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EXECUTIVE SUMMARY

The Kafue River Basin is one of Zambia's important basins for hydropower generation. The Zambian Government has conducted several feasibility studies in the past that have resulted in the development of the Itezhi Tezhi dam and the Kafue Gorge Power Station in the 1970s. Great potential still exists for further development of hydropower in Kafue basin and the Government intends to build two additional power stations along the Kafue River (Itezhi-tezhi – 120MW and Kafue Gorge Lower 750MW).

The proposed Itezhi Tezhi Hydropower project is located in the Itezhi Tezhi District in Southern Province in Zambia. The power plant will be built adjacent to the existing Itezhi Tezhi Dam and will utilize the water in the reservoir.

The current installed electric power capacity in the country (1670 MW) has been adequate to meet both regional (5% export) and local power (1200MW) demand. However, over the years power demand has been increasing tremendously due to among other factors, improvement in national economic growth (average GDP of 4%) as well as increase in regional power demand. According to recent power demand forecast studies, the current regional export and internal consumption has been outstripped by demand during the year 2007.

The Kafue River system presents an opportunity to develop another Power Station that could help lessen the impact of the anticipated power shortages. The Itezhi Tezhi has a potential for hydropower development that has not yet been exhausted and will utilize the head from the dam and other already existing infrastructure.

The Environmental Impact Assessment

The Environmental Impact Assessment for the project was undertaken as a legal requirement and in accordance with the requirements of the Environmental Protection and Pollution Control Act of 1990 and in particular Statutory Instrument No. 28, the Environmental Impact Assessment Regulations of 1997. Section 3 (1) of Statutory Instrument No. 28 of 1997 of the above Act states that "A developer shall not implement a project for which a Project Brief or Environmental Impact Statement is required under these Regulations, unless the Project Brief or an Environmental Impact Statement has been concluded in accordance with these regulations and the Environmental Council of Zambia has issued a decision letter". These EIA regulations have the main objective of ensuring the protection of the environment by highlighting impacts and formulation of mitigation measures to ameliorate the identified adverse environmental impacts. The report is outlined as closely as possible to the general EIA outline given in the EIA regulations with eleven main sections.

In the category of Electrical Infrastructure, the types of projects which need EIAs are new electricity generation stations, electrical power transmission lines more than 1 km long and surface roads for electrical and transmission lines for more than 1km long. The project under consideration falls within the types of projects which require an Environmental Impact Assessment.

The identified significant environmental impacts of the project

The fact that the Itezhi Tezhi project will utilize the existing dam, reduces the adverse impacts which are usually associated with hydro power development projects. No settlements will be affected since the existing dam will not be raised and there are no houses at the power station site.

However, the project will affect the general physical and biological environment in the immediate project area. The excavation works associated with the construction of access roads, surface powerhouse and tailrace canal will generate noise, dust, distabilisation to the geology and induced soil erosion. Construction and other works induce changes on the hill where the power station will be located. Slopes on the hill may erode easily during construction and may lead to rock falls in some once denudated during the reservoir filling and draw down process.

A project of this magnitude could trigger an influx of job seekers in the area there by creating stress on the social amenities in the area. An influx of migrant labour force could also be associated with the introduction of diseases not prevalent in the area. The local economic activities may however, be enhanced due to an injection of capital in the area.

This project has an inherently significant positive impact in the economic aspects as additional capacity for Zambia would lead to economic expansion and growth in the industrial sector. In addition, both at construction and operation stages, there will be the creation of jobs in different operational areas of the Power Station. The development of this Power Station will also lead to efficient water resources utilisation in the Kafue river basin as the same water that was just spilled to make available water for generation at Kafue Gorge Upper would now be channeled the power station to generate power before being released for generation needs at the both the existing Kafue Gorge power station and the proposed Kafue Gorge Lower power station.

Mitigation measures

Timing for blasting can be arranged as to reduce noise impact on surrounding population. A watering program to reduce dust from drilling, blasting and excavation can be easily implemented during construction. If necessary, gravel roads can be kept wet near populated areas to avoid clouds of dust.

An adversarial relationship between project laborers and the surrounding population can easily be avoided by requiring the contractor to hire local laborers preferentially and to assist them in matters of fuel.

Educational campaigns for both local community and construction workers will be given at regular intervals throughout the construction period to mitigate the spread of communicable diseases such as HIV/AIDS and STIs.

The remedy for the potential effect on increased poaching due to construction activitie, lies in properly educating the work force, requiring registration of firearms, and attaining a working arrangement between park management and the project staff, to ensure that there is no hunting in the KNP. In return, KNP staff could advise project staff who wish to hunt game of the procedures for obtaining hunting permits and places where hunting is permitted.

Three measures have been proposed to mitigate the impact of water wave surges during operational phases of the project and these are: careful control of the water releases; developing and installing warning devices and; undertaking education of the at-risk population to adequately equip them with knowledge on the water surges and safety aspects to avoid flood and wave surge related accidents.

An amount of US$ 150,000.00 has been estimated and proposed to take care of all the proposed mitigation measures including capital costs such as transport support to the Fisheries Department and the Zambia Wildlife Authority and installation of monitoring equipment for water related aspects

A comprehensive monitoring programme has been proposed to include: downstream flows; water quality; fisheries aspects and; wildlife aspects. An amount of US$ 26,000.00 has been estimated as annual monitoring costs.

Recommendations

Taking into account the available options and all the identified negative and positive environmental impacts of the proposed project and recommended mitigation measures for the identified negative impacts and enhancement measures for positive impacts: and also among other reasons, to meet the growing local and regional power demand, to forestall power shortages that could constrain economic growth, to forestall environmental degradation in the event of power shortage in the country and to create employment opportunities arising from improved power supply that will meet the economic growth of the country, the development of the Itezhi-tezhi Hydro Power Station should be considered favorably for implementation by the Authorising Agency.

1. INTRODUCTION

1.1 Background

Increasing electricity demand in Zambia and surrounding countries has prompted tr reopening of studies of new hydropower resources. As a result, feasibility studies of the 1,600 – MW Batoka Hydroelectric Project in 1993, followed by a feasibility study for the Kafue Gorge Lower Hydroelectric Project in 1995. The study of the ItezhiTezhi Project is a logical next step as the project provides additional firm and secondary energy as well as the potential for increasing the firm supply from the existing Kafue Gorge Upper Hydro Project as well as the planned Kafue Gorge Lower Hydro Project.

The Itezhi – Tezhi (ITT) Project is located on the Kafue River, about 295 Km upstream of the confluence of the Kafue River and the Zambezi River and 230 Km upstream from the Kafue Gorge Upper Hydro Project. A vicinity and location map is shown in exhibit 1. The proposed ITT project will be located at an existing dam, which impounds the Itezhi – Tezhi Reservoir. The reservoir I currently used for seasonal stream flow regulation to serve the other Kafue River Hydroelectric projects. The proposed project will develop the head of available at the existing dam.

1.2 Purpose of the EIA

Performing the EIA for the proposed development allows the comparison of the capacity and energy benefits generated by the project with the environmental and socio-economic impacts, in accordance with the requirements of the Environmental Protection and Pollution Control Act – Environmental Impact Assessment Regulations, Statutory Instrument No. 28 0f 1997.

1.3 Scope of the EIA

This report addressed the potential environmental effects of the Itezhi – Tezhi Hydroelectric (ITT) Project on the Kafue River, in Zambia. The report has been prepared mostly by ZESCO Environment and Social Affairs Unit to conform with the guidelines of the Environmental Council of Zambia. A copy of the Terms of References from the contract between Harza and ZESCO is shown in Annex D. The key people involved in the preparation of the EIA Report are:

Environment and Social Affairs Unit of ZESCO ltd.

Ackim Tembo, Manager – Bs. Msc. PhD (Range Ecology)
Nixon Majaka (late), Social Scientist – BA. MA (Demography)
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Elenestina M. Mwelwa, Hydrologist – BA, Postgraduate Dip, Msc. (Hydrology)

Zondwayo Ndhlovu, Information specialist – BA (Information Technology)
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Harza Engineering Company International LP

Bruno Trouille, Project Manager, BS, MS
Peter L. Ames. Senior Environmental Scientist, BA, MS, PhD (Biology)

The Itezhi–tezhi Project differs from the majority of hydroelectric projects in that the dam and reservoir are already present and have been in operation for more than 20 years. Thus most of the environmental impacts normally associated with hydroelectric development – the installation of a dam, blocking of the fish migrations, inundation of arable land and habitat, displacement of people – have already taken place.

The study considers the effects of drilling, excavations, solid and liquid waste, fluctuation of flows in the river, disturbance arising from vegetation removal, and the large presence of construction workers in the area.

2. ENVIRONMENTAL REGULATIONS

2.1 Environmental Council of Zambia

The legislative responsibility of environmental impact assessment is vested in the Environmental Council of Zambia (ECZ) which administers the Environmental Protection and Pollution Act No. 12 of 1990, Statutory Instrument No. 28 of 1997 – The Environmental Impact Assessment Regulations. The Council is mandated to: a) identify types of projects, plans and policies for which environmental impact assessments are necessary and to undertake or request relevant institutions to undertake such assessments for consideration by the Council; b) to monitor trends in the use of natural resources and their impact on the environment; c) to request information on the quantity, quality and management methods of natural resources and environmental conditions from any individual or organization anywhere in Zambia and: e) to consider and advise the government, on all major development, on all major development projects at an initial stage and on the effects of any sociological or economic development on the environment.

In addition to the above, the Ministry of Environment and Natural Resources in consultation with the ECZ, is empowered to make regulations by statutory instrument for any matter that can be prescribed under the Act in the protection of the environment.

2.2 Department of Water Affairs.

The department of Water Affairs administers the Water Act (CAP 312). The Act prohibits the pollution of public water so as to render it harmful to man, animal, fish or vegetation. It also empowers the water officers to direct persons responsible for fouling or polluting water to take appropriate measures to prevent the fouling or pollution. There are plans to establish water quality standards for public water.

A water policy was ratified in 1992 as regards to water resources management, The 1992 Dublin Statement on Water and Sustainable Development provided the priority for an integrated management plan preparation for international watersheds. As such the Zambezi River Authority has the mandate for managing of the Kariba dam and the portion of the Zambezi River shared by Zimbabwe and Zambia and is charged with collecting, accumulating and processing hydrological data for the Zambezi River.

2.3 Department of Energy

The Department of Energy is responsible for the administration of the petroleum policy including pricing, storage and the oil pipeline control and administration of electricity, production and processing of fossil fuels, and development of renewable energy resources. The Department also administers the Electricity Act, the Petroleum Act (No. 13 of 1985), the Zambia – Tanzania Pipeline Act, and the Zambezi River Authority Act.

2.4 Department of Natural Resources

The Department of Natural Resources administers the Natural Resources Conservation Act (CAP 315). The Conservation plan under the Act provide for the preservation of, or protection of, or limitation of entry upon, any hillside, water catchment, spring water, sponge mash, swamp forest, stream, stream bank or water hole; the allocation of land as preserves for water catchment; the construction of dams, weirs and any works for conserving water, or for regulating water supply, or for distributing water, or for irrigating land, or for draining the courses of rivers, and for flood prevention. The Natural Resources Department of the Ministry of Environment also has departmental functions as regards to forests, fisheries and wildlife in its provision for the conservation plans. Under the conservation plans, there is authority to provide for the demarcation of and preservation of nature and wildlife reserves, as well as for location of land for fuel wood, forestry or fish farms.

2.5 Department of Forestry

The Department of Forestry administers the Forestry Act (CAP 314). The Act provides for the conservation of the forests through the establishment and management of forest reserves and through the licensing and sale of forest produce.

2.6 Local Authorities

The Local Authorities, under the Ministry of Local Government and Housing, administers the provisions for the Local Government Act (CAP. 22 of 1991). The functions of the Local Authorities in relation to environmental regulation of water are to exercise general control, care and maintenance of public water resources and to remove obstacles thereof; to take and require the taking of measures of water drainage; to provide and maintain water supplies and establish and maintain water works; to take and require the taking of measures for the conservation and prevention of pollution of water supplies.

In relation to the above, the Local Administration (Trade Affairs) Regulation No. 161 of 1985 was instituted. These regulations prohibit the discharge of trade effluent into any water course without the written permission of the district council.

2.7 National Parks and Wildlife Services

The National Parks and Wildlife Act (no.10 1991) provide for the establishment, control and management of National Parks, the conservation and protection of wildlife and objects of interest in National Parks; the establishment of Game Management Areas; Licensing of hunting; control of possession of trophies and the control of bush fires.

2.8 Department of Fisheries

The Fisheries department administers the Fisheries Act (CAP 314, 1974) The Act regulates commercial fishing through registration of fishermen and boats, and prohibition of certain fishing methods and equipment.

2.9 Ministry of Lands

The Department of Lands administers the Land Act (CAP 292, CAP 289, CAP 288) for the allocation and alienation of land under statutory leaseholds. The Department is also responsible for the administration of lands and deeds registration and land surveys and mapping.

2.10 Ministry of Mines and Mineral Development

The Ministry is responsible for mines and mining policy including the development of small mines; precious and semi-precious mineral; mineral research and mine safety. The ministry administers the Mines and Minerals Act (CAP 320), the Petroleum and Production Act (No. 13 of 1985) and the Zambia Iron and Steel Authority.

2.11 National Heritage Conservation Commission

The National Heritage Conservation Commission Act (No. 23, 1989) provides for the conservation of ancient, cultural and natural heritage and establishes the Commission and sets out its functions. The Act is the implementing legal framework in Zambia of the World Heritage Convention 1992, under which the heritage site (such as Victoria Falls) are included in the World Heritage list as World Heritage Sites.

2.12 International Convention and Protocols

Zambia has signed and is party to more than thirty International and Regional Conventions and Protocols. The most relevant environmental conventions are: Convention dealing with the Protection of the World Cultural and Natural Heritage (!972) and ratified by Zambia in 1982., statutes of the International Union for the Conservation of Nature and Natural Resources (IUCN), Convention on International trade in Endangered Species of the wild fauna and flora (CITES), 1993, ratified in 1993 and the RAMSAR Convention and Bonn Convention. Zambia has also ratified the Basel Convention (1994) which regulates transboundary movements of hazardous wastes.

3. NEED FOR PROPOSED ACTION

3.1 Importance of the Hydropower Project

ZESCO's Twenty Year Plan developed by EKONO included a demand forest that was based on a discretionary analysis of the qualitative changes taking place in the operating environment and quantitative interpretation of these changes. This was necessary because the historic data included disturbances such as load shedding and there was no econometric model available for the country. The key variables that were assumed to drive the energy consumption were as follows:

- Gross Domestic Product for demand in the industrial, agricultural and service sectors
- Annual copper production in the mining sector, and
- Population growth and electrification for the residential sector.

The forecasts were estimated by sector and aggregated. The demand was presented for three economic scenarios: a most probable, optimistic and pessimistic. The forecasts are presented in Table 3.1

Table 3.1
All – Sector Energy Demand Forecast (GWh)

Year	Economic Scenario		
	Most Probable	Optimistic	Pessimistic
2000	7,197	8,726	6,624
2005	8,380	9,968	5,257
2010	8,651	12,710	6,167
2014	9,312	13,114	6,636

The growth rate for the most probable condition is about 1.1% p.a. Mining is the major sector in the demand accounting for about 45 percent of the demand at the end of the period; however, it is forecast to peak in about 2002 and then decrease. The domestic, industrial and services sectors all are about equal ranging between 13 and 19 percent of the total demand.

A sensitivity analysis was performed that considered the impact of demand side management (DSM), fuel substitution, and price elasticity. It was concluded that the long – term effect of DSM would be to reduce demand by about 500GWh and that the effect of fuel substitution would be fairly small. If large price increases are applied, there would be a chance that the most probable demand would be reduced about halfway to the pessimistic scenario in the years. The effect of income elasticity outweighs the price effect toward the end of the period

Peak demand was computed of the basis of an estimate of the annual capacity factor that was estimated to equal 0.72 in 2000, 0.70 in 2005, 0.69 in 2010, 0.68 in 2014 (Harza 1995). The estimates of demand are shown in Table 3.2.

Table 3.2
All – Sector Energy Demand Forecast (MW)

Year	Economic Scenario		
	Most Probable	Optimistic	Pessimistic
2000	1,200	1,321	1,016
2005	1,304	1,513	869
2010	1,388	1,927	967
2014	1,537	2,005	1,049

With a current capacity of 1,760 MW and a 1994 generation of about 8,094 GWh, the Itezhi – Tezhi Project, with a capacity of 120 MW and an annual average generation of about 640 GWh could easily be absorbed into the system even without the possibility of exports.

3.3 Alternatives to the Proposed Project

The project objective is the provision of additional electric energy to meet the growing demand of the Zambian economy. Electricity is far from the principal energy source in Zambia. In 1990, nearly 70 percent of the national energy demand was met by domestic burning of fuelwood (both firewood and charcoal). The remainder (31.7 percent) was divided among electrical energy (12 percent) petroleum and petroleum products (14 percent) and coal (5.6 percent). Data from ZESCO indicate that some 95 percent of electrical energy was obtained from hydroelectric plants, and the remainder from gas turbines and small diesel plants. About 90 percent of the electricity is derived from two hydroelectric plants, Kariba North (600MW) and Kafue Upper Gorge (900MW).

The gradually increasing demand for electricity could be met by alternative hydroelectric projects or by additional use of diesel and gas turbine units. The use of coal is also possible. Economic considerations dictate the use of hydroelectric power where water is available. Although the hydroelectric plants usually exert higher initial impacts, through the inundation of land and habitat and the displacement of people, coal and diesel alternatives impact air quality and may require substantial consumption of water for cooling.

Several other hydroelectric projects are under consideration and one or more of them may be constructed. Those under study include Batoka Project (1,600 MW), on the Zambezi River and the Kafue Lower Gorge Project (750MW), on the Kafue River, at the lower end of Kafue Gorge. These are large and more expensive projects, which would provide considerably more power than that needed for the country's short – term growth. In time, however, they may be justified.

Alternative site developments at the ITT site were evaluated for two features of the project: 1) the type of powerhouse, and 2) the height of the Itezhi – Tezhi Dam. The analysis of the powerhouse was straightforward and consisted of comparison of costs at a most likely level of development. The analysis of the dam included a determination of the existing condition of the dam, the technical feasibility of raising the dam, and the approach to raising the dam. Two approaches to raising the dam were considered, the construction of a parapet wall and the additional fill.

Arrangements featuring two-units surface and underground powerhouses were compared for various installed capacities. The surface powerhouse would be located on the right bank of the Kafue River immediately adjacent to the diversion tunnel outlet channel. The arrangement will make use of the outside diversion tunnel and a tunnel extension to deliver water to the powerhouse. The underground powerhouse would be located about adjacent to the crest of the dam in a cavern comprised of the existing outside diversion tunnel and additional excavation on the sideway from the dam. The arrangement would make use of the existing intake and upstream portion of the outside diversion tunnel as does the surface alternative and discharge from the powerhouse would be direct back into the diversion tunnel. On the basis of a cost advantage of about 30 percent, the underground powerhouse was selected.

Dam raises of 3, 5 and 10 meters were analysed. For the raises up to three meters, the installation of a parapet wall has been adopted as the most cost effective approach to raising the dam. For a five meter raise, an extension of core is preferred. However a parapet wall could probably be considered for a dam raise up to five meters although that height exceeds any currently existing parapet wall. For raises above five meters, an extension of the core will be required. For any raise above five meters, the core and downstream rockfill shell will be extended. The procedure would be to construct the downstream shell to approximately EL. 1030, excavate the crest to same elevation, prepare the core surface and extend the dam upward. The core would be 7.0m and placed at the slope of the upstream face of the dam. The transition and filter zones also would be extended. The upstream face would be protected with riprap and rockfill would be placed on the downstream side. The wing dams would raised in a similar fashion. The saddle dams, and intake tower would be raised to the new top-of-dam.

The cost of raising the dam 3m, 5m and 10m is $37million, $67 million and $97 million respectively. The random fill berm required to provide stability under earthquake conditions if the pore pressure reaches the operating level of EL. 998 account for about $19 million for each of the alternatives. For comparison, a 5m raise by installing a parapet wall would cost about $ 43 million.

Annex C of this report presents the estimated resettlement population that would have been affected by the proposed raising of the ITT dam. The results are based on the survey conducted by ZESCO Environment and Social Affairs Unit with the surveyors at ITT from 26th March to 14th April 1997.

By utilizing the dam at the present height, inundation of arable land, habitat, displacement of people and considerable aquatic disturbance will be avoided. On the other, if the dam is raised even by 5m, 1,241 village houses, 2 tourist lodges (musungwa and Kalala lodges), 2 primary schools, an office block for the Department of Veterinary Services and 9 churches will be destroyed, 3,757 people will be displaced, 397 assorted fruit trees will be destroyed, large trucks of arable land, natural vegetation will be inundated, part of the road link Itezhi – Tezhi and Nangoma Wildlife Camp and part of Kafue National Park will be inundated and this will reduce wildlife habitat.

After examining the two alternatives, it was recommended that the first alternative of utilizing the dam at the current height would be more environmentally friendly because it has a few impacts. Alternative two was not recommended because of major environmental impacts. The selection process for the final configuration of the Itezhi–tezhi Project also consisted of an economic evaluation of the level of development followed by an economic evaluation of the feasibility of raising the dam. The analysis was performed for a 30 year operating period at a discount rate of 12 percent. As a result of the analysis, it was concluded that it was not economically feasible to raise the dam.

3.4 The Do-Nothing Option

If the project is not constructed, ZESCO will not be able to meet the future load demand. This would result in load shedding affecting acceptable quantity and quality of electricity supply to customers (industries as well as residents).

3.5 Potential benefits of the Project

There are a number of benefits that will result from the construction and operation of the project. These include:

1. Employment opportunities for the local communities during construction and operation. Thus it will play apart in improving the quality of life in the area;
2. Development of the project is part of the long term strategy to develop the hydropower potential of the country and earn export revenues.
3. Development of the project will help meet the growing electricity demand in Zambia and the region.

3.6 Study Area

The Kafue River basin is located approximately in the central part of Zambia approximately between 11 degrees and 16 degrees south latitude and 26 degrees and 29 degrees east longitude. The basin covers an area of about 150,000 square kilometers (km^2), up to the confluence of the Kafue Rivers and the Zambezi River, which is about 20 percent of the total area of the country. The terrain near the Zambia –Zaire border is largely mountainous and covered with trees. Precipitation is fairly high. Further downstream, up to the Kafue Gorge, the topography in general is undulating to a flat, vast plateau, at places interrupted by some ranges of hills and mountains of moderate heights. The basin, above the gorge, mostly lies at an elevation ranging from about 1,000 meters to 1,300 meters above mean sea level. For the most part, the basin is covered with trees and bushes with the exception of some low-lying areas along the river and the tributaries.

The Kafue River rises near the Zambia – Zaire border in the north at an elevation of 1,400 meters and flows southward through the copperbelt of Zambia, passes near the western edge of the Lukanga Swamps, turns west and then south, down to the Itezhi-Tezhi Reservoir. At the reservoir the river passes through a range of low hills and turns eastwards across the Kafue Flats, where it meanders for a distance of about 230 kilometres before entering the 90 kilometres long Kafue Gorge. After exiting the Gorge, the river flows about 65 km to its confluence with the Zambezi River. The average gradient in the reach upstream of the Kafue Gorge is about 0.025 percent. The gradient is very low through the flats and increases to about 0.7 percent through the Gorge. The length of the main river is about 1,550 km and the total drop is about 1,400 meters.

Exhibit 1 shows the Kafue River Basin, the location of the ITT reservoir, the existing Kafue Upper and proposed Lower Hydro project sites. Refer to Figure 1.

Major tributaries of the Kafue River are the Luswishi, Lukanga, Lunga and Lufupa rivers, with drainage areas of about 9,500, 15,000, 24,000 and 10,000 km^2, respectively. About 30 small tributaries drain the Kafue Flats.

A very significant feature of the basin is the presence of swamps and marshy lands (generally known as “dambos”). The Lukanga swamp covers an area about 2,500 km^2 and consists of reeds with occasional patches of open water. The general depression in which the swamp is located has no outlet except two small channels that connect to the Kafue River. One channel connects to the Kafue River near Mswebi and a second channel connects downstream from Chilenga. The second channel operates during floods only, when the water flow from Kafue River to the Swamps. There is practically no contribution to the Kafue River from the Lukanga River. The Kafue Flats, located downstream from Itezhi-Tezhi, cover an area of about 5,000 km^2 and slope gently from the west to the east with a drop of about 6 meters in about 230 km. There are a number of tributaries in the Kafue Flats that contribute a small amount of runoff. Much of the runoff is used in filling the depressions, and is subsequently lost through evaporation.

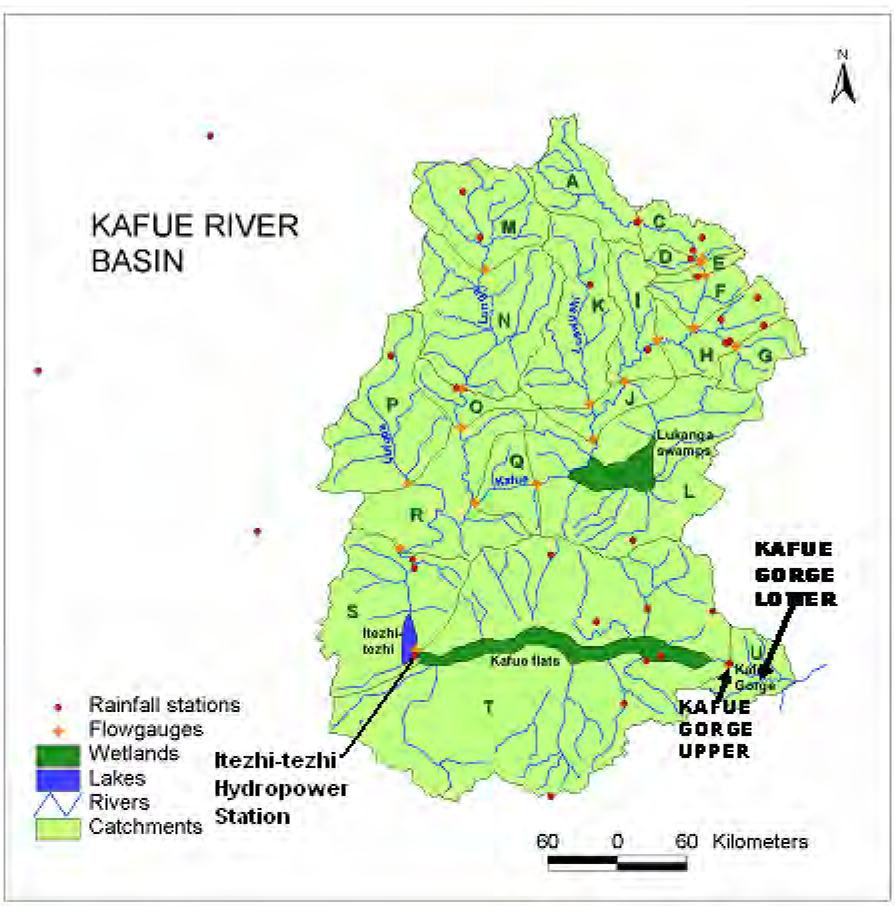

Figure 1 Kafue Catchment with associated hydropower schemes (source: E.M. Mwelwa, 2004)

4. SCOPING OF THE PUBLIC HEARING MEETINGS

Meetings were held with relevant stakeholders to the project. Among the major stakeholders consulted were the people likely to be affected if the dam height was to be increased, the Chiefs under their jurisdiction and government institutions operating in the area.

4.1 Consultative Meetings with Stakeholders in Musungwa and Kaingo Villages

Meetings were held with relevant stakeholders in the Musungwa and Kaingo Villages. The people consulted included:

Musungwa Village:

Chief Musungwa
Headman Shamwene
Headman Mwiila

Kaingo Village:

Chief Kaingo and his Indunas

The Chiefs Kaingo and Musungwa identified a series of concerns and offered suggestions with respect to the implementation of the projects as follows:

- Compensation for the effected people
- Set up labor council and involve local Chiefs in the recruitment of construction workers
- Since the dam was constructed in 1978, there has been less flooding downstream and the ponds have no water. They would prefer more flooding as it would assist the pasture for grazing.
- ZESCO should inform the Chiefs downstream of the dam before opening the water gates. Would be submerged if the dam is raised.

4.2 Consultative Meeting With Institutions Operating in Itezhi – Tezhi

A consultative meeting with the heads of department of various institutions operating in Itezhi-Tezhi was also held. All the major institutions were represented. Refer to figure 2.

A brief background was presented by the Consultant after which the meeting went into deliberations. The meeting participants were informed the surface and underground power station options were being considered, and building the power station would result in increased flow releases fro the reservoir, with the release being varied according to the demand of electricity during the day.

The main concerns brought up in the meeting included:

- The effect that potential raising of the dam would cause to the immediate surroundings
- The effect that the potential raising of the dam would have on the fishing Industry.
- The effect of continuous flooding on fishing downstream of the river. Fishermen catch more fish when the river is low.
- People need to be informed before releases are changed.
- Fluctuation of water releases would effect fish breeding
- The intake should be designed to avoid use of deoxyginated water. Use of this water would kill the fish
- Relocation should take into consideration the differences in ethnic composition of people along the reservoir and that of the upper land.

A visit was made to the Kafue National Park, Nangoma Camp. Indications are that a large part of the park is bordering the reservoir area.

Figure 2: Scoping meeting at Itezhi-tezhi

5. PROJECT DESCRIPTION

The Itezhi Tezhi Hydroelectric project consists of adding a powerhouse and ancillary structures to the existing rock-filled dam on the Kafue River. As recommended, the Project will consist of modifications to the existing intake, construction of an underground cavern to house two Kaplan turbines direct connected to synchronous generators with a maximum capability of 120 MW, construction of an access tunnel to the underground cavern and the placement of a switchyard at the outlet of the access tunnel. The dam will remain at its current height.

5.1 Itezhi Tezhi Dam

The existing Itezhi-Tezhi Project was completed in 1978 regulate the flow of the Kafue River for hydroelectric power generation and other water uses at downstream locations. The reservoir is located on the Kafue River, about 295 km upstream of the confluence of the Kafue River and the Zambezi River and about 230 km upstream from the existing Upper Kafue Gorge Hydro Project.

The Itezhi-tezhi Reservoir has a total storage of approximately 5,640 million cubic meters (MCM) at elevation 1029.5 meters above mean sea level (El.1029.5), its design full supply level. Most of the storage is available for regulating the flows of the Kafue

River. The reservoir is impounded by an earthfill dam with a maximum height of about 51 meters and a crest length of about 1,400 meters. The top dam is at el 1035m. The general layout of the Project is shown on Exhibition 2, 3 and 4.

The dam is a conventional rockfill dam with a central impervious core and shell zone designed for the control of seepage and prevention of any degradation of the embankment material properties. There are berms located at the upstream and down stream toes fo the structure at highest part of the dam. The berms were originally constructed as cofferdams and were incorporated as part of the main dam fill during construction.

The main spillway consists of a gate controlled, chute spillway with a flip bucket dissipation structure. The spill way is located between the left abutment of the main dam and a small saddle dam. The spillway discharge is directed to the river valley about 800m downstream from the toe of the main dam. The discharge is controlled by three radial – type spillway gates that measure 15 m wide with a sill elevation at 1018.7 m. The spillway will discharge 2,920 m^3/s, with the reservoir level at the full supply level and 4,450m^3/s at the point of incipient failure of the fuse plug (El.1033).

The emergency spillway is fuse plug embankment, located in an open cut channel through a small topographic saddle about 1,000 m north of the main spillway.. The fuse plug would be overtopped at el 1033 and upon complete failure of the plug would have capacity of 750m^3/s. Discharge from the fuse plug section would flow along a short excavated channel and would then cascade down the river valley slope to re-enter the main river channel. The combined main and emergency spillway capacity at El 1033 is 5,200 m^3/s.

The river was diverted through two diversion tunnels during construction. Each tunnel has a cross section area of about 190m^2 and a horseshoe shaped cross section with a width of 12.5m and height of 15m. The overall diversion works comprise an inlet channel, an intake structure, the two tunnels, and a discharge channel downstream from the toe of the dam. The head works for the gate extends above the reservoir full supply level.

The southerly tunnel was plugged after the intake bulkhead gate was closed. The northerly tunnel was converted for use as a permanent low level outlet. The works consisted of placement of the intake bulkhead followed by construction of a plug section that included a control and guard gate located in the tunnel near the axis of the main dam.

Flow is normally released from the reservoir through the low level outlet gate in the former diversion tunnel. The upstream reach of the tunnel will normally be exposed to the full reservoir water pressure. The other tunnel has also remained under reservoir pressure from the tunnel plug upstream to the reservoir. The downstream section of the abandoned tunnel has been flooded since the end of the diversion period with the water level determined by the tailwater level in the river channel downstream.

5.2 Intake and Headrace Tunnel Modification.

The existing tunnel intake will be rehabilitated for placement and removal of bulk gates. An intake trashrack will be installed in the existing check at the face of the structure and provisions for intake trash raking will included. The bulkhead gates will be rehabilitated and a hydraulic hoist system will be installed. The headrace tunnel lining will be repaired As needed and rock consolidated grouting will be provided downstream from the existing plug.

5.3 Powerhouse

The powerhouse will consist of three galleries. A 9.0 m by 73 m by 33 m valve chamber will house two inlet valves and a construction crane. The machinery hall will be 19 m by 74 m by 42 m. The hall will house the two units, an overhead traveling crane, an erection and laydown area, and the ancillary mechanical and electrical equipment. The transformer gallery will be located about 15 m downstream from the mechanical hall and will be 12 m by 59 m by 12.5 m. In the case where the underground alternative will be preferred, the rock around the caverns is expected to be competent and only elastic support consisting of 7 mm of shotcrete is required. Local areas may also require rock bolts and wire mesh. The surface powerhouse alternative would not require any rock protection as the structure will be on the surface of the ground. In this case, the surface powerhouse has been preferred after some feasibility studies. Refer to attaché drawings in Annex D.

There will be three main floors, the main operating floor at the level of the top of the generators, the turbine floor on top of the spiral casing and a third lower floor for storage and offices.

The draft tubes will pass under the area between the machine hall and transformer gallery. The draft tubes can be isolated by slide gates operated by hydraulic or chain lifting hoists. After the slide gates, the individual draft tube tunnels coverage into a single 9.0 m horseshoe – shape tailrace tunnel that will be connected to the downstream part of the outside diversion tunnel. The diversion tunnel will be inspected and strengthened as needed. The tailrace tunnel will flow full during the peaking operation and part full during the rest of the operating period.

5.4 Mechanical Equipment

The turbine will be conventional vertical – shaft Kaplan units each rated at 56.3 MW with a maximum capability of 60 MW. The rated speed will be 176 rpm and the rated discharge will be 156 m^3/s at a net head of 40 m. The center of the turbine distributor will be at El. 976 or about ten meters below tailwater.

Each turbine will be provided with a digital microprocessor-controlled electric-hydraulic governing system with speed and acceleration sensing, speed regulation, stabilizing, and diagnostic functions. The governing system also will have provisions for remote starting and automatic load control. Each turbine will be protected by a butterfly shutoff valve located in the gallery 20 m up stream from the machine hall. The valve will permit isolating the turbine, in conjunction with the draft tube gates, for maintenance.

A main powerhouse crane will be provided for installation and removal of the generating equipment during erection and for future maintenance of auxiliary equipment in the machine hall. A third crane will be located in the valve chamber for installation and maintenance of the inlet valves.

In addition, other general mechanical equipment will include:

- Turbine flow meters and taps,
- Water level monitoring and sensing systems,
- A cooling and service water system that will be supplied from the draft tubes,
- A treated water system that will include a self contained water treatment plant,
- A governor and turbine inlet valve compressed air system to provide pressure for the oil pressure tanks,
- A sanitary drainage and sewerage treatment system,
- A station service compressed air supply system
- A unit unwatering and filling system to unwater the area between the draft tube gate and the inlet valve,
- A station drainage system to eliminate water from wash-down areas,
- An oil purification and recovery system,
- A fire protection unit system
- A forced, recirculating air conditioning and ventilation system and
- Emergency generating equipment to supply emergency power to essential station services in the event of station power loss.

5.5 Electrical Equipment

The generator will be designed for an output of 67 MVA at a power factor of 0.9 and maximum 80 – degree C winding temperature rise. The generator will operate at a speed of 176 rpm with a rated voltage of 13.8 kV. Each generator will include its own excitation system and accessories consisting of a static exciter and voltage regulator.

The three phase transformer will be used to step up the generator voltage from 13.8 kV to the transmission voltage, which is assumed to be 220 kV. Each unit will be connected to an individual unit transformer with a continuous rating of 70 MVA and a rated voltage of 220/13.8 kV. He transformer will be oil – filled, two winding types that are cooled by forced oil – to – water heat exchangers.

The generator/transformer connections will be through the connecting tunnel to the transformer gallery. An isolated – phase bus with an integrally mounted main disconnecting switch will provide the connection between the generator and transformer. Low voltage switchgear will be provided to provide power for the emergency diesel generators, other electrical loads and a site distribution feeder.

A 220 kV switchyard will be located near the outlet of the access tunnel on the right bank of the river about 75 m away from the existing outlet channel. The 220 kV equipment, including circuit breakers, isolators, instrument transformers etc. will be located in the switchyard. The high voltage windings of the main transformer will be connected to air-insulated switchgear in the switchyard by 220 kV cables.

The control system will include a hard-wire manual system and a distributed control system to provide control from either the generator local or remote control room.

Other electrical equipment will include:

- A DC system with rectifiers and battery to provide a secure supply of power,
- A fire detection system
- Communication systems
- Lightning systems. , and
- Grounding.

5.6 Switching and Transmission Lines

Power generated would be directed to a switchyard on the east (right) side of the river, downstream of the dam and thence over 220-kV transmission lines to connect with the Zambian grid through Mumbwa to Lusaka West Substation. The transmission line routing would be about 350 km long, will cross the Kafue river about 1 Km downstream of the dam and therefore would not pass over the Kafue Flats.

5.7 Work Force and Housing

A peak work force of proximately 500 men will be required during the construction of the project. Of these, about 20-25 will be management and technical personnel, 50-60 semiskilled workers(equipment Operators, welders, carpenters, glazers, electricians, etc), and the rest unskilled. The unskilled labor would be recruited from the local villages.

Managerial and technical personnel will be housed in the existing ZESCO colony near the dam. Housing for semiskilled labor will be provided there also. The unskilled laborers are expected to continue living in their villages, being bused to the site by the contractor.

5.8 Operating Mode

The project is expected to be operated 24 hours a day with greater generation during an 8 to 10 hour peaking period during the day time. It is anticipated that the rapidity with which that plant is started up will be determined largely by the surge in the river that can be tolerated downstream without risk to human life or property. The hydraulic characteristic of the river are expected to be investigated during the design phase, in order to establish the acceptable ramping rate.

6. DESCRIPTION OF THE ENVIRONMENT

6.1 Physical Environment

6.1.1 Geology

The Itezhi-Tezhi Project is located on a high (1000m) desert peneplain. There is little pronounced topographic relief except at the damsite where the Kafue River follows an entrenched course about 200 meters below the uplands. Structurally, the damsite is in the down-faulted valley (graben) in a relatively inactive segment of the East African Rift System. Bedrock at both abutments and throughout most of the reservoir is granitic basement rock, but the central part of the valley, beneath the main section of the dam is underlain by 30 – 100 meters of flat-lying mudstone(Karoo System). Granitic basement rock, including some foliated metamorphic rock, underlies the mudstone sequence.

Overburden is either a sandy/silty residual soil (laterite) from the in-situ weathering of the granitic bedrock, or sandy alluvium in the flood plain of the Kafue River. Residual soils are on the order of 2-5 meters thick; alluvium ranges to a maximum thickness in the order of 10-12 meters.

The embankment dam was constructed primarily with granite rockfill from a local quarry. Residual soil and alluvium were used for the central core of the dam. Foundation grouting was conducted in multiple rows as needed beneath the dam, with high grout takes in local section of the left abutment and in a shear zone at the spillway wing dam. The grouting program was augmented by extending and impervious upstream blanket from the core to increase the seepage path in selected areas of the left abutment, at the spillway approach channel and the spillway wingdam.

Artesian conditions developed at the site on first filling of the reservoir. Hydrothermal water from beneath the reservoir exited downstream of the dam in the initial years of operation. An extensive system of pressure relief drains/wells was installed to reduce foundation pressure. Pressure has decreased and stabilized since 1982 and is well below guideline safety values determined by the original designers.

Source quarries and borrow pits for soil and rock construction materials are available on site for future expansion work. Some concrete works from the original project have experienced distress due to silica alkali reactivity between cement and the crushed granite aggregate. This will require attention in future concrete design work to determine and specify the necessary cements.

6.1.2 Seismicity

The dam site is known to be located in the seismic region. The site actually lies on the relatively suitable plateau, about 200 km west of the more active regions of the East African System. This is manifested by frequent low intensity activity with occasional larger events. Initial review of data revealed no earthquakes larger than 5.6 M within approximately 300 km of the damsite since records were first kept in the early 1900s (1904 – 1910) to 1978. Data for the largest two earthquakes are presented in table 6.1

Table 6.1: earthquake records

Date	**Magnitude**	**Epicenter**	**Distance from Site**
12 Aug 1969	5.2	15S 26.5E	80 km
15 May 1968	5.6	15.9S 25.9E	20 km

Subsequent review of the worldwide seismic database (US Geological Survey) has revealed only three additional events exceeding the 5.6 level, in the period ending December 1995 details outlined in table 6.2.

Table 6.2 Seismic events exceeding 5.6

Date	Magnitude	Epicenter	Distance from Site
23 Sept. 1963	5.8	16.6S 28.8E	305 km
25 Sept. 1963	5.8	16.7S 28.7E	298 km
02 Dec. 1968	6.0	13.9S 23.8E	328 km

There is limited data indicating the possible occurrence of the reservoir induced seismicity at the Itezhi Tezhi reservoir. In early May 1978 and late August 1978, the number of earthquakes reached a local high (25 and 15 daily events) compared to more normal daily occurrences of <2/day. The Magnitudes of "most can be expected to be lower than 2.8" (Seismic Activity During Filling of Itezhi – Tezhi Reservoir, VBB, 2?7/79,p.5)

In addition to the evaluation by VBB (above reference), microseismic earthquake data in the period March 1981 to April 1987 were also reviewed and evaluated by the Central Water and Power Research Station, Pune, India (see attachments to Memo 380-22, October 1991). In their summery of activity, the following points are made:

- The increased seismic activity in 1978 shortly after filling began could be surmised to be RIS (reservoir induced seismicity).
- After a quiet period of about three years, the seismicity in close proximity to the dam increased in August 1982, with several shocks ranging in magnitude from 3.0 to 4.0 (see figure B3-6). These can be considered as reservoirs induced shocks. (Ed. Note: This is also the seismic activity that has been associated with the general decline in aquifer pressures, which began in October 1982)
- After 1982, the level of activity "steadily reduced almost to its natural level", the exception being a "spurt of activity" in October 1984, with the main shock rated as 4.4 M; this was judged by pune to have characteristics of a natural, rather than a reservoir induced shock.

Since the issuance of the pune study covering earthquake activity for the project operation period trough April 1987, no further comprehensive seismic reviews have been conducted. ZESCO has provided data for this update but has not yet received the evaluation.

In the 1991 site review report (memo 380-22), SWECO agreed with the owner that the seismic monitoring effort could e reduced. This was in recognition of the fact that RIS events at Itezhi-tezhi to date had been of a similar magnitude as natural seismic events (generally <3-4 M), and perhaps also that RIS at Itezhi-tezhi had been nowhere near the levels of activity that had been experienced at Kariba, in southern Zambia.

6.1.3 Topography

The terrain of the Kafue Basin, in which the Itezhi-tezhi project is located, lies in western part of Zambia, near the Zaire border. The upper basin is largely mountainous and forested. Farther downstream, from the dam to Kafue Gorge, the topography is gently undulating on a vast plateau, interrupted by ranges of hills and mountains of moderate height. The basin above the gorge lies mostly between 1,000 and 1,400 meters above sea level.

A significant feature of this basin is the presence of swamps and marshes generally known as "dambos," that tend to regulate the flow of the Kafue River. One of these, Lukanga Swamp lies upstream of ITT reservoir and covers an area of about 2,500km^2 .It consists mostly of reeds, with occasional patches of open water . It is generally believed that there are only two outlet channels. Another important wetland is Busangu Swamp, on the Lufupa River, upstream of ITT Reservoir.

The Kafue Flats, located downstream of the Itezhi-Tezhi Dam, covers an area of about 5,000km^2. The flat slopes gently from west to east, with a drop of about 6m over some 230km. The total drainage area between ITT Dam and Kafue Gorge is about 45,400km^2. Along the river channel are numerous depressions, old river channels, and sloughs, which are flooded during high flow periods and retain water for some months. They not drain, due to the impervious nature of the soils, but lose water by evaporation. These are important areas for fisheries.

6.1.4 Soils

The surface soils are two to five meters thick, with alluvium in the floodplain in the order of 10-12 meters thick. Most of the soils have been formed in place by weathering of the granitic substrate. The alluvium of the flood plain is mostly sandy.

6.1.5 Climate

In general, the weather is subtropical continental and can be classified in four seasons:

- April – August Cool and dry
- September – October Hot and dry
- November – January Hot and wet
- February – May Cool and wet

The rain season starts at the beginning of November and may last until the end of March. The annual precipitation ranges from slightly from 1,400mm in the upper Kafue River basin to about 800 mm in the lower basin. The average rainfall above the Itezhi-Tezhi Reservoir is about 1,100 mm. The maximum rainfall months are December and January

The average temperature in Lusaka is about 21^0C ranging from an average low of 15^0 c to an average high of 27^0C. June and July are the coolest months averaging slightly more than 16^0C while the warmest temperatures occur in October and November when the temperature reaches about 24^0C. The mean humidity is about 62 percent ranging from 41 percent in November to 81 percent in January and February. Winds are generally from the east in the cool and dry months and from the northeast in the other seasons. Wind velocities are generally around 5m/s and range from calm to about 10m/s

6.1.6 Hydrology

A long-term stream flow sequence was developed at the reservoir. A number of stream gauging stations are or have been operative in the basin. The stream gauging stations are or have been operative in the basin. The stream gauging stations pertinent to this study are listed below:

Station	Drainage Area Km^2	Period of Record
4-670 Kafue R. at Mankoya	94,924	February 1952 - June 1973
4-669 Kafue R. at Hook Bridge	95,053	October 1973 - August 1976
4-710 Kafue R. at Itezhi-Tezhi	105,620	May 1955 - April 1977

Itezhi-Tezhi Res. Outflow		October 1978- January 1994
4-997 Kafue River at Kasaka	150,971	October 1905-December1993

A long- term monthly inflow series was generated for the Itezhi-Tezhi Reservoir for the period January 1905 through December 1995 and is presented in the ITT Feasibility Report. The inflow series was generated using basic data collected for the South African Development Community.

The impoundment of water in the Itezhi-tezhi reservoir has led to the development of a common feature of hot springs in the area of the Kafue Flats close to the reservoir. This is associated with the confined aquifer that has produced common features associated with artesian wells and hot springs in the area. Refer to Figure 3.

Figure 3: Common hot springs in the Kafue Flats

6.1.7 Significant pollutant sources

There are no known sources of significant pollutants.

6.2 Biological Environment

6.2.1 Flora

There are five distinct vegetation types around the Lake Itezhi-tezhi, Kafue National Park (KNP) and Namwala Game Management Area (GMA) below the dam along the Kafue River. These are 1) Dry Deciduous Forest, 2) Riparian Woodland, 3) Open forest with Grass, 4) Termitaria Vegetation and 5) Grasslands.

6.2.1.1 Dry Deciduous Forest

The Dry Deciduous Forest is classified in three distinct forest types namely, 1) Baikiaea, 2) Secondary baikiaea and 3) pteleopsis.

Baikiaea Forest

This plant community is in the south and south west of Lake Itezhi-Tezhi in the KNP and south of Ngoma Wildlife Station. This community is probably the most widely distributed.

The overstory is dominated by *Baikiaea plurijuga* and *pterocarps antunesii. Lonchocarpus nelsi* occurs in moderate numbers. The common short trees include *Baphia massaiensis obovata* and *combretum celastroides.*

Other common understory trees are *Acacia ataxacantha. Acalypha cylindrical. Alchornea occidentalis. Grewia avellana. Tarenna luteola, Citropsis daweana, popowia obovata, Waltheria indica* and *Triumfetta dekindtiana.* Forbs and smaller shrubs common are *Achyranthes aspera, plumbago zeylanica* and *Blepharis madaraspatensis.* Common climbers include *Hippocratea parviflora* and *Baissea wulfhorsti*. *Epiphytes* are few.

Secondary Baikiaea forest

This community is mainly found southeast of the lake and near Ngoma Wildlife Station and along the southeast of KNP. This forest community is easily vulnerable to fire and heavy browsing especially by elephant (*Loxondota Africana*).

Tall tree species include *Burkea Africana. Combretum callinum, Eythropleum africanum, Lonchocarpus capassa, Acacia giraffae, A. galpini, Terminalia sericea, Baikiaea plurijuga* and *xeroderris stuhlmanni.* Common small trees include *Croton gratissimus, Markhamia obtusifolia, Accacia fleki, Combretum celastroides, C.psdioides* and *Terminalia brachystemma.*

Shrubs include *Barkinia macrantha, Combretum elaegnoides, Acacia ataxacantha, Dalbergia martini, Grewia SPP, Hemizygia bracteosa, Disperma crenatum, justice* *betonicoides, Waltheria indica* and *Tepharosia cophalantha.* The common climber is *Combretum microphyllum.* Under story grasses are *Panicum spp, Setaria spp.* and *Sporobolus spp.*

Pteleopsis Forest

This community is common south west of the Lake Itezhi-Tezhi and along Musa stream a tributary of lake Itezhi-tezhi.

The dominant tall tree species of this community include *pteleopsis mystifolia, p. antunesis, p. anisoptera and Entandrophragma caudatum.*

Common small shrubs are *Phaulopsis longifolia, Sancivieria deserti, Achyranthes aspera,Blepharis madaraspatensis and Dicliptera nemorum.* Climbers are *Bonamia spectabilis, Tiliacera funifera, Baissea wulfhorsti* and *Strychnos lucens.*

The dry deciduous forest is of very economic from the standpoint of browsing and under story grazing by wildlife especially elephant. The important tree species include *Baikiaea spp.* used for timber and wood fuel in adjacent areas to KNP.Some shrubs within this vegetation community are used for local medicines.

6.2.1.2 Riparian Woodland

Riparian woodland occurs in a few places along perennial or even seasonal streams where there are still pools pools of water in dry season. The riparian woodland is dominated by *Syzygium guineense spp. barotsense.* Naturally there is a greater variety of species along the perennial Kafue River than along the seasonal streams.

Common tall trees associated with *Syzygium guineense* and include *acacia albida (*on riparian stanbanks), *Albizia glaberrima, Diospyros mespiliformis, Homalium abdessammadii* and *S*yzygium *cordatum.* At one place of the Nansenga River, *Syzygium guineense* and *S.cordatum* are replaced by a hybrid between the two species. Small trees are represented chiefly by *Nuxia oppositifolia, Oncoba spinosa, phoenix reclinata, rhus quartiniana* and *salix subserrata.*

Common shrubs include *Acalypha ornate, Antidesma venosum, Byrsocarpus orientalis, Diospyros lycioides, Mimosa pigra, Nidorella resedifolia, phyllanthus reticulates, Sesbania sesban, and phragmites mauritianus.*

Climbers are chiefly *Cissampelos mucronata, Glycine wightii, jasminum fluminense, Mikania cerdata, Mucuna pruriens, Paullinia pinnata* and especially *Tacazzea apiculata.*

This vegetation community is important for river bank stability and grazing by a variety of wildlife species. In the GMA the vegetation is used by both wildlife and cattle grazing.

6.2.1.3 Open Forest with Grass

The open forests with grass are classified in four woodland types namely, 1) Miombo 2) Kalahari 3) Mopani 4) Munga

Miombo woodland.

Miombo woodlands occur in two forms: 1) dominated by *julbernardia paniculata* north of the Kafue River and 2) dominated by *J. globiflora* on the south bank of the river.

A typical species which occur in the miombo woodland are *Acacia goetzei spp*. *Microphylla* in escarpment country, *Hymenocardia acida* and *phyllanthus engleri*.

Common tall trees include *Amlygonocarpus angolensis*, *Brachystegia boehmii*, *B. longifelia* and *B.speciformis* although most of the Miombo type *Bracchystegia* appears to be intermediate between and B. longifolia and *Erythrophleum africanum*. Small trees are chiefly *Diospyros kirkii*, *Monotes glaber* and *Pseudochnostylis maproneifolia*. Refer to Figure 4.

Common shrubs are composed of *Dichrostachys cinerea*, *Diplorhynchus condylocarpon, Eriosema elliptcum, Flacourtia indica, Hippocratea indica* growing as a shrub instead of a climber. Other common shrubs are members of the following genera – *Abrus*, *Adenodolicchos*, *Aeschynomene, Clerodendrum, Deesmodium, Diplolophium, Fadogia*, *Hypoestes*,*Indigofera*, *Lannea* and *Triumfetta with broken fern (pterridium)* and small colonies of the succulent A*loe christianii.*

Figure 4: Miombo woodlands

Kalahari woodland

Both Kalahari woodland proper and Miombo/Kalahari woodland occur in two forms on the south bank. Kalahari woodland is dominated by *Burkea Africana, Brachystegia spiciformis, Erythrophleum africanum and julbernardia paniculata.*

Common tall trees in Miombo/Kalahari woodlands include *Amblygonocarpus andogenensis, Baikiaea plurijuga, Combretum collinum, Guibourtia coleosperma, Parinari curatellifolia, Pterocarpus angolensis* and *Terminalia sericea.*

Small trees are *Diplorhyncus condylocarpon and Schrebera trichoclada associated with Baphia massaiensis spp obovata, Diospiros batocana, Ochna pulchra, Phyllanthus engleri, Pseudolachnostylis maprouneifolia, Terminalia brachystemma, Xylopia odoratissima* and *Zahna Africana.*

Common shrubs are *Bauhinias spp., Byrosocarpus orientalis, Cissus cornifolia, Copaifera baumiana, Diospyros virga, Eriosema affine, Friesodielsia obovata, Grewia spp.,Hymenocardia acida, paropsia brazzeana, Salacia luebbertii, Vangueria infausta and Xeromphis obovata. Annona stenophylla spp. nana,Chamaeclitandra henriquesianna,Gardenia brachythamnus, Hemizygia bracteosa Parinari capensis, Phyllanthus maderaspatensis, Sapium oblongifolium and Triumfetta annua.*

Climbers are few in numbers and species. Only *Ipomoea shirambensis* and *Landophia parvifolia* are common.

Mopane Woodland

Mopane woodland occurs the Kafue flats almost pure or in a mixture with the typical Munga species of the flats. In both cases, the Mopane trees are of poor quality and small.

In general, the canopy associates are *Acacia nigrescens, combretum imberb, Lannea Stuhlmannii* and *Sterculia quinqueloba.* The only common small trees are *Erythrina abyssinica, Piliostigma thoningii and Pterocarpus antunesii.* Colonies of the succulent *Aloe chabaudii* occur also.

Munga Woodland

This open savanna type of woodland occurs in two forms; on shallow Kalahari sands over alluvium and on upper valley clays and clay loams.

The Woodland is only found on a few small areas of Kalahari sand e.g. around Namwala boma. It is characterized by widely spaced *Acacia* and *Albizia spp. especially Acacia* *albida, A. galpinii, A. gerrardii* and *A. giraffae, Albizia amara* and *A. versicolor.* Common associates are *Combretum imberbe, Commiphora karibensis, Ficus sycomorus, kigelia Africana, Lonchocarpus capassa, Parinari curatellifolia, Acacia nigrescens. A polyacantha and A.sieberama, A.harveyi, Erythrina abyssinica, Erythrophleum africanum, Pericopsis angolensis, Pseudolachnostylis maprouneifolia, Pterocarpus angolensis* and *Terminalia brachystemma.*

Small trees are chiefly *Combretum fragrans, Diplorhynchus condylocarpon, Markhamia obtusifolia, Piliostigma thonningii* and *Terminalia brachystemma.*

Common shrubs includes *Baphia massaiensis spp. obovata, Bauchinia petersiana, Grewia praecox, Phyllanthus reticulates, Urena lobata. Annona stenophylla spp. nana. Clerodendrum unicinatum, Euginia angolensis, Ochna leptoclada* and the *Pollichia campestris. Climbers are Combretum paniculatum* and *jasminum fluminense.*

Small trees are *Acacia kirkii, Combretum fragrans, Piliostigma thonningii* and *Terminalia mollis* associated with *Antidesma venosum. Combretum apiculatum, Dalbergiella nyassae, Diplorhynchus condylocarpon, Lannea discolor. Markhamia obtusifolia, phyllanthus engleri, pterocarpus rotundifolius, Terminalia brachystemma. T.stengstachya, Combretum elaegnoids* associated with *Boscia salicifolia* and *Schrebera trichoclada.*

Shrubs are less numerous, the commonest being *Baphia nassaiensis spp. obovata, Bauhinia petersiana, Holarrhena pubescens, Hymenocardia acida, Phyllanthus reticulatus* and *Vangueria infausta.*

Other shrubs are *Anona stenophylla spp. nana, Disperma crenatum. Impomoea vernalis, Lannea edulis, Ochna leptoclada, Sphenostylis marginata* and *Syzygium guineense spp.huillense.*
Boscia mossambicensis, Clerodendrum capitatum. Dalbergia martini. Friesodielsia obovata, Maerua juncea and *Ximenia Americana.* Climbers are *Bonamia specabilis, Combretum mossambicense* and *Maerua friesii* associated with *Capparis tomentosa. Hippocratea Africana. Impomea shirambensis* and *Tiliacora funifera.*

The only common emergent is *Lonchocarpus capassa,* an invader of long standing. Grooves of *Borassus* and *Hyphaene* palms occur in Munga woodland or Munga grassland on the Kafue flats. Refer to figure 5.

Figure 5: Palm trees common in munga and open grasslands of the Kafue Flats

Suffrutex Savanna

These savannas have a distinctive shrub, sub-shrub, herb, sedge, grass flora characterized by the presence of *Annona stenophylla spp. nana, Combretum platypetalum, Euginia angolensis, Lannea edulis, Ochna leptoclada, Parinari capensis, Pygmaeothamnus zeyheri, Salacia luebbertii, Sesamum calycinum* and especially *Syzygium guineense spp. huillense.*

Open forest with Grass in one of the most important vegetation types due to its heterogeinity in its plant species composition. Therefore, this vegetation types attracts almost all wildlife species for grazing and browsing purposes, while in the GMA the trees are used for house construction, timber for furniture and wood fuel. In GMAs this community is the most vulnerable to degradation due to pressure.

6.2.1.4 Termitaria

Miombo temitaria

Termite mounds are widely distributed in Miombo woodland. Their flora is quite distinct from that of the surrounding Miombo. They are dominated by *Diospyros mespiliformis, Manikara mochisia* and *Mimusops zeyheri associated with Albizia amara, combretum* *molle, Euphorbia candelabrum, Markhamia obtusifolia* and *Ziziphus mucronata spp. rhodesiaca.*

Small trees are represented by the two *Boscias, B. angustifolia* and *B. salicifolia, euclea divinorum* and *Lannea discolor.* Common shrubs are *Hyrsocarpus orientialis, Diospyros lycioides, eretia aeruginescens* and *Grewia flavescens.* The succulent bowstring hemps *Sanseviera desertii* and *S.kirkii* are the only common subshrubs with *Capparis tomentosa* and *Carissa edulis* the only common climbers.

Munga termitaria

Termite mounds in the Munga woodland are characterised by *Albizhia amara, Ficus spp., Lannea discolor* and *Markamia obtusifolia* in the upper storey, *Cassine aethiopica* in lower storey. Undergrowth shrubs are largely *Acalypha chirindica* and *Clerodendrum tanganyikense,.* Subshrubs *Aloe zebriana* and the *Achyranthes aspera.* Common climbers include *Capparis tomentosa, Glycine wightii, jasminum fluminense* and *J.streptopus* and *Turbina shirensis.*

The Munga termitaria woodland is found in valley areas which include the Kafue river basin and attracts both grazing by wildlife and livestock in GMA. The trees are also used as fuel wood.

6.2.1.5 Grassland

Dambo grassland

The Dambo grassland is a moderately dense mat of grasses and forbs. The grasses are perenial bunch grasses, cushion like or tussocky with *Luodetia simplex* as the dominant species. This grassland type is found along the Kafue River and its tributaries.

Riverine grassland

The riverine grassland is composed of a narrow belt of *Hyparrhenia* grasses of many different species. Bunch grasses typified by *Loudetia simplex* cover extensive areas of the seasonally inundated flats.

Flood plain grassland

The flood plain grassland consists of a very uniform mat of perennial bunch grasses. Pure stands of a single grass are a feature. Reeds are the common aquatic plants of value to wildlife species and some species of fish.

Hyparrhemia rufa associated with *Setaria phragmitoids* and *S. ciliolata* are the typical grasses of shallow flooded margins, while *Echinochloa pyramidalis* and *Vossia cuspidate* are of the swamp areas where the flooding is deepest and most prolonged.

Grasslands in the area are important source of forage for grazers which include Zebra, Lechwe, buffalo, waterbuck, etc. Livestock especially cattle also depend on grasslands in the area.

All vegetation types in KNP are almost in pristine condition with little disturbances due to protection. However, vegetation in the GMA is disturbed by various uses by human inhabitants who are allowed to reside in the area.

6.2.2 Fauna

6.2.2.1 Mammals

KNP has the largest variety of large wildlife species in the country (about 80% of all Zambian mammalian species are represented). These species are distributed through out the park. A list of total numbers of families, genera, species of mammals, birds, reptiles and amphibians known to occur or have occurred in the past are listed in Table 6.1 (Ansell 1960, 1978). Table 6.2 shows habitat preference of some big mammals and predators in KNP and adjacent areas.

Dominant antelopes include Roan antelope (*Hipprotragus Niger),* buffalo *(Syncerus caffer)* eland (*Traurotragus oryx),*wildbeest (*Connochaetes taurinus),* Zebra (*Equus burchelli),* impala (*Aepyceros melampus*), warthog *(phacochoerus aethiopicus),* waterbuck (*Kobus ellipsiprymnus crawshayi), bushpig (Potamochoerus porcus),* Common duiker (*Silvicapra grimmia),* Oribi (*Ourebia ourebi),* reedbuck (*Redunca arundinum),* Kafue lechwe (Kobus leche subsp.) (this species is found in Kafue flats below Lake Itezhi-Tezhi), puku (*Kobus vardoni),* hartebeest (*Alcelaphus lichtensteini),* bushbuck *(Tragelaphus scriptus),* and kudu (*Tragelaphus strepsiceros).*

Less frequent seen antelopes include Blue duiker (*Cephalophus monticola)* and yellow backed duiker (*Cephalophus sylvicultor).* These mammals are under protection due to their low numbers.

Other mammals of great importance to the park and internationally are elephant (*Loxondonta Africana) (*which is protected and hunting is not allowed) and the rare black rhino (*Diceros bicornis)* which is said to be on verge of extinction in KNP due to poaching. The exact numbers of the remaining rhino if there are any, is not known. Many schools of hippopotamus (*Hippopotamus amphibious)* occur along the Kafue River and in Lake Itezhi-Tezhi.

Vervet monkey (*Cercopithecus aethiops)* and Chacma baboons (*Papio ursinus)* are plentiful all over the park and adjacent areas.

Carnivores include lion (*Panthera leo), leopard (Panthera pardus),* Hyena (*Crocuta crocuta),* Cheetah (*Acinonyx jubatus)* wild dog (*Lycoan pictus),* jackal *(Canis adustus).*

The majority of wildlife species in the area move from area to area due to seasonality, therefore, the dam rising may influence future movements of these animals.

Table 6.1
Families, Genera and Species of Fauna of KNP.

Fauna	Families	Genera	Species
Mammals	36	95	158
Birds	77	215	423
Reptile	17	50	69
Amphibians	4	17	35
Fishes	12	28	55

Table 6.2

Habitat Preferences of some Big Mammals Predators in KNP Park and adjacent Areas (After Ansell, 1960, 1978)

Species	Open Woodland and savanna	Dense woodland and thicket	Grassland	Floodplain	Riverine
Elephant	Common	Common	Occasional	Occasional	Common
Zebra	Common	Rare	Common	Common	Rare
Impala	Common	Rare	Occasional	-	Common
Puku	Common	-	Common	Common	Common
Roan	Common	-	Common	Common	-
Sable	Common	Rare	Occasional	-	-
Hartebeest	Common	-	Common	Common	-
Reedbuck	Common	-	Common	Rare	Common
Oribi	Occasional	-	Common	Common	-
Warthog	Common	Occasional	Common	Occasional	Rare
Kafue lechwe	-	-	-	Common	Common
Wildebeest	Common	-	Common	Common	-
Sitatunga	-	-	-	-	Common
Kudu	Occasional	Common	Rare	Occasional	
Buffalo	Common	Occasional	Common	Common	Rare
Eland	Common	-	Occasional	-	-
Oribi	Occasional	-	Common	Common	Occasional
Common duiker	Common	Occasional	-	-	-

Yellow backed Duiker	-	Common	-	-	-
Blue duiker	-	Common	-	-	-
Waterbuck	Common	Occasional	Common	Rare	Common
Bushbuck	Rare	Common	-	-	Common
Hyena	Common	Occasional	Occasional	Occasional	Occasional
Lion	Common	Occasional	Common	Common	Rare
Leopard	Common	Occasional	Occasional	Rare	Common
Cheetah	Common	Occasional	Common	Common	Rare
Wilddog	Common	Occasional	Occasional	Rare	Occasional
Jackal	Common	Rare	Common	Occasional	Occasional
Crocodile	-	-	-	Common	Common

6.2.3 Birds

Numerous waterbirds and unplanned bird species are found in the area. Common waterbirds include: pelican (*Pelecanus onocrtalus),* Spurwing goose *(Plectopterus gambensis)* Wattled crane (*Bugeranus caruculantus)* Crowned crane (*Bulearica regulorum),* Openbill (*Anustomus lamelligerus),* White faced tree duck (*Dendrocygna viduata),* Redbilled teal (*Anas spp.),* Yellowbilled duck (*Anas undulate)* and pygmy goose (*Nettapus auritus).*

Upland birds include Helmeted guinea fowl (*Numida meleagris),* Crested guinea fowl (*Guttera edouardi),* Scaly francolin (*Francolinus squamatus)*, African fish eagle (*Haliaeetus vocifer)* and bateleur (*Terathopius ecaudatus).*

6.2.4 Reptiles

Very little information is available on reptiles in the KNP and adjacent Lake Itezhi-tezhi area. The important reptiles in the area from qualitative information are crocodile (*Crocodilus niloticus)* common both in the Kafue River and Lake Itezhi-tezhi. Lizards are represented by Geckos, Chameleons and Skinks and Monitor Lizard (*Varantus niloticus).* Snakes are represented by Python (*Python sebae),* Boomslang (*Dispholidus typus),* Cobra *(Naja mosambica)* and puffadder (*Bitis arietans).*

6.2.5 Rodents

A variety of rodents occur in the KNP and adjacent GMA which will be affected by dam raising. These include Giant rat (*Cricetomys gambianus), Tetra valida*, *T. leucogaster, Saccostamus campestris, Pelomys fallax, Lemniscomys Griselda, Elephantulus brachyrhynchus* and *Petrodromus tetradactylus.* Family pedelidae is represented by spring hare (*pedetes capensis).*

KNP within which Itezhi-Tezhi dam partially covers attracts substantial number of tourists. The nearest lodges to the dam is Musungwa, Ngoma and New Kalala. The Mumbwa and Namwala GMAs attract international safari hunting clients who come hunt big game.

Endangered species of the area are Black rhino which is almost extinct. The other ones are Wilddog and Cheetah with very low numbers.Aadvarks and Pangolin are rarely seen. The major animals which will be affected due to dam rising are Puku, reedbuck, waterbuck because there are riverine/plain mammals.

6.2.6 Fish

The fishermen in the study area rely mostly on gill nets and seines. Some traditional gear, such as baited lines and traps, are used but not extensively. Gill nets are used day and night, with mesh sizes from 32 to 127mm (1.25-5in).The smaller mesh sizes are used mostly at night. Seines are of 63 or 76 mm size, but used mostly during the day. Annex A of this report presents the results of a survey on fishing activities in the Kafue basin.

The fishery downstream of the ITT Dam is regulated in four “strata” of administrative units. Stratum 1 extends from Kafue Gorge to Chanyanya Lagoon and includes 27 villages, Stratum 2 from Chanyanya Lagoon to Chunga (Lochinvar) and includes 61 villages, and Stratum 3 from Lochinvar to Namwala and includes 47 villages. Stratum 4, with headquarters in Namwala, extends from Namwala to ITT Dam and includes 34 Villages.

With the reduction of flooding since the construction of ITT Dam, fishing villages, which used to be moved to high ground during wet season, have become more permanent. In the last five years, the number of fishermen has increased, partly due to immigration from other areas of Zambia. A survey of ten villages undertaken for this project indicated household sizes of 6 to 8 persons and 6 to 24 fishing households per village. The total number of fishermen in all strata of the Kafue Flats area increased sharply following dam construction, from 1229 in 1974 to 2632 in 1978. During that period the number of fishing villages increased from 96 to 169.

The total catch from the Kafue Flats is widely believed to be correlated with the degree of annual flooding, but this is not supported by the catch statistics for the years 1986-1995 (Table 6.4). Although catch statistics are not available for the years before construction of ITT Dam, fishermen interviewed agreed that their catch declined severely in the years following the closure of the dam. From what is known about the off-channel spawning of many species, one would expect that fish populations would benefit from greater flooding of the flats. Evidently, there are other factors, ecological and social, that affect the actual amount fish taken. The highest catch in recent years was recorded in winter of 1993-1994, an exceptionally wet year, when ITT Reservoir was filled and spilling at the dam produced flooding of the flats to an exceptional degree from March through September of 1993. In that year, according to fishermen, even species normally rare in their catch were noticeably more abundant. On the other hand, 1992, when storage was nearly at its lowest (158 MCM) the catch was relatively large (7601 MT). Conversely, in 1986, when storage was high (848 MCM) the catch was the lowest in this ten-year period (4264 MT). Refer to figure 6.

Figure 6: Type of fish in the Lake Itezhi-tezhi and Kafue Flats Fishery

Table 6.3
Spawning and Rearing Habits of the major species in the Kafue Flats Fishery

Common Name	Scientific Name	Breeding habitat	Status
Green-headed Bream	*Oreochromis machrochir*	Shallow along river banks and lagoons	Decreasing
Three-spotted Bream	*Oreochromis andersoni*	same	Reduced
Red-breasted Bream	*Tilapia rendalli*	Same	Reduced
.Thin- faced Bream	*Serrachromis angusticeps*	Same	Reduced
Purple-faced Bream	*Serrachromis marcocephala*	Same	Reduced
Bulldog	*Marcusenius macrolepidotus*	In lagoons, rainy season	Reduced
Silver Robber	*Alestes lateralis*	Shallow running water	Reduced
Dot Tail	*Barbus poechi* *Clarias ngamensis* *Clarias gariepinu*	Shallow waters off main stream	Increased
Bottle Nose	*Mormyrus lacerda*	Deep water	Reduced

Table 6.4
Fisheries Production in Comparison with Annual Storage in Kafue Flats

Year	Production Flats, MT	Production Lochinvar, MT	Annual Mean Storage, MCM
1986	4264	77.6	848.08
1987	5955	272.0	754.23
1988	4440	276.1	489.41
1989	8969	388.3	654.18
1990	7335	256.6	556.33
1991	5362	111.5	466.64
1992	7601	220.1	158.07
1993	8724	282.8	900.39
1994	6293	665.2	564.66
9195	6579	147.2	102.15
9196	-	45.6	166.72

6.3 Social-Cultural Resources

6.3.1 General Characteristics of Reservoir Population

The eastern edge of the ITT Reservoir is densely settled with villages composed of a number of ethnic groups. The western edge is mainly occupied by the Kafue National Park. Most of these are fishermen who have migrated from other parts of Zambia since the ITT dam was constructed. A social survey conducted by ZESCO, presented in Annex C, indicated that there are 17 villages between and the head of the reservoir with a total populatin of 3,757. Table 6.5 provides the number of settlements recorded during the survey and the number of households to be potentially affected in the event that the dam would be raised. However, it was found that the raising of the dam would result in flooding more land than it is necessary, therefore this option was not considered under this phase.

Table 6.5
Number of villages, Households to be Affected Along the Reservoir in the event that the dam was raised.

No	Village Name	Affected population	Thatch Huts	Tin Roofed Huts
1.	Magazine	289	78	1
2.	Chongo	202	58	3
3.	Ikonkaile	473	130	6
4	Nachisenga	529	165	
5.	Kalombe	260	90	
6.	Malembwe	199	67	
7.	Naumba	230	74	
8.	Kayeka	171	65	
9.	Munyanja	269	83	
10.	Namutekwa	33	15	
11.	Buutwa	149	55	
12.	Katongo	389	130	1
13.	Namilio	37	11	
14.	Kalala	179	65	
15.	Maunga	183	79	
16.	Keela	110	41	
17.	Shimaponda	55	24	
TOTAL		3757	1230	11

Most of the people interviewed in the survey indicated that they came from other areas more than five years ago. The fishing villages are populated mainly by people of Lozi, Bemba, Luvale and Mbunda linguistic origins, having come from other fisheries areas in Western, Central, Northern, North Western and Luapula Provinces. Refer to figure 7.

Many of those who are not actually fishermen are vendors of fish. In addition to fishing, these people keep some livestock, although they do not consider themselves herdsmen. They also plant gardens in the drawdown zone of the reservoir.

Villages away from the reservoir edge are populated primarily by natives of the Southern Province (in which the project is located). The Ila are the traditional indigenous group of the Itezhi-Tezhi area, subsistence herdsmen who also grow maize and cassava. They fish part-time and barter with the lake-shore villages for fish. Other tribal origins represented among the villages away from the reservoir are Batwas and Tongas.

Figure 7: Common vessels used by the Fishermen in Kafue Flats fishery.

6.3.2 Settlement Pattern

The people along the reservoir rim live in villages or in fishing camps, the latter less permanent. Since they move as the reservoir recedes. Both the villages and the fishing camps are under the jurisdiction of traditional chiefs, who arbitrate all matters of land alienation and civil cases. Other cases, especially those of criminal nature, are handled by Zambia police, based at the ITT office, and disposed of through the subordinate court (commonly known as magistrate court) based in Namwala. All the people of the region live in houses predominantly constructed of mud (dagga), with roofs of grass thatch.

Most are one-room structures, but many families have separate houses for children or other relatives. Refer to figure 8.

Houses of chiefs, community buildings, most schools, churches and clinics are made of mud brick and have galvanized iron roofs. A few buildings in KNP have walls of corrugated iron sheet. Houses of park officials and the owners of the Musungwa and Kalala lodges are made of concrete block and have glass windows.

Figure 8: Typical houses in the project area

6.3.4 Demography

Demographic information is generally not available below the district level. National population figures can be extrapolated to the local level only to a certain degree. The population of Zambia was estimated at 5.6 million in 1980 censused at 7.8 million in 1990, an annual increase of 3.4 percent. The Namwala District had a 1990 population of 83,000, 47 percent of who were less than 15 years of age. Between 1980 and 1990 the average population growth was 4.0 percent. The recently established Itezhi-Tezhi Boma has a population of about 41,000.

An intensive set of interviews was conducted for ten households along the reservoir margin. An average household size was 9.4, with the 94 individuals comprising the 10 heads of household, 33 dependent adults, and 51 children. The heads of household ranged in age from 21 to71.

6.3.4 Economy

Fishing is the main economic activity in the Itezhi-Tezhi District. Lusaka Town and Mumbwa provide the market for the ITT fish. The local authority collects levy on all the fish leaving the District.

Tourist is another important economic activity in the area. The department of national parks and wildlife service and the lodges collect revenue from local and foreign tourists who visit the area to view game in Kafue National Park.

6.3.5 Land Tenure

In Zambia, there are several Acts governing the administration of land, viz.; Cap 292, 289 and 288 for the allocation and alienation of land. The land acquisition Act provides for the compulsory acquisition of land while the local Government Act (No. 22 of 1991) provides for control of land by local Authorities. Under the land Act, land has been divided into categories, namely: state, local authority and traditional land.

Itezhi-Tezhi District has abundant land, most of which is under the custody of traditional chiefs. Traditional authorities (chiefs) have rights over traditional land, with a mandate to recommend to Government lease to those who want to acquire land. Part of the land is under local Authority and the Zambia Electricity Supply Corporation Limited. The land in Kafue National Park is under the jurisdiction of the Department of National Parks and Wildlife Service.

6.3.6 Land Use

The study area has a wide range of land uses. The major ones are agriculture, fisheries, mining and tourism. Part of the area is covered by the ITT Dam which is used for fishing and as a reservoir for power generation. Some of the land is used for urban development at ITT center and infrastructure development.

6.3.6.1 Agriculture

Subsistence farming is the most common form of agriculture in the area. Crops grown include maize, cassava and vegetables. Many people also keep cattle, goats and chicken along side crop farming.

6.3.6.2 Fisheries

ITT Dam provides abundant fishing grounds. Fish provides income to the people which is used to buy other commodities they need. Fish also provides a cheap source of protein. Fish traders transport most of the fish caught to Lusaka and Mumbwa.

6.3.6.3 Mining

Small-scale gemstone mining is currently taking place in Namwala Game Management Area.

6.3.6.4 Tourism

The wildlife in Kafue National Park and Namwala Game Management Area are the main attractions to both local and foreign tourists. Tourists visit the area mainly for game viewing, photographic safaris and hunting safaris. Lodges such as Kalala and Musungwa provide accommodation for the tourists.

Substantial amount of revenue is generated through park entry, camping and angling fees.

6.3.7 Employment

Most of the people in the District are in informal employment mainly subsistence farming and fishing. Those in formal employment are mainly employed by ZESCO, Government Departments and tourism related companies.

6.1.8 Public Health

A number of health facilities are available in the District. ITT District Hospital caters for people in ITT town and it also acts as a referral hospital to rural health centers scattered in different parts of the District. Health facilities are, however, inadequate forcing some people to walk long distances to seek for medical treatment.

Common diseases in the area include malaria, diarrhea and respiratory disorders. With the large presence of fish traders from Lusaka and other parts of the country, it is possible to find cases of HIV/AIDS in the area.

6.3.9 Water Resource and Sanitation

Piped and treated water is provided to the residents of ITT town. The sewage reticulation is also available. People around the Dam get their drinking water directly from the reservoir. People in the villages away from the Dam rely on unprotected shallow wells and a few boreholes provided by the Government. Pit latrines are commonly used in the villages. Refer to figure 9

Figure 9: Water pumping station for the water treatment plant at Itezhi-tezhi

6.3.10 Education

Schools located in various parts of the District provide education to children of school going age. ITT District has only one secondary school and several primary schools. Schools are, however, not enough forcing some children to walk long distances to reach the nearest school.

The District has no tertiary institutions of learning. Children who complete secondary school education have to go to other parts of the country for higher education.

6.3.11 Goods and Services

Most of the goods and services are provided by the modern sector at ITT town. Goods provided are mainly household commodities such as groceries. Other goods, such as electrical appliances and agricultural inputs, have to be bought from Lusaka and Mumbwa.

6.3.12 Recreation

ZESCO provides some recreation facilities at ITT Town such as clubs and sports facilities. Football is the most popular sport. Boating and sport fishing are also common. In the villages, recreation is provided through localized cerebrations, sports, beer drinking and traditional ceremonies.

6.3.13 Cultural Properties

There are a number of archaeological sites around ITT Dam. The Nkala fortified camp is located on Nakalomwe Hill on the western side of ITT Dam. At Namwembwe Hill west of ITT Dam, there is a sacred tree that is of mystical and religious importance to the Ila people. There are several sites for Late Iron Age, Early Stone Age and Late Stone Age, but most of these sites have been submerged by the ITT reservoir. The proposed project, however, does not affect any known cultural sites.

7. IMPACT ASSESSMENT AND MITIGATION

7.1 General Consideration

This section of the environmental report address the interactions of the project with the natural and social resources around it. These interactions are often termed "impacts," but that word will be used here only for adverse effects, because the word has acquired a negative connotation through its application to the "Environmental Impact Assessment." Many of the effects of a project may be secondary benefits, such as improved fisheries, that are not part of the primary objective of the project.

It is convenient to separate project effects into direct (or primary) effects., which result from the direct interaction of some component of the project with one or more environmental resources, and indirect (or secondary) effects, which arise from the primary effects. For example, higher flows at certain of the year might be foreseen during project operation, a direct effect. Inundation of off-channel pools might be predicted to result from the higher flows, an indirect effect. A further step in the chain might be improved survival of fish in the pools, another indirect (or tertiary) effect. Each of these levels of effect has its own degree of probability, based partly on the certainty of the previous effect and on the knowledge of baseline interactions in the ecosystem. A given effect may produce several further effects, some of which may be undesirable, e.g, increased production of mosquitoes due to greater amount of standing surface water. This in turn may result in an upturn in the incidence of malaria, dengue, encephalitis, or some other mosquito-borne disease in the local population.

The main objective in assessing the potential effects of a project is to allow planning of actions to prevent or reduce undesirable effects, at whatever level of the chain they may be predicted. Also, it may be possible to identify actions to enhance the secondary benefits of the project, through a program of resource management.

Most projects exert a suit of effects during construction that largely end when the project comes into operation. At that time a second suit of effects may be observed, which largely continue through project life. It is common practice, therefore, to discuss the effects of project construction (including the exploratory phase, if there is one) separately from those of project operation.

7.2 Construction Phase

7.2.1 Structures

The potential impacts of project construction are substantially reduced by the use of an existing dam, as opposed to the construction of a new one. Noise from drilling, blasting and excavations associated with the construction of the powerhouse and tailrace tunnels will be underground.

Sand aggregate, cement, and construction steel would be trucked in from outside the area, the first two being available within a short distance. Other than the placement of small cofferdam (probably of sheet piles) at the end of the existing tailrace and pumping out seepage water, there would be little disturbance of the riverbed or degradation of water quality.

Mitigation. Timing for blasting can be arranged as to reduce noise impact on surrounding population. A watering program to reduce dust from drilling, blasting and excavation can be easily implemented during construction. If necessary, gravel roads can be kept wet near populated areas to avoid clouds of dust.

7.2.2 Work Force

Economic Interaction. It is anticipated that most of the incoming work force would be housed at the existing ZESCO colony, with some new houses constructed if necessary. The work force would consist of about 20-25 management and engineering personnel on the staff of the construction contractor, about 30-40 semi-skilled workers (equipment operators, welders, glazers, etc.), and perhaps 150 unskilled laborers, hired locally. In the interest of maintaining a healthy and eager labor force, the contractor probably will run buses to villages from which laborers are recruited.

The work of a large project, placed in a sparsely settled rural area, may cause disturbance to the lives of local people, by competing for resources, such as fuelwood, drinking water, and heath facilities. In this case, ZESCO is expected to render the work force relatively self-sufficient by bringing in most amenities and prohibiting the use of local fire wood or charcoal by the work force. The project offers the possibility for local farmers to sell vegetables and fruit to the project, which they would be able to do at lower prices than vendors in cities further away. At present there appears to be little production of market crops by local people.

Mitigation. An adversarial relationship between project laborers and the surrounding population can easily be avoided by requiring the contractor to hire local laborers preferentially and to assist them in matters of fuel.

Public Health. A potentially serious adverse effect of a project work force on local people is the introduction of infectious diseases, especially sexually transmitted ones. It is an unfortunate but unavoidable fact that the entry into an area of a group of semiskilled and well-paid workers engenders prostitution. This has been observed in a number of recent projects and public health planners are beginning to take on steps to control the exchange of diseases. The access road for the Mohale Dam Project, a component of the Lesotho Highlands Water Project, brought some 400 workers from lowland Lesotho in contact with a number of highland villages. In less than a year, the incidence of HIV

(AIDS) positive individuals of both sexes in the local population rose from less than 3 percent to over 15 percent. Other sexually transmitted diseases also increased. A similar situation occurred on the Trans-Amazonian Highway, in northern Brazil, with both AIDS and syphilis.

Mitigation. The usual means of protecting the local population is mandatory testing of the work force for the major sexual and infectious diseases. This is prohibited by Zambian law, so the project will have to rely on optional testing for sexual and vector-borne diseases and on educational programs. Educational campaigns for both local community and construction workers can be given at regular intervals throughout the construction period.

To cater for human waste, toilets will be provided at the construction site. There are three options of non-flush toilets which can be considered for the disposal of sewage, namely: Pit latrines, buckets, chemical toilets and dry composting toilets (e.g. Enviro-Loo). The first three options are unsuitable for this project.

In pit latrines, it is difficult to control the smell and flies and there is a possibility of polluting ground water. Buckets need regular waste removal which makes them cumbersome and expensive to maintain. It is undignified in that users are able to see the waste already collected in the bucket. It also smells. Chemical toilets have high maintenance costs and are not environmentally friendly.

The fourth option, Enviro-Loo, is dry composting toilets which use no water, electricity or chemicals. One unit of Enviro-Loo can accommodate about 15 users per day. A pit of 2.6m long 1.2m wide and 1.2m deep needs to be excavated to put the waste container. Enviro-Loo has guaranteed zero discharge because it is closed-circuit system, thus, no pollution of ground water will be experienced. The Loo can be erected as a permanent toilet in which case compost should be removed every one or two years, or it can be shifted whenever need arises. In the later case, a portable wooden hut needs to be constructed to protect the toilet bowl from the wind and to provide privacy.

Regarding domestic waste, rubbish bins should be provided in which construction workers can put food remains and other domestic waste. Rubbish should be sorted out so that things like paper can be taken for recycling. Those which can not be recycled should be disposed of in the sites approved by the District Council.

For the waste management program to succeed, construction workers have to be educated on the importance of using the toilets provided and disposal of domestic waste.

Wildlife Effects. Another potential impact of the work force is illegal hunting in Kafue National Park, where the force of wardens is already unable to prevent poaching by people living around the park. It is common for foreign nationals on construction projects to bring firearms for the purpose of sport hunting, and they may reasonably be allowed to engage in hunting, within the laws of the country. There is no reason why, with proper indoctrination the professionals in the work force should represent a threat to the wildlife of the park.

Mitigation. The remedy for this potential effect lies in properly educating the work force, requiring registration of firearms, and attaining a working arrangement between park management and the project staff, to ensure that there is no hunting in the KNP. In return, KNP staff could advise project staff who wish to hunt game of places were hunting is permitted.

7.3 Operation Phase

7.3.1 Downstream Flow Changes

Impact. The principal effect of the project on the river will be an alteration of the flow regime. Since the project is expected to produce peaking power, the flow in the Kafue River will fluctuate between the low flow release, about 20-25 m^3/s, and 315 m^3/s. At the present time, it is not known if the maximum discharge from the power plant will cause overbank flooding. Studies to determine this potential impact will be performed during a preliminary engineering stage.

The change in river flow during operation is expected to be accomplished at a ramping (increase) rate selected with regard to public safety. Hydroelectric turbines are capable of extremely rapid starts (less than one minute from stationary to full revolution), but such a start would cause a substantial wave of water to move down stream.

Mitigation. There are several ways of reducing the risk of wave surges in peaking projects, or other projects where the spillway might be opened suddenly: 1) control of the release; 2) warning devices; and 3) education of the at-risk population. All three of these will be used on this project.

During the design phase of the project, engineers will determine the safe ramping rate for startup. A ramping time of 20-30 minutes is likely.

A warning system will be installed at points, such as Namwala, where people usually are in close proximity to the river. The form of this warning system will be discussed with district authorities; the usual devices are a siren or a spoken warning.

Public education will be aimed at ensuring that all sectors of the public are aware of the risk of a river surge at start-up and of the meaning of the warning devices. The time of peaking will be posted in prominent places in settlements along the river. Education signs will be placed in schools and clinics, informing the public about the danger of river surges. Teachers in primary and secondary schools will make sure that their pupils understand the significance of the warning devices.

Public awareness of and interest in the hydropower project could be enhanced by organized tours.

During the dry season, the daily generation flow will be an augmentation of the natural flow of the river and will serve to keep some of the side channels inundated. This may result in greater survival of juvenile fishes, with general benefits to fishery production. If these benefits are to be realized, however, some changes in fisheries regulations and their enforcement may be required.

7.3.2 Reservation Fluctuation

The operation of the Project for peaking generation is not expected to have a daily fluctuation of the reservoir to any noticeable extent. The reservoir has a surface area of approximately 400 million m^2, over which will be dispersed a daily removal of about 10 million m^3. Even without allowing for inflow, this removal would lower the surface only about 2.5 cm (1 in), an amount that would be masked by wave action.

Annual reservoir fluctuation will remain about as at present, about 15 m in the average year, more in a dry year, less in a wet year.

7.4 Summary

Table 7.1 summarizes the environmental impacts and mitigation measures.

Table 7.1 Summary of Environmental Impacts and Mitigation Measures

Potential Impact	**Mitigation Measures and Comments**
Settlement displacement	No settlement will be affected.
Economic interactions	Unskilled labor will be hired locally to create employment. Local farmers will be able to sell their produce to project staff.
Downstream flow release	Simulation of various operating regimes should be performed during the project design studies. Impacts can be mitigated by control of the release, warning devices and education of at risk population.
Reservoir fluctuation	Annual reservoir fluctuation will remain about as present. Operation of the project will not cause any noticeable daily fluctuation.
Health (Spread of infectious diseases)	Health education on HIV/AIDS and other diseases will be provided to construction workers.
Illegal hunting of wildlife	Construction workers will be educated on the need to avoid illegal hunting and logistical support will be provided to National Parks and Wildlife Service for research and to combat poaching.
Wetlands	Monitoring of downstream flows, water quality sampling and downstream surge protection.
Soils	The hilly nature of the terrain creates the potential for soil erosion. Under-story vegetation cover should be maintained. Terracing is also recommended.
Bush clearing	Trees, grass and other vegetation should be planted to replace those, which will be destroyed.
Noise	Noise pollution will arise only during construction of the line. During operational stage, noise will be minimal.
Visual	No significant visual impact since the power station will be underground.
Cultural sites	There are no known cultural sites at the project site, but if found during construction, the National Heritage Conservation Commission will be contacted

	for advice on how to mitigate for them.
Stones (aggregates)	Stones from blasting will be used for compaction and other construction works.
Cable drums	Remove from site and store for reuse.
Cement bags	To be collected and taken to paper mills for recycling.
Conductors, insulators, steel bars, bolts, nuts and other metal pieces.	Procurement should be according to ZESCO standards. Leftovers should be removed from site and stored for reuse. Those which cannot be reused can be sold as scrap metal.
Waste oils and lubricants	All oil leakage should be sealed and non-reusable oils should be containerized, stored and transported to a suitable storage site or should be disposed of according to the government regulations.
Human waste	Enviro Loo latrines should be belt in designated areas during construction and construction workers should be educated on the importance of using the latrines.
Wood and other leftovers	To be given to the local community to use as firewood . Some of the green matter will be left for natural recycling through decomposition. The use of fire at the workers' camp should be controlled to avoid starting bush fires.
Transformer oil	Transformers to be procured are those which have no PCB oils.

8. ENVIRONMENTAL IMPACT MANAGEMENT PLAN

8.1 Purposes

The Mitigation Actions enumerated above and summarized below are intended to diminish or eliminate adverse environmental effects of the project.

The Monitoring Program serves two basic purposes: (1) to ensure that the mitigation actions have been carried out in accordance with instruction given in the project design and operating plan, and (2) to identify and arrest any unforeseen deleterious effects of the Project on its environment.

8.2 Mitigation

8.2.1 Effects of the Work Force

Adverse economic effects of the large and well-paid work force will be mitigated by ensuring that the work force is well taken care of in terms of resources that they might otherwise buy locally.

8.2.2 Public Health

Optional testing of workers for sexual, infectious, and vector-borne diseases, coupled with educational programs.

8.2.3 Downstream Surges

The risk of surges to local people will be reduced by) 1 Adopting a slow ramping rate, 2) conducting education programs, and 3) installing a warning system.

8.2.4 Downstream Channel Drying

At time when the project is not generating, the drying out of the downstream channel and stagnation of water will be prevented by maintaining an established minimum release.

8.2.5 Wildlife Protection

Wildlife will be protected during project construction and operation by education of the work force, control of firearms among the project work force, and logistical support to intensify patrols in the nearby National Park.

8.3 Monitoring Program

Monitoring of environmental resources should be conducted throughout construction and operating periods of the project, and in all areas where potential environmental effects have been identified. The project developer should have an environmental specialist at the site and in the environmental study area sufficiently frequently that he or she can be confident that the mitigation program is being carried out appropriately.

8.3.1 Reference Points

It is impossible to detect and measure change without a baseline level against which to gauge it. The baseline data gathered for the environmental report is adequate for some kinds of monitoring, but data are essentially lacking on many resources. Such baseline data must be gathered before the impacts are likely to occur. If construction activities are expected to impact water quality downstream, the parameters to be studied must be examined before the start of construction.

8.3.2 Target Resources

The "impact" section of this report has identified several areas of potential project effects: downstream flooding conditions; downstream water quality, recharge of off-channel wetlands and its effect on fisheries; illegal hunting of wildlife.

8.3.3 Monitoring Program

Downstream Flows. ZESCO should attempt to establish linkages between measured flows and overbank flooding. This could easily be accomplished by visual observations at critical points down the river while the discharge at the dam is being varied in a controlled fashion. This activity probably will have to be carried out in the rainy season, in order to get a full spectrum of flows at the upper end of the range. As back-up for flow measurements obtained at the dam, staff gauges should be established at key points in the downstream channel (requiring cross sections) and the extent of off-channel flow observed over at least half a day.

A computer model of the Kafue Flats was considered during the environmental assessment but rejected, due to the complexity of the system and the fact that it may be expected to act differently under medium and high flow conditions.

Water Quality. In view of the lack of data on water chemistry of the reservoir and the river downstream of the dam, it would be impossible to identify any project effects without some baseline testing prior to construction. We recommend quarterly sampling at two or three points in the reservoir and several points downstream of the dam, in order to establish baseline conditions. The usual suite of physical and chemical parameters should be measured. Since the laboratory used probably will be in Lusaka, it will not be possible to obtain reliable values for fecal coliform bacteria, but under the existing conditions this parameter probably is not of great importance.

During construction and operation, the same suite of parameters should be monitored, initially quarterly. After several quarters of sampling, parameters that show zero or trace amounts could be dropped from testing, except perhaps for once a year.

Fisheries. We believe that the condition of the fisheries in the reservoir, the river downstream, and the Kafue Flats should be further evaluated. ZESCO's Hydrologist/Aquatic Ecologist in collaboration with the Department of Fisheries can conduct the fisheries research. This research program should start at least a year prior to the beginning of construction and continue well into operation, following the same methods throughout.

Wildlife. In view of the lack of a predicted effect of the Project on wildlife resource (assuming that control of firearm is exercised by the contractor and an educational program instituted for semiskilled and managerial worker), an extensive program of wildlife monitoring does not seem warranted. The project Environmental Manager should establish and maintain contact with the Wildlife Warden of KNP and undertake studies if those experts indicate that the Project or its personnel are affecting wildlife locally.

8.4 Estimated Cost of Mitigation and Monitoring Activities

The cost of mitigating the effects of the project and monitoring the management program are included as a project cost. This cost consists of a capital component for one-time expenses that will occur during or just after construction and an annual cost for continuing operations. Estimates of these costs are presented in Table 8.1.

Table 8.1
Mitigation and Monitoring Costs

Capital (one-time) Costs

Activity	**Estimated Cost ($)**
HIV/AIDS education for construction workers	14, 000
Downstream surge protection - Warning system - Public education	 5, 000 5, 000
Wildlife protection - Education of workforce - Provisions of 4 x 4 vehicle and logistical support	 5, 000 60, 000
Downstream flows - Channel cross section - Installation of staff gages	 1, 000 5, 000
Fisheries Monitoring - Provisions of 4 x 4 vehicle and logistical support	 55, 000
Total Capital Cost	**150, 000**

Annual (continuous) Expenses

Activity	Estimated Cost ($)_
Observation of downstream flows	5, 000
Water quality sampling	5, 000
Water quality testing (analysis)	6, 000
Fisheries research	5, 000
Wildlife research	5, 000
Total Annual Cost	**26, 000**

9.0 RECOMMENDATIONS AND CONCLUSION

The Environmental Impact Assessment(EIA) for the proposed Itezhi Tezhi Hydropower Station followed the laid down EIA format in accordance with the Environmental Impact Assessment Regulations, Statutory Instrument No. of 1997. During this process, the various options and alternatives were considered to come up with potential environmental Impacts and the mitigation measures for the negative impacts and enhancement measures for the positive impacts.

By opting to use the existing Itezhi Tezhi with its current storage capacity as opposed to increasing the height of dam, minimizes the impacts that are normally associated with hydropower development. By taking this option, environmental and social impacts are reduced immensely. There are no resettlement issues are there are no people living in the area where the power station will be located. The identified impacts of the project will be addressed by the mitigation measures recommended in this report.

To ensure implementation of the proposed mitigation, monitoring and positive impact enhancement aspects, it is recommended that the environmental costs totaling US$ 176,000.00 should be included in the total project cost. Further, the actual implementation of the various environmental aspects recommended in this report will be guided by the Environmental Management Plans for the different project components and will be strictly monitored by the Environment and Social Affairs of ZESCO.

It is further recommended that this EIA report, the Environmental Council of Zambia Decision letter and all associated Environmental Management Plans shall form part of the tender documents and all subsequent contracts related to the implementation and supervision of the Itezhi Tezhi Hydropower Project.

Taking into account the available options and all the identified negative and positive environmental impacts of the proposed project and the recommended mitigation measures for the identified negative impacts and enhancement measures for positive impacts, the development of the Itezhi Tezhi Hydropower Station should be considered for implementation by the Authorising Agency favourably. The project will boost power generation in the country in the face of anticipated power deficit in the near future.

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ANNEX A

EVALUATION OF THE ITEZHITEZHI DAM
DOWNSTREAM FISHERIES IMPACTS

Table of Contents

1. INTRODUCTION

1.1 Background

The Kafue River is one of the principal river systems in Zambia where ZESCO has its two major assets, the Itezhi – Tezhi Dam and the Kafue Gorge Hydro Power Station. From the source, the river flows in the general southerly direction up to Itezhi-Thezi dam. There after it flows eastward to Kafue Gorge and to its confluence with the Zambezi River.

The part of the river which forms an important fishery resource is from Itezhi-Tezhi dam to Kafue Gorge. For most part of the stretch, the river meanders through a large flat grassland flood plain. The flood plain which is about 353 km long comprises the river channel itself, lagoons and swamp areas. The main lagoons are Chansi, Chunuka, Luwato. Namatanga, Namwala and Lukwato. The topography of the surrounding terrain from Itezhi-Thezi to Kafue road bridge is fairly flat bordered by low escarpment. From the road bridge to the confluence with the Zambezi River, the topography is mountainous.

In terms of fish production, the Kafue River system contributes a substantial amount of fish to the nation. According to official 1992 estimates, fish production for the country was 67,498 tonnes of which 7,601 or 11% came from Kafue. This shows the importance of this fishery, and hence the need to carry out an impact assessment of the current reservoir operation.

The filling and subsequent operation of the Itezh-Tezhi reservoir substantially reduced the extent of flooding of the Kafue Flats, especially in the dry years. There have been complaints that the reduction in flooding has damaged the fishery leading to production of smaller catches. With this background, there is need to determine the extent the which the reduction in fish production has been directly due to reduced flooding and to what extent the poor fisheries management and over fishing has contributed to the reduction in fish production.

This therefore calls for a better understanding of the life history of the major and rare species to see what habitats are/or will be affected by the flow changes of envisaged rehabilitation.

1.2 Objectives of the Survey

This study was intended to provide data on which to base predictions of effects of changes in the timing and extent of dry season river level fluctuations, and their potential effects of fish production, grazing land and other resources.

1.3 Methodology

The data collection was done by ZESCO- ESU hydrologist in collaboration with Fisheries Research Officer, through extensive interviews with fishermen from the main fishing camps in the stretch between Itezhi-Tezhi and Namwala. The interviews were conducted through a questionnaire, while fish catch trends were contrasted to the storage time series hydrograph of the Kafue Gorge Reservoir and time series hydrograph of Itezhi-Tezhi reservoir spillage. Direct observation was done to assess other activities in the Kafue Flats. More information was obtained through interviews with the Fisheries Research Officer based at Itezhi-Tezhi, the Fisheries Statistician at Chilanga and the Fisheries Development Officers at Namwala, Lochinvar and Kafue.

2. STATUS OF THE KAFUE FLATS FISHERY

2.1 Life History of Major and Rare Species

The general observation about the Kafue flats fishery is that there is more pressure in terms of fishing as more and more people are engaging in fishing. The aspect of over fishing has a part to play in the reduction in fish population and species diversity. However the irregular release of water from the reservoir and irregular flooding which is not coordinated with the breeding patterns of fish was seen to have a significant impact on the fishery particularly in terms of fish species delivery and population

2.1.1 Major Species

The spawning and rearing habits of major species in the Kafue Fishery are shown in Table 1

Table 1
Spawning and Rearing Habits of Major Species

No.	Fish Type	Spawning/Raring Habitat	Remarks
1	Oreochromis macrochir	Shallow water along river banks and lagoons	Population on the decrease
2	Oreochromis andersoni	As above	Lower species population
3	Tillapia Redalli	As above	Lower species population
4	Saranochromis angusticeps	As above	Lower species population
5	S. macrocephala	As above	Lower species population
6	M. macrolepidotus	Rain season in lagoons	
7	Alestes lateralis	Shallow running water	Lower species

			population
8	Barbus poechii	Leave main river to spawn in very shallow waters	Higher species population
9	Clarias ngamensis	As above	As above
10	Clarias gariepinus	As above	As above
11	Mormyrus Larceda	Deep water	Lower species population

2.1.2 Rare Species

The spawning and rearing characteristics of rare species in the Kafue Fisheries is present in Table 2.

Table 2
Spawning and Rearing Habitats of Rare Species

No.	Fish Type	Spawning/Rearing Habitat
1	M. larceda	Not much known
2	H. odoe	In lagoons
3	C. Theodoe	In lagoons
4	S. giadii	In lagoons
5	S. Codringtoni	In lagoons
6	M. Mellandi	In lagoons and very shallow water
7	C. Multispinis	Shallow running water

2.2 Fishing Culture

The fishermen on the Kafue fishery mainly used gill nets. Traditional gear such as fishing lines and traps are also used but not to a large extent. Table 3 gives details on the net mesh sizes used, while Table 4 gives an outline on the fish caught, method and condition under which a specific species is caught.

Table 3
Description of the Fishing gear

Gear Type	**Net mesh(mm)**								**Time Used**
	32	50	63	76	89	102	114	127	
Gill nets	√	√	√	√	√	√	√	√	Both night and day except 32mm used at night
Seine nets			√	√					Used both night and day but mostly during the day (illegal method)

Table 4
Fish Types, Methods and Conditions

No.	Type of Fish	Gear Used	Season/ Common	Time caught	Remarks
1	Oreochromis macrochii (green headed bream)	Seine and gill nets	Throughout the year	Anytime	
2	Oreochromis andersonii (three spoted bream)		Throughout the year	Anytime	Being over fished
3	Tillapia rindalli (red breasted bream)	Seine and gill nets	Rain Season	Anytime	Mostly seine net caught
4	Tilapia sparmanii (banded bream)	Seine and gill nets	Rain Season	Anytime	
5	Serranochromonis angusticeps (thin faced bream)	Mostly Gill ne	Rain Season	Anytime	
6	Serranochromis macrocephala (purple faced bream)	Mostly Gill net	Rain Season	Anytime	
7	Serranochromis robustus (yellow belly bream)	Gill net	Cold season	Anytime	
8	Serranochromis thumbergi (brownsport bream)	Gill net	Cold season	Anytime	Running water
9	Serranochromis codringtoni (green bream)	Seine and gill nets	Cold season	Anytime	
10	Sarrachromis giardi (Frederics bream)	Seine and gill nets	Through out	Day time/morning	In deep water
11	Mormirus Lacerda (Bottle nose)	Gill net	Rain Season	Night	In deep and shallow
12	Marcusenius marcrolepidotus (Bull dog)	Seine and gill nets	Rain Season	Night	
13	Petrocephalus catastoma (Churchill)	Seine and gill nets	Rain Season	Any time	

14	Marcusenius castelnalli (Stone basher)	Seine and gill nets	Rain Season	Day and Night	
15	Hepsetus odoe (Kafue pike)	Gill net	Cold season	Night	Running water
16	Alestes lateralis (Silver robber	Seine and gill nets		Night	Running water
17	Leboe cylindincus (mud sucker)	Gill net	Rain Season	Night	Running water
18	Barbus poechii (dot tailed)	Seine and gill nets	Cold season	Night	Running water
19	Barbus paludinosus (serated spine barb)	Seine and gill nets	Cold season	Night	Running water
20	Schilbe mystus (Silver barbel)	Gill net	Rain Season	Night	Breeds in shallow water
21	Clarias ngamensis	Gill net and long line	Rain Season	Night	Breeds in shallow water
22	Clarias gariepinus	Gill net and long line	Rain Season	Night	Rare
23	Clarius theodoe (Snake Barb)	Gill net	Rain Season	Night	Not very common
24	Ctenopoma multipinis	Hand line	January to May	Day	Not very common
25	Mastacemblas mellandi	Small meshed net	During floods (feb – May)	Night	Not very common
26	Synodontis Kafuensis (squeaker)	Gill net 37&50mm	Rainy season	Night	Very common

2.2 Location of Fishing Activities

The Kafue fisheries, excluding the Itezhi-Tezhi Lake, is divided into four strata and the fishery is administered accordingly. The stratum location, administrative centre, and number of villages are outlined in Table 5.

Table 5
Fishery Stratum Location

Startum	**Location**	**Administration**	**Number of Fishing**

		point	villages
1	Kafue Gorge Reservoir to Chanyanya	Kafue Town Fisheries office	27
2	Chanyanya logoon to Chunga	Lochinvar Fisheries office	61
3	Lochinvar to Namwala	Namwala Fisheries office	47
4	Namwala to Itezhi-Tezhi dam	Itezh-Tezhi Fisheries office	34

The observation is that the fishing villages have become more permanent in the last 15 years due to lack of extensive flooding. While the village numbers have remained constant, the fishermen population has shown a steady increase. This can be seen from the 1997 population estimate for Startum 4, composed to the 1993 survey carried out by the Chilanga Fisheries Department, as presented in Table 6. The increase in stratum gives an indication of the general increase in the whole Kafue fishery.

Ten fishing villages were as sample for survey in stratum 4. From these villages, the village leader was interviewed. The house hold per village ranges from 6 to 24 with household size ranging from 6 to 8. Some of the fishermen were reported to have migrated to the area within the last two years. This explains the increase in population of the fishermen in stratum 4. Appendix 2 gives the villages, number of fishermen and number of boats as per 1993 Kafue Fishery Frame Survey.

Table 6
Comparison of Fishermen and Villages

Attribute	Year					Totals
		1	2	3	4	
Fishermen	1974	126	533	298	272	1229
	1978	482	1092	688	370	2632
	1987	493	594	461	350	1903
	1993	271	513	399	241	1424
	1997				500*	
Villages	1974	17	28	27	24	96
	1978	23	28	37	28	116
	1987	32	46	43	40	161
	1993	27	61	48	33	169
	1997	27	61	47	34	169

Source: Lupikisha j J.M. (1993) Frame Survey of the Kafue Fisheries, Department of Fisheries, Chilanga
*Estimate through the May, 1997 survey

2.3 Fish Catch Trends Compared to the Storage Levels

There is a correlation in the flooding patterns and the annual fish catch. All the fishermen interviewed recall the exceptionally large fish catch they had 1993/94. This year was preceded by a drought year of 1991/92. During the 1993/94 fish season, it was reported that even rare species, outlined in Table 2, were seen in abundance. Therefore, the exceptionally high rainfall led to addition spillage from Itezhi-Tezhi and consequently flooding of the Kafue Flats from the months of March to September. The annual fish catch trends and storage figures are shown in Table 7. Appendix 1 presents monthly data from Lochinvar fish catch and storage.

Table 7
Kafue Fishery Fish Catch Trends

Year	Fish production (Metric Tons)	Fish Catch for Lochinvar (kg)	Annual mean Storage(mcm)- (Kafue Flats)
1986	4264	77642	848.083
1987	5955	271994	754.229
1988	4440	276079	489.405
1989	8969	388298	654.178
1990	7335	256621	556.327
1991	5362	111513	466.643
1992	7601	122098	158.066
1993	8724	282780	900.385
1994	6293	665242	564.658
1995	6579	147196	102.153
1996	-	41591	166.718

Source: Itezhi-Tezhi Fisheries Office and ZESCO – Hydrology Unit
Source: Lochinvar Fisheries Office and ZESCO – Hydrology Unit

3. OTHER ACTIVITIES IN KAFUE FLATS

3.1 Farming Activities

From the survey conducted it was discovered that fishermen are now engaging in a lot of farming activities. The main crop is maize, which is the staple food. The drought years of the early 1990's had brought an awareness among fishing communities of the need to have food security by growing their own food. A number of fishermen are also engaged in vegetable growing. As the Kafue flats support cattle grazing to a large extent, the cow dung acts as fertilizer to the fields, therefore the maize harvests are quite good.

Each household in the fishing villages owns a field for maize growing as was seen during the survey. The period between December and March is the closed season for fishing, which gives the fishermen time to engage in other activities such as farming.

Apart from the subsistence farming system, the lower Kafue Flats from Mazabuka support some of the largest irrigation schemes in Zambia. Among the farmers are the Nanga farms and the Nakambala Sugar Estates.

3.2 **Grazing Grounds**

The Kafue flats are increasingly supporting a large number of cattle from the surrounding villages. Some villages as far as 30 kilometers from the river do bring their cattle to the flood plains for grazing, around the month of May. They camp there until the commencement of the next rain season when the cattle is taken back to the upland villages. The regular flooding of the flats is therefore essential for the growth of grass to support the large number of cattle.

Two National Parks exist in the Kafue flats: Lochinvar and Blue Lagoon National Parks. These two parks support large numbers of animals such as the buffalo, Zebra, wildebeest and the Kafue Lechwe (Kobus leche Kafuensis) which is endemic to Kafue system. Therefore, the Kafue flats are grazing grounds for the wildlife and are a bird sanctuary.

4 PROLIFERATION OF AQUATIC WEEDS

During the 1996-97 season, a carpet like weed known as Azola piñata (water firn) has been observed to be colonising the river banks and lagoons. This problem was observed in the stratum 4 for a distance of about 40 kilometers from the dam. According to one fisherman interviewed, he had observed his fishing ground, a lagoon, being completely covered within a month. This problem has been observed t be on the increase. Other weeds which were seen during the survey are: Pistia(water lettuce), Pistia (duck weed) and salvinia molesta(Kariba weed).

ThE fisheries research officer indicated that the problem may have worsened due to the continuous discharge of reservoir water from the bottom gates of the Itezhi-Tezhi reservoir, which has been a practice for this hydrological year(1996/97). This is due to the high nutrient levels in the water from the bottom of the lake. This could have led to the proliferation of the weeds within the section close to the reservoir.

5. CONCLUDING REMARKS

5.1 Irregular flooding of the Flats

The complaints from the fishermen and Fisheries Officers about the irregular flooding of the flats came out very prominently throughout the survey. It was evident that there is lack of consultation with the Fisheries specialist on the optimum way of simulating the natural flooding of the river system to conform to the fish breeding patterns

The disappearance of certain species which have sensitive breeding habits could be directly attributed to the uncoordinated flooding regime.

The reduction in fish catch in seasons of low storage levels could be attributed to poor fish breeding for those specific seasons.

As a mitigation measure, a water release model should be developed to simulate natural river flows in order to conform to the breeding patterns of fish, as much as possible.

5.1 Poor Fishery Management

The reduction in fish catch can also be partially attributed to poor fishing methods, lack of constant monitoring of fishing activities and too much pressure on the fishery as more and more people are taking up fishing as an alternative means of getting income.
There is no control from the Fisheries Officer on the number of fishermen for each stratum as there is no system of licensing of fishing activities. The fisheries Department should therefore come up with a system of limiting the number of fishermen per fishery stratum. This would help control over fishing.

More and more fishermen are turning to illegal methods of fishing such as seining. This method through illegal seems to be tolerated because all the fishing villages visited indicated the extensive use of sein nets with smaller mesh sizes.

Another issue that became evident is the lack of resources for the Fisheries Officers to perform their duties of monitoring of fishing activities. Therefore, institution of an effective system of registration and licensing of fishing operation would enhance the revenue collection for monitoring and research purposes.

6 REFERENCES

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Subramaniam S.P. 1992. A brief review of the status of the fisheries of the Bangweulu Basin and Kafue Flats. In R.C. Jeffery et al eds. Managing the Wetlands of the Kafue Flats and Bangweulu Basin. IUCN, Switzerland.

MONTHLY MEAN STORAGE DATA FOR KAFUE AT KASAKA (1986-1996)
(Million Cubic Meters)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean
1986	858.53	871.79	853.09	886.05	900.39	909.02	919.35	877.4	862.8	835.88	769.49	633.21	848.08
1987	542.96	740.29	751.84	761.64	800.79	818.98	870.38	835.23	834.55	795.80	720.89	577.40	754.23
1988	463.86	356.40	295.05	278.65	345.63	412.57	470.23	555.24	720.22	692.67	658.09	624.15	489.40
1989	616.41	606.50	669.60	856.37	658.83	491.92	490.27	553.10	535.79	667.60	837.06	866.65	654.18
1990	815.75	580.50	683.49	839.53	765.69	597.35	512.88	409.88	376.56	382.07	354.56	357.62	556.33
1991	496.80	593.80	544.53	494.98	537.56	600.18	584.31	507.61	355.17	320.77	299.18	264.74	466.64
1992	261.36	206.50	166.50	131.80	122.18	144.41	145.14	144.11	153.07	142.69	117.99	160.70	158.07
1993	335.23	509.70	762.52	875.37	947.35	1282.16	1338.57	1226.20	1119.41	944.76	795.06	688.19	900.38
1994	611.31	452.5	517.82	641.96	886.08	965.65	881.55	610.56	371.53	306.94	285.03	244.94	564.66
1995	203.38	117.20	122.91	96.76	93.86	13.76	120.54	87.27	86.39	74.29	83.13	126.26	102.15
1996	121.87	132.70	239.13	249.15	136.71	78.08	112.06	184.46	183.01	181.56	164.06	217.76	166.72

FISH CATCH TRENDS (IN KG) FOR THE LOCHINVAR AREA (1986-1996)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean
1986			3,298	6,825	7,824	5,533	10,592	11,427	8,526	11,677	11,904		77,642
1987			7,505	17,297	22,607	33,205	66,934	28,613	25,934	29,471	40,428		271,994
1988				12,689	16,814	21,440	29,727	27,361	132,489	14,302	21,257		276,079
1989				5,476	12,799	28,266	34,312	47,516	76,872	88,325	94,732		388,298
1990			5,764	16,551	29,709	51,228	39,300	48,178	22,193	18,121	25,576		256,621
1991			7,971	17,471	14,981	9,054	8,155	10,681	13,048	15,928	10,449	3,775	111,513
1992	1,577	3,120	5,528	30,718	7,730	11,125	11,826	10,818	11,346	10,589	10,363	7,358	122,098
1993	2,955	3,905	1,906	4,978	15,720	25,976	50,279	59,988	48,223	38,671	30,179		282,780
1994			33,076	44,609	63,391	83,483	313,20.5	70,270	42,639	6,428	8,141		665,242
1995			27,987	37,445	13,146	15,798	15,219	14,629	7,988	6,356	8,630		147,196
1996			2,490	10,625	6,333	5,353	3,918	3,993	4,745	4,134			41,591

Attachment 2

Number of Fishermen and boats by village and stratum in the Kafue Flats, 1993 frame survey

Stratum 1

VILLAGE NAME	No. of FISHERMEN	No. of BOATS
NANGA	25	24
KABUYU	16	20
MUCHENGA	8	7
DIPI	17	31
MUTUMBI	4	20
NAMILOLI	3	3
DOOBE(B)	16	17
KAKUNKA	13	14
CHANZE	1	2
CHIMBAMBA ISLAND	17	21
MUKATA	4	4
JEREMIRE	2	2
CHANYANYA	20	27
DOOBE(A)	11	10
MANYONYO	9	13
MIPANI	8	8
CHILUMBA	10	16
ZAMBIA COMPOUND	13	16
NAMAPANDE	17	19
NAMANOZE	1	1
KASAKA	4	4
KALAPA	8	12
MUCHUTO	3	3
SHINGOMA	6	5
MUTENTAMI	1	1
KAPONGO	2	2
CHEEBA	20	9

Staratum 2

FISHING VILLAGE	NO. OF FISHERMEN	NO. OF BOATS
SIWILE	12	10
KAMUNGA	28	26
NAMALYO	21	21
NANKUMBA	14	14
CHULWE(A)	8	5
CHULWE(B)	2	2
CHULWE©	3	3
SIKAFUSE	17	16
KABWE	7	10
NYIMBA(A)	15	17
NYIMBA(B)	13	13
NYIMBA(C)	11	11
MATANDA	7	8
NACHIMBWEMBWE	11	13
NAMATUSI	2	2
MOOMBA	3	4
KASAKO(A)	6	6
KASAKO(B)	10	8
KASIKIYO	7	3
KAMPALWE	7	8
KASOKWE	6	7
MAAMBA	7	8
ZAIRE	8	7
CHIMWAIKILA	11	11
NACHAMBA(A)	7	7
NACHAMBA(B)	9	14
NGULUBE(A)	1	1
NGULUBE(B)	5	6
MULYANGO	7	7
KAMUTENGO	1	1
CHINDELELO	3	3
NAMAFUFULA	2	2
SHAKAPINGA	15	16
MALIMBA	4	5
NACHONGA	2	2
LONGO	21	21
MALIPISI	4	3
MUTIMA	9	9
KANGWA	8	10
NEW CAMP	4	4
MAALO	1	2
MUTENDELE(A)	11	11

MUTENDELE(B)	5	5
NAKWAKO	12	11
KAMWANJA	2	3
SHAMBALU(A)	14	14
SHAMBALU(B)	4	5
KANDUZA	7	8
CHIKUNKA	2	2
KACHOLA	1	2
CHIKULULA	9	10
MOOBE	9	10
CHITETE	6	7
KAFWAMASHILU	3	3
NGONGOLO	2	4
KAOMA	5	4
PUMP NO.2	17	17
SHIMUNGALU	57	66*
NAMANGWALALA(A)	6	5
NAMANGWALALA(B)	6	8
KASHEWE	8	8

Stratum 3

FISHING VILLAGE	NO.OF FISHERMEN	NO. OF BOATS
NEW SOWETO	13	13
CORNER ISLAND	6	5
KABANDA	4	2
MATANDA	2	2
NAKACHELE(A)	16	14
NAKACHELE(B)	11	9
MAHUBA	2	3
KAPULANGA(A)	1	5
KAPULANGA (B)	8	5
KAHUMA	5	5
MUTENDE	2	2
KAFWEFWE	5	4
CHINSHINDE	3	2
CHIKU	47	55
CHIMPANZYA	13	9
MAYEYE	2	4
KABULUNGWE	30	28
MAMPANDA(A)	9	9
MAMPANDA(B)	7	8
LUHULA(A)	11	12
LUHULA(B)	2	2
MWITO	7	4
MANDILI	9	9
NGONGO	4	4
NAMITWI	8	5
CHUUBI	4	2
KAPUSHO	2	1
MUKUNTU	3	3
NALUBETA	8	11
NSANJEMULEKE	4	4
INDEPENDENCE	3	4
ZINGWANGWA	3	2
CHINKOMONA	1	1
CHIBENDA	9	8
CHIKUZU	4	5
CHANZA	2	2
CHIKWATO	20	19
LOMBOLA	2	1
CHILALA	11	12
BUSANGU	12	11
LUBUNDA	7	8
CHITUMBI	10	12

FISHING VILLAGE	NO.OF FISHERMEN	NO. OF BOATS
ISENGA	2	6
KATOSHI	13	13
IBAMBA	14	13
CHIBUNZE	32	36
BANAMWEZWA	1	3

Stratum 4

VILLAGE	NO. OF FIS11HERMEN	NO. OF BOATS
CHONAMAMBWE	5	5
CHIBEBO	11	12
CHIMPAWA	6	6
KACHENJE	4	4
CHIKOTO(A)	4	4
CHIKOTO(B)	2	2
NAKALONGWE(A)	3	2
NAKALONGWE(B)	5	5
KAKUSU	11	9
MUZELWA	10	10
NALUBIYA	4	5
CHIMWANDO	2	2
KAKUZU	7	7
ZAMBWA	14	12
CHILALA	3	2
NUNGU	8	15
SALAMA	6	5
PELABULA	2	2
MAUNGA	2	1
NAMACHEKA	9	8
CHIKONA	3	3
CHANZA	6	6
ITUMBA	6	9
KAKUZU	6	7
MANG’ONGO	23	25
SHAMUMBE	8	6
NAMIBALA	8	9
BATUNGA(A)	5	5
BATUNGA(B)	5	4
CHIKOLEKOLE	6	5
KABISHABISHA	10	17
MUBITANO	5	4
KALUNDU	10	6
COOPERATIVE	22	18

ANNEX B

TEMPERATURE AND DISSOLVED OXYGEN
FOR ITEZHI-TEZHI

TEMPERATURE AND DISSOLVED OXYGE
FOR ITEZHI TEZHI

This annex presents the results of the temperature and dissolved oxygen (DO) surveys performed at the Itezhi-Tezhi reservoir and down stream of the dam. The survey was conducted by ZESCO Senior Civil Engineer and Hydrologist from 26th March to 28th March 1997.

The discharge was not adjustable during the time of measurement because the tunnel discharge gate was being serviced. Throughout the period of measurement there was a constant release of 120 cubic meters per second from the tunnel discharge. There was no discharge from the spillway. The Itezhi-Tezhi reservoir elevation was at 1024.174 on March 26th and increased to 1024.327 on March 28th.

The results are presented on Exhibit B-1. All the measurements downstream of the dam were in the range of close to saturation (86% – 199.7%) for all days of measurement. The DO saturation in the reservoir was in the range of 52% to 76%.

Exhibit B-1
Page 1 of 9

DISSOLVE OXYGEN DATA FOR THE ITEZHI TEZHI RESERVOIR AND DISCHARGE WATER DOWNSTREAM OF THE DAM

STATION No: 1 At the intake structure
DATE: 26/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
06.55	0.1	24.9	5.50	64.2	Sample taken close to the intake structure though there was flow through the diversion tunnel. A boat could not be secured early in order to measure outside the influence of the velocity zone.
06.58	2.0	25.0	4.90	59.9	
07.00	4.0	25.0	5.01	60.6	
07.04	6.0	25.0	4.92	59.3	
07.07	8.0	25.0	4.97	60.3	
07.10	10.0	25.0	4.68	56.6	
07.14	15.0	25.0	4.54	55.0	
07.18	20.0	25.0	4.46	54.0	
07.27	25.0	25.0	4.57	55.0	
07.30	30.0	25.0	4.67	56.6	
07.33	35.0	25.0	4.67	56.5	
07.40	40.0	25.0	4.73	57.4	

STATION No: 2 Half way between the tunnel and the spillway discharge into main river channel
DATE: 26/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
12.06	0.1	24.8	8.31	100.2	The point was characterized by very high velocity so that deeper samples could not be done
12.07	2.0	24.8	8.32	100.3	

STATION No: 3 Center of the spillway discharge channel
DATE: 26/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
11.50	0.1	26.6	7.89	98.0	Very shallow and no flow from spillway.
11.52	1.5	25.4	10.15	123.0	

STATION No: 4 Approximately 200m downstream of the spillway discharge
DATE: 26/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
Center					
11.56	0.1	25.4	8.05	98.0	
11.56	2.0	25.0	8.43	101.7	
11.58	3.0	24.9	8.31	100.5	
11.59	4.0	24.9	8.50	102.4	
(Right)					
12.00	0.1	25.4	8.23	100.2	
12.02	2.0	25.2	8.43	102.4	
(left)					
12.11	0.1	25.0	8.11	98.2	
12.12	1.5	24.9	8.30	100.3	

STATION No: 5 Approximately 500 downstream of spillway discharge
DATE: 26/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
Center					.
12.15	0.1	24.9	8.29	100.1	
12.16	2.0	24.9	8.34	100.6	
(Left)					
12.20	0.1	24.9	8.10	98.1	
12.22	2.0	24.9	7.82	94.4	
(Right)					
12.25	0.1	24.9	8.18	98.8	
12.26	2.0	24.9	8.11	97.5	

DISSOLVE OXYGEN DATA FOR THE ITEZHI TEZHI RESERVOIR AND DISCHARGE WATER DOWNSTREAM OF THE DAM

STATION No:1 At the intake structure
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
06.29	0.1	24.5	5.05	60.6	Sample taken close to the intake structure though there was flow through the diversion tunnel. A boat could not be secured early in order to measure outside the influence of the velocity zone.
06.31	2.0	24.9	4.85	58.6	
06.33	4.0	25.0	4.63	56.0	
06.34	6.0	25.0	4.65	56.0	
06.36	8.0	25.0	4.39	53.1	
06.38	10.0	25.0	4.39	53.1	
06.41	15.0	25.0	4.41	53.2	
06.44	20.0	25.0	4.98	60.3	
06.46	25.0	25.0	4.88	59.0	
06.48	30.0	25.0	4.68	56.7	
06.52	35.0	25.0	4.78	57.9	
06.54	40.0	25.0	4.77	57.8	
06.55	45.0	25.0	4.42	53.5	
06.57	50.0	25.0	4.35	52.5	

STATION No: 2 halfway between the tunnel and the spillway discharge into the main river channel
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
11.12	0.1	24.6	8.30	99.5	The point was characterized by very high velocity below 1.0 m so deeper samples could not be taken
11.13	1.0	24.6	8.21	98.7	
11.14	2.0	24.6	8.22	99.8	

STATION No: 3 Center of the spillway discharge channel
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
11.19	0.1	25.7	7.02	86.1	Very shallow and no spillage from the spilway
11.21	1.0	25.6	7.11	86.3	

STATION No: 4 Approximately 200m downstream of the spillway discharge
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
Center					
11.30	0.1	24.7	7.95	95.4	
11.31	1.0	24.7	7.88	94.6	
11.32	1.5	24.7	7.88	94.8	
11.32	2.0	24.7	7.90	95.0	
11.33	3.0	24.7	7.94	95.4	
(Right)					
11.38	0.1	24.8	7.64	92.1	
11.39	1.0	24.8	7.75	93.5	
11.39	2.0	24.8	7.80	94.1	
(Left)					
11.26	0.1	25.0	7.78	94.0	Left side was shallow
11.27	1.0	24.9	8.29	100.1	
11.28	1.5	24.8	8.06	97.4	

STATION No: 5 Approximately 200m downstream of the spillway discharge
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
(Left)					
11.43	0.1	24.7	7.84	94.4	
11.43	1.0	24.7	7.88	94.9	
(Right)					
11.46	0.1	24.7	7.85	94.5	
11.47	1.0	24.7	7.89	94.9	
11.48	2.0	24.7	7.92	95.2	

DISSOLVE OXYGEN DATA FOR THE ITEZHI TEZHI RESERVOIR AND DISCHARGE WATER DOWNSTREAM OF THE DAM

STATION No: 1 At the intake structure
DATE: 28/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
06.33	0.1	24.2	5.05	75.9	Sample taken close to the intake structure though there was flow through the diversion tunnel. A boat could not be secured early in order to measure outside the influence of the velocity zone.
06.34	2.0	24.8	4.75	71.9	
06.35	4.0	24.8	4.65	70.5	
06.36	6.0	24.8	4.56	69.1	
06.38	8.0	24.8	4.43	67.3	
06.38	10.0	24.9	4.38	66.4	
06.40	15.0	24.9	4.25	64.5	
06.41	20.0	24.9	3.87	58.8	
06.42	25.0	24.9	3.73	56.5	
06.43	30.0	24.9	3.34	50.6	
06.46	35.0	24.9	3.72	56.2	
06.49	40.0	24.9	3.69	56.0	
06.51	45.0	24.9	3.57	54.0	

STATION No: 2 halfway between the tunnel and the spillway discharge into the main river channel
DATE: 28/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
09.41	0.1	24.7	7.79	117.7	The point was characterized by very high velocity below 1.0 m Discharge of 120cumecs from the diversion tunnel during the whole period of measurement
09.41	1.0	24.7	7.81	117.8	
09.43	2.0	24.7	7.80	117.7	
09.43	3.0	24.6	7.87	118.6	
09.43	4.0	24.6	7.93	119.7	

STATION No: 3 Center of the spillway discharge channel
DATE: 28/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
09.47	0.1	24.5	7.20	108.6	Very shallow and no spillage from the spillway
09.48	1.0	24.6	7.40	111.8	
09.49	1.5	24.4	6.75	101.5	

STATION No: 4 Approximately 200m downstream of the spillway discharge
DATE: 27/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
Center					All points were above saturation with very high velocity due to discharge from diversion tunnel
09.54	0.1	24.7	7.89	119.0	
09.55	2.	24.7	7.85	118.5	
09.56	4.0	24.7	7.75	117.0	
09.57	4.5	24.7	7.75	117.0	
(Right)					
09.58	0.1	24.7	7.70	116.0	
09.58	20	24.7	7.75	117.0	
(Left)					
09.52	0.1	24.7	7.77	117.5	
09.53	1.0	24.7	7.70	116.0	
					Left side was shallow

STATION No: 5 Approximately 200m downstream of the spillway discharge
DATE: 28/03/97

TIME(Hrs)	Depth (m)	Temp.Deg C	DO(Mg/L)	DO(%Sat)	REMARKS
(Right)					
10.01	0.1	24.7	7.63	115.3	
10.02	1.0	24.8	7.87	119.0	
10.03		24.7	7.73	116.6	
(Center)					
10.04	0.1	24.7	7.73	116.8	
10.05	1.0	24.7	7.65	115.5	
10.06	2.0	24.7	7.67	115.6	
Left					
10.07	0.1	24.7	7.86	118.5	

10.08	1.0	24.7	7.60	114.5	

ANNEX C

ESTIMATED RESETTLEMENT POPULATION (IN THE EVENT THAT THE DAM IS RAISED)

Table of Contents

1. INTRODUCTION

This appendix presents the results of the resettlement study of the population that would be affected by raising the dam at Itezhi-Tezhi. It is based on the survey conducted by the Environment and Social Affairs Unit with the surveyors at ITT from 26th March to 14th April, 1997.

- Immigrant population is concentrated along the reservoir, largely due to fishing activities. Most of the fishermen live along the eastern side of the reservoir. A total of 3,757 people will be affected in the surveyed area.
- The main tribes in ITT are the Ilas, Batwas and Tongas, though along the reservoir Lozis, Luvales and Bemba are the predominant tribes.
- Houses are similar, constructed mainly from dagga(mud) and grass thatch. A total of 1230 thatch huts and 11 tin roofed houses will be affected. Water resources are poor largely from the reservoir and dugout wells in dry zone areas.
- 17 villages, 2 camps, Ngoma road, ZESCO 11KV electricity line and 6 private houses would be affected.
- Discussion with the villagers and the local chief (Chief Kaingu) indicated that land would be available to accommodate displaced people, though ZESCO should compensate all affected.

2. PURPOSE

- To determine, for each alternative maximum reservoir surface elevation under consideration, the number of people and houses, and other infrastructure that would have to be relocated to avoid flooding

3. MOTHODOLOGY

A team of officers visited all the villages along the reservoir to gather data on the resettlement population. Numerators were engaged to assist with the counting process. The following personnel comprised the team:

Mr. Zondwayo Ndlovu	-	Information Specialist, ESU
Mr. Moses Mulambe	-	Surveyor, ITT
Mr. Elias Mukuka	-	Surveyor, Head Office
Mr. Francis B. Yotamu	-	Assistant Surveyor, ITT
Mr. Moses Chonga	-	Pole Man
Mr. Luka Silomba	-	Pole Man
Mr. Gabriel Kabwe	-	Numerator
Mr. Evans Mabona	-	Numerator
Mr. M. Mukubesa	-	Numerator
Mr. Coster Phiri	-	Numerator

The survey team dertermined the range of elevations of each village along the northern end of the reservoir and pegs of different colors were used to identify particular levels. Using the days reservoir surface elevation as reference, the team determined the elevations starting with 1030.5, 1031.5, 1032.5, up to1040 after every elevation pegs of different colours were used for identity.

The numerators would then get information of people, households and other economic activities within the elevation band using the fixed pegs as reference points.

4. POPULATION GROWTH

Population size, growth and composition are important characteristics of a population. However, the recording of such data up to lowest geographical levels was not possible due to lack of such localized information. The population of Zambia was estimated at 5.6 Million in 1980 and increased to 7.8 million in 1990 (CSO, Pop. Cencus). This represents percentage growth of 3.4%. The population of Southern Province indicated a similar characteristic with the population having increased from 671,923 (1980) to 907,156(1990) representing a rate of increase of 3.0 per annum (see Table 1). The population density of the district is relatively low (2.6 square km) compared to the provincial average(7.9 square km). The total population of ITT is estimated at 41,000 people (ITT Council). In comparison of all the districts in Southern Province, Namwala experienced the third largest growth rate. The population increased from 56,058 in 1980 to 83,075 in 1990. Thus the population of the district grew at a higher rate(4.0) than the national and provincial averages (Southern Province analytical report, 1990 Census). 47 percent of the population in Namwala is below the age of 15, rate higher than the national average. This phenomenon has implications for future growth of the population. It is an in-built population growth momentum.

Table 1
Population Growth by District – Southern Province

	1980	Rate	1990
Provincial Total	671,923	3.0	907,156
Rural	505,368	3.2	692,253
Urban	166,555	2.6	214,897
District		2.3	163,050
Choma	130,416	5.5	35,462
Gwembe	20,666	5.3	162,674
Kalomo	97,177	1.5	82,952
Livingstone	112,528	3.3	155,436
Monze	110,423	1.3	126,039
Namwala	56,058	4.0	83,075

Siavonga	26,633	1.6	34,876
Sinazongwe	43,771	3.8	63,586

5. CHARECTERISTICS OF THE RESETTLEMENT POPULATION

Table 2 below provides the number of settlements recorded during the survey, the number of households to be affected. Information of the number of people, huts and other structures and activities in each village was obtained from the counting process conducted during the field work.

Most of the people interviewed indicated that they come from other areas outside the province, the majority having lived for more than five years. Most of the migrants are from Western, North Western, Northern and Luapula provinces.

Tongas, Ilas and Batwas are natives of the Southern Province. The three tribes are traditionally agriculturists. They are mainly engaged in maize and cassava growing for domestic use, those who are not engaged in fishing barter their crops with fish. For them fishing is a part time activity. It is therefore not surprising that the natives of the province are in minority in most of the fishing villages. The majority are mainly Lozi, Bemba, Luvale and Bunda speaking peoples. These came from the other fisheries areas of Western, Central, Nothern, North Western and Luapula provinces. Some people living along the reservoir are just engaged in vending of fish

Table 2
Number of Villages, Households to be Affected Along the Reservoir

No.	Village Name	Affected Population	Thatch Huts	Tin Roofed Huts
1	Magazine	289	78	1
2	Chongo	202	58	3
3	Inkonkaile	473	130	6
4	Nachisenga	529	165	
5	Kalombe	260	90	
6	Malembwe	199	67	
7	Naumba	230	74	
8	Kayeka	171	65	
9	Munyanja	269	83	
10	Namutekwa	33	15	
11	Buutwa	149	130	1
12	Katongo	389	11	
13	Namalio	37	65	
14	Kalala	179	79	
15	Maunga	183	41	
16	Keela	110	24	
17	Shimaponda	55	1,230	

TOTAL		3,757		11

6. AREAS TO BE AFFECTED IF THE DAM IS RAISED

As outlined above, 17 villages would be affected if the dam is heightened. In addition, 4 properties would be affected between Kalala and Musungwa Lodges. Also to be affected are the Veterinary and Tsetse Control, National Parks Camps, part of the road to Ngoma Camp and the 11KV electricity line. Tables 3, 4 and 5 indicate the areas to be affected and the likely worst level of impact

Table 3
Anticipated Number of People to be Affected at Different Levels of Elevation

Reservoir Level	Male Adults	Male Children	Female Adults	Female Children	Totals
1030.5 -1031.5	222	179	180	185	766
1031.5-1032.5	247	213	207	228	895
1032.5-1035	281	282	272	331	1,166
1035 – 1040	235	227	225	243	930
TOTALS	985	901	987	884	3,757

Table 4
Anticipated Number of Structures to be affected at Different Levels

Reservoir Level	Thatch Huts	Tin Roofed Huts	Schools	Hammer Mills	Churches
1030.5 -1031.5	286				1
1031.5-1032.5	279			1	3
1032.5-1035	375	8		1	1
1035 – 1040	290	3	2		4
TOTAL	1,230	11	2	2	9

Table 5
Anticipated Number of Domesticated Animals and Fruit Trees to be Affected at Different Levels

Reservoir Level	Chickens	Guinea Fowls	Ducks	Goats	Cattle	Mango	Paw paw	Banana
1030.5 - 1031.5	1,398		36		48	58	2	8
1031.5-1032.5	2,146	6	12		8	58		13
1032.5-1035	2,250	8	21	13		133	4	5
1035 – 1040	1,330				21	136		

TOTAL	7,124	14	69	13	77	365	6	26

In all the elevation bands indicated in the tables above, the area between 1032.5 – 1035.0 MASL would cause the worst impact if the elevation of the dam is increased up to 1035 MASL

7. TYPES OF DWELLING AND OTHER STRUCTURES

The majority of the households in all the villages occupy one-roomed structure, though most of them have separate dwelling for their children and other relatives. There are however others with two bedrooms.

It is apparent from the survey that the most common construction materials for these houses are pole and mud with grass thatched roofs. A few are constructed from mud bricks and iron sheets. All the schools found in the affected areas are mud bricks, thatched roofs. All churches are made of mud bricks with thatched roofs except one which has a tin roof. The Hammer mills are also made of mud and thatch roofs some with tin roofs. Photographic pictures have been taken of the type of structures to be affected.

8. MODERN HOUSES TO BE AFFECTED

The houses located between Musungwa lodge and Kalala lodge are made from different materials. The house belonging to Mr. Mcreen is constructed from pan bricks with grass thatched roof, this

ANNEX D: Drawings