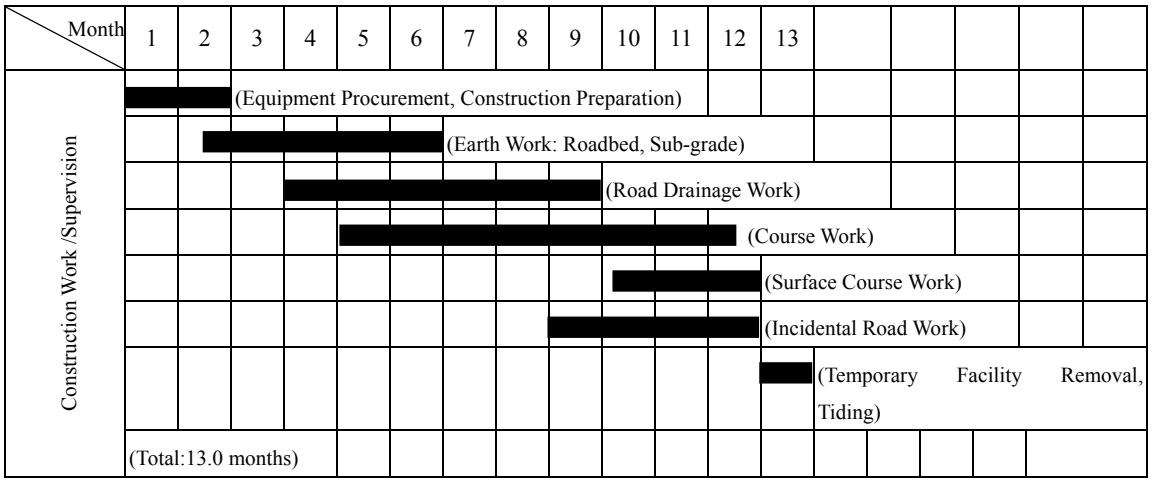
Machinery	Standard	Lease/ Purchase	Procurement Source			Remarks
			Local	Japan	Third Country	
Bulldozer	15ton	Lease	○			
Bulldozer	21ton	Lease	○			
Bulldozer	32ton	Lease	○			With ripper
Back hoe	0.13m^3	Lease	○			Hydraulic crawler
Back hoe	0.45m^3	Lease	○			Hydraulic crawler
Back hoe	0.8m^3	Lease	○			Hydraulic crawler
Dump truck	4ton	Lease	○			
Dump truck	10ton	Lease	○			
Truck crane	5ton	Lease	○			Hydraulic
Truck crane	20ton	Lease	○			Hydraulic
Truck crane	25ton	Lease	○			Hydraulic
Road roller	10-12ton	Lease	○			Macadam
Vibrating roller	3- 4ton	Lease	○			Combined
Vibrating roller	0.8-1.1ton	Lease	○			Hand guided
Rubber-tired roller	8-20ton	Lease	○			
Motor grader	3.1m	Lease	○			
Wheel loader	1.2m^3	Lease	○			
Wheel loader	2.1m^3	Lease	○			
Asphalt plant	60ton/hr	Lease	○			
Asphalt finisher	2.4-6.0m	Lease	○			Wheel
Asphalt distributor	6,000ℓ	Lease	○			
Engine generator	20KVA	Lease	○			Diesel power
Engine generator	100KVA	Lease	○			Diesel power
Engine generator	300KVA	Lease	○			Diesel power
Air Compressor	5.0m^3/min	Lease	○			
Concrete mixer	100 ℓ	Lease	○			Pot mixer

2-2-4-7 Implementation Schedule

The implementation schedule prepared in accordance with procedures of the Japanese Grant Aid is shown in Table 2-25.

Table 2-25 Implementation Schedule





Note) The rainy season lasts from November to March in the following year in Zambia

2-3 Obligations of the Recipient Country

(1) General Requirements

Although general requirements to be taken by the Zambian side have already been confirmed in the minutes of discussions (M/D) agreed by both governments, the contents are described as follows.

1) Land required for implementing the Project shall be secured prior to the commencement of the construction work.

2) Customs duties, domestic taxes and other surcharges arising by the recipient country with respect to provision of products and services in accordance with the approved contracts shall be exempt for Japanese nationals.

3) Necessary convenience and assistance to Japanese nationals who enter and stay in the recipient country for the implementation of the Project with respect to provision of products and services shall be provided.

4) Customs duties on materials and machinery for the Project shall be exempted.

(2) Specific Requirements for the Project

Specific requirements other than the general requirements for Grant Aid Scheme are shown in the following table.

Table 2-26 Requirements Undertaken by the Recipient Country and Cost

Construction Type		Description	Cost (ZK)	Remarks
(1)	Street light removal or relocation cost	Removal or relocation of existing 95 damaged street lights that do not function	114,000,000	(Approx. ¥3.4 million)
(2)	Buried pipe depth replacement cost	Piping correction of existing water pipes where covering earth is thin (less than 0.8m) affected by the present road improvement: 3 locations	24,000,000	(Approx ¥0.7 million)
(3)	Buried sewer pipe depth changing cost	Adjustment of buried depth of existing sewer pipes affected by the present road improvement: 3 locations	30,000,000	(Approx. ¥0.9 million)
(4)	Manhole repair cost	Adjustment of the existing manhole height affected by the present road improvement: 3 locations	2,400,000	(Approx. ¥0.1 million)
(5)	Electric line replacement cost	Since electric lines buried under sidewalks at the border of the terminal point are exposed and will hinder sidewalk construction work, the lines should be relocated or reburied. (Approx. 250m)	20,000,000	(Approx. ¥0.6 million)
(6)	Street light lead-in wire cost	Electric lines for new street lights should be lead in. (About 50m)	4,000,000	(Approx. ¥0.1million)
(7)	Bank Service Charge	A/P cost	37,000,000	(Approx. ¥1.1 million)
Total			231,400,000	(Approx. ¥6.9million)

Conditions in Cost Estimate

① Date of Estimation : December, 2007

② Exchange Rate : 1 ZK = ¥0.03 (average for June - November, 2007)

(3) Requests for Construction from Commencement to Completion

The recipient country is required to carry out the following matters in order to ensure smooth implementation of construction work.

1) Holding of project explanatory meetings with local residents living along the project routes

After the signing of the Exchange of Notes (E/N) to officially conclude the implementation of the Project, the Livingstone City Council (LCC), which is the implementing agency, is requested to take the initiative to immediately hold project explanatory meetings for adjacent residents or their representatives.

2) Traffic safety

The recipient side is requested to thoroughly inform passengers and drivers passing the construction sites and instruct them to follow the directions of traffic control personnel.

3) Assuring publicity of inconveniences during construction

Since a certain degree of inconvenience caused by construction work is anticipated, the recipient side is requested to thoroughly inform local residents via the public media (radio broadcasts) of the inconveniences as a result of construction.

2-4 Project Operation Plan

(1) Maintenance Contents

Implementation of the following maintenance work will at least be required for facility maintenance after implementation of the Project.

- Patching of the damaged asphalt layer (filling potholes)
- Repair of the base course
- Repair of the road shoulders
- Repair of the sidewalks
- Cleaning and maintenance of the transversal closed conduits and the catch pits
- Cleaning and maintenance of the gutters
- Maintenance inspection and cleaning of the street lights

In particular, it is requested to sufficiently carry out regular inspections and patrols for early detection of damage to structures in order to ensure early repair.

(2) Points on Maintenance

In order to sustain the project effects, it is important to retain favorable conditions and to improve the durability of the facilities through sufficient maintenance. Accordingly, the following matters should be taken into account.

1) To constantly grasp the facility conditions by conducting periodical inspections.
2) To sufficient clean drainage facilities particularly before the rainy season.
3) To secure a maintenance budget based on the maintenance plan.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Cost to be Borne by the Japanese Side

The Project will be implemented in accordance with the Japan's Grant Aid scheme and the cost will be determined before concluding the Exchange of Note for the Project.

(2) Cost to be Borne by the Zambian Side

The Zambian side is expected to fund certain costs described below as a condition for the implementation of the Project.

Based on 2-2-4-3 Scope of Work for the Zambian Side, it is estimated that the Zambian side will need to provide some 231.4 million kwacha (approximately JPY6.9 million) to cover the cost of relocation obstructive items and securing the necessary land, etc.

(3) Conditions in Cost Estimate

1) Date of Estimation : December, 2007

2) Exchange Rate : 1 US$ = ¥118.26 (average for June - November, 2007)

3) Project Period : The Project will be implemented through one phase and the period required for detailed design and construction work will be 18.0 months as shown in “2-2-4-7 the implementation schedule”.

4) Other : Cost estimation is in accordance with the grant aid scheme of the Government of Japan

2-5-2 Operation and Maintenance Cost

The operation and maintenance cost based on the operation and maintenance plan described earlier is shown in Table 2-27.

Table 2-27 Major Items and Annual Cost for Maintenance and Operation

(1 ZK = ¥0.03)

O/M Item	Specifications	Unit	Unit cost (ZK)	Unit work Amount	Cost (ZK)
Patching	0.5% of the total paved roadway area	M^2	51,000	524.0	26,724,000
Roadbed repair	0.5% of the total paved roadway area	M^2	24,300	524.0	12,733,200
Road shoulder repair	1.0% of the total paved shoulder area	M^2	32,400	403.0	13,057,200
Sidewalk repair	1.0% of the total paved sidewalk area	M^2	12,600	142.0	1,789,200
Structure cleaning	25% of the total Transversal closed conduit, catch pit	spot	180,000	24.5	4,410,000
Same as above	25% of the total Drainage gutter	M	3,300	925.0	3,052,500
Structure repair	5.0% of the total Transversal closed conduit, catch pit	spot	620,000	1.0	620,000
Same as above	5.0% of the total Drainage gutter	M	112,000	37.0	4,144,000
Sub Total					66,530,100
General Administrative Cost	10% of Sub Total	formula	-	-	6,653,010
Total					73,183,110
		Japanese Yen Equivalent =			2,195,493

As calculated above, the total annual cost of maintenance is approximately 73 million Kwacha (approximately ¥2.1 million). This is approximately 7.1% of 1,021 million Kwacha (approximately ¥30 million), which is the annual budget for 2007 LCC maintenance and is judged to be reasonable burden.

In addition, the Project plans to install 62 units of street lights. The calculation for an operation and maintenance cost is described as follows.

(A-1) Annual operation cost necessary for street lights (electricity charges)

One unit of street light・annual electricity charge : 328,047 Kwacha / unit (approx. ¥ 9,800)
Annual operation cost : 62 units × K328,047 / unit = 20,338,914 Kwacha (approx. ¥610,000)

(A-2) LCC annual budget for operation cost for street lights (electricity charge)

LCC regards an operation cost relating to street lights in 2008 (including 62 street lights under the Project) (electricity charge) to be 197 million Kwacha (approx. ¥5.94 million) for a total 512 units. It is therefore possible to bear a cost for 62 units sufficiently.

(B-1) Annual maintenance cost necessary for street lights

The necessary maintenance cost throughout the year is a depreciation cost and maintenance cost (such as part replacement, inspection and cleaning).

- Annual depreciation cost (10-year guarantee) : 1.0 million Kwacha (approx. ¥30,000)/year
- Annual maintenance cost : 62 unnits×110,000 Kwacha (maintenance cost per street light)
  = 6.8 million Kwacha (approx. ¥200,000) /year

Total : 1.0 million Kwacha＋6.8 million Kwacha
= 7.8 million Kwacha (approx. ¥230,000) /year

(B-2) LCC annual budget for operation cost relating to street lights

LCC regards an operation cost relating to (including 62 street lights under the Project) (electricity charge) to be 70 million Kwacha (approx. ¥2.1 million) for a total 512 units. It is therefore possible to bear a cost for 62 units sufficiently.

2-6 Other Relevant Issues

In order to smoothly carry out the requested Japanese assistance and to sufficiently display and sustain the project effects, the Zambian side is required to pay attention to the following matters.

1) Since the urban district will be included in the target construction sections, in particular, safety control should be taken into account for local residents.

2) The competent governmental agency and the implementing agency are different, and there are many related organizations involved (such as national border facility organs, National Heritage Conservation Commission, national park administrator and railway corporation). It is therefore necessary to consider timely communication and coordination in the implementation of the construction work.

3) Relocation and removal of obstacles to be taken by the Zambian side should be promptly started after the signing of the Exchange of Notes (E/N).

4) After the signing of the E/N, a meeting to explain the Project should be implemented through the initiative of LCC by gathering local residents or representatives.

5) In order to alleviate traffic congestion and to avoid unnecessary problems with local resident during the construction work period, detailed advanced notice should be given to motorists and residents through the initiative of LCC.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

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3-1 Project Effects

By implementing the Project, the conditions of Mosi O'Tunya Road in Livingston City will be improved, and safe and smooth traffic flow will be ensured. It is therefore expected to benefit 104,000 citizens in Livingstone and 600,000 tourists.

The project effects are shown in Table 3-1.

Table 3-1 Project Effects

Current Situation and Problems	Remedial Measures under the Requested Japanese Assistance	Direct Effects and Degree of Improvement	Indirect Effects and Degree of Improvement
Although the target road was improved after 1964, it has deteriorated and has not been repaired. There is no indication that repair work is being planned. The target Mosi O'Tunya Road (T1) is located at the junction of the route to South Africa by way of Zimbabwe from Lusaka, the capital of Zambia, and the route to South Africa by way of Botswana. The road is regarded to be an important transit route for most physical distribution in Zambia. However, road surfaces and shoulders are severely damaged. Sidewalks and drainage facilities are also in bad condition, and are hindering economic growth in the city where tourism is a key industry.	- Road repair	1) Through improvements, smooth traffic flow and travel efficiency will be secured. The average safe travel speed between the starting and terminal points (except for urban areas) will be raised from the present 30km/h to 50km/h. The average travel speed between urban areas will be raised from 20km/h to 40km/h. 2) By improving road shoulders, sidewalks and street lights, it will become possible to separate pedestrians and bicycles from vehicles. By installing street lights, various measures including night safety will also be assured. The accident rate will therefore be reduced so as to contribute to improvement in safety of the relevant road at night and during daytime hours.	1) By functioning as a major international trunk road, physical distribution and personnel exchange will be promoted and will contribute to the revitalization of social and economic activities. 2) By improving the convenience for tourists through better accessibility to tourism facilities, it will contribute to the tourism industry, which is a key industry in the city.

3-2 Recommendations

3-2-1 Recommendations to be Taken by the Recipient Side

Although the above-mentioned effects can be expected through the implementation of the Project, in order to secure further effects and to ensure sustainable development even after the completion of the Project, the Zambian side is required to carry out the following.

1) In order to reinforce a road maintenance system and to build up managerial ability, engineers should be continuously secured and human resources should be trained.

2) A long-term maintenance system should be established and a maintenance budget should be secured based on it.

3) Overloaded vehicles which are a biggest cause of road damage (especially on pavement) should be regulated. A regulating system should be established and reinforced and should be implemented comprehensively.

3-2-2 Technical Cooperation and Coordination with Other Donors

At the present time, improvements to the section between the junction at T2 and Zimba have been completed (please refer to the location map shown on the following page of Table of Contents). It has been decided that T1 road from Zimba to Livingstone (starting point of the Project) will also be improved through European Union financing, and bidding for construction work is scheduled in 2008. In addition, since improvement of urban roads is under way in the city through the SEED project, the implementing conditions have been confirmed and problems were inspected in order for the Project to be in harmony with the projects financed by other donors as a whole.