8.10. ENVIRONMENTAL MANAGEMENT

8.10.1. INTRODUCTION

Effective environmental management during, pre-construction and construction requires the establishment of effective institutional arrangements for the implementation of the Envirhildren were observed wielding cFor optimum effect, any environmental management programme should be carried out as an integrated part of project planning and execution, making a significant and continuous contribution to the overall development of the scheme. It must not be seen merely as an activity limited to monitoring and regulating activities against a pre-determined checklist of required actions. Rather, it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts - both expected and unexpected as they arise. For this reason, the plan provides for periodic audits which will serve to evaluate compliance of on-site environmental management practices with the EMP requirements and also to refocus the plan in the light of experience and issues arising.

The construction of the proposed bridge will present challenges in terms of maintaining environmental quality; minimising nuisance and disturbance to local residents; and ensuring supplies of essential requirements such as clean drinking water, energy, medical care and schooling to the construction workforce, their families and local residents during the construction period. This section outlines the requirements of the management plan, section 8.8 details the mitigation plan and section 8.10 deals with monitoring requirements.

8.10.2. OBJECTIVES

The broad purpose of the EMP is to ensure that the various environmental protection measures identified during the project planning phase are implemented during the construction phase, so that environmental degradation and pollution resulting from construction activities are minimised.

Specific objectives of the plan are to:

Define organisational and administrative arrangements for environmental monitoring of the contracts, including the definition of responsibilities of staff, and the co-ordination, liaison and reporting procedures.

Discuss procedures for pro-active environmental management, so that potential problems can be identified and mitigating measures adopted, prior to works being carried out.

8.10.3. SCOPE OF THE ENVIRONMENTAL MANAGEMENT PLAN

The EMP is concerned with the impacts on the environment due to construction of the new bridge over the River Zambezi at Chirundu border post, and the means of controlling these impacts through the provisions made under the contract.

The EMP is also concerned with the social impacts of the proposed project, with regard to health, energy provision, schooling, water supply etc, as well as the impacts on socio-economic activities. The health and safety of the construction workers will also be controlled by national legislation and regulations.

8.10.4. METHODOLOGY

The basic approach to preparing the management plan has comprised:

review of the mitigation plan;
discussions with engineering staff engaged on the design phase of the project; and
consideration of the experience gained in environmental monitoring.

8.10.5. ENVIRONMENTAL MANAGEMENT PLAN - EMP

The Engineer and contractors engaged to undertake the pre-construction and construction phase of the project will have sufficient experience in project management, that training in environmental monitoring and mitigation will not be required, and that the specifications of the contracts will be upheld.

Environmental control of construction activities can only be achieved within the provisions of the various contracts for the works. The Engineer's role is to monitor the activities of the contractors and, where necessary, take action under the terms of the contract to prevent and minimise environmental damage.

(1) Contractors' Organisation

The tender documents should require the contractor to state his environmental policy. The designation of clear responsibility for environmental protection within the contractor's organisation is a critical factor in the achievement of good environmental control and should figure in the tender adjudication procedure.

It is thus necessary that the contractors are asked to develop their proposals for environmental management of the contracts, in a similar manner to those required for Health and Safety (H&S). As a minimum, this must include:

a clear statement of their environmental policy;
details of their organisational framework, in particular the designation of an engineer to take overall responsibility and to manage environmental control facilities on a day to day basis and liaise with the Resident Engineer's monitoring team;
details of the principal pollution control facilities proposed, including procedures for operation, maintenance and disposal of wastes, and of contingency plans in the event of failure of these facilities, particularly with regard to the River Zambezi;
details of his proposed environmental monitoring procedures, to ensure facilities are operating satisfactorily and that problems are being dealt with promptly; and
details of the environmental awareness training programme proposed for the workforce.

(2) Resident Engineer's Organisation (REO)

The following arrangements may need to be adjusted when the staffing structure for the project is finalised.

Ultimate responsibility for environmental matters within the REO will rest with the Project Manager (PM), with the Chief Resident Engineer (CRE) being responsible for day to day direction and management on the site. It will be necessary to have a Environmental Monitor (EM), who will make occasional visits to the sites, and a full time local Assistant Environmental Monitor (Assistant EM), who will be responsible for day to day monitoring of the projects.

The Environmental Monitor should have suitable experience in environmental management, and may need to be employed from an international consultancy.

The responsibilities of the team members are as follows:

Environmental Monitor (EM)

The EM has to act on two levels, on the one side he has to give overall advice and define the general procedures which will include environmental reports, on the other side he will be involved in the establishment of the day by day monitoring procedures. The following tasks a) to c) belong to the first category and tasks d) to p) belong to the second category.

a) To review and familiarise himself with the EMP, including advice on:
   - the environmental management framework;
   - reporting and liaison requirements;
   - key environmental issues;
   - monitoring strategy;
   - data management;
   - environmental control measures.

b) To carry out periodic environmental audits of the project in order to:
   - identify any deficiencies in environmental performance and advise on measures to address these;
   - assess the degree of compliance with the EMP achieved on site;
   - review the continuing relevance of the EMP in the light of experience, and instigate changes where appropriate;
   - review the organisation and administrative frameworks for environmental management and the inputs of the environmental monitoring team;
   - review environmental monitoring data and its management;
   - review environmental problems which have arisen and how these have been dealt with;
   - propose changes to the environmental management procedures and framework and identify the need for additional measures to control environmental degradation.

c) To provide ad-hoc advice on environmental issues to the Project Manager, CRE and Assistant EM.

d) To establish an effective environmental monitoring, sampling and analysis programme.

e) To establish routine management, liaison and reporting systems, including the establishment of an environmental database.

f) To interpret initially the results of the monitoring programme and advise the responsible REs of action required.

g) To prepare, initially, routine management reports.

h) To advise the CRE/PM on the contractors' proposals for site establishments in terms of landscape, drainage, erosion control, liquid, solid and hazardous waste management, fuel and chemical storage and site restoration.

i) To review the contractors' proposals for pollution control facilities and advise on the adequacy.

j) To vet the contractors' proposed methods of working for environmental impacts and recommend safeguards.

k) To co-ordinate initially the sampling and analysis programme with a nominated laboratory.
l) To liaise and report on a routine basis, in respect of environmental matters, with senior management, and the Ministry of Works and Supply, and the Ministry of Environment and Natural Resources (Environment Council of Zambia) in Zambia, and with the Ministry of Transport and Energy and the Ministry of Environment (Natural Resources) in Zimbabwe.
m) To train and support the Assistant EM.
n) To recommend the procurement of the equipment required for environmental monitoring.
o) To advise on the need for expert assistance when required.

Assistant Environmental Monitor

The Assistant EM has to take over, after training, the tasks f, g, k, and l of the EM, in addition to the basic routine tasks as listed below:

a) To undertake environmental monitoring through site inspections on a day to day basis and notify the EM or the REs of any problems.
b) To carry out the routine sampling and analysis programmes, and take ad-hoc samples as and when necessary.
c) To look after the environmental monitoring equipment and advise the EM or RE of any defects, problems or replacement/additional requirements.
d) To assist the EM in the analysis of results, preparation of reports and with other duties, as required.
e) To be responsible for the day to day management of the database systems established.
f) To liaise with the local communities and act as a channel for their concerns.

(3) Liaison, Co-ordination and Reporting

1) Consultant's Internal Co-ordination and Reporting

The Environmental Monitoring Team on site will report to the responsible REs.

Daily Report Forms which comprise a checklist of environmental issues at each work site, will need to be drawn up by the EM to suit the specific problems of the works under each of the contracts. These forms are intended to demonstrate that compliance with the environmental requirements of the contract is being achieved and to identify any problems arising. The forms should be copied to the RE for information and for action where required. When there are serious infringements of the environmental requirements of the contract, a *Failure Report Form* will be issued to notify the CRE/RE that urgent action is required. These forms will also provide an incident log for the project.

The Environmental Monitoring Team will prepare a monthly report, which should not be lengthy, but will summarise issues carried over from the previous report, stating whether they have been resolved or are on-going, and new issues arising. This should be included in a general monthly progress report submitted to the Ministry of Works and Supply in Zambia and the Ministry of Transport and Energy in Zimbabwe. It is not envisaged that formal meetings will be required for internal management of the environmental programme, and that ad-hoc meetings would be adequate.

2) Liaison with the Contractors

The Assistant EM will attend a weekly site meeting of the relevant contractors' staff and address environmental shortcomings there.

From the contractor's side, when there are particular problems, the meetings should be attended by a senior manager, and the engineer responsible for environmental protection. For the consultant, the EM or Assistant EM and the RE/CRE will attend. These meetings will be minuted.

3) Liaison with Ministry of Works and Supply, Zambia, and Ministry of Transport and Energy, Zimbabwe

As noted above the Assistant EM will prepare a short monthly report for submission to the relevant ministries, and will be available to attend progress meetings where required.

4) Liaison with the Local-Community

Liaison with the local community will be important during the construction period, to ensure that their views are being taken into account and that problems and nuisances, such as noise and dust, are reduced to a minimum.

All complaints must be recorded, giving the time, date and category of complaint, ie urgent (if the problem is life or injury threatening); standard (if a genuine valid complaint which can be dealt with under the contract); or minor (if only a matter of inconvenience not covered by the contract). The records should show what action was taken, and when, and what monitoring is needed.

(4) Environmental Management and Audit Programme

The first few months of the construction phase of the project components will be critical for the establishment of the EMP. It is anticipated that the Programme should be audited annually, but that the first audit should be carried out after about 6 months to review the establishment of the management systems and procedures. The process of environmental management should be continuously evolving and improving as the project proceeds.

8.11. ENVIRONMENTAL MONITORING

8.11.1. INTRODUCTION

Monitoring is the continuous assessment of project implementation in relation to agreed schedules. It is an integral part of good management by the Engineer during construction. The main objectives of monitoring are to provide continuous feedback on implementation, and to identify actual or potential successes and problems as early as possible, to facilitate timely adjustments to project operation. The creation or strengthening of monitoring activities under the project should not be seen as a temporary requirement, but an institution-building component of the project which should permanently improve overall management practice.

8.11.2. OBJECTIVES

The objective of a monitoring system is to assist project management, through:

defining requirements and procedures for environmental monitoring, including equipment needs, frequencies of monitoring, parameters to be monitored, analytical services required, data management and presentation etc.

identifying targets and objectives for project implementation;

maintaining easily retrievable records of project implementation which can be used for evaluation;

identifying problems encountered by the project and defining procedures for environmental control, in the event of pollution or similar incidents requiring action; and

providing readily available analyses for decision-making.

8.11.3. SCOPE OF THE MONITORING PLAN

The scope of the monitoring plan is:

To identify the monitoring tasks which should be undertaken by the EM during the construction phase of the project.

To identify the frequency and nature of monitoring.

To recommend samples to be taken for analysis and parameters to be measured.

8.11.4. METHODOLOGY

The basic approach to preparing this monitoring plan has comprised:

a review of the Mitigation Plan developed in section 8.8, and in particular of the monitoring requirements identified for the construction phase of the project;

discussions with engineering staff engaged in the design of the project; and

consideration of the experience in environmental monitoring.

8.11.5. ENVIRONMENTAL MONITORING

The aim of the monitoring plan is to develop a cost effective approach to monitoring the contractors' environmental performance. Certain parameters (eg noise, water quality etc) can be monitored through measurement; others can only be monitored through observation (eg tree loss). However, in all cases anticipation of environmental problems through assessment of the environmental impact of the contractors' working methods, followed by forward planning to prevent problems (or at least to limit their effects), is seen as the key to successful environmental management.

Baseline data presented in this EIA has been collected to establish existing conditions, which will help to define the requirements for site restoration and provide a basis for comparison of effects during construction.

A post project audit should be carried out to examine the success of the site restoration and evaluate the effectiveness of the mitigation measures adopted.

8.11.6. MONITORING REQUIREMENTS

The monitoring requirements of the Monitoring Programme were identified in the Mitigation Plan. The Engineer should be responsible for monitoring the activities of the contractor and the EM and the Assistant EM should assist the Engineer in monitoring which requires measurement, according to the list of responsibilities identified in section on Environmental Management.

The monitoring activities can be divided into two groups, those which can be carried out through measurement, and those which will be carried out through observation. The majority of monitoring to be carried out under the Monitoring Plan will be through observation, and as stated above, will be the responsibility of the Engineer.

Table 8.6 provides details of the activities to be undertaken for each of the monitoring requirements. It is strongly recommended that corresponding clauses be developed for inclusion in the bid documents.

Table 8.6 Monitoring Activities and Indicators

Monitoring Issue	Method of Monitoring	Country of Relevance		Positive Indicator
		Zambia	Zimbabwe	
Soils	The Engineer should make a daily inspection of earth works, and ensure that slopes are suitably graded. Once earthworks are complete the Engineer should monitor the restoration measures implemented by the Contractor, such as re-vegetation or use of geotextiles.	*	*	Absence of rills, gullies or other erosion features.
Vegetation	The Engineer should ensure that excessive clearance of vegetation is avoided. The Contractor must seek the approval of the Engineer prior to clearance.	*	*	Area of vegetation cleared minimised.
Animals	The Engineer should carry out regular inspections of the site fencing, looking for holes or evidence of animal intrusion onto the site, and to check that animal access to the river is maintained. If animal intrusion on to the sites becomes a significant problem consultation should be carried out with the Parks and Wildlife Department.		*	Animal damage to site reduced to a minimum.
Birds	No monitoring required			

Monitoring Issue	Method of Monitoring	Country of Relevance		Positive Indicator
		Zambia	Zimbabwe	
Fish	The Engineer should monitor the contractor's procedures for preventing polluted water from flowing into the River Zambezi. Environmental Monitor to take water samples from the River Zambezi.	*	*	No dead fish found along river banks, and maintenance of water quality in the river.
Game Corridors	See "Animals"		*	
Poaching	Monitoring is the responsibility of the Zambia and Zimbabwe Police Departments	N/A	N/A	N/A
Land Take	Engineer to ensure contractor gives advance warning of any land take or demolition. The Ministry of Works and Supply, Zambia, and the Ministry of Transport and Energy Zimbabwe to arrange compensation for land loss where necessary. New houses to be built prior to demolition.	*	*	Land take and demolition minimised.
Health	The Engineer must ensure that the Contractor has liaised with the relevant government bodies (eg National AIDS/STD/TB/Leprosy Programme in Zambia and NECTOI and NACP in Zimbabwe) and that education and awareness campaigns are implemented, see Section 11.6.4 below.	*	*	Reduction in number of AIDS related diseases recorded at hospital and medical clinic.
Education	The Ministry of Works and Supply, Zambia and the Ministry of Transport and Energy, Zimbabwe should liaise with the relevant government departments to ensure that additional funds and teaching staff are available prior to the commencement of works.	*	*	Construction work force children receive education.
Road Safety	The Engineer should monitor the condition of trucks arriving at the site and keep a record of night driving.	*	*	No road accidents associated with project. Night driving kept to minimum.
Crime	The Engineer should ensure that the Contractor has provided lighting and security fencing where appropriate. Liaison with Police Department may be necessary if crime/theft becomes a problem.	*	*	Crime/Theft kept to minimum.

Monitoring Issue	Method of Monitoring	Country of Relevance		Positive Indicator
		Zambia	Zimbabwe	
Tourism	The Engineer should monitor complaints from tourist operators. Where appropriate measures should be taken to reduce nuisance (such as noise, dust etc)		*	Complaints from tourist operators minimised
Fisheries	The Engineer should monitor the procedures of the contractor and ensure that pollution (sediment or chemicals) does not enter the River Zambezi. Environmental Monitor to take water samples.	*	*	Water quality in river maintained, and no complaints from fish farm or other fisheries.
Archaeology	Provision should be made to allow archaeologists to be present on site during the excavation period if they so wish. The Engineer should inspect all excavations, and where archaeological remains are found work must stop until the Engineer has given the all clear to proceed. The Engineer should contact the Livingstone Museum in Zambia, or the Museum of Human Sciences in Zimbabwe in the event of a significant archaeological find.	*	*	Archaeological remains not excavated or disturbed.
Minerals	The Engineer should inspect borrow pits to ensure that they have been properly filled/restored after excavation.	*	*	Pits left so that water cannot accumulate.
Energy	The Engineer must inspect the provisions made by the Contractor to supply energy to the work force, and ensure that fuel wood is not being collected.	*	*	Energy supplied by electric generator or other suitable source.
Noise	Noise monitoring should be carried out on an ad-hoc basis by the assistant environmental monitor to establish noise levels at the centre of the works areas, at the boundary of the site and at the nearest sensitive receiver.	*	*	Noise levels at the nearest sensitive receiver should not exceed the levels suggested in Appendix 3.
Air Pollution	Observations should be made on the level of dust generated during construction activities by the assistant environmental monitor. Damping down should be carried out if levels are unacceptable. Further details on the method to be used are given below.	*	*	Deposition of dust on surfaces should decrease with increased dampening.

Monitoring Issue	Method of Monitoring	Country of Relevance		Positive Indicator
		Zambia	Zimbabwe	
Water Resources	The Engineer must inspect the provisions made by the contractor to provide the construction workforce, and the local residents with drinking water during the construction period. In Zambia a new water treatment works should be built prior to commencing works. In Zimbabwe the water intake works should be moved upstream from the proposed works.	*	*	Clean water supply maintained throughout construction period.
Landscape	The Engineer should make visual inspection of earth works to ensure that excessive excavation is not being carried out. Temporary screening may be appropriate in some cases.	*	*	Landscape alteration reduced to a minimum.
Complaints	The Engineer should inspect the record of complaints made by local residents, to be kept by the Contractor, and should check that action is taken quickly and that the number of complaints does not rise significantly.	*	*	Number of complaints decreases.

The following monitoring requirements (for water quality, noise and dust) will be the responsibility of the Assistant EM (after training and instruction from the EM).

(1) Water Quality

Water quality checks during the construction phase of the project are necessary, to determine the quality of water pumped from excavations and discharges from construction sites, and to monitor the effects of any localised pollution due to human activities and spills.

The principal aim of water quality monitoring is to ensure that the construction activities do not compromise the availability of good quality water for other uses. The monitoring strategy must reflect this objective.

Monitoring of ambient quality will determine whether there are likely to be problems for downstream uses, whereas monitoring of the effluents will help to identify the source of the problem and the remedial action.

Even if specific effluents are not fully compliant with the specification, if their impact is not significant (eg due to small discharges), then action to improve the effluent is not warranted. Similarly, if both impact and control samples show water quality parameter levels in excess of the guideline limits, then it can be taken that these are not attributable to the works.

Parameters monitored should reflect the type of contaminants likely to be encountered. For example contamination with concrete may be shown through elevated pH levels.

Ad-hoc sampling shall be taken during the course of construction as required. Some parameters can be measured directly in the field, whereas others will need to be sent to a laboratory for analysis. Arrangements should be made with the laboratory to ensure that correct bottles and preservatives are used. Direct reading instruments are available for field measurement of pH, temperature, conductivity and dissolved oxygen. Calibration procedures need to be followed before use, and it is recommended that two instruments of each type are purchased for quality assurance checking purposes and to provide back up in the event of equipment failure.

Portable incubating equipment should be used in the event of sample collection for microbiological analysis for determination of faecal coliforms. The same applies to oil and grease measurements.

Samples should be taken in running water, as far from the bank as possible. The sampling bottle should be plunged neck down into the water for about 0.2m (if possible), and then turned until the neck points slightly upwards, the mouth being directed into the current so that any contamination on the hands will be washed away from the bottle. Where samples are collected for analysis of microbiological content care should be taken not to touch the inside or mouth of the bottle or the inside of the lid, which should be sterilised before use.

(2) Noise

During construction, noise should be measured through measurement. The aim of environmental noise monitoring is to limit nuisance to local inhabitants and the work force. Likely sources of nuisance include heavy construction plant and vehicles, and blasting.

An ad-hoc approach should be adopted, depending on which activities are in progress and their respective locations on site in relation to sensitive receivers. Measurements should be made at the locations where the sound is being received.

During the pre-construction phase it will be necessary to take background noise readings, where there are sensitive receivers close to sites, before works begin.

The schedule of monitoring will be in accordance with need. The contractors' plant, equipment and working methods shall be such that the maximum sound levels recommended in the specification shall not be exceeded. Possible measures include limitations on working hours, construction of noise barriers, the use of silencers on equipment and speed limits on roads. Noise levels from mechanical plant can also be reduced through regular servicing. The noise meter should be recalibrated by a recognised acoustics laboratory, every two years..

(3) Dust

The objective of monitoring dust is in order to control nuisance, to both local inhabitants and the work force on site. Sites for monitoring must, ideally, be located in areas where there are sensitive receivers. However, this may not be practical due to the problems of theft and vandalism, and therefore, monitoring sites within the boundary of the working sites may be used.

In view of this shortcoming, and the fact that ambient dust levels are generally high anyway (and local inhabitants are thus used to dust), the value of monitoring is limited. However, the equipment is relatively cheap to install and run, and can provide a lever to encourage the

contractors to control dust arisings through watering. Other means of dust control, such as the spraying of oil, will not be permitted.

Dust arisings are generally greatest along un-surfaced access roads, and at areas where loose materials are handled (spoil handling areas, stockpiles, tips etc). The sites for monitoring stations should reflect this and the proximity of sensitive receivers (eg site offices) within the site boundaries. In general the parameter to be measured is the weight of dust accumulated within a specified time period, generally one week to one month, although any period may be used, depending on circumstances, site activity and need. This measurement is then converted to units of $g/m^2/d$ using a formula based on the type of equipment used. A multi-directional fallout bucket is recommended, for monitoring, and consists of four removable dust collectors placed at right angles, mounted at a height of 2m above ground and fitted with bird guards.

The weight of dust accumulated is measured by gravimetric analysis: the dust in each collector is entrained in a small volume of clean water and the mixture filtered through standard filter paper (of know weight), dried and weighed. Results are presented in terms of accumulations of dust in each direction (N, S, E and W) and as a total. Background dust levels will be measured before works begin, and where there is an increase of more than 50% remedial measures will be taken.

(4) AIDS/HIV

HIV/AIDS in Zambia and Zimbabwe is reaching epidemic proportions. It is estimated that since 1988 there have been 36,000 deaths in Karoi District (Zimbabwe) alone, and a large proportion of the this is attributed to the Chirundu border crossing and the population of prostitutes who serve the transport industry. There is strong evidence to show that increased mobility is linked to the spread of HIV, and in addition to this workers involved in the construction and maintenance of infrastructure may comprise a mobile and at risk population. The spread of AIDS is therefore of great concern, not only for the construction of the new bridge, but also in the long term. Four main areas of concern have been highlighted:

People employed in building and maintaining infrastructure
People who work on the roads
Professionals engaged in the management of the sector
Passengers

These group must be appropriately targeted if the spread of HIV is to be reduced.

There is no need to develop a separate education package, since there this can be drawn from existing government or non-governmental organisations. Contacts have already been identified in the Mitigation Plan, and include the National AIDS/STD/TB/Leprosy Programme in Zambia and NACP in Zimbabwe.

Key points for the Engineer to monitor are that:

The Contractor has contacted government/non-government organisations to implement education.
Whole families are moved rather than individual workers
Condoms are continuously available
Key Managers are trained
Peer construction workers, lorry drivers, prostitues etc are trained

8.11.7. MANPOWER AND BUDGETING

It is envisaged that the Engineer will carry out the construction environmental monitoring programme as part of the contract. The EM will be employed on a full time basis. The Assistant EM will be full time, and will report to the Engineer, and the EM. The cost of implementing the monitoring plan will include the full time salary of the EM and Assistant EM. It may be necessary to employ an international environmental expert for the initial training of EMs and subsequently to attend at audit time.

9 CONSTRUCTION PLAN AND PROJECT COST ESTIMATION

9 CONSTRUCTION PLAN AND PROJECT COST ESTIMATION

9.1. GENERAL

9.1.1. TOPOGRAPHY AND GEOLOGY

The Zambezi River flows down generally in the low land called Zambezi Escarpment which is a part of the East African Escarpment. The existing Otto Beit bridge is located at the narrowest point of the Zambezi River around the project site. At upstream of the Bridge, the river bank at right side (Zimbabwean side) is a gentle to steep cliff with riverside woods but at left side (Zambian side) is a steep cliff with riverside woods and swampy area. At down stream of the Bridge, relatively gentle slopes ascend from the river edges. On the Zambian side, privately developed township is formed on the riverside slope, however, on the Zimbabwean side, relatively thick bush covers the river bank.

The geological condition of the area is lying Karoo series and consisting of grits, sandstones and siltstones laid down as marine deposits in the Triassic period. The soils consist in general of fine to medium grained sands, overlaying compact sodic horizons, which are usually almost impervious.

9.1.2. WEATHER

Climatic condition of both countries are classified as Tropical Savannah however, the highest temperature seldom reaches beyond 30℃ since most of the land is situated on high plateau. There are three seasons classified as cool dry season from May to August, hot dry season from September to November and hot and high humid rainy season from December to April. The survey area lies in low land and sometime the maximum temperature goes up to more than 40℃ during October to December. Annual rain fall is approximately 700mm and most of the rains fall from January to March in rainy season.

9.1.3. EARTHQUAKE

There have been no big scale earthquake in both countries however earthquake record shows that there were small scale earthquakes around the Lake Kariba. The maximum magnitude was 4.5 in 18.7.1996.

9.2. CONSTRUCTION PLAN

9.2.1. TEMPORARY FACILITIES

(1) Temporary Bridge and Access

River bank of Zambezi river at Zambia side is steep cliff and further more, according to the investigation of river bed profile, river bed at Zambia side is scoured very deep. Therefore, except for construction of abutment and a part of bridge superstructure at Zambia side, all the material and equipment for construction of foundation, substructure and superstructure have to be supplied through temporary access road and bridge extended from Zimbabwe side.

As shown in Figure 9.1, temporary access road will be constructed on the same route as permanent access road, however, it will be diverted approximately 10 to 15m away parallel to the bridge axis from behind of abutment of Zimbabwe side and connected to the temporary bridge. Temporary bridge will be built of section steel with pre-cast concrete deck. Bridge deck level will be at elevation 375m which is 2.5m higher than Medium Floodwater Level (MFL) to assure safe work through out the construction period.

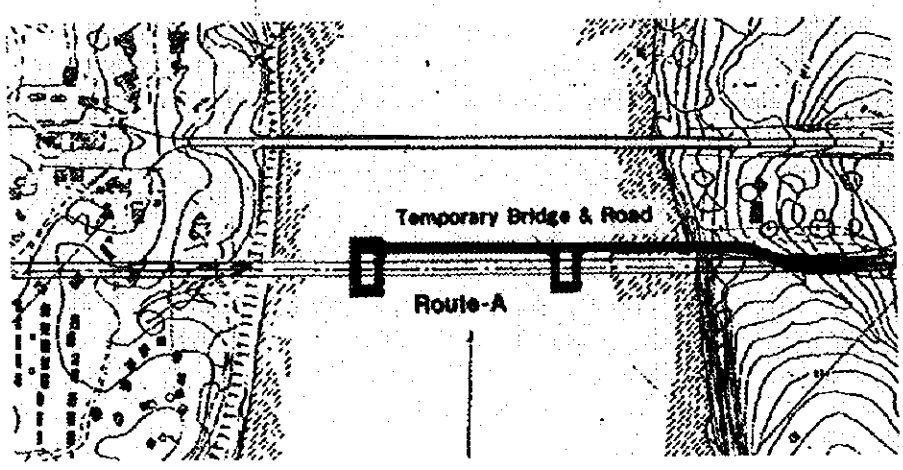


Figure 9.1 Temporary Road and Bridge

(2) Camp Yard

As a camp yard, 10,000m² of land with the facilities of temporary site office, worker's accommodation for both local and expatriate, material stock yard and parking is secured between the existing road and access road newly built at Zambia side. As a base camp, 20,000m² of land with the facilities of main site office, worker's accommodation for both of local and expatriate, material stock yard, parking, concrete batching plant of 50m³/hr capacity and water purification plant will be secured in front of V.I.D. site in Zimbabwe.

(3) Water Supply

Quality of water of Zambezi river is suitable for mixing concrete in dry season, however water contains many sediment during the rainy season. Therefore, water used for the construction and daily site life will be pumped up from the river, purified mechanically, reserved in tank and distributed by water pipe with pressure as required. 10m³/hr capacity plant will be installed on Zambia side and 2 by 10m³/hr capacity plant will be installed on Zimbabwe side.

(4) Power Supply

In general, all the power supply for construction purpose including supply to the temporary facilities at both side is generated by diesel engine generator.

9.2.2. BRIDGE CONSTRUCTION

(1) Foundation

Temporary cofferdam using steel pipe sheet piles will be built prior to the foundation work. Toe of the pile will penetrate approximately 4m into the hard layer of more than 50 of SPT value to serve for both as temporary cofferdam and anti-scouring of substructure.

After the piling has been completed, excavation inside of cofferdam will be carried out to the surface sediment and medium hard layers with simultaneous work of dewatering and temporary strutting and waling. Then after bedding, levelling concrete will be cast, reinforcing bar for footing will be assembled and the concrete will be cast.

(2) Pier concrete

Ordinary form of large sections will be used for pier concrete work.

(3) Deck concrete

The first block of deck concrete of approximately 12m in length will be cast on the pier head with temporary bracket and staging erected from pier concrete, then the deck concrete work will be advanced to both of left and right by mobile erection platform with balancing method. Deck length of one block will be 2.0 to 3.5 meters and will be tied together block by block by pre-stressing cables.

After the bridge decks are extended approximately 60m, mobile erection platform will be shifted to the opposite side of deck cast priory on temporary staging at both of Zambia and Zimbabwe and will be advanced towards center of the bridge to join with the deck end on the above. Final closing of the deck will be made with hanging shattering at the bridge center.

(4) Finishing Work

After the bridge deck work has been completed, finishing work such as sidewalk, handrailing, lighting and paving work will follow.

9.2.3. BORDER POST FACILITIES CONSTRUCTION

(1) Yard Formation

After clearing and grabbing work, yard preparation for border post facilities will be carried out using heavy earth moving equipment to the required area and height. Due to the proximity of existing border facilities and buildings, blasting method will not be used although it is expected to encounter with rocks while doing the earthworks. Giant breaker will be used for breaking.

(2) Road and Parking Area

Section of road and parking are as shown in Figure 5.10 however hard standing at freight inspection will be paved with reinforced concrete to prevent dent on the surface of pavement due to longer period of parking for inspection of cargoes.

(3) Buildings

All the buildings will be designed and constructed following the local standard, and locally available construction materials and technique will be fully utilized.

9.2.4. WORKING PROGRAM

Working program for bridge and other facilities is shown in Figure 9.2 and the total construction period is estimated at approximately 36 months.

9.3. PROJECT COST ESTIMATION

9.3.1. CONDITIONS

(1) Working Condition of Labour

1) Working Hour

In Zambia, working hours per week are 45hrs. based on a 6days week.

Sunday is holiday.
There are 12 public holidays per annum.
Overtime rate are as follows;

- Exceeding 45hrs in working day is to add	50%
- Sunday, Christmas and New Year's Day	100%
- Public Holiday	200%

In Zimbabwe, working hour a week is 44hrs. based on a 5days week.

Saturday and Sunday are holidays.
There are 12 public holidays per annum.
Overtime rate are as follows;

- Monday-Friday is to add	33.3%	(up to 16hrs per week)
- Saturday	50%	
- Sunday	100%	
- Bank Holiday	200%	

2) Minimum Wages

In Zambia, minimum wages of worker is decided by Ministry of Labour and Social Security varies depending on the category.

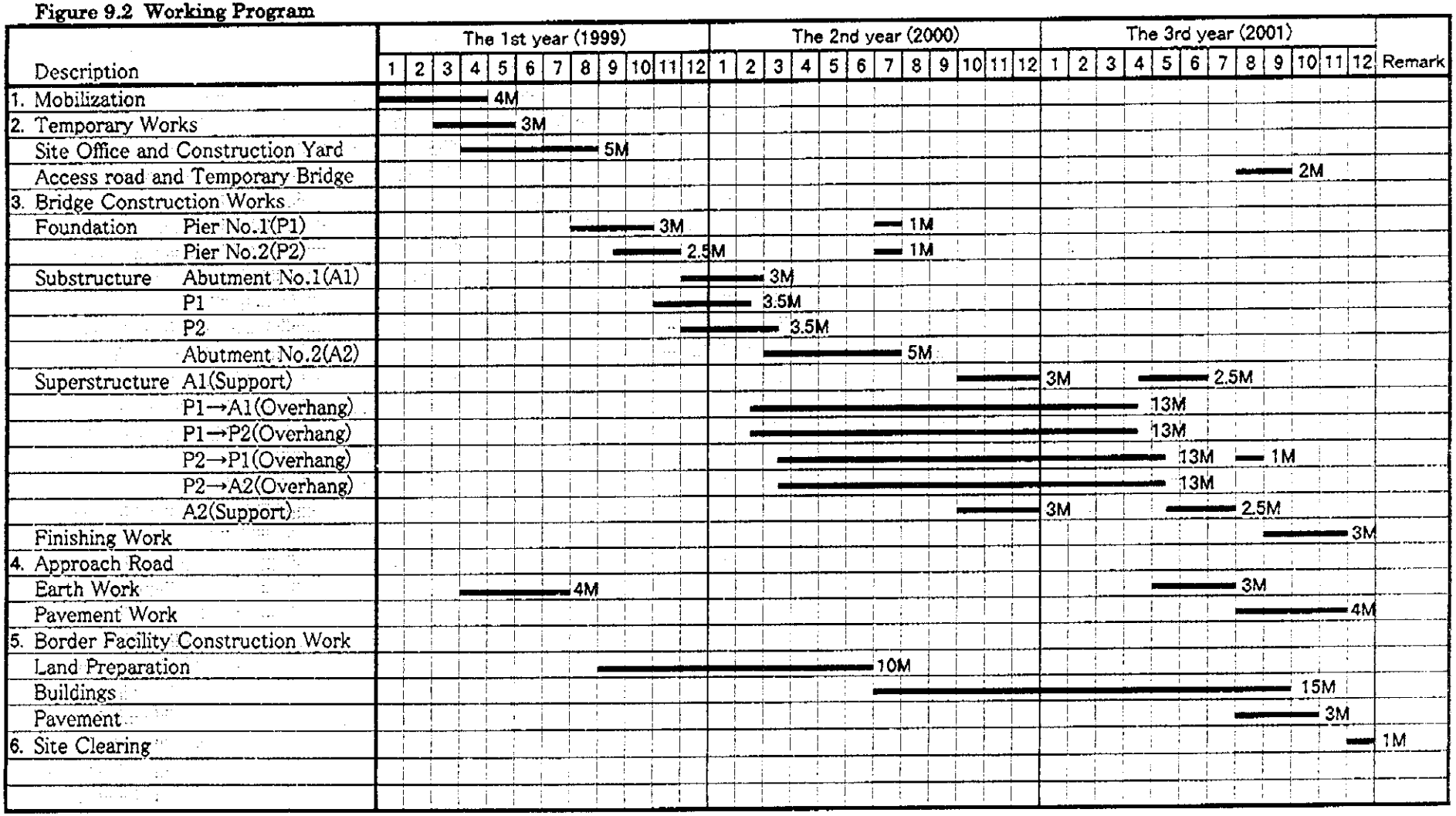
	K/hr		1st July,1997 K/hr
Workmen	279.00	Semi-Skilled	286.00
Skilled Class III	373.00	Skilled Class II	403.00/408.00
Skilled Class I	443~454.00		

In Zimbabwe, minimum wages of worker is decided by National Employment Council and varied depending on the category.

		Z$/hr			1996/97 Z$/hr
Skilled Worker	1	11.23	Worker Grade	1	4.25
Skilled Worker	2	9.55	Worker Grade	2	4.45
Skilled Worker	3	8.48	Worker Grade	3	5.11
Skilled Worker	4	6.40	Worker Grade	4	6.15

The above figures will be increased by 28~30% for 1997/98.

Figure 9.2 Working Program



(2) Social Security

In Zambia, there are two categories in the social securities namely;

Pension Fund: 7%
Both of employer and employee has to contribute the same percentage (3.5%) of the basic wage of the employee.

Workmen's Compensations Fund: varies
Only the employer has to contribute to the fund as insurance against injury of his employee.

In Zimbabwe, employer has to contribute following allowances in addition to the wage.

Pension Fund:	5%
Social Security:	3%
Death Benefit:	1%
Workmen's Compensation:	2%
Council General Fund:	Z$26/a for unskilled and Z$ 52/a for skilled.

The same percentage and amount of pension fund and general fund are to be deducted from the wage of the employee and contributed to the Council.

(3) Capability of Local Contractors

In Zambia, there are several local contractors registered with the Ministry of Works and Supply however, most of them are rather small scale companies. Among them are; Burton Construction Ltd., J. J. Lowe (Zambia) Ltd. and Minestone (Zambia) Ltd. who are considered to be capable to carry out this type of project. In addition to the above, Basil Read (PTY) Ltd., Belga Construction and Trading (PTY) Ltd., Murry and Roberts Ltd., Phoenix A/S Contractors, Shimizu Corporation and China Hainan International Corporation Co., Ltd. are registered with The Roads Department and Nemerit Enterprise Ltd., Appollo Enterprises Ltd.m Delkins Ltd., Velos Enterprises Ltd., Met-Weld Fabrication Ltd. and Simu Ltd. are registered with The Building Department.

In Zimbabwe, there are some considerably larger local contractors with full support from international contractors such as Costain and Skanska. Among them are: Costain (Africa) Ltd., Skanska Jensen Zimbabwe (Pvt.) Ltd. and International Construction Zimbabwe. They are considered to have sufficient capability to carry out this type of project. Specialized contractors such as Zimfranki who is foundation contractor with full support from Franki South Africa (Pty) Ltd. is also available in Zimbabwe.

1) Construction Equipment

Except for rather small size cranes and earth moving machines, heavy equipment normally deployed for such a project are not available in either country. Most of heavy equipment need to be brought from South Africa.

2) Experience

In Zambia, Minestone (Zambia) Ltd. has been working with a Japanese contractor on a Japanese Grant Aid project for many years. Burton Construction Ltd. has also worked for another Japanese contractor in upgrading of Kafue Road project a couple of years ago.

In Zimbabwe, Costain (Africa) Ltd. built major buildings in Harare skyline and also built a New Road and a Bridge at Raffingoa-Guruve and the Claw Dam etc. Skanska Jensen Zimbabwe (Pvt.) Ltd. built the Bulk Storage Silo in Bulawayo, the Morton Jeffrey Water Works in Harare and a Sewage Treatment Facility in Mavsingo Sewage Works. International Construction Zimbabwe worked for a Japanese contractor in the construction of Six Bridges a Project under Japanese Grant Aid.

(4) Procurement of Materials

1) Aggregates

In Zambia, there is a granite stone quarry belonging to Roads Department in Kafue about 100km away from the project site. Fine aggregate is also available from a river near the project site.

In Zimbabwe, there is no granite stone quarry near to the project site other than lime stone quarry therefore, for high strength concrete, granite stone has to be transported from Harare. Fine aggregate is easily obtainable from Zambezi river bank and bed.

2) Cement

In Zambia, cement is produced at Chilanga, south of Lusaka. The annual production is more than 350,000 ton and about one third of products are exported to neighbouring countries including Zimbabwe.

In Zimbabwe, the nearest cement factory to the project site is located in the outskirts of Harare. Its annual production is smaller than the one in Zambia.

Cement produced in both countries has enough strength to supply the 400kgf/cm2 of concrete for pre-stressed concrete.

3) Reinforcing Bar

Max. 40mm diameter of high yield deformed bar is produced in Zimbabwe under the specification of the British Standard.

4) Premix

The nearest premix plant for pavement is located in the Roads Department quarry at Kafue, Zambia.

9.3.2. PROJECT COST ESTIMATION

(1) Cost Estimation Conditions

1) Contract Method

For the purpose of this cost estimation it is assumed that the project is contracted through international bidding.

2) Construction Method

The construction method is as prescribed in 9.2 of this chapter.

3) Base Year for Cost Estimation

Cost calculations are based on the material cost, labour cost and equipment cost estimated at October 1997 prices. Imported material costs include all import taxes at October 1997 rates and the exchange rate applied are 1US$ =12.3Z$ =1,300K.

4) Foreign and Local Currency Portions

As the total cost, the proportion of foreign currency and local currency have also been estimated with classification into foreign and local currency components based on the following principles.

A) Foreign Currency
- Wages of foreign personnel,
- Overhead and profit of foreign firms,
- Imported equipment, materials and supplies,
- Partial cost of domestic materials

B) Local Currency
- Domestic equipment, materials and supplies,
- Wages of local personnel,
- Overhead and profit of local firms,
- Taxes

(2) Cost Estimation Procedure

1) Method

Cost estimation procedure is as shown in Figure 9.3. Direct construction cost of each work item is estimated by accumulating method which combines cost of labour, equipment and material as in the normal estimation method. In case of project utilizing heavy construction machines, cost of machine occupy a major share of the work items. Although it may vary widely depending on length of time the machine is used, the cost of machine is calculated by usage and capacity of machines. Working time of machine is estimated taking into consideration the typical construction machine and its capacity.

Indirect construction cost can be calculated by the accumulation of cost of each work item. Indirect cost which include temporary facilities, field management expenses and general management expenses is calculated as a percentage against direct construction cost. Project costs also include contingencies, land acquisition and compensation cost which are calculated and added separately.

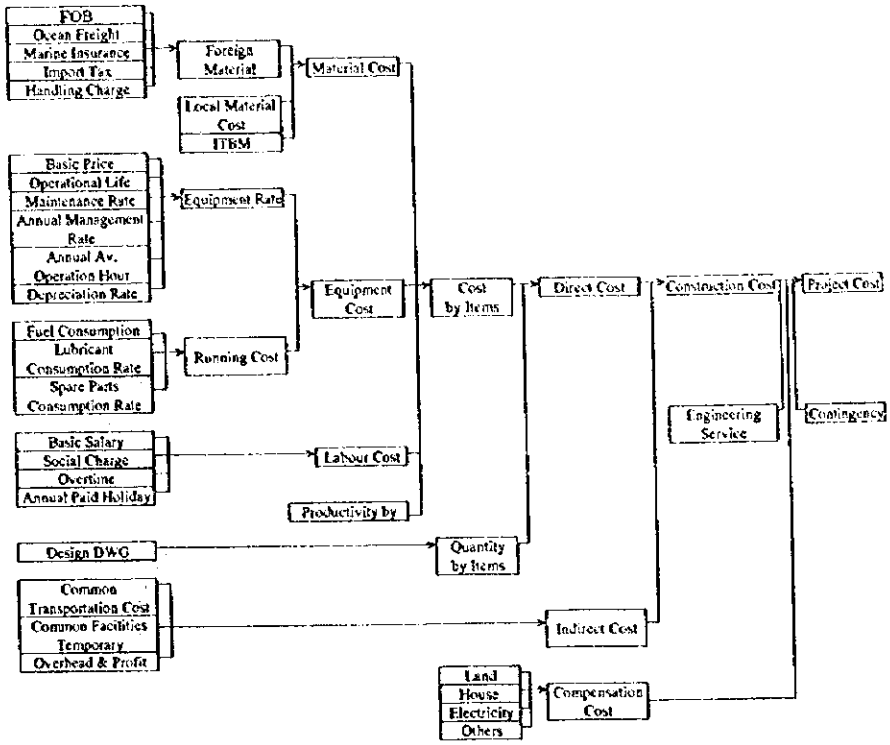


Figure 9.3 Cost Estimation Procedure

2) Labor Cost

Based on the conditions described in (1) of 9.3.1 of this chapter, basic salaries for both countries have been calculated over a whole year including holidays. Unit labour costs include 30 hours in Zambia and 65 hours (including Saturday work) in Zimbabwe, of overtime work per month. Basic salary includes social security charges in both countries respectively. Unit labour costs are classified into 5 categories as follows. (Refer to Table 9.1)

Table 9.1 Unit Labour Cost

		Zambia		Zimbabwe	
Classification	Unit	Foreign	Local(K)	Foreign	Local(Z$)
Driver	hour	0	690	0	16
Foreman	hour	0	1560	0	45
Operator	hour	0	780	0	27
Skilled Labour	hour	0	640	0	20
Unskilled Labour	hour	0	410	0	10

3) Material Cost

Materials are divided into domestic products and imported materials. CIF(cost, insurance and freight) prices of imported materials which are not available in both countries are estimated from foreign prices. Material costs are estimated including charges and levies for import duty and tax, handling charge, sales tax in Zimbabwe and VAT in Zambia. 25% of the selling prices of imported materials are regarded as handling charge. 7.5% of the selling price is considered transportation charge and 50% of the transportation charges are estimated as the

foreign portion. Sales tax of 15% in Zimbabwe and VAT of 17.5% in Zambia is added to the material costs. In case of domestic products, majority of the cost component of raw materials is regarded as expenses of the production plants, equipment, transportation and fuel which would have been imported. Unit costs of material are shown in Table 9.2 and assumed foreign and local currency portions for the major materials are shown in Table 9.3 respectively.

Table 9.2 Material Cost

		Zambia	Zimbabwe
Description	Unit	K	Z$
Cement	ton	143,000	1,130
Fine Aggregate	m3	7,800	100
Coarse Aggregate	m3	50,700	471
Section Steel	ton	2,873,000	24,000
Reinforcement	ton	663,000	4,950
Wood	m3	328,900	4,800
Asphalt	ton	479,700	3,750
Gasoline	l	1,100	5
Diesel Oil	l	995	4
Electricity	kwh	48	0.4

Table 9.3 Foreign Currency Portion in Raw Material (%)

	Zambia		Zimbabwe	
Description	Foreign	Local	Foreign	Local
Cement	48.0	52.0	49.0	51.0
Fine Agg.	48.0	52.0	49.0	51.0
Coarse Agg.	49.0	51.0	48.0	52.0
Section Steel	69.0	31.0	67.5	32.5
Reinforcement	68.8	32.2	49.0	51.0
Wood	38.0	62.0	48.0	52.0
Asphalt	76.5	23.5	74.8	25.2
Gasoline	64.8	35.2	47.4	52.6
Diesel Oil	68.8	32.2	52.3	47.7
Electricity	62.0	38.0	61.0	39.0

4) Equipment Cost

Construction equipment costs are estimated assuming that the equipment will be assigned to other projects when the same is not being used for the project. Only limited types of construction machines are available in both countries and most of the major construction machines will be rented from RSA (Republic of South Africa). Machine cost includes transportation charge, sales tax and all other expenses except for operator and driver which are calculated in labour cost.

Machine cost could be divided into rental cost and operation cost.

rental cost per hour = basic price(1.0−residual value ratio)] ×depreciation rate
+annual maintenance rate per hour+ management rate per hour

depreciation rate = 1/(annual operation hour×operation life)

Operation costs include fuel, lubricant, spare parts, wages of management and maintenance costs per hour.

5) Contingency

Contingency consisting of price contingency and physical contingency is estimated as 15% of Direct Cost.

6) Indirect Costs

Indirect cost including common temporary facilities, site management, bonds and insurance and overhead and profit is estimated as 25% of Direct Cost and Contingency. The foreign currency portion and the local currency portion of indirect costs at both countries are shown in Table 9.4.

7) Engineering Service Cost

Engineering cost varies depending on the scale of project, tender processing and contract method. As a standard case, engineering cost of this project is estimated as 10% of the total cost. Currency portion of foreign and local is allocated in the same ratio as the total cost.

8) Land Acquisition and Compensation Costs

Cost of land acquisition and compensation was estimated by category using the result of market price investigation at both countries.

Table 9.4 Indirect Cost Component (%)

Description	Foreign	Local	Total
1. Common temporary facilities			
1-1 Transportation	1.0	0.5	1.5
1-2 Mobilisation	0.5	1.0	1.5
1-3 Temporary facilities	0.5	1.0	1.5
1-4 Environmental control	0.2	0.3	0.5
1-5 Safety facilities	0.1	0.4	0.5
1-6 Public service charge	0.0	0.5	0.5
1-7 Quality control	1.0	1.0	2.0
1-8 Field office maintenance	0.5	1.5	2.0
Subtotal	3.8	6.2	10.0
2. Field management	2.0	6.0	8.0
3. General management	7.0	0.0	7.0
Total	12.8	12.2	25.0

9) Cost of Major work items

Table 9.5 summarises cost of major work items.

Table 9.5 Cost of Major Work Items

Description	Unit	Zambia		Zimbabwe	
		Foreign US$	Local US$	Foreign US$	Local US$
Excavation	m3	9.4	14.1	0.6	0.9
Rock Excavation	m3	28.2	49.4	10.6	16.5
Reinforcing	ton	756.5	547.8	201.5	470.2
Wood Form Work	m2	7.8	15.7	4.8	4.3
Steel Form Work	m2	16.3	13.2	2.0	5.3
Structural Concrete	m3	62.5	92.6	41.3	67.4
PC Concrete	m3	-	-	92.0	104.0
Post Tensioning	ton	-	-	2,555.4	1,095.2
Cantilever Box Girder	m2	-	-	501.4	1,253.2
Steel Pipe Sheet Pile	ton	-	-	1,568.3	371.9
Staging	m3	1.2	1.8	0.2	1.3
Section Steel Pile	ton	119.9	79.8	84.0	46.4
Support	m3	1.2	1.8	0.2	1.3
Sub Base	m3	21.5	14.3	9.8	6.3
Asphalt Pavement	ton	105.8	41.1	73.0	31.3
Building	m2	370.5	291.0	310.8	254.4

9.3.3. TOTAL PROJECT COST

Total project cost separated to foreign and local portion is as shown in Table 9.6 and total project cost separated to labour, material, equipment and tax and duty is shown in Table 9.7

Table 9.6 Total 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	15,385
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

Table 9.7 Break Down of Total Project Cost

US$ thousand

	Labor	Material	Equip.	Tax	Total
1. Direct Cost					
Bridge					
superstructure	456	2,877	727	1,607	5,667
substructure	514	3,218	753	1,012	5,497
sub total	970	6,095	1,480	2,619	11,164
Access Road	103	123	362	131	719
Border Post					
housing	3,877	6,294	2,752	2,462	15385
buildings	2,859	4,767	1,907	1,816	11,349
parking area	1,298	1,854	4,636	1,483	9,271
sub total	8,034	12,915	9,295	5,761	36,005
Direct Cost Total	9,107	19,133	11,137	8,511	47,888
2.Contingency(15%)	1366.05	2869.95	1670.55	1276.65	7,183
Total of 1~2	10,473	22,003	12,808	9,788	55,071
3.Indirect Cost(25%)	3,470	5,782	2,313	2,203	13,768
4.Engineering Cost(10%)	3,469	1,157	0	881	5,507
5.Land Acquisition	0	0	0	0	0
6.Conpensation	26	171	54	49	300
Total Project Cost	17,438	29,113	15,174	12,921	74,646

9.4. OPERATION AND MAINTENANCE COST

9.4.1. OPERATION AND MAINTENANCE METHOD

The maintenance and the operation of the bridge are considered separately. The bridge is mainly to be of concrete structure and should be relatively maintenance free. Routine maintenance is therefore confined to the cleaning and minor repairs and the operation is to supply of electricity for lighting.

9.4.2. OPERATION AND MAINTENANCE COST

The yearly maintenance and operation cost shown below shall be equally borne by both countries.

Operation & Maintenance Yearly Cost	Electricity Cost	(1)
	Cleaning Cost	(2)
	Repair Cost	(3)
	Others	(4)

1) Electricity Cost

This cost includes the cost of electricity for lighting and other facilities and services.

2) Cleaning Cost

This cost includes the cost of cleaning the bridge surface, drainage facilities, guardrails, regulatory signs and other services, including two persons to be provided for this purpose.

3) Repair Cost

This cost includes the cost of bridge surface repairs, overlays, inspection of structures, expansion joint repairs and inspection and repair of electric lighting.

4) Others

This item is taken as 10% of the total of (1)~(3).

The cost for the above maintenance work is summarized as follow.

Item	Cost (US$)
Electricity Cost	2,000
Cleaning Cost	4,500
Repair Cost	3,000
Others	950
Total	10,450

10 SOCIO-ECONOMIC EVALUATION OF THE PROJECT

10 SOCIO-ECONOMIC EVALUATION OF THE PROJECT

10.1. GENERAL

10.1.1. OBJECTIVES OF THE WORKS

The objective of this chapter is to carry out a socio-economic evaluation of the project. The project covers construction of a new bridge and border facilities, and provision of services through operation and maintenance of both facilities. Improved efficiency is expected from the view point of socio economic impact to the region in the affected geographical area of the project.

10.1.2. OUTLINE OF THE EVALUATION METHOD

(1) The Evaluation Procedure

The procedure is depicted in Figure 10.1. The detailed explanation of the procedure will be presented later, but the following comments supplement the procedure:

a) In general, the costs and benefits of a project can be classified into tangible and intangible ones.

b) There are three kinds of indices for evaluating the investment efficiency; Cost-Benefit ratio (B/C), net benefit (B-C), and Internal Rate of Return (IRR). Only the IRR is adopted in this study.

c) In general, when investment efficiency is not clearly seen and the project is supposed to be very important to the region, "re-estimation of the costs", "re-forecasting of the demand", and/or "clarification of methods and data of/for the tangible costs and benefits" are carried out in order to find feasible alternatives. In this study, these processes were not carried out.

(2) Project Life

With proper maintenance works, the bridge should serve for more than 100 years. However, from the viewpoint of a conservative evaluation of the project, the following project life, i.e., period of evaluation of the project, is adopted in this study.

The project life:	29 years
Construction:	4 years
Operation:	25 years

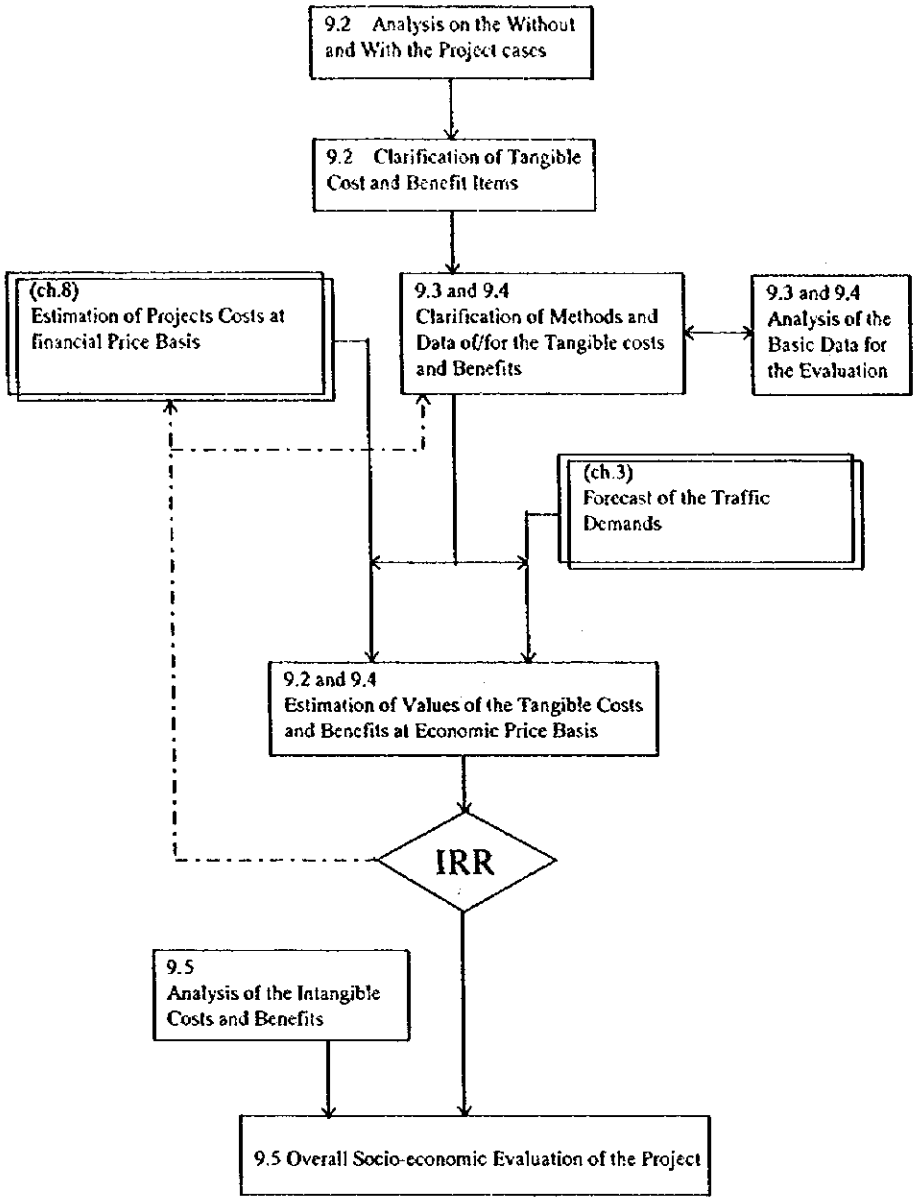


Figure 10.1 Procedure of Socio-economic Evaluation

(3) Numeraire and Price Basis for the Evaluation

1) Numeraire

The numeraire can be defined as a basis with monetary unit against which values of costs and benefits of a project are projected. The numeraire is indispensable because it is impossible to compare different values which may be obscure at different times and phases.

Generally, one of two types of evaluation is adopted for the evaluation; Local Currency Numeraire or International Currency/ National Border Price numeraire.
In this study, the latter is adopted, considering that the project is international (i.e., the project crosses international border).

2) Price Basis

There are two types of price basis for expressing value of the costs and benefits; Financial and Economic basis. In economic price basis, transfer costs such as taxes and subsidy, are deducted and shadow rate is used for labour and exchange rate.

Unit values expressed by the International Currency numeraire is assumed to be internationally competitive price, whilst values expressed by local currency does not. Therefore, unit values expressed in local currency need to be converted to economic values using conversion factors. Methodology will be discussed in later section.

(4) Calculation Method for Values of Costs and Benefits

For the calculation of costs and benefits, so called "with-without project" principle is used. Difference of "with project" case and "without project" case is considered as costs or benefits attributed to the project.

10.2. WITH AND WITHOUT THE PROJECT CASES

10.2.1. "WITHOUT THE PROJECT" CASE

The Study Team defines the following future situation at Chirundu Border Post as the "Without the Project" case.

1) Facilities and the handling capacities

The existing bridge which limits maximum vehicle weight at 55 tons is still used without construction of a new bridge. The handling capacity of the existing bridge is 30 vehicles per hour for both directions at a maximum.

The existing customs clearance facilities and staff will be increased in accordance with the increase in the traffic demand in future. The processing capacity of the customs clearance is estimated to be 25 vehicles per hour for both directions at present. Capacity will be increased to 30 vehicles per hour in the future.

2) Operation hours

The operation hours will be prolonged until the clearance of last vehicle which arrives at the gate one hour before the closing time. Vehicles are assumed to arrive at the gate in predefined arrival distribution which has a trapezoid shape. Waiting time which arise from short operating hours will be called "unintended waiting time" hereinafter. The operating hours will be

prolonged to 18 hours as a maximum. Therefore, the processing capacity can be expanded up to 480 vehicles per day. If the daily traffic exceeds this capacity, remainders will use the Kariba dam route.

Based on the traffic demand per day in the future and the traffic handling capacity of the existing bridge, the operation hours can be estimated as follows:

Present - 2000	:	12 hours	
2001-02003	:	14	
2004 - 2006	:	16	
2007 - 2009	:	18	
2010 - 2026	:	18	:Regulated

(2) Level of the Customs Clearance Inspection

The existing insufficient processing capacity of the customs clearance involves 1.5 - 3.0 hour-check of cargoes. The time used for the inspection is substantially shorter, compared with the other standards at nearby international borders (5 hours per cargo).

10.2.2. SITUATION OF THE "WITH THE PROJECT " CASE

(1) Facilities and the Handling Capacity

A new bridge will be constructed in 2002. The bridge has no limitation in terms of capacity or weight. Capacity of the customs clearance facilities and staff will be increased in accordance with traffic demand. Cargoes are checked to meet international standard.

(2) Effects of the Project

Following types of effects are expected in "with the project" case;

a) Unintended waiting time will not occur in this case
b) Whole vehicles with no limitation on the weight which arrive at the entrance gate can proceed through customs clearance before 22:00pm.
c) Reduce smuggling

10.2.3. SOCIAL AND ECONOMIC COSTS AND BENEFITS OF THE PROJECT.

Based on the differences between "with" and "without the project" cases and impacts on social and natural environment around the border, the following social and economic benefits and cost of the Project can be examined. (Refer to Table 10.1)

Table 10.1 Social and Economic Benefits and Costs

Benefits and Cost	Characteristics of the benefits and cost	Basis from which they are generated
Time and VOC saving	Direct	See Table 10.2
Avoidance of smuggling	Direct	Stricter inspection of cargoes
Effects on employment and economy	Direct (but temporary)	Construction of facilities
Development of the towns	Indirect	Longer stay of vehicles (especially cargoes)
Impacts on the Natural Environment	Direct	See Chapter 7

In this study, only the "time and VOC saving" is used for quantitative analysis, and others are treated as qualitative analysis.

Table 10.2 Benefits of the Project

Effects	Benefit Items
Avoidance of unintended waiting time which will occur in the "without the project" case	1) Time saving of passengers, 2) Avoidance of devaluation of goods, 3) Vehicle operation cost (VOC) saving
Reception of heavy trucks which now use the Kariba dam route	1) VOC saving of heavy vehicles 2) Avoidance of devaluation of goods
Absorption of vehicles which will be forced to use Kariba dam in the "without" case	1) VOC savings 2) Time saving of passengers 3) Avoidance of devaluation of goods
Avoidance of costs which will be required in "without" case	1) Cost for operation and maintenance after year 2002

10.3. ECONOMIC COSTS

10.3.1. COSTS FOR THE "WITH THE PROJECT" CASE IN FINANCIAL PRICE

(1) Project Costs

Table 10.3 shows project cost rearranged for economic evaluation. Cost for housing is disregarded in economic evaluation, since it will be counterbalanced between "with" and "without" cases.

Table 10.3 Project Cost of "with project" case, after tax (1,000 US$)

		Foreign	Local	Total
Bridge				
	Material	5,000	2,576	7,575
	Labour	485	485	970
Access Road				
	Material	320	165	485
	Labour	52	52	103
Border Post				
	Material	8,688	4,476	13,164
	Labour	2,079	2,079	4,157
Subtotal				
	Material	14,008	7,216	21,224
	Labour	2,615	2,615	5,230
Contingency(10%)		1,662	983	2,645
Indirect Cost(25%)		4,595	2,913	7,508
Engineering Cost(10%)		1,622	1,382	3,003
Land Acquisition Conpensation			251	251
Total Project Cost		24,502	15,360	39,862
o/w	Material	14,008	7,216	21,224
o/w	Labour	2,615	2,615	5,230
o/w	Others	7,879	5,529	13,408

(2) Operation and Maintenance Cost per Year

Operation and maintenance cost accounts for 0.2% of project cost for border post facilities. Maintenance cost of Otte Beit bridge is counterbalanced between "with" and "without" cases. Maintenance of new bridge is approximately 10,000 US$ per annum (refer to Section 9.4).

10.3.2. COSTS FOR THE "WITHOUT THE PROJECT" CASE AT FINANCIAL PRICE BASIS

(1) Project Costs

The project cost in this case is generated from the improvement/expansion of the existing facilities, from customs and immigration offices . The estimated cost of improvement is shown below:

2000: 1,000,000 US$
2002: 1,000,000 US$
2006: 3,000,000 US$

(2) Operation and Maintenance Cost

Operation and maintenance cost accounts for 0.2% of project cost for border post facilities. Maintenance cost of Otte Beit bridge is counterbalanced between "with" and "without" cases.

10.3.3. CONVERTING FINANCIAL PRICE TO ECONOMIC PRICE

(1) Formulas

The financial prices are converted to economic prices using following formulas;

1) Foreign Portion

Values expressed as foreign portion in financial prices are also used as foreign portion in economic prices.

2) Material Cost Classified as Local Portion

Value at Economic Basis = Value at Financial Basis x Standard Conversion Factor (SCF)

3) Labour Cost Classified as Local Portion

a) Skilled Labour

Value at Economic Basis = Value at Financial Basis x SCF

b) Unskilled Labour

Value at Economic Basis = Value at Financial Basis x 1/2 x SCF

4) Land Acquisition, Compensation, and Administration Cost

Value at Economic Basis = Value at Financial Basis x SCF

(2) Principal Unit Value

1) Standard Conversion Factor (SCF)

SCF is one of "national parameters" and a conversion factor by which the values at local and economic price basis are converted into the one at International and Economic basis. The SCF is a ratio of real exchange rate of local currency into international key currency at the nominal exchange rate. The study team supposes the SCF in this study at 0.825, based on following:

SCF of Zambia	:	0.80	(provided by Zambian govt)
SCF of Zimbabwe	:	0.85	(Study team estimate)
Average	:	0.825	

2) Opportunity Cost of Unskilled Labour

In general, the opportunity cost of the unskilled labour in developing countries is estimated on the basis of productivity in agriculture sector in the country concerned, assuming that the unskilled labours are provided from the traditional sector. The study team assumes the opportunity cost of 0.5 (data was insufficient to estimate).

10.3.4. COSTS AT ECONOMIC PRICE

Table 10.4 shows summary of costs expressed in economic prices.

10.3.5. ANNUAL DISBURSEMENT OF THE COSTS

Based on the construction schedule explained in previous chapters, annual disbursement of the project is shown in Table 10.5.

Table 10.4 Economic Price of Project

	Foreign	Local	Total
Bridge			
Material	5,000	2,125	7,124
Labour	485	320	805
Access Road			
Material	320	136	456
Labour	52	34	86
Border Post			
Material	8,688	3,693	12,381
Labour	2,079	1,372	3,450
Subtotal			
Material	14,008	5,953	19,961
Labour	2,615	1,726	4,341
Contingency(10%)	1,662	768	2,430
Indirect Cost(25%)	4,595	2,217	6,812
Engineering Cost(10%)	1,622	954	2,576
Land Acquisition Conpensation		234	234
Total Project Cost	24,502	11,853	36,355
o/w Material	14,008	5,953	19,961
o/w Labour	2,615	1,726	4,341
o/w Others	7,879	4,173	12,052

Table 10.5 Disbursement Schedule of the Costs (US$ 1000)

	With Project			Without Project	
Year	Bridge	Border Facilities	O/M	Project Cost	O/M
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	635	-	-	-	-
1999	3,812	2,365	-	-	-
2000	3,812	3,547	-	1,000	-
2001	4,448	3,547	-	-	-
2002	-	2,365	10	1,000	-
2003	-	2,365	10	-	-
2004	-	2,365	10	-	-
2005	-	2,365	10	-	-
2006	-	2,365	10	3,000	-
2007	-	591	10	-	10
2008	-	591	10	-	10
2009	-	591	10	-	10
2010	-	591	10	-	10
2011-2026	-	-	57	-	10

O/M = Operation / Maintenance

10.4. Economic Benefits of the Project

10.4.1. Principal Data and Unit Values for the Estimation

(1) Unintended Waiting Time

The unintended waiting time occurs when the number of the arriving vehicles per hour exceeds the processing or handling capacity of the existing border post facilities (30 vehicles as a maximum for both directions after enhancement). Estimated waiting time provides basis on which the time saving and VOC saving benefits are calculated.

Step 1 : Assumption of distribution of the vehicles. In this study, trapezoid shaped distribution is assumed referring to the actual distribution at both sides. Height of the distribution will increase in accordance with the increase in the daily traffic demand.

Step 2 : Calculation of number of vehicles which will exceed the hourly capacity in each hour during the daily operation hours.

Step 3 : Calculation of the unintended waiting time which will occur in a day based on the excess number of vehicles in each hour and its distribution. "First-in, first-out" principle is adopted to calculate the unintended waiting time.

Table 10.6 shows annual unintended waiting time for both directions.

Table 10.6 Annual Unintended Waiting Time at Chirundu

Year	Total hour (hours)
2002	96,567
2003	133,322
2004	210,106
2005	264,370
2006	354,147
2007	489,812
2008	548,011
2009	672,817
2010	862,008
2011	862,008
~	~
2026	862,008

(2) Vehicle Operating Cost (VOC)

The VOC at economic price basis is estimated through conversion of the VOC in Zimbabwe at financial price basis into economic price basis by the VOC subclassified items.

The VOC per 1000km of running distance in US dollars can be estimated as follows. (study team estimate)

	Economic Cost	Financial Cost
All vehicles:	1,309	3,053
Heavy vehicles:	2,023	4,918

(3) Time Value of International Passengers

It can be assumed that trip purpose of large part of the international passengers at Chirundu are "business". However, the passengers between Zambia and Zimbabwe represent the largest portion of the whole passengers. The above-mentioned facts suggest that time value at financial price basis be connected to the GDP per labour force of Zambia and Zimbabwe.

The time value at economic price basis is estimated through conversion from the one at financial price basis. Below is study team estimate of time value of passenger at US dollar per hour for every passenger.

Economic Price Basis :	0.393
Financial Price Basis :	0.476

(4) Time Value of International Cargo

The time value can be estimated using the following formula:

$$\text{Time value of cargo} = \left\{ \text{Short-term Interest Rate} \Big/ (365\text{day} \times 24\text{hr}) \right\} \times \text{Value of Cargo}$$

The cargoes transported through Chirundu are international cargoes, never domestic, which implies that the estimated values of the cargoes are expressed in economic price. The value is estimated based on the basic data estimated for forecasting the traffic demand and price by commodities. Below is study team estimate of time value of total cargo at Chirundu.

Economic Price Basis	22,753
Financial Price Basis	22,753

10.4.2. ANNUAL VALUES OF BENEFITS AT ECONOMIC PRICE BASIS

Adopting the estimates of the unintended waiting time and other unit values presented in the previous sections, annual values of benefits in economic prices are tabulated in Table 10.7.

Table 10.7 Economic Benefits of the Project

(Unit: 1,000 us$, 1997 constant price)

	Avoidance of unintended waitng time in "Without Project Case"			Aoidance of Detour to Kariba for Heavy Vehicles		Cost of vehicles forced to use Kariba Dam in "Without" case			Total
	Time-saving of passengers	Devaluation of cargo	VOC saving	VOC saving	Devaluation of Cargo	VOC saving	Time-saving of passengers	Devaluation of Cargo	
2002	139	19	164	25	2				349
2003	189	24	227	27	2				469
2004	295	36	357	28	2				718
2005	368	43	449	30	2				892
2006	489	55	602	32	2				1180
2007	588	63	731	34	2				1418
2008	743	76	932	36	2				1789
2009	901	88	1144	38	2				2173
2010	1143	106	1465	40	3	994	54	6	3811
2011	1143	106	1465	40	3	994	54	6	3811
≀	≀	≀	≀	≀	≀	≀	≀	≀	≀
2026	1143	106	1465	40	3	994	54	6	3811

10.5. ECONOMIC EVALUATION OF THE PROJECT

For the process of economic evaluation of the project, refer to Figure 10.1.

10.5.1. INTERNAL RATE OF RETURN (IRR) OF THE PROJECT

(1) IRR

IRR is a discount rate which makes present values of costs and benefits of the project equal. IRR is a measure of investment efficiency where costs and benefits are observed only in the field of economy. Evaluation of IRR is comparison with Social Discount Rate (SDR) or Opportunity Cost of the Capital (OCC) of the economy which means only investment efficiency is concerned here.

(2) Basic Data for Calculation of IRR

Table 10.5 and Table 10.7 are the basic data for calculation of IRR of this project.

(3) The IRR and degree of its Stability

In Table 10.8, the IRR of the base case and the result of sensitivity analysis are tabulated. The sensitivity analysis presents degree of stability of the IRR. The degree of the stability can be judged by comparing the IRRs of different cost and benefit values. Values are fluctuated by 10% (+10%, 0%, -10%) , and combination is taken as one case (total of 9 cases).

Table 10.8 Sensitivity Analysis of the Project

Cost / Benefit	+10%	±0%	−10%
+10%	6.92%	7.65%	8.48%
±0%	6.28%	6.99%	7.80%
−10%	5.60%	6.29%	7.07%

(4) Evaluation based on IRR

As shown in the above table, the IRR of the base case is 6.99%. Figures range from 5.6% to 8.5% depending on frame. The IRR of the Base case is below the social discount rates or opportunity cost of capital of the two countries (12%), and it is lower than IRRs usually observed on road projects in developing countries.

10.5.2. OTHER KINDS OF THE BENEFITS OF THE PROJECT

Values of the following benefits which are classified as "other kinds of benefits" are not considered in calculation of the IRR.

(1) Stricter inspection at customs

The project not only provides design of a new bridge and border post facilities but also improving customs procedures to International Standards. Improvement in procedure (or administration) will bring about following benefits and costs.

1) Increase in general consumption

This benefit is expected as a result of the following processes:

a) Provision of accurate information and data by, which the central government can establish appropriate economic and industrial policies,
b) Strengthening basis of administration of commodity trade balance, and foreign exchange rate
c) Suppressing price inflation caused by insufficient administration of external trade.

2) Expanding stocks of the domestic infrastructure

This benefit is expected as a result of the following processes:

a) Increase in national income of the treasury through enforcement of levy on regulated import goods
b) Expansion and stabilization of national funds,
c) Expansion and stabilization of Government expenditure

3) Keeping social and economic order

This benefit is expected as a result of the following processes:

a) Maintaining the existing production level of industries which suffer from smuggled goods by securing employment
b) Maintaining purchasing power of people

4) Decrease in demand for smuggled goods

The decrease will be brought about by increase in the market price of the products being smuggled.

5) Increased funds to protect industries from smuggled goods

The smuggling can be observed all over along the national border, not only at Chirundu. According to a staff in charge of external trade, value of smuggled goods totals to be 15-30% of recorded trade. Figure at Chirundu alone is 5-7%.

Based on the above, value of the goods smuggled through Chirundu from both sides in 1996 can be estimated around US$ 25 million.

(2) Effects of Demand for Local Material and Labour

Value of the demand for local materials at the peak year of the construction is estimated to be around 3.6 million US dollars. Supposing that multiplier coefficient of the demand to the production in the domestic industries is 1.2, and value added rate of the products is 30%, the additional demand would bring about value added (GDP by Industrial origin) of around 5.6 million US dollars at the peak year. The additional value added corresponds to 0.06% of the sum of GDPs in 1995 (8,863 million US$). On the other hand, local employment at the peak year of the construction is estimated to be 200 - 250 employees.

(3) Development of Towns at Border Post

Stricter inspection of cargoes will force truck drivers to stay longer at the border towns. Expenditure expected from the drivers would contribute to development of the towns especially through service sectors.

(4) Beneficiary from the Project

The beneficiary from the project are considered as follow;

1) Direct beneficiaries

Improvements to the border post facilities and bridge will result in reduction of the time necessary to clear the border posts. It will also be able to carry trucks over 55 tons, whose presently forbidden to cross the Otto Beit Bridge.

Direct beneficiaries are mainly those who are using Chirundu and crossing Otto Beit Bridge. According to the traffic survey by the Study team, more than 50% of vehicles using Chirundu was registered in Zimbabwe. Some 30% of vehicles are registered in Zambia, followed by 16% registered in South Africa. (refer to Table 10.9)

Table 10.9 Vehicle by Registered Country

Registered Country	Outboud fm Zambia	Inboud to Zambia	TOTAL
Zambia	30%	24%	27%
Zimbabwe	51%	59%	55%
South Aftica	18%	14%	16%
Other	1%	3%	2%
total	100%	100%	100%

These vehicle owners who are suffering now by the limited capacity of Chirundu will enjoy direct benefits from the project.

2) Indirect beneficiaries

The major purpose to improve border facilities is to control the traffic of people and goods crossing the border. Ensuring national security and protecting national economy to internationally agreed standard is considered as primary reason in setting up such borders. In this viewpoint, the people of both Zambia and Zimbabwe will benefit from the project in following ways;

- stricter drug control
- lower cost of goods derived from less transportation cost

10.5.3. Overall Economic Evaluation of the Project

Form viewpoint of economy, or national economy, this project is not recommendable. However, the project would bring about other favourable effects such as avoidance of smuggling, demand for local materials and labour, and development of towns at the border post. These benefits will compensate the low investment efficiency, and thus the project is recommendable in overall evaluation.

11 PROGRAMME OF THE PROJECT

11 PROGRAMME OF THE PROJECT

11.1. FINANCIAL RESOURCE AVAILABILITY

The Project is composed of three (3) components: Border post facilities in Zambian side, bridge structure over Zambezi river, and border post facilities in Zimbabwean side. The budget for each component shall be assessed taking into consideration the characteristics of the Project and a relative low EIRR of the Project.

The bridge is expected to be operated toll-free. Construction budget (total about 18.4 million US$) shall be, therefore, prepared with own budget from both governments or official development aid such as bilateral grant or very soft loan. In case of government fund preparation, 3 to 4 million US$ shall be prepared every year by each government. The total budget for road construction in 1996/7 is only about 3.3 million US$ in Zimbabwe, which will be almost equivalent to the amount of yearly bridge construction budget. Table 11.1 shows budget of Zimbabwe from 1993 to 1996.

Table 11.1 Budget of Zimbabwe Government (1993/4 - 1996/7)

(100 million Z$)

Financial Year	1996/7	1995/6	1994/5	1993/4
Total Budget	331.5	312.0	256.8	180.6
MOTE Budget	5.5	6.6	6.2	4.6
Road	2.6	2.2	2.4	2.7
Maintenance	2.2	1.8	1.5	1.4
Construction	0.4	0.4	0.9	1.4

On the other hand, the Zambian economy is now under a very strict structural reform. The investment for new project is severely controlled from her own budget and an official loan, even though a very soft one, is very hard to be realized under this situation. Table 11.2 is budget allocation of Zambia from 1995 to 1998. According to the table, budget for Roads Department in 1998 is about 87.2 million US$.

Table 11.2 Budget of Zambia Government (1995 - 1998)

(K' Million)

Institution	1998	1997	1996	1995
Total Government	1,818,339	1,625,562	1,266,026	964,569
o/w Ministry of Works and Supply	**119,845**	**81,193**	**64,114**	**56,755**
o/w GRZ	33,468	37,421	31,067	28,679
o/w Donor	86,377	43,772	33,047	28,076
o/w Roads Department	**113,455**	**71,071**	**58,579**	**50,173**
o/w GRZ	27,078	27,299	25,532	22,097
o/w Donor	86,377	43,772	33,047	28,076
o/w Chirundu Bridge	100	-	-	-

The construction cost for border post facilities are:

a) housings 24.4 million US$
b) buildings 17.6 million US$
c) parking area 13.3 million US$.

The renovation of border post facilities is expected to increase the customs revenue resulting from more accurate inspection works on import goods. There is a sufficient possibility to implement the innovation works by using the customs revenue increase. For the construction of border post facilities, Zambian Revenue Authority responsible for preparing the budget for Zambian side border post. On the other hand, the construction of the facilities in Zimbabwean side will be carried out by Ministry of Construction with the budget allocated from national general budget.

The estimated amount of border post facility renovation is very huge taking into consideration the budgetary situation of both Governments. Therefore, the scale and/or construction schedule shall be examined further by the relevant authorities concerned with this issue.

11.2. PROJECT SCHEDULE

Tentative project implementation schedule is indicated in Table 11.3. Based on the forecast of traffic demand and capacity of the border facilities as well as existing bridge, the Project shall be completed by year 2002 as a first stage. The immigration facilities for pedestrians and passenger control shall be improved at second/third stages to best utilise the existing facilities, and also to lighten financial loads of the Project implementation. Therefore, the preparation works such as financial resource assessment, detailed design, contract preparation, etc. should be completed before early 1999.

The construction of the border post facilities shall be carried out depending upon the demand increase as second and third stages during 2002 and 2010.

Table 11.3 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														

11.3. TASKS FOR THE PROJECT IMPLEMENTATION

The following tasks for the Project implementation shall be made after this Study:

a) approval of environmental assessment for the Project,
b) detailed design of the facilities,
c) construction of new houses for government officials and demolition of houses at the Project sites,

11.4. MAINTENANCE PLAN OF THE BRIDGE ON BORDER

The bridge structure requires proper maintenance works in order to be open for public traffic.

(1) Organization

Both Governments have to share equally the responsibility to maintain the bridge facilities in good condition. Towards this end, the committee for New Chirundu Bridge maintenance shall be organized and be given the following function:

a) budgetary preparation for maintenance works,
b) staff preparation for maintenance works,
c) technical capability for maintenance work assessment.

The committee shall be composed of the relevant staff from Ministry of Works and Supply, Zambia and from Ministry of Transport and Energy, Zimbabwe.

(2) Maintenance Works

The following works are identified for the proposed concrete bridge:

1) Routine Works

Road surface and drainage cleanings, and road light a changes shall be made as daily routine maintenance works.

2) Periodic Works

Repair of pavement, painting of handrail, inspection and repair works of expansion joints, bearing shoes and embankment slopes, etc. shall be carried out periodically, for example, every 7 years.

3) Accidental Repair Works

In case of vehicle collision or any violence on the bridge facilities, repair works shall be made promptly.

These maintenance works shall be carried out based on the maintenance manual to be prepared before the completion of the Bridge Construction. The manual will contain the procedure and important points for the maintenance works as well as the necessary information about the bridge structure and facilities, such as structural drawings, material characteristics used, catalogue of equipment, etc.

(3) Budget for Maintenance Works

Routine works shall be done by either Ministry mutually, for example, one year each on a

rotation basis. The budget of periodic and accident repair works shall be prepared by the Committee and both governments shall share it equally.

Approximately, the following budget shall be made available:

a) routine maintenance: cleaning and road lighting
   10 thousand US$ per annum
b) periodic maintenance: pavement overlay
   150 thousand US$ for every 7 years.

12 CONCLUSION AND RECOMMENDATION

12 CONCLUSION AND RECOMMENDATION

12.1. CONCLUSION

This report presents the results of the study which was carried out during June to December 1997. The results are based on the findings and analyses by field surveys as well as by home office works. The summaries of major elements of the Study follow:

(1) Existing Bridge Condition

a) The major structural members of the Bridge are in good condition and there seems to be no problem regarding the loading capacity under the conditions of one way traffic, restriction of 55 ton vehicle weight and one vehicle on the bridge at a time.

b) The loading capacity under the present bridge design standards, such as British Standard, Japanese Standard or South African Standard, indicate that the existing structure is not acceptable. Floor system has insufficient bearing capacity under present design code loading.

c) Estimated traffic capacity of the bridge is about 30 vehicles per hour under the existing traffic control condition. Under 12 hours operation, total capacity of the bridge will be about 330 vehicles per day, which is slightly larger than the present traffic demand of 250 vehicles per day.

(2) Future Traffic Demand

a) Traffic demand in Chirundu at present is about 250 veh. per day, of which 70 % is freight vehicle and only 30 % is passenger vehicles including buses. The major origin and destination is between Zambia and Zimbabwe (41%), followed by between Zambia and South Africa (26 %).

b) Traffic demand in Chirundu at 2010 is about 500 veh. per day, which is twofold of the demand in 1997.

(3) Bridge Alternative Route

a) Three alternative routes are identified for the comparison, 100m upstream from existing bridge, 50m downstream and 225m downstream.

b) The route 100m upstream is selected as the best option from viewpoints of bridge engineering, utilization of existing border facilities, less environmental impacts and construction cost.

(4) Bridge Alternative

a) Concrete bridge is selected from stand points of local material usage as well as local employment development.

b) Two lanes bridge is designed from the traffic capacity limit against future traffic demand.

c) Four types of bridge are compared; suspension bridge with concrete stiffening girder, prestressed concrete cable stayed bridge (symmetry and asymmetry), prestressed concrete girder bridge.

d) Prestressed concrete girder bridge is selected from view points of construction cost, ease of maintenance, as well as contribution to the local economy.

(5) Border Post Facilities

a) Separate type of border posts are provided based on the comments from the relevant Authorities of both Governments.

b) Border post facility improvement(stage construction) shall be made in accordance with the traffic demand increase.

(6) Environmental Impact Assessment

a) The project will have positive impacts on economic development of the region and improvement of customs and immigration system.

b) Bridge route 100 m upstream from existing bridge has least impact on game corridors and vegetation of the area.

c) The project also has temporary construction impact on the area, such as noise and dust, increase traffic demand, disturbance of river flow, etc. The mitigation measures monitoring system shall be discussed in the process of engineering design as well as during construction period.

d) The qualitative assessment on fish population and water pollution by coffer dam construction shall be carried out during detailed design stage.

e) A comprehensive awareness programs and a high level of community participation shall be effected in course of the Project implementation in those areas where the local community in likely to be significantly affected. These are areas such as education, medical cares, wafer supply, fishing, traffic and energy supply.

(7) Project Cost and Construction Period

a) Total project cost is about 74.6 million US$, including contingency, engineering cost and compensation cost of which 18.5 million US$ is for the bridge construction and 32.0 million US$ for border post facilities construction.

b) Approximately 3 years of construction period is required.

(8) Socio Economic Evaluation

a) The benefits of the Project accrue from improved border facilities and the new bridge structure. Improvement of either one alone will not bring about much benefits.

b) Economic internal rate of return (EIRR) by the project is expected to be around 6.99%.

c) About 832 thousand workdays of for job opportunity will be provided.

(9) Intangible Benefits from the Project

A border post is an indispensable facility of the country. By controlling and inspecting the flow of the goods and passengers through the border, the government could protect its citizens.

It is indeed very difficult to evaluate the effects/benefits derived from stricter control on drug trafficking or any other illegal movement of people and goods, in monetary term. Nevertheless, better treatment to those activities could never be over emphasised. Well managed border posts is essential element of government administration.

12.2. RECOMMENDATION

a) Border post facilities and bridge structure shall be improved simultaneously in order to maximize the benefits from the project.

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

c) Prestressed concrete girder bridge with two(2) lanes shall be employed from viewpoint of economy.

d) Separate border posts in each country shall be employed considering the political situation of the countries.

e) Mitigation measures to protect environment shall be further investigated during the course of design, construction and management stages. For this end, private sector (contractor/ developer) and the public sector must have strong commitments to these issues.

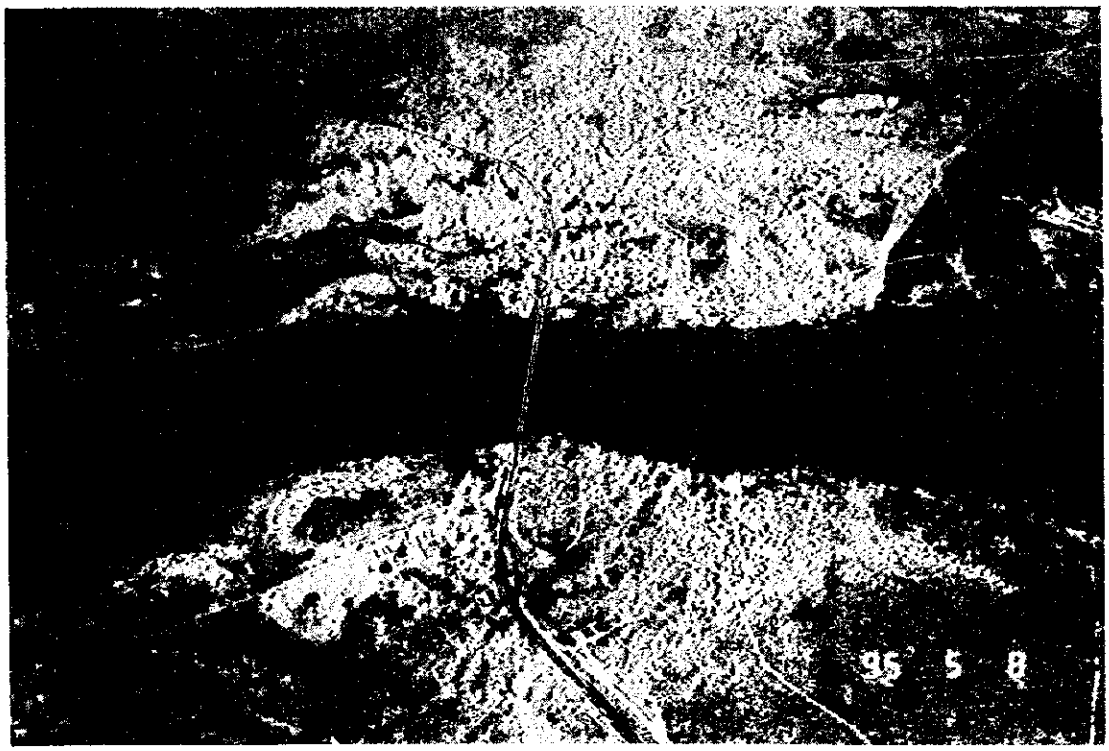
f) Stage construction for border post facilities shall be considered due to the high cost.

APPENDICES

Appendix 1

Photographic Record

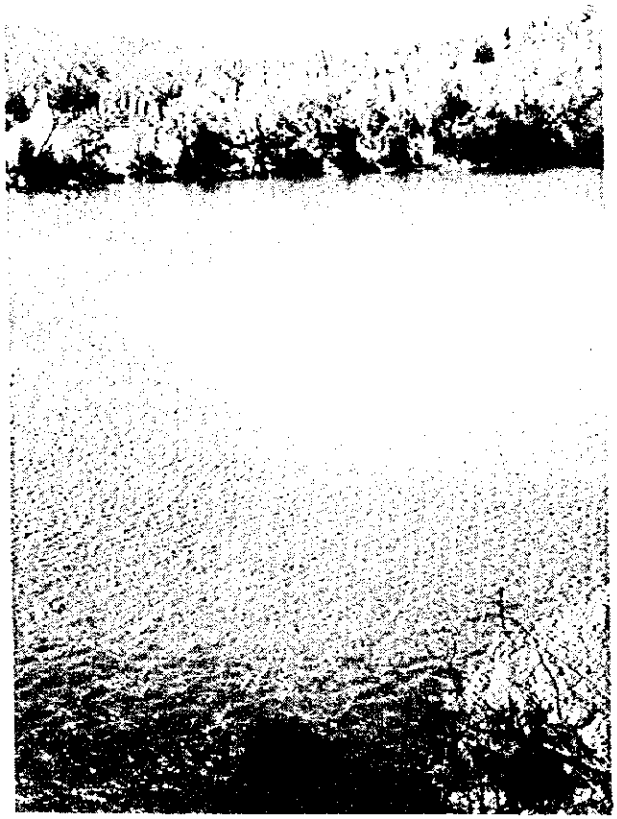
Panorama of Study Area



New Border Facility Construction Site (Zimbabwe Side)

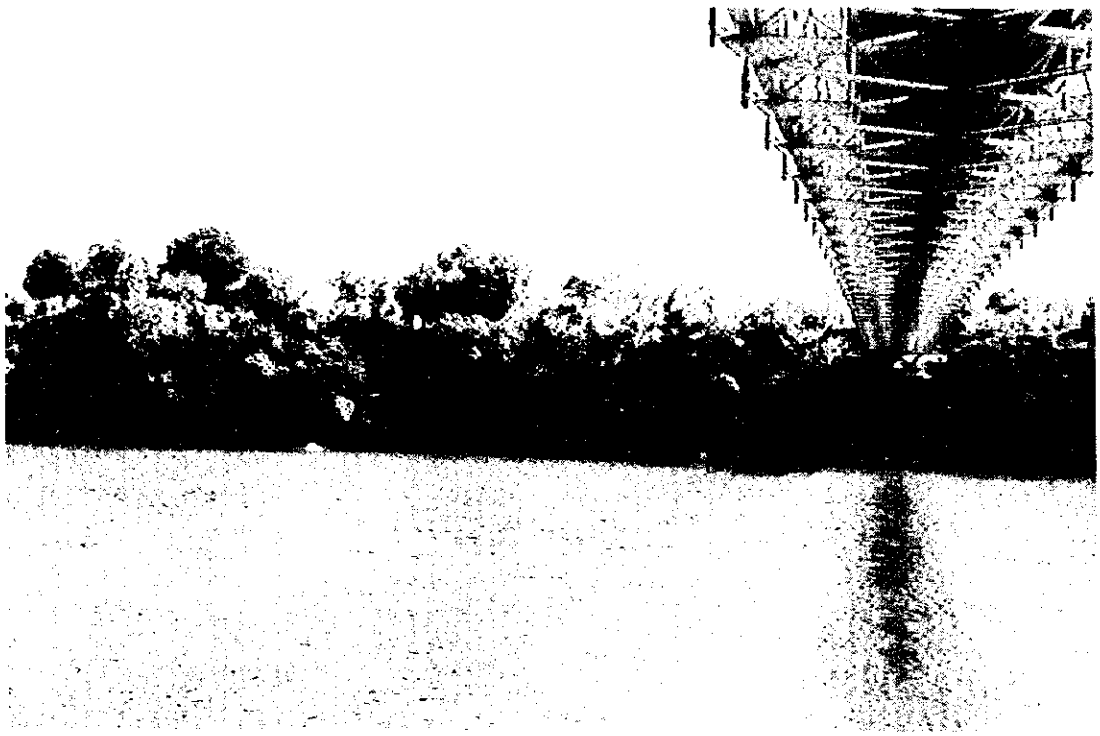
New Border Facility Construction Site (Zambia Side)

New Bridge Construction Site (Zimbabwe Side)

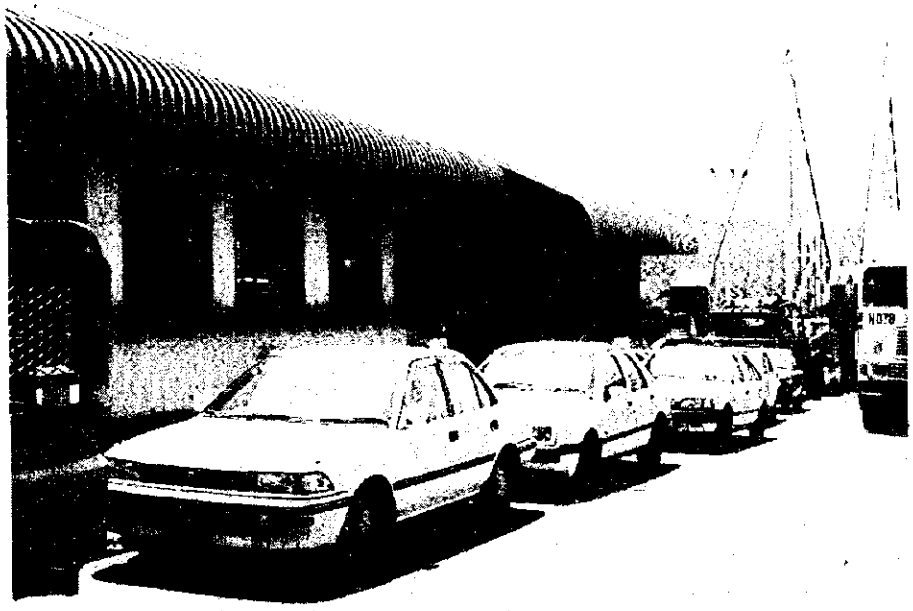


Existing Border Facility (Zimbabwe Side 2)

New Bridge Construction Site (Zambia Side)

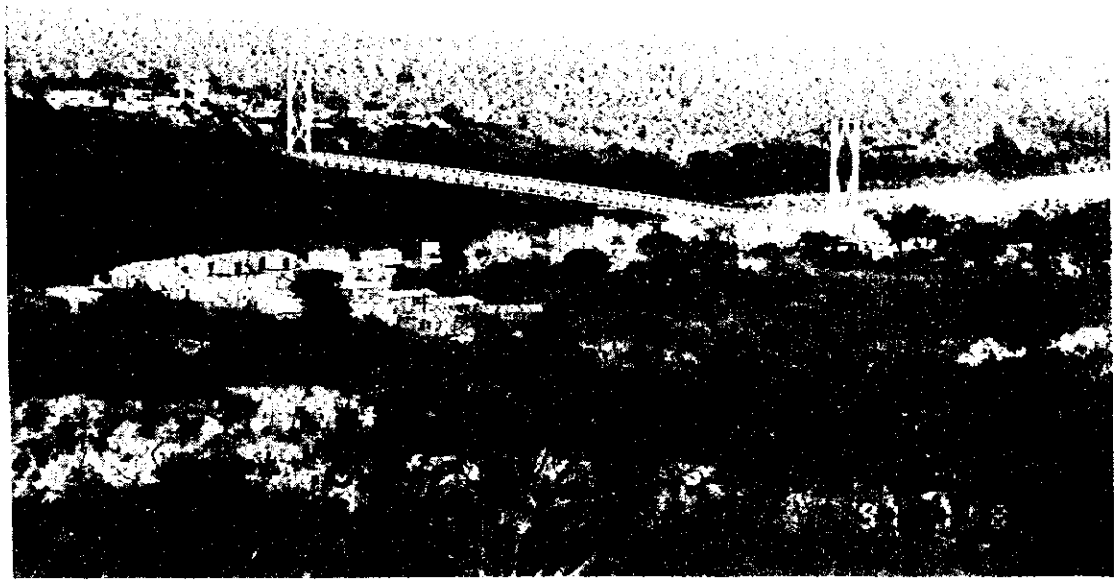


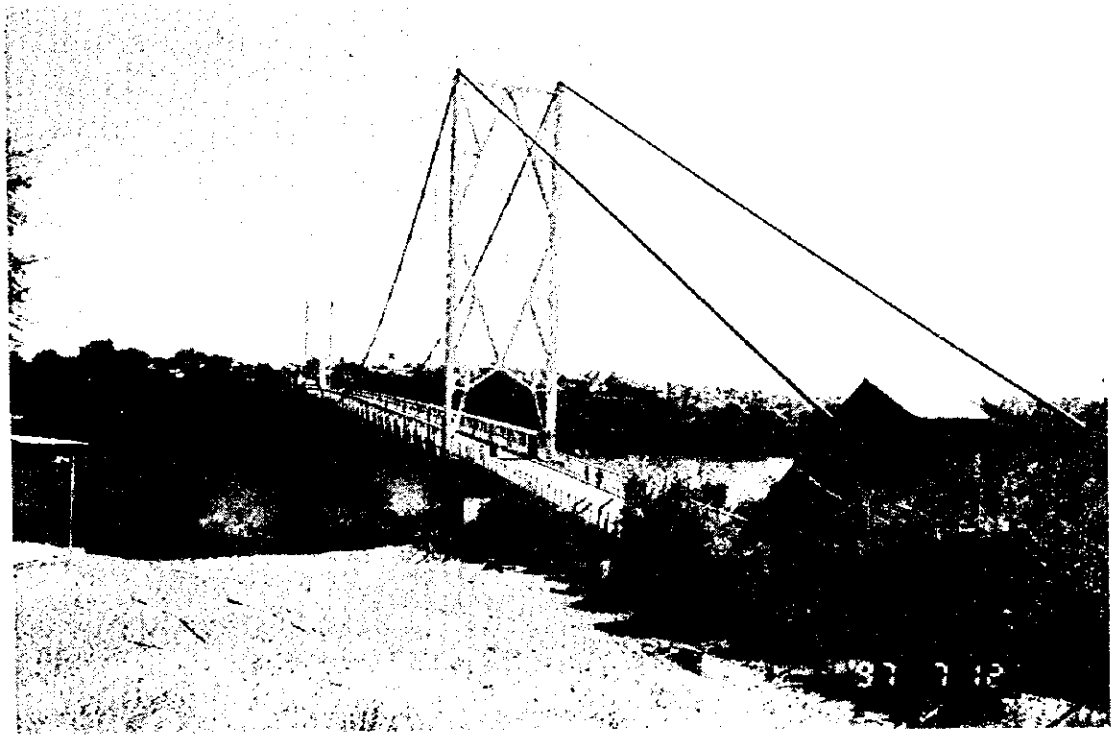
Existing Border Facility (Zambia Side 2)



Existing Border Facility (Zimbabwe Side 1)

Existing Bridge (Otto Beit Bridge)





Existing Border Facility (Zambia Side 1)