

MINISTRY OF AGRICULTURE, FOOD AND FISHERIES
THE REPUBLIC OF ZAMBIA

No. 1

BASIC DESIGN STUDY
ON
THE PROJECT FOR UPGRADING OF MWEKERA
AQUACULTURE STATION
IN
THE REPUBLIC OF ZAMBIA

September 1996

JICA LIBRARY



J 1140014 [0]

JAPAN INTERNATIONAL COOPERATION AGENCY
SYSTEM SCIENCE CONSULTANTS INC.

ORT
96-152

BASE DESIGN STUDY ON THE PROJECT FOR UPGRADING OF MWEKERA
AQUACULTURE STATION IN THE REPUBLIC OF ZAMBIA

September 1996

3
26
7
ARY





1140014 (0)

**MINISTRY OF AGRICULTURE, FOOD AND FISHERIES
THE REPUBLIC OF ZAMBIA**

**BASIC DESIGN STUDY
ON
THE PROJECT FOR UPGRADING OF MWEKERA
AQUACULTURE STATION
IN
THE REPUBLIC OF ZAMBIA**

September 1996

**JAPAN INTERNATIONAL COOPERATION AGENCY
SYSTEM SCIENCE CONSULTANTS INC.**

PREFACE

In response to a request from the Government of the Republic of Zambia, the Government of Japan decided to conduct a basic design study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Zambia a study team from March 8 to April 14, 1996.

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

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

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

September, 1996



Kimio Fujita
President

Japan International Cooperation Agency

September, 1996

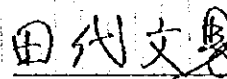
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Upgrading of Mwekera Aquaculture in the Republic of Zambia.

This study was conducted by System Science Consultants Inc., under a contract to JICA, during the period from March 6, 1996 to September 24, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Zambia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,



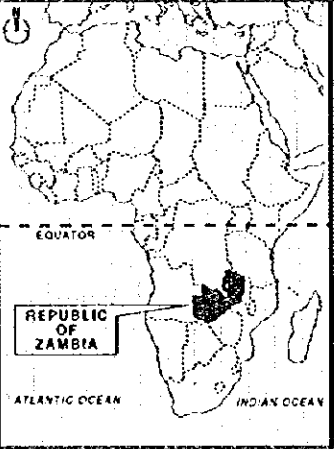
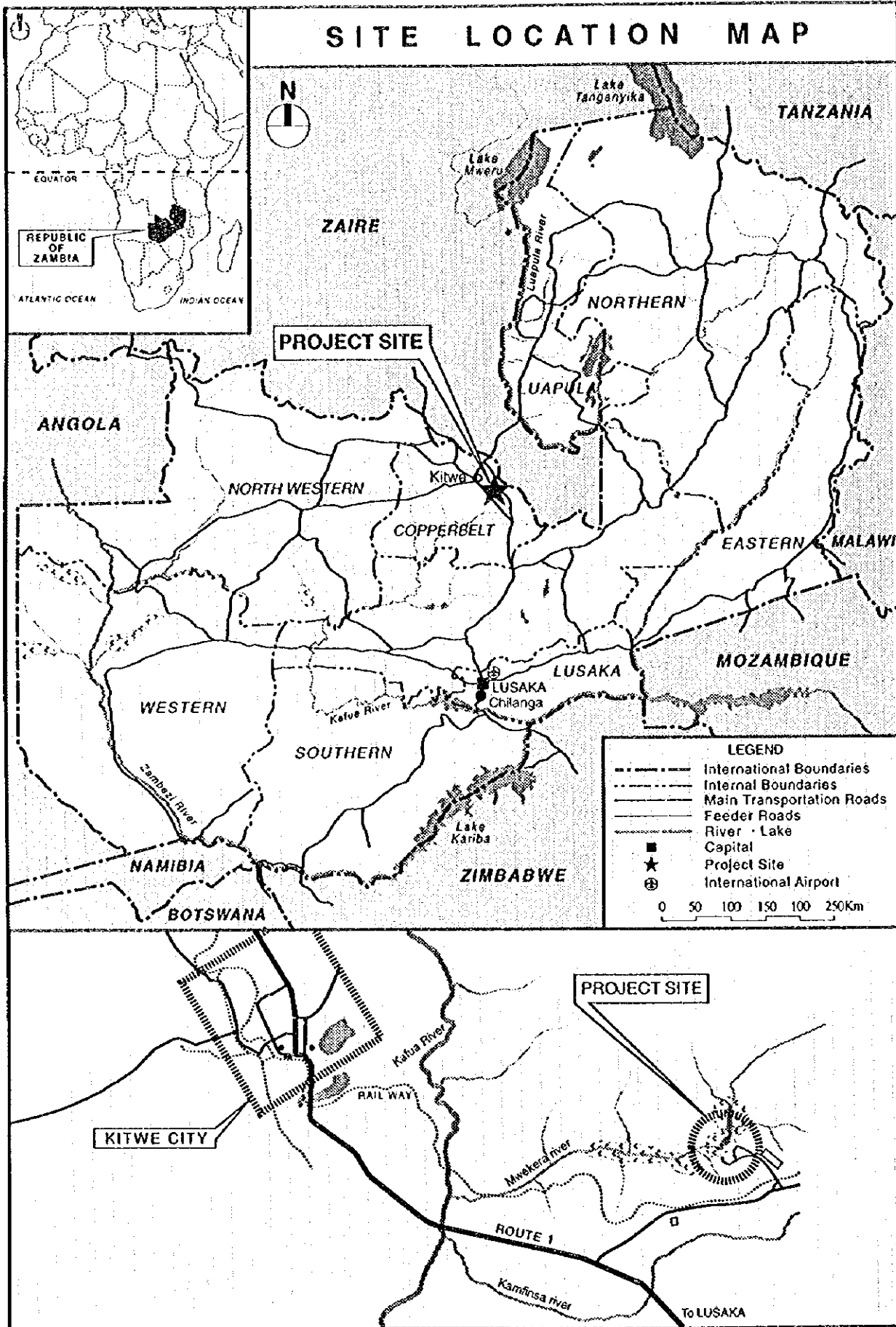
Fumio Tashiro

Project manager,

Basic design study team on Project for
Upgrading of Mwekera Aquaculture in
the Republic of Zambia

System Science Consultants Inc.

SITE LOCATION MAP



LEGEND

- International Boundaries
- - - Internal Boundaries
- ==== Main Transportation Roads
- ==== Feeder Roads
- River · Lake
- Capital
- ★ Project Site
- ⊕ International Airport

0 50 100 150 200 250Km

KITWE CITY

PROJECT SITE

Kafue River

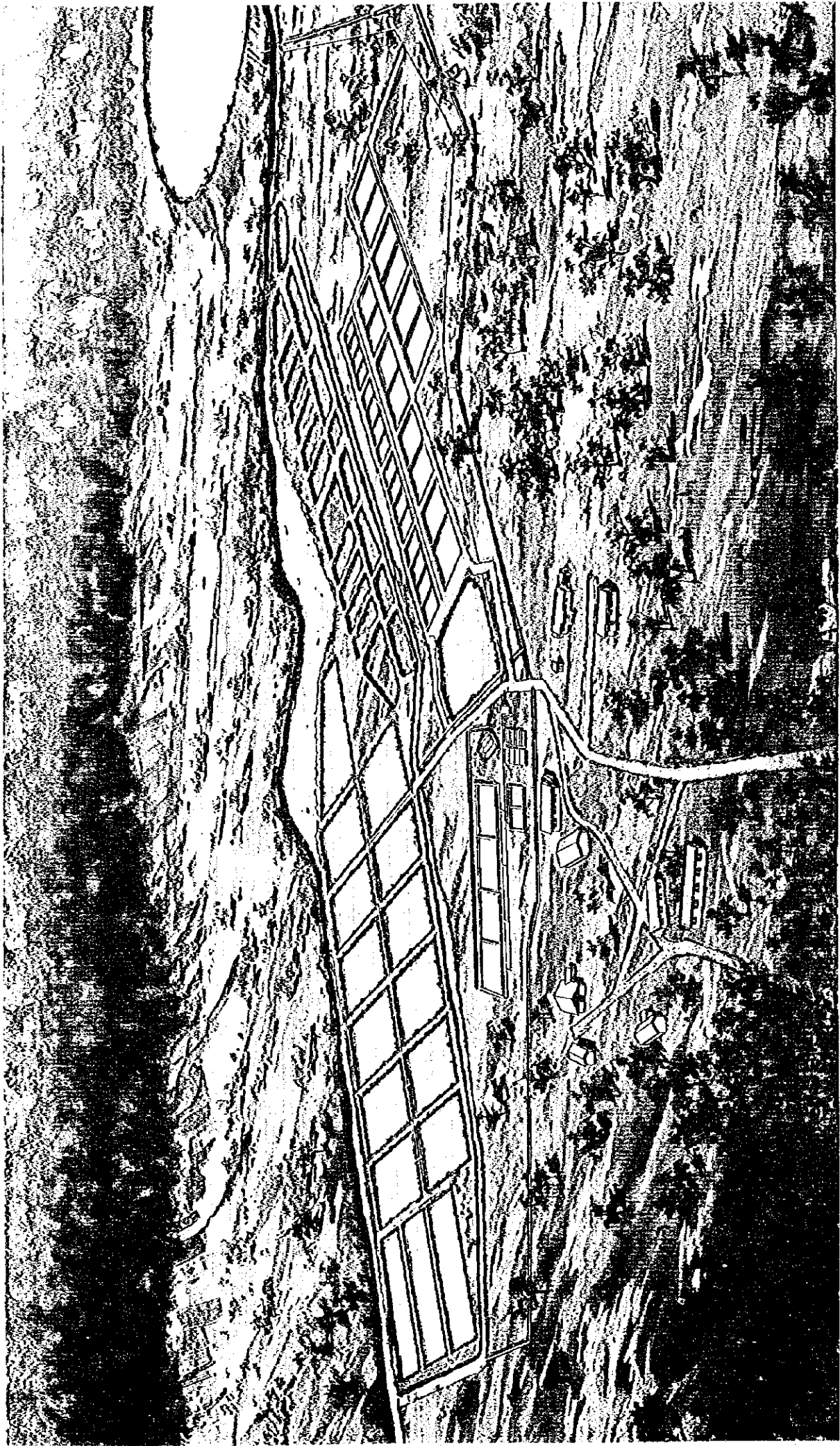
RAIL WAY

ROUTE 1

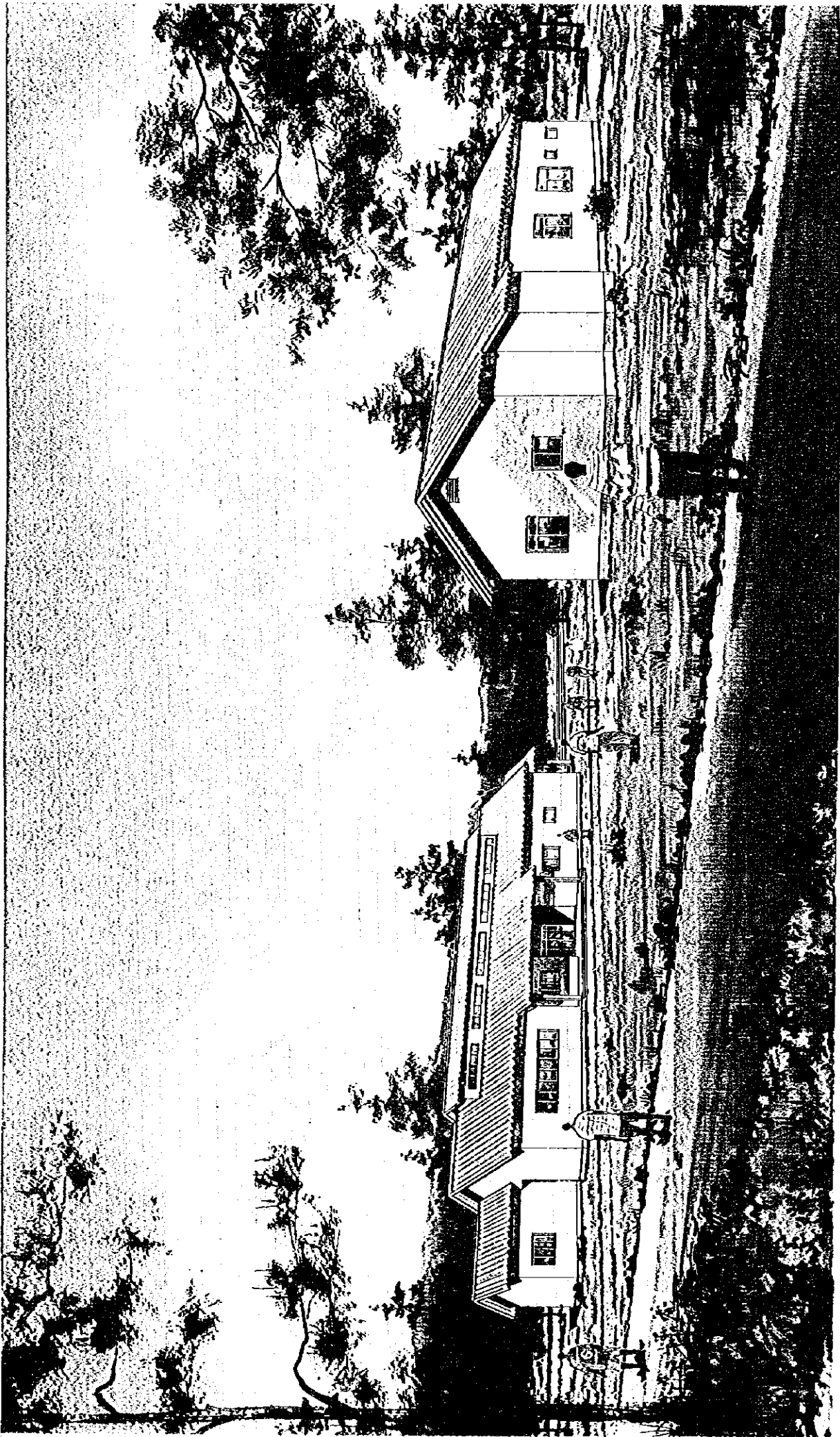
Mwekera river

Kamfinsa river

To LUSAKA



BIRD'S-EYE VIEW OF THE PROJECT SITE



PERSPECTIVE DRAWING OF THE BUILDINGS

Abbreviations

ORGANIZATIONS

FAO	: FOOD AND AGRICULTURAL ORGANIZATION
JICA	: JAPAN INTERNATIONAL COOPERATION AGENCY
JOCV	: JAPAN OVERSEAS COOPERATION VOLUNTEER
MPTC	: MINI-PROJECT TECHNICAL COOPERATION(CONDUCTED BY JICA)
NARDC	: NATIONAL AQUACULTURE RESEARCH AND DEVELOPMENT CENTRE
NORAD	: NORWEGIAN AGENCY FOR DEVELOPMENT COOPERATION
WHO	: WORLD HEALTH ORGANIZATION

OTHERS

AP	: AUTHORIZATION TO PAY
ASIP	: AGRICULTURAL SECTOR INVESTMENT PROGRAMME
B/A	: BANKING ARRANGEMENT
E/N	: EXCHANGE OF NOTES



CONTENTS

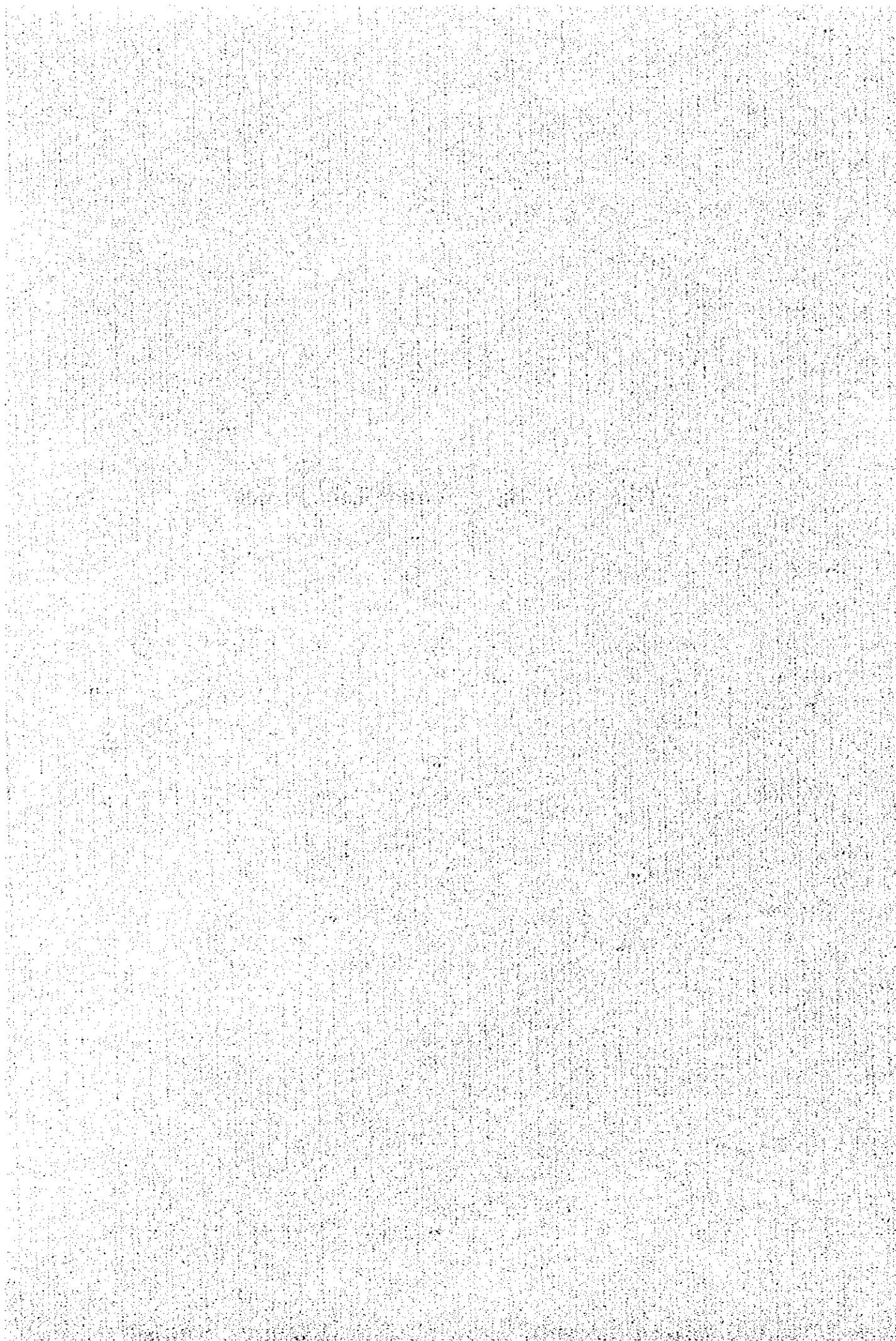
Preface	
Letter of Transmittal	
Location Map / Perspective Drawing	
Abbreviations	
Chapter 1 Background of the Project	1
Chapter 2 Contents of the Project	
2.1 Objective of the Project	3
2.2 Basic Concept of the Project	3
2.2.1 Civil Works	5
2.2.2 Basic Concept of Building Facilities	10
2.2.3 Basic Concept of Equipment	12
2.3 Basic Design	13
2.3.1 Design Concept	13
2.3.2 Basic Design	14
2.4 Project Implementation Plan	38
2.4.1 Organizations	38
2.4.2 Budget	40
2.4.3 Technical Level of Personnel	41
Chapter 3 Implementation Plan	
3.1 Implementation Plan	45
3.1.1 Implementation Concept	45
3.1.2 Implementation Conditions	45
3.1.3 Scope of Works	46
3.1.4 Consultant Supervision	47
3.1.5 Procurement Plan	48
3.1.6 Implementation Schedule	49
3.1.7 Obligations of Recipient Country	50
3.2 Cost to be shared by Zambian side	51
3.3 Operation and Maintenance Plan	51
3.3.1 Operation and Maintenance Plan of Research and Production Activities	51
3.3.2 Maintenance and Management Plan of the Facilities	54
Chapter 4 Project Evaluation and Recommendation	
4.1 Project Effect	59
4.2 Recommendation	60

(Appendices)

1.	Member List of the Survey Team	1 - 1
2.	Survey Schedule	2 - 1
3.	List of Party Concerned in the Recipient Country	3 - 1
4.	Minutes of Discussions	4 - 1
5.1	Natural and Environmental Condition Study	
1.	Field Survey Location Plan	5 - 1
2.	Results of Geological Test	5 - 2
3.	Results of Water Quality Analysis	5 - 3
4.	Observation record of Kafironda Station	5 - 4
5.	Segmentary Map for Topography Survey	5 - 5
5.2	Cultivation Plan	
1.	Annual Schedule of Experimental Ponds Usage	5 - 6
2.	Comparison of Pond Structure	5 - 7
3.	Estimation of the Scale of the Spawning Pond	5 - 8
4.	Seed Production Cost	5 - 11
5.	Research Activity Expenses	5 - 14
6.	Earnings from Sales Operation	5 - 15
5.3	Equipment	
1.	List of Equipment	5 - 19
6.	Data Collected	6 - 1

Chapter 1 Background of the Project

Chapter 1 Background of the Project



CHAPTER 1 BACKGROUND OF THE PROJECT

The Republic of Zambia, located in Eastern Africa, has a land area of about 752,610 km² and population of 9,188,190 (as of 1994). Although the country is located in the tropical region, the weather is relatively mild throughout the year. The atmospheric temperature is stable throughout the country except in some river basin areas. The maximum temperature seldom exceeds 30°C.

Geographically, the country is land locked, occupying the Zambia Block, a highland 1,280 m in mean altitude. The northeastern part is adjacent to the Tanganyika Shield. It is surrounded by Zaire and Tanzania on the north, Malawi on the east, Zimbabwe and Botswana on the south, and Angola on the west. The annual precipitation is between 1,000 mm and 1,500 mm in the north and between 400 mm and 1,000 mm in the south.

The country has abundant inland waters such as Lake Tanganyika, Lake Kariba, Zambezi River system, and Zaire River system. Inexpensive freshwater fishes, such as tilapias, in these inland waters are an important source of animal protein for the people especially the low income class. The fish protein accounts for 57% and 65% of the total protein intake in urban areas and rural areas, respectively. Fish is supplied to the people through capture fisheries and aquaculture.

However, fishery production cannot keep up with the increasing demand attributable to population increase because the production of capture fisheries has remained nearly unchanged at a level of 70,000 ton/year over the past 10 years. Hence, the per capita fish consumption has decreased from between 10 and 12 kg/year in the 1960s and '70s to 8 kg per year at present.

Since no great increase in fish catch can be expected from the natural waters, enhancement of fish supply by means of aquaculture has become necessary to meet the increasing demand for fisheries products. However, aquaculture is still in its intermediate stage of development in this country and the aquaculture production is still small. Generally, small scale fish farmers are unable to operate farming without assistance from public organizations. In order to increase aquaculture production, it is therefore necessary to develop and increase the number of small scale aquaculture farmers through providing them with basic public services such as seed supply and culture technique development / dissemination.

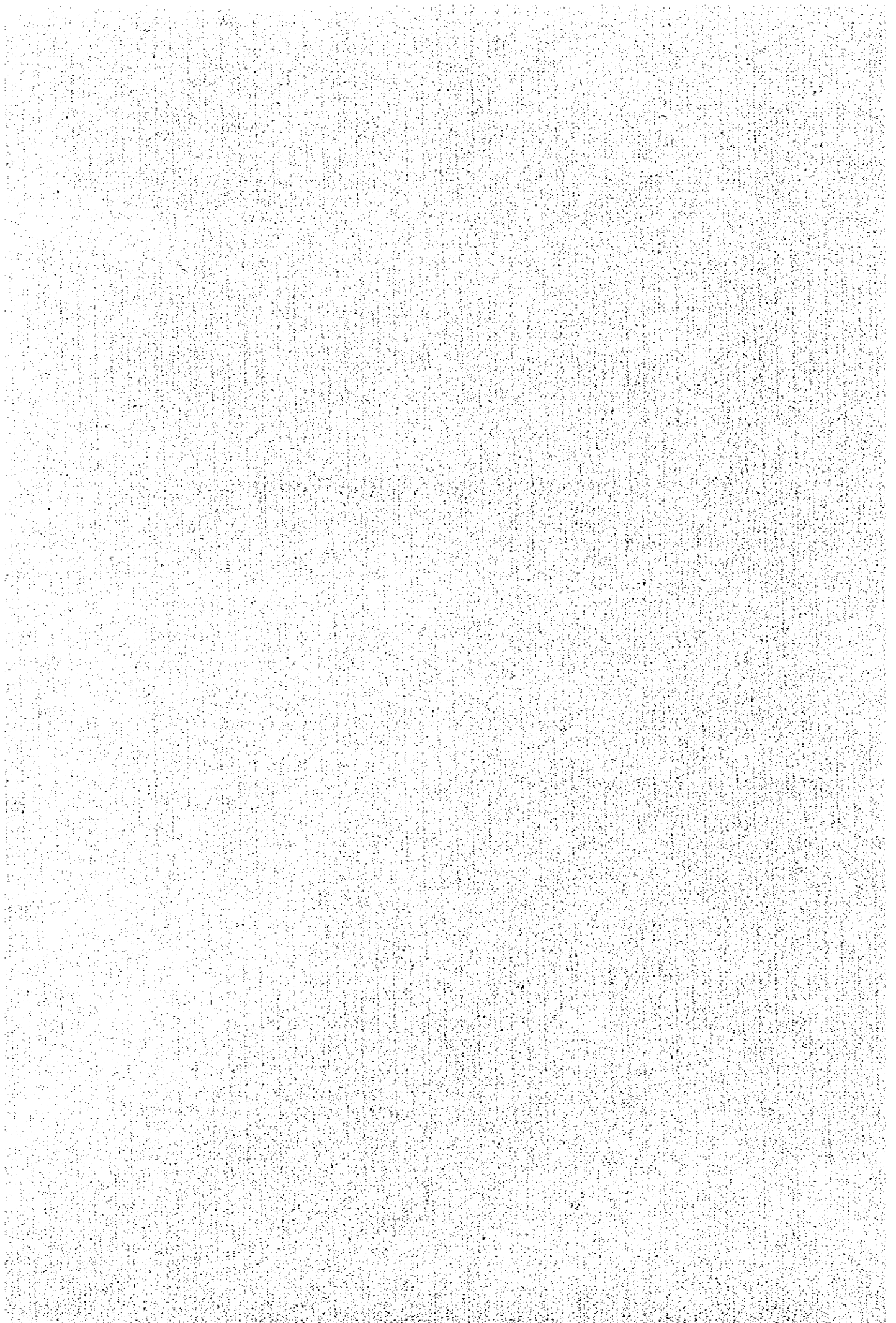
Under such circumstances, the Zambian Government has placed high priority on aquaculture promotion in its long-term agricultural development plan called Agricultural Sector Investment Programme (ASIP) targeted at 2015. In the fisheries development plan based on ASIP, Mwekera Aquaculture Station is expected to function as a core institution for aquaculture extension in the country, acting as the national center for the research and dissemination of

aquaculture technology and production, and supply of fish seed. However, the water supply/drainage system and other facilities at the station have become old and obsolete. Their reduced functions and structural defects hinder seed production and research activities at the station, making it difficult to operate the facilities appropriately and efficiently.

In view of such situation, the Zambian Government requested the Japanese government in March 1995 to provide a grant aid for upgrading of the Mwekera Aquaculture Station.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project



CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

Fisheries products are a stable and inexpensive source of protein for the people of Zambia. This is particularly true for lower income households where fisheries products provide a means of improving nutritional intake. In this respect, a stable and secure supply of fisheries products is vital. However, in recent years the production of fish harvested from inland waters has leveled off and the increasing demand for fish cannot be met by capture fisheries. Hence there is a growing need to supplement the fish production by enlarging the aquaculture industry. However, the aquaculture in Zambia is still at an intermediate stage, and it is essential that national institutions focus their efforts on such services as the supply of fish seed, development of appropriate technology, and extension of technology in order to support small-scale fish farmers.

Under such circumstances, the Mwekera Aquaculture Station, as the nation's center for aquaculture extension, has been required to play a key role in the production and supply of fish seed, development of suitable technology, extension activities, etc. However, some segments of the station's facilities, such as the water supply and drainage network, have deteriorated due to superannuation or structural factor, and are impeding the overall operations of the institution.

ASIP, a substantially preferential project of the sector concerned, makes it one of its objectives to promote small-scale aquaculture industry through disseminating and promoting aquaculture technology in the fishery sector. This project aims at restoring the functions necessary for the appropriate and efficient operation, through repair and improvement of the Mwekera Aquaculture Station's facilities. This station is planned in the ASIP to function as a core institution for developing aquaculture technology in the future in order to contribute to the expansion and promotion of aquaculture in the country.

2.2 Basic Concept of the Project

In the original request, the objective of the project was to improve and enlarge the facilities of the Mwekera Aquaculture Station. However, the need to expand the facilities is not very high, in view of the actual market conditions. In contrast, field study results have clearly showed that there is a greater need to renovate and improve segments of the station's facilities which have depreciated or lost their original function. Therefore, the framework of the project has been drawn up as follows.

Table 1 Project Framework

	Project as Requested	Project to be Implemented	Civil Works	Building Facilities	Equipment
Production	Expand the facility to enable production of 3 million fingerling annually.	Scope of facility will not be changed. Renovate water supply and drainage facilities and repair a portion of production ponds.	Water supply / drainage canals, production ponds, roads in station compound		
Research	Improve research ponds, renovate research/administrative building and equipment.	As requested.	Water supply / drainage canals, research ponds, spawning ponds, roads in compound.	Research/administrative building, accommodations building, well, elevated water tank, generator room	Equipment for laboratory experiments, survey, meteorological observation, and others
Extension & training	Renovate accommodations building for trainees	Excluded from the project.			-----

The basic project concepts on production, research, extension and training facilities have been drawn up taking account of the following points.

- (1) Priority shall be given to the development of technology and seed production suited to the local fish farming system/practice.
- (2) The scope and content of the research plan shall correspond with the capabilities of researchers of Mwekera Aquaculture Station.
- (3) The design of the facilities and the scope of the equipment shall be such that the Fisheries Section and the station personnel can manage, maintain and operate the station by themselves with as low costs as possible.
- (4) The facilities and the scale shall be such that the operation and management is possible by themselves even after the completion of the Mini-Project Technical Cooperation (MPTC).

In the original request, seed production and research ponds were not different in pond structures, all ponds being concrete-walled. In this project, however, the ponds have been divided into two groups, a group for seed production and a group for research, with a basic concept of improving facilities drawn up for each type of pond.

2.2.1 Civil Works

(1) Water supply and drainage canals

As improvement of the function of the water supply canal cannot be expected only by partial repair, the whole canal system will be improved.

Drainage canal will be improved and partially reinforced so that its cross section is sufficiently large for smooth drainage.

(2) Production pond

As mentioned earlier, the present scope of production facilities is sufficiently capable of supplying seed, and the problem lies in the depreciated functions of the water supply and drainage facilities. Therefore, the basic policy of this project will be to rehabilitate the seed production facilities to a level of basic operational capability and it will not be concerned with expanding the facilities.

Seed production activities are carried out in Zones A and B. No specific problems were observed with the ponds in Zone B where primary (fry) rearing is carried out, and therefore, this Zone B is excluded. This project is concerned with rehabilitating the drainage facility of the ponds in Zone A and the station's overall water supply and drainage network. The ponds in Zone A will keep its present size and only the pond beds will be raised in order to allow adequate drainage.

The 14 ponds in Zone A which are engaged in broodstock rearing and secondary (fingerlings) rearing of common carp and tilapias, and seed production of tilapias, and the 16 ponds in Zone B which are used for common carp spawning and seed production will be allocated as production ponds (see Fig. 1 Pond Layout Plan).

Table 2 Outline of Production Ponds

Zone	Number of Ponds	Use
Zone A	6	Common carp fingerling rearing and tilapias seed production
	6	Broodstock rearing of common carp and tilapias
	2	Spare ponds
Zone B	16 (Existing)	Common carp seed production

(3) Experimental ponds

1) Determination of the number of ponds

In rearing experiments, the number of experimental treatments and experimental series are determined according to the universal principle of experimental design. The number of experimental ponds will be determined so that the three researchers presently working at the Mwekera Aquaculture Station may constantly secure the number of ponds necessary for their respective studies.

The list of research topics undertaken by the Mwekera Aquaculture Station consists mainly of themes requiring verification through comparative experiments. In comparative experiments, a specific experimental condition is set at different levels while all other conditions are maintained unchanged. A minimum of four treatments (i.e., ponds) are required for one experiment, in order to compare and verify the data.

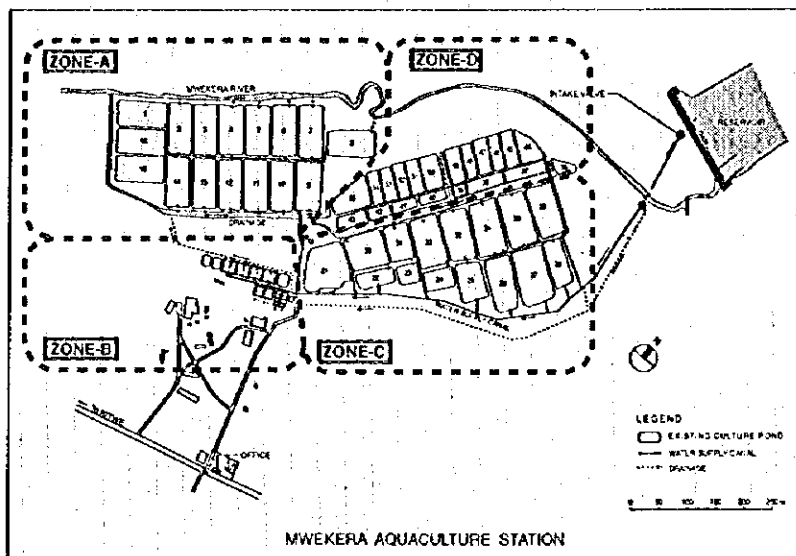


Fig. 1 Layout Map of the Mwekera Aquaculture Station

In rearing experiments, the number of experimental treatments and experimental series are determined according to the universal principle of experimental design. In the present project, the simplest single-factor experiments are to be conducted, setting only a single-factor at four different levels while maintaining all other factors at fixed levels. In such experiments, at least duplicate series of experiments are desired to obtain accurate data. It follows that in this project, at least eight experimental ponds (4 treatments x 2 ponds) are required for each study subject.

The number of experimental ponds required for research is 30 ponds as shown in the following table, taking account of research topics in each field.

Table 3 Number of Experimental Ponds Required

Experiment	Research theme	Number of ponds	Period of Use	Remarks
(1) Seed production experiment *1)	Comparison of tilapia production efficiency			Four species are used.
	1) Preservation of original strains	4	Throughout the year	
	2) Comparison of growth/propagation performances	4	Throughout the year	
(2) Feed experiment *2)	Effects of various feed ingredients	8	3 months for one experiment	4 treatments in duplicate series. Combination of feed materials. Experimental fish are tilapias and common carp.
Subtotal		16		
(3) Plankton culture experiment *3)	Effects of fertilization and fertilizers on plankton culture	8	6 months for one experiment	Conducted in 2 seasons i.e. dry and rainy seasons. Examination of appropriate quantity of fertilizer.
(4) Polyculture experiment *4)	Combination of fish	6	Throughout the year	Various species of tilapias, combination of tilapias and common carp
Subtotal		14		
Total		30		

*** 1) Seed production**

The objective species of tilapias are *Oreochromis andersonii*, *O. macrochir*, *O. niloticus* and *Tilapia rendalli*. Maintenance of original strains and comparison of growth/propagation performance will be conducted using these four species. In the comparative experiments, growth, stocking density, food habit, etc. will be examined in plankton-propagated ponds without feeding. Sampling will be done every three months.

*** 2) Feed experiment**

a) Feeds with different rates of mixture of grain leavings (maize, wheat, etc.) and brewery wastes will be compared. The period for one experiment is three months. Object fish species will be tilapias and common carp.

b) Method (wet mash, lump feed, and broadcasting) of feeding will be examined.

***3) Plankton culture**

Effects of fertilizers on plankton culture will be examined during the dry and rainy seasons at fertilization rates of 0 ton, 2 tons, 4 tons, and 8 tons per pond.

In these experiments, the timing and quantity of additional fertilizers and composition of fertilizers will be examined through plankton monitoring.

***4) Polyculture experiment**

Polyculture experiments will be conducted using tilapias and common carp. Experiments will be conducted in duplicate series employing species combination rates of 1:1, 1:2, and 2:1.

The annual schedule of pond usage for the above-mentioned experiments is shown in "Appendix 5.2, Fishery 1. Annual Schedule of Experimental Ponds Usage".

2) Determination of pond size

In order to make efficient utilization of research findings for the activities of the production section of the station and for the extension work, it is necessary to determine the size of experimental ponds taking into account the size of the station's production ponds and that of the culture ponds in private fish farms. The surface area of the station's production ponds is 2,500 m² and that of private fish ponds is generally 200 - 300 m². Based on these observations, the size of a group of experimental ponds at the station is determined to be 250 m², to facilitate the direct application of research outputs to extension activities and the conversion of data between the experimental and production ponds in the station.

However, in polyculture experiments and comparative experiments of fertilization which are conducted in fertilized ponds, appropriate management of pond water conditions may be difficult in small ponds, since water characteristics easily change and pond environments are not stable in such ponds. Therefore, experimental ponds to be used for fertilization culture should be of large size.

The size of experimental ponds is determined based on drainage capacity. Pond water should be changed totally in one day in the event of disease outbreak or water quality changes. The capacity of the water supply facility planned in this project is about 850 tons/day for the whole station. If the 850 tons of water is used for only one pond in the event of the situation described above, the surface area of the pond is 850 m² (depth 1m). Based on these factors and with an allowance of 10% for contingency, the size of the large experimental ponds is set at 750 m².

Table 4 Number and Size of Ponds

Research Field	Research Subjects	Number of Ponds	Size of Pond
Seed production	Selection of tilapia spp. for culture	8	250m ²
	Polyculture systems	6	750m ²
Plankton culture	Effects of fertilization and fertilizers on plankton culture	8	750m ²
Artificial Feed	Evaluation of feed formulation	8	250m ²

3) Pond structure

Various problems have been occurring at the station, such as the collapse of earthen pond walls, diminished fertilization efficiency due to overgrown weeds on the surface of pond walls, and the dabbling of pond walls by fish which may result in the collapse of the wall and invasion of fish from one pond to the neighboring pond. If such phenomena occur, comparison of experimental data becomes impossible since pond conditions should be uniform for comparative experiments.

As corrective measures to solve these problems, it can be considered appropriate to perform sufficient maintenance in earthen ponds, or to cover the wall surface of earthen ponds with vinyl sheet as is done at the Misamfu Station or concrete the wall surface.

Although the initial construction cost of ponds covered with vinyl sheeting is low, these ponds require periodic maintenance cost. In contrast, although the initial construction cost of concrete ponds is high, the ponds require almost no maintenance cost.

Taking into account of the economic situation of Zambia which is under structural adjustment by the World Bank, high maintenance expenditures will cause difficulty in the management of the facilities, leading to deterioration of the activity efficiency. Therefore, the facilities should be planned so that the operation, maintenance, and management costs can be lowered as much as possible. For this reason, concrete walls are judged to be desirable for the experimental ponds (see "Appendix 5.2 Fishery 2. Comparison of Pond Structure"). With the decrease in maintenance and operation costs accompanying the introduction of the concrete walls, improvement of the overall maintenance and operation of pond facilities can also be expected.

3) Common carp spawning ponds

The new spawning ponds for common carp will be designed to allow the present production quantity of approximately 500,000 fingerlings. The ponds will be designed to enable two cycles ($250,000 \times 2 = 500,000$) of production in one season as practiced at present.

For details, see the calculations in "Appendix 5.2 Fishery 3. Estimation of the Scale of Spawning Pond".

From the above calculation results, the total area of spawning ponds required can be assumed to be 60 m^2 . Since small, plural spawning ponds will be more efficient in spawning operations than a single pond, three ponds with an area of 20 m^2 per pond will be installed in this project.

2.2.2 Basic Concept of Building Facilities

In order to make the functions of the Mwekera Aquaculture Station more comprehensive and enterprising, each of the building facilities requested in the project shall be designed for efficient operation and maintenance, taking account of the priority of each building and the burden on the requesting country.

The basic concept for each facility is explained below according to the priority.

(1) Research/administration building

This building is a combined research and administration facility. The facility will be used mainly by researchers and administrative personnel of the station but also used by trainees during training sessions.

The size of the building and the number of rooms will be within reasonable limits. The space of each room will be in accordance with the local specification.

The results of the review of each of the requested rooms are shown in the following table.

Table 5 . Review of Each Room

Room	Purpose	Result of Review	Remarks
Research room 1. Incubation room 2. Chemical laboratory 3. Biology laboratory	Facilities will be used for research and training activities	The chemical analysis and biology laboratories will be placed in one room	Required.
Data analysis room	Storage and analysis of experimental data	Storeroom and/or office can be used for the purpose.	Not particularly needed.
Meeting room	For staff and researchers	Office may be used for small meetings.	Not particularly needed.
Extension office	Extension staff room	Not relevant to this project's objectives	Excluded.
Reception	Entrance reception desk	Can be combined with the office.	Not particularly needed.
Office for experts	Office for JICA experts	MPTC will be terminated	Not particularly needed.
Secretarial (Chief aquaculturist)	Office for Chief Aquaculturist	In accordance with Zambian custom	Required.
Research office	Office for researchers	To be used by three researchers in feed, culture, environment	Required.
Office for visiting researchers	Office for guest researchers	Possible future need, but space will be prepared in research office.	Not particularly needed.
Library	Storage room for data, publications, etc.	Research office can perform the function.	Not particularly needed.
Other office		General office will function as reception, with two staff members.	Planned
Garage	To house motor vehicles.	Not relevant as vehicles will not be provided in this project.	Excluded.

(2) Accommodation house

In view of the increasing necessity of overnight experimental work as the research functions of the station are strengthened, an accommodation facility will be built for researchers and administrative personnel working overnight. The accommodation house will have quarters for one person for temporary stay and for one family of administrative personnel, and the size of the accommodation house will be determined based on this composition.

(3) Generator shed

This is a shed to house a generator provided by the MPTC. The size of the generator shed will depend on the outside dimension of the 10-kVA generator.

(4) Well and elevated water tank

The source of the water supply system to the facilities is a well. A new water supply system will be designed as part of the planned new facilities. Water will be pumped up from the well to an elevated water tank, which will supply water to the facilities by gravity flow.

The water will be used for research and domestic purposes. The capacity of the tank will be 10 tons, which is equivalent to a two-day supply of water for 31 staff members of the station.

(5) Accommodation house for trainees

The major training facility is the accommodation house for trainees. A three-month training program for students and government officers has so far been conducted twice a year and training programs targeting small-scale fish farmers have been implemented occasionally. However, the frequency of the training programs is low, and the renovation of the accommodation house for trainees does not appear to be urgent at present. Therefore, the accommodation house will be excluded from this project.

(6) Car shed

Car sheds are excluded, because vehicles are not provided in this project.

2.2.3 Basic Concept of Equipment

The equipment requested in this project covers the following seven areas: (1) cars, (2) experimental equipment, (3) feed production equipment, (4) survey equipment, (5) equipment for dark rooms, (6) meteorological observation equipment and (7) other equipment.

While paying attention to the priority order presented by the requesting country, necessary kinds of equipment and their minimum quantity shall be selected based on the following three points: (a) equipment which will meet the work objectives and the activities of the center shall be selected, (b) equipment already existing or equipment already provided by the MPTC or scheduled to be provided shall be excluded in principle, and (c) equipment which can be easily operated and maintained by the requesting country side shall be selected.

2.3 Basic Design

2.3.1 Design Concept

The basic design of the facilities in this project will be in accordance with the following policy.

(1) Natural conditions

As the planned site for construction of the facilities is situated near the flood areas of the Mwekera River, the facilities should be so positioned, designed and constructed to cope with the natural conditions such as the surface and underground drainage pattern, large seasonal fluctuations in the water level of the river, underlying clay stratum, flooding, sinking of the ground, etc.

(2) Social conditions

The region is plagued by a shortage of service water during the dry season and the local inhabitants periodically block the water supply canal to the production ponds, diverting it for domestic use (drinking water, washing clothes, etc.). This not only prevents the station from securing a sufficient volume of water for its ponds, but also gives rise to contamination of water. Therefore, the water supply facility which will be installed in this project has been designed to allow a part of the water to be used as domestic water by local inhabitants without affecting the water supply used for the production ponds.

(3) Construction work

The Mwekera Aquaculture Station, planned site for construction, is only 30 to 40 km from the urban areas of Kitwe and Ndola cities. These two cities are an adequate source of construction material such as concrete block and cement and labor.

(4) Local contractors and construction materials

Construction materials which can be obtained locally will be used. They will be selected after the overall cost, durability, and quality have been strictly assessed. Local contractors will be evaluated for technical expertise and a simple execution method for short term works will be employed.

(5) Operations and maintenance

The facilities and equipment which will be designed and provided by this project will have minimum operation and maintenance costs; for example, the water supply and drainage system in

particular will employ a gravity system which requires no operational costs and is easy to maintain and control.

(6) Equipment selection

The equipment requested in the plan does not require advanced techniques or skills, nor difficult supply. Equipment has been selected according to the following criteria: a) maintenance and control costs are minimal; b) equipment sensitive to environment or requiring delicate handling has been avoided; and c) equipment must have consumable and spare parts available locally.

(7) Construction term

Construction work on ponds will be carried out in two stages: one for research and the other for production ponds, in consideration of the work presently under implementation by MPTC experts .

2.3.2 Basic Design

(1) General facility plan

The project site is located about 26 km northeast of Kitwe City on the left bank of the Mwekera River, a tributary of the Kafwe River. The civil works such as culture ponds will be located in the lower area adjacent to the Mwekera River to allow the water supply/drainage systems to employ the gravity system. Construction facilities such as the research/administration building will be built on a moderately inclined rise in the southeastern part of the project site, in order to avoid flooding during the wet season and in consideration of the work procedure.

The main supply canal will be installed on the existing canal as much as possible. The current drainage canal will be partially repaired and will use the existing route. The overflow canal located on the east side of the main supply canal will be enlarged cross sectionally, and a new overflow canal will be installed in the undeveloped southern part of the site.

As for culture ponds, the experimental ponds will be located in Zone C on the northeastern side nearest to the research/administration building while the production ponds in Zone A on the southwestern side. Sedimentation ponds will be installed adjacent to the Mwekera River in order to collect the sand and other things from the waste water of the culture ponds. Three spawning ponds, 20 m² in area each, will be newly constructed on the northeastern side.

An access road connecting the site to the exterior will run from the existing entrance located on the southeastern side, to each of the pond groups and to the central area of the

experimental ponds. Maintenance roads will be constructed along the ponds.

Water for the ponds, which will be supplied through the intake valve from the reservoir, will pass through the crossing work of the Mwekera River, run south downstream via the main supply canal installed along the eastern border of the site, and be diverted into the experimental ponds. Then the water in the main supply canal will cross the access road and flow west to the production ponds.

The construction site will be located in the area of about 0.48 ha on a moderately inclined rise to the east of site road, the accommodation wing on the south side, and the research/administration one on the north side, standing in a row. Both wings will be situated with the space between them enough for cars to have easy access.

The layout plan for the site is outlined below.

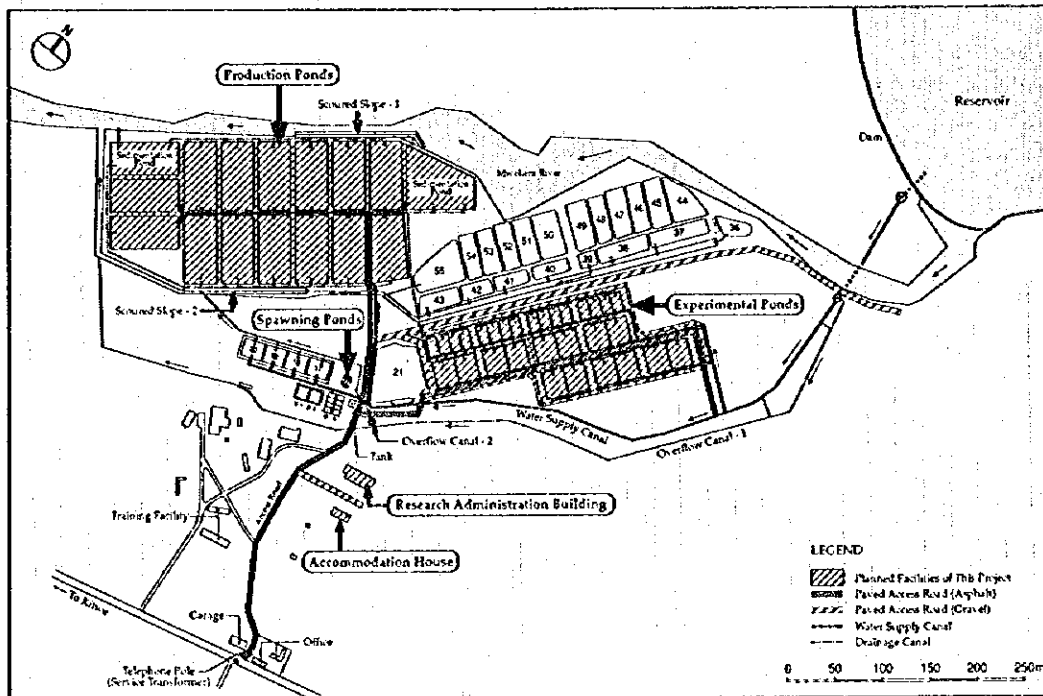


Fig. 2 Outline of Pond Layout Plan

(2) Civil works plan

The basic policy of the civil works plan of the Mwekera Aquaculture Station will be to keep the operation and maintenance costs of the facilities in this project to a minimum. Therefore, the water supply and drainage facilities will employ a gravity system which will incur no operating costs. In addition, the ponds, which effectively utilize the topographical configuration of the project site, will contribute to an efficient water supply and drainage system. It is anticipated that the ponds will be restored to their optimum functionality.

Table 6 Civil Works Plan

Facility	Content
Water intake valve and supply canal	The existing deteriorated intake valve will be replaced with new one. The water supply canal is the artery of the station, but some portions of the main canal are damaged by wall cracks and collapse, with complete lost of function. Repairs will be carried out. Water intake will employ a gravity system, which requires no operating drive and is easy to maintain.
Drainage canal	Drainage canal will be repaired in conjunction with renovation work on production and experimental ponds. Drainage network will also employ the gravity system.
Production ponds	Of the production ponds requested, those used for seed production will remain earthen ponds (Zone A). As for ponds that are difficult to drain and dry up, pond beds will be raised to restore drainage function.
Experimental and spawning ponds	Experimental ponds will be designed to suit the objectives of respective experiments to be conducted. The size of the spawning ponds will be determined based on the projected quantity of seed to be produced.
Access roads	Roads should be renovated for effective rearing operation and transport activities. The main road will be lined with asphalt as it is steeply inclined and frequently used by motor vehicles. The maintenance roads surrounding the ponds will be paved with gravel in order to enable their use during the rainy season.

1) Water intake pipe and valve

The water intake pipe is a cast iron pipe which has still maintained its function despite the onset of corrosion. If the existing pipe, which is set directly into the dam wall of the reservoir, is replaced, flooding may be induced and an alternate intake system or large scale earth works will be required. Therefore, the intake pipe will not be replaced.

Although the intake valve is presently barely functioning, the risk of damage or breakdown is high. In the event of a breakdown, repairs cannot be carried out by the station alone. Since the valve is the backbone of the intake system, it should be replaced. The new valve will be 8 inches (0.20 m) in diameter with a maximum intake capacity of $0.045\text{m}^2/\text{sec}$ under normal conditions.

2) Water supply canal

The existing water supply canal is cracked and collapsed in several areas and partial rehabilitation will not restore its initial function. The existing route of the canal cannot be changed due to the gentle gradient of the site (1/600 to 1/1000), therefore the route will remain unchanged and the existing supply canal will be replaced with a new facility. The new water supply system facility will employ a gravity system, in order to reduce maintenance and operational costs.

The main canal will be 0.6 m in width and depth, as is at present. The structure of the new canal will be reinforced concrete in view of the soft ground and the differential settlement that may occur during the rainy season. The tributary canals connecting each pond will be constructed together with the ponds. The tributary canals will be 0.4 m in both width and depth.

3) Drainage canal

Drainage water from the outlet work of each pond will be conveyed to the sedimentation pond by the drainage canal which will be placed along each pond. The drainage canal will be made of reinforced concrete, 0.6m wide and 1.6m to 1.8m deep.

The overflow canal located on an incline in Zone C, which is designed to receive and drain underground seepage water and surface runoff, will have a bed width of 1m and a top width of 4 m. It will be built on the south side of the main water canal.

4) Production and experimental ponds

In accordance with the scope specified in the aquaculture plan, the ponds will be so designed that a gravity operated supply and drainage system can be installed.

The production ponds will be located in Zone A, and of the existing 15 seed production ponds, the one located at the furthest end will be converted to a sedimentation pond. The remaining 14 ponds will undergo renovation and slope grading to raise the pond beds by about 0.5 m in height with soil filling. In addition, reinforced concrete tributary water supply and drainage canals, inlet and outlet works, and renovation work on the side slopes and maintenance road are planned. The water surface area will be 2,500 m² (72 m x 34 m) and the depth 1.6 m. In order to facilitate fish harvesting activities, a harvest pit 1.6 m x 1.6 m and 0.2 m deep will be installed at the outlet.

The experimental ponds, located in Zone C, will be concrete-walled for experiment and research activities. A pond in Zone A will be used for sedimentation. The ponds will be divided into two groups: one group of 14 ponds with a surface area of 750 m² (30 m x 25 m) each and the other 16 ponds with surface area 250 m² (20 m x 12.5

m) each. Each pond will be 1.6 m deep with an efficient depth of 1.2 m. The side wall between two ponds is deemed unsafe due to the pressure of the sliding force, so a double wall structure filled in with soil will be installed. A harvest pit 1.6 m x 1.6 m and 0.2 m deep will be installed at the outlet to facilitate harvesting activities.

Three spawning ponds with a surface area of 20 m² each and a reinforced concrete structure 0.2 m thick are planned. The side walls of the center pond will form the inside walls of the remaining two ponds.

5) Access roads in the station compound

The access road connecting the existing office and the hatchery will be 3.5 m wide and paved with asphalt, with a drainage ditch. The maintenance road running adjacent to the ponds will be 3.5 m wide and will be installed in conjunction with the ponds. They will be paved in gravel to improve operation activities. Civil works crossing the supply and drainage canals will be carried out paying attention to research and culturing activities.

(3) Building design

1) Scale design

The design of the requested facilities and the number of staff members are shown below.

• Research/administration building

Chief Aquaculturist:	1 person
Researcher:	2 persons
Office clerks:	2 persons

• Accommodation house

Researcher:	1 person
Administrator:	1 family

The standard design adopted by existing facilities and the PWD in Zambia was used to calculate the scale of the facilities. With reference to the information on equipment by the Architectural Institute of Japan and based on the general standards adopted by public works ministries and facilities in Zambia, the per capita area required is given in Table 7.

Table 7 Per Capita Floor Area

Room	Japanese Standard	Zambian Standard	This Project
Office	7.5m ² /person	6.0m ² /person	6.0m ² /person
Researchers' Office	10-22m ² /person	15.0m ² /person	10m ² /person
Storeroom	20% of total floor area of offices/laboratory	-----	20% of total floor area of offices/laboratory
Laboratory	With laboratory tables; 15 trainees	-----	A laboratory table in the center; 15 trainees

The actual floor area which will be used in this project are calculated from the floor area in Table 7 and is shown in Table 8 below.

Table 8 Planned Floor Area of Each Room

Building/Room	Floor Area Requested (m ²)	Calculations of Floor Area	Designed Floor Area (m ²)
Research/administration Building			
Office	15.0	2 per. x 6.0m ² /per. = 12.0	12.0
Researchers' office	30.0	3 per. x 10.0 m ² /per. = 30.0	30.0
Storeroom	49.0	174.0m ² x 16% = 28.0	28.0
Wet Laboratory	56.0	plastic containers	56.0
Chemical Laboratory	56.0	shelves/lab table + 15 trainees x 2.0m ² /per. = 30.0	2 labs in 1 room
Biology Laboratory	35.0		56.0
Accommodation House	-----	Researcher (ILDK)*1) 64.0	64.0
		Administrative staff (2LDK) 96.0	96.0

*1) ILDK means one bedroom, with living, dining, and kitchen areas.

The figures for the designed floor area shown above will be used in the scale plan. Fig. 3 shows the wet laboratory and chemical laboratory.

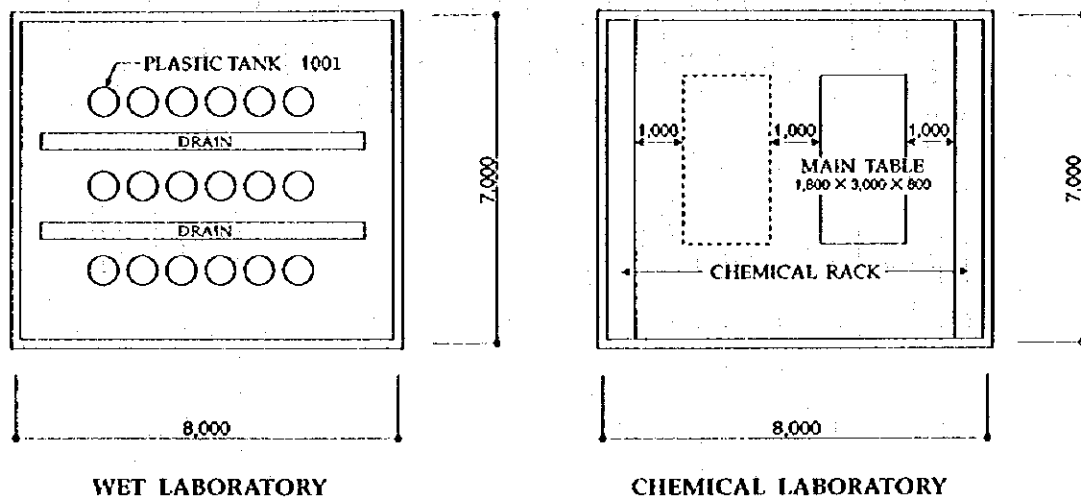


Fig. 3 Planned Floor Area of Wet and Chemical Laboratory

2) Plan and Cross Sectional Design

a) Research/administration building

The long spanning laboratories and the small offices will be separated by a center corridor and the entranceway will be located in the center to minimize the flow of movement. The working yard and wet laboratory will be connected by an entranceway in the working yard. A small reception window will be designed in the wall between the office and entrance hall.

To prevent flooding, the floor level will be 30 cm higher than the road level. A sufficient roof pitch will be provided to cater for the heavy rainfall during the rainy season. High eaves will be adopted as a roof truss to allow sufficient natural ventilation against the summer heat. Each room will be provided with windows to allow ample light and natural ventilation.

b) Accommodation house

A 1LDK with a functional layout for researchers and a 2LDK for the maintenance staff, with a laundry room at the back, will be constructed. The sectional planning will be in accordance with the research/administration building.

c) Generator shed

The generator shed will have space to accommodate a 10-kVA generator provided by MPTC and that for maintenance work. A pierced block will be set in the wall to allow natural ventilation.

3) Structure Plan

The building will adopt the standard structure generally seen in Zambia, and a suitable method of execution will be employed in its construction.

The soil condition of the south side of the facility site is firmed clay from the ground surface to a depth of 5 meters, with an N-value of higher than 15 according to penetration tests. The soil condition on the north side is sandy clay up to a depth of 4 meters, suited for construction with an N-value higher than 13. Based on these data and in view of safety consideration, the bearing capacity of the soil will be set at 5 tons/m².

The foundation will be made of concrete continuous footing and the direct foundation method will be used. The structure will be a reinforced concrete block construction and it will have a roof truss made of light-weight steel. The corner of the wall will be made of reinforced concrete. Building standards established by the Architectural Institute of Japan will be employed in the structure design.

Based on the data obtained from the survey on natural conditions, the following structural design conditions will be used.

a) Wind load

Standard for monsoon areas: 35 m/s.

b) Earthquake load

Earthquake load will not be taken into consideration since no earthquakes have been recorded in the surrounding areas of Kitwe.

4) Building equipment plan

a) Electricity

Electric power will be supplied to each building through a transformer attached to a pole in the facilities after it is reduced to 230V from ZESCO's overhead power cable of a single phase 3-line 11 kVA. The existing transformer has a capacity of only 50 kVA, and is required to be constructed to have an increased capacity of 100 kVA. Voltage will be 380V to 230V.

The number of lighting and outlet fixtures will be kept to a minimum as in the existing facility to keep the maintenance cost at its present low level.

The estimated capacity of electricity is shown in Table 9.

Table 9 Estimated Electricity Requirement

Facility	Power Purpose	Area x Requirement (VA/m ²)x Efficiency x Use Rate
Research/admin.	Lighting; outlet	434 x 20 x 0.8 x 0.4 = 2,777.6(W) 3.0KW
Accommodation House	Lighting; outlet	264 x 20 0.8 x 0.5 = 2,112 2.0KW
Well, pump	Underwater pump	1.5KW

The total load of the transformer will be 25 kVA, within safe limits in consideration of changes in voltage.

b) Water supply and sewage facility

- Water supply facility (a well, 70 m deep, and an elevated water tank, 15 m high, capacity 10 tons)

Water will be pumped from a well to an elevated water tank and supplied to all facilities by gravity flow.

- Sewage facility

Waste water will be discharged into a drain where it will be treated by a septic tank and infiltrated into the ground. Chemical waste water from the laboratories will be collected by a special sink into a container for dilution.

Rain water will not be collected in any special tank or drainage canal, but will be absorbed through the gravel.

c) Ventilation

Ventilation equipment will be installed in the toilet, shower room, kitchen, etc., since air conditioners will not be installed.

d) Lightning rods

Lightning rods will be installed due to frequent lightning in Zambia.

5) Building/finishing materials

Basic building and equipment materials are produced in Zambia. Other materials manufactured in South Africa or Zimbabwe can also be procured in Zambia. However, some of the materials may not be of best in quality.

In principle, locally supplied building and finishing materials will be used, as well as local work methods.

The finishing work of buildings is outlined in Table 10.

Table 10 Finishing Work of Building

Item	Finishing Work	Remarks
Exterior finish		
Roof	cement roof tile	local method of work
External wall	paint on mortar	local method of work
Floor	terrazzo tile, mortar trowel	local method of work
Doors, windows	aluminum sash, steel, wood door	local method of work
Interior finish		
Floor	terrazzo tile	local method of work
Wall	paint on mortar	local method of work
Ceiling	board for ceiling, paint	local method of work

(3) Equipment Plan

1) Overall plan

a) Vehicles

Vehicles at the station are used to transport fingerlings, adult fish, fish feed and ingredients, equipment, etc.

Presently, the Mwekera Aquaculture Station has one four-wheeled drive vehicle and one truck provided by MPTC, and hence such vehicles are excluded in this project. A mini-bus, which was requested as a personnel transportation, seems to be unnecessary, considering the scale of the project. As for a requested pick-up truck, the truck provided by MPTC can be used. Therefore, the vehicle supply requested is excluded from this project.

b) **Laboratory equipment**

Laboratory equipment for seed production, grow-out technology, feed production, etc. are included.

All instruments which will be provided in the project are basic experimental and research equipment. Two sets of dissection kit will be supplied by MPTC and are considered adequate in number. In addition, MPTC will furnish two chemical cupboards: one in the laboratory and the other in the feed plant. The protein analyzer and the freezer for storing samples have been deemed in little need judging from the present research/experiment levels. The conductivity meter will not be provided in this project since the water quality checker which will be supplied by MPTC can be used for the same purpose. Desks and chairs have been excluded from the project since they can be provided by the Zambian side. The quantity of laboratory glassware will be determined on the basis of use frequency and damage. The universal projector has been excluded from the project since there is presently one universal projector in the station.

c) **Feed manufacturing equipment**

Feed manufacturing equipment includes manufacturing and processing equipment for the study of artificial feed development, development of mass-production techniques, extension of feeding culture, etc. for common carp and tilapias.

The station presently manufactures moist pellets using a pulverizer and a pelletizer, and plans have been underway since 1996 to market feed to private fish farms and farmers engaged in fish culture. The Mwekera Aquaculture Station is the country's only domestic feed manufacturing facility, and its role as a pilot plant for the expansion of feed production is very important. However, the volume of demand and market outlet are as yet unknown at this time and it is still premature and untimely to increase equipment and manufacturing volume.

d) **Survey equipment**

Survey equipment includes land surveying equipment, scales for weighing fish, and water analysis instruments for surveying existing and new production ponds, rivers, lakes and wetland.

One portable water quality checker will be provided by MPTC although three were initially requested. The number is considered sufficient to meet the needs of the station if the instrument is used efficiently, despite the fact that the instrument will be in frequent use and plural survey teams work concurrently. There seems to be little need for chemical oxygen demand (COD) and biological oxygen demand (BOD) meters in the activities carried out by the station at present. Surveying equipment requires specialized technical

knowledge in their usage, and since there is no technician with such knowledge employed in the station, they have been excluded from this project.

e) Other equipment

The category of other equipment includes fish tanks for transporting live fish, radio communication equipment, office equipment, and other administrative equipment.

It has been decided that two fish tanks will adequately meet the station's needs in view of past data of seed distribution quantity. Video equipment and a book binding machine requested for use in training and extension activities will not be provided in this project, since their use is minimal. Beds and mattresses have also been excluded since they can be provided by the Zambian side. A copier and computer have already been provided by MPTC and adequately meets the station's current needs.

f) Darkroom equipment

Darkroom equipment includes equipment which will enable the station to develop photographs taken in their laboratory and research surveys. However, darkroom equipment will be excluded from this project as the volume of photographed film generated in the station is still minimal.

g) Meteorological observation equipment

Requested meteorological observation equipment is general weather survey instruments such as air temperature and humidity recorder, aneroid barometer, anemometer, rain gauge, etc.

Presently, the Mwekera Aquaculture Station does not possess any meteorological observation equipment, and a rain gauge meter, etc. used in the station are handmade instruments which have been made by the specialist dispatched to the station. In view of such present conditions, meteorological observation equipment will be provided as it is considered essential for gathering basic weather data.

(4) Basic plan

1) The basic plan for civil works is given in Table 11.

Table 11 Basic Plan for Civil Works

Civil Facility		Facility Scale
1. Water supply/drainage facility		
• Intake valve	Replacement of valves	8" diameter of South African-made
• Main water supply canal	Overall improvement L = 905 m	Reinforced concrete structure 0.6 m x 0.6 m Reinforced -concrete lid to be installed 130 m up the cross sectional work
• Tributary supply canal	Development with that of the ponds L = 429 m	Reinforced concrete structure
• Main drainage canal	Unlined, cross-sectional rehabilitation L = 1,507 m	Lined with gabion mat
• Tributary drainage canal	Development with that of the ponds	Reinforced concrete structure
• Overflow canal	Enlargement of cross section and other improvements L = 982 m	Lined with gabion mat
2. Aquaculture ponds		
• Experiment ponds (concrete side walls)	25 m x 30 m x 14 ponds = 10,500 m ² 20 m x 12.5 m x 16 ponds = 4,000 m ²	Not included in this project Jointly developed with supply/drainage canals and maintenance roads
• Production ponds (unlined)	72 m x 34 m x 14 ponds = 34,272 m ²	Improvement of the ponds on the west side jointly with the development of water supply/drainage canals and maintenance roads (production ponds)
• Spawning ponds	Three ponds = 60 m ²	
• Sedimentation ponds	72 m x 34 m x 1 pond = 2,448 m ² (67.5 + 34.5) x 67.5/2 x 1 pond	Improvement of the ponds on the west side = 3,443 m ²
3. Access roads in the station		
	Access roads, L = 1,057 m	Asphalt pavement: W = 3.5 m
	Maintenance roads, L = 3,207 m	Easy pavement: W = 3.5 m

2) The basic plan for construction facilities is given in Table 12.

Table 12 Basic Plan for Construction Facilities

Facility	Floor Area (m ²)	Remarks
Research/administration building	362	The office is dependent on the number of users.
Accommodation House	176	2 rooms for researchers/administrative staff
Generator shed	18	10KVA generator
Total	556	-----

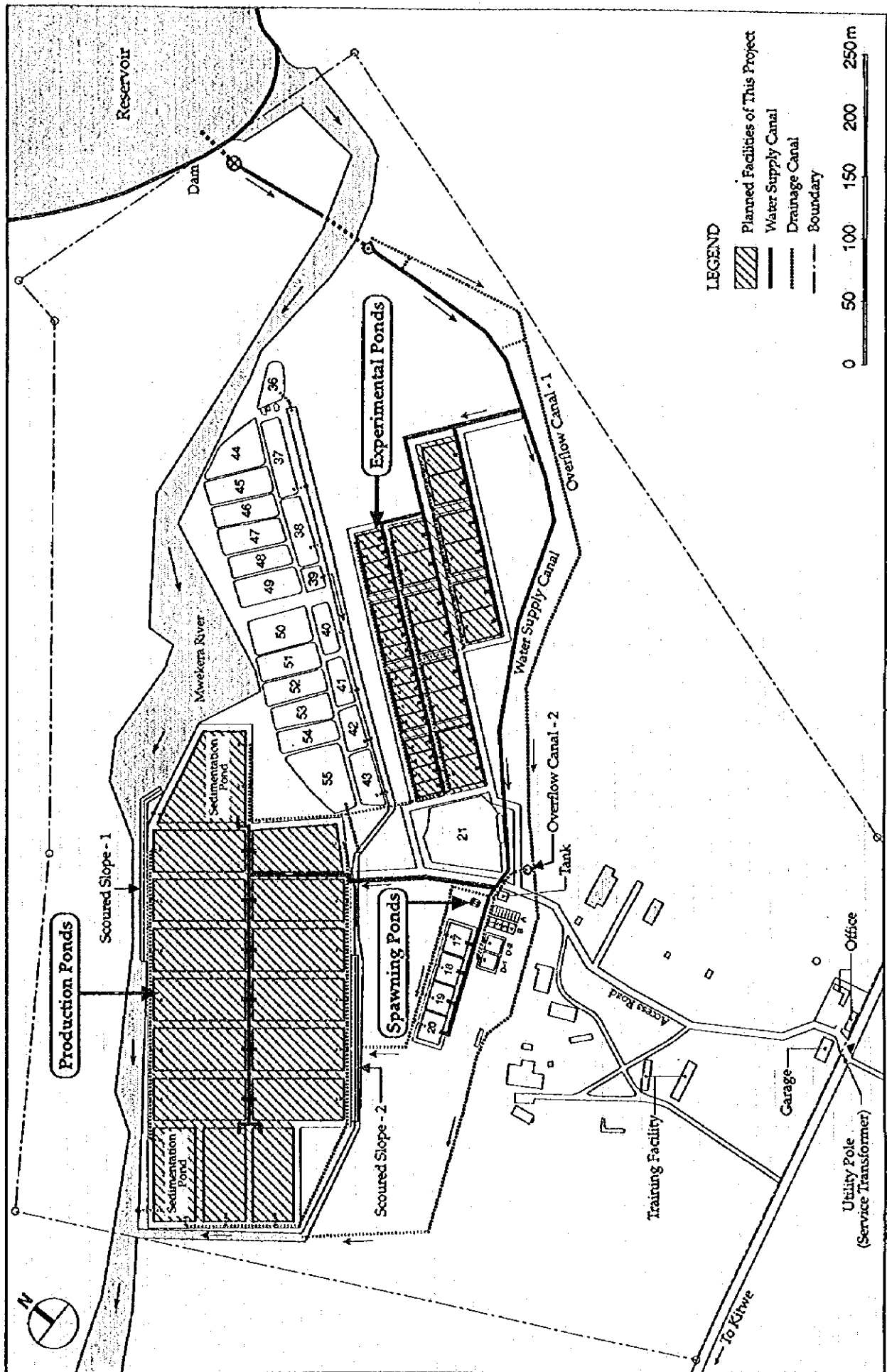
3) The basic plan for equipment is given in Table 13.

Table 13 List of Planned Equipment

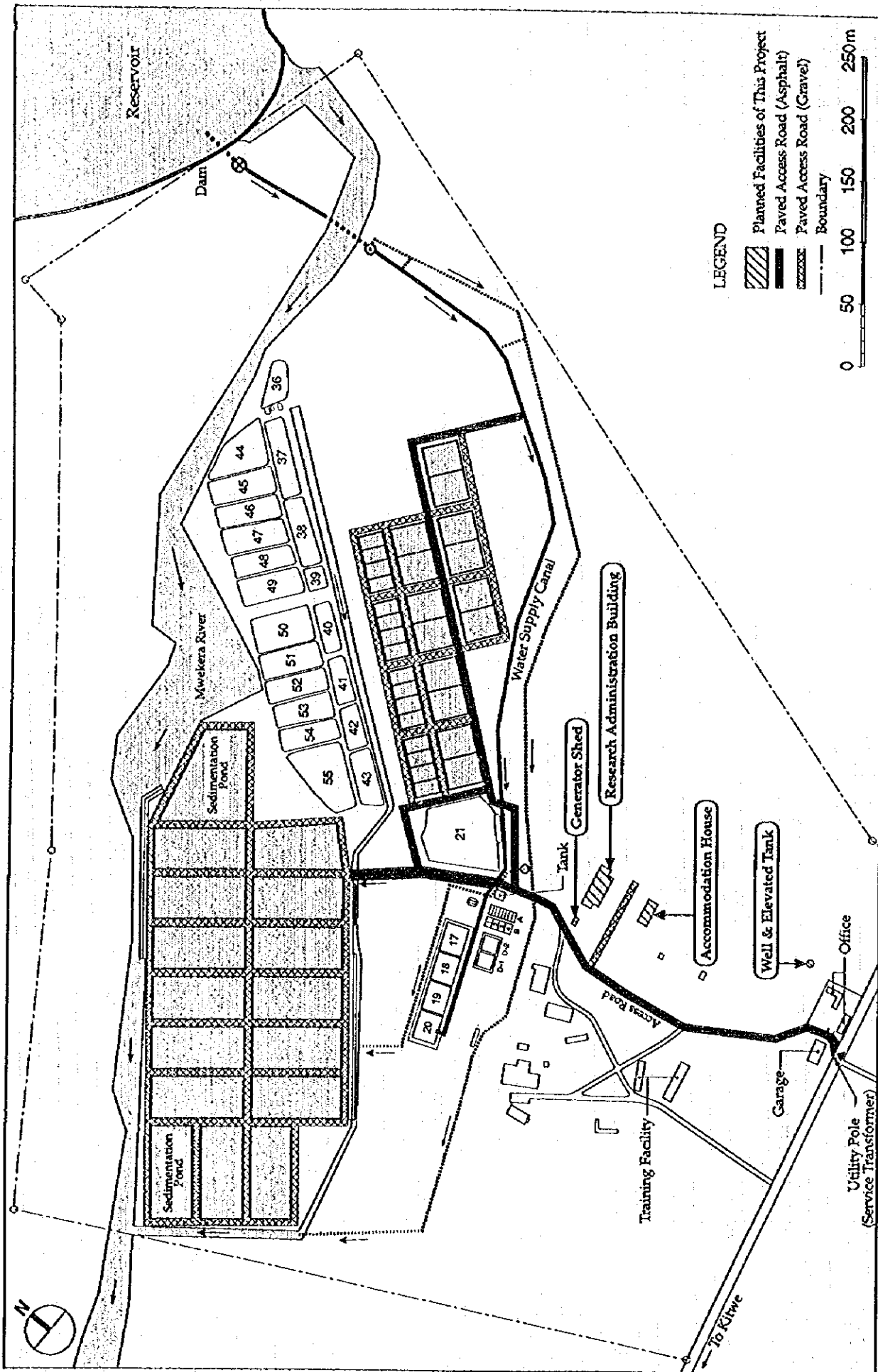
No.	Item	Unit	Quantity	Use	Specification
1. Laboratory equipment					
1	Laboratory mill	1	1	Mixing, pulverizing test material	60-100rpm, AC220V
2	Hand meat chopper	1	1	Mixing, pulverizing test material	table mounted
3	Blender	1	1	Mixing test material	2L, 2,000rpm
4	Refrigerator for storing samples, 300L	1	1	Storing test material, specimens, chemicals	two door type
5	Flask, 2000ml	1	5	"	glass
6	Flask, 1000ml	1	3	"	"
7	Flask, 500ml	1	20	"	"
8	Flask, 100ml	1	15	"	"
9	Flask, 50ml	1	15	"	"
2. Survey Equipment					
1	Transparency plate		2	Measure turbidity, depth	30cm diameter, 30cm pull rope
2	Body length measurement plate		3	Measure length of fish	scale of 0-50cm
3	Spring top-pan scale, 0-10kg	1	3	Weighing breeders, etc.	smallest unit of measure 0.1kg
3. Meteorological observation equipment					
1	Aneroid barometer				scope of 685-785mmHg
	U type maximum/minimum thermometer				measuring range of -20C to +50C
	Thermometer				-10C to +50C, 0 to 100%
	Anemometer				16 directions, velocity 2 to 70m/sec
	Rain gauge				measuring range of 0 to 50mm
2	Instrument screen shelter with legs	1	1		4 simple steel legs
4. Other equipment					
1	Insulated fish tank, 1000L	1	2	Transporting fingerlings, broodstocks	made in FRP, with a lid

(5) Basic design

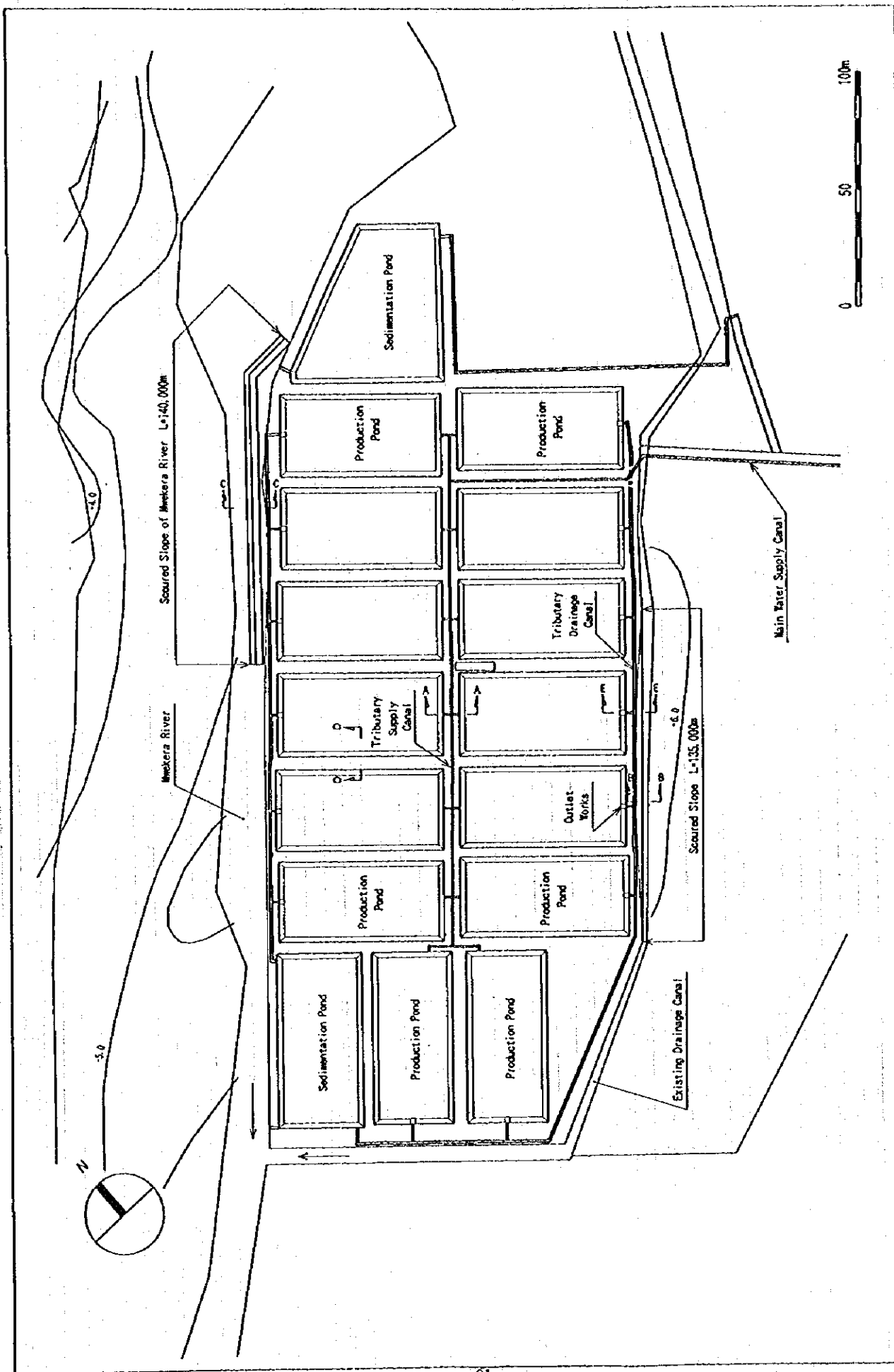
The basic design drawings are attached hereto:



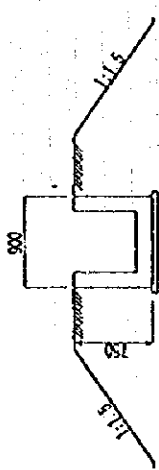
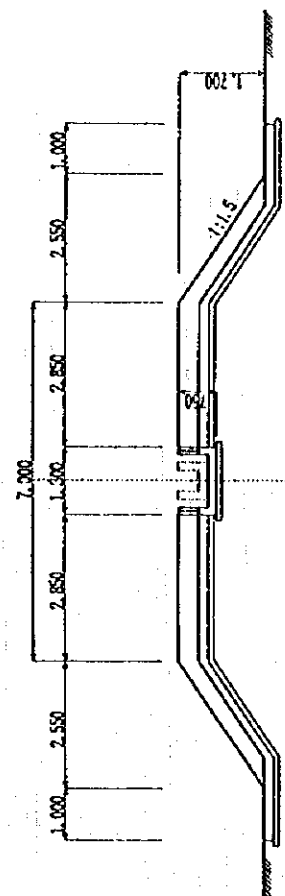
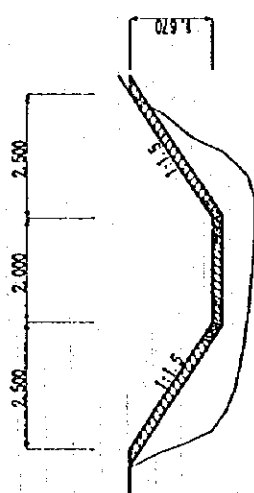
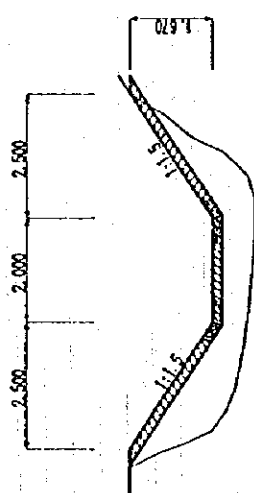
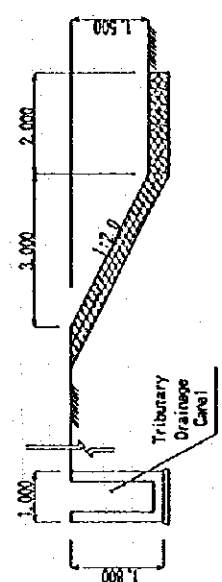
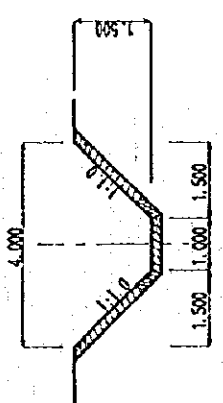
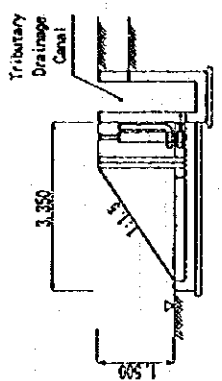
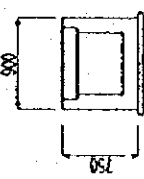
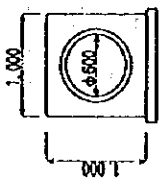
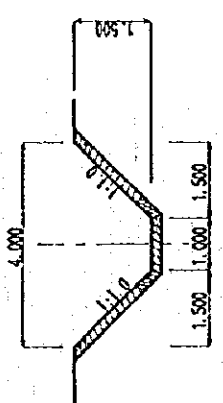
Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station In the Republic of Zambia	General Plan of Facilities (1)	Title
--	--------------------------------	-------

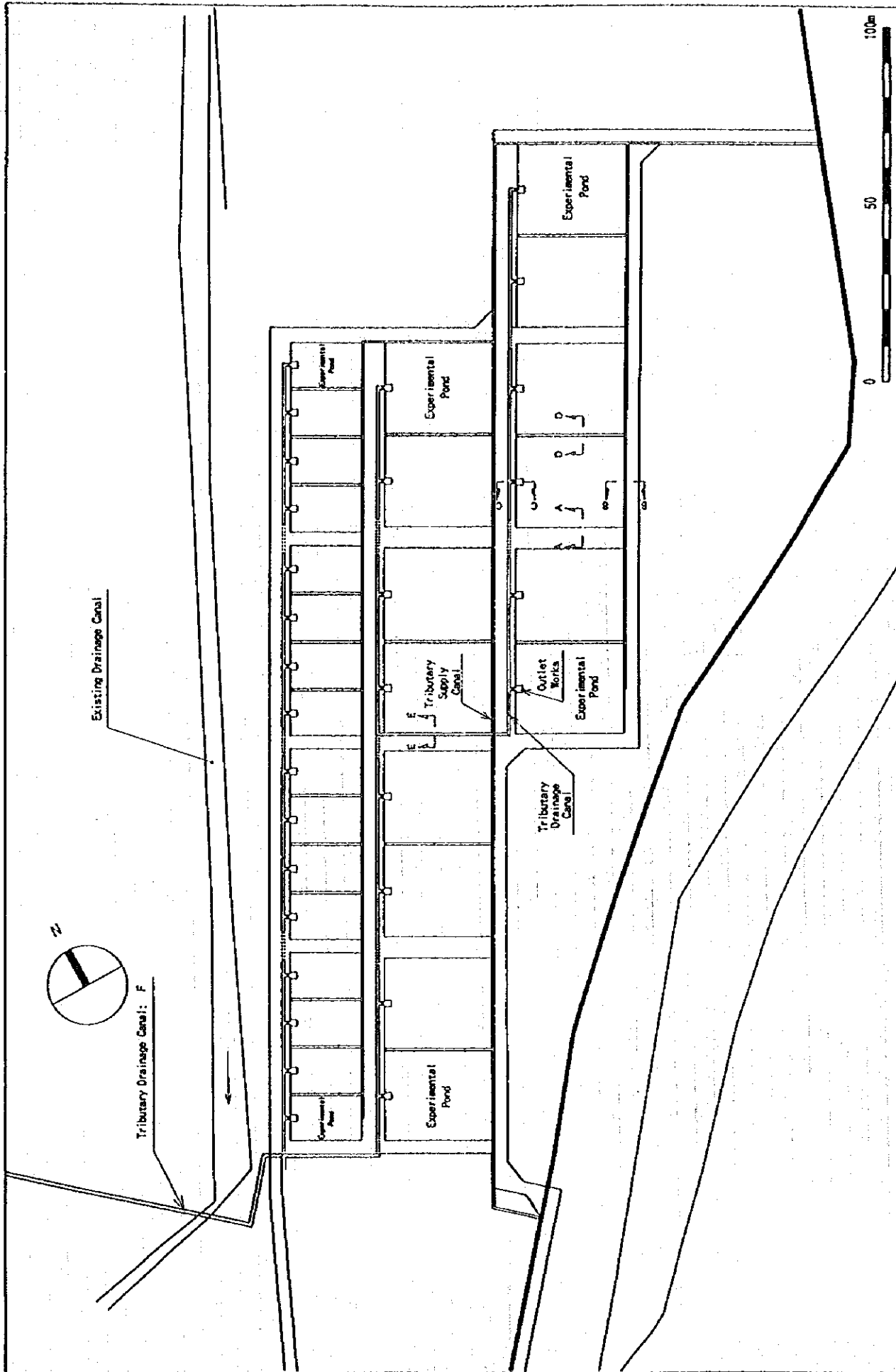


Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia	General Plan of Facilities (2)	Title
--	--------------------------------	-------

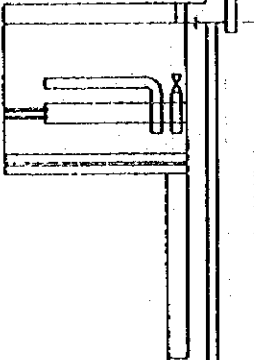
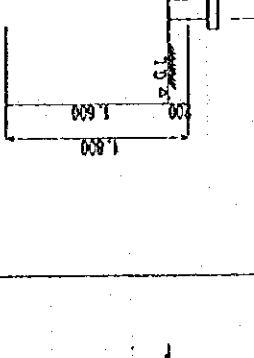
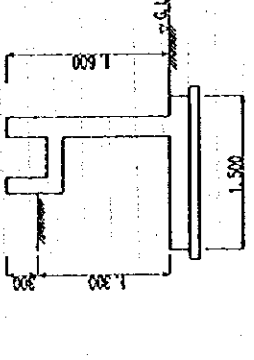
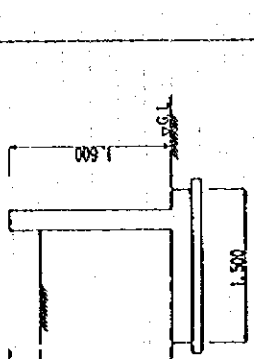
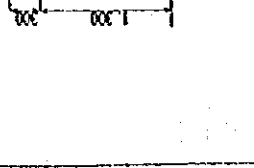


Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia	Layout of Production Ponds	Title	Scale 1 : 1,500
--	----------------------------	-------	-----------------

Common Facilities	Production Pond	Tributary Supply Canal and Side Wall	Tributary Supply Canal and Side Wall	Scored Slope	Scored Slope of Mwekera River	Outlet Works	Profile and Cross Section of Common Facilities and Production Pond
 <p>Main Water Supply Canal S = 1 : 50</p>	 <p>Section A-A S = 1 : 100</p>	 <p>Section B-B S = 1 : 100</p>	 <p>Section D-D S = 1 : 100</p>	 <p>Section C-C S = 1 : 100</p>	 <p>Section E-E S = 1 : 100</p>	 <p>Section E-E S = 1 : 100</p>	<p>Scale 1 : 50, 1 : 100</p> <p>Title</p> <p>Profile and Cross Section of Common Facilities and Production Pond</p>
 <p>Tributary Supply Canal S = 1 : 50</p>	 <p>Profile of Road Crossing Works for Tributary Drainage Canal S = 1 : 50</p>	 <p>Profile of Overflow Canal S = 1 : 100</p>	<p>Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia</p>				



Scale 1 : 1,000	Title	Layout of Experimental Ponds	Basic Design Study on the Project for Upgrading of Mosikera Aquaculture Station in the Republic of Zambia
-----------------	-------	------------------------------	---

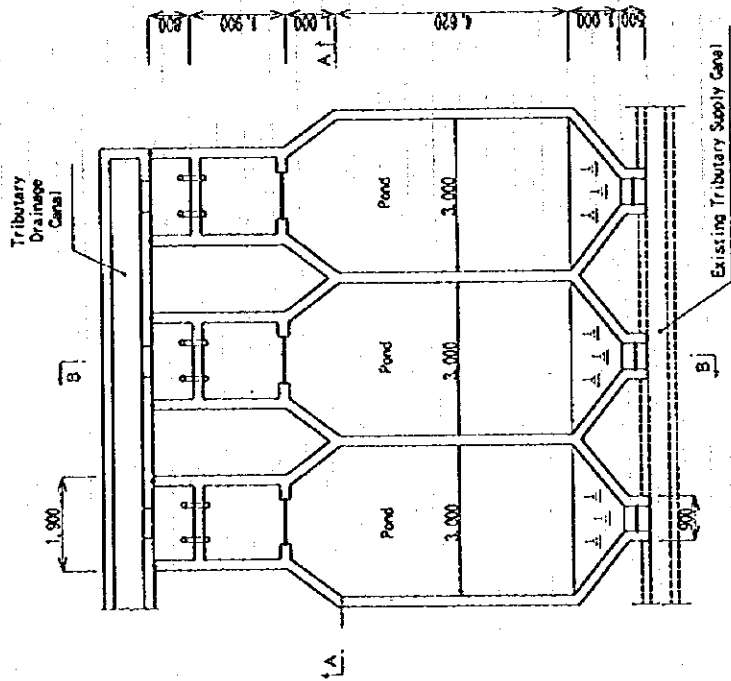
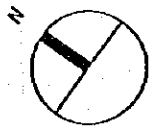
 <p>Side Wall Section A-A</p>	 <p>Side Wall Section B-B</p>	 <p>Side Wall Section D-D</p>
 <p>Side Wall Section E-E</p>	 <p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>
<p>Side Wall Section A-A</p>	<p>Side Wall Section B-B</p>	<p>Side Wall Section D-D</p>
<p>Side Wall Section E-E</p>	<p>Outlet Works Section C-C</p>	<p>Profile of Tributary Drainage Canal: F</p>

Basic Design Study on the Project for Upgrading of
Mankera Aquaculture Station
in the Republic of Zambia

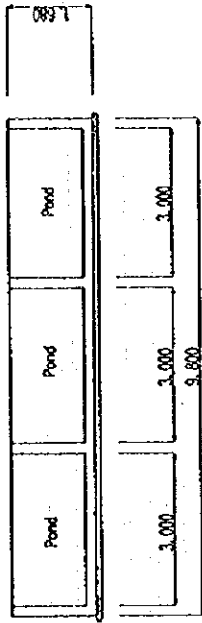
Profile and Cross Section of
Experimental Pond

Title

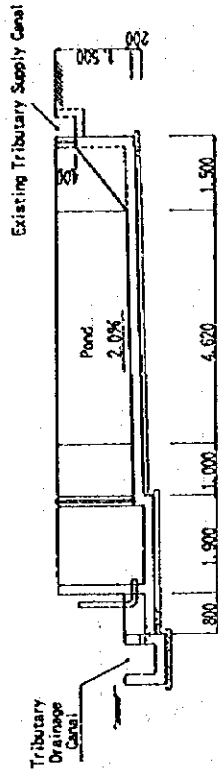
Scale 1 : 50



Layout of Spawning Pond



Section A-A

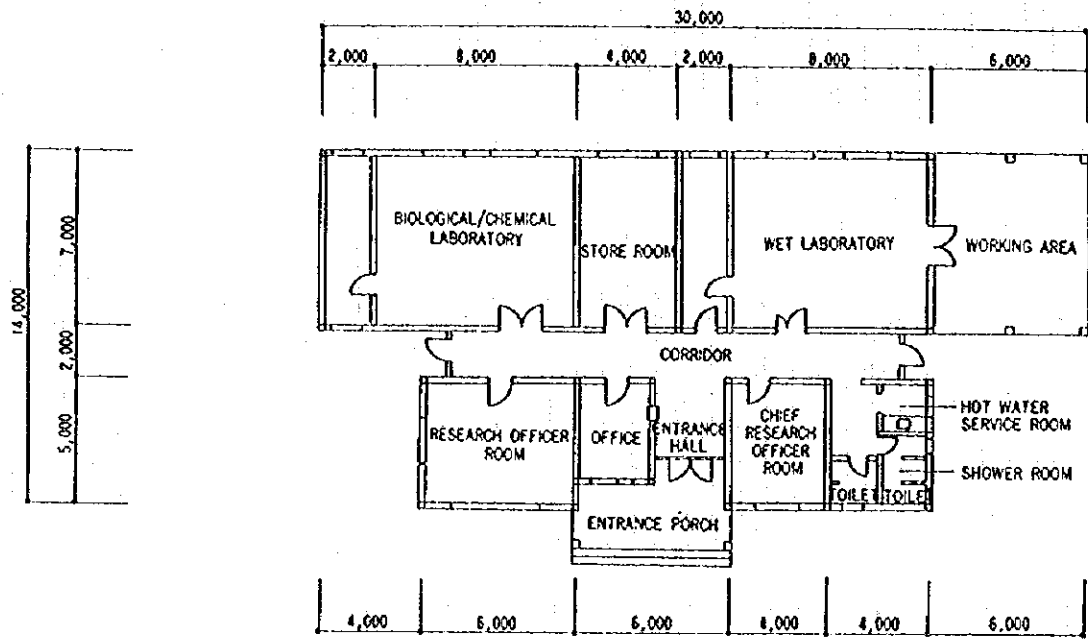


Section B-B

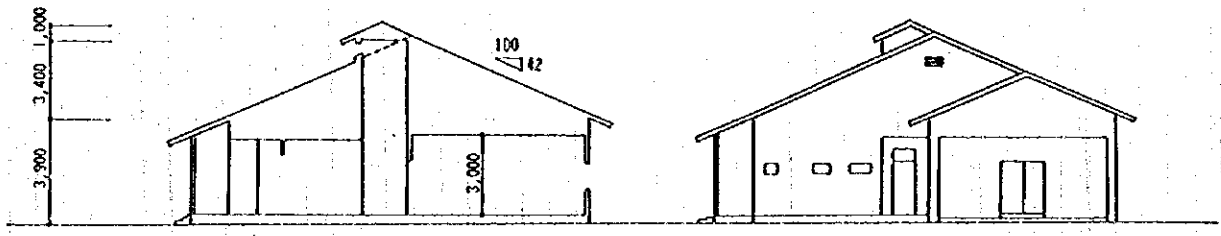
Scale 1 : 100

Title Plan and Profile of Spawning Pond

Basic Design Study on the Project for Upgrading of
Mwaka Aquaculture Station
in the Republic of Zambia

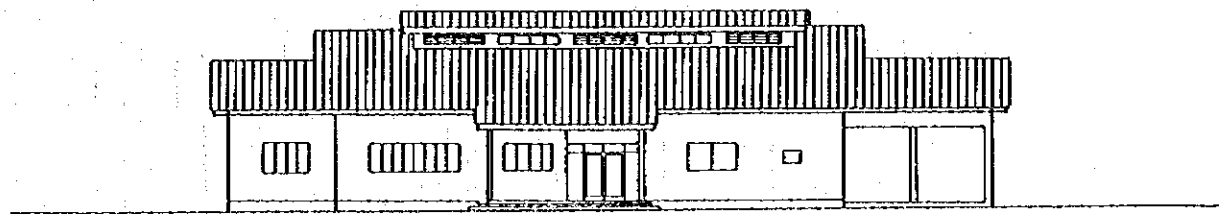


RESEARCH ADMINISTRATION BLDG. PLAN

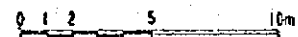


SECTION

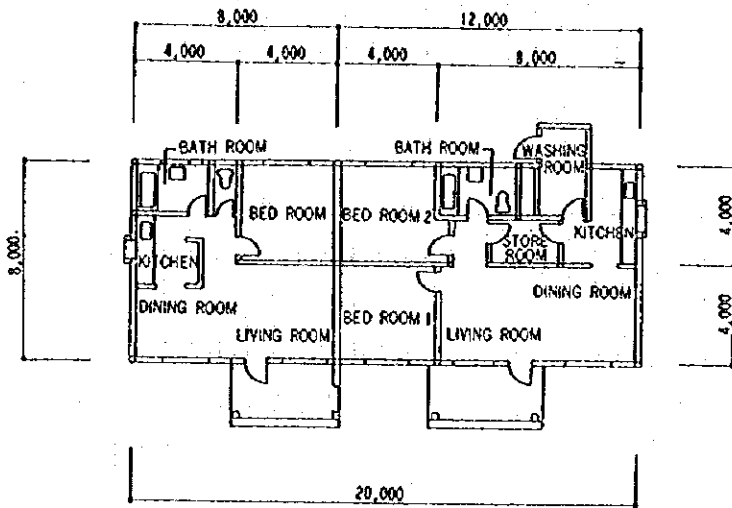
EAST ELEVATION



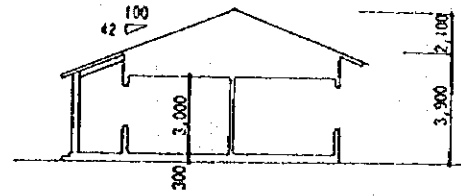
SOUTH ELEVATION



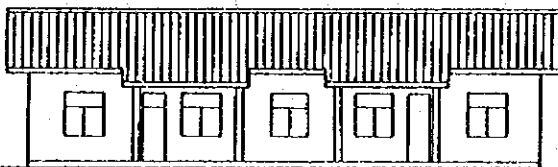
	Title	RESEARCH ADMINISTRATION BLDG.	Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia
--	-------	-------------------------------	--



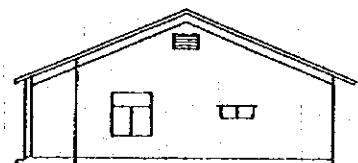
ACCOMMODATION HOUSE PLAN



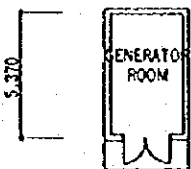
SECTION



SOUTH ELEVATION



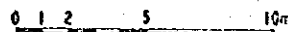
EAST ELEVATION



GENERATOR SHED PLAN



SECTION EAST ELEVATION SOUTH ELEVATION



	Title	ACCOMMODATION HOUSE GENERATOR SHED	Basic Design Study on the Project for Upgrading of Mwekera Aquaculture Station in the Republic of Zambia
--	-------	---------------------------------------	--

2.4 Project Implementation Plan

2.4.1 Organizations

(1) Department of Fisheries

Of the 7,090 personnel members employed by the Ministry of Agriculture, Food and Fisheries, 885 employees work in the Department of Fisheries (462 full-time government employee and remaining part-time staff). Officers classified as researchers are mainly university graduates from the fisheries course of the Natural Resource Development College, the Department of Zoology of Zambia University, National Aquaculture Development Center or Kasama Fisheries College; two or three graduates from these institutions are recruited every year with the objective of strengthening the technical side of the department.

The Mwekera Aquaculture Station, with a staff of 31 members, falls under the jurisdiction of the Aquaculture Division of the Department of Fisheries, which is staffed by 148 personnel (of which 49 are full-time officers).

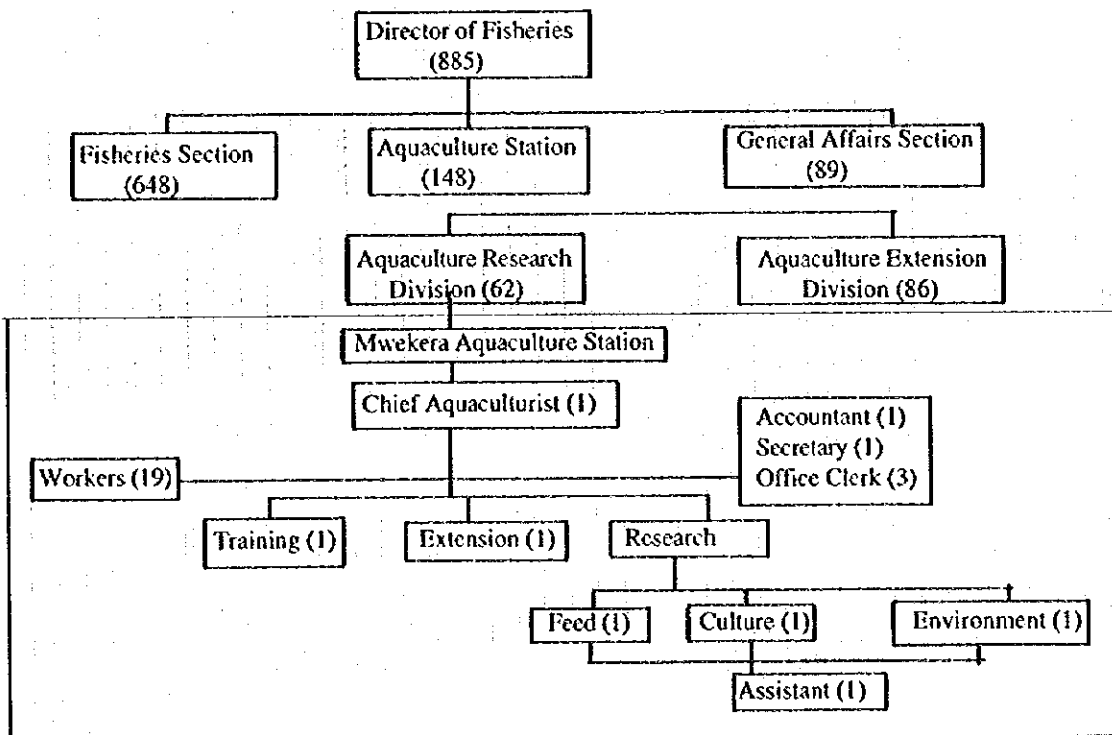


Fig. 4 Existing Organizations of Department of Fisheries

In conjunction with the administrative reform recommended by the World Bank, the Ministry of Agriculture reviewed a plan to dismiss 2,000 government employees last year, but no specific action had been taken by the time of this survey. As of January 1996, Cabinet approved a measure to reorganize the following 4 departments from a vertical to parallel ranking, which will be put into effect in August after an official notice in July. If this measure is implemented, the parallel reorganization will basically consist of the following departments.

1. Research & Specialist Service Department
2. Field Services Department
3. Human Resources & Administration Department
4. Economics & Market Development Department

Based on these changes, the Department of Fisheries, which is the implementing agency of this project, will be reorganized into the following two sections: 1) Fisheries Extension Section, Field Services Department; and 2) Fisheries Section, Research & Specialist Service Department. There is a high probability that the Mwekera Aquaculture Station, along with the Chilanga and the Misamfu Aquaculture Stations, will be placed under the management of the Research & Specialist Service Department, while the remaining national aquaculture stations will assigned to the Fisheries Extension Section in the Field Services Department.

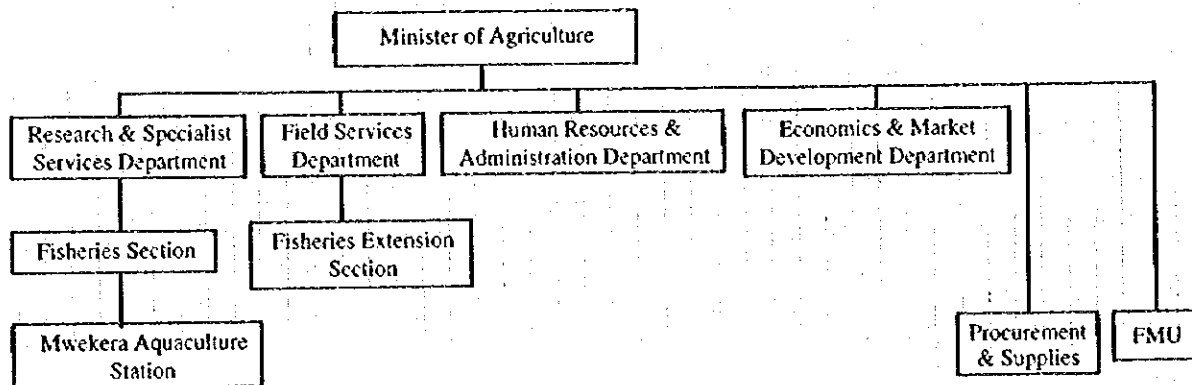


Fig. 5 Reorganization Plan of the Ministry of Agriculture, Food and Fisheries

(2) The Mwekera Aquaculture Station

Measures to privatize respective government institutions are being pursued, in connection with these administrative reforms. However, the Mwekera Aquaculture Station, which has been designated as the National Aquaculture Research and Development Centre by ASIP, will not be privatized.

2.4.2 Budget

With regard to budget allocation for the Department of Fisheries, ASIP budget of the first quarter in FY 1996 of four million Kwacha was, though delayed, disbursed in March and the budget of the second quarter will be disbursed in August. However, taking into consideration the situation that only 70%-80% has been allocated, the contents of operation plan should be commensurate with it.

Due to the introduction of the cash income and outgo system, the budget of FY1995 allocated for Mwekera Aquaculture Station was cut down to 60% of the previous year's. ASIP budget appropriated in FY1996 was \$1,245,400, amounted about 3.9 times as much as that of previous year. However, some of the items of expenditure appropriated are impractical ones; and final amount is expected to be around \$53,700 dollars (66.49 million Kwacha) excluding them. This would result in about 29.48 million Kwacha increase, 1.8 times as much as that of the previous year.

Increased amount required after the project implementation is 2 million Kwacha, which is expected to be 3.9% of the estimation for this year of 66.49 million Kwacha. Since this is rather small, compared to the average level of previous budget increase, it is expected that at least the budget required for future operation will be maintained after the project implementation.

The budget of the Mwekera Aquaculture Station was originally provided by two sources, the Department of Fisheries and the Department of Administrative Affairs of the Copper Belt Province. In January 1996, a new system was put into effect as part of the government's administrative reforms; and the budget is now allocated by the Finance Management Unit (FMU) in the Ministry of Agriculture and directly distributed to the Mwekera Aquaculture Station from the FMU in Kitwe City.

This prevented the possible loss that was previously collected at the account department of the Copper Belt Province and the budget allocation system has been much improved to secure allocation for the Mwekera Aquaculture Station.

Furthermore, in order to cover part of the operating fund, the Ministry of Fisheries has planned to introduce a system that allows self-management of seed sales profit as funds for the operation and maintenance of the facility. This system, the so-called Appropriation in Aid, allows application of fund from sales profit within certain limits. It has already approved by the Cabinet and its method of application is now under examination.

In 1995, sales profit of seed and market-size fish at the Mwekera Aquaculture Station was about 3 million Kwacha, equivalent to 8% of the budget for the Aquaculture Station. It is expected that this appropriation of fund will ease the financial limitation to the research.

Budget allocations for the Ministry of Agriculture, the Department of Fisheries, and the Mwekera Aquaculture Station are shown in Table 14, 15 and 16.

Table 14 Budget Allocated for the Ministry of Agriculture, Food and Fisheries

Unit: 1000 Kwacha				
FY	1992	1993	1994	1995
Zambian Government	8,260,716	13,921,014	81,501,433	96,660,284

Table 15 Budget Allocated for the Department of Fisheries

Unit: 1000 Kwacha				
FY	1992	1993	1994	1995
Zambian Government	75,032 (0.9%)	263,269 (1.9%)	1,538,452 (1.9%)	1,684,298 (1.7%)

Note: (%) means the budget amount as a percentage of the budget of Min. of Agriculture, Food and Fisheries.

The budget allocated to the Mwekera Aquaculture Station is shown in Table 30. Although uniform budget increases have been provided annually, the annual inflation rate was 116% in 1993, 35.1% in 1994, and 45.5% in 1995 (Central Bank of Zambia); and the actual effectiveness of these increases is minimal.

Table 16 Budget Allocated to the Mwekera Aquaculture Station

Unit: 1000 Kwacha									
FY	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total	277	623	673	1,192	2,436	5,867	18,250	64,375	37,012

Note: Budget reduction in FY1995 was due to a system of cash income and expenditure which was introduced in FY 1995.

2.4.3 Technical Level of Personnel

The personnel staff of the Mwekera Aquaculture Station will not be reduced due to its priority ranking, and one additional researcher will be employed when this project is implemented. In preparation for its future role as NARDC in the mid and long term agricultural sector plan by ASIP, the Mwekera Aquaculture Station has requested for an additional four researchers with university degrees to increase the total number of staff researchers to eight. The Mwekera Aquaculture Station consist of three sections: 1) research; 2) extension; and 3) training. The research section, which is in charge of implementing this project, consists of three researchers in charge of feed, culture, and environment (plankton), respectively, and one technical assistant. There is a plan to increase the number of assistants to three this year. In the extension and training sections, there is one personnel in each section and two additional researchers and planned to be added this year. Therefore, there will be an adequate number of staff members capable of coping with the rehabilitated facilities brought on by this project.

(1) Technical level of researchers

The research staff at the Mwekera Aquaculture Station presently comprises three members, and an additional researcher will join the staff in 1997 (university graduate, field unassigned at present). The research staff is fully capable of fulfilling their responsibilities since research subjects are focused mainly on basic topics and the experiments are moderate in scale.

(2) Maintenance system

Personnel who are engaged in the station's maintenance, control, and operations are listed below.

1. Plumber, carpenter, auto-mechanic (electrician) *	3 persons
2. General workers	5 persons
3. Security guards	5 persons
4. Driver	3 persons
5. Cook	3 persons
<hr/>	<hr/>
Total	19 persons

(Note: *The position of (electrician) is presently vacant.)

1) Civil works

The operation and maintenance work of the civil facilities planned in this project are listed below.

- Clean the intake valve and the strainer of the Mwekera River crossing work.
- Operate the intake valve and diversion works and inspect their opening and closing functions.
- Inspect the water conveyance of the canals, check for water leakage, carry out repairs, remove mud.
- Operate and inspect the inlet and outlet works, carry out repairs.
- Inspect and repair pond walls.
- Maintain pond bed, remove bottom mud.
- Control weed around facilities.

The personnel required to implement the work listed above are as follows.

- Supervisor (accounting staff): 1 person
- Water control manager: 1 person
- Water control assistant: 2 persons
- Civil works: 3 persons
- Weeders: 5 persons

Excluding the weeders, the present staff members will be able to fulfill the work delineated above. Therefore, the personnel cost for five temporary workers to do the weeding must be allocated in order to maintain the facilities in good working conditions following project implementation.

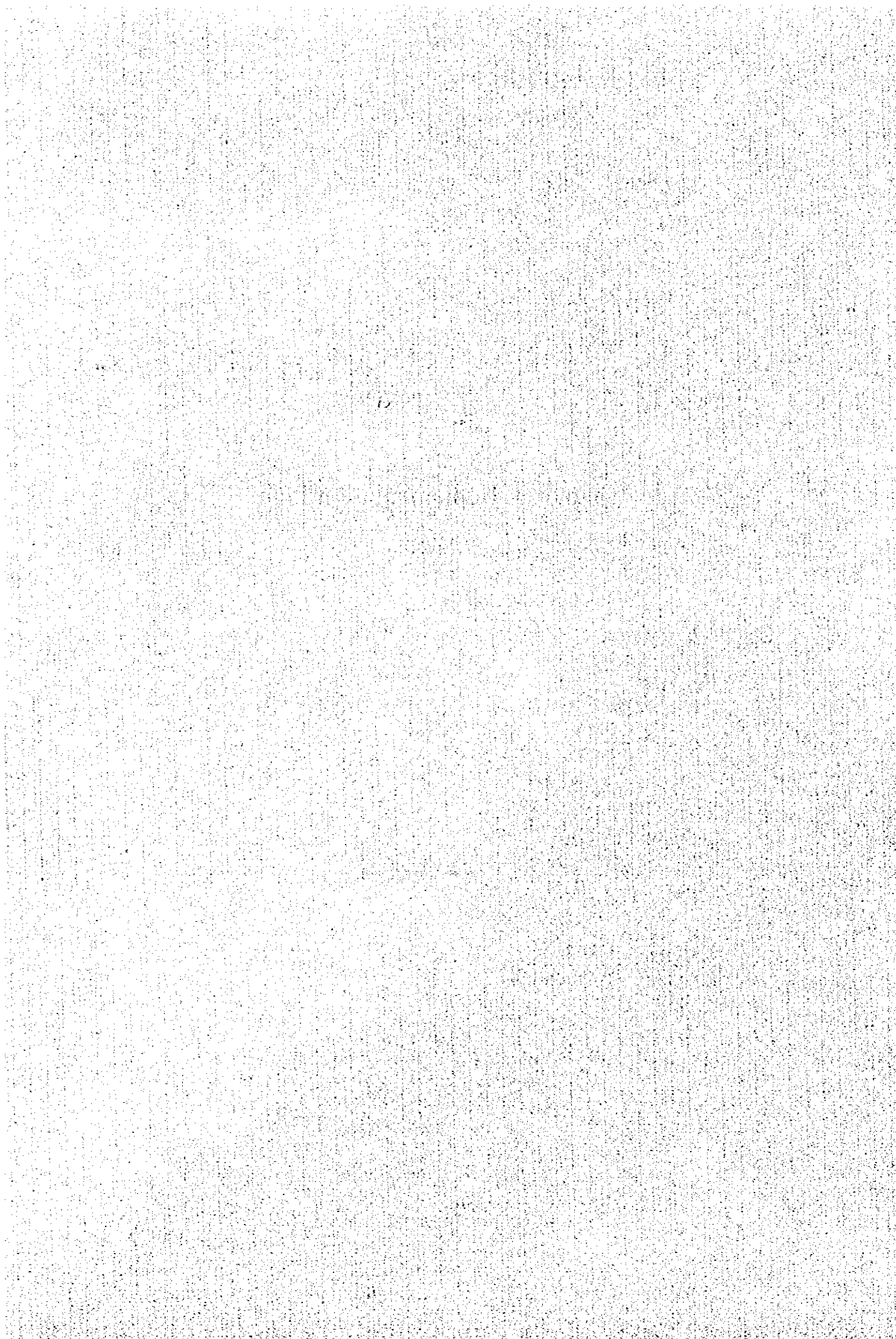
2) Construction facilities

The construction facilities were originally maintained by an electrician, a plumber, and a carpenter, but with the retirement of the electrician, the maintenance staff has been reduced to two members. Repair work for the existing facilities is divided between the staff members and the work is simple and does not require a high level of technical knowledge in general. The post of electrician has not been filled, but a replacement must be found after the project is implemented.

3) Equipment

The equipment which will be provided in this project will not require a high level of technical knowledge to operate or maintain. The majority of the equipment will generally be maintained by the individual researcher or user in their daily use of the equipment. MPTC will be overseeing the transfer of technical knowledge pertaining to equipment to the researchers. Presently, the mechanic, the plasterer, and the plumber are in charge of operations and maintenance of the equipment. Although none of these three personnel have received a high level of technical education, they are fully capable of handling the planned equipment, due to their skills and knowledge based on practical experience.

Chapter 3 Implementation Plan



CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The Department of Fisheries in the Ministry of Agriculture, Food and Fisheries, which is the implementing agency of this project, has not had prior experience in the implementation of a Japanese government grant aid project. In view of this, the Department of Fisheries will be advised on matters pertaining to the burden of construction on the Zambian side, convenient provisions, payment procedures, etc. based on an exchange of opinions with the JICA office in Zambia or the Japanese Embassy.

If the construction work involving these two components are supervised with great care, it is possible to employ local consultants and construction workers without sending Japanese technicians to Zambia for special works.

The agency responsible for project implementation on the Zambian side is the Ministry of Agriculture, Food and Fisheries.

Considering that this project is a grant aid project from the government of Japan, it will be implemented according to the following policy.

3.1.2 Implementation Conditions

- (1) Although a high level of technical skills is not required in the construction work of this project, one special feature is the use of the gravity scheme in the water supply and drainage facilities, as a means of reducing the operation and maintenance costs of production ponds. The most important facets of the construction work are the layout of the production ponds and water supply and drainage canals, effectively utilizing the general slope of the site.
- (2) The content of the construction work will be based completely on the implementation period, content, etc. delineated in the Exchange of Notes (E/N) signed and exchanged between the two governments.
- (3) Present research work and seed production activities by MPTC at the project site will be carried out until August 1996. A construction plan with minimal interference of these activities will be drawn up. In addition, great attention will be paid to the inflow of drainage water, vibration, noise, etc. which may occur during construction work, since stable water quality must be maintained for experiments and seed production activities.

- (4) The wet season in Zambia usually occurs from December to May; and the finishing and exterior structural work will not be carried out during this season.
- (5) The project site is located adjacent to the Department of Forestry; and the water supply canal will be installed nearby. Therefore, the border of the station's site will be confirmed with the attendance of officers from both the Departments of Fisheries and Forestry.
- (6) The foundation of the project site is mainly made up of a layer of clay in which consolidated settlement occurs easily. A sinking foundation will greatly damage the facilities. Therefore, sufficient compaction must be carried out during construction.

3.1.3 Scope of Works

The works which the government of Zambia will be responsible for implementing in this project are as follows.

- (1) Confirmation of the land rights of the project site and its boundaries, procurement of the site, and preparation work for construction work such as hiring weeders, etc.
- (2) Payment of bank commission fee for the foreign exchange bank in Japan.
- (3) Operational changes and reduction due to temporary transfer of cultured fish in conjunction with construction work implemented by the Japanese side.
- (4) Tax exemption and customs clearance
- (5) Preparation of construction licenses/permits.

In conjunction with the construction work which the Zambian side is responsible for implementing, the Japanese side will inform the Zambian side of rough cost estimates, the time when they must be paid, the required procedure on matters pertaining to budget procurement, etc. The division of work which will be implemented by the Zambian and Japanese sides are shown in the table below.

Table 17 Division of Works

	Area of Responsibility	Japan	Zambia
1.	Confirmation of land ownership rights and boundaries of project site		○
2.	Preparatory work such as weeding, etc.		○
3.	Changes/reduction of function, i.e. temporary transfer of cultured fish, etc., due to construction work by Japanese side.		○
4.	Application for permits pertaining to construction work		○
5.	Construction work (civil works facilities, construction facility)	○	
6.	Materials, equipment (procurement, installation)	○	
7.	Import and customs clearance		
	a. Sea transport to Zambia and domestic transport	○	
	b. Tax exemption and custom clearance formalities		○
8.	Banking Arrangement (B/A) for foreign exchange with Japanese bank, payment of fees		○
9.	Complete formalities for convenient entry/departure and stay for relevant Japanese personnel engaged in the project in Zambia.		○
10.	Effective and appropriate implementation plan for equipment and facilities provided by grant aid cooperation		○
11.	Expenditures for construction of facilities, transport of equipment and furniture, installation that are not included in the grant aid cooperation project		○
12.	Tax exemptions for all internal tax, including VAT for payment of materials, equipment, and services made by contractors and equipment procurers in Zambia.		○

3.1.4 Consultant Supervision

The basic policy of consultant supervision and the important points which were considered are delineated below.

- (1) In order that new equipment may be purchased and installed smoothly and the construction work carried out efficiently, the consultants will carry out meticulous adjustments with the Department of Fisheries, especially when the Zambian side transfers the cultured fish from zone C where the construction work will begin, to zone A. The construction work must be implemented efficiently according to the work plan, since the spawning season of common carp is from August to October and harvesting activities are carried out from November to December. The commencement of construction work will be decided following comprehensive adjustments with the Zambian side and MPTC.
- (2) Prior to the start of construction work, the implementation and construction plans submitted by the contractors will be evaluated comprehensively, and the appropriateness of the provisional and progress plans, the quality of the proposed equipment, construction

method, etc. will be reviewed.

- (3) The completed work will be inspected and confirmed to see that it conforms to the blueprints; and appropriate revisions, etc. will be given if so required.
- (4) This project will be divided into the three areas of civil works, construction work, and equipment provision. Dispatch of technical personnel for each area will be conducted efficiently and without waste of time.

3.1.5 Procurement Plan

(1) Procurement of Construction Materials/Equipment

Construction materials, excluding the aggregate, which can be supplied from Kitwe City are cement, form, brick, and roofing materials. The aggregate will be supplied from Ndola City, 40 km away. Facility equipment and other materials which are not manufactured in Zambia will be procured from the neighboring South Africa. Basic construction materials and equipment will be supplied from the following areas.

Table 18 List of Construction Materials and Equipment

	Item	Source of Procurement
1	Cement	Ndola, domestically manufactured cement
2	Aggregate	Ndola
3	Reinforcement, steel frame	South Africa, due to lack of domestically manufactured items
4	Form	South Africa, due to inadequate quality of domestically manufactured items
5	Aluminum sash	South Africa, due to lack of domestically manufactured items
6	Concrete block	Local supply
7	Roofing material	Domestically manufactured slate wave shingle
8	Valves, pipes	South Africa, due to inadequate quality of domestically manufactured items
9	Light fixtures	South Africa, due to inadequate quality of domestically manufactured items

(2) Transport Route

The majority of the materials and equipment will be supplied from Kitwe and Ndola cities and South Africa. The procurement plan will include overland transport for materials and equipment which will be supplied from South Africa, since the site is located 500 km from Lusaka, the capital.

The overland transport route of materials and equipment will start from Johannesburg (South Africa), and travel through Parare (Zimbabwe), Chirundu, Bota (border of Zambia and Zimbabwe), Lusaka, and Kitwe (project site).

A part of the equipment which will be supplied from Japan will be unloaded in Durban, South Africa and transported to the project site using the same overland route explained above.

3.1.6 Implementation Schedule

Table 19 Project Implementation Schedule

Month		1	2	3	4	5	6	7	8	9	10	11	12
Detailed design (4.5 Month)	Field Survey	■											
	Design	▬	▬	▬	▬	▬							
Construction (12.0 Month)	Field Survey	■											
	Preparation	▬	▬										
	Temporary Work		▬	▬	▬								
	Earth Work			▬	▬	▬	▬	▬	▬	▬			
	Concrete Work				▬	▬	▬	▬	▬	▬	▬		
	Building Work				▬	▬	▬	▬	▬	▬	▬		
	Elec. & Mech. Work								▬	▬	▬	▬	▬
Equipment	Access Road Work							▬	▬				
	Production	▬											
	Transportation		▬	▬									
	Installation												■

Legend:

- ▬ Work in Japan
- Work in Zambia

When a Japanese government grant aid project is implemented after the signing of the E/N, tender documents are drawn up, followed by tender and contract for construction work and equipment procurement, construction work, and equipment procurement and installation. The implementation schedule of the project is outlined below.

(1) Implementation design

Based on the basic design survey report, the implementation schedule and tender documents will be drawn up. This process will take approximately 2.5 months.

(2) Tendering

Following the completion of the project implementation schedule, advertisements to recruit construction companies and equipment procurers who are qualified to bid for this project in Japan will be published. The qualifications of the respondents will be reviewed and participants eligible to participate in the tendering will be selected. The implementing agent will invite the selected bidders and conduct the tendering in the presence of relevant parties. The entire process from the advertising to the signing of the work contract will take about 2.0 months.

(3) Construction Work, Equipment Procurement, and Installation

Following the signing of the work contract, the construction work will begin with the approval of the Japanese government. If the Zambian side is able to efficiently carry out its share of the allocated work pertaining to project implementation, the duration required for the construction work is estimated to be 12.0 months.

3.1.7 Obligations of Recipient Country

(1) Tax exemption and Custom Clearance Formalities

The Zambian side will be responsible for overseeing tax exemption and custom clearance procedures for all materials and equipment to be used in the project. The procedures which must be taken in conjunction with tax exemption and custom clearance formalities are given below.

1) Materials and equipment supplied from Japan and third countries

All commodities imported to Zambia are generally levied duties and a customs handling fee must be paid. In order to show proof that equipment and materials are earmarked for this project, the following measures must be taken.

- A clause on VAT, customs, internal tax will be added in the contracts of the consultants and contractors with the approval of the Zambian government.
- Official documentation from the Zambia Revenue Authority approving tax exemption must be obtained.
- If required, copies of the aforementioned documents will be submitted to relevant personnel, in order to implement tax exemption procedures.

2) Locally procured materials and equipment

The following measures must be taken by contractors in order for materials and equipment procured locally to be exempted from taxes.

- Official documentation from the Zambia Revenue Authority approving tax exemption must be obtained.
- A purchase order form giving an outline of the commodities purchased for this project will be drawn up in the name of each respective contractor.