NO.

MINISTRY OF AGRICULTURE
AND RURAL DEVELOPMENT
THE REPUBLIC OF MOZAMBIQUE

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
REHABILITATION OF CHOKWE IRRIGATION SCHEME
IN
THE REPUBLIC OF MOZAMBIQUE

JUNE 2001

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

GR4
CR(2)
01-118

PREFACE

In response to a request from the Government of the Republic of Mozambique, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Chokwe Irrigation Scheme and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mozambique a study team from November 18 to December 30, 2000.

The team held discussions with the officials concerned of the Government of Mozambique, 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 Mozambique in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

June, 2001

Kunihiko SAITO

President
Japan International Cooperation Agency

June, 2001

Letter of Transmittal

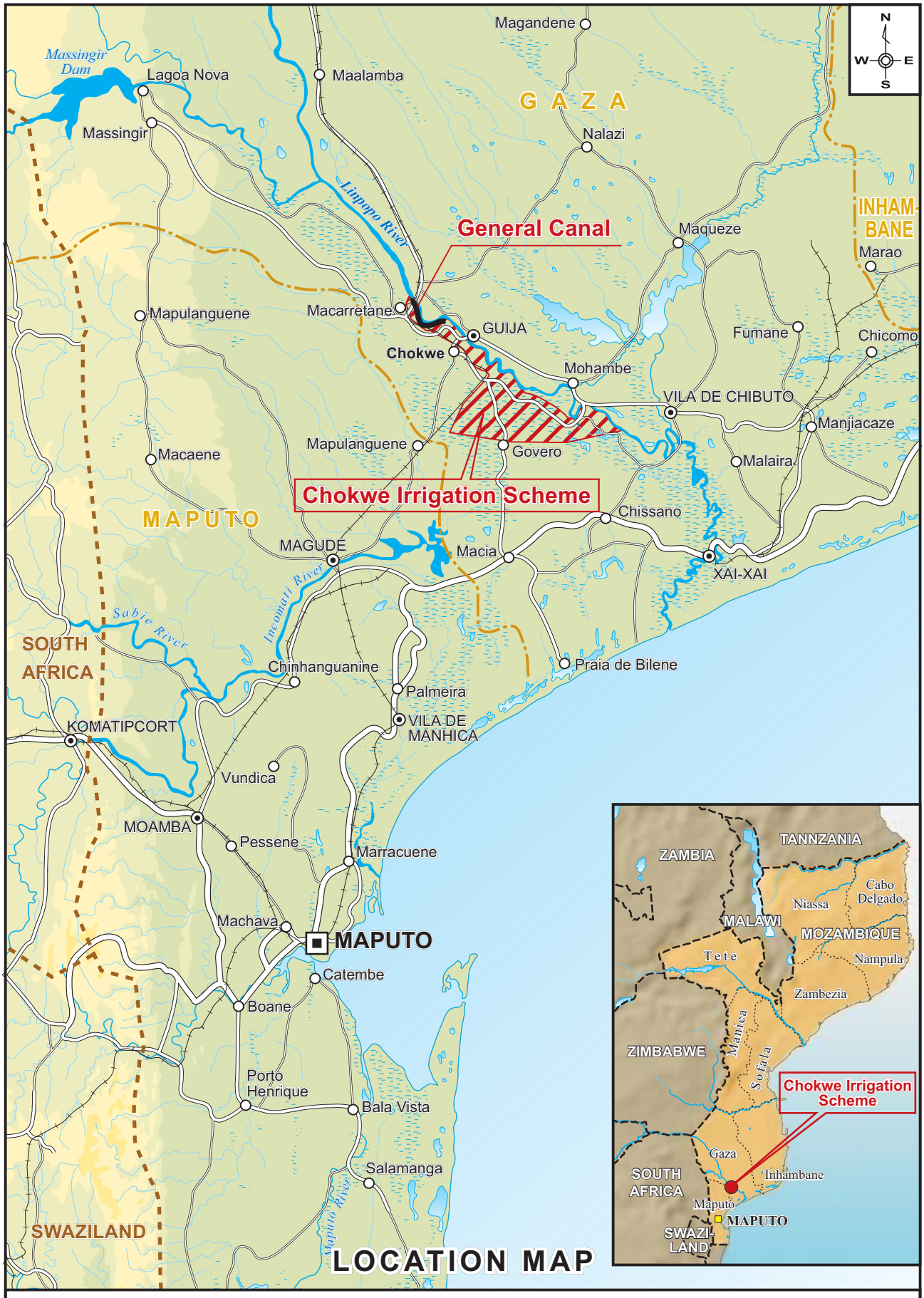
We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Chokwe Irrigation Scheme in the Republic of Mozambique.

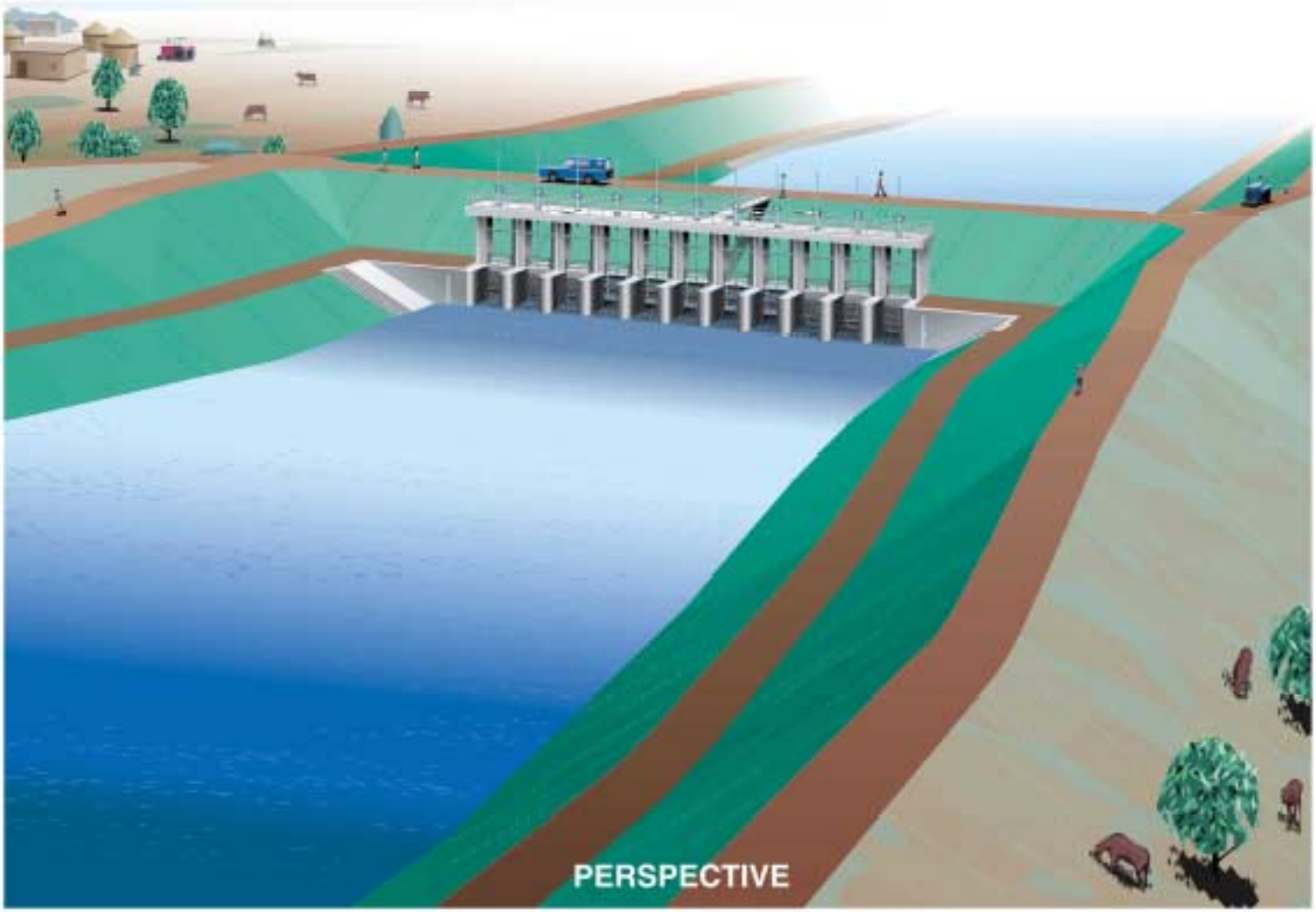
This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from November 17, 2000 to July 19, 2001. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mozambique and formulated the 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,

Shigeyuki TANAKA
Project manager,
Basic design study team on the Project for Rehabilitation of Chokwe Irrigation Scheme in the Republic of Mozambique
Nippon Koei Co., Ltd.


N
W
E
S
Magandene
Massingir Dam
Lagoa Nova
Maalamba
GAZA
Massingir
Nalazi
Limpopo River
General Canal
INHAM-BANE
Maqueze
Marao
Mapulanguene
Macarretane
GUIJA
Chokwe
Fumane
Chicomo
Mohambe
VILA DE CHIBUTO
Manjiacaze
Mapulanguene
Govero
Macaene
Malaira
Chokwe Irrigation Scheme
MAPUTO
Chissano
MAGUDE
Macia
XAI-XAI
Incomati River
Sabie River
SOUTH AFRICA
Chinhanguanine
Praia de Bilene
Palmeira
KOMATIPCORT
VILA DE MANHICA
Vundica
MOAMBA
Pessene
Marracuene
Machava
MAPUTO
Catembe
Boane
Porto Henrique
Bala Vista
Salamanga
SWAZILAND
Maputo River
LOCATION MAP
ZAMBIA
TANNZANIA
Cabo Delgado
Niassa
MALAWI
MOZAMBIQUE
Tete
Nampula
Zambezia
Manica
Sofala
ZIMBABWE
Chokwe Irrigation Scheme
Gaza
SOUTH AFRICA
Inhambane
Maputo
MAPUTO
SWAZI LAND
LEGEND
International Boundary
Province Boundary
Road
Railway
River
Lake
City
0
50km
Scale


PERSPECTIVE

ABBREVIATIONS

AfDB	African Development Bank
AFD	Agence Française de Développement
ARA-SUL	Regional Administration of Southern Water
DANIDA	Danish Internatioanl Development Assistance
DNHA	National Directorate of Agricultural Hydraulics
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDHA	Fund for the Development of Agricultural Hydraulic
GDP	Gross Domestic Product
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
HICEP	Hidráulica de Chókwè, E.P.
IFAD	International Fund for Agricultural Development
INIA	National Institute for Agricultural Research
I/R	Inception Report
IVA	Imposto Sobre Valor Acrescentado
JFS	João Ferrieira dos Santos
JICA	Japan International Cooperation Agency
LOMACO	Lonro-Moçambique Agriculture Company
MADER	Ministry of Agriculture and Rural Development
M/D	Minutes of Discussion
MF	Massey Furgason
NDI	National Demining Institute
NGO	Non-Governmental Organization
OPEC	Organization of Petroleum Exporting Countries
PROAGRI	National Programme of Public Investment
SEMOC	Sementes de Moçambique
SIREMO	Sistema de Regadio Eduardo Mondlane
UHS	Unit for Secondary Canal
UIP	Programme Implementation Unit
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organization
USAID	United States of Agency for International development
VAT	Value Added Tax
WID	Women in Development
ADB	Asian Development Bank

ABBREVIATIONS OF MEASURES

Length

mm	=	Millimeter
cm	=	Centimeter(cm=10mm)
m	=	Meter(m=100cm)
km	=	Kilometer(km=1,000m)

Area

ha	=	Hectare(10,000 m^2)
m^2	=	Square meter(1.0mx1.0m)
km^2	=	Square kilometer

Volume

cm^3	=	Cubic-centimeter
l	=	Liter($1dm^3$)
l/sec	=	Liter per second
m^3/sec	=	Cubic meter per second
t/ m^2	=	Ton per square meter
t/ m^3	=	Ton per cubic meter
ton/ha	=	Ton per hectare

Currency

MT	=	Meticais
US$	=	United State dollar

Weight

g	=	Gram
kg	=	Kilogram(1,000g)
t	=	Ton(1,000kg)

Time

s	=	Second
min	=	Minute(60s)
h	=	Hour(60min.)
d	=	Day

Others

%	=	Percent
°	=	Degree
’	=	Minute
”	=	Second
℃	=	Degree celsius
EL	=	Elevation (m)
WL	=	Water Level (m)
HWL	=	High Water Level (m)
LWL	=	Low Water Level (m)

SUMMARY

SUMMARY

Mozambique is located on the east coast of the African continent. It is bound by Tanzania and Malawi in the north, Zimbabwe and Zambia in the west, and south by Swaziland and South Africa and the coast line is 2,500km long. An area of 801,600 km^2 is categorized in subtropical zones. The total population was estimated at about 16.95 million as of 1998, of which approximately 13 million, or almost 80 %, live in the rural area and engage in agricultural production. The population has increased at 1.9 % a year as of 1980. Mozambique is a predominantly agricultural country. Agriculture generates almost 30 % of the Gross Domestic Product (GDP) and more than 50 % of the foreign exchange earnings. However, it is mainly traditional and rainfed, so that agricultural productivity is low and production unstable.

The Government of Mozambique (GOM) has given a high priority to improvement of basic infrastructure for agriculture, particularly rehabilitation of irrigation facilities in order to improve agricultural productivity by focusing on poverty alleviation, food security, generation of employment opportunity and improvement of trade balance.

Under the situation described above, the Project for Rehabilitation of Chokwe Irrigation Scheme (the Project) aims at rehabilitation of the General Canal located at the most upstream point in the Scheme. The Project has been given a high priority in the Activities and Budget Annual Plan (PAAO) of Irrigation Component of the National Programme for Agricultural Development (PROAGRI 1999 - 2003).

Chokwe Irrigation Scheme of 26,000 ha was developed during period from 1950s to 1970s on largest scale irrigation project in Mozambique. The Scheme, however, has deteriorated due to change of national policy such as repeal of operation from state farm to self-operation and reducing budge from the government. As a result, irrigated farm land has been decreased to approximately 6,000 ha at present.

The Ministry of Agriculture and Development, GOM thus requested the Government of Japan (GOJ) on October 1998, to provide grant aid for rehabilitation of the General Canal which is key facility of the Scheme under the rehabilitation programme organized in 1995.

May 2000, Paris conference of the donors was held for discussion on rehabilitation of facilities of the Scheme which was accelerated due to disastrous to the Scheme by flood occurred in February 2000. GOM has strongly requested in the conference the financial and technical support for the rehabilitation of the Scheme. At the conference, donor for respective rehabilitation has been discussed. These are the rehabilitation of Macarretane Weir for Islamic Development Bank, right bank repairing around Macarretane Weir for EU, general canal located upstream portion of the Scheme for GOJ, primary, secondary and drainage canals downstream of the General Canal for France, Portugal and OPEC.

GOJ, through JICA, dispatched the Basic Design Study Team to Mozambique from November 18, 2000 to December 30, 2000. The Study Team had a series of discussions with MADER,UIP and HICEP with taking into consideration of the Basic Component of the

Project. As a result, there were no changes in the requested items by GOM.

The basic design study for rehabilitation of the General Canal and related structures was made through analyzing the results of field survey. This included investigation of the flood which occurred in February 2000 and economic assistance of donors on Chokwe Irrigation Scheme. The results of the study and field survey were compiled in the draft basic design report.

JICA dispatched a mission to explain the draft basic design report to GOM during the period from March 24, 2001 to April 6, 2001. The report was principally agreed by GOM and the minutes of discussion was signed by both parties on April 2, 2001.

The basic concepts for the basic design are as follows:

(1) Rehabilitation Plan of the General Canal

The General Canal would be rehabilitated so as to secure the canal's stability and effective functioning and provide convenient operation and maintenance. The following basic concepts are applied for rehabilitation of the General Canal:

(a) Discharge of the General Canal is calculated from the existing areas of paddy and upland crops as follows:

- The design discharge at the downstream end of the General Canal:

Existing paddy field area	: 18,686ha x 2.00 l/sec/ha	= 37.4 m^3/sec
Other field area	: 5.074ha x 1.10 l/sec/ha	= 5.6 m^3/sec
Total	: 23,760ha	= 43.0m^3/sec

- Required inflow volume at the Intake Structure is calculated considering the discharge for the pumping irrigation area (2,270 ha) along the General Canal in addition to the above design discharge at the downstream end of the General Canal:

Pumping irrigation area along the General Canal

Other crops area : 2,270ha x 1.10 l/sec/ha		= 2.5 m^3/sec
End of the General Canal : 23,760ha		= 43.0 m^3/sec
Total	26,030 ha	= 45.5 m^3/sec

Accordingly, the design discharge of 45.5m^3/sec would be adopted the section between the Intake Structure and Regulator and 43.0m^3/sec would be adopted between the Regulator and the downstream end of the General Canal.

(b) The General Canal should be rehabilitated and expanded along the existing canal route.

(c) The General Canal should be rehabilitated so as to keep a uniform trapezoidal section with constant canal gradient to secure the canal's stability and convenience for operation and maintenance work and easier construction.

(d) Sod facing of the slope of the General Canal would be made using a stable method to maintain the slope safety.

(e) Inspection road along the General Canal would be paved with materials available near the project site, in viewing of the role and importance in the project area, frequency in use, and easy maintenance.

(2) Rehabilitation Plan of Intake Structure

There are two intakes in the Scheme. One of them is the old intake located just upstream of the Macarretane Weir in the right bank of the Limpopo River and the other is the new intake in the inlet channel located at around 1 km upstream of the Macarretane Weir on the right bank of the Limpopo River. As the result of the study, the new intake would be rehabilitated in order to ensure the designed discharge, based on the following reasons:

(a) Signle intake system could be provided for easier control of intake water and maintenance than double intake system.

(b) The old intake was constructed in the 1950s and it is not used now due to heavy silting in front of the intake and the difficulty of the gate hoisting.

(c) Rehabilitation of the old intake is troublesome since the old intake is located close to the Macarretane Weir, national road bridge, and railway bridge, and cofferdam works for rehabilitation works is also troublesome due to high water pressure of the Macarretane reservoir.

Basic concepts for rehabilitation and upgrading of the new intake are as follows:

(a) The planning new intake is be constructed about 60 m upstream of the existing intake structure, considering deterioration of the existing structures such as gates, hoists and parts of the concrete structures, and the insufficient flow capacity of the existing intake structure.

(b) Crest elevation of the dike is set at EL 38.00 based on the water level of EL 36.80 corresponding to a 100-year probable flood which is linked with the rehabilitation plan of the dike to be provided surrounding the Macarretane area in the right bank of the Limpopo River.

(3) Rehabilitation Plan of the Regulator

The existing Regulators are located at a point about 4.8 km downstream (the existing New Regulator) from the Intake Structure and at a point about 8.8 km downstream (the existing Old Regulator) from the Intake Structure. According

to the study, the existing Old Regulator would be rehabilitated based on the following reasons:

(a) The existing Old Regulator was provided to regulate the water level so as to supply irrigation water to the irrigation pumping area in the right bank to upstream of the General Canal. The existing Old Regulator would be rehabilitated near the present location to maintain to supply irrigation water as same as the present condition.

(b) The existing New Regulator was constructed for to prevent the water that has flown into the General Canal from flowing downstream. It is, however, observed that the inflow of flood-water can be prevented by the Intake Structure to be rehabilitated in the Project.

(c) A New Canal Crossing Structure would be constructed to promote operation and maintenance of the canal and also facilitate movement of inhabitants in the area.

Basic concepts for rehabilitation of the existing Old Regulator are as follows:

(a) The planning New Regulator would be constructed near the existing Old Regulator after removing the existing Old Regulator that has been overturned due to the flood.

(b) The planning New Regulator would be a box culvert structure equipped with a water control gate, as for the existing Old Regulator.

(c) A road shall be constructed on the culvert for crossing the canal.

(4) Rehabilitation Plan of the Diversion Work

The gate and the other parts of the superstructure of the Diversion Work have been removed by GOM. A part of the superstructure and the substructure remain as a wreck in the existing Diversion Work. The function of the Diversion Work is maintained by the operation of a regulator that was constructed about 3.5 km downstream of the primary canal in 1999.

A New Canal Crossing Structure would be constructed at the downstream end of the General Canal for operation and maintenance of the canal and the inhabitants' convenience.

(5) Rehabilitation Plan of the Drain Inlet

This structure was destroyed by the flood of February 2000 and the structure itself has disappeared. A Drain Inlet would be constructed on the right bank at about 3.3 km downstream in the General Canal for the improvement of the poor drainage area in the right bank.

The proposed contents of the Project are as follows:

(1) Irrigated Area : Total 26,030 ha
(Paddy 18,686 ha, Other crop 7,344 ha)

(2) Major Crops for Planting : Paddy, maize, onion, tomato

(3) Rehabilitation of the General Canal
:14.3 km : dredging and shaping work

(a) Design discharge: 45.5 m^3/sec: Beginning Point of the General Canal ~ Regulator
43.0 m^3/sec: Regulator ~ End Poin of the General Canal

(b) Canal type: Trapezoidal section, earth canal

(4) Rehabilitation of the Intake Structure: One site (Beginning Point of the General Canal)

(a) Planned intake discharge: 45.5 m^3/sec

(b) Type: Box culvert structure with discharge control function by manually operated gate

(c) Gate: Roller gate B x H = 2.0 x 2.0 m, 11 units

(d) Box culvert: B x H = 2.0 x 1.6 m, 11 barrels box culverts

(5) Rehabilitation of the Regulator

: One site（about 8.8 km point downstream in the General Canal）

(a) Design discharge: 43.0 m^3/sec

(b) Type: Box culvert structure with discharge control function by manually operated gate

(c) Gate: Roller gate B x H = 2.0 x 2.0 m, 8 units

(d) Box culvert: B x H = 2.7 x 3.5 m, 8 barrels box culvert

(6) Canal Crossing

: Two sites (about 4.8 km point downstream in General Canal and downstream end of the General Canal)

(a) Design discharge: 45.5 m^3/sec and 43.0 m^3/sec

(b) Type: Box culvert structure

(c) Box culvert: B x H = 3.5 x 3.5 m, 6 barrels box culvert

(7) Drain Inlet

: One site (about 3.3 km point downstream from BP of the General Canal)

(a) Type: Concrete pipe structure with gate
(b) Gate: B x H = 0.8 x 0.8 m, 2 units
(c) Pipe: Concrete pipe diameter 0.8 m, 2 barrels

The implementation of the Project would require about 28.5 months.

The Ministry of Agriculture and Rural Development (MADER) is the executing agency for the Project. The Programme Implementation Unit (UIP) and Hidráulica de Chókwè, E. P.(HICEP) under the MADER will have direct responsibility for the Project implementation.

Operation and Maintenance of the Scheme will be carried out by HICEP and farmers association consisting of beneficiary farmers in the light of laws and regulations established by the government and HICEP. HICEP has responsibility for operation and maintenance of the primary system and farmers association has responsibility for the secondary and tertiary systems.

HICEP has a plan to promote capacity building and strengthening of the farmers' association under assistance of Portugal, aiming at establishing sustainable operation and maintenance of the relevant facilities by the farmers' association. The plan is summarized below.

(1) First Term

Training period of the programme is two years in principle. Basic components of the programme are summarized below.

(a) To understand legal, internal rules established by the government and HICEP for operation and maintenance of the Scheme
(b) To understand overall aspects of administration, accounts and organization
(c) To recognize technical aspects of selection of crops and their water calendars
(d) To comprehend technical aspects of operation and maintenance of infrastructure particularly those of secondary and tertiary canals

(2) Later Term

During the later term (principally for three years), farmers will apply the practice learnt in the first term to their respective sites and it is expected that the farmers' association will improve its capacity for operation and maintenance of the facilities.

A water tax, to be collected mainly from beneficiary farmers of the Scheme, will be recovered for operation of HICEP and operation and management of the Scheme.

Ministry of Finance and Planing and MADER had discussed a maximum water tax at US$120/ha/year to be applied from 2009 that HICEP would be managed by the independent

profit system. HICEP has given user farmers and Agriculture Season's Committee in Chokwe advance notice that a US$120/ha/year water tax would be applied at maximum value after the whole infrastructures are rehabilitated properly and have thus obtained their agreement tentatively. In parallel to the advanced notice, HICEP has made an effort to explain to them (i) method and schedule of rehabilitation and repair (ii) extent of duties for farmers, (iii) contents on strengthening programme of farmers association.

Meanwhile, HICEP being made some trial calculation and has estimated at US$111.3/ha/year as water tax at a future stage condition after rehabilitation of the Scheme.

Additionally, HICEP considers the following measures to reduce the water tax in order to accomplish sustainable and effective operation and maintenance of the Scheme. When the following considerations are achieved sufficiently, it is expected that HICEP will have responsibility only for operation and maintenance of the General Canal and primary canals thus resulting in the water tax being reduced to US$78/ha/year, which is approx. 70% of US$111.3/ha/year.

(a) To reduce the number of staff in the headquarters from 40 to 30.

(b) To transfer simple maintenance works on the primary infrastructures to farmers association

The Project will generate the following direct and indirect impacts, contributing to improvement in farmer's income, stability of food security, and farmer's living condition in the Scheme and Mozambique.

(1) Direct Impact

Through the Project, the existing irrigation area will receive required water, namely 45.5 m^3/sec at the beginning point of the General Canal and 43.0 m^3/sec at the ending point. As a result, HICEP will be able to supply irrigation water to the whole irrigable area of 26,030 ha.

(2) Indirect Impacts

The following indirect impacts are premised to secure the economic assistance of donors for rehabilitation of irrigation facilities downstream of the General Canal and strengthening of farmers association.

(a) Implementation of sustainable irrigation on paddy in rainy season and upland crop in dray season in 26,030 ha

(b) Improvement of cropping intensity

(c) Increment of unit yield and improvement of quality of agricultural products

(d) Improvement of farmers' income

(e) Role as granary of Mozambique

(f) Generation of employment opportunity

In order to ensure the above direct and indirect impacts, the Mozambique Government should achive the following responsibilities effectively.

(1) HICEP should undertake proper operation and maintenance of irrigation facilities.

(2) Farmers associations should be strengthened and their operation and maintenance performed properly.

(3) Rehabilitation and Repair works for existing irrigation facilities in the downstream of the General Canal should be implemented on schedule by donors.

(4) Training for farmers associations should be implemented on schedule by donors.

(5) HICEP should collect water charges properly and regularly.

(6) Users should pay water charges properly.

(7) Agricultural extension work should be undertaken in cooperation with HICEP, Ministry of Agriculture and Rural Development, Chokwe Agricultural Research Station, and District Agricultural Office.

(8) Farmers in the System should carry out agricultural activities enthusiastically.

(9) Research work for the System should be undertaken and achieve useful results through closer cooperation between Chokwe Agricultural Research Station and District Agricultural Office.

(10) HICEP should try to reduce the cost of operation and maintenance of irrigation facilities, including the General Canal, in order to alleviate farmers' water charge burden.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
REHABILITATION OF CHOKWE IRRIGATION SCHEME
IN
THE REPUBLIC OF MOZAMBIQUE

Table of Contents

List of Table

List of Figures

Attachments

Appendices

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Mozambique is located on the east coast of the African continent. It is bound by Tanzania and Malawi in the north, Zimbabwe, Zambia in the west, and south by Swaziland and South Africa and the coast line is 2,500km long. An area of 801,600 km^2 is categorized in subtropical zones. The total population was estimated at about 16.95 million as of 1998, of which approximately 13 million, or almost 80 %, live in the rural area and engage in agricultural production. The population has increased at 1.9 % a year as of 1980.

Mozambique is a predominantly a

gricultural country. Agriculture generates almost 30 % of the Gross Domestic Product (GDP) and more than 50 % of the foreign exchange earnings. However, it is mainly traditional and rainfed, so that agricultural productivity is low and production unstable.

Taking this situation into consideration, through the National Programme for Agricultural Development (PROAGRI 1999 - 2003), The Government of Mozambique (GOM) placed an emphasis on the development of the agriculture sector with particular emphasis on activities to increase production of export-oriented economic crops through structural improvement of the existing traditional irrigation systems based on poverty alleviation and improvement of trade.

The Project for Rehabilitation of Chokwe Irrigation Scheme (the Project) aims at rehabilitation of the General Canal located at the most upstream point in the Scheme. The Project has been included with high priority in the Activities and Budget Annual Plan (PAAO) of Irrigation Component of PROAGRI.

Rehabilitation and repair work of facilities in the Scheme has been commenced under economic assistance of AFD, OPEC, France, Portugal, EU, Islamic Development Bank through Paris conference of the donors in May 2000. They are rehabilitation and repair work of facilities downstream of the General Canal, strengthening of farmers' association, rehabilitation work of Macarretane Weir and rehabilitation of the flood dike surrounding Macarretane area.

In February 2000, the Limpopo River which supplies water to the Scheme was under flood. The flood caused disastrous damaged to the Scheme including canals and related structures.

GOM thus requested the Government of Japan (GOJ) to provide grant aid for the rehabilitation of the General Canal and related structures on October 1998. GOJ, through JICA, dispatched the Basic Design Study Team to Mozambique from November 18, 2000 to December 30, 2000. In field work, the Study Team had a series of discussions between MADER though the discussion with UIP and HICEP taking into consideration the scale of grant aid and operation and maintenance of the Project.

As a result, there were no changes to the requested items by GOM which are mentioned below:

(1) Rehabilitation of General Canal (43 m^3/sec, about 14km)
(2) Rehabilitation of the related structures (Intake; 2 sites, Regulator; 2 sites, Diversion Work; 1 site)

The draft basic design report on rehabilitation of the General Canal and related structures was made basing on the field survey. JICA dispatched a mission to explain the draft basic design report to GOM during the period from March 24, 2001 to April 6, 2001. The report was principally agreed by GOM and the minutes of discussion was signed by both parties on April 2, 2001.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

In the national policy for social and economic development, GOM has given high priority to strengthening sustainable development of the agriculture sector which is indispensable for economic development of the country. Following this strategy, improvement of basic infrastructure for agricultural production, particularly rehabilitation of irrigation facilities, has been promoted under PROAGRI focusing on poverty alleviation and improvement of trade balance.

The Chokwe Irrigation Scheme (the Scheme) had been developed during the period from 1950s to 1970s by the Portuguese Government. At present, the Scheme has 26,030 ha of existing farmlands to be irrigated. Since the function of the facilities has deteriorated with the passing years, it is reported that agricultural productivity in the Scheme has been reducing year by year. Therefore, it is strongly required that the Scheme facilities shall be rehabilitated and repaired in order to improve agricultural productivity of major food crops (rice and maize) and cash crops (tomato, onion, etc.). As a result, it is expected that this would ensure sustainable food supply for the southern region of the country, the center of politics and economy, while farmer's income and living standard in the Scheme could be improved as well.

The Project aims at rehabilitation of the General Canal located at the most upstream point in the Scheme. The Project has been listed with high priority in PAAO of Irrigation Component in the PROAGRI.

In February 2000, the Scheme was damaged by floods that caused a huge disaster in Mozambique. The GOM requested financial and technical support for rehabilitation and repair work of facilities in the Scheme and France, OPEC, and EU decided to support GOM at a Paris conference of the donors in May 2000.

2.2 Present Condition of Canal Facilities

The existing Chokwe Irrigation Scheme is fully equipped with a canal system consisting of general, primary, secondary, tertiary canals, and drainage canals. It is necessary for the General Canal to be rehabilitated due to decreased capacity for water flow after passing years and damage caused by the flood in February 2000. The remainder of the canal system could be restored through such regular maintenance work as desilting, reshape of canal, weeding, etc. The present condition of the respective canals in the Scheme are summarized as follows:

- General Canal : Decrease of canal capacity has developed through deterioration of function over the years and be cause of flooding. According to the site survey, the present canal

section varies in its features such as the base width of 10m～30m, inside slope of 1:1.0～3.0, inside height of 4m～7m and longitudinal slope. It is considered that decrease of the canal capacity may have been caused by sedimentation from collapse of the canal for many years and abundance of weeds in the canal.

- Primary Canal : Weed removal, reshaping and bank heightening are required in some portions. It is clear, however, that overall canal condition could be restored by regular maintenance work. Major structures such as regulator, turnout, etc., have already been rehabilitated by the French Government at present.

- Secondary Canal : Has a similar condition as the primary canal. Some portions have erosion caused by flooding, and also there are weeds partly. It might be solved and recovered the function properly in applying similar degree of the regular maintenance works.

- Tertiary Canal : The tertiary canal system consists of 922km of concrete flume canal and 110km of trapezoidal earth canal.
  Most of the flume canals are laying on the ground and some canals require piers to maintain the required hydraulic gradient. There is no serious deterioration in the condition of concrete itself, however some joint work has lost the asphalt joint materials in some portion and should be repaired in the regular maintenance. On the other hand, tertiary canals of 110km branching from the Nwachicoluwane primary canal were constructed of trapezoidal earth canal. It is observed that those canals have became weedy, silted, eroded in some banks, etc. after passing years and also by flooding. This deterioration might be effectively solved by applying regular maintenance work using manpower because the canal features are small (base width 0.3～0.5m, canal height 0.4～0.6m).

- Drainage Canal : These also have reduced function by sedimentation, weeds, etc. after many years. Further deterioration might also have happened through flooding. Lands not being cultivated these days are rank with weeds. Weeding and desilting works are required to recover the function.

As explained above, condition of the system downstream of the General Canal could be restored and functioned to maintain water flow by applying regular maintenance work. It seems that damaged portions of the primary, secondary and tertiary canals caused by the flood in February 2000 have been rehabilitated with the financial support of the French Government (AFD). Therefore, it is expected that the Scheme would be able to function properly after the above-mentioned rehabilitation work assisted by AFD, repairing works of the system programmed to be executed under the financial support of various donors, and rehabilitation of the General Canal as well.

Schedule of the repair work to be carried out in cooperation with Donors except Japan is shown in Table-2.2.1 and summarized in comparison with the tentative rehabilitation schedule of the Project as follows:

Repair Schedule for Chokwe Irrigation Scheme

Completion Year	2000	2001	2002	2003	2004	2005	2006
General Canal Rehabilitation Schedule			(Scheduled)				
Area Completed (ha)	500	3,757	4,765	5,000	6,358	3,556	2,094
Accumulated Area Completed (ha)	500	4,257	9,022	14,022	21,077	24,633	26,030

In accordance with this repairing schedule, irrigation water for 14,022 ha could be supplied from 2004 when rehabilitation of the General Canal is completed. After that, the irrigated area would increase to 21,077 ha in 2005, 24,633 ha in 2006, and finally the whole scheme of 26,030 ha in 2007. GOM has been endeavoring to achieve the rehabilitation and repair work on schedule.

The Project aims at the rehabilitation of the General Canal, in order to restore the original discharge capacity. Therefore, the bottleneck of the whole system, that is unstable supply of irrigation water to down stream of the Scheme, would be solved. However, it is strongly reminded that the mentioned-above repair work carried by the donors should be completed on schedule, so as to realize the anticipated significant impact of the Project.

2.3 Basic Concept of the Project

Basic concept of the rehabilitation of the General Canal is to rehabilitate the General Canal, deteriorated after the lapse of years and also damaged due to the flood in February 2000. As a result, it is expected to restore the flow capacity to the initial planned volume through rehabilitation of the General Canal and to realize the stable irrigation water supply for the downstream facilities.

Basically there is no alteration to the components requested by GOM on the point of the rehabilitation of the General Canal. However, some alterations to the

components would seem necessary to related structures of the General Canal after studying their role and functions. Components of the rehabilitation requested by GOM are as follows:

(1) Rehabilitation of General Canal (43 m^3/sec, about 14 km)
(2) Rehabilitation of the related structures (Intake; 2 sites, Regulator; 2 sites, Diversion Work; 1 site)

General layout of the Scheme including the location of the General Canal is shown in Figure-2.3.1.

2.3.1 Basic Concept for Rehabilitation of the General Canal

(1) Background of the General Canal

The General Canal was constructed in 1951-1954 as the irrigation canal for the downstream of the Chokwe Irrigation Scheme. The water discharge was designed at 21 m^3/sec. The Old Intake Structure, which was constructed on the right bank at a point just upstream of the Macarretane Weir in the Limpopo River, had been used as the intake facilities.

The General Canal was rehabilitated in 1977, and the New Intake Structure was constructed, also on the right bank, about 1 km upstream from the Weir, in order to solve water shortage derived from enhancement of irrigated area of the Scheme from around 11,000 ha to 26,000 ha. As for the canal rehabilitation, the canal width (width between both inside edges of canal banks) was expanded from 20 ~ 25 m to 35 ~ 40 m, and hereby the design discharge increased from 21 m^3/sec to 43 m^3/sec.

At the works for the width expansion, the Old Regulator constructed in the General Canal (8.8 km downstream from the Intake Structure) was also repaired without increasing its function. A New Regulator was constructed at about 4.8 km downstream from the New Intake Structure, in order to interrupt flood-water of the Limpopo River at the weir and further prevent it from flowing into the downstream reaches of the General Canal.

GOM conducted the study for rehabilitation of the Chokwe Irrigation Scheme in 1994. In particular, the discharge capacity and required discharge of the General Canal were reconsidered in cooperation with AFD. As a result, it was observed that the capacity of water discharge had dropped to19 m^3/sec in 1995 due to deterioration of the facilities. Furthermore, the discharge capacity had dropped to 11 m^3/sec ~ 13 m^3/sec due to the flood damage in February 2000.

(2) Discharge of the General Canal

HICEP concluded that the design discharge of 43 m^3/sec in the downstream end of the General Canal rehabilitated in 1977 was required if the whole area of 26,030ha was going to be irrigated. The design discharge of the General Canal was checked by applying the following process.

a) Existing irrigable area for paddy and upland crops was categorized by blocks divided into the respective canal networks. The canal network of the Scheme is shown in Figure-2.3.2. The existing irrigable area in the defined blocks divided is shown in Table-2.3.1.

b) The peak unit irrigation water requirement was calculated as follows:

i. Peak irrigation water requirements at diversion points in the secondary canal were set as follows:

Paddy	:	1.60 l/sec/ha
Other crops	:	0.88 l/sec/ha

ii. Peak water requirements in the General Canal and the primary canal were assessed with a conveyance efficiency of 80 % as follows:

Paddy	:	2.00 l/sec/ha
Other crops	:	1.10 l/sec/ha

iii. Using the above peak water requirements and the existing field area, the design discharge at the downstream end of the General Canal was determined as follows:

Existing paddy field area	:	18,686ha x 2.00 l/sec/ha	=37.4 m^3/sec
Other field area	:	5,074 ha x 1.10 l/sec/ha	= 5.6 m^3/sec
Total	:	23,760 ha	= 43.0 m^3/sec

iv. Required inflow at the Intake Structure was calculated as shown below considering the discharge for the pumping irrigation area (2,270 ha) in the upper reaches along the General Canal in addition to the above design discharge at the downstream end of the General Canal.

① Pumping irrigation area in the upper sector (along the General Canal)

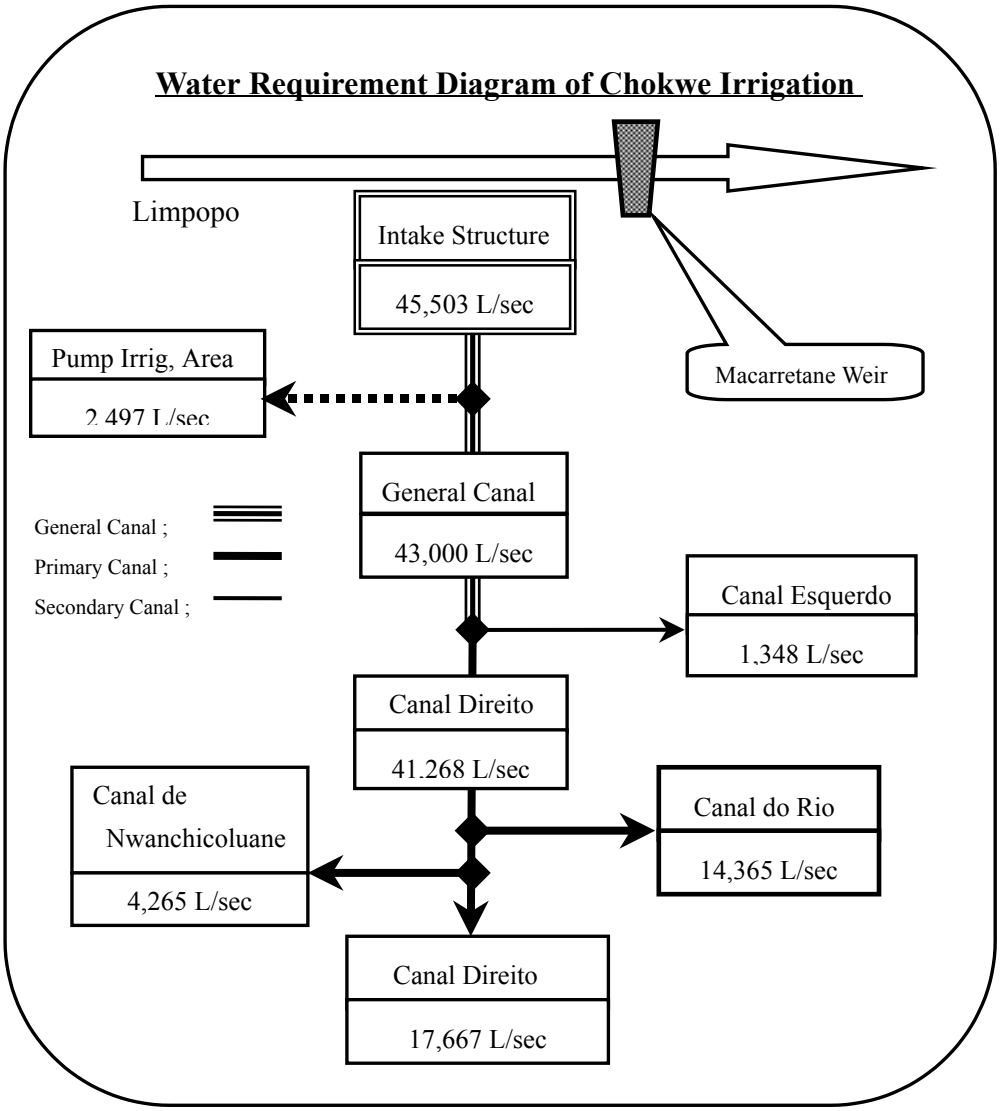
Other crops area	:	2,270 ha x 1.10 l/sec/ha	=	2.5 m^3/sec
② End of General Canal	:	23,760 ha	=	43.0 m^3/sec
Total		26,030 ha	=	45.5 m^3/sec

The peak irrigation water requirement mentioned above was calculated by HICEP based on meteorological data of the Chokwe Agricultural Research, applying the Modified Penman Method. Although peak water requirement, including the calculated irrigation efficiency varies depending on the cropping season of crops in the Scheme, it is judged that the design water requirements being used for the Scheme are adequate.

These calculations also show that the conveyance efficiency of 80 % for the General Canal and the primary canal would be adequate. Therefore, the design discharge of 43 m^3/sec at the downstream end of the General Canal planned in 1997 and the required intake discharge of 45.5 m^3/sec at the Intake Structure are judged to be adequate values.

Irrigation water requirement diagram of the Scheme is shown in Figure-2.3.3 and

summarized as follows:



(3) Rehabilitation of the General Canal

The General Canal classified into an earth canal has various ranges of features, such as bottom width of 10 m ~ 30 m, side slope of 1 : 1.0 ~ 3.0, and height of 4 m ~ 7 m, while canal gradient also varies at the respective sections. It is understandable that there are many problems on the form of flow section and there also is some siltation caused in reaches where water velocity is low, resulting in rank growth of weeds. On the other hand, scouring is caused in reaches where water velocity is high and side slope is steep.

Considering the above-mentioned situation, the General Canal would be rehabilitated so as to keep uniform trapezoidal section with the constant canal gradient based on the following reasons:

- Uniform section secures the canal stability and function effectively to prevent the canal structure from scouring and siltation.
- Uniform section is more convenient than irregular one, viewing from the operation and maintenance work for the General Canal.
- Uniform section is convenient for the construction works. Viewing construction supervision, control work is easier in case of uniform section. Further, accuracy of construction quality is secured in the progress control.

2.3.2 Basic Concept for Rehabilitation of the Intake Structure

There are two intakes in the Scheme. One of them is the old intake located at just upstream of the Macarretane weir in the right bank of the Limpopo River, which was constructed when Macarretane weir was settled during the period from 1953 to 1955. However, the old intake is not been used now due to a heavy silting in front of the intake and the difficulty of the gate hoisting. The other is the new intake in the inlet channel located at around 1 km upstream of the Macarretane weir on the right bank of the Limpopo River. That new intake was constructed for the expansion programme of the Chokwe Irrigation Scheme in 1977, but the inflow capacity of the new intake is around 20 m^3/sec.

Rehabilitation plan to the old intake is not included as a component of the Project, but the new intake will be rehabilitated in order to ensure the designed discharge, based on the following reasons:

- The old intake has not been used and HICEP requested to rehabilitate the new intake in order to keep design discharge by the new intake itself alone,
- Rehabilitation plan of the new intake to take design discharge required is more economical than rehabilitation plan for both of the old and new intakes and more easier to control the amount of intake water,
- The old intake, which is located just upstream of the Macarretane weir, is affected with the direct flowing of sediment from the Limpopo River, and
- Rehabilitation works of the old intake is troublesome since the old intake is located close to the Macarretane weir, national road bridge, and railway bridge, and cofferdam works for rehabilitation works is also troublesome due to high water pressure of the Macarretane reservoir.

It is recommended that new structure be constructed instead of rehabilitation of the existing intake structure, considering deterioration of the existing structures such as the gates, hoists and a part of the concrete structures, and insufficient flow capacity of the existing intake for the designed discharge.

Settling basin is not provided downstream of the new intake considering the following reasons:

- Flushing out of sand deposited in the settling basin by water flow through the flushing canal is impossible due to the topographic condition around the intake construction site, and further manual or mechanical sand removal is required,
- It is very difficult to do manual or mechanical sand removal since irrigation water shall be supplied to the irrigation area throughout the year in accordance with the HICEP's regulation and sand deposited in the settling basin is always under water, and
- The intake is reconstructed in the inlet channel same as the existing new intake, and new construction site is located at a distance of around 200 m from the river bank of the Limpopo River. Accordingly, it is enable to avoid the direct flowing of sediment from the Limpopo River into the intake. Judging from the result of site investigations and field survey, sedimentation could not be seen around the entrance sill of the existing intake. It is observed that most of the sediment in the General Canal was caused by flood inundation of the Limpopo River and gully erosion of canal slope.

2.3.3 Basic Concept for Rehabilitation of the Regulator

The existing Regulators are located at a point about 4.8 km downstream (New Regulator) from BP and at a point about 8.8 km downstream (Old Regulator) from BP.

The Old Regulator was constructed in 1954 in order to supply water to an irrigated area (Pumping Irrigation) on the right bank along the General Canal. On the other hand, the New Regulator was constructed in 1977 to interrupt floodwater of the Limpopo River that enters into the General Canal.

The Old Regulator has overturned, due to scouring on the side and the bottom of the structure from the flood discharge in February 2000, which runs along its side. At present, the irrigation water flows down passing the left side of the structure through the temporary canal that has been constructed beside the overturned structure.

The New Regulator has not suffered any big damage from the flood. However, the upstream and downstream parts connecting the canal have been damaged considerably. In addition, scouring has taken place in a part of about 30 m in width and about 50 m in length at the downstream reach of the structure. There are cracks in various parts of the concrete at the sheet parts of the gate. Therefore it would be impossible to reuse the gate by means of repairing.

As the result of discussion with HICEP in consideration of the above-mentioned situation, it was decided that the New Regulator would be excluded from the rehabilitation plan due to the reasons below. The existing structure should be withdrawn and the canal crossing structure is constructed as canal inspection road.

- New Regulator was constructed for the purpose of preventing the water that has flown into the General Canal from flowing downstream. It is, however,

observed that the inflow of flood-water can be prevented by the Intake Structure to be rehabilitated in the Project.

- It might be meaningless because upstream reaches are left to the risk of collapse due to the water level rising up to the flood level, even if a regulator for flood protection would be constructed at the point.
- A Canal Crossing Structure would be constructed to promote operation and maintenance of the canal and also facilitate movement of inhabitants in the area, since this structure has been used as a crossing structure for the canal inspection and daily life.

On the other hand, the Old Regulator will be rehabilitated as a component of the Project in response to the strong request of HICEP. Instead of the Old Regulator, a structure with a manually operated gate would be constructed to regulate the water level so as to supply irrigation water to the pumping irrigation area in the right bank to the upstream of the General Canal.

Elevation of the banks in the upper reaches than this structure has been set higher so as to prevent the General Canal from damage due to wrong gate operation of the intake structure. Bank elevation was set higher than the normal water level (WL 32.58) at the Macarretane Weir. In the facilities' design, following the above-mentioned consideration of HICEP, the canal bank elevation is set at EL 32.58 or higher so that the canal bank elevation would be the same as the existing canal bank elevation or higher to make it possible to keep the normal water level of the Macarretane Weir in the canal, considering canal protection. Damage to the canal in the downstream area due to the wrong operation of the gate of the Intake Structure and ineffective inflow would be prevented in dual means with these measures.

2.3.4 Basic Concept for Rehabilitation of the Diversion Work (Canal Crossing Structure)

The Diversion Work was constructed in 1950s at the downstream end of the General Canal. However, the gate and the other parts of the superstructure have been removed. A part of the superstructure and the substructure remain as a wreck in the existing Diversion Work.

The General Canal is bifurcated at its downstream end to the primary canal (Canal Direito) and the secondary canal (Canal Esquerdo). The General Canal is connected directly to the primary canal without any structures. The required water level for the secondary canal is maintained by the Regulator that was newly constructed at about 3.5 km downstream of the primary canal in 1999 under the aid of France. Further, the diversion works in the secondary canal have been constructed newly also under the aid of France, so it is not necessary to construct the diversion facilities for water control of the secondary canal.

In consideration of the above situation, it has been confirmed in the discussion with HICEP that construction of structures at this location concerning the water diversion

is not necessary. However, it is reported that a wooden temporary bridge has been built at about 50 m downstream of this point and is being used by inhabitants in the area to cross the canal. Accordingly, a Canal Crossing Structure should be constructed at the downstream end of the General Canal for operation and maintenance of the canal and the inhabitants' convenience.

2.3.5 Basic Concept for Rehabilitation of the Drain Inlet and Pump Inlet

The inlet structure (Drain Inlet, concrete pipe diameter 800 mm x 2) had been constructed on the right bank at about 3.3 km downstream in the General Canal for the improvement of the poor drainage area in the right bank. This structure was destroyed by the flood of February 2000 and the structure itself has disappeared.

A Drain Inlet of the same scale would be constructed at the same location in consideration of the HICEP's strong request concerning the importance of the Drain Inlet for the poor drainage area mentioned above.

In addition, there exist the Pump Inlets at four locations in the General Canal for pumping irrigation of the area requiring the pumped-up water along the General Canal. HICEP has agreed that these facilities would be excluded from the object of the rehabilitation and left as they are. It is noted that this would no influence the rehabilitation works of the General Canal, the function of the canal and the pumping intake of the water.

2.3.6 Basic Concept for Operation and Maintenance Plan

A State Company (SIREMO) had managed operation and maintenance of the General Canal before HICEP started the management instead of the state company in 1997. Rehabilitation and repair works of the General Canal has been managed by HICEP itself or by employing a public company in conformity with the management regulations that was formulated by the Cabinet at the same time as the establishment of HICEP. At present, the work order to public companies is issued as the needs arise by means of a tendering method. Rehabilitation plan of the General Canal should be with the same structures as the existing ones in principle and should not interfere with operation and maintenance being managed by HICEP.

HICEP has estimated the amount of the water service charge, and tried to obtain an agreement from the beneficiary farmers for it. It is sensible that HICEP will try to further curtail the amount of the charge.

2.3.7 Basic Concept for Water Management Plan

The Scheme does not need any strict water control because there is an abundance of water resources in the Limpopo River. HICEP has been undertaking water management including operation maintenance of the General Canal and other irrigation facilities in HICEP's own responsibility, although some troubles may have

arisen sometimes. Furthermore, it is considered that similar facilities with similar degree of function should be adopted in the components of the Project. Therefore, it is judged that HICEP will be able to undertake proper water management with her own experience and knowledge. The Intake Structure and the Regulator would be equipped with the discharge-measuring device in order to control the accuracy in the water management. HICEP's staffs, who have much experience of similar operation at present, could easily perform this operation.

2.3.8 Features of the Project Components

On the basis of the above-mentioned basic concept for the Project, the general layout is shown in Figure-2.3.4, and the features are described as below.

(1) Irrigated Area : Total 26,030 ha
(Paddy 18,686 ha, Other crop 7,344 ha)

(2) Major Crops for Plant : Paddy, maize, onion, tomato

(3) Rehabilitation of the General Canal
: 14.3 km: dredging and shaping work

(a) Design discharge : 45.5 m^3/sec: BP ~ Regulator
43.0 m^3/sec: Regulator ~ EP

(b) Canal type : Trapezoidal section, earth canal

(4) Rehabilitation of the Intake Structure
: 1 site (BP of the General Canal)

(a) Planned intake discharge: 45.5 m^3/sec
(b) Type: Box culvert structure with discharge control function by manually operated gate
(c) Gate: Roller gate B x H = 2.0 x 2.0 m, 11 units
(d) Box culvert: B x H = 2.0 x 1.6 m, 11 barrels box culverts

(5) Rehabilitation of the Regulator
: 1 site（about 8.8 km point downstream in the General Canal）

(a) Design discharge: 43.0 m^3/sec
(b) Type: Box culvert structure with discharge control function by manually operated gate
(c) Gate: Roller gate B x H = 2.0 x 2.0 m, 8 units
(d) Box culvert: B x H = 2.7 x 3.5 m, 8 barrels box culvert

(6) Canal Crossing
: 2 sites (about 4.8 km point downstream in General Canal and downstream end of the General Canal)

(a) Design discharge: 45.5 m^3/sec and 43.0 m^3/sec
(b) Type: Box culvert structure
(c) Box culvert: B x H = 3.5 x 3.5 m, 6 barrels box culvert

(7) Drain Inlet

: 1 site (about 3.3 km point downstream from BP of the General Canal)

(a) Type: Concrete pipe structure with gate

(b) Gate: B x H = 0.8 x 0.8 m, 2 units

(c) Pipe: Concrete pipe diameter 0.8 m, 2 barrels

2.4 Basic Design

2.4.1 Design Concept

(1) Design Concept for Natural Conditions

(a) Intake structure site

As described in Sub-section 2.3.2, Basic Concept for Rehabilitation of the Intake Structure, the existing intake structure located in the inlet channel, which had been constructed in 1977 at the right bank of the Macarretane reservoir, was demolished and new intake structure should be constructed in the same inlet channel. Through the result of longitudinal profile survey for the inlet channel carried out in the Basic Study, it was found that the channel bed elevation of around 150m in length from the right bank of the Macarretane reservoir is higher by about 0.3 m ~ 0.4 m than that of the downstream channel. Therefore silting occurred in the area of the above-mentioned channel.

If spread foundation is adopted for the intake structure, the foundation is placed on sandy – silty clay layer distributed at around EL 29.0. According to the result of the geological investigation carried out in the field survey, N-value of the sandy – silty clay layer ranges from 7 to 9. It is estimated that the allowable bearing capacity of the sandy – silty layer ranges from 10.5 t/m^2 to 13.5 t/m^2 as shown in Figure-2.4.1. Through the Basic Design on the intake structure in the case of the spread foundation, it is confirmed that the reaction force of the bottom of the intake is smaller than the above-mentioned allowable bearing capacity. Accordingly, it is judged that the spread foundation is adopted for the intake structure.

The seismic force is not considered for the design of the intake structure since the accelerations by earthquakes at the intake construction site are estimated to be low and negligible.

(b) General Canal

Irrigation water, which is taken from the right bank of the Limpopo River, is distributed to the Scheme through the General Canal running on a route in parallel along the route of 1.5 km far from the Limpopo River.

The General Canal should be rehabilitated and expanded instead of construction of new route because there are no technical and economical

problems with this existing canal route. It is judged the canal inside slope of 1:2.0 designed will be satisfied on structural stability and minimize erosion of the slope.

It was confirmed that there is basically no problem about the land acquisition for the width of expansion of the canal and the access for the construction works, and further HICEP would take measures to meet the situation with its responsibility.

(c) Structures of the Canal Related Facilities

Components of the Project except the Intake Structure consist of the Regulator at 1 site, the canal Crossings at 2 sites and the Drain Inlets at 1 site, which are decided through the discussion with HICEP after confirming the necessity as described before.

Locations of the works have been decided to be the same location as or near to or around the points where the existing structures were constructed based on the technical studies on the necessary points for the respective structures, the topography, and the canal system. Furthermore, it was judged that those locations are convenient from point of the view points of operation and maintenance for the existing structures because the staffs of HICEP have been familiar with those works.

As some structures have been deteriorated partly or completely collapsed due to flood damage, those structures would not function with partial repair, but have to be newly constructed.

Results of the geological investigation show the range of 10.5 ~ 19.5 t/m^2 of bearing capacity and 6 ~ 13 of N-value for structure foundation. It was confirmed that the load is less than one of the bearing capacity in the basic design study. Therefore, the spread foundation would be adopted for all the foundation work of those structures like the Intake Structure. It is noted that seismic force is not taken into account in the design as well as for the Intake Structure. Difference of existing and rehabilitated structures is shown as follows:

Comparison between Existing and After-rehabilitation Structures

Existing Structure Points (Distance from BP of General Canal)	Name of Existing Structure	Name of Structure after Rehabilitation
About 3.3 km Downstream	Drain Inlet	Drain Inlet
About 4.8 km Downstream	New Regulator	Canal Crossing Structure - 1
About 8.8 km Downstream	Old Regulator	Regulator
End of General Canal	Diversion Work	Canal Crossing Structure - 2

(2) Design Concept for Social Conditions

In the rehabilitation works for canal, it is understandable that the best way is to

interrupt irrigation water during the construction period, from technical and economical viewpoints. However, in conformity with the agreement promulgated when HICEP was established in 1997, it is prescribed that water conveyance in the General Canal should not be stopped. Furthermore, considering strong requests of HICEP and the relevant farmers in the Scheme, it has been planned that the rehabilitation works would be executed without interrupting the conveyance of the irrigation water.

On the other hand, as HICEP performs operation and maintenance of the General Canal, the following points should be strictly noted and given much attention for the basic design of the facilities.

- Materials that can be procured at the site or in Mozambique would be used, in order to undertake operation and maintenance easily.
- Complex structure would be avoided as much as possible so as to performs the easy way of operation and maintenance.
- It is strongly recommended that the operation and maintenance section of HICEP would participate to construction of the facilities, because they perform operation and maintenance of the facilities.

(3) Design Concept for Local Contractors and Materials

Relevant facilities would be designed considering construction materials available in Mozambique such as cement, reinforcement bar, concrete pipe, etc., while local contractors will be involved within technically allowable limits to activate the societies of the local contractors and the construction materials suppliers.

(4) Design Concept for Grade of Facilities and Equipment

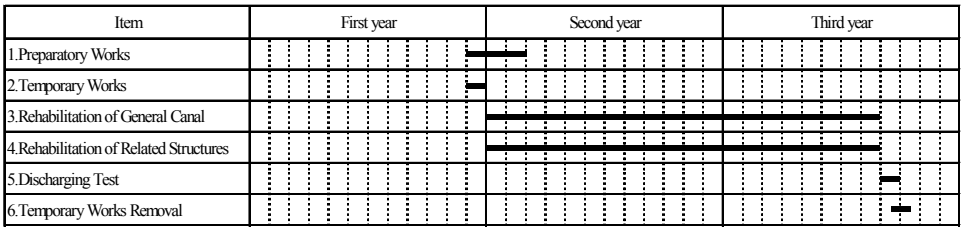
Rehabilitation of the General Canal will apply the current conditions as much as possible, viewing easy operation and maintenance of the existing facilities and proper operation of water distribution. In addition, the structures should be rehabilitated to keep to uniform canal sections and easy control of water discharge, considering the effective use of the water resources, and stable / sustainable operation and maintenance.

Inspection road along the General Canal would be paved with lateratic soil available near the project site, in view of the role and importance in the project area, frequency in use, and easy maintenance.

(5) Design Concept for Implementation Schedule

In formulation of the construction schedule, consideration is given to the number of annual workable days, places of the works, quantities of the works, consistency with the Japanese fiscal year, and tax exemption procedure in Mozambique. Besides this, it is considered that requirement of materials, equipment, and labours should not fluctuate so much through the whole construction period. In addition, the

periods required for the preparation before the works, and for the clearing away after the works should be determined in consideration of the period for various procedures concerning the works. The period for installation and removal of temporary facilities, and period for procurement of major materials and equipment to be used. As a result, the construction period of the Project is estimated to be 22.5 months. It means that it would be implemented in 28.5 months after execution of the Exchange of Notes (E/N).



2.4.2 Basic Design

(1) Rehabilitation Plan of the General Canal

In the rehabilitation plan of the General Canal, the basic plan is shown as follows:

a) In the rehabilitation plan of the General Canal, earth canal with uniform trapezoidal section and constant gradient that makes canal flow hydraulically stable is adopted because of the reasons as described in the previous section Basic Concept of the Project.

b) Though there are such construction methods as the concrete lining and the earth lining with which the canal inside slope surface is lined, earth canal is adopted because of the following reasons:

- The most effective measures in the meaning of the rehabilitation of the General Canal is to recover the condition as of 1977 when the width was expanded, because the existing canal is the earth canal.
- Lining work would be unnecessary because the General Canal is an excavated one of which the bottom is lower than the original ground surface in all the reaches and so there is no anxiety about leakage from the canal.
- Construction cost of the lining canal becomes much higher than if it were dredging and shaping works for the earth canal.
- Lining canal would face certain difficulties in dredging works in case that dredging works would become necessary in the future operation and maintenance.

c) Such canal section as rehabilitation works with excavation works should be as easy as possible taking into consideration that the works will be executed under the condition that irrigation water is continuously flowing in the canal.

d) Design velocity is determined in the range which both of siltation and scouring is not caused. Specified criteria is adopted as the minimum velocity is 0.30 m/sec and the maximum velocity is 0.60 m/sec. Taking such condition into consideration, the velocity of more or less 0.50 m/sec is applied.

e) Initial water level of the General Canal is determined to be WL 31.16 m in consideration of the intake water level (WL 31.38 m) and the head loss (0.22 m) caused at the Intake Structure. On the other hand, the required water level at the downstream end of the General Canal is determined to be WL 29.53 m, which is the planned water level at BP of the primary canal. This was determined in the rehabilitation plan for the downstream area formulated by HICEP.

f) Canal inside slope is determined to be 1 : 2.0 in consideration of stability of the slopes surface of the existing canal. This inside slope is of the value that is generally applied for the earth canal with considerably large discharge. As to the water depth to bottom width ratio, it is 1 : 8 more or less, which is generally applied for earth canal with large discharge, has been adopted.

g) Roughness coefficient to be used for the hydraulic calculation of the General Canal is determined to be 0.027, which is the standard value of earth canals with the short weeds and uniform condition.

h) Inspection road for operation and maintenance of the canal would be constructed on the right bank of the General Canal in consideration of discussion with HICEP and the current condition of the inspection road of the existing canal. The Morrum pavement that is generally adopted in the African countries, in which the soils in the laterite group are taken from the neighbouring areas and compacted, would be adopted for the pavement.

i) Inspection road width is determined to be 5.0 m for the whole width and 4.0 m of the effective width in consideration of the existing road width, the scale of the General Canal, traffic of heavy equipment and vehicle for the operation and maintenance, etc. On the other hand, as for the left bank width of the canal, it is determined to be 5.0 m in consideration of the strong request of HICEP. Regarding the bank width of the present General Canal, the present situation is that the bank crest is used as the farm road, canal scale, and traffic required of heavy equipment for operation and maintenance on the right bank as well. The pavement would not be executed.

j) Berm would be made on the canal inside slope in consideration of canal scale and excavation depth. Berm width is determined to be 4.0 m in consideration of the request of HICEP, and the passage of heavy equipment for operation and maintenance, and the necessity to secure the working space. Berm would be made in the portion from canal BP to the Regulator at about 8.8 km downstream in consideration of the present canal height. Cross slope of 3 % would be put on the canal bank crest and berm so as to keep it well drained.

k) Minimum canal bank elevation is planned to be higher than the present bank

elevation or to be 1.0 m higher than the original ground surface. The part of slope surface higher than the design water level would be covered with the sodding to prevent slope surface from gully erosion.

On the basis of the above basic plan, basic rehabilitation section of the General Canal is determined as shown in Figure-2.4.2. General features of the rehabilitation plan of the General Canal are shown as follows:

General Features of Rehabilitation Plan of the General Canal

Item	General Features
a) Design discharge	Canal BP ~ Regulator: 45.5 m^3/sec, Regulator ~ canal down stream end: 43.0 m^3/sec
b) Canal bottom width	25.0 m, partially expand to 30 m ~ 40 m to avoid earthfilling in the canal (about 800 m)
c) Total canal length	14.3 km (from the Linpopo River to canal downstream end)
d) Net canal part length	13.8 km (excluding longitudinal lengths of Intake Structure part, No.1 Canal Crossing Structure, Regulator and No.2 Canal Crossing Structure)
e) Design water depth	45.5 m^3/sec: 2.61 m 43.0 m^3/sec: 2.53 m
f) Design velocity	45.5 m^3/sec: 0.58 m/sec 43.0 m^3/sec: 0.57 m/sec
g) Canal inside slope	1 : 2.0
h) Canal height	4.34 ~ 8.35 m (including excavation depth)
i) Canal bank crest width	5.0 m
j) Planned Water Level at canal BP	WL 31.16
k) Planned Water level at canal downstream end	WL 29.53
l) Canal longitudinal slope	1 / 11,500

(2) Rehabilitation Plan of the Intake Structure

Basic plan for rehabilitation of the Intake Structure is as follows:

a) Existing new intake structure is demolished for reasons of deterioration of the structures such as the gates, hoists and a part of the concrete structures and insufficient flow capacity for the designed intake discharge of the Project. Therefore intake structure should be newly constructed.

b) The intake is constructed in the inlet channel same as the existing new intake, to avoid in-flow of sediment from the Limpopo River into the intake and the effect of bank erosion and vortex of the river flow caused by flood-water of the Limpopo River to the intake structure. Based on the result of the topographic survey, it was found that siltation was observed for a distance of around 150m from the river bank of the Limpop River. The intake is constructed at 200m

distance from the riverbank and the location is around 60m upstream of the existing new intake.

c) Design intake discharge is determined to be 45.5m^3/sec.

d) Since the average canal bed elevation along the intake construction site is around EL 30.00 as per the survey result carried out in 1994 and 2000, the elevation of entrance sill of the intake is set at EL 30.00.

e) Design intake water level is determined to be EL 31.38 lower by 1.2m compared with full supply level of EL 32.58 considering the stable water supply from the Macarretane Reservoir. This design intake water level of EL 31.38 is adopted based on the study carried out for the construction of the Macarretane Weir, and the rehabilitation plan of HICEP applies the same design intake water level.

f) Water velocity at the entrance sill of the intake is estimated at 1.0 m/sec.

g) Crest elevation of the dike is set at EL 38.00 based on the water level of EL 36.80 corresponding to 100–year probable flood. (Freeboard of the dike is 1.2m.) The crest width of the dike is decided to be 6 m since the magnitude of flood of the Limpopo River is large and the dike crest is used for not only the inspection road of the Project but also the public traffic.

h) As for the intake structure, box culvert is adopted considering design intake water level, flood water level, and sill elevation of the intake. Screen, hoist deck and roller gates are provided at the inlet of the intake.

i) Spread foundation, on sandy-silty clay layer with N-value ranging from 7 to 9, is adopted.

j) For the sake of easy operation for discharge control and maintenance work, the gate of manual operation is adopted, and all the gates of the intake are to be closed during flooding of the Limpopo River.

k) Orifice type discharge measuring device is provided of the intake structure. The staff gauges for measuring water level are also provided in the inlet and outlet portions. Measuring of the discharge will be made in calibration of the difference of the water levels in the inlet and outlet and the opening of the gate.

l) Upstream and downstream parts of the structure would be protected with the gabion mattress basket-work to prevent the canal from erosion.

General features of the Intake Structure are as follows:

General Features of Rehabilitation Plan of the Intake Structure

Item	General Features
a) Location	About 200 m downstream from junction of the Linpopo River and the existing General Canal, about 60 m upstream from the existing New Intake Structure
b) Type	Box culvert structure with discharge control function by operation of manual gate
c) Planned intake discharge	45.5 m^3/sec
d) Planned intake water level	WL 31.38
e) Bottom elevation of inlet of Intake Structure	EL 30.00
f) Intake width	34 m
g) Gate	Roller gate, B x H = 2.0 x 1.6 m 11units
h) Box culvert	B x H = 2.0 x 1.6m, 11 barrels box culvert
i) Longitudinal length ofculvert part	27.74 m
j) Structure total length	89.8 m (including lengths of upstream and downstream transitions, culvert part, stilling basin part , etc.)
k) Discharge measuring facilities	Orifice type in combination of water level and gate opening

(3) Rehabilitation Plan of the Regulator

The basic plan for rehabilitation of the Regulator is as follows:

a) The Regulator would be constructed near the existing Old Regulator (about 8.8 km downstream in the General Canal) after removing the Old Regulator that has overturned due to the flood.

b) The Regulator structure is determined to be the box culvert structure, same as the existing Regulator having taken into consideration the canal bank height in the upstream, the regulating water level, the economical advantage and the construction work convenience. Roller gate by manual operation for water level regulating will be installed on the front surface of it. A road shall be constructed on the culvert for crossing the canal.

c) Design discharge is determined to be 43.0m^3/sec, which is the design discharge in the downstream reaches of this structure in the General Canal.

d) Bottom elevation of the inlet is determined to be of the same as the bottom elevation of the General Canal at the upstream of the structure so as to prevent the structure from the siltation and to decrease the hydraulic turbulence of the flow.

e) Foundation of the Regulator would be spread foundation on sandy clay (silty clay) with a N-value of 10 ~ 13.

f) Structure height is determined in consideration of the canal bank heights at upstream and downstream of the structure.

g) Orifice type discharge measuring device is provided of the intake structure. The staff gauges for measuring water level are provided in the inlet and outlet

portions. The measuring of the discharge will be made in calibration of the difference of the water levels in the inlet and outlet and the opening of the gate.

h) Upstream and downstream of the structure would be protected with the gabion mattress basket-work to prevent the canal from erosion.

General features of the Regulator are as follows:

General Features of Rehabilitation Plan of the Regulator

Item	General Features
a) Location	About 8.8 km downstream in the General Canal, about 50 m downstream of the Old Regulator
b) Type	Box culvert structure with discharge control function by operation of manual gate
c) Design discharge	43.0 m^3/sec
d) Inflow width	23.35 m
e) Gate	Roller gate, B x H = 2.0 x 2.0 m 8units
f) Box culvert	B x H = 2.7 x 3.5m, 8 barrels box culvert
g) Structure total length	73.13 m (including lengths of upstream and downstream transitions, culvert part, inflow gate part, etc.)
h) Discharge measuring facilities	Orifice type in combination of water level and gate opening

(4) Rehabilitation Plan of the Canal Crossing Structure

The basic plan for rehabilitation of the Canal Crossing Structure is as follows:

a) One of Canal Crossing Structures would be constructed at the place of the existing New Regulator (about 4.8 km downstream in the General Canal). The other would be constructed at the place of the existing Diversion Work at the downstream end of the General Canal. Those structures are provided after removing the existing structures.

b) As for the facilities for crossing the canal, road bridge and box culvert type are considered as alternatives. Box culvert type of canal crossing structure, which would be economical and easy in construction is selected, considering the result for the comparative study of bridge type and culvert type with canal width (width between inside edges of the bank crest of 50 m, bottom width of 25 m) and the canal height (7.4 m). It is noted that all the existing structures in the General Canal are of the box culvert type and in case of the culvert, the stability of the foundation that is the spread foundation would be higher than it is for the road bridge.

c) Road width is determined to be 5.0 m (effective width of 4.0 m) consequent to the results of discussion with HICEP, the traffic of heavy equipment, and the vehicle for operation and maintenance, canal size, and the current condition of the existing inspection road.

d) Bottom elevation of box culvert is determined to be same as of the bottom elevation of the General Canal to the upstream of the structure so as to prevent

structure from siltation and to decrease hydraulic turbulence of the flow.

e) Foundation of the Canal Crossing Structure would be of the spread foundation type on sandy clay (silty clay) with a N-value of 7 ~ 10.

f) Structure height is determined after paying due consideration to the canal bank heights at upstream and downstream parts of the structure.

g) As for the culvert section, the design velocity in the box culvert is determined for it to stay at about 1.5 times of the design velocities in the canal at upstream and downstream of the structure.

h) Upstream and downstream of the structure would be protected with the gabion mattress basket-work to prevent the canal from erosion.

General features of the Canal Crossing Structure on the basis of the above consideration are as follows:

General Features of Rehabilitation Plan of the Canal Crossing Structure

Item	General Features	
	No.1 Canal Crossing Structure	No.2 Canal Crossing Structure
a) Location	4.8 km downstream in the General Canal, about 50 m downstream of the existing New Regulator	Downstream end of the General Canal, about 50 m downstream of the existing Diversion Work
b) Design discharge	45.5 m^3/sec	43.0 m^3/sec
c) Type	Box culvert structure	Box culvert structure
d) Inflow width	22.75 m	22.75 m
e) Box culvert	B x H = 3.5 x 3.5 m, 6 barrels box culvert	B x H = 3.5 x 3.5 m, 6 barrels box culvert
f) Structure total length	61.0 m (including lengths of upstream and downstream transitions and culvert part)	61.0 m (including lengths of upstream and downstream transitions and culvert part)
g) Road width	5.0 m (effective width 4.0 m)	5.0 m (effective width 4.0 m)

(5) Rehabilitation Plan of the Drain Inlet

Basic plan for rehabilitation of the Drain Inlet is as follows:

a) The Drain Inlet (inflow structure) would be constructed on the right bank at about 3.3 km downstream from BP of the General Canal as an improvement to the poor drainage area.

b) The structure would be of the same type as the previous Drain Inlet that has disappeared due to flood. The drainage-water could be made to flow into the General Canal through the concrete pipe (pipe diameter 800 m x 2) passing under the right bank of the canal.

c) Drainage water could be discharged when water level of the General Canal becomes lower. It depends on the relationship between water levels on the drainage area and the level in the General Canal. Slide gate would be installed at the canal side to prevent the irrigation water in the General Canal from flowing out.

General features of the Drain Inlet are as follows:

General Features of Rehabilitation Plan of the Drain Inlet

Item	General Features
a) Location	About.3 km downstream in the General Canal
b) Type	Concrete pipe structure with gate
c) Concrete pipe	Inner diameter 0.8m, total length 20 m x 2 barrels
d) Gate	Slide gate, B x H = 0.8 x 0.8 m, 2 units
e) Structure of inlet part	Trapezoidal section with bottom width of 7.0 m, inlet part is protected with gabion mattress basket work in 7.5 m length
f) Structure of outlet part	Chute type along inside slope of the General Canal (width 2.3 m, height 1.0m) is protected with gabion mattress basket

2.5 Basic Concept for Project Implementation

2.5.1 Organization

Ministry of Agriculture and Rural Development (MADER) is the executing agency of the Project. The Programme Implementation Unit (UIP) and Hidráulica de Chókwè, E. P.(HICEP) under the MADER will have direct responsibility for the Project implementation. Figure-2.5.1 presents the relation between MADER and UIP.

UIP is the direct agency for promotion and implementation of rehabilitation of the Scheme under the minister of MADER directly. At present, the rehabilitation works of the Scheme has been undertaken by UIP in collaboration with HICEP, which is the responsible agency for operation and maintenance works of the Scheme.

UIP has three sections and a staff of 21 in total. Therefore, the joint works of UIP and HICEP is essential for the implementation of rehabilitation works of the Scheme. For the purpose to getting together smooth activities of both agencies, the president of UIP and HICEP is made one and the same person. Organization of UIP is shown as below.

2.5.2 Budget

The budgets of UIP for the past two years are tabulated below. The budget will be allocated upon the negotiation with DNHA and it is included in PAAO.

(Unit : Meticais)

Year	Budget
2000	102,336,000
2001	616,494,000

The budget of UIP has increased by about 6 times in 2001, covering only the salaries of the staff and office consumables. Rehabilitation of the Scheme has been performed applying the budge funded from the foreign donors.

On the other hand, the operation budget of HICEP is being managed by utilizing the water tax paid by water users who have the responsibility of cultivation in the Scheme. Organization and responsibilities of HICEP is described in Sub-section

3.2.2 and 3.2.3.

2.5.3 Staffing

(1) Staffing

(a) Programme Implementation Unit (UIP)

UIP is a direct agency for construction supervision of the rehabilitation of the Scheme and consists a staff of 21 in total as of December 2000. Out of 21 staffs, there are one Director, one Technical Director, 9 staffs in Fiscalization section, 4 staffs in Rural Development section and 6 staffs in Administration section. These directors, technical director, and 4 staffs of rural development are irrigation engineers.

(b) Hidráulica de Chókwè, E. P.(HICEP)

As described in Sub-section 3.2.3 concerning organization of HICEP, the staff is broadly divided into two categories in Headquarters and Hydraulic Sectors. The headquarters has 40 staffs, out of which seven Administration Counsels, three Supervisor Counsels, eight Cabinet members, six Technical Directors, nine Administration Directors, and seven Secretaries. Meanwhile, the hydraulic sectors consists of three sub-sectors, such as Montante, Sul and do Rio, and 146 staff members in total are deployed, that is six staff members in Direction section, 116 staff members in Water Management section, and 24 staff members in Administration and Finance section. Six technical directors in the headquarters are high level civil and/or irrigation engineers. While six staff members in direction section and 116 staff members in water management section of the hydraulic sectors are middle and/or more lower level civil/irrigation engineers.

(2) Technical Level

UIP has concerned in the rehabilitation of the Scheme since 1994 at the time when the government decided its implementation. HICEP was established in 1997. On the other hand, AFD has dispatched her engineers, and carried out technical assistance from 1994, by formulating organization of the executing agency, rehabilitation of the Scheme, and supervision of construction works under the rehabilitation. Since December 2000, 7 engineers of AFD have been deployed in UIP.

UIP has experience in undertaking construction works together with HICEP, through such contract management system, such as the current rehabilitation works of the Scheme. Rehabilitation works for the damaged facilities caused by the flood occurred in February 2000 have been executed on the contract basis with the contractors from Portugal and South Africa under the supervision of AFD staff. From such experience mentioned above, it is judged that the staff concerned with UIP and HICEP has enough knowledge to supervise the construction works.

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

(1) Implementation Method

The Project will be implemented on the following conditions in consideration of the application for Japan's Grant Aid System.

(a) MADER will be the executing agency for the Project implementation.
(b) When the Exchange of Note (E/N) between GOJ and GOM regarding the stages of detailed design and construction works is signed, MADER will take care of overall procedures necessary for the implementation of the Project.
(c) A Japanese Consultant firm, recommended by the Japan International Cooperation Agency (JICA) and entrusted by MADER will sign the contract with MADER, and will prepare detailed design and tender documents. After that, the Japanese Consultant will start the tendering work.
(d) GOM shall commence arrangement for land secure in parallel with detailed design.
(e) A Japanese Contractor after signing the contract for construction works, will undertake the construction works and the consultant will execute construction supervision.
(f) Upon completion of the construction works, the responsibility of operation and maintenance function will be transferred to HICEP.

(2) Formation of Construction

In Mozambique, several Japanese contractors have been engaged in the construction works of projects under the Japan's Grand Aid Programme. These contractors have employed the local contractors as subcontractors, mostly for the purpose of manpower supply and construction equipment.

In this Project, construction works are planned to be performed on the basis that the Japanese contractor will arrange construction equipment and materials by himself and also use the manpower supplied by the subcontractors.

(3) Necessity of Japanese Experts for the Contractor

The construction works will consist of the following construction works:

(a) Rehabilitation of General Canal,
(b) Rehabilitation of Related Structures

Taking into account the quantities of the construction materials, condition of the rehabilitation that water flow of the general canal would not be stopped during the construction period, these works are divided into two working groups one for canal

work and one for structure work. One (1) Japanese expert will be assigned for each work group. In addition, at the beginning of the construction works, two Japanese experts will be assigned for quality control (concrete and soil mechanics). Thus, the following Japanese experts will be assigned;

(a) Manager
(b) Expert (general canal)
(c) Expert (related structures)
(d) Expert for quality control (soil mechanics)
(e) Expert for quality control (concrete)

3.1.2 Implementation Conditions

(1) Environment Impacts during Construction

The possible environment impacts during the construction will be (i) noises due to the construction, (ii) dusts mainly from the vehicles, (iii) vibration due to operations of heavy machines and (iv) traffic accidents. At every construction site, it is likely that any damage to buildings will not occur due to noise and vibration. However, considering the inhabitants, night works should be strictly prohibited in principle. In order to avoid dusts mainly from the vehicles, spreading of water on to the construction road will be carried out properly. In addition, prevention of accidents caused by construction equipment should be encouraged by (a) gadget for limiting driving speed, (b) regular safety meeting, and (c) deployment of traffic control officer.

(2) Construction in Existing Cultivated Land

The construction works will be executed in the existing general canal along cultivated lands. Regarding suspension of farming of such lands during the construction work, it was confirmed through HICEP that the beneficiary farmers would cooperate with the contractor so as not to interfere with the construction works. The Contractor, however, should explain to the farmers about construction schedules and sites with the assistance of office staff of HICEP, prior to commencement of the construction works.

3.1.3 Scope of Works

(1) Scope of Works to be executed by Japanese Side

(a) Detailed design and preparation of tender documents.
(b) Undertaking of the construction for rehabilitation of general canal and related structures as described in Section 2.3.

(2) Undertaking by Government of Mozambique

(a) Land provision and arrangement required for implementation of the Project.
(b) Coordination with other relevant agencies and issue necessary consent(s)

concerned for implementation of the Project

(c) Provision of technical support by HICEP to Farmers' association.

(d) Budget arrangement and payment for import tax, internal taxes, and other levies under implementation of Japan's Grant Aid project.

(e) Confirmation and security the safety including landmine in and around the construction area by HICEP

3.1.4 Construction Supervision

(1) Preparation of Detailed Design and Tender Documents

Immediately after signing E/N between GOJ and GOM for the detailed design and construction works, the contract for the consulting services will be concluded between MADER and the Japanese Consultant, and then detailed design and tender documents will be prepared in collaboration with MADER. The Consultant should discuss the design and implementation schedule of the works with MADER during the site investigation. At the detailed design stage, the following works will be done:

(a) Additional investigation / survey

1) Investigation for the locations of the bypasses for construction of related structures
2) Investigation of road network around intake structure
3) Checking of shape and position of canal section where the existing canal is wider than the design section
4) Checking of location of pavement materials for inspection road

(b) Preparation of detailed design

1) Detailed design based on the basic design and the additional investigation/survey results.
2) Review of the Project cost through the detailed design.

(c) Preparation of the tender documents

1) Preparation of the tender drawings.
2) Preparation of the tender documents for the construction works.

(2) Tendering and Construction Supervision

After completion of the works on the detailed design and preparation of tender documents, the Japanese Consultant will start tendering work in collaboration with MADER at first. The scope of construction supervision is summarized as follows:

(a) Evaluation and approval of construction drawings

1) Evaluation and approval of construction drawings, application for commencement of the works, sample of materials, specifications of the equipment, etc. submitted by the contractor.

(b) Progress and quality control

1) Checking and guidance on the construction plan and time schedule, quality control and progress of the construction works and necessary inspection of the construction methods.

(c) Approval for the payment to the contractor

1) Checking and evaluation of the performance of the works necessary for issuing payment certificates and completion certificate to the contractor.
2) Attendance at the handing-over of the completed facilities to HICEP after confirming the completion of the works and fulfillment of the contract.

3.1.5 Procurement Plan

Major construction materials for the construction works are cement, aggregates, crushed stones, pre-cast concrete products, forms, reinforcement bars, PVC pipes, etc. These materials are available in Mozambique. On the contrary, water-sealing gate having adequate quality standard is not purchasable, and thus it will be imported from Japan.

Since there are several lease companies of construction equipment in South Africa, it is possible to hire construction equipment from them. Accordingly required construction equipment will be leased for this Project.

3.1.6 Implementation Schedule

As stated in Section 2.3 of Basic Design, the Project will be implemented under the following phases:

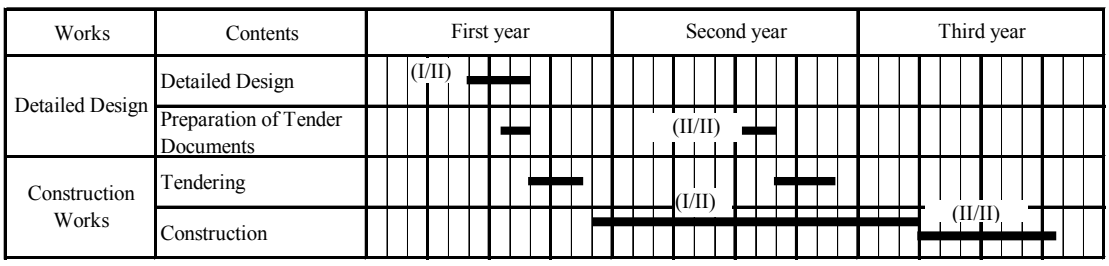
(a) Stage of detailed design

	Phase-I/II	Phase-II/II
1) Detailed design	3.0 months	-
2) Preparation of tender documents	2.0 months	1.5 months

(b) Stage of construction

	Phase-I/II	Phase-II/II
1) Tendering works	3.0 months	3.0 months
2) Construction works	16.0 months	6.5 months

The construction schedule is shown below.



3.1.7 Obligations of Recipient Country

a) To provide data and information necessary for the Project.

b) To secure the land necessary for the execution of the Project, such as the Right of Way, land for temporary offices, working areas, storage yards and others.

c) To arrange budget and staff of MADER for the implementation.

d) To bear commission to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement, namely the advising commission of the "Authorization to Pay" and payment commissions.

e) To ensure prompt unloading and customs clearance ports of disembarkation in the Government of the Republic of Mozambique and prompt internal transportation therein of the materials and equipment for the Project purchased under the Grant Aid.

f) To exempt Japanese juridical and physical nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Mozambique with respect to the supply of the products and services under the verified contractors.

g) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contract such facilities as may be necessary for their entry into Mozambique and stay therein for the performance of their work.

h) To provide necessary permissions, licenses and other authorizations for implementing the Project if necessary.

i) To maintain and use properly and effectively the facilities constructed and equipment provide under the Project.

j) To coordinate and solve any issues related to the Project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

k) To bear all the expenses, other than those covered by Japans Grand Aid, necessary for the execution of the Project

l) To secure the safety of Japanese national engaged in the Project and to provide tight security against riot, insurrection, civil commotion, rebelling, usurped power and landmine.

3.2 Operation and Maintenance Plan

3.2.1 Government Policy for Chokwe Irrigation Scheme

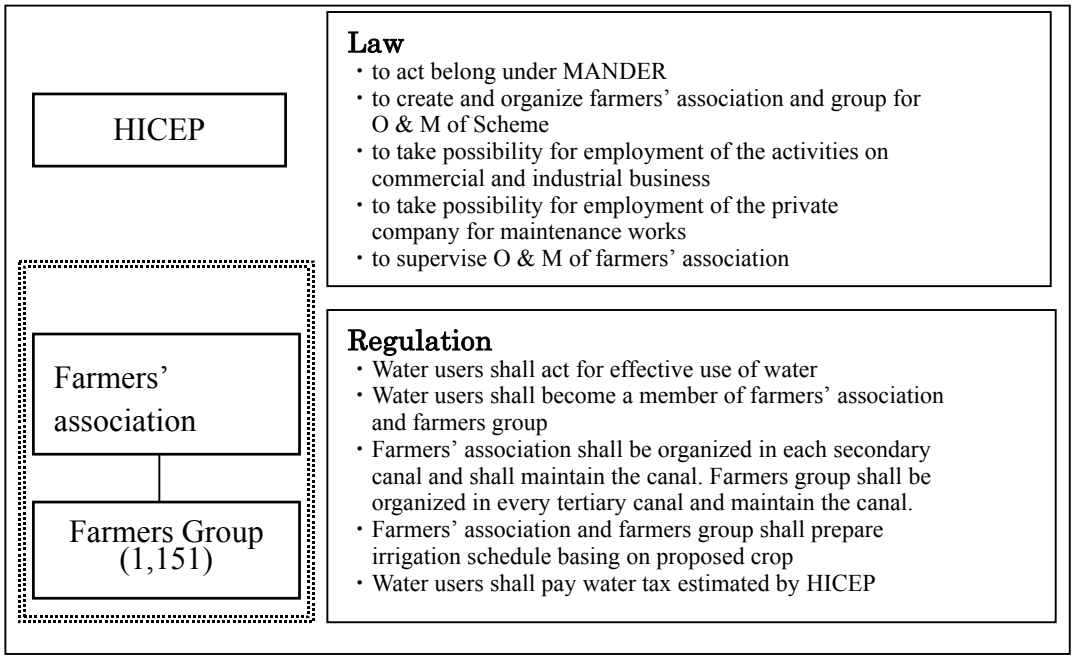
Operation and Maintenance of the Scheme has been managed by a state enterprise since the early 1950s when it was constructed. In 1980s, the management of the Scheme by a state enterprise deteriorated financially because of state cutbacks on national spending and slacking income due to the extension works with falls in

equipment hire and water tax. In the early 1990s, the project rehabilitation was initiated and the government undertook a rehabilitation plan including creation of new enterprise to manage the Scheme. As a result, HICEP was established to manage the Scheme. Immediately after this establishment in 1997, HICEP commenced the activities following the laws and regulations of the Scheme enacted by the government.

3.2.2 Roles of HICEP and Farmers' Association

Operation and Maintenance of the Scheme will be carried out by HICEP and farmers' association consisting from beneficiary farmers in the light of laws and regulations established by the government and HICEP. The roles of HICEP and water users such as farmers' association and farmers' groups are summarized below.

Roles of HICEP and Farmers' association



3.2.3 Organization of HICEP

The public company, HICEP, is responsible for the overall management of the Scheme, and has the formal mandate for the reorganization and substantial increase of the profitability, particularly after the completion of rehabilitation of the Scheme.

The organization of HICEP is broadly divided into two categories, namely in Headquarters and Hydraulic Sectors. The headquarters has a staff of 40. These are seven Administration Counsels, three Supervisor Counsels, eight Cabinets, six Technical Directors, nine Administration Directors, and seven Secretaries. Meanwhile, the hydraulic sectors consists of three sub-sectors, such as Montante, Sul and do Rio, and 146 staff members in total are deployed, that is six staff members in Direction section, 116 staff members in Water Management section and

24 staff members in Administration and Finance section. Six technical directors in the headquarters are high level civil and/or irrigation engineers. While six staff members in direction section and 116 staff members in water management section of the hydraulic sectors are middle and/or lower ranking civil/irrigation engineers. The organization chart is shown in Figure-3.2.1 and the constitution of staff members are shown in Table-3.2.1 and Table-3.2.2.

Staff members from the state enterprise who is the former responsible agency for the operation of the Scheme are in majority group in HICEP, so that they are aware of the system and objectives to manage the Scheme.

3.2.4 Farmers' Association

Beneficiary farmers who practice their activities in the Scheme shall be member of farmers' association and comprise approximately 12,400 farmers who are all the whole farmers at present. Farmers' groups, who have responsibility of management of tertiary canal, are located under farmers' association. Roles of the farmers group are explained in Sub-section 3.2.2 and list of the groups is shown in Table-3.2.3.

3.2.5 Training Programme of Farmers' Association

HICEP has a plan in order to promote capacity building and strengthening of farmers' association, aiming at establishing a sustainable operation and maintenance of the relevant facilities such as secondary and tertiary canals in the Scheme which will be performed by the farmers' association. The plan is summarized below and the schedule is shown in Table-2.2.1.

(1) First Term

Training period of the programme is two years in principle, but altered as required, depending on the progress of the programme. Basic components of the programme are summarized below.

- To understand legal, internal rules established by the government and HICEP for operation and maintenance of the Scheme
- To understand overall aspects of administration, accounts and organization
- To recognize technical aspects of selection of crops and its water calendars
- To apprehend technical aspects on operation and maintenance of infrastructures particularly those secondary and tertiary canals

The programme will be carried out obtaining the technical assistance of Portugal government and further the engineers of HICEP concerned to for water tax and farmer's credit will also participate in the programme.

(2) Later Term

During the later term, farmers will have actual practices, namely the results achieved in the first term will be applied in the respective sites. The three years planned for this training is the maximum period in the schedule, but a minimum of one year depending on the performance of the farmers' association. This training will be carried out under the supervision of HICEP, and it is expected that farmers' association promote their capacity for operation and maintenance of the facilities.

3.2.6 Water Tax

Water tax to be collected from water users, who are mainly beneficiary farmers of the Scheme, will be recovered for operation and management of HICEP and water fee of Limpopo river to be paid to ARA-SUL (Regional Administration of Southern Water in Ministry of Public Works and Housing). The tax of each cropping season will be estimated by HICEP based on the cropping schedule prepared by farmers' association. Tax amount calculated by HICEP shall be announced to farmers' association and should be authorized.

At present, HICEP have estimated at US$129/ha/year for water tax taking the current situation of the Scheme into consideration. It seems, however, that HICEP is merely collecting the water tax of US$45/ha/year from user farmers because irrigation water has not been supplied properly to farm plots due to poor maintenance of the existing infrastructures. Meanwhile, HICEP has estimated at US$111.3/ha/year as water tax at a future stage condition after rehabilitation of the Scheme. Water tax of Limpopo river to be paid to ARA-SUL is estimated at 4MT/m^3 compared with that for the present price of 20MT/m^3.

In advance, HICEP has given user farmers and Agriculture Season's Committee in Chokwe of advance notice that US$120/ha/year of the water tax would be applied at a stage when the whole infrastructures are rehabilitated properly and have thus obtained their agreement tentatively. In parallel to the advanced notice, HICEP in being effort to farmers to explain (i) method and schedule of rehabilitation and repair (ii) extent for duties of farmers, (iii) contents on strengthening programme of farmers' association and (iv) manner for collection of water tax. Therefore, HICEP takes no serious notice of; the water tax at US$111.3/ha/year. However, it is strongly recommended that HICEP should consider the following countermeasures for reducing of the water tax in order to accomplish sustainable and effective operation and maintenance of the Scheme.

- To try steady operation and maintenance of HICEP and supply irrigation water to user farmers effectively, and ensure collecting the water tax from user farmers.
- To support user farmers technically concerning improvement of agricultural productivity and farmers' income.
- To complete rehabilitation and repair work of the whole infrastructures on schedule.
- To retrench number of staffs in the headquarters from 40 to 30.

- To transfer completely HICEP's responsibility for secondary canal to farmers' association
- To transfer simple maintenance works on the primary infrastructures to farmers' association

It seems that HICEP and farmers' association would need 10 years as the transition period at least, in order to accomplish smooth and effective operation and maintenance of infrastructures. When the above mentioned consideration are achieved sufficiently, it is expected that HICEP will have responsibility only for operation and maintenance of the General Canal and primary canals, and thus resulting in the water tax being reduced to US$78/ha/year, which is approx. 70% of US$111.3/ha/year.

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATIONS

4.1 Project Effect

The Project will generate the following direct and indirect impacts, contributing to an improvement in farmers' income, stability of food supply, and enhancing farmers' living conditions in the Scheme and Mozambique.

4.1.1 Direct Impact

Through the implementation of the Project, the existing irrigation area will reliably receive the required water of 45.5 m^3/sec at the head of the General Canal and 43.0 m^3/sec at the tail. As a result, HICEP will be able to supply irrigation water to the whole irrigable area of 26,030 ha.

4.1.2 Indirect Impacts

The following impacts would be expected with the rehabilitation of the General Canal.

(1) Implementation of Sustainable Irrigation in 26,030 ha of HICEP

Existing irrigated area of around 5,000ha will be expanded up to 26,030ha by the year of 2007, as sustainable supply of irrigation water would be achieved.

(2) Improvement of Cropping Intensity

The cultivated area will be expanded by achieving a sustainable supply of irrigation water during the rainy and dry seasons. Namely, it means that users will be able to cultivate crops during the dry season, although crop cultivation during the dry season is hardly carried out under the present condition. HICEP will strengthen technical assistance for agricultural activities with the aim of reaching 150% of cropping intensity. Furthermore, it is expected that the District Agricultural Office, Chokwe Agricultural Research Station, Agricultural Cooperative, NGO, etc. will, singly or acting in combination, mutually support a series of activities on agricultural extension, research, and micro-finance.

(3) Increment of Unit Yield and Improvement of Quality of Agricultural Products

Based on the sustainable supply of irrigation water and adequate input of farming materials, crop yield will be improved rather than at the present condition. For instance, paddy yield levels for small scale farmers and middle/large scale farmers are currently 1.5 ton/ha and 3.5 ton/ha, respectively. In future, those levels would be increased to 3.5 ton/ha and 5.0 ton/ha, respectively. It is expected to obtain products with improved quality, due to proper farming practices and harvesting at proper time.

(4) Improvement of Farmers' Income

As shown in Table 2.2.1, it is expected that around 4,600 persons will benefit from a stable supply of irrigation water to around 14,000 ha of the Scheme when rehabilitation of the General Canal is completed in 2004. The number of users will be increased to 12,400 persons, when all the rehabilitation and repair work will be completed by the year of 2007.

It is said that a householder and some of his (or her) family members have been registered as users of Chokwe Irrigation Scheme. As opinion of HICEP, it is noted that average holding size of users in the Scheme is around 4 ha.

(i) Cost and Revenue for Paddy Cultivation

Tables 4.1.1 to 4.1.4 show cost and revenue per ha for paddy cultivation by farm size in the current and proposed situations and are summarized as follows:

Cost and Revenue for Paddy Cultivation per Ha

	Farm Size of less than 4ha		Farm Size of more than 4ha	
	Current	Proposed	Current	Proposed
Unit Yield(ton/ha)				
Cost(MT)	2,509,500	5,061,300	6,062,600	8,569,400
Gross Revenue(MT)	3,750,000	8,750,000	8,750,000	12,500,000
Net Revenue(MT)	1,240,500	3,733,700	2,687,400	3,930,600

Source: Internal data of HICEP, December 2000

(ii) Current Situation of Users' Income and Expenditure

In order to understand the status of farmers, 60 sample farmers were selected for farm economy survey based on the users' list prepared by HICEP. The farmers were selected from the typical four villages, considering holding size (less than 1 ha, 1 ha to 4 ha, 4 ha to 10 ha, more than 10 ha), as shown in the below table.

Sampled Users

Village	Holding Size（ha） (Averaged Size)				Total
	0～1.0 (0.5)	1.0～4.0 (1.0)	4.0～10.0 (4.0)	10.0～ (10.0)	
Chokwe	7	3			10
Chilembene		7	6	7	20
Massavasse		9	7	4	20
Lionde	4	5	1		10
Total	11	24	14	11	60

Table 4.1.5 shows an estimate of the current income and expenditure of users and is summarized as follows:

Current Income and Expenditure of Users by Farm Size

(1) Farm Size	0.5ha		1.0 ha		4.0ha		10ha	
	MT	US$	MT	US$	MT	US$	MT	US$
(2) Net farm income	620,000	36	1,241,000	72	10,750,000	625	26,874,000	1,562
(3) Income of livestock and non-farm income	6,384,000	371	9,606,000	558	8,010,000	466	9,735,000	566
(4) Expenditure	6,066,000	352	6,398,000	372	7,876,000	458	16,296,000	947
(5) Water tax	387,000	22	774,000	45	3,096,000	180	7,740,000	450
(6) Net revenue	551,000	32	3,675,000	213	7,788,000	453	12,573,000	731

Source: Internal data of HICEP and result of farm interview survey, December 2000

(iii) Expected Situation of Users' Income and Expenditure

A stable supply of irrigation water in the System would be attained after rehabilitation of the General Canal and completing repairs to other irrigation and drainage facilities. As a result, double cropping with 150% cropping intensity instead of single cropping would be carried out. Therefore, it is expected that the net revenue of user's would increase by 2 to 4 times in the future. Table 4.1.6 shows the proposed income and expenditure of users and is summarized as follows:

Expected Income and Expenditure of Users by Farm Size

(1) Farm Size	0.5ha		1.0 ha		4.0ha		10ha	
	MT	US$	MT	US$	MT	US$	MT	US$
(2) Net farm income	2,801,000	163	5,601,000	326	23,585,000	1,371	58,959,000	3,427
(3) Income from livestock and non-farm income	6,384,000	371	9,606,000	558	8,010,000	466	9,735,000	566
(4) Expenditure	6,066,000	352	6,398,000	372	7,876,000	458	16,296,000	947
(5) Water tax	954,600	55	1,909,200	111	7,636,800	444	19,092,000	1,110
(6) Net revenue	2,164,400	127	6,899,800	401	16,082,200	935	33,306,000	1,936

Source: Internal data of HICEP and result of farm interview survey, December 2000

(iv) Discussion

For paddy cultivation, the proposed annual water tax of US$111 per ha is estimated, that is around 30% of net farm income. Judging from this estimate, users would have sufficient capacity to pay the water tax in the future. Additionally, HICEP will try to reduce the amount of water tax to around US$78, as described in Sub-section 3.2.6. In this case, the proportion of water tax could be reduced to around 20% of the net farm income for paddy cultivation. Furthermore, it is strongly recommended that the annual water tax should be gradually settled from US$45 to US$111 year by year, in order to mitigate the load of payment which small-scale users would have to bear.

(5) Role as Granary of Mozambique

The trend in paddy production in Mozambique between 1964 and 1999 is shown as follows:

Paddy Production in Mozambique

	1964	1974	1979	1984	1989	1994	1999
Production (ton)	105,000	120,000	70,000	84,000	95,000	101,212	186,000
Harvested (ha) area	65,000	75,000	90,000	100,000	110,000	121,287	170,000
Unit yield (ton/ha)	1.6	1.6	0.8	0.8	0.9	0.8	1.1

Source: FAO Production Yearbook (http/www.fao.org/)

It seems that annual paddy production has been increasing steadily, although it was affected by the internal war that followed independence in 1975. However, this increase has been caused by expansion of the cultivated area, not by improvement of productivity. In fact, it is noted that the unit yield of paddy in 1999 is still lower than the level of the 1960s.

Ministry of Agriculture and Rural Development has estimated supply and demand of major crops as of 1999 as follows:

Supply and Demand of Major Food Crops in Mozambique in 1999

	Maize	Paady	Wheat	Millet	Cereal Total	Cassava	Root Crops	Pulses
1.Domestic Supply								
Carry-over	60	24	46	12	142	20	0	10
Domestic production	1,200	116	0	372	1,684	5,553	601	324
Total （1）	1,260	140	46	384	1,826	5,573	601	334
2. Consumption								
Food	920	236	195	320	1,671	3,587	459	271
Materials for processing	29	0	0	15	44	555	0	0
	27	9	0	9	45	0	0	19
Seeds	119	6	0	30	155	1,111	121	27
Loss	1,095	251	195	374	1,915	5,253	580	317
Total （2）								
3. Surplus／Shortage (1) - (2)	161	-111	-149	10	-89	320	21	17
4. Import	60	150	175	0	385	0	20	16
5. Export	150	0	0	0	150	0	0	20

Source） Vulnerability Assessment for Mozambique 1999/2000

As shown in the above table, there was a shortage of around 110,000 tons of paddy in Mozambique in 1999/2000. This shortage was covered by imports, however an increase in domestic production is essential for the purpose of national food security. In future, it is expected that Chokwe Irrigation System will generate more than 100,000 tons of paddy, meaning that the system must play a significant role as a granary for Mozambique.

(6) Generation of Employment Opportunity

Implementation of the Project will generate employment opportunities during the construction period. Based on the construction schedule, 150 persons will be employed on a daily basis in the Rehabilitation.

4.2. Recommendations

In order to ensure the above direct and indirect impacts, the Mozambique Government should achieve the following responsibilities effectively.

(1) HICEP should undertake proper operation and maintenance of irrigation facilities.

(2) Farmers' associations should be established and their responsibilities performed properly.

(3) Rehabilitation and repair works for existing irrigation facilities in the downstream parts of the General Canal should be implemented on schedule by donors.

(4) Training for farmers' associations should be implemented on schedule by donors.

(5) HICEP should collect water charges properly and regularly.

(6) Users should pay water charges properly.

(7) Agricultural extension work should be undertaken in cooperation with HICEP, Ministry of Agriculture and Rural Development, Chokwe Agricultural Research Station, and District Agricultural Office.

(8) Farmers in the System should carry out agricultural activities enthusiastically.

(9) Research work for the System should be undertaken and achieve useful results through closer cooperation between Chokwe Agricultural Research Station and District Agricultural Office.

(10) HICEP should try to reduce the cost of operation and maintenance of irrigation facilities, including the General Canal, in order to alleviate farmers' water charge burden.

Summary of the project activities, purpose, target, etc., is shown as a Project Design Matrix (PDM) in Figure-4.1.7.