No. 22

Japan International Cooperation Agency
Ministry of Works and Supply, Republic of Zambia
Ministry of Transport and Energy, Republic of Zimbabwe

The Feasibility Study on the Proposed New Bridge Over
the Zambezi River at Chirundu Border Post

Between

the Republic of Zambia
and
the Republic of Zimbabwe

Final Report

March 1998

Chodai Co., Ltd.

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| 1 US$ = | 1,300 kws |
| 1 US$ = | 12.3 Z$ |

PREFACE

In response to the request of the Governments of the Republic of Zambia and the Republic of Zimbabwe, the Government of Japan decided to conduct the Feasibility Study on the Proposed New Bridge Over the Zambezi River at Chirundu Border Post between the Republic of Zambia and the Republic of Zimbabwe and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Zambia and Zimbabwe a study team headed by Mr. Yusuke Kajimura of Chodai Co., Ltd. The team was dispatched three times between June 1997 to January 1998.

The team held discussions with the officials concerned of the Governments of Zambia and Zimbabwe, and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope this report will contribute to the promotion of the project and to the enhancement of friendly relations among three countries.

I wish to express my sincere appreciation to the officials of the Governments of the Republic of Zambia and the Republic of Zimbabwe for their close cooperation extended to the team.

March, 1998

Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

March, 98

Mr. Kimio Fujita
President
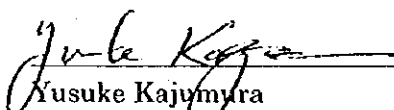Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

It is a great honour to submit herewith the final reports of the Feasibility Study on the Proposed New Bridge Over the Zambezi River at Chirundu Border Post between the Republic of Zambia and the Republic of Zimbabwe. The report includes the advice and suggestions of the concerned authorities of the Government of Japan and your Agency, as well as the comments made by Ministry of Works and Supply, Zambia and Ministry of Transport and Energy, Zimbabwe, and other authorities concerned in both countries.

This report describes conditions of the existing bridge, border post facilities and environment of the region, and presents feasibility of the new bridge construction and border post facilities improvement. Environmental aspects were duly considered through out the course of the study.

As a result of the analyses of the project from technical, environmental and economical viewpoint, a new bridge crossing at about 100m upstream from the existing bridge is recommended, with required improvements to border post facilities. It is strongly recommended to implement both the new bridge construction and border post facilities improvements, as either one of them would not facilitate the movements of traffic alone.

On behalf of the team, I wish to express our deep gratitude to your Agency, Ministry of Foreign Affairs, and other officials concerned for their valuable comments and suggestions to the Study. I also wish to express my heartfelt appreciation to the officials concerned of the Government of Zambia and the Government of Zimbabwe for their warm friendship and cooperation extended to us during the Study. I hope this report will contribute to the development of the Republic of Zambia and the Republic of Zimbabwe.

Yours Faithfully,

Yusuke Kajumura
Team Leader

1 DEVELOPMENT OF THE STUDY

The Chirundu Border Post is located on the Beira Corridor connecting Mozambique, Zimbabwe and Zambia. The existing bridge (Otto Beit Bridge) was constructed and opened for traffic in 1939 and has 5.5 meters carriageway with sidewalk of 0.9 meters on both sides. Only one vehicle is allowed to pass on the existing bridge at a time and 55 tons maximum vehicle weight limitation is strictly enforced due to the structural capacity of the Bridge. The Governments of Zambia and Zimbabwe requested the Government of Japan to conduct the Feasibility Study for the Construction of a Bridge over the Zambezi River, taking into consideration the necessity for improvement of the border post.

Issues concerning the existing bridge and border post facilities are as below.

(1) Otto Beit Bridge

- Only one vehicle is allowed on a bridge at a time, hence traffic capacity is 30 vehicles per hour for both directions at maximum.
- 55 tons maximum vehicle weight limitation is strictly enforced due to the structural capacity of the Bridge. Heavier vehicles are forced to use border post at Kariba dam.
- Visual inspection to the existing bridge found no major defections of the structure.
- The existing bridge is maintained in sound condition. Usage under present limited operation will provide adequate service.
- Beira Corridor is considered as vital international corridor, many projects has been carried out to improve efficiency. Chirundu could be a bottleneck without any improvement.

(2) Border Post Facilities

- Capacity of the border post facilities is 25 vehicles per hour for both directions. Border post facilities are being bottleneck at Chirundu rather than the bridge.
- Border post is opened from 6:00 am to 6:00 pm, therefore 250 vehicles per day can be dealt with.
- Lack of both the facilities and personnel is causing serious shortage for inspection. Drug trafficking and smuggling are serious problem.

Projects on Beira Corridor
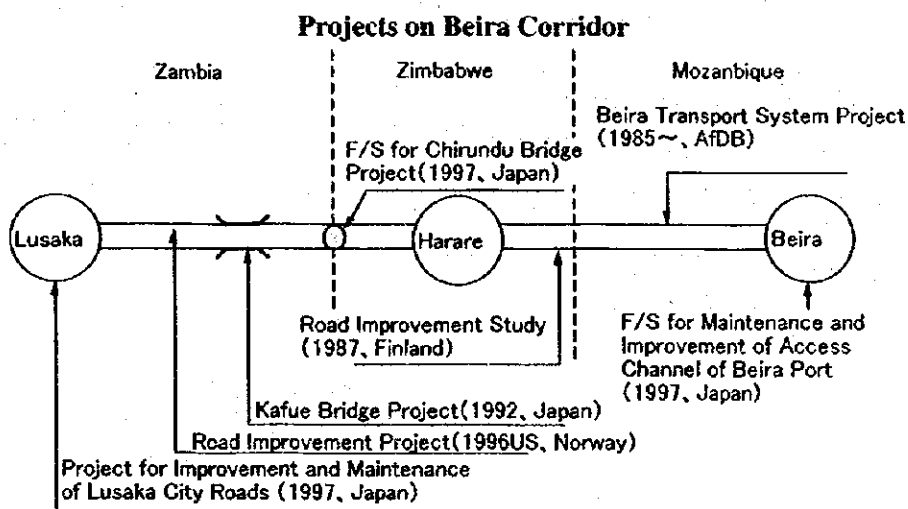
2 TRAFFIC CONDITIONS

Result of future traffic forecast study is as shown below.

Traffic Demand Forecast at Chirundu Border Post

Direction Zambia – –)   Zimbabwe   (Unit : vehicle / day)

Vehicle Type	1997			2002			2010		
	Loaded	Vacant	Total	Loaded	Vacant	Total	Loaded	Vacant	Total
3	1	0	1	1	0	1	1	0	1
4	33	0	33	41	0	41	66	0	66
5	2	0	2	3	0	3	4	0	4
6	6	0	6	8	0	8	12	0	12
7	1	18	19	2	22	24	4	33	37
8	0	2	2	14	4	18	25	6	31
9	1	3	4	3	3	6	4	4	8
10	8	36	44	13	48	61	24	74	98
Total	52	59	111	88	76	161	137	116	252

Direction Zambia (– –   Zimbabwe

Vehicle Type	1997			2002			2010		
	Loaded	Vacant	Total	Loaded	Vacant	Total	Loaded	Vacant	Total
3	0	0	0	0	0	0	0	0	0
4	23	0	23	47	0	47	70	0	70
5	2	0	2	2	0	2	3	0	3
6	9	0	9	8	0	8	11	0	11
7	13	2	15	22	2	23	33	4	36
8	2	2	4	4	14	17	6	25	31
9	3	1	4	3	3	6	4	4	8
10	49	4	53	48	13	61	74	24	98
Total	101	9	110	131	30	161	199	56	254

Source : JICA Study team's estimates and forecasts

Vehicle type: 3 : Motorcycle   7 : 2 axle Light Trucks
           4 : Passenger car   8 : 2/3 axle Heavy Truck
           5 : Minibus   9 : 4/5 axle Truck
           6 : Bus   10: 6 or more axle Truck

3 BRIDGE AND ROUTE ALTERNATIVES

The evaluation of alternative routes study was conducted from viewpoint of the technical, environmental and economic aspects. As a result of the study, the Alternative Route-A, 100m upstream of the Otto Beit Bridge, was selected as site for a new bridge construction and improvement of customs facilities.

As a result of bridge alternative study, 3 spans continuous PC box girder bridge was chosen as a best alternative, owing mainly to its cost and contribution to local economy. Preliminary design was conducted with following criteria.

    a)   Number of traffic lanes = 2-Lanes
    b)   Lane width = 3.5 meters
    c)   Shoulder width = 1.0 meter on both sides
    d)   Maintenance walk width = 0.75 on both sides

4 BORDER FACILITIES IMPROVEMENT STUDY

The improvement in the border post facilities and staff requirements will be made depending on the demand increase. However, some amount of investment shall be prepared immediately for improving the existing capacity of the facilities as well as improving the amenity conditions of the staff at border post. Taking into account the above mentioned matters, the following steps are recommended.

a) Initial investment during the three (3) years of construction; 40 % of total investment.

b) Complementary investment until 2010; 60 % of total investment.

Below is a summary of total land area required for necessary improvements of border post facilities for both countries. Stage construction was recommended for the border post facilities, due to huge construction cost.

ELEMENT	Zambia	Zimbabwe
FREIGHT TERMINAL	63,215 m²	61,681 m²
PASSENGER CONTROL BUILDING	13,956 m²	16,224 m²
PEDESTRIAN CONTROL BUILDING	1,025 m²	240 m²
DRUG ENFORCEMENT COMMISSION	928 m²	769 m²
POLICE STATION		820 m²
VEHICLE INSPECTION UNIT AND WEIGH BRIDGE	84 m²	116 m²
KIOSK AND FAST FOOD OUTLET	375 m²	375 m²
PERIMETER FENCING AND GUARDHOUSES	1,785 m²	2,181 m²
Total	81,368 m²	82,406 m²

5 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental impact assessment was made to selected alternative route, which is 100m upstream of the existing bridge. There are no noteworthy environmental problems in these preliminary design results, however, there are some environmental problems and issue during the construction stage which need great attention.

Elements	Negative Impact	Mitigation Measure	Implementation
Soils	Potential for soil erosion.	1. Slopes should be re-vegetated 2. Slopes should be suitably graded.	D/D Stage Construction Stage
Vegetation	Destruction of river edge cliff vegetation	1. The areas to be cleared should be well marked to ensure that the area cleared of vegetation is kept to a minimum.	Site preparation stage
Resettlement	Demolition of police station in Zimbabwe	1. Alternative station must be built	Before demolition
Road Safety	Increased accidents	1. Traffic safety to be enforced by police	After construction
Noise	Noise and vibration	1. Contractor must limit the working hours to daylight hours.	Construction stage
Air Pollution	Increased in the air dust	1. Dust should be controlled with the use of water sprays.	Construction stage
Water Resource	Demolition of water treatment in Zambia	1. Alternative water treatment should be constructed	Before demolition
Water Resource	Demolition of water pipe line in Zimbabwe	1. Alternative water pipe line should be constructed	Before demolition
Water Resource	Risk of water pollution	1. Contractor must submit written details of the procedures.	Construction stage

6 PROJECT COST AND SCHEDULE

Below are summary of total project cost and construction schedule. As shown, the bridge is to be completed in three years and the border post facilities are to be constructed in separate stages.

Project Cost

US$ thousand

	Foreign (US$)	Local (US$)	Total (US$)
1. Direct Cost			
Bridge			
superstructure	3,431	2,236	5,667
substructure	3,751	1,746	5,497
sub total	7,182	3,982	11,164
Access Road	328	391	719
Border Post			
housing	8,616	6,769	15385
buildings	6,356	4,993	11,349
parking area	4,228	5,043	9,271
sub total	19,200	16,805	36,005
Direct Cost Total	26,710	21,178	47,888
2.Contingency(15%)	4007	3177	7,184
Total of 1~2	30,717	24,355	55,072
3.Indirect Cost(25%)	7,049	6,719	13,768
4.Engineering Cost(10%)	3,099	2,408	5,507
5.Land Acquisition	0	0	0
6.Conpensation	0	300	300
Total Project Cost	40,865	33,782	74,647

Project Implementation Schedule

Work Item	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Remarks
Financial Resource Assessment														
Approval of EIA														
Detailed Design														
Contract Preparation														
Bidding/Contract														
Construction														
Bridge														
Border post facilities														
Immigration														stage construction
Customs														for border post
Drug enforcement/ police														facilities
VID/weigh bridge														
Staff housing														

7 ECONOMIC EVALUATION

Taking into account the conditions and characteristics of transportation and traffic, the following four (4) items were identified for benefits of the project.

    a)   Time saving benefits arising from less waiting time at border posts

    b)   Cost savings of heavy trucks for not detouring to Kariba dam

    c)   Vehicle operating cost savings of traffic which are over capacity of the existing bridge.

    d)   Cost required in the "without" case will be regarded as a benefit of the project.

As a result of economic evaluation, economic internal rate of return (EIRR) is estimated as 6.99 %. This value of EIRR is comparatively low compared with other infrastructure projects.

The following benefits can be expected as intangible benefits or social benefits.

    a)   Creation of working opportunities during project implementation period.

    b)   Contribution to the socio economic activities in Chirundu area.

    c)   Elimination of the smuggling and drug trafficking.

    d)   Promotion of the various kinds of developments in the Chirundu area.

8 RECOMMENDATION

(1)   Border Post facilities and bridge structure shall be improved simultaneously in order to maximise the benefits from the project.

(2)   Bridge route of 100 meters upstream from the existing bridge shall be adopted from viewpoints of economical, technical, and environmental aspects.

(3)   Prestressed concrete girder bridge with 2-lanes shall be employed from viewpoints of economy.

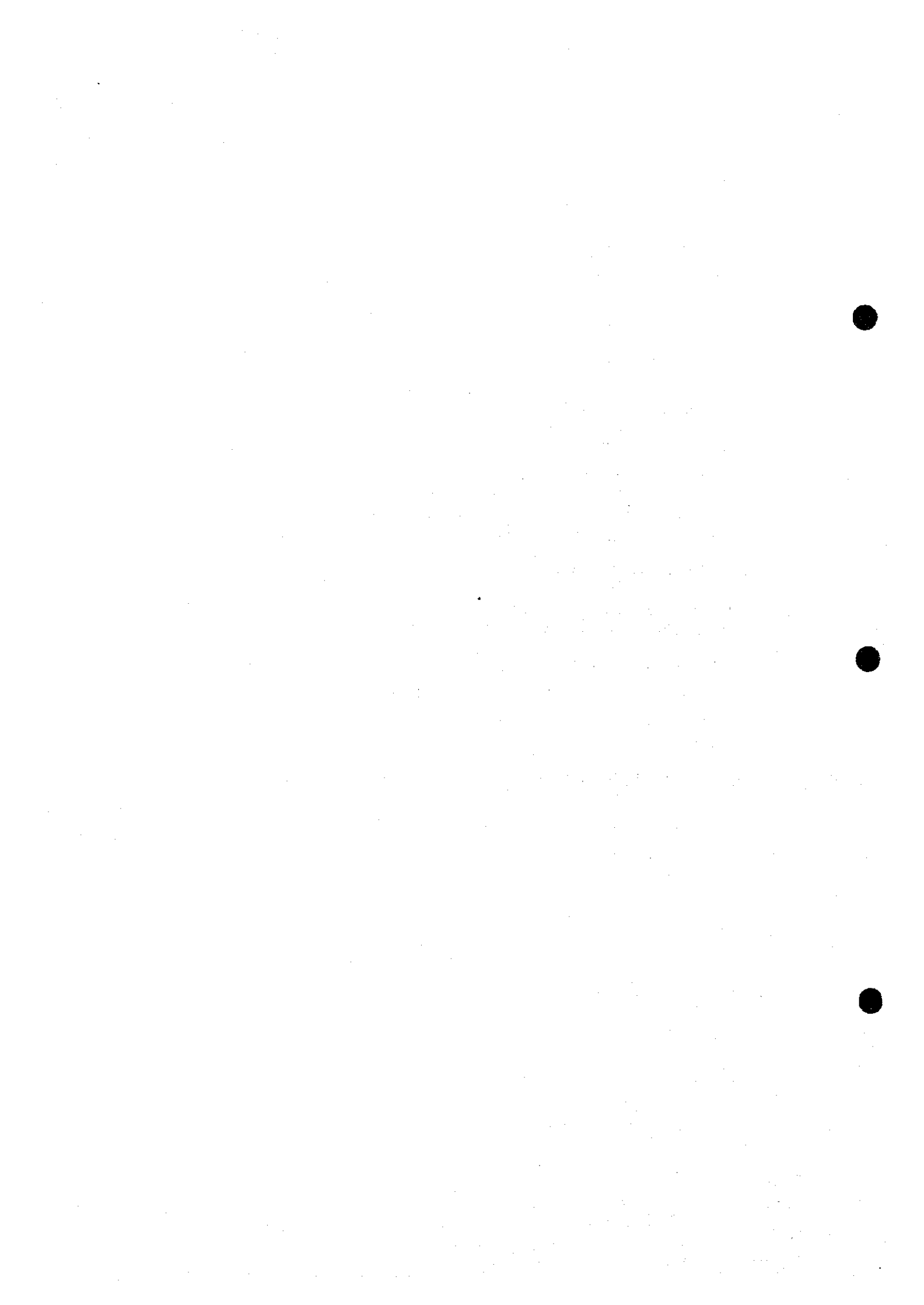(4)   Stage construction for border post facilities shall be considered due to a huge amount of cost.

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List of Abbreviations

ASYCUDA	:	Automated System for Customs Data
CAMPFIRE	:	Communal Areas Management Programme for Indigenous Resources
CSO	:	Central Statistical Office
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
ESP	:	Environmental Support Programme
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
MOTE	:	Ministry of Transport and Energy (of Zimbabwe)
MOWS	:	Ministry of Works and Supply (of Zambia)
Mpa	:	Mega Pascal
NEAP	:	National Environmental Action Plan
ECZ	:	National Environmental Council of Zambia
NGO	:	Non-governmental Organization
OD	:	Origin and Destination
SADC	:	Southern Africa Development Community
SATCC	:	Southern Africa Transport and Communication Committee
SITC	:	Standard International Trade Classification
SPT	:	Standard Penetration Test
TTC	:	Travel Time Cost
VAT	:	Value Added Tax
VOC	:	Vehicle Operating Cost
ZRA	:	Zambian Revenue Authority

1 INTRODUCTION
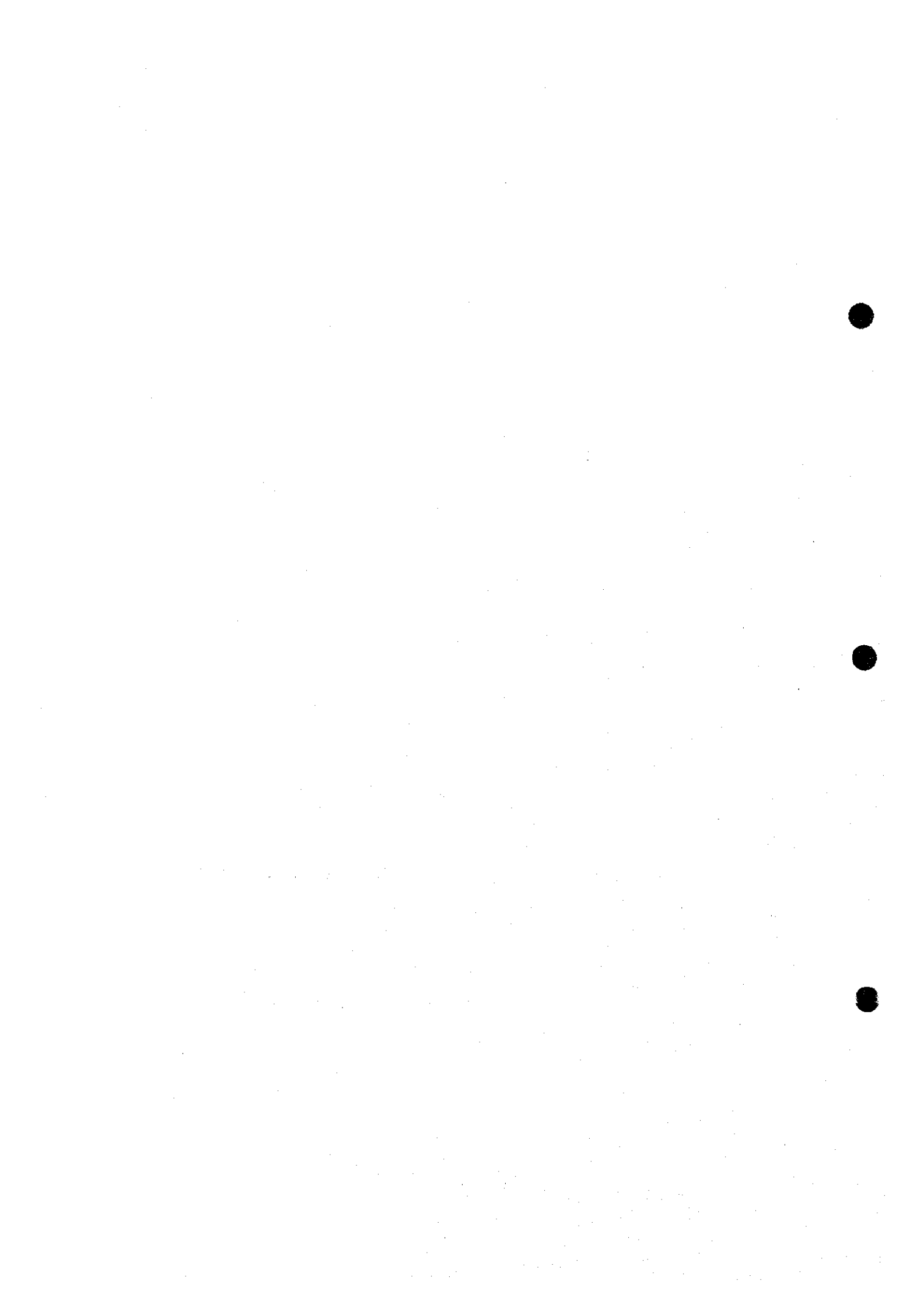
1 INTRODUCTION

1.1. GENERAL

The Chirundu Border Post is located on the trunk road connecting Lusaka of Zambia and Harare of Zimbabwe. This border post is most important border facility between Zambia and Zimbabwe for the movement of people and goods. The border post is composed of several facilities including the bridge over Zambezi River, customs and immigration offices, warehouses, vehicle inspection offices, police offices, clearing agency offices, finance/insurance company offices, etc.

The existing bridge (Otto Beit Bridge) was constructed and opened to traffic in 1939. It has 5.5 m carriageway with 0.9 m sidewalk on both sides. The carriageway width of 5.5 m is insufficient for two lanes traffic movement in both directions, and therefore, the traffic on this bridge is limited to one-way traffic. Only one vehicle is allowed to pass on the Bridge at a time. Vehicle weight limitation of 55 tons is strictly enforced due to the structural capacity of the Bridge.

The facilities at both border posts are opened for traffic passage from 6 a.m. to 6 p.m. Existing total traffic volume is about 200 vehicles per day in both directions. The border post facilities are insufficiently equipped, however, due to the low level of present traffic demand, no major congestion at the border post was observed.

The Governments of Zambia and Zimbabwe requested to the Government of Japan to conduct the Feasibility Study for the construction of a New Bridge over the Zambezi River, including the improvement of the existing border post facilities. Upon this request, Government of Japan, through Japan International Cooperation Agency (JICA), dispatched the Study Team in June 1997 to carry out the necessary studies.

1.2. STUDY OBJECT

The Study aims to examine the feasibility of the improvement of border post facilities as well as the construction of a new bridge at Chirundu. The Study Team carried out comprehensive investigations and studies such as traffic and transport survey and planning, geological and topographical surveys, bridge structure planning and design, customs clearance survey, border post facilities planning and design, environment impact assessment, construction planning and cost estimate, socio-economic evaluation, etc.

1.3. STUDY AREA

Two different levels of Study Area are considered. For the engineering study purpose, the Study Area was limited to the area around the existing Otto Beit Bridge. On the other hand, for the transport and traffic study purpose, the Study Area covered a large part of South African Development Community (SADC) countries. Both Study Areas are indicated in Figure 1.1.
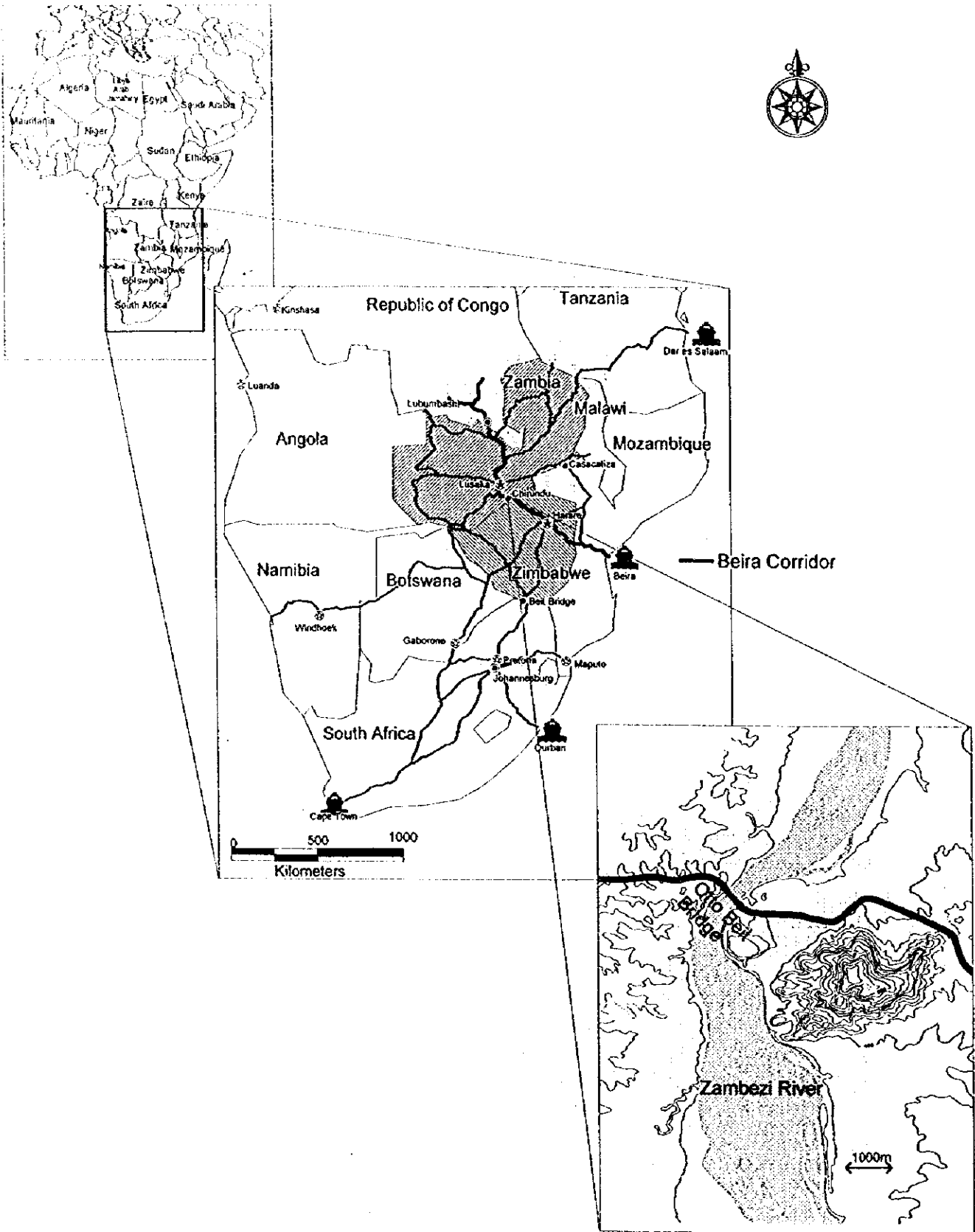
Figure 1.1   Study Area

2 FRAME OF REFERENCE OF THE STUDY AREA

2 FRAME OF REFERENCE OF THE STUDY AREA

2.1. GENERAL

The Project site is located at Chirundu border point in the Zambezi valley between Zambia and Zimbabwe. Chirundu border point is located on the Beira corridor connecting Lusaka, capital city of Zambia, and Harare, capital city of Zimbabwe. This corridor is a part of a major highway network covering Southern Africa countries. Beira corridor has been considered as a vital network of international transportation and many projects have been carried out to improve efficiency (Figure 2.1). Zambia and Zimbabwe are inland countries and their economies depend largely on the land transportation system including road and railway transportation.

Figure 2.1 Projects on Beira Corridor
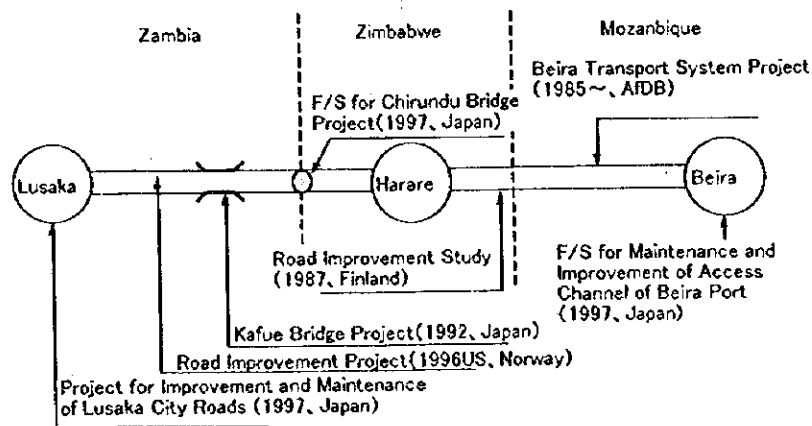
2.2. REPUBLIC OF ZAMBIA

2.2.1. GENERAL

Zambia is located in the center of Southern Africa. It has common borders with eight (8) countries, Tanzania and Republic of Congo in the north, Angola in the west, Namibia, Botswana, Zimbabwe in the south , Mozambique and Malawi in the east.

The climate of Zambia is relatively moderate due to its high altitude except in the low land area such as Zambezi valley. Zambia lies in the Savannah region. There are three seasons: cool dry, hot dry and hot rainy. In the cool dry season from May to August, the temperature is 17 to 22 ℃ and humidity is 40 to 50 % in average. In the hot dry season from September to November, the temperature is 25 to 30 ℃ and humidity is 40 to 69 % in average. In the hot rainy season from December to April, the temperature becomes 26 to 30 ℃ and humidity 70 to 80 % in average. Rainfall amount increases from south to north, and ranges from less than 800 mm to

more than 1200 mm. The land area, is about 753,000 km2 of which about 5 % is close forest without grass and the rest is open forest with grass and grassland/swamp area.

2.2.2. ECONOMIC BACKGROUND

Zambia is one of the low income countries in the world. In 1994, per capita gross national income was estimated at some 350 US$ per annum. Manufacturing sector occupies the primary position in terms of its contribution to GDP, however, the mining sector is still a major source of foreign trade earning (refer to Table 2.1). Textiles, food processing and chemical goods for domestic consumption are major items in manufacture sector. A large part of basic items used for production are imported.

Table 2.1   Gross Domestic Products of Zambia

	1989		1994	
Sector	million Kw	ratio (%)	million Kw	ratio (%)
Agriculture, Forestry and Fishery	425	19.1	392	18.0
Mining	176	7.9	132	6.1
Manufacture	544	24.5	550	25.2
Electronics, Gas and Water Supply	50	2.2	69	3.1
Construction	63	2.8	65	3.0
Trade, Tourism	233	10.5	255	11.7
Transport and Communication	110	4.9	88	4.0
Real Estate, Commercial and Services	193	8.7	197	9.0
Other Services including Public Sector	446	20.1	466	21.3
Others	-15	-0.7	-33	-1.5

Source: Central Static Bureau (1997 current price)

In mining sector, copper is the most important mineral in Zambia. However, its production has been decreasing in the recent decade (refer to Table 2.2). In addition to copper, cobalt, lead and zinc are other important ores for export.

Table 2.2   Export of Copper

Year	1989	1990	1991	1992	1993	1994
Export (1000 ton)	442	460	382	412	437	*361

* : Government Estimate
Source: EIU (Economic Intelligence Unit)

The agricultural land covers about 9 million hectares. But due to the lack of irrigation system and low amount of rainfall, only 20 % of agricultural land is cultivated. Some 75 % of the population is engaged in agriculture sector.

Main food crops produced in Zambia are maize, tobacco, cotton, groundnuts, coffee, tea, sugarcane etc. These are grown as cash crops. The amount of production of these crops depends on weather condition. (Refer to Table 2.3)

Forest covers about 50 % of the total land of the country, most of which is virgin. However, huge amounts of firewood (about 7 million m3) are consumed every year. Although Zambia is landlocked, the country produces a fairly large amount of fish from her lakes, ponds and rivers.

Major fish fields are the lakes of Tanganica, Kariba and Bangweulu and the rivers of Zambezi and Kafue.

Table 2.3   Production of Crops (thousand ton)

Crop Type	1990	1991	1992
Maize	639.6	601.1	464.0
Tobacco	3.3	0.9	3.6
· Cotton	30.7	48.0	27.8
Wheat	51.8	58.9	61.3
Soy beans	22.2	24.4	23.5
Sunflower	18.6	90.5	5.1
Sugarcane	3801.5	-	-

Source : Zambia in Figures, 1992

The population is estimated to be approximately 9.2 million. Table 2.4 shows the growth in population over the period 1980 to 1994. With a land area of 753 thousand km2 this gives a population density of 12.2 persons per square kilometer. Of the total population, approximately 45 % lives in urban areas. In 1994, the population of Lusaka is estimated at about 1.1 million.

Zambia has one of the highest population growth rates in the world. In the 27 years following the census of 1963, the population increased by 234% in 1990. One of the reasons for the rapid increase in population is declining death rates due to better medical care. During the period between 1980 to 1990, the growth rate was calculated at 3.2 %, while the death rate dropped to 1.3 %.

Table 2.4   Population Growth   (unit:1000persons)

Year	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total Population	5,740	6,860	7,100	7,350	7,610	7,870	8,150	8,400	8,650	8,940	9,200
Growth (%)			3.50	3.52	3.54	3.42	3.56	3.07	2.98	3.35	2.91

Source : Central Statistics Office (CSO), Lusaka, 1994-5

2.2.3.   TRANSPORT SECTOR

(1)   Transportation Mode

In Zambia, there are several kinds of transport mode such as road, railway, air transport, and pipeline transports. The percentage of each transportation mode is shown in Table 2.5. About 63 % of total exported goods are transported by road. Also about 63% of total imported goods are transported by road. Also about 63 % of total imported goods are transported by road. The percentage of goods transported by railway were 33 % and 2 % for exports and imports respectively.

(2)   Transportation Network

The major transportation networks in Zambia are road and railway transportation. The railway network in Zambia and surrounding countries is shown in Figure 2.2. As shown in Figure 2.2, railway networks form radial pattern from Lusaka to Tanzania, Lusaka to Zaire, and Lusaka to Zimbabwe and South Africa. Major road networks in Zambia and surrounding countries is also forming radial pattern as shown in Figure 2.3. As shown in Figure 2.3, the major roads are part

of international highway connecting Lusaka to Tanzania (T2 road), Lusaka to Malawi (T4 road), Lusaka to Mozambique (T4 and T6 road), Lusaka to Republic of Congo and Angola (T5 road), and Lusaka to Zimbabwe (T2 road) and South Africa (T1 road). The Chirundu border post is located at the border on the T2 road. The T2 road passes through the city of Harare and connects to the Beira Port in Mozambique.

Table 2.5 Transport of goods by Mode

	Exported Cargo Volume (t)	Imported Cargo volume (t)	Total Cargo Volume (t)
Air Transport	27,485	261,751	289,236
Inland Water Transport	10,274	146	10,420
Mail	60	244	304
Rail Way	326,267	60,397	386,664
Road Way	609,004	1,604,553	2,213,557
Pipeline	--------	635,883	635,883
Total	973,110	2,563,074	3,536,184

Source : CSO, Lusaka, 1994/95

(3) Road Transportation

The road functional classification in Zambia is divided into four (4) categories: Principal Arterial, Minor Arterial, Collectors, and Local Road. Road type is classified into three (3) types, I, II, and III according to the design speed. The total road length by pavement type in Zambia is shown in Table 2.6, and the number of vehicles registered in 1995 in the whole country is shown in Table 2.7.

Table 2.6 Road Length by Pavement Type in Zambia

	Paved Road Length(km)	Gravel Road Length(km)	Earth Road Length(km)	Other Road Length(km)
Total Road Length	6,476	2,260	28,025	30,000
Good Condition(%)	30	40	30	------
Normal Condition(%)	30	40	20	------
Bad Condition(%)	30	20	50	------

Source : CSO, Lusaka, 1994/95

Table 2.7 Number of vehicle registered in 1995 in Zambia

Type of Vehicle	Number
Passenger Car	90,000
Bus and Min Bus	4,500
Truck	7,000
Small Truck	22,000
Total	129,000

Source : CSO, Lusaka, 1994/95
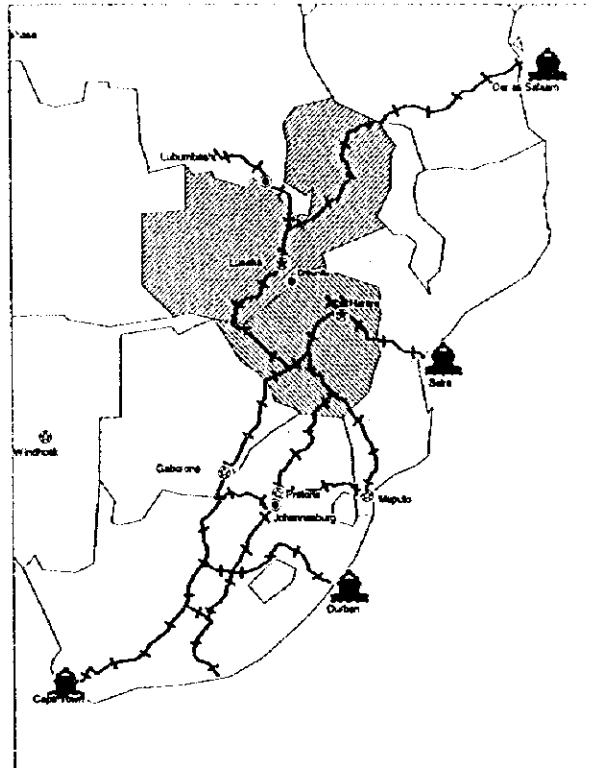
Figure 2.2   Railway Network in Zambia and Surrounding Countries.
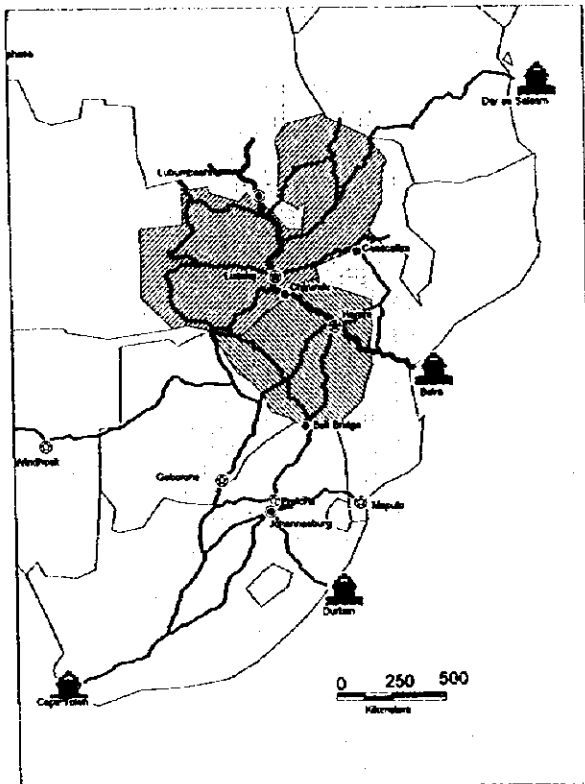
From Lusaka to	Distance (km)
Port of Dar es Salaam	1,890
Beira Port via Harare	990
Beira Port via Casacatiza	1,240
Beit Bridge via Harare	1,070
Beit Bridge via Victoria Falls	1,120
Maputo Port via Harare, Beit Bridge	2,070

Figure 2.3   Road Network in Zambia and Surrounding Countries

2.3. REPUBLIC OF ZIMBABWE

2.3.1. GENERAL

Zimbabwe is located in the mid-eastern part of Southern Africa. It has common borders with four (4) countries, Zambia in the north, Botswana in the west, South Africa in the south, and Mozambique in the east.

The climate of Zimbabwe is relatively moderate due to its high altitude except in the low land area such as Zambezi valley. Zimbabwe lies in the Savannah region. There are three seasons: Cool dry, hot dry and hot rainy. In the cool dry season from May to August, the temperature is 17 to 22 °C and humidity is 40 to 50 % in average. In the hot dry season from September to November, the temperature is 25 to 30 °C and humidity is 40 to 69 % in average. In the hot rainy season from December to April, the temperature becomes 26 to 30 °C and humidity 70 to 80 % in average. Rainfall amount increases from south to north, and ranges from less than 400 mm to more than 1200 mm. The land area, is about 391,000 km2 of which about 5 % is dense forest without grass and the rest is open forest with grass and grassland/swamp area.

2.3.2. ECONOMIC BACKGROUND

Zimbabwe is one of the low income countries in the world. In 1994, per capita gross national income was estimated at some 500 US$ per annum. Manufacturing sector occupies the primary position in terms of its contribution to GDP, however, agriculture and mining sectors are still major sources of foreign trade earning (refer to Table 2.8). Textile, food processing and transport equipment are major ones in manufacture sector.

Table 2.8 Gross Domestic Products of Zimbabwe

Sector	1991		1994	
	million Zw$	ratio (%)	million Zw$	ratio (%)
Agriculture, Forestry and Fishery	2,559	11.4	6,450	13.6
Mining	1,616	7.2	3,415	7.2
Manufacture	5,656	25.2	10,861	22.9
Electronics, Gas and Water Supply	673	3.0	1,281	2.7
Construction	292	1.3	854	1.8
Banking, Insurance	1,414	6.3	2,751	5.8
Commercial, Tourism	2,581	11.5	5,075	10.4
Transport and Communication	1,414	6.3	2,893	6.1
Public Sector	4,713	21.0	10,623	22.4
Others	1,525	6.7	3,223	7.7

Source: Central Bank of Zimbabwe (1996 current price)

Most of the agricultural land receives rain fall (more than 900 mm per annum), some 7 thousand km2 is used for afforestation and production of fruit and intensive livestock. In frost-free area, tea, coffee, macadamia nuts and other plantation crops are harvested. Some 59 thousand km2 having rain fall of 750 to 1000 mm per annum is cultivated for crops and intensive livestock production. About 73 thousand km2 of land having 650 to 800 mm rain fall

per annum is cultivated for livestock production with fodder crops and cash crops. Main food crops produced in Zimbabwe are maize, sorghum and wheat. Tobacco, cotton, groundnuts, coffee, tea, sugarcane, soybeans and etc. are grown as cash crops. The amount of production of these crops is influenced by weather conditions. (Refer to Table 2.9 for Crop Production)

Table 2.9   Production of Crops (thousand ton)

Crop Type	1991	1992	1993	1994	1995	1996
Maize	779.2	605.9	12.6	1349.9	1171.1	84.8
Wheat	322.9	259..3	56.9	276.4	20.3.3	2.3
Cotton	183.3	200.1	59.9	204.9	178.9	84.3
Tobacco	139.8	178.6	210.7	235.2	177.8	208.9
Coffee	13.6	12.1	5.0	0.1	0.1	0.1
Sago	102.2	111.5	30.6	3.2	0.4	20.9

Source : Quarterly Digest of Statistics.1997

In mining sector, asbestos, gold, chrome, nickel and copper are the major minerals in Zimbabwe. Production of minerals saw fluctuation in last decade (refer to Table 2.10).

Table 2.10   Production of Minerals (ton)

Year	1990	1991	1992	1993	1994	1995
Asbestos	160.5	141.8	150.0	157.0	152.0	169.7
Gold	544	574	587	598	660	770
Chrome	562.6	566.2	525.6	2	516.4	707.5
Nickel	11442	11312	10715	11889	13518	10863
Copper	14.8	13.8	9.6	8.1	9.3	8.1

Source : Quarterly Digest of Statistics.1997

The population is estimated to be approximately 10.8 million. Table 2.11 shows the growth in population over the period 1960 to 1994. With a land area of 391 thousand km2 this gives a population density of 27.6 persons per square kilometer. Of the total population, approximately 30 % lives in urban areas. In 1994, the population of Harare is estimated at about 0.75 million.

Table 2.11   Population Growth

Year	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total Population	7130	8390	8670	8970	9270	9580	9900	10160	10430	10740	11000
Growth (%)			3.34	3.46	3.34	3.34	3.34	2.63	2.66	2.97	2.42

Source :CSO, 1995

2.3.3. TRANSPORT SECTOR

(1) Transport Network in Zimbabwe

1) Railway Network

As shown in Figure 2.2, there are five (5) routes of railway network in Zimbabwe. They all start in Harare and connect to Beira, to Lusaka via Livingstone, to Gaborone, to Johannesburg, and to Maputo.

In 1989, the percentage of transport of cargo by railway represented about 79 % of total cargo, however, the percentage of cargo transport by railway has been decreasing year by year due to increasing vehicle transport. The percentage of railway transport in1993 is about 53 %.

2) Road Network

As shown in Figure 2.3, the road network in Zimbabwe is formed as radial road network pattern with the city of Harare as the focal point. There are five national radial roads in the city of Harare: National Road No.901, 202, 203, 304, and 905. The National road No.901 goes to Lusaka in Zambia passing through Chirundu border post. National road 202 goes to the Beira Port in Mozambique.

(2) Road Transport

The road functional classification in Zimbabwe is divided into three categories: Primary road, Secondary road, and Feeder road. There are six (6) road maintenance classifications are adopted by different responsible organizations for road maintenance. The road length of each road maintenance classification is shown in Table 2.12.

Table 2.12 Road Length by Maintenance Classification   unit: km

	National Road	Provincial Road	Local Road	City Road	District Road	Park Road	Total
Paved Road > 2-Lane	966	0	0	70	0	0	1,039
Paved Road=2-Lane	5,575	0	140	3,326	0	0	9,041
Paved Road=1-Lane	1,720	0	1,615	730	0	0	4,073
Gravel Road	6,445	16,993	19,786	1,153	2,593	9,000	55,970
Earth Road	3,728	13,828	0	0	3,407	0	20,958
Total	18,434	30,816	21,541	5,287	6,000	9,000	91,078

2.3.4. ROAD IMPROVEMENT PLANS IN SADC

(1) Planned Projects

In 1996, SADC is planning several road improvements as its Program of Action. According to this program, the following major road improvement programs are identified within the SADC countries. Figure 2.3 illustrates the location of each project.

A) Dar Salaam Port Transport System
    a)   Balaka-Salima- Karonga- Uyore Road Improvement Plan.
    b)   Morogoro- Iringa- Mbeta- Dar Salaam Road Improvement Plan
    c)   Kapiri Mposhi- Nakonde Road Improvement Plan
B) Nacara Port Transport System
    a)   Mangochi- Mandimba-Mitande Road Improvement Plan
    b)   Lusaka- Chipata Road Improvement Plan
C) Beira Port Transport System
    a)   Beira- Machipanda Road Improvement Plan
    b)   Harare- Mutare Road Improvement Plan
D) Maputo Port Transport System
    a)   Mohale' s Hoek- Quthig- Qacha' s Nek Road Improvement Plan
    b)   Taung- Mokhotlong- Sani Top Road Improvement Plan
    c)   Ramabanta- Semonkong- Sekake Road Improvement Plan
    d)   Morokhatlong- Oxbow Road Improvement Plan
    e)   Maputo- Swaziland Road Improvement Plan
    f)   Chicualacuala- Chokwe- Manhika Road Improvement Plan
    g)   Mbabane- Manzini Road Improvement Plan
    h)   Rutenga- Boli- Sango.Road Improvement Plan
E) Lobito Port Transport System
    a)   Benguela- Lobito Road Improvement Plan

(2) Relation between Chirundu Bridge Project and SADC Project

The Chirundu Bridge Project is located on the existing Beira Corridor at the Chirundu border point. The Beira Corridor is very important road connecting Beira port of Mozambique to Lusaka of Zambia via Harare, Zimbabwe. The improvement of the Beira corridor will contribute to the economic growth among these countries. The Beira Port Transport System will be strengthened by the Chirundu Bridge Project.
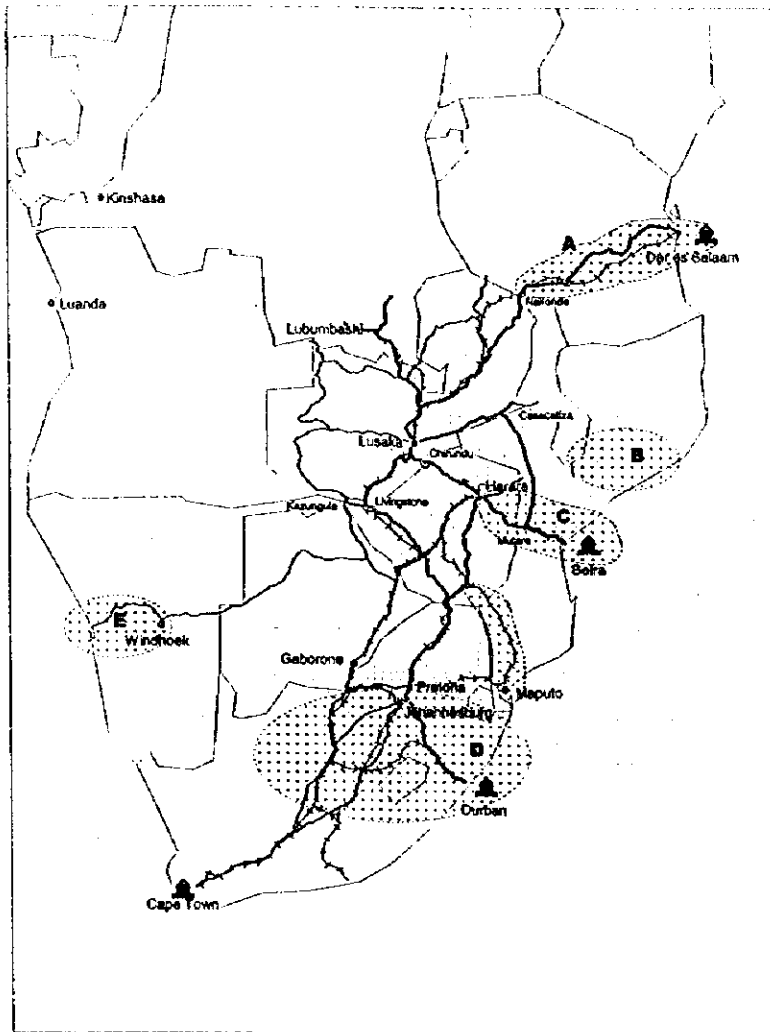
Figure 2.4   Locations of Projects

3 TRAFFIC DEMAND FORECAST
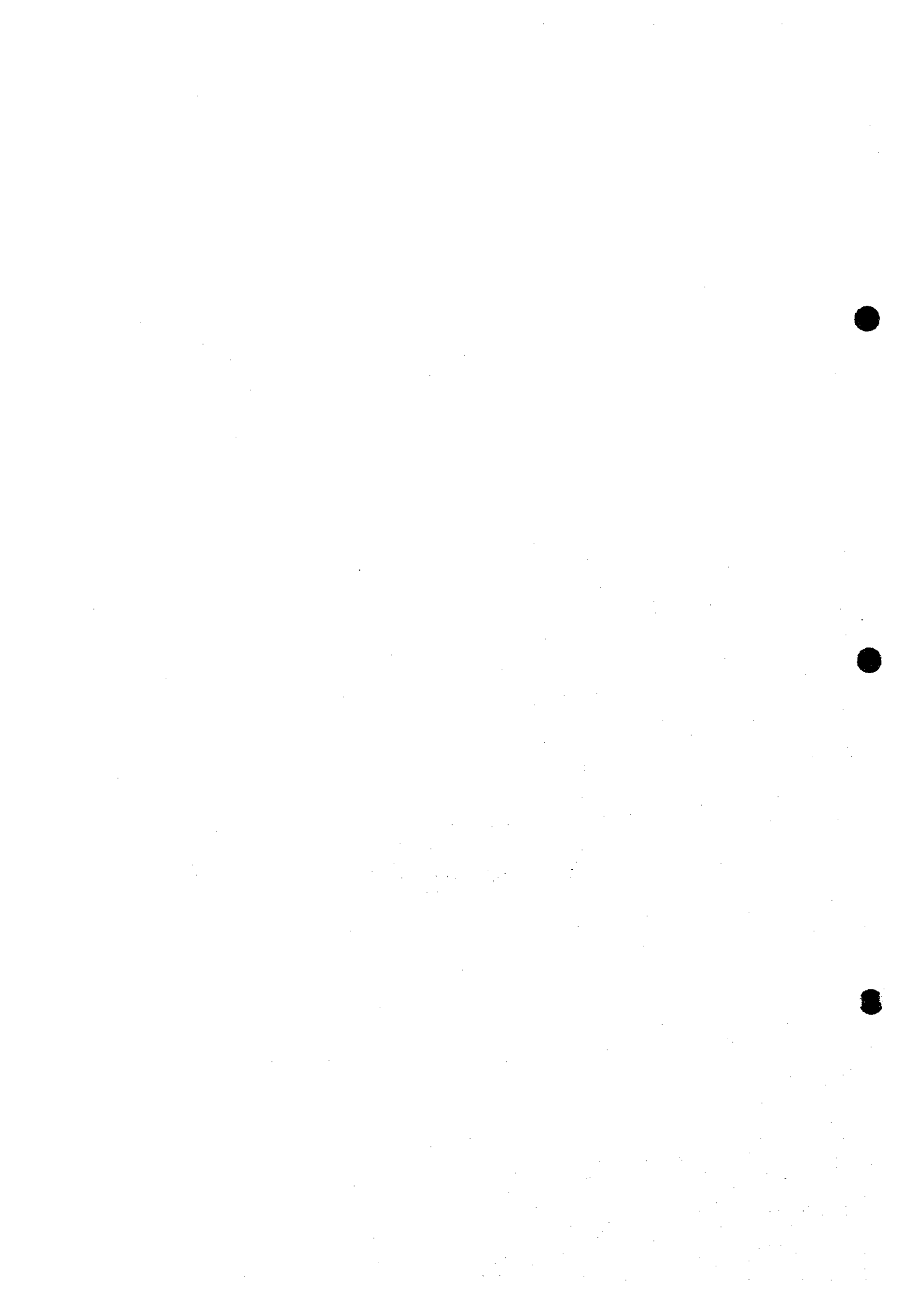
3 TRAFFIC DEMAND FORECAST

3.1. GENERAL

3.1.1. OBJECTIVE OF THE WORK

The objective of the work presented in this chapter is to forecast the traffic demand by vehicle types which will be induced by transportation of international cargoes and passengers at Chirundu Border post up to the year 2010.

3.1.2. STANCE OF THE FORECASTING

(1) Basic recognition on basic determinant factors of future vehicle traffic volumes by vehicle types which will use Chirundu Border Post at regional level.

The study team has adopted the following basic recognition which has been formed after rough analysis of the information and data relating to the forecast. The future vehicle traffic volume will be induced from transportation of both international cargoes and passengers through Chirundu Border Post.

a) The Chirundu route is one of the indispensable routes for transportation of cargoes not suitable for air and railway transportation, and

b) The effect from the cargoes on custom clearance work is larger than the one from the passengers. The study team thought that a large part of its efforts needed to be concentrated on analysis and forecast of the international cargoes. As shown in Table 3.4, not only the international cargoes with origin/destination in Zambia but also the transit cargoes (cargoes whose origin and destination are not Zambia) are transported through Chirundu Border post. The cargoes to Zambia represented 54% of the total cargoes volume and the cargoes from Zambia represented 16% of the total transported through Chirundu Border post in 1996. The volume of exports from Zambia reflects the existing unfavourable transportation circumstances on the Chirundu route (Lusaka - (Chirundu) - Beira/Mozambique). The route is expected to play a main role in the transportation between Zambia and Beira international seaport. The present and future situation of usage of the Chirundu route led the study team to make the forecast pivoting Zambia. Based on the following reasons, basic-functions which will determine the future volumes of the international cargoes from / to Zambia can be pointed out.

Determinant factor of the volume of Exports from Zambia	Future supply of export commodities of Zambia against international competitive power
Determinant factor of the volume of Imports to Zambia	Future purchasing power of Zambia for import commodity which is largely affected by the above mentioned future supplying power.

The reasons are;

a) The merchandise exports from Zambia in US dollar basis has stagnated, while the merchandise imports of Zambia had grown at rate of 7.5% per annum during the first half of 1990's, (but, the import rate for period from 1992 to 1995 was △0.6% per annum.)

b) The past and future economic situation in Zambia which will be presented 3.3.2 (1).

c) The volume of the exports are relatively small compared to the scale of the markets, except the copper products. This implies that the volumes will not be affected by the scale of the markets, on condition that the export commodities have an international competitive power.

(2) Features which will affect the future cargo volume from/to Zambia transported through Chirundu route.

The Study Team assumes that the following four (4) factors which will affect the future cargo volume from/to Zambia transported through the Chirundu route;

a) Future economic development of Zambia

b) Future railway transportation in Zambia

c) Future promotion of the free-trade among SADC countries, and

d) Potential advantages of the Chirundu route compared with other competitive routes

The first factor determines the future scale of the international cargo volumes of Zambia, the second factor determines the future volumes which will be transported by roads, the third factor affects the future cargo volumes among the given origin-destination pairs (O-D pairs), and the fourth factor works as an amplification factor of the cargo volumes transported via the Chirundu route through shift in the transportation route from the ones which are now used.

3.1.3. PRINCIPLE DATA AND INFORMATION UTILIZED FOR THE FORECASTS

Various kinds of data and information are necessary for forecasting the vehicle traffic volume at Chirundu Border Post (refer to Table 3.1). The following data and information which have been obtained by the study team will facilitate the forecasting.

Table 3.1   Data and Information for Forecasting

Objective of Usage	Data and Information (sources)	Reasons of Usage
Estimation of the cargo volume from / to Zambia by SITC in 1995	Zambia trade statistics (sources) (1995* and 1993*)	
	Zambia prospect for Sustainable Growth 1995·2005*	For checking of the Zambia trade Statistics
	World Bank Zambia Trade Statistics (1995*)	For estimation of prices by subclassified commodities
Cargo Volumes Transported by Zambia Railways by SITC in 1995	Zambia Railway statistics (1995*)	
Cargo Volumes Transported by Roads by commodities and Vehicle Traffic by vehicle types by Border in 1996	Border Post Surveys (1996 *), SATCC	The survey covers the data at eight (8) Zambia and Zimbabwe Border Posts including Chirundu Border Post
Past and forecast of Zambia Economic Macroframe and Industrial Development Plans	Zambia Prospects for Sustainable Growth 1995-2005* World Bank	Non of other document provides the forecast and the W. B. Report provides reliable data on the Macroframe.

Note: The year with asterisk indicates the year of the date, not the year of publication of the sources.

Along with the above-mentioned data and information, the following are also referred to and/or used for estimating same types of unit values.

a)   Macro frame data presented in Central Statistic Office of Zambia and Zimbabwe

b)   Statistics of National railway of Zimbabwe and corporate plans of railway companies of Zambia and Zimbabwe.

c)   Border post surveys in 1997, especially at Chirundu and Beit Bridge, JICA study team

d)   Data and information published by SATCC, and

e)   Documents of Beira Corridor development Conference in 1997,

The basic data for the forecasting contain problems as pointed below:

a) Survey areal coverage: For example, only the Chirundu Border Post survey is not sufficient for the forecasting as discussed in the previous section

b) Accuracy of data   There exist some discrepancies among various accounts and over-estimation of figures in field of the Zambia National Accounts as the World Bank pointed out. There are some survey and data input mistakes even in the Border Post Surveys Data provided by SATCC.

c) Representativeness of the observed data   The Border Post Surveys by SATCC are the result of one week survey, and the study team survey is for five days. The results are supposed to be a effected by the survey period and timing, and the social and economic factors in Zambia at the time. Accordingly, one must be very careful in estimating an annual average figure based on the observed data.

d) Classification of data   Classification of commodities adopted in the External Trade Statistics (Standard International Trade Classification (SITC)) is different from those used at Border post surveys. None of the data at sub-classified level was able to be correlated.

In order to supplement the unavailable sub-classified data necessary for the forecasting and overcome the problems on the basic data, many kinds of the JICA study Team's estimates and suppositions are introduced. They seem, in turn, to give a great influence on the final estimation.

3.2. EXISTING TRAFFIC AND TRANSPORT CONDITIONS

3.2.1. PAST TREND OF TRAFFIC AT CHIRUNDU BORDER POST

As shown in Table 3.2, the daily vehicle traffic at Chirundu Border Post has increased since 1985. The estimated traffic (by adopting one-direction linear equation with most least square root method) increases by 12.2 vehicles each year, i.e. 7.5% per annum during the period from 1985 to 1997. The following transportation circumstances are supposed to indicate the annual fluctuation of the vehicle traffic compered to the estimated trend beside the effect from seasonal factors of the transportation. This is base on the assumption that a large portion of the traffic consists of the ones from/to Zambia:

a) Exogenous circumstances such as the drought which occurred in 1992, and

b) Circumstances caused by the Zambia economic situation

The peak observed in 1991 and 1992 is supposed to be brought about by extra demands on cereals caused by the drought and a cooled demand mind of the Zambia people which had been basically caused by the Zambia economic policy, while the valley during the period from 1994 to 1996, indicates a reverse-direction demand mind which seems to reflect correctly the Zambian economic situation.

In reality, the vehicle traffic has increased in spite of the minus economic growth of Zambia since 1990. The increase can not be completely explained only from the viewpoint of Zambia people's purchasing power, and the exogenous factor and situation of the people's mind. However, the Study team assumes that the future vehicle traffic, in other words, the future international cargo volume transported through Chirundu Border Post, will be strictly controlled by the economic factor in Zambia and the industrial development plans in Zambia.

Table 3.2   Past Trend of Vehicle Traffic at Chirundu Border Post

Unit: vehicles/day

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Out	36	37	55	82	66	65	111	104	86	90	NA	82	137
In	34	49	56	63	69	61	103	118	93	102	NA	81	119
Total	70	86	111	145	135	126	214	222	179	192	NA	163	256

Out: Outbound from Zambia   1996 is result from SATCC survey
In: Inbound to Zambia   1997 is result from JICA survey

3.2.2. TRAFFIC SURVEY RESULTS

(1) Traffic surveys

The study team used the following traffic survey results for forecasting the vehicle traffic at Chirundu Border Post:

- a) Border Post Survey in 1996, SATCC
- b) Border Post Survey in 1997, JICA Study Team
- c) Annual Vehicle Traffic Survey at Chirundu Border Post, Zimbabwe

The Border Post Surveys in 1996 carried out by SATCC cover international cargo volumes by OD pairs and vehicle types and other survey items. The surveys were conducted for one week (seven days) during the period from February to June 1996 at 63 border points in SADC countries. The Study Team utilised the results at eight border posts (5 Zambian, 3 Zimbabwean) which were selected from the following viewpoints;

- a) Movement of the international cargo from/to Zambia can be roughly identified, and
- b) Characteristics of the movement at Chirundu Border Post can be imaged through comparison with the other Border Posts.

The surveys carried out by the JICA study team in July, 1997 cover same kinds of survey items as the ones of the surveys done by SATCC. However, survey period is five days and the survey points at Chirundu, Beit Bridge (Zimbabwe-SA), and Forbes (Zimbabwe-Mozambique). Only total vehicle traffic is provided through the third survey.

(2) Situation of the Traffic in 1996

The figures which are summarised from the Border Post Survey results carried out by SATCC are presented hereinafter. The locations of the principal border posts are depicted in Figure 3.2.

1) Transportation of the international cargoes between Zambia and her principal external trade counterparts

In Table 3.3, the cargo volumes by the principal counterparts, exports and imports, and Border Posts are summarized. Characteristics of the situation are as follows:

a) In case of the external trade of Zambia from/to rest of the world (countries excluding SADC and other African countries), the Lusaka-Nakonde-Dar es Salaam route is still most important, followed by the Lusaka-Beira route, though the volume through the former has a tendency of relative decrease and the one through the latter has reverse tendency.

b) For the transportation between Zambia and Mozambique/Beira, the Chirundu route, the shortest route, is not used at present. The Cassacatiza route, which is around 250km longer than the Chirundu route is used.

c) For the transportation between Zambia and South Africa/Zimbabwe, there exist three routes; Kazungula route, Chirundu/Victoria Falls-Beit Bridge route and Chirundu/Victoria Falls route.

Table 3.3   Transportation of International Cargoes between Zambia and Her Principal External Trade Counterparts in 1996

1. Zambia ◄···► Rest of the World (Unit : ton / week)
   A. Export from Zambia

Through International Seaports	Through Border Posts	Volume
Beira	- Cassacatiza	1,043
	- Forbes (Mutare)	109
	Subtotal	1,152
Dar es Salaam	- Nakonde	1,096
Durban	- Beitbridge	65
	Total	2,313

   B. Imports of Zambia

Beira		
	- Cassacatiza	827
	- Forbes (Mutare)	86
	Subtotal	1,032

2. Zambia ◄ · ► South Africa
   A. Exports from Zambia

	Through Border Posts	Volume
	- Kazungula	368
	- Beit bridge	1,058
	Total	1,426

   B. Impors of Zambia

	- Kazungula	1,300
	- Beit bridge	1,999
	Total	3,299

3. Zambia ◄ - ► Zimbabwe
   A. Exports from Zambia

- Chirundu	632
- Victoria Falls	N.A
Total	632

   B. Imports of Zambia

- Chirundu	3,018
- Victoria Falls	N.A
Total	3,018

4. Zambia ◄ --► Mozambique
   A. Exports from Zambia

- Cassacatiza	50
- Forbes (Mutare)	0
Total	50

   B. Imports of Zambia

- Cassacatiza	40
- Forbes (Mutare)	0
Total	40

Source: JICA Study Team calculations based on the results of
" Border Post Surveys " carried out by Southern African
Transport and Communications Commission (SATCC).
The survey period (one week) are :

Beit bridge	:	February,1996
Cassacatiza	:	April,1996
Kazungula	:	May.1996
Chirundu	:	ditto
Nakonde	:	ditto
Victoria Balls	:	ditto
Forbes(Mutare)	:	ditto

2) Transportation of the international cargoes and passengers at Chirundu Border Post in 1997

OD table of the international cargoes observed for one week in May 1996 at Chirundu Border Post is presented in Table 3.4, the OD table of the international passengers in Table 3.5, and the OD table of the vehicle in Table 3.6.

Cargo volume between Zambia and South Africa/Zimbabwe represents 70% of the total cargo volume which were transported through Chirundu border post, while the transit cargoes (between South Africa/Zimbabwe and other countries) represent the remaining 30%.

The international passengers between Zambia and South Africa/Zimbabwe represent 95% of the total, and the OD pairs are almost correspondent with the ones of the international cargoes.

Table 3.4   International Cargo Volumes at Chirundu Border Post
- May, 1996 -

(unit;ton/week)

From	OD 01	OD 02	OD 03	OD 04	OD 05	OD 06	OD 07	OD 08	OD 09	OD 10	OD 11	OD 12	OD 13	OD 14	OD 15	Total
OD 01		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OD 02	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
OD 03	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
OD 04	0	0	0		0	0	93	0	0	0	0	0	34	0	0	127
OD 05	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
OD 06	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
OD 07	0	0	0	5	0	0		0	0	0	0	1,822	0	0	1,287	3,114
OD 08	0	0	0	0	0	0	0		0	0	0	102	35	0	59	196
OD 09	0	0	0	0	0	0	0	0		0	0	0	0	0	22	22
OD 10	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
OD 11	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
OD 12	0	0	0	0	0	0	801	30	0	0	0		632	0	27	1,490
OD 13	0	0	0	84	0	0	82	0	0	0	0	3,018		0	671	3,855
OD 14	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
OD 15	0	0	0	0	0	0	242	55	0	0	0	35	55	0		387
Total	0	0	0	89	0	0	1,218	85	0	0	0	4,977	756	0	2,066	9,191

Source: JICA Study Team calculation based on results of the Border Post Surveys carried out by SATCC.
Survey period;   one week, May 1996

Legend: OD01: Angola
         OD02: Botswana
         OD03: Lesotho & Swaziland
         OD04: Malawi
         OD05: Mozambique
         OD06: Beira
         OD07: South Africa
         OD08: Durban
         OD09: Cape town
         OD10   Tanzania

         OD11: Dares Salaam
         OD12: Zambia
         OD13: Zimbabwe
         OD14: Republic of Congo, but it is included in OD15(Others)
         OD15: Others

Table 3.5　International Passengers at Chirundu Border Post　(passenger/week)

From	OD 01	OD 02	OD 03	OD 04	OD 05	OD 06	OD 07	OD 08	OD 09	OD 10	OD 11	OD 12	OD 13	OD 14	OD 15	Total
OD 01		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OD 02	0		0	1	0	0	0	0	0	0	0	15	0	0	0	16
OD 03	0	0		0	0	0	0	0	0	0	0	8	0	0	0	8
OD 04	0	0	0		0	0	2	0	0	0	0	0	48	0	0	50
OD 05	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
OD 06	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
OD 07	0	0	0	5	0	0		0	0	0	2	60	0	0	7	74
OD 08	0	0	0	0	0	0	0		0	0	0	8	0	0	0	8
OD 09	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
OD 10	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
OD 11	0	0	0	0	0	0	2	0	0	0		0	0	0	0	2
OD 12	0	6	0	0	0	0	45	0	1	0	0		2,098	0	7	2,157
OD 13	0	0	0	23	0	0	0	0	0	0	0	1,755		0	46	1,824
OD 14	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
OD 15	0	0	0	0	0	1	4	0	0	0	0	2	17	0		24
Total	0	6	0	29	0	1	53	0	1	0	2	1,848	2,163	0	60	4,163

Source & Legend : see Table 3.4

Table 3.6　Vehicle OD at Chirundu Border Post (vehicle/week)

From	OD01	OD02	OD03	OD04	OD05	OD06	OD07	OD08	OD09	OD10	OD11	OD12	OD13	OD14	OD15	Total
OD01		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OD02	0		0	1	0	0	0	0	0	0	0	5	0	0	0	6
OD03	0	0		0	0	0	0	0	0	0	0	3	0	0	0	3
OD04	0	0	0		0	0	5	0	0	0	0	0	3	0	0	8
OD05	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
OD06	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
OD07	0	0	0	3	0	0		0	0	0	1	104	0	0	53	161
OD08	0	0	0	0	0	0	0		0	0	0	9	1	0	2	12
OD09	0	0	0	0	0	0	0	0		0	0	0	0	0	1	1
OD10	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
OD11	0	0	0	0	0	0	1	0	0	0		0	0	0	0	1
OD12	0	3	0	0	0	0	52	1	1	0	0		188	0	3	248
OD13	0	0	0	4	0	0	2	0	0	0	0	262		0	28	296
OD14	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
OD15	0	0	0	0	0	1	13	2	0	0	0	4	11	0		31
Total	0	3	0	8	0	1	73	3	1	0	1	387	203	0	87	767

Source & Legend : see Table 3.4
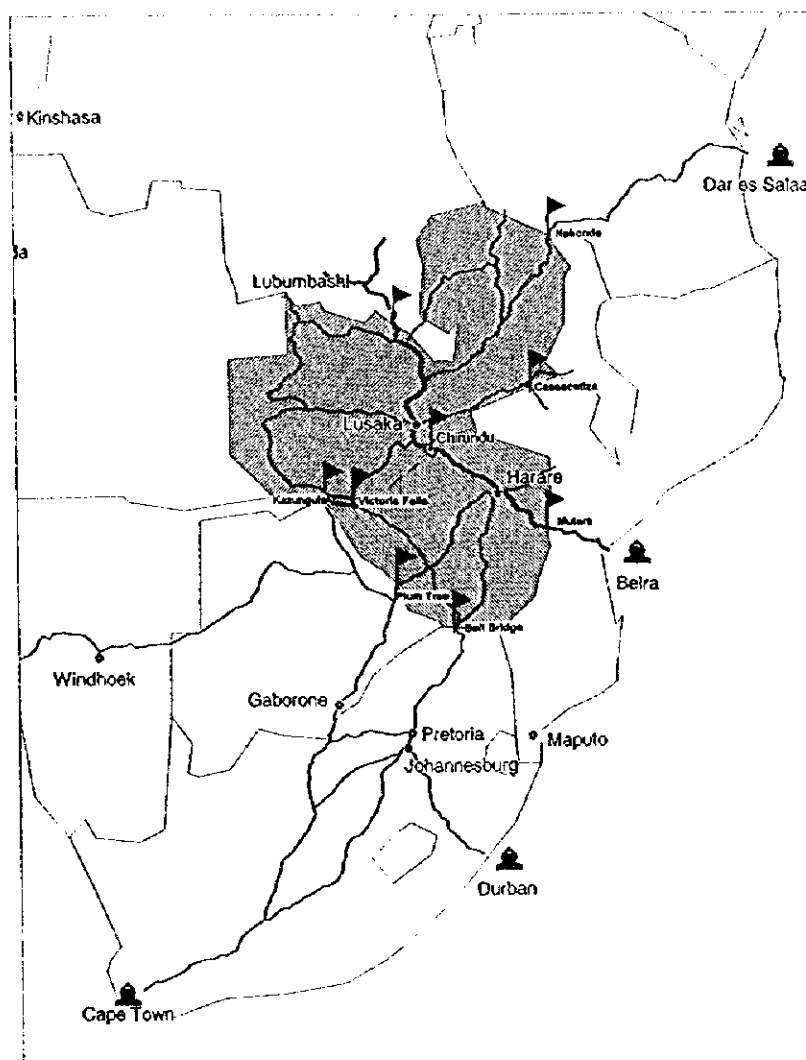
Figure 3.1   Location of Principal Border Posts

(3)   Representative average daily vehicle traffic at Chirundu Border Post in 1997

Table 3.7 shows the vehicle traffic observed for five days in July, 1997 at Chirundu Border Post. The average daily vehicle traffic calculated based on the survey results is around 260 vehicles in both directions which increased by around 50% from the volume in 1996 (170 vehicles) calculated based on the SATCC Border Post Surveys. As mentioned before, the figures seem to be affected by the seasonal factors during the survey period as well as by the economic and social situation in Zambia and the neighbouring countries.

The study team did not adopt the results in 1997 itself as a basic figure for the forecasting because the Study Team judged that the increase is too large, though the same situation can be observed between 1990 and 1991. The vehicle traffic actually adopted as the base in 1997 is shown in Table 3.21.

(4) Implication from the traffic survey results

The traffic survey results have the following implications:

a) There are two types of international routes for the transportation of the international cargoes from/to Zambia selected from the following view points;

i) Routes which have been selected from the standpoint of locations of the markets of Zambia products and supplies to Zambia in the neighbouring countries, have also satisfied a condition of the transportation efficiency, and will not be diverted to other routes in future. Among these routes (a) are: the Kazungula route (Zambia - SA), the Chirundu/Victoria Falls Beit Bridge route (Zambia - SA), the Chirundu route (Zambia - Zimbabwe) can be enumerated.

ii) Routes which are currently used, but may be diverted to other routes when transportation circumstances on the other routes are improved. Among these route (b), there may exist two groups; the first group consists of the Lusaka - (Nakonde) - Dar es Salaam, Lusaka - (Cassacatiza/Chirundu) - Beira/Mozambique, and Lusaka - (Chirundu/Victoria Falls - Beit Bridge) - Maputo/Durban Routes. The second group encompasses the Lusaka - (Chirundu) - Beira/Mozambique and the Lusaka - (Cassacatiza) - Beira/Mozambique routes. These routes relate to the transportation of cargoes between Zambia and rest of the world. As shown in Table 3.8, the Lusaka - (Chirundu) - Beira route is the shortest route to the international seaports among the above mentioned routes, though the route is not fully utilised at present. When transportation circumstances are improved, especially on the Lusaka - (Chirundu) - Beira route (the Beira Corridor), e.g. expansion/ improvement of Beira seaport, improvement of road condition, simplification of customs clearance procedures, it can be expected that the Chirundu route be mainly used for the transportation of the cargoes between Zambia and rest of the world.

b) Two types of the international cargoes of Zambia are now transported through the Chirundu route; the cargo whose transportation route have been fixed and will not change in future, and which have been selected from the standpoint of the markets of Zambia products and supplies in the neighbouring countries, and the cargoes whose routes will be changed depending on the future transportation circumstances. This implication is automatically induced from the one in a) above.

c) The OD pairs of the international passengers (Table 3.5) and the cargoes (Table 3.4) which now use the Chirundu route are almost identical, which implies that trip purpose of a large portion of the passengers seems to be "Business".

Table 3.7 Traffic Volume at Chirundu Border Post

Zambia to Zimbabwe

Day	Peds	Bicycle	M/Cys	Cars	M'bus	Bus	Ltruck	2/3 axl	4/5 axl	6 and over	Total
Sun	125	2	0	26	4	8	36	10	41	30	155
Mon	219	7	1	34	0	10	31	7	17	26	125
Tue	148	2	0	24	7	10	27	5	26	33	132
Wed	171	2	1	23	3	10	20	14	9	66	145
Thu	167	4	1	25	3	12	28	4	4	45	121
Ave.	166	3	0	26	3	10	28	8	19	40	137

Zimbabwe to Zambia

Day	Peds	Bicycle	M/Cys	Cars	M'bus	Bus	Ltruck	2/3 axl	4/5 axl	6 and over	Total
Sun	30	3	0	29	4	10	27	3	2	68	143
Mon	140	6	0	25	2	8	18	7	0	45	105
Tue	58	2	0	19	2	9	15	12	1	52	110
Wed	56	4	1	13	2	10	19	6	1	47	98
Thu	126	4	0	26	5	11	15	4	0	59	120
Ave.	82	3	0	22	3	9	18	6	0	54	115

Note: Total exclude pedestrians, bicycles and motorcycles
source: JICA study team estimate

Table 3.8 Distance[*1] between Lusaka and Principal Border Points or International Sea Port

unit:km

Lusaka - (Nakonde) - Dar es Salaam	1,870
Lusaka - (Chirundu) – Beira	990
Lusaka - (Cassacatiza) – Beira	1,240
Lusaka - (Chirundu) - Harare - (Beit Bridge)	1,070 [*2]
Lusaka - (Victoria Falls) - (Beit Bridge)	2,070
Lusaka - (Chirundu, Beit Bridge) - Maputo/Durban	2,120
Lusaka - (Victoria Falls) – Maputo/Durban	2,120

*1 : Distance measured approximately
*2 : Shortest Route

3.3. TRAFFIC DEMAND FORECAST AT CHIRUNDU BORDER POST

3.3.1. PROCEDURE OF DEMAND FORECAST

(1) Demand Forecast Procedure

1) Characteristics of the procedure

The procedure of demand forecast of the traffic demand is depicted in Figure 3.2. The procedure is basically in compliance with the four (4)-step method generally adapted in the traffic demand forecast; the first-step, trip generation/attraction forecast (how many trips from/to each zone?), the second-step, trip distribution forecast (from where, to where?), the third-step, modal split (by what means?), the four-step, traffic assignment (through which route?).

Cargo volumes which relate to the above-mentioned forecast steps from the first-step to the third-step are forecasted by 1 digit SITC or commodity whose classification is adopted in the transportation industry. The following forecast circumstances, which are different among the commodities, force to forecast the volumes by SITC or commodity:

a) Industrial development plans (especially, copper and agriculture industries in Zambia),
b) Explanatory variable for the forecast,
c) Transportation means by which a large portion of the cargo concerned is efficiently transported, and
d) Problems of the data and information.

In general, there exist two types of approaches; forecast at aggregated level - then distribution into sub-classified level, and forecast at sub-classified level-then aggregation. The latter approach is adapted in this forecast. The cargo and passengers transported through the Chirundu route are classified into the following three (3) groups and forecasted by the groups:

a) International cargo transported from/to Zambia,
b) International transit cargo transported from/to other countries except Zambia, and
c) International passengers.

The Study Team allocated a large part of the forecast works to the forecast of the international cargo transported from/to Zambia, taking into consideration;

a) The cargo volumes share a large portion of the whole volumes transported through the Chirundu route, as pointed out already, and
b) The forecast methods for the cargo volumes by commodities are more complicated than the ones for the international transit and passengers.

2) Outline of the procedure

Steps 1 to 6 shown in Figure 3.2 relate to the forecast of the international cargo transported from/to Zambia. The transit cargo and passengers are forecasted in step 7 and the vehicle traffic induced by the cargo and passengers is calculated at the final step. Forecast of Zambia macro economic framework which includes the industrial development plans in Zambia, especially, the copper and agricultural industries, at the step 1 provides principal explanatory variables for the forecast of international cargo volumes transported from/to Zambia at the step 2. Forecasts of the cargo volumes from/to Zambia transported by railway and roads are made at step 3. The forecast of the cargo volumes by roads is calculated as differences between the forecast of the whole cargo volumes at the step 2 and the forecast transported by railways. The forecast of volumes transported by railways aims at:

a) Reflecting effects of the future railway transportation on the future road transportation (the second factor which will affect the future cargo volume, see paragraph 3.1.2-(2)), and
b) Supplementing lack of data on cargo volumes transported by roads by SITC or commodities at Zambia countryside level.

Mutual external trade development among SADC countries will surely lead Zambia to export and import relatively more volumes of commodities from/to other SADC countries in the future. The cargo volumes from/to Zambia in the situation are forecasted at the step 4.

As stated before, the Chirundu route has a relative advantage in the transportation efficiency among the competitives (section 3.2.2 (4)). The effect from realisation of the advantage on the cargo volumes is examined at step 5, and OD tables of the international cargo from/to Zambia transported through the Chirundu route which include the effects of above-mentioned four (4) factors are forecasted at step 6.

International transit cargo volumes and passengers are forecasted at step 7. The forecasts in themselves have to be made as detailed as the ones of the cargo volumes from/to Zambia. The results at steps 6 and 7 are converted into vehicles traffic basis at step 8, adapting load to volume and passenger per vehicle by commodities and/or vehicle types.
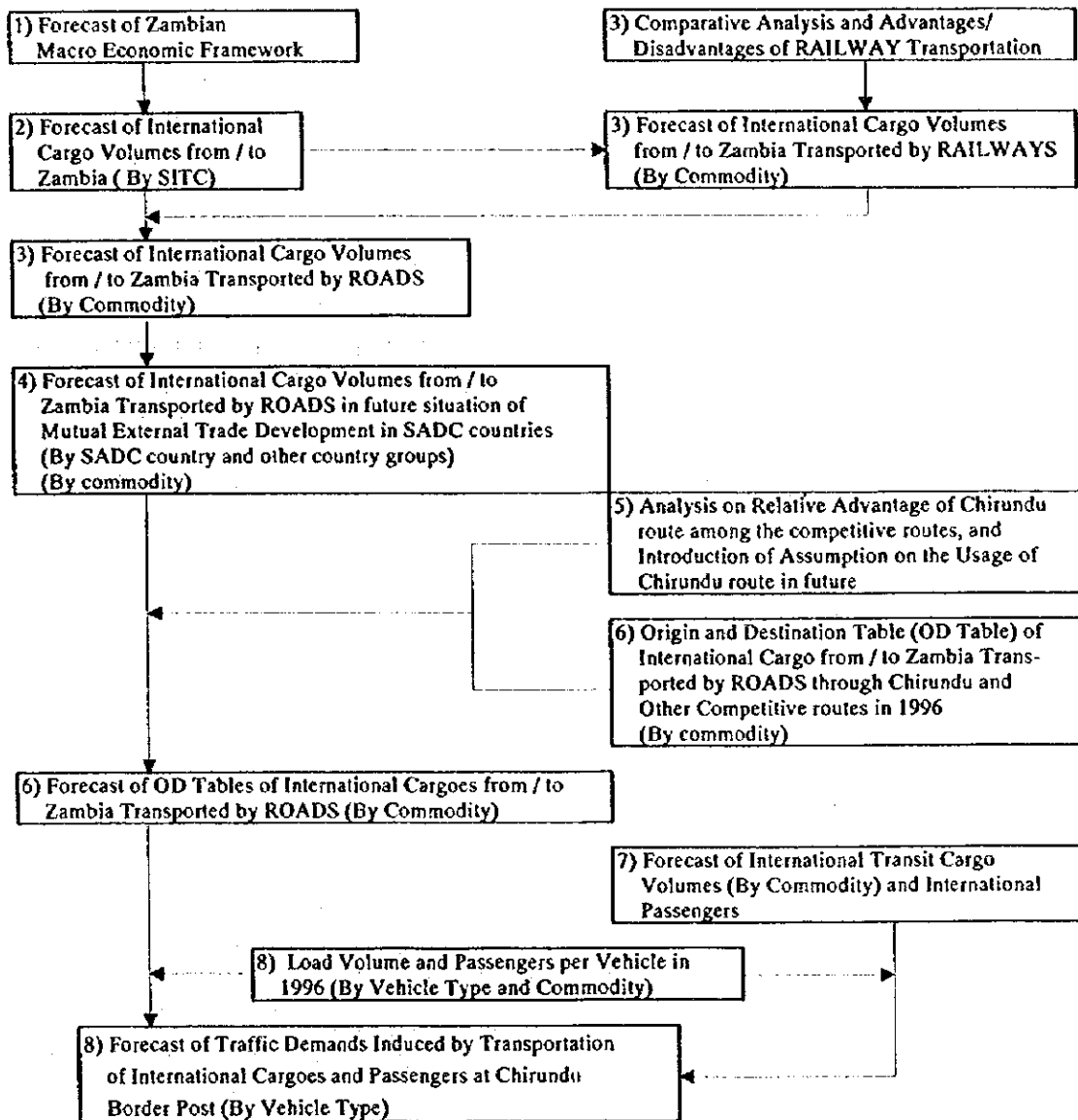
Figure 3.2   Forecasting Process of Traffic Demands

3.3.2. FORECAST OF INTERNATIONAL CARGO TRANSPORTED THROUGH CHIRUNDU BORDER POST

In this section, forecasts at aggregated levels (Zambia, by transportation means and/or whole commodities levels) are described. The forecasts related to steps 1 to 6 are shown in Figure 3.2.

(1) Forecast of Zambia Macro Economic Framework

1) Introduction

The forecast of Zambia macro economic framework provides the principal basis which the international cargo volumes from/to Zambia by SITC are forecasted.

Explanation on past and future economic and industrial structure of Zambia, the prior years date of the GDP (Gross Domestic Products) by Industry of Origin and the forecast up to the year 2005 are cited from the World Bank Report 1996 "Zambia Prospect for Sustainable Growth 1995-2005", and extrapolation from the year 2005 to 2010 is provided by the Study Team.

2) Highlights of the past and future macro economy of Zambia

a) Zambia economy had stagnated during the first half of 1990s. The period can be interpreted as one during which favourable effects of the Economic Structure Adjustment Programs could not be observed. The Program has been introduced into Zambia since middle of 1980s, but earnestly in 1991.

b) The economy is expected to grow at a rate of 5.3% per annum up to the year 2010 (Table 3.9), mainly because the programs are expected to succeed and fruits from the programs can be expected in the coming period, albeit with some serious conditions.

c) Main factors of the future economic growth are expected to be expansion of the agriculture products and its related industry. It seems difficult to expect that the mining industry and the existing manufacturing industry which were the growth factors in the latter half of 1960s will be again in the future. Mining has to play a very important role in sustaining the Zambia economy in the future.

Forecast of the Zambia GDP by Industry of Origin is tabulated in Table 3.9.

Table 3.9   Forecast of Zambia GDP by Industry of Origin up to the Year 2010

1)   GDP by Industry of Origin

(unit : Million kwacha in constant 1977 prices)

	Actual					Estimate	Forecast		
	1990	1991	1992	1993	1994	1995	2002*	2004	2010*
GDP at market prices	2,213.5	2,212.7	2,157.0	2,298.0	2,227.2	2,140.1	3,112.1	3,385.4	4,641.4
Net indirect tax, etc.	244.9	194.4	218.8	210.3	246.5	214.1	305.3	331.1	454.9
GDP at factor cost	1,968.6	2,018.3	1,938.2	2,087.7	1,980.7	1,926.0	2,806.8	3,054.3	4,186.5
Agriculture	386.7	406.7	272.2	488.8	391.8	340.1	562.3	620.4	844.2
Industry	860.8	860.2	943.0	862.7	851.3	842.2	1,108.3	1,182.5	1,575.6
Mining	274.1	293.6	286.0	274.8	301.6	262.3	328.9	334.6	471.4
Manufacturing Other Manufacturing	586.7	586.6	657.0	587.9	549.7	579.9	779.4	847.9	1,104.2
Service	711.1	751.4	723.0	736.2	773.7	743.8	1,136.2	1,251.3	1,766.7

Source   "Zambia prospects for Sustainable Growth 1995-2005", World Bank , 1996.
Note   Consultant estimate and forecast.

2) Average annual growth rate

(unit : % / annum)

	1990 ↓ 1995	1995 ↓ 2002	2002 ↓ 2004	2004 ↓ 2010	1995 ↓ 2010
GDP at market prices	Δ 0.7	5.5	4.3	5.4	5.3
Net indirect tax, etc.	Δ 2.7	5.2	4.1	5.4	5.2
GDP at factor cost	Δ 0.4	5.5	4.3	5.4	5.3
Agriculture	Δ 2.5	7.4	5.0	5.3	6.2
Industry	Δ 0.4	4.0	3.3	4.9	4.3
Mining	Δ 0.9	3.3	0.9	5.9	4.0
Manufacturing Other Manufacturing	Δ 0.2	4.3	4.3	4.5	4.4
Service	Δ 0.9	6.2	4.9	5.9	5.9

(2) Forecast of International Cargo Volumes Transported from/to Zambia

1) Outline of the forecast method

The Study Team had to start estimating the volumes of export and import by 1 digit SITC in 1995 due to lack of such data in Zambia. The estimates were carried out mainly based on the external trade statistics of Zambia and prices by sub-classified commodities which were derived from the estimated external trade statistics of Zimbabwe.

In the forecast, the Study Team clarified, at first, determinant factors of forecasts of the volumes and then estimated affecting degree of the determinants. Future industrial development plans by industries of Zambia, etc. which were discussed with officials concerned before are reflected in the selection of the factors and setting of the degree by SITC with same sub-classification.

2) Estimated and forecasted volumes of the international cargo transported from/to Zambia

Those at aggregated level are shown in Table 3.10 below:

Table 3.10   Forecast of whole volume of merchandise exports and imports
from Zambia

	1995	2002	2010
Total volume of merchandise exports from Zambia (tons)	553,480	638,040	996,920
Total volume of merchandise imports to Zambia (tons)	1,170,420	1,560,050	2,363,110

Source: Study team's estimates

The volume of exports is expected to grow at a rate of 4% per annum, while the volume of imports will grow at 4.8% per annum up to the year 2010.   Stagnation of production of copper products will make a great influence on the volume of the exports, especially in 2002, while the self-sufficiency and export-oriented policy of principal crops in Zambia will depress the increase in the volume of the imports.

(3) Forecast of International Cargo Volume Transported from/to Zambia by Railways and Roads

1) Outline of the forecast methods

The volumes transported by the roads by commodities are calculated as differences between the whole volumes which were presented in the Table 3.9 and volumes transported by railways by commodities.   In the forecast of the volumes by railway, relative advantages and disadvantages of the railway transportation versus the road transportation by commodities are reflected, which implies that their effects are automatically considered in the forecast of the volumes transported by roads.

Estimated and forecasted volumes of the international cargo from/to Zambia by the transportation means at aggregated level are shown below in Table 3.11.

Table 3.11   Forecast of Whole Volumes of Merchandise Exports and Imports of
Zambia by Transportation Means.

Whole Exports from Zambia level ;

	1995	2002	2010	
By Railways	314,127	347,710	422,360	tons
Roads	239,353	290,330	574,560	
Total	553,480	638,040	996,920	tons
By Railways	56.8	54.5	42.4	%
Roads	43.2	45.5	57.6	
Total	100.0	100.0	100.0	%

Increasing rates (1995 - 2010)
by Railways   2.0% / annum
Road   6.0%
Total   4.0%

Whole Imports to Zambia level;

	1995	2002	2010	
By Railways	234,050	301,350	384,790	tons
Roads	936,366	1,258,700	1,978,320	
Total	1,170,416	1,560,050	2,363,110	tons
By Railways	20.0	19.3	16.3	%
Roads	80.0	80.7	83.7	
Total	100.0	100.0	100.0	%

Increasing rates:
by Railways   3.4% / annum
Road   5.1%
Total   4.8%

Source: JICA study team estimates and forecast

The volumes transported by railways are expected to increase though the share of the railways will gradually decrease. The increase in the volumes is an unexpected result because both volumes and share have decreased in the past. This implies that the forecasted volumes transported by roads are conservative.

Share of the roads transportation is expected to increase from 43% in 1995 to 58% in 2010, a 15% increase, in case of merchandise exports from Zambia. While for imports, it is forecasted to increase from 80% in 1995 to 84% in 2010, a 4% increase. The relative weak competitive power of the railways in future has an acceleration effect on the road transportation by 2.0% per annum in case of transportation of the exports, and 0.3% per annum in case of the imports.

If the volumes by railways are assumed to be unchanged from those in 1995, the volumes by roads are expected to increase at a rate of 7.2% per annum (by 1.2% per annum point higher than the one of the adopted case) in case of the exports and 5.6% per annum (by 0.5% per annum points higher) in case of the imports.

(4) Forecast of International Cargo volumes from /to Zambia Transported by Roads in Future Situation of Mutual External Trade Development in SADC Countries

1) Forecast methods

A) Expectation of effect of the development on Zambia external trade in future.

As shown below, exports and imports of Zimbabwe to and from SADC countries rose from 1990 to 1995. The tendency is also expected in Zambia in the future. (Refer to Table 3.12)

Table 3.12   Shares of Zimbabwe and Zambia External Trade by Regions
(External trade value basis)

(1) Zimbabwe	1990	1995	(2) Zambia		
Exports to SADC countries	28.4	30.0	Exports to SADC countries	N.A.	4.3
Other African countries	2.0	0.7	Other African countries	N.A.	2.0
Rest of the World	69.4	69.3	Rest of the World	N.A.	93.7
Total	100%	100%	Total		100%
Imports from SADC countries	24.6	41.6	Imports from SADC countries	N.A.	41.9
Other African countries	0.7	0.1	Other African countries	N.A.	0.6
Rest of the World	74.7	58.4	Rest of the World	N.A.	57.5
Total	100%	100%	Total		100%

Source: JICA study team estimate

B) Forecast methods by commodities

i) The development is expected to make an impact on all kinds of commodities transported from/to Zambia in the future.   However, the Study Team encounters the following problems with the data for forecasting the cargo volumes:

    a)   The cargo classification adopted in the road transportation is not always compatible with the SITC which was previously used, and

    b)   Forecasting the cargo volumes by commodities whose classifications are different from the SITC requires new kinds of the basic data and information.   Unfortunately these have not been provided from the results of the previous paragraphs, nor are they available from any statistics and documents.

These problems make the forecasts of the aggregated total volume at Zambia countryside level impossible to correlate with the effects of the developments.

ii) In order to reflect the effects on cargo volumes by commodities as much as possible, the Study Team evaluated the effects on the cargo volumes in the following ways:

    L1: Change in the shares of cargo volumes transported between Zambia, and SADC and other African countries, and

    L2: Change in the shares of cargo volumes transported between Zambia and the SADC three (3) countries (South Africa, Zimbabwe and Mozambique),

    F1: Reflection of the effects in formula for the forecast the cargo volumes concerned, and

    F2: Indirect reflection of the effects through calculation of the cargo volumes concerned.

The effects are reflected on the cargo volumes with combination of the expression methods. On the other hand, the F1 is adapted only to import of "Textile and Others" at the SADC three countries level, and the F2 to both export and import of "Miscellaneous" at Chirundu Border Post level.

The following items arc taken into consideration in the L1:

a) Zambia external trade by countries in the past

b) Future External Trade Development in SADC countries by commodities, and

c) Possibilities of exporting the Zambia products and saving goods from abroad which Zambia will demand by regions and commodities.

In the L2, the following arc reflected:

d) Future External Trade Development in SADC countries, especially in the SADC three (3) countries by commodities,

e) Possibilities of change in exports and imports from/to Zambia to/from SADC and other African countries by commodities, in future,

f) Cargo volumes by commodities between Zambia and the SADC three countries in 1996, and

g) Populations in the countries.

iii) Effects of the development on cargo volumes by commodities in the future is as shown in Table 3.13.

Table 3.13   Effects of the development

Case		Commodities adopted	Reflecting ways of the effects
Possibility of the effect	Result of the effect		
Possible	Effected	* Export of "Agricultural Products"	L1 and L2
		* Export of "Basic Metals"	L1 and L2
		* Import of "Agricultural Products"	L1 and L2
		* Import of "Mineral Products"	L1
		* Import of "Chemical Products"	L1 and L2
		* Import of "Textile and Others"	F1
		* Export of "Miscellaneous"	F2
		* Import of "Miscellaneous"	F2
	Non-effected	* Export of "Mineral Products"	L1 and L2
		* Export of "Chemical Products"	L1 and L2
		* Export of "Ward Products"	L1 and L2
		* Export of "Stone,Ceramic Products"	L1 and L2
		* Export of "Machinery, etc "	L2
		* Export of "Other Manufactured Goods"	L1 and L2
		* Import of "Stone, Ceramic Products"	L1 and L2
Impossible		* Export of "Textile and Others"	
		* Import of "Wood Product"	
		* Import of "Basic Metals"	
		* Import of "Machinery, etc"	
		* Import of "Other Manufactured Goods"	

2) Forecast of cargo volumes transported through Chirundu Border Post which will include the effects of the development

The cargo volumes of all kinds of commodities transported through Chirundu Border Post are forecasted as follows. The volumes are those before taking into consideration the relative and potential advantages of the Chirundu route which will be discussed later. (Refer to Table 3.14)

Table 3.14   Forecast of Cargo Volumes from/to Zambia through Chirundu

(unit : tons / annum)

	1996	2002	2010
Exports from Zambia	81,744	114,170	225,970
Imports of Zambia	256,984	289,050	464,510
Total	338,728	403,220	690,480

Note: Advantage of Chirundu route is not considered.

3) Effects of the future External Trade Development in SADC countries on the cargo volumes from/to Zambia transported through Chirundu Border Post

The total effects can be estimated by calculating those classified as the "Possible, Effected" group shown in Table 3.13.

The degree of the effects can be calculated as differences between case of "Effected" and ones estimated on conditions that no change in the L1 and L2, i.e. the shares in 2002 and 2010 are unchanged from the ones in 1996, and cancellation of the factors which reflect the effect in the formula of the F1.

The total effects are as shown in Table 3.15.

Table 3.15   Total Effects of Future External Trade Development in SADC at Chirundu

(unit : tons / annum

	1996	2002	2010
Exports from Zambia			
With the Effect case	81,744	114,170	225,970
Without the Effect case	81,744	105,590	196,940
Sub - net Effect	0	8,580	29,030
Imports of Zambia			
With the Effect case	256,984	289,050	464,510
Without the Effect case	256,984	285,250	448,230
Sub - net Effect	0	3,800	16,280
Total net Effect	0	12,380	45,310

The total net effect in 2010 amounts to 7.0% of the total cargo volumes of Zambia transported through Chirundu Border Post of the "Without the Effect" case, in other words, the future external trade development in SADC countries is expected to increase the cargo volumes

from/to Zambia which will be transported through Chirundu Border Post by 7.0% of the volumes of the "Without the Effect" case.

The effect seems to be relatively small, compared with the rough expectations.

a) The effect was based on only eight (8) of the twenty (20) categories of commodities, due to the limitation of the available data, and

b) Markets for Zambia products will relatively concentrate and at same time relatively scatter in and among the SADC and African countries as seen in case of the export of agriculture products, and

c) Demand for higher-quality commodities in Zambia will increase the dependency on the supplies from Rest of the World rather than the SADC and African countries as seen in case of the import of agricultural products and chemical products.

(5) Relative and Potential Advantages of the Chirundu Route among the Competitive Routes

The advantages are supposed to affect the future international cargo volumes from/to Zambia which will be transported through the Chirundu Route. This factor is the 4th factor affecting the cargo volumes transported through the Chirundu route in the future.

1) The Relative and Potential Advantages, the Judgement Bases and the Effects on the Cargo Volumes Transported through the Chirundu Route

A) Functions of the Chirundu route in the transportation of the international cargo from/to Zambia and the present utilisation ratios of the route

a) The following are the international trunk routes between Zambia and the principal trading counterpart countries:

South Africa: * Lusaka - (Kazungula) - (Botswana) - South Africa,
              * Lusaka - (Chirundu/Victoria Falls) - (Beit Bridge) - South Africa.
Zimbabwe :   * Lusaka - (Chirundu) - Northern region of Zimbabwe,
              * Lusaka - (Victoria Falls) - Southern region of Zimbabwe.
Dar es Salaam (Tanzania): * Lusaka - (Nakonde) - Dar es Salaam
Beira (Mozambique): * Lusaka - (Cassacatiza) -Beira,
              * Lusaka - (Chirundu) - (Forbes (Mutare)) - Beira.
Maputo (Mozambique)/Durban (South Africa): * Lusaka - (Chirundu/Victoria Falls) -
(Beit Bridge) - Maputo/Durban.

b) In checking the trunk routes from viewpoints of their characteristics of competitiveness and non-competitiveness, the four (4) routes between Zambia and South Africa and Zimbabwe can be classified as non-competitive routes because the routes have been selected from viewpoints of locations of markets of Zambia products and supplies of raw, intermediate and final products to Zambia in South Africa and Zimbabwe. Accordingly, the routes have already satisfied of condition of the transportation efficiency and will not be affected by the potential advantages of the Chirundu route which will be discussed hereinafter.
On the other hand, the remaining trunk routes can be characterized as competitive routes, in the sense that , when transportation conditions/circumstances on the routes will change in future, the cargo volumes will also relatively change among the routes.

The relative changes are expected to accrue at two levels: Between Zambia and the using principal international seaport and Between Zambia and Beira/Mozambique. The routes will be affected by the advantages of the Chirundu route in future.

c) Though the Zambia - (Chirundu) - Beira route is the shortest route to the international seaports at least by 880 km (see Table 3.8), only 49.8% of the total cargo volumes from Zambia to the three (3) seaports (Dar es Salaam, Beira and Durban) and 11.5% in case of the imports were moved through Beira in 1996. It can be assumed that higher convenience at Dar es Salaam and Durban and the railways between Zambia and these ports make the utilisation ratio of Beira lower. The ratios are estimated based on the SATCC Border post Survey results.

On the other hand, almost all cargo volume between Zambia and Beira/Mozambique were transported through the Lusaka - (Cassaeatiza) - Beira/Mozambique route, in spite of longer distance by around 250 km than the Lusaka - (Chirundu) - Beira route. Several factors which will be pointed out later seem to hinder usage of the Lusaka - (Chirundu) - (Forbes) - Beira/Mozambique route.

B) Bases on which the Chirundu route (the Lusaka - (Chirundu) - Harare route) has relative and potential advantages among the competitive routes.

The Study Team judges that the Chirundu route has the advantages among the competitive routes based on the following:

a) The Zambia - (Chirundu) - Beira route and the Lusaka - (Chirundu) - Beira/Mozambique route are the shortest routes between Zambia and the international seaports and between Lusaka and Beira/Mozambique. This means that the routes are superior in the transportation efficiency.

b) The following developments were proposed at the International Conference held in February 1997, along with industrial development in the sub-region of Zimbabwe and renewal of the railways:
   - Expansion of functions of Beira seaports, and
   - Improvement of the trunk roads in the sub-region.
   The Study Team assumes that those proposals will be realized.

c) The "Report on Border Post Surveys and the Establishment of Regional Road Funds" published by SATCC in January 1997 proposes that the road-user charge imposed on vehicles registered in foreign countries should be modified based on standard regulations among SADC countries, whose tolls are now different at the border post. The standardization will work favourably to the usage of the Chirundu route in future, and

d) According to the Ministry of Industry and Commerce of Zambia, simplification of customs procedures which will be commonly applied at the Border Post is now proposed and investigated. The realization of the proposal would substantially shorten the time necessary for clearing the customs procedure. The Lusaka - (Chirundu) - Beira/ Mozambique route now requires two instances of customs clearance.

C) Expression of the relative and potential advantages of the Chirundu Route.

The Study Team believes that advantages will be realised, and that additional cargo volumes will be transported through the Chirundu route above the normally expected volumes, when the above-mentioned transportation circumstances will be improved.

The advantages are expressed in the forms of assumptions:

Assumption 1: Beira Seaport be able to handle 70% of the total volume from Zambia to Rest of the World and 50% in case of the imports in 2020.

Assumption 2 : As to the Lusaka to Beira/Mozambique route, the Chirundu route will be fully utilised in stead of the Lusaka to Cassacatiza to Beira/Mozambique route in 2002.

Behind the assumption, the followings are roughly supposed:

a) The future cargo capacity of Beira Seaport will not put any limitation on the cargo volume from/to Zambia which will be transported through Beira Seaport, and

b) The realization of industrial developments prepared in the International Conference on Beira Corridor Industrial Development will affect the future cargo volume between Zambia and Zimbabwe/Mozambique. The realization of improvement on transportation circumstance of the Beira Corridor will work favourably to the future cargo transportation.

(6) Effects of Realization of the Advantages on the Cargo Volume from/to Zambia Transported through the Chirundu Route.

Effects can be calculated as differences between the cargo volume which will be expected in the With-Realization of the Advantage case tabulated in Table 3.19 attached later and the Without-Realization of the Advantage case tabulated Table 3.15. Results are shown in Table 3.16.

Table 3.16   Effects of Chirundu route advantage

(unit : tons / annum)

	1996	2002	2010
Exports from Zambia			
With the Effect case	81,744	175,540	349,410
Without the Effect case	81,744	114,170	225,970
Sub - net Effect	0	61,370	123,440
Imports of Zambia			
With the Effect case	256,984	328,090	530,440
Without the Effect case	256,984	289,050	464,510
Sub - net Effect	0	39,040	65,930
Total net Effect	0	100,410	189,370

The total net effects in 2002 represents 27.4 % of total cargo volume of Zambia transported through Chirundu Border Post of the " Without the Effect" case, in other words, the realization

of the Relative and Potential Advantages of Chirundu Route is expected to increase from/to Zambia by 27.4 % of the total volume of the " Without the Effect" case.

(7) Forecast of OD Table of International Cargo from/to Zambia Transported through Chirundu Border post.

In Table 3.19, the cargo volume by OD pairs (Rest of the World, South Africa, Zimbabwe, and Mozambique), directions (from Zambia and to Zambia) and commodities in 1996, 2002 are tabulated. The volume includes the following four (4) kinds of effects of ;

   a)   Future Zambia macro economic framework and industrial development plans,
   b)   Advantages and disadvantages of railway transportation by commodities,
   c)   Future mutual external trade development in SADC countries, and
   d)   Realization of relative and potential advantage of the Chirundu route in future.

The OD table in 1996 is estimated based on the SADC Border Post Survey results, and the volume of some commodities are used as the base-year volume for the forecasting and the remaining are not adopted as described in the previous paragraph-4) . Accordingly, the forecasting methods by commodities in addition to the methods of reflecting the effects of realization of the relative and potential advantages of the Chirundu route described in the paragraph-5) disturb the full continuity among the ones 1996, 2002 and 2010. The total volume of the cargo from/to Zambia are summarised as shown in Table 3.17.

Table 3.17   International Cargo Volume from/to Zambia Transported through the Chirundu Route.

	Volume (tons / annum)			Composition Rates (%)		
	1996	2002	2010	1996	2002	2010
Exports from Zambia	81,744	175,540	349,410	24.1	34.9	39.7
Imports to Zambia	256,984	328,090	530,440	75.9	65.1	60.3
Total	338,728	503,630	879,850	100.0	100.0	100.0

Annual average growth rates (% / annum) (1996 - 2010)		
Export from Zambia	:	10.9
Import of Zambia	:	5.3
Average	:	7.1

Elasticity of the volume to the Zambia Economic Growth Rate (1996 - 2010)		
Exports from Zambia	:	2.06
Import of Zambia	:	1.00
Average	:	1.34

Commodities with large volume in 2010 are shown below in Table 3.18;

Table 3.18 Commodities with Large Volume from/to Zambia transported through the Chirundu Route in 2010.

Exports from Zambia			Imports to Zambia		
Commodities	Volume (ton/annual)	A (%)	Commodities	Volume (ton/annual)	A (%)
Basic Metals	129,010	36.9	Chemical Prod.	129,950	24.5
Agricultural Pro.	61,330	17.6	Mineral Prod.	91,080	17.2
Other Manufactual	50,860	14.6	Machinery, etc.	69,930	13.2
Wood Products	37,170	10.6	OtherManufactured	60,720	11.4
Textiles and Others	32,820	9.4	Basic Metals	58,900	11.1

Note ; A ; Shares in the totals.

Table 3.19 Summary of International Cargo Volumes at Chirundu Border Post

(Unit;ton/annum)

1.   Year 1996 (*1

	Foreign (*2		South Africa		Zimbabwe		Mozambique		Transit		Total	
	A(*3	B(*3	A	B	A	B	A	B	A	B	A	B
Agricultural Products	0	1,820	0	11,492	8,060	77,792	0	0	9,100	44,564	17,160	135,668
Mineral Products	0	1,924	4,316	9,932	4,368	20,332	0	0	364	25,064	9,048	57,252
Chemical Products	0	364	0	25,688	780	15,756	0	0	0	21,476	780	63,284
Wood Products	1,560	0	5,980	10,972	3,952	7,592	0	0	0	1,456	11,492	20,020
Textile and Others	0	0	8,424	1,976	3,588	7,228	0	0	0	0	12,012	9,204
Stone, Ceramic Products, etc.	0	0	2,496	1,456	0	2,340	0	0	0	5,876	2,496	9,672
Basic Metals, etc.	5,668	0	19,084	6,136	9,100	12,480	0	0	12,740	6,448	46,592	25,064
Machinery, Electric Goods, etc	0	624	1,352	11,076	3,016	2,860	0	0	2,704	1,976	7,072	16,536
Other Manufactured Goods	0	0	0	0	0	1,300	0	0	0	0	0	1,300
Miscellaneous	0	572	0	16,016	0	9,256	0	0	0	3,796	0	29,640
Total	7,228	5,304	41,652	94,744	32,864	156,936	0	0	24,908	110,656	106,652	367,640

2.   Year 2002

	Foreign		South Africa		Zimbabwe		Mozambique		Transit		Total	
	A(*3	B(*3	A	B	A	B	A	B	A	B	A	B
Agricultural Products	9,580	4,770	11,320	4,520	7,850	26,970	0	0	11,510	56,390	40,460	92,650
Mineral Products	1,970	2,860	3,220	15,710	5,750	33,740	0	0	460	31,710	11,400	84,020
Chemical Products	1,570	17,000	360	33,730	550	27,440	1,760	520	0	27,170	4,240	105,860
Wood Products	2,900	750	11,130	7,040	7,360	8,160	0	0	0	1,840	21,390	17,790
Textile and Others	2,170	6,280	10,650	2,660	5,480	10,270	160	1,700	0	0	18,460	20,910
Stone, Ceramic Products, etc.	0	0	1,660	1,980	0	2,480	0	0	0	7,440	1,660	11,900
Basic Metals, etc.	40,840	0	6,200	11,010	3,240	22,400	0	0	16,120	8,160	66,400	41,570
Machinery, Electric Goods, etc	1,270	1,070	2,350	36,380	3,890	7,370	0	560	3,420	2,500	10,930	47,880
Other Manufactured Goods	6,040	0	16,470	550	4,760	2,290	4,140	0	0	0	31,410	2,840
Miscellaneous	0	820	700	28,170	0	8,890	0	0	0	4,800	700	42,680
Total	66,340	33,550	64,260	141,750	38,880	150,010	6,060	2,780	31,510	140,010	207,050	468,100

3.   Year 2010

	Foreign		South Africa		Zimbabwe		Mozambique		Transit		Total	
	A(*3	B(*3	A	B	A	B	A	B	A	B	A	B
Agricultural Products	11,350	8,740	29,720	6,260	20,260	38,380	0	0	15,760	77,170	77,090	130,550
Mineral Products	3,050	3,960	4,990	27,670	8,920	59,450	0	0	630	43,400	17,590	134,480
Chemical Products	2,350	31,450	550	53,860	820	43,800	2,640	840	0	37,190	6,360	167,140
Wood Products	5,050	1,070	19,340	10,000	12,780	11,590	0	0	0	2,520	37,170	25,180
Textile and Others	3,860	9,360	18,930	4,130	9,750	15,950	280	2,640	0	0	32,820	32,080
Stone, Ceramic Products, etc.	0	0	2,920	2,780	0	3,480	0	0	0	10,180	2,920	16,440
Basic Metals, etc.	101,350	0	18,170	19,410	9,490	39,490	0	0	22,060	11,170	151,070	70,070
Machinery, Electric Goods, etc	1,790	1,640	3,320	56,060	5,500	11,370	0	860	4,680	3,420	15,290	73,350
Other Manufactured Goods	9,790	0	26,670	1,060	7,700	4,420	6,700	0	0	0	50,860	5,480
Miscellaneous	0	1,410	1,370	44,950	0	14,360	0	0	0	6,570	1,370	67,290
Total	138,590	57,630	125,980	226,180	75,220	242,290	9,620	4,340	43,130	191,620	392,540	722,060

Note (*1 :   - At Chirundu Border Point, "Border Point Survey" SATCC, January 1997
　　　　　　- 52 times of the surveyed volumes
Note (*2 :   All other countries except SADC and other African countries.
Note (*3 :   Direction :　　A : Zambia　▶　Zimbabwe
　　　　　　　　　　　B : Zambia ◀ － Zimbabwe

(8) Forecast of International Transit Cargo Volume.

1) The International Transit Cargo Movement which was Transported through the Chirundu Route in 1996.

The OD table of the transit cargo has been shown in the Table 3.3 and the cargo volume by commodities in the Table 3.19. The transit cargo volume represented 23.4 % of the total cargo volume transported by the Chirundu route from Zimbabwe side and 30.1 % in case of the reverse direction in 1996. The volume transported between South Africa and other Countries was the largest, followed by the ones of Zimbabwe to other countries OD pair, and South Africa/ Zimbabwe to Malawi OD pairs in 1996.

Based on the status of the OD pair, it can be judged that the Chirundu route is used for the transportation of the international cargo whose origin and destination was already fixed, which implies that the Chirundu route is not in competition with other routes in the case of the transit cargoes.

2) Forecasting Method

The existing OD pair including the South Africa/ Zimbabwe- Malawi are assumed to be kept in the future. The forecasts of the transit cargo volume commodities are carried out based on the volume in 1996 and with a rate of increase of increase of 4 % annually. The increasing rate is fairly lower than 7.1 % annually in case of forecasts of the international cargo transported from/to Zambia.

3.3.3. FORECAST OF INTERNATIONAL PASSENGERS.

OD table of the passengers which passed Chirundu Border Post in 1996 have been shown in Table 3.5. The passengers between Zambia and Zimbabwe represented 92.6 % of the total passengers in 1996.

The OD pairs are almost corespondent with the ones of the international cargo (Table 3.4), which implies that trip purpose of almost all passengers seems to be "On Business". Number of the passengers between Zambia and Zimbabwe is supposed to increase at the GDP growth rate of their destination country respectively, and the passengers to Zambia from/to other countries at the GDP growth of Zambia, while the passengers of other OD pairs are expected to increase at a rate of 4 % per year. The last increase rate is based on the same viewpoint and fact as the increase of the international transit cargo.

The forecasts of the international passengers who will pass Chirundu Border Post are tabulated in Table 3.20.

Table 3.20   Forecast of International Passengers(*1) by Direction at Chirundu Border Post

passenger/annum

	1996(*2,*3)		2001(*3)		2010(*3)	
	A(*4)	B(*4)	A	B	A	B
Zambia Zimbabwe	109,096	91,260	148,460 (*6)	125,830 (*7)	222,710 (*6)	188,050 (*7)
Zambia Other Countries (*5)	3,068	4,836	4,910 (*8)	6,670 (*7)	5,310 (*8)	9,970 (*7)
Transit	4,056	4,160	5,130 (*8)	5,260 (*8)	7,020 (*8)	7,200 (*8)
Total	116,220	100,256	158,500	137,760	235,040	205,220

Note *1 : Excluding pedestrians and passengers who use bicycle.
Note *2 : At Chirundu Border Post, " Border Point Survey " SATCC, January 1997.
        52 times of the surveyed number of passengers (person/week)
Note *3 :OD pairs of the international passengers at Chirundu Border Post in 1996 almost
        corresponded to those of the international cargo.
        Accordingly, trip purposes of the passengers who go through the Chirundu Border Post are
        supposed to be " Business".
Note *4 : Direction : A: Zambia to Zimbabwe. B: Zimbabwe to Zambia
Note*5 : All other countries excluding Zimbabwe.
Note*6 : Adopting the forecasted growth rate of GDP of Zimbabwe (4.9%/annual rate, 1995 to 2010)
Note*7 : Adopting the forecasted growth rate of GDP of Zambia (5.3%/annual rate, 1996 to 2010)
Note*8 : Adopting an annual increase rate of 4.0 %.

3.3.4.   FORECAST OF DAILY VEHICLE TRAFFIC VOLUME.

(1)   Conversion Method

Daily vehicle traffic volume by vehicle types are converted from the forecasts of the cargo volume transported through Chirundu Border Post (Table 3.19) through the following formula:

$$Vi,t = \sum_j Cj,t \times \left(\frac{\overline{Ci,j,1996}}{\overline{Cj,1996}} \right) / Li,1996 / 365$$

$$\overline{Cj,1996} = \sum_j \overline{Ci,j,1996}$$

Vi,t   : Number of daily vehicle traffic i in year t.
Cj,t   : Annual cargo volume of commodity j transported through the Chirundu route in year t (Table 3.19).
Ci,j,1996 : Cargo volume of commodity j transported by vehicle i for one week in 1996 (SATCC border post survey results)
Cj,1996   : Cargo volume of commodity j for one week in 1996.
Li,1996   : Load volume of vehicle i observed in 1996 (SATCC border survey results)
i   : Vehicle type (7 - 10)
j   : Commodity (1 - 10)

On the other hand, the vehicle traffic volume are calculated on the forecasts of international passengers transported through Chirundu Border Post (Table 3.20) through the following formula;

$$Vi,t = Pt \times \left(\frac{\overline{Pi,1997}}{\overline{PA,1997}} \right) / PVi.,1997 / 365$$

$$\overline{PA},1996 = \sum_i Pi,1997$$

Vi,t   : Number of daily vehicle traffic i in year t.

Pt   : Annual number of the passengers transported through the Chirundu route in year t (Table 3.20)

Pi,1997 :   Number of the passengers transported by vehicle i for five (5) days in 1997 (JICA Study Team's Border Survey results)

Pa,1997   : Number of the passengers for five days in 1997.

Pvi,1997 : Number of the passengers per vehicle i observed in 1997.

i   : Vehicle type (3 - 6)

The daily vehicle traffic which can be calculated through the above two formulas are the ones used for transporting the commodities and passengers for one of two directions. They return to their home place as vacant vehicles. The two categories of the daily vehicle traffic form a daily vehicle traffic which goes through Chirundu Border Post in both directions.

(2) Forecasts of the Daily Vehicle Traffic Volume which will go through Chirundu Border Post.

Table 3.21 presents the forecasts of the daily vehicle traffic by directions (from Zambia to Zimbabwe, and from Zimbabwe to Zambia) and vehicle types. The traffic will increase to 322 vehicles in 2002 and 506 vehicles in 2010 from 221 vehicles in 1997. Annual average increasing rate of the daily vehicle traffic during the period from 1997 to 2010 is 6.6 %. Passenger cars and six or more axle trucks share 66 % of the whole daily vehicle traffic in 2002 and 2010.

Table 3.21   Traffic Demand Forecast at Chirundu Border Post

Direction Zambia — —>   Zimbabwe   (Unit : vehicle / day)

Vehicle Type	1997			2002			2010		
	Loaded	Vacant	Total	Loaded	Vacant	Total	Loaded	Vacant	Total
3	1	0	1	1	0	1	1	0	1
4	33	0	33	44	0	44	66	0	66
5	2	0	2	3	0	3	4	0	4
6	6	0	6	8	0	8	12	0	12
7	1	18	19	2	22	24	4	33	37
8	0	2	2	14	4	18	25	6	31
9	1	3	4	3	3	6	4	4	8
10	8	36	44	13	48	61	24	74	98
Total	52	59	111	88	76	161	137	116	252

Direction Zambia<— —   Zimbabwe

Vehicle Type	1997			2002			2010		
	Loaded	Vacant	Total	Loaded	Vacant	Total	Loaded	Vacant	Total
3	0	0	0	0	0	0	0	0	0
4	23	0	23	47	0	47	70	0	70
5	2	0	2	2	0	2	3	0	3
6	9	0	9	8	0	8	11	0	11
7	13	2	15	22	2	23	33	4	36
8	2	2	4	4	14	17	6	25	31
9	3	1	4	3	3	5	4	4	8
10	49	4	53	48	13	61	74	24	98
Total	101	9	110	131	30	161	199	56	254

Source : JICA Study team's estimates and forecasts

Vehicle type:
- 3 : Motorcycle
- 4 : Passenger car
- 5 : Minibus
- 6 : Bus
- 7 : 2 axle Light Trucks
- 8 : 2/3 axle Heavy Truck
- 9 : 4/5 axle Truck
- 10: 6 or more axle Truck

(3)   Examination of the Forecasts of the Daily Vehicle Traffic

In Figure 3.3, four (4) cases of the forecasts of the daily vehicle traffic are depicted, including the forecasts (Base case) which is made through the forecasting procedures presented in this report. The forecasting method of each case is as follows;

Highest case : The daily vehicle traffic will increase at a rate of 7.5 % annually. The rate is calculated through the following steps.

a)   Estimating the formula (one dimension- leaner function, Figure 3.3) based on the actual daily vehicle traffic observed at Chirundu Border Post during the period from 1987 to 1996.

b)   Estimating the traffic during observed period by adapting the formula.

c)   The compound rate is calculated, using the estimated traffic in 1987 and 1996.

2nd highest case (Base case)

Low case : Simple extrapolation, adopting the formula same as the one applied in the highest case.

Lowest case : The forecasting procedure is the same as the ones for the Base case. But the following forecasting conditions are different from the ones of the Base case;

    a) Zambia economic growth rate : 4.0 % per year.
    b) Railway share : Unchanged from the share in 1995.
    c) External trade development in SADC countries: Not promoted, and
    d) Relative and potential advantage of the Chirundu route : Not realized.

The Base case has a position between the highest case and the low case, and even the lowest case is a little under the low case. This implies that the forecasts of the Base case are not extreme ones. However, as was already pointed out, the forecasts of the Base case are conservative ones in the following senses:

Conditions to be satisfied:

    a) Realization of the future Zambia economic growth (5.3 % / annual increase up to the year 2010), and
    b) Realization of the relative and potential advantages of the Chirundu route.

Factors which make the forecasts conservative:

    a) Over estimates of the international cargo volume which will be transported by railway.
    b) Under estimates of the effects of the external trade development in SADC countries on the international cargo volume from/to Zambia due mainly to the limitations of the basic data,
    c) Adoption of an increasing rate of 4 % / year to the forecasts of the international transit cargo volume and passengers which is lower than the rate of cargo volume from/to Zambia, and
    d) Adaptation of a high conversion factor for estimating number of buses.

In conclusion, it can be pointed out that the forecasts of the Base case are not extreme, but rather conservative forecasts.
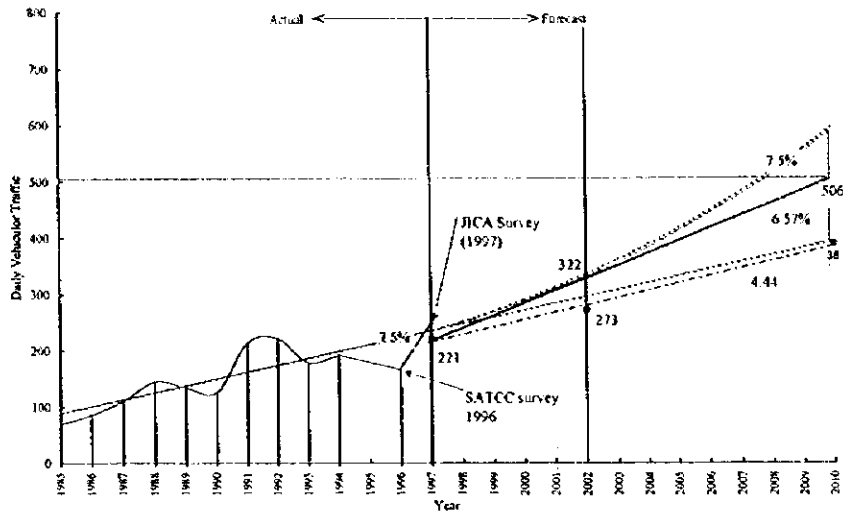
Figure 3.3   Four Cases of the Forecast of Daily Vehicle Traffic
at Chirundu Border Post

3.4. TRAFFIC DEMAND AND EXISTING FACILITIES

(1) Needs for the New Bridge (Figure 3.4)

Traffic capacity of the existing bridge is 300 vehicles per day under 12 hours operation. Future traffic demand will exceed this capacity by the year 2001, and under 14 hours operation, in 2003. Overflowed traffic have to detour to other route (Kariba dam, Victoria falls route, etc.)

(2) Needs for border post facilities improvements (Figure 3.5)

Dealing capacity of the border post facilities is estimated at 250 vehicles per day under 12 hours operation, and it will increase to 300 vehicles per day under 14 hours operation. Future traffic demand will exceed the capacity under 12 hours operation in 1999 and 14 hours operation 2001. Vehicles arrived during the day could be dealt in the evening, but when traffic volume exceeds the capacity of the border post, it will lead to malfunction of the border.
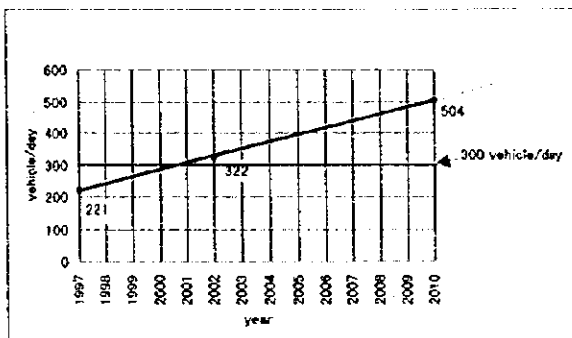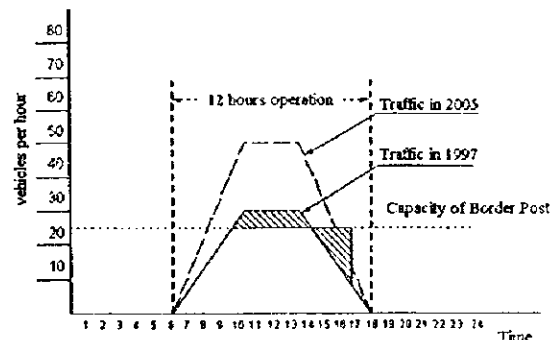

Figure 3.4 Traffic Volume and the Bridge
Capacity

Figure 3.5 Traffic Volume and the
Border Post Capacity