No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE REHABILITATION
OF
THE BWANJE VALLEY IRRIGATION SYSTEM
IN
THE REPUBLIC OF MALAWI

OCTOBER 2005

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Republic of Malawi, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of the Bwanje Valley Irrigation System in the Republic of Malawi and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malawi a study team 4 times from February 21, 2003 to March 8, 2005.

The team held discussions with the officials concerned of the Government of Malawi, 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 Malawi 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 Malawi for their close cooperation extended to the teams.

October, 2005

Seiji Kojima

President
Japan International Cooperation Agency

October, 2005

Letter of Transmittal

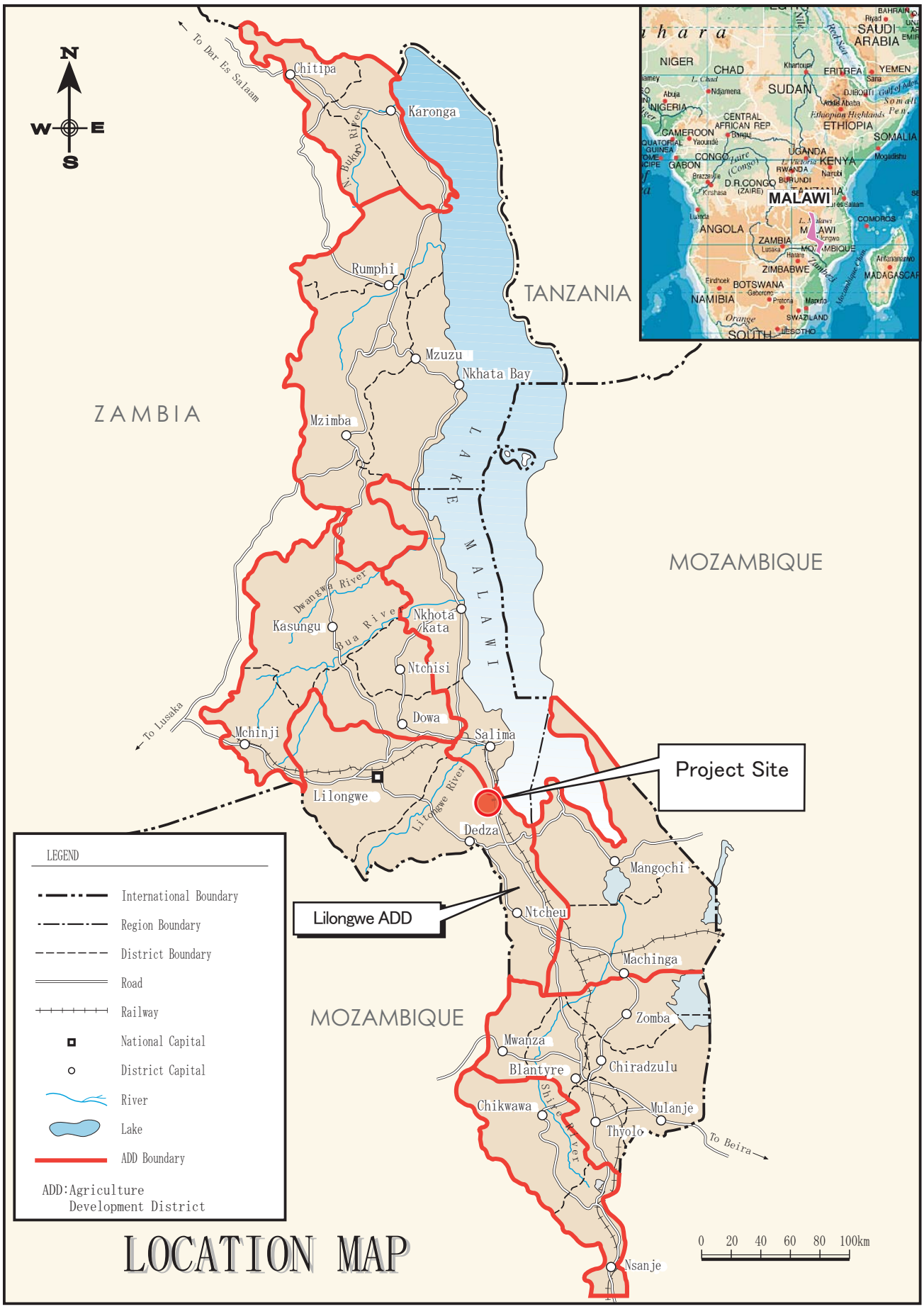
We are pleased to submit to you the basic design study report on the Project for Rehabilitation of the Bwanje Valley Irrigation System in the Republic of Malawi.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from February, 2003 to October, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Malwi and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

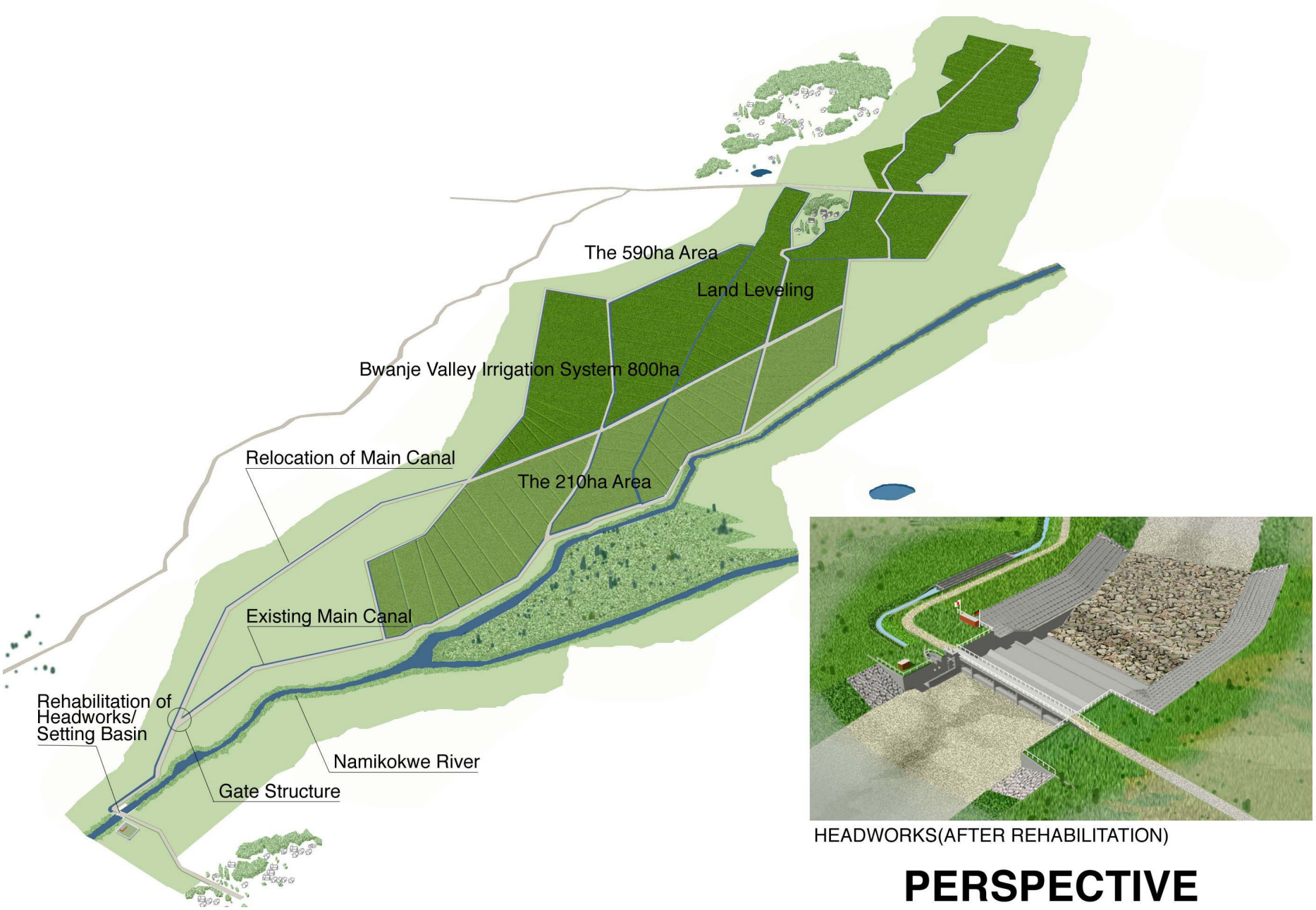
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Toshikazu Kambara
Chief Consultant,
Basic design study team on
The Project for Rehabilitation of the Bwanje Valley Irrigation System in the Republic of Malawi
Nippon Koei Co., Ltd.



LOCATION MAP



HEADWORKS(AFTER REHABILITATION)

PERSPECTIVE

① Downstream of the Headworks (2005.2)

③ Sedimentation in the Settling Basin (2005.2)

④Proposed Alignment of New Main Canal (2005.2)

⑤Land which requires levelling by dozer (2005.2)

② Headworks in the flood on Feb. 28, 2005 (2005.2)

⑥ Dike Damaged by the Flood (2004.12)

⑦Main Canal damaged by the Flood (2004.12)

⑧Downstream of Namikokwe River (2005.2)

←Mtakataka
BC-3
BC-1
BC-2
MC
Situation of land: ⑤
Route of the New Main Canal: ④
Main Canal Damaged in 2003.2 ⑥⑦
←M5
IP4
Settling Basin: ③
→
M10↓
Headworks: ①②
Namikokwe River
IP13
IP12
Downstream of Namikokwe River: ⑧
Dike Damaged in 2003.2
Downstream Part Damaged in 2002.1
Middlestream Part Damaged in 2002.1
Upstream Part Damaged in 2002.1
River Course Changing Works by GOM
N
W
E
S
0 1 2km
SCALE

Legend

- Main Canal
- Branch Canal
- Tertiary Canal
- River
- Road
- Headworks
- MC Main Canal
- BC Branch Canal

Layout Map of the Bwanje Valley Irrigation System

Abbreviations

ADD	Agricultural Development Division
AEDO	Agricultural Extension Development Officer
B/D	Basic Design
BC	Beginning of Curve
DC	District Commissioner
DOI	Department of Irrigation
EIA	Environmental Impact Assessment
EL	Elevation
EMP	Environmental Management Plan
E/N	Exchange of Notes
F/S	Feasibility Study
GDP	Gross Domestic Product
GNI	Gross National Income
GOM	Government of Malawi
GOJ	Government of Japan
FAO	Food and Agricultural Organization of the United Nations
KATC	Kilimanjaro Agricultural Training Centre
IFPRI	International Food Policy Research Institute
IP	Intersection Point
JICA	Japan International Cooperation Agency
JOCV	Japan Overseas Cooperation Volunteers
MK	Malawi Kwacha
MOA	Ministry of Agriculture
MOAFS	Ministry of Agriculture and Food Security
NSO	National Statistical Office
O & M	Operation and Maintenance
ORT	Other Recurrent Transaction
PVC	Polyvinyl Chloride
RDP	Rural Development Project
TA	Traditional Authority

SUMMARY

1. BACKGROUND OF THE PROJECT

1. Agriculture is the main economic sector in Malawi, contributing 40% of the GDP (2003), employing 79% of the working population (2002) and 83% of the foreign exchange earnings (2003). In "Vision 2020", "Malawi Poverty Reduction Paper" and "Malawi Economic Growth Strategy" identified as national plans, poverty reduction, food security and sustainable economic growth are planed as the major goals. And those plans identify the importance of agriculture and irrigation development. In "Strategic Plan 2003-2008" planned by the Ministry of Agriculture and Food Security (MOAFS), "the increase of agriculture productivity", "program for irrigation development" and "rehabilitation and new construction of irrigation schemes" are clearly stated and those promotions were undergoing. However, the most of the agriculture in Malawi is still depending on rainfall so that it has brought unstable productivity of the agriculture in Malawi conjointly with the traditional farming practice. The irrigation development is considered urgent and given high priority.

2. The Bwanje Valley Irrigation System (the System) was aimed at the development of irrigation of an area of 800 ha. Under Grant Aid from the Government of Japan (GOJ), it was constructed from 1997 to 1999. The irrigation service commenced operating in 2000. However, the irrigation facilities were damaged due to frequent floods from 2001 and the function of the facilities was decreased. Especially, scouring and erosion of the flood protection dike occurred due to unprecedented floods in January 2002 and the main canal, with its operation road running on the dike, was seriously damaged. As part of a follow-up cooperation for the system, GOJ assisted GOM in repairing the damaged dike and the main canal. However, the facilities other than the dike and the main canal repaired under the follow-up cooperation still have a risk of suffering future flood damage. In addition, during the rainy seasons, the water level of the Namikokwe River

rises and some farmers who live in the right bank of the river had difficulty accessing this system across the river. Under these circumstances, GOM requested 1) Shifting of certain parts of the main canal 2) Construction of a footbridge in order to mitigate the risk of future flood damage and achieve the effect as envisaged in the original grant aid project in October, 2002.

3. After this request, the dike and the main canal were again damaged by a flood in February 2003. Considering those several damages, a comprehensive rehabilitation plan was required to strengthen the System from the view point of disaster protection, and increase the function of the facilities for attaining the project effect as envisaged.

4. GOJ dispatched the Basic Study Team (the Team) to Malawi through Japan International Cooperation Agency (JICA) for four times between Feb. 21, 2003 and Mar.8, 2005. Based on the field survey, the Team examined the counter measure against floods disaster to the main canal. The Team discussed with the executing agency of GOM and MOAFS and finally agreed to execute the following components:

Component	Initial Request by GOM	Final Plan and its Content
1. Rehabilitation of Headworks	No request	1 no. It is judged that the headworsks needs to be repaired because its apron part has been damaged by floods.
2. Construction of a Footbridge (Access to Farm Land)	1 no.	None. For the improvement of the access, it is ideal to construct a footbridge crossing the Namikokwe River between the System and the right bank area. However, it is rather difficult to construct such a structure because of meandering and lowering of the bed of the Namikokwe River.
3. Rehabilitation of Settling Basin	No request	1 no. At present, sediment removal work has not been properly performed because of manual removal and it causes a problem of disturbing conveyance of water in the main canal due to sediment in it. It, therefore, is necessary to rehabilitate the settling basin.
4. Reallocation of Main Canal	1 part	No revision.
5. Land Leveling	No request	419ha Although the land leveling work was scheduled to be performed by GOM, the present progress is still low (25%). For the increase of the agriculture productivity or the overall goal, it is essential to expand the irrigable area as soon as possible.

Component	Initial Request by GOM	Final Plan and its Content
6. Technical Support (land reallocation, water management and flood damage mitigation and repair measure assistance)	No request	Assistance by soft component program Land Reallocation As the present land allocation is not equitable and the irrigable area by the new main canal is changed to 590ha from 800ha, it is essential to execute land reallocation. Water Management Due to the shifting of the main canal, the water management system should be reformed. And its technical assistance is required. Flood damage mitigation and repair measure assistance As the existing main canal is scheduled to be maintained under control of GOM, its operation and maintenance is necessary.

5. At the site, the present problems were surveyed in the System from both physical and soft aspects. From the physical aspect, the cause of the floods of the Namikokwe River was examined from the field investigation and with hydro-meteorological data. At the same time, the present condition of the existing facilities was also investigated to check the cause of the damage to them and their functional condition. After that, the most effective rehabilitation plan was formed. In parallel, the land level condition was checked to make a new land leveling plan. From the soft aspect, regarding the social and agriculture condition, a baseline survey was conducted to 103 farmers as well as interviewing the staff of the project O&M office in the System and the farmers' cooperative. The result of the baseline survey was reflected on grasping of the present social/agriculture conditions and used as a reference for the examination of the future plan. In addition, the present condition of the operation and maintenance (O&M) to the facilities was checked to seize the current problems and obstacles. And a supporting plan and future O&M program were made from the view point of soft aspect to enable the stable water supply. From those results, the Team prepared a draft final report after forming the plan taking the stakeholders' needs.

6. JICA dispatched to Malawi the Team for the explanation of the draft final report to MOAFS from Sep. 1 to Sep. 8, 2005. After the discussion on the report between them, the

report was basically agreed by MOAFS. It was confirmed on the minutes of discussions.

2. CONTENTS OF THE PROJECT

1. The Project is aimed at i) to mitigate flood damage of the previously damaged system, ii) to restore the function of the irrigation facilities damaged by floods, and iii) to realize a stable irrigation water supply to the System with the overall goal of increasing agricultural productivity in the System.

2. The basic policy of the requested Japanese assistance for the Project is:
   - To execute technical assistance in physical aspects for disaster prevention measures to the System.
   - To execute technical assistance in software aspects to operate and maintain the facilities properly and to achieve sustainable water supply to the System.

3. In the basic design, the main focus was planning a measure for protection of the main canal against floods, because several parts of the dike and the main canal have been seriously damaged by floods and the other parts still have a risk of suffering future flood damage. As a result of comprehensive evaluation from the viewpoints of O&M, safety, and construction costs, the relocation of the main canal was selected as a recommended plan. Meetings and discussions with GOM and the farmers' cooperative were held to explain the recommended plan, afterward it was finally accepted by them. As a result, 590 ha out of 800 ha will be irrigated through the new main canal, and the remaining 210 ha, located between the existing main canal and new one, will be irrigated through the existing main canal under responsibility of GOM.

4. The requested Japanese assistance for the Project consists of i) rehabilitation of the headworks, ii) rehabilitation of the settling basin, iii) relocation of the main canal, iv) land leveling and v) soft component program (land reallocation assistance, water

management strengthening assistance and flood damage mitigation and repair measures assistance). The assistance focuses mainly on the rehabilitation works to the 590ha area The range of the assistance to the System of 800ha is divided to the 590ha area and the 210ha area as shown in the following table. The technical support of the soft component program is applied to the whole area of 800ha.

	Item	Bwanje Valley Irrigation System (Original Plan, 800ha)	Bwanje Valley Irrigation System	
			590ha Area	210ha Area
	Planting Plan	Rainy Season：Paddy Dry Season：Maize (145ha)	Rainy Season：Paddy Dry Season：Maize (145ha)	Rainy Season：Maize
Design for Facilities	**1.** Irrigation & Drainage Works			
	Irrigable Area	800 ha	590ha	210ha (water supply to upland crops)
	Headworks (fixed weir)	1no.	**1no.(rehabilitation)**	Utilization of the same structure in the left column
	Settling Basin	1no.	**1no.(rehabilitation)**	-ditto-
	Irrigation Canals Main Canal	6.8 km	(existing) 1.0 km **(new) 5.8 km**	(existing) 5.8 km
	Branch Canals	14.8 km	(existing)10.5 km **(new) 1.8 km**	(existing) 4.3 km **(new) 1.2 km**
	Tertiary Canals	60.8 km	(existing)43.5 km **(new) 0.8 km**	(existing) 17.3 km
	Drainage Canals	17.3 km	(existing)14.2 km **(new) 1.0 km**	(existing) 3.1 km **(new) 3.0 km**
	Inspection Road	13.7 km	(existing)10.0 km **(new) 5.8 km**	(existing) 3.7 km
	Flood Protection Dike／Road	7.8 km	(existing) 2.0 km	(existing) 5.8 km
	Area for Land Leveling	800 ha (leveled: 203ha) (planned: 597ha)	590 ha (leveled 171ha) **(planned 419ha)**	210 ha (leveled 32ha) (planned 178ha)
	2. Rural Infrastructure			
	Rural Road (Headworks～M10)	2.3 km	(existing) 2.3 km	
	Rural Water Supply (Borehole and Hand Pump)	13nos.	(existing) 13 nos.	
	3. Post-harvest facilities			
	Ricemill (100-120kg/hr)	4nos.	(existing) 4 nos.	
Soft Component		－	**1)Land Reallocation Assistance** **2)Water Management Strengthening Assistance** **3)Flood Damage Mitigation and Repair Measures Assistance**	

: Range of the Requested Japanese Assistance

5. The rehabilitation plan for each component is given in the table below:

Component	Rehabilitation Plan
1. Rehabilitation of Headworks	River Slope/Bed Protection Works below the Downstream Apron Construction of drop structure and ground sill with sheet pile Construction of concrete slope protection Operation Bridge Raising bridge (0.5m) and rehabilitation of Connective Road Sluiceway Gate Construction of suspending wall and heightening gates Intake Installation of operation deck and suspending wall Conducting Wall at the Upstream Sluiceway Raising conducting wall to EL. 518.80m
2. Rehabilitation of Settling Basin	Sediment Conduit Length: 31.0 m, Width: 1.5m x 3 nos., Slope: 1/60 Discharge Pipe Length: 35.0 m, Width x Height: 1.0m x 1.0m, Slope: 1/38 Flush Gate : 1.0m x 1.0m x 3 nos. Control Gate : 1.2m x 0.5m x 3 nos. Spillway Gate : 1.0m x 1.25m x 1 no.
3. Relocation of Main Canal	Main Canal Length: 5.8km, Design Discharge: 1.14 ~0.53 m^3/s Branch Canal Length: 3.0km, Design Discharge: 0.33 ~0.18 m^3/s Tertiary Canal Length: 0.8km Raising Existing Canal Height Length: 10.2km, Raising Height:10cm~20cm Canal Related Structure Gate Structure, Bifurcation, Turnout, Drop, Culvert, Drainage Culvert, Footbridge, Washing Basin, Field Inlet, Division Box Drainage Canal Length: 4.0km, Design Discharge: 0.04~0.37 m^3/s Inspection Road Length: 5.8km, Width: 5.0m (Width of Pavement 3.0m)
4. Land Leveling	Lesser Degree Leveling Area : 146 ha Middle Degree Leveling Area : 179 ha Greater Degree Leveling Area : 94 ha (Total 419ha)

6. As the area irrigated through the new main canal will become 590ha from 800ha after the relocation of the main canal, it is essential to carry out equitable land reallocation of the farm plots for all beneficiaries. It is also necessary to restructure the organization for water management and strengthen its system to realize equal water distribution under the new irrigation network. The remaining 210 ha area will be irrigated continuously through the existing main canal. It, however, has been damaged by floods, and needs a repair and measures to mitigate future flood damages. Although those works shall be performed under the responsibility of GOM, technical support to GOM by GOJ is required. In the basic design, therefore, the following soft component program is planed.

1) Land Re-Allocation Assistance
2) Water Management Strengthening Assistance
3) Flood Damage Mitigation and Repair Measure Assistance

3. IMPLEMENTATION PLAN FOR THE PROJECT

1. The implementation for the Project would require 27 months including the detailed design stage. The total implementation cost is estimated to be 978 million yen (Japanese side: 973 million yen, Malawi side: 5.1 million yen). The main works by GOM are i) land acquisition, ii) land reallocation, and iii) repair of the existing main canal.

2. The executing agency of GOM is MOAFS, and the responsible organization is Lilongwe Agricultural Development Division (ADD). After the completion of the Project, Lilongwe ADD is also in charge of O&M for the System, and at the site, Dedza Rural Development Project (RDP) and the project O&M office under Lilongwe ADD practically commence O&M works and support to farmers' cooperative. Department of Irrigation (DOI) under the Ministry of Irrigation and Water Development provides a technical assistance concerning the Project.

3. In principle, as for the irrigation facilities, the government owns the headworks, main canal and branch canals. Tertiary canals and other facilities below tertiary level are to be transferred to the farmers' cooperative. The regular O&M of the System will be performed by the farmers' cooperative, and the government mainly provides a technical support to them. The breakdown of O&M roles between the government and the farmers' cooperative are shown in the following table.

Institutions		Roles
Government	DOI	Technical assistance from the view point of techniques of rehabilitation and O&M of the irrigation facilities (dispatch of experts etc.)
	Lilongwe ADD	Large scale rehabilitation beyond farmers' capacity, river works, strengthening of farmer's organization, irrigation technique and farming practice assistance

Institutions		Roles
	Dedza RDP	Ditto
	Project O&M Office at the site	Training for farmers at the site level on cooperative institutional management, irrigation O&M, irrigated agriculture, protection measure for flood damage
Farmers' Cooperative		O&M of irrigation facilities, small and medium scale rehabilitation

4. CONCLUSION AND RECOMMENDATIONS

4. The following direct and indirect effects are expected through the implementation of the Project.

(1) Direct effects

1) Future flood risk will be reduced in the 590 ha area which is going to be irrigated through the new main canal.
2) Stable irrigation water will be provided and the cropped area will be 590 ha in the rainy season and 145 ha in the dry season in the 590 ha area which is going to be irrigated through the new main canal.
3) Competence of government staff for flood damage mitigation and repair measures will be improved and the possibility of upland farming with the supplementary irrigation will be raised in the 210 ha area.
4) Capacities and techniques for operation and maintenance of irrigation facilities by government staff and farmers' cooperative will be improved through guidance of operation and maintenance of irrigation facilities.

(2) Indirect effects

1) The production of rice in the rainy seasons and maize in the dry seasons could be stabilized and increased through reliable utilization of the irrigation facilities as a result of the Project.
2) By the stabilization of agriculture production and increase in productivity, the farmers could obtain surplus products to sell and thus increase their income.

3) The increase of farmers' income contributes to the rural poverty reduction.

5. After the rehabilitation of the irrigation facilities affected by floods and implementation of soft component programs (land reallocation assistance, water management strengthening assistance and flood damage mitigation and repair), the production basis will be restored. To realize and maintain the long-term effect of the Project, GOM should make the following self-efforts:

(1) Equitable Land Reallocation

After realization of equitable land reallocation by GOM under the soft component program, continuous control of land possession will be needed. GOM should guarantee equitable land cultivation rights to farmers continuously in the Project area. For the rights, principally, no administration boundaries will be adopted.

(2) Operation and Maintenance of Existing Main Canal

After the completion of the Project, the disaster function of the irrigation facilities could be improved so that they are expected to alleviate damage by future floods. The existing main canal, however, will still be weak against large-scale floods, even after the repair works. As damage is expected to some extent during floods, the project O&M office and farmers' cooperative should carry out monitoring and repair works continuously.

(3) Improvement of Technology of Irrigated Farming

The implementation of the Project is expected to alleviate the risk of damage by floods and to supply irrigation water sufficiently to the paddy fields for full-scale irrigation farming. Accordingly, the improvement of the farmers' farming practices, especially in irrigation farming technology, is important for the next stage.

(4) Need to Strengthen Farmers Cooperative

Apart from O&M of facilities and water management, the most important activities

are rice milling/selling and strengthening of the farmers' cooperative for future development. Among them the rice milling/selling are the most profitable enterprise, but they can only cope with small-scale operations and could not respond to a large-scale offer of rice from a market. Achievement of stabilized irrigation productivity and full-scale rice milling facilities is expected to bring much profit and return to the farmers in the Project area through the sale of rice. Therefore, GOM needs to maintain the project O&M office to support the above activities of the farmers' cooperative.

(5) Demarcation of Responsibility for O&M of Irrigation Facilities

At the present, responsibility for O&M of the irrigation facilities has not been clearly demarcated between the government and the farmers' cooperative. When the irrigation facilities are renovated after the completion of the Project, including land leveling, an irrigation management agreement is recommended to be prepared, and responsibility for the possession and O&M of the facilities should be clearly demarcated.

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Units and Measures

Length

mm	milimeter
cm	centimeter
m	meter
km	kilometer

Area

cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare

Volume

cm^3	cubic centimeter
m^3	cubic meter
MCM	million cubic meter

Weight

g	gram
kg	kilogram
t	ton
MT	metric ton

Time

s	second
m	minute
hr	hour
d	day

Power and Energy

A	ampere
V	volt
W	watt
kW	kilowatt
kWh	kilowatt hour
HP	horse power

Others

ppm	parts per million
℃	degree centigrade
%	percent

Currency

$	USA Currency (Dollar)
¥	Japanese Currency (Yen)
MK	Malawi Kwacha

Exchange Rate

$ 1.00 = ¥ 107.03
MK 1.00 = ¥ 0.99
(As of March, 2005)

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Agriculture is the main economic sector in Malawi, contributing 40% of GDP and employing 79% of the labour force and accounting for 85% of foreign exchange earnings[1]. GNI per capita in 2004 was estimated at US$170, and the population was 11.2 million in 2004 (World Bank). The main food crop is maize and its production is fluctuating. The Republic of Malawi has suffered serious food shortages since 2001 due to low agricultural production and decreases in food reserves resulting from droughts and floods. As a result, the Government of the Republic of Malawi (GOM) has received urgent food supply aid from the FAO and other donors.

In order to cope with such food shortages, the Ministry of Agriculture (MOA, now its name has been changed to the Ministry of Agriculture and Food Security) of GOM has prioritized the development of irrigation.

The Bwanje Valley Irrigation System (the System) was aimed at the development of irrigation of an area of 800 ha. Under Grant Aid from the Government of Japan (GOJ), the headworks, irrigation and drainage canals, inspection roads, and water supply boreholes were constructed from 1997 to 1999 based on the results of a feasibility study conducted during 1992 to 1994 with the assistance of the GOJ. A general outline of this grant aid project (Bwanje Valley Irrigation Development Project) is as follows.

1) Irrigation and Drainage Works

Irrigable Area			: 800 ha
Number of Headworks (fixed weir)	4.5m (H) x 50m (L)		: 1
Design Intake Discharge (maximum)			: 1.14 m^3/s
Number of Intake Gates	1.2 m (W) x 1.2 m (H)		: 1
Irrigation Canals	Main canal	Q = 1.140 - 0.385 m^3/s	: 6.8 km
	Branch Canals	Q = 0.350 - 0.395 m^3/s	: 14.8 km
	Tertiary Canals	Q = 0.01 - 0.07 m^3/s	: 60.8 km

[1] Statistical Yearbook 2004, Natural Statistical Office, January 2005

Drainage Canals	: 17.3 km
Inspection Road	: 13.7 km
Flood Protection Dike/Road	: 7.8 km
Area for Land Leveling	: 47.8 ha

2) Rural Infrastructure

Rural Road (Headworks ~ M10)　Width 5.0 m	: 2.3 km
Number of Rural Water Supplies (Borehole and hand pump)	: 13

3) Post-harvest Facilities

Number of Rice mills with 100-120 kg/hr output（including Diesel Engine）: 4.

The irrigation service commenced operating in 2000. However, the irrigation facilities were damaged due to frequent floods from 2001 and the function of the facilities was decreased. Scouring and erosion of the flood protection dike occurred due to unprecedented floods in January 2002 and the main canal, with its operation road running on the dike, was seriously damaged. As part of a follow-up cooperation for the system, GOJ assisted GOM in repairing the damaged dike and the main canal. However, facilities other than the dike and the main canal repaired under the follow-up cooperation still have a risk of suffering future flood damage.　In addition, during the rainy season, the water level of the Namikokwe River rises and some farmers who live in the right bank of the river have difficulty accessing this system across the river.　Under these circumstances, GOM requested 1) Shifting of certain parts of the main canal 2) Construction of a footbridge in order to mitigate the risk of future flood damage and achieve the effect as envisaged in the original grant aid project (on 29th of October, 2002).

After this request, the dike and the main canal were again damaged by a flood in February 2003. Considering those several damages, in order to strengthen the Bwanje Valley irrigation system from the view point of disaster protection, and to increase the function of the facilities to attain the project effect as envisaged, GOJ and GOM finally agreed on implementation of

the following components as a result of field survey, work in Japan, and discussion.

- Main canal relocation works,
- Settling basin rehabilitation works,
- Headworks rehabilitation works,
- Land leveling works, and
- Technical Assistance (land re-allocation, water management strengthening, flood damage mitigation and repair measures)

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

2.1.1 The Objectives of the Project

The Republic of Malawi has suffered serious food shortages since 2001 due to low agricultural production and decreases in food reserves resulting from droughts and floods. As a result, the Government of the Republic of Malawi (GOM) has received urgent food supply aid from FAO and other donors.

In order to cope with such food shortages, the Ministry of Agriculture and Food Security (MOAFS) of GOM has prioritized the following policies through the development of irrigation[1]:

- Improvement of agricultural productivity through irrigation
- Strengthening of irrigation development programs
- Rehabilitation and construction of irrigation schemes

The Bwanje Valley Irrigation System (the System) was aimed at the development of irrigation over an area of 800 ha. Under Grant Aid from the Government of Japan (GOJ), headworks, irrigation and drainage canals, inspection roads, and water supply boreholes were constructed from 1997 to 1999. Irrigation service was commenced in 2000. However, scouring and erosion of the flood protection dike occurred due to unprecedented floods in January 2002 and the main canal, with its operation road running on the dike, was seriously damaged. As part of a follow-up cooperation for the system, GOJ assisted GOM in repairing the damaged dike and the main canal. However, the dike was again damaged by a flood in February 2003 resulting in these work outcomes not being achieved.

As a result, the Project for Rehabilitation of the Bwanje Valley Irrigation System (the Project) will be implemented under Japan's Grant Aid Scheme with the overall goal of increasing agriculture productivity in the System. The main objectives of the Project are as follows:

- to mitigate flood damage of the previously damaged system,
- to restore the function of the irrigation facilities damaged by flooding, and
- to make possible a stable irrigation water supply to the System.

[1] Strategic Plan 2003-2008, Ministry of Agriculture and Food Security (MOAFS)

2.1.2 Project Outline

In the basic design, the main focus of the work was to formulate measures of mitigation of flood risks to the main canal, resulting in its relocation to the mountain-side. (Details are shown in "2.2.2".). Accordingly, the area irrigated by the new main canal on the shifted alignment shall be changed from 800 ha to 590 ha. For the remaining 210 ha, located between the existing main and new canals, the farmers' cooperative in the system adopted a farming practice using water supplies from the existing main canal, under technical assistance of GOM.

Considering the issues, rehabilitation works shall be executed with a view to mitigating flood risk, after taking into consideration field survey results. In addition, technical supports for the land re-allocation works and others done by GOM shall be implemented. As results, the project components are listed as below:

1) Rehabilitation of irrigation facilities
   - Headworks rehabilitation works,
   - Settling basin rehabilitation works,
   - Main canal relocation works, and
   - Land leveling works
2) Components of software
   - Land re-allocation
   - Water management strengthening
   - Establishment of flood damage mitigation and repair measures

With implementation of the above rehabilitation and software components, the following benefits are anticipated:

1) Physical benefits
   - The stability of irrigation facilities against floods will be significantly higher than without rehabilitation, enhancing stable irrigation water supply through the facilities.
   - The problem of sedimentation will be minimized and the design canal capacity of the main canal will be secured.
   - The land leveling works will substantially increase functionality of paddy fields than would be possible without land leveling, encouraging their improved utilization by farmers in the project area.
2) Non-physical benefits

- Unequal and inefficient land distribution will be solved and the paddy field utilization rate will be improved.
- Water management capability of farmers will be improved and equal water distribution will be possible.
- Long-term use of irrigation and drainage facilities will be possible through farmers' Operation and Maintenance (O&M) capacity.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Policy

The basic policy of the requested Japanese assistance is:

- To execute technical assistance in physical aspects for disaster prevention measures to the Bwanje Valley Irrigation System.
- To execute technical assistance in software aspects to properly operate and maintain the facilities and to achieve sustainable water supply to the system.

The Scope of Works of the requested assistance, shown in the following table, was determined by analyzing both present physical problems of the facilities and software aspects based on the survey results.

Table Scope of Works by GOJ

Problems	Present Status and Countermeasures	Scope of Works by GOJ
1. Physical Problems of Facilities	① Headworks Floods have caused the riverbed to degrade since 2002, resulting in damage of river slope / bed protection works. The flood in February 2003 overtopped the operation bridge of the headworks. Measures to protect the facilities against floods are therefore needed. In addition, improvement of operation and maintenance capability for the scouring sluice and intake gates are required.	⇒Rehabilitation of Headworks
	② Settling Basin Sediment removal work has to be manually carried out without natural flushing by gravity in the present settling basin. Since this removal work is a heavy burden for farmers, they are reluctant to implement it as required. As a result, after substantial accumulation of sediment in the settling basin, a large amount of sediment is conveyed to the canals. This disturbs the smooth flow of water, due to a reduction in canal capacity. Rehabilitation of the settling basin is needed to make possible a stable irrigation water supply to the System.	⇒Rehabilitation of Settling Basin
	③ Main Canal The existing main canal has been damaged by floods and relocation of the main canal is necessary.	⇒Relocation of Main Canal

Problems	Present Status and Countermeasures	Scope of Works by GOJ
	④ Land Leveling Works The land leveling was done in the limited area. In the other area, the land leveling was not done and has not been irrigated. Land leveling has to be done to such area.	⇒Assistance in Land Leveling Works
2. Software Aspects Problem	① Unequal Land Allocation The project area has been allocated unequally. When the main canal is relocated, land re-allocation will have to be done to solve unequal land allocation problem.	⇒Soft Component Program on Land Re-allocation
	② Water Management There is proper water management but no O&M manual suitable for the existing irrigation facilities. A new water management system for the existing main canal and new main canal is required. Preparation of a water management manual and water management training are necessary.	⇒Soft Component Program on Water Management Strengthening
	③ Flood-damage Mitigation of the Existing Main Canal It is necessary for the GOM to itself implement flood-damage mitigation and repair measures to restore the function of the existing main canal.	⇒Soft Component Program on Flood Damage Mitigation and Repair Measures

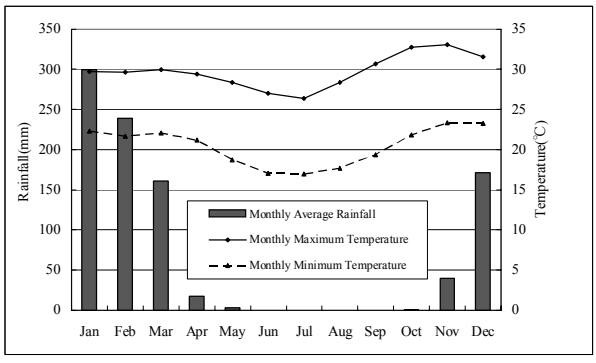
As shown in the above table, the Scope of the Works by GOJ can be summarized as follows:

- Headworks rehabilitation works,
- Settling basin rehabilitation works,
- Main canal relocation works
- Land leveling works, and
- Soft Component Program (land re-allocation assistance, water management strengthening assistance, flood damage mitigation and repair measures assistance).

2.2.1.2 Policy on the Natural Condition

(1) Hydrometeorology

As shown in the figure to the right, the annual average temperature at the Salima station is 25.1ºC; monthly average temperature ranges from 28.2ºC in November to 21.7ºC in June. The monthly maximum average temperature exceeds 30.0ºC

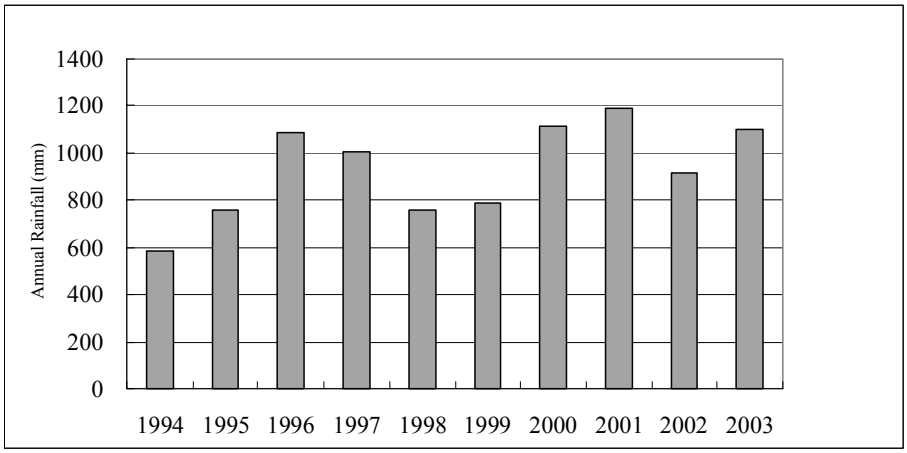


Source：Department of Meteorological Services

Figure Monthly Maximum and Minimum Average Temperature (1992-2004, Salima)
Monthly Average Rainfall（1994-2003、Mtakataka）

from September to December, and the monthly minimum average temperature reduces to 16.0ºC from June to July. The annual average relative humidity is 65%. The annual average wind velocity is 2.3 m/sec and annual average sunshine hours are 8.5 hours/day. These meteorological data will be used for construction and quality control planning.

The average annual rainfall for the last 10 years was 930 mm. About 90% of rain occurs during the rainy season from November to April. Rainfall is erratic, and the associated maximum and minimum annual totals are 1,187 mm and 587 mm, respectively, as shown in the following figure:



Source : Department of Meteorological Services

Figure Variation of Annual Rainfall (1994-2003, Mtakataka)

(2) Flood Discharge of the Namikokwe River

According to the basic design study in 1997 (original design), the design flood peak discharge for the headworks and flood protection dike was estimated by applying Drayton's equation, which is commonly used in Malawi, as follows:

Headworks : 205 m^3/s (return period: 50 years)

Flood protection dike : 170 m^3/s (return period: 25 years))

On February 1 2003, an unprecedented flood of about 460 m^3/s occurred, exceeding the above design flood discharges. In the basic design study, the largest flood discharge previously recorded was conservatively adopted as a design flood discharge for the headworks. This took into account the extraordinary changes in prevailing weather conditions.

(3) Geology

The System is located in the alluvial stratum of the Rift Valley. According to the

original design, the foundation 12 m below the ground surface at the headworks site is a silt layer with an N-value estimated to be 0 to 10. The lower layer of EL 511.00 m is a clay layer mingled with sand and gravel with an N-value estimated at more than 25. The existing headworks was designed to be founded on this layer with supplementing pile foundations. The same foundation design concept in this basic design is to be utilized for the downstream apron to be constructed downstream of the weir.

(4) Earthquake Condition

In and around the System, no large earthquakes have been reported to date. There is no authorized value for the seismic coefficient (Kh) to be considered in the design of civil structures in Malawi. For this basic design, Kh=0.10 (minimum value) has been adopted in accordance with "the Design Standard for Land Improvement Projects" issued by the Ministry of Agriculture, Forestry and Fisheries of GOJ.

2.2.1.3 Policy on the Social Condition

(1) Necessity of Land Re-allocation

Since the main canal will be relocated from the existing to new alignment, 210 ha will receive irrigation water from the existing main canal located adjacent to the river. Therefore, safety against floods of the main canal in this 210 ha is lower than in the 590 ha. Therefore, if the present condition of the land allocation to the farmers continue in the future, unfair condition might occur between those areas in the sense of the continuity of farming practice.

As land allocation was along the administrative boundaries during the construction (1997 to 1999) under Japan's Grant Aid, the present condition of land possessing in the System also reveals the unfairness of the average size of the land per farmer among the group villages as shown in the following table:

Table Average Size of Land per Farmer in Each Group Village

Group village	Kafulama	Bwanari	Mchanja	Mthenbanji	Total
Number of farmer (person)	105	250	508	1,041	1,904
Average size of land (ha)	0.21	0.20	0.43	0.45	0.40

Data source：land registration book, 2004

The above table shows that the average size of the land per farmer in Kafulama and Bwanari is approximately half of that in Mchanja and Mthenbanji. And even in a certain village group, unfair situation (The maximum differential on the size of land per farmer is 7.5 ha.) is observed and these facts lead to large complaints of the farmers possessing small lands. This unfairness of the land allocation is one of the causes of the land abandonment in the System and an important issue for the realization of the Project goal.

To solve the above problems, land reallocation is quite necessary. GOM and the farmers' cooperative also recognize its necessity and a land reallocation committee has been organized.

(2) Survey of Land Allocation Procedure in Other Irrigation System

To survey the land allocation in other irrigation schemes for this Project, a study tour to Domasi Irrigation System in Machinga ADD was carried out attended by the staff of Lilongwe ADD, Deza RDP, the project O&M office and farmers' cooperative on March 2, 2005. Its construction was completed in 1975. Its irrigable area is 470 ha and the number of the beneficiaries is 1,655. At present, rehabilitation of the irrigation facilities and capacity building of the water control organization are being executed under the Smallholder Flood Plains Development Project financed by IFAD.

In this system, the land allocation to the farmers was made by the land allocation committee after the construction of the facilities. According to the chairman of the water control organization, the average size of the land per farmer is 0.2 ha. The maximum difference on the size among the lands is six times (0.1~0.6ha) and no problem on this issue has been reported.

The differences of the land allocation between this system and the Bwanje Valley Irrigation System are summarized in the following three main points:

1) In the Domasi Irrigation System, the land allocation was made after the completion of the construction works including the tertiary canals and land leveling. On the contrary, in the Bwanje Irrigation System, the land allocation was commenced before the completion of the land leveling.
2) In the Domasi Irrigation System, influence people (TA, group village leaders and village leaders) were playing the role of advisors to the land allocation committee. In the Bwanje System, they carried out land allocation by themselves.

3) In the Domasi Irrigation System, no administrative boundaries were taken into consideration for the land allocation so that the farmers could receive equitable land allocation in spite of their home village. In the Bwanje Valley Irrigation System, the administrative boundaries were applied for the land allocation so that the size of land is unbalanced.

(3) Alternatives of Land Re-allocation

Taking the present conditions of the irrigation system of Bwanje and Domasi, the following three alternatives are considered:

Table Tentative Alternatives for Method of Land Re-allocation

Alternative-1. Present Approval (to utilize present condition)	Alternative-2. Even Distribution (to reshuffle)	Alternative-3. Even Substitution
To reallocate 590ha to farmers who have their land under 590ha originally and farmers who have their land under 210ha and want to get some lands under 590ha, taking the present condition into consideration as much as possible.	To reallocate 590ha equally and mechanically to farmers who want to get some lands under 590ha.	To reallocate 590ha and 210ha respectively to all farmers under 800ha, equally and mechanically
Explanation on the necessity of land reallocation is made and confirmation whether he/she may remain outside the scheme or he/she wants to get some lands inside the scheme is taken one farmer by one in 210ha. Toward farmers who want to get some land inside the scheme, land reallocation is made. Firstly the land which is possessed by one farmer and bigger than average area 0.4ha is reallocated to the farmers. Finally, some adjustments are made in order for every farmer to have almost equal size of land. On the other hand, discussion is required among stakeholders regarding reallocation of 210ha.	590ha is reallocated equally and mechanically to farmers who want to get some lands under 590ha. On the other hand, discussion is required among stakeholders regarding reallocation of 210ha.	This is the reallocation to all farmers under 800ha. Namely, 590ha ÷ 1,926 farmers = 0.3ha, and 210ha ÷ 1,926farmers = 0.1ha. Each plots are reallocated to farmers respectively (0.3ha in 590ha, 0.1ha in 210ha) and mechanically.

As a result of the discussion with the staff of GOM, TA, the farmers' cooperative and beneficiaries, it was realized by them that the second alternative was the most recommendable one. Based on this alternative, GOM intends to make a detailed program for the land allocation.

(4) Basic Policy for Land Re-allocation

GOM is now planning the following policy for land re-allocation:

1) Implementation Body

The implementation body is the land allocation committee organized in the farmers' cooperative. It will be supported by Lilongwe ADD, Deza RDP and the staff of the farmers' cooperative. If it has difficulty to arrange land re-allocation by confliction among farmers, it will request TA and/or District Commissioner (DC) to solve the problem.

2) Areas for Land Re-allocation

At present, land re-allocation in the 590 ha area is given first priority. Land re-allocation to the 210 ha area is also being planned, but its policy should be formed through consultation with the farmers' cooperative.

3) Target Farmers of Land Re-allocation

Target farmers are farmers registered as regular members to the farmers' cooperative. In the registration, he/she should pay 500 MK for share and 100MK for annual fee.

4) Land Size for One Farmer

The maximum land size for one farmer should be 0.4 ha after the land re-allocation. As the actual land size is subject to the number of the registered farmers, it should be finalized at the stage of the preparation of a detailed plan for land re-allocation and its standard.

5) Schedule

The schedule for land re-allocation is given below:

Item	Schedule
(1) Registration of Farmers	
1. Preparation of condition for registration	Mid. Feb.2005～Mid. Mar.
2. Explanation of land re-allocation to farmers	Mid. Feb. 2005～Late Mar.
3. Payment of share	Late Feb. 2005～Late Sept.
4. Preparation of list of farmers	Late Feb. 2005～Late Sept.
(2) Training for Land re-allocation	Late Feb. 2005～Late Jun.
(3) Collection of Agreement from Farmers	Oct. 2005～Late Feb.2006
(4) Preparation of a detailed plan for land re-allocation and its standard	Dec. 2005～Feb. 2006
(5) Land Re-allocation	

Item	Schedule
1．Land re-allocation	May 2006～Dec. 2007
2．Preparation of land registration list and cadastral map	May 2006～Dec. 2007

In this Japanese assistance, the Soft Component Program shall be undertaken in order that GOM could implement the land re-allocation smoothly.

2.2.1.4 Policy on Construction and Procurement

(1) Working Conditions

In general, employment opportunities in the services and industry sectors in Malawi are very limited with agriculture and fishery sectors being chronically oversupplied. Since employment opportunities of construction workers are also limited in Malawi, deployment of common laborers is extremely easy, even in and around the Project site. Skilled laborers (e.g. carpenter, mason, mechanic etc.) and equipment operators must, however, be deployed from Lilongwe, Blantyre, etc. Deployment of experienced technicians (e.g. foremen) is an important factor to secure construction quality and ensure the construction period. They should therefore be deployed from South Africa.

(2) Construction Materials and Equipment

1) Cement

Ordinary Portland cement imported from Zimbabwe can be procured in Malawi. The compressive strength of concrete using this cement is 32.5 N/mm^2 while the design compressive strength is 21 N/mm^2. Therefore, it can be used in the Project. The volume of cement available within the market in Malawi is sufficient and no difficulties in its procurement are anticipated.

2) Concrete Aggregate

In and around the project area, there is no quarry site where concrete aggregate is available, in terms of either quality or quantity. About 30 km from Lilongwe to Salima, there is a quarry site in Kamvula where a crushing plant has operated and the quality and volume are satisfactory. For the Project, concrete aggregate, boulders/cobbles for gabions, and crushed materials will be procured from this quarry site.

3) Reinforcing Bars

Reinforcing bars in Malawi are imported by private suppliers. The supply volume is limited and the price is high because of the supplier's overhead and profits as well as handling charges of other intermediate agencies. Under the project, reinforcing bars will be procured directly from South Africa in order to minimize costs.

4) Gates

Since there is no gate manufacturer in Malawi, gates will be procured from a manufacturer in South Africa.

5) Construction Equipment

Local contractors and local lease companies own construction equipment mainly for road construction, but the number and the type of equipment in Malawi are limited. Therefore, rental and lease prices of the equipment are rather high. Under the Project, construction equipment available in South Africa will be used, but a final procurement plan for construction equipment will be determined through a comparative study of prices in South Africa and Malawi.

2.2.1.5 Policy on Application of Local Contractors

According to an interview survey with local contractors, most constructors are experienced in road construction with little experience in irrigation facilities construction works. The construction of irrigation facilities does not generally require special construction equipment nor a technically difficult construction methodology. If Japanese experts and South African engineers experienced in Malawi supervise the local contractor in construction of the irrigation facilities, the latter will be able to complete the works.

2.2.1.6 Policy on Operation & Maintenance Capacity of the Executing Agency

(1) Executing Agency

The executing agency of the Project is Ministry of Agriculture and Food Security (MOAFS). Lilongwe Agricultural Development Division (ADD) under MOAFS is the direct organization for Project control. Lilongwe ADD functions as a regional office of MOAFS and also has responsibility for operation and maintenance of the System. Although Salima ADD managed this System from 2000, this was transferred to Lilongwe ADD in 2002. In terms of engineering, the Department of Irrigation (DOI), which was formally a department of MOA at that time and is now within the

Ministry of Irrigation and Water Development, provides technical assistance to Lilongwe ADD on Project control and operation and maintenance of the System.

Administratively, the Bwanje Valley Irrigation System is under control of Dedza Rural Development Project (RDP), under Lilongwe ADD. Dedza RDP installed a project operation and maintenance (O&M) office, which assists the farmers' cooperative in operation and maintenance works. In the office, one (1) project manager and three (3) agricultural extension development officers are assigned.

The organization chart is shown below:

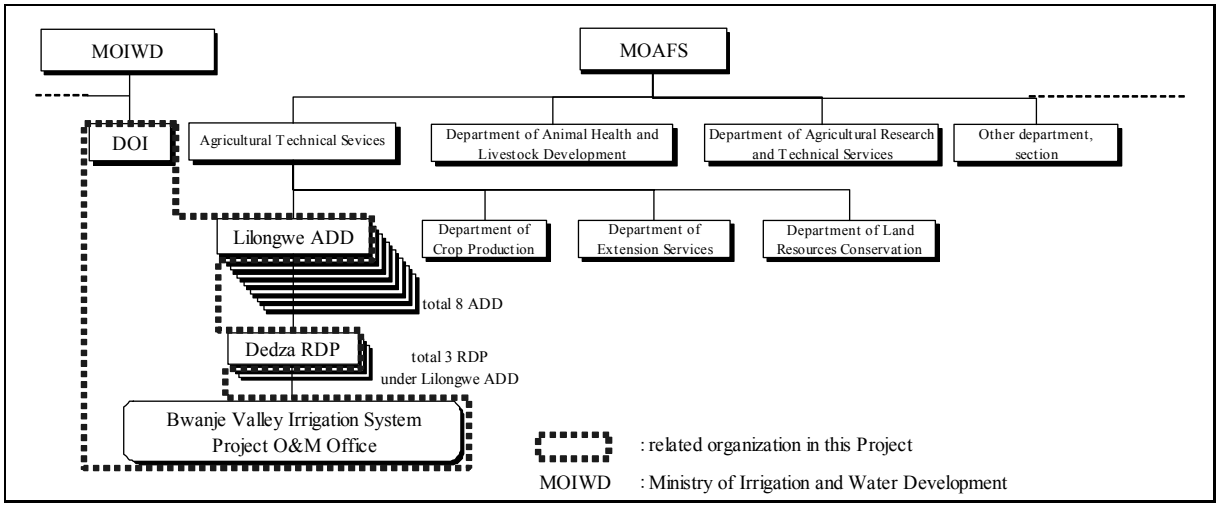


Figure Organization Chart of Executing Agency

The annual budget of about 1.8 million MK (salaries, allowances, fuel, etc.,) has been arranged for the office since 2000 and continuation of the budgetary arrangement is anticipated.

The O&M of the irrigation facilities has been undertaken by the farmers' cooperative under technical assistance given by the project O&M office. By transferring technical know-how on water management, flood mitigation and repair measures to the farmers' cooperative and the project O&M office through Soft Component Program, it will substantially contribute to a sustainable and smooth O&M of the irrigation facilities.

(2) Farmers' Cooperative

Benefiting farmers in the System have carried out O&M of the irrigation facilities since 1999, making efforts to establish and register a cooperative. In August 2004, the benefiting farmers finally succeeded in official registration of a farmers' cooperative in accordance with the Cooperative Society Act.

Main activities of the cooperative have been O&M of the irrigation facilities, and rice mill services for the paddy harvested in the System. Incomes are derived from annual fees, water fees, rice mill fees, share sales and profit of milled rice sales. Their expenditures are related to O&M costs for the irrigation facilities, O&M costs of the rice mill services, and salaries of workers. Since 2000 all expenses necessary for O&M costs, except repair cost of the facilities damaged by unprecedented flood, have been borne by the cooperative.

Five years have elapsed since the O&M of the irrigation facilities was started by farmers. Their O&M capability has been gradually improved but is not yet at a satisfactory level. The cooperative strongly needs further improvement or strengthening of O&M capability of the headworks, settling basin and irrigation canals and structures. Considering their demand and the importance of O&M capacity building, O&M training is to be performed under the Soft Component Program. In addition, training of the cooperative is also scheduled to strengthen its financial status by improving a low collection ratio of water fee. In the future, it is desired that the financial status will be strengthened to attain a sustainable O&M activity by increasing profit of rice mill services.

2.2.1.7 Policy on the Quality Grade of the Rehabilitation Works

The policy on the quality grade of the rehabilitation works is as follows:

1) To mitigate flood damage to the existing facilities and make them stable against floods
2) To minimize O&M costs borne by the farmers' cooperative and executing agency
3) To apply the same quality grade of the existing irrigation facilities to the rehabilitation works

2.2.1.8 Policy on Construction Methodology and Construction Period

From the physical aspect, the requested Japanese assistance has the following four components:

a) Headworks rehabilitation works

Since the rehabilitation of headworks will be undertaken in the river, it should not be implemented in the rainy season to protect the construction works from floods.

During the construction works, temporary diversion channel and coffer dams shall be constructed to divert the Namikokwe River for keeping dry in the construction area.

b) Settling basin rehabilitation works

Firstly, the existing settling basin will have to be removed. Since irrigation water delivery cannot be stopped, a temporary diversion canal will be constructed. This canal construction will have to be done in the dry season to avoid flood damage.

c) Main canal relocation works

The main canal relocation works will be possible in both dry and rainy seasons. To secure the water supply temporary culverts shall be provided at the cross point of the new main canal and the existing one.

d) Land leveling works

The land leveling of paddy field will be done in the dry season since paddy will be planted in the rainy season and bulldozers necessary for land leveling will not be used in the field due to the depth of irrigation water in the field.

The construction periods necessary for the above four components have been estimated, based on the quantity of the rehabilitation works and constraints of construction methodology and period. The results are shown in the following table.

Table Construction Period of Rehabilitation Works

Rehabilitation Works	Period of Possible Construction	Months
1.Rehabilitation of headworks	Dry Season（Apr to Nov）	8 months
2.Rehabilitation of settling basin	Dry Season（Apr to Nov）	4 months
3.Relocation of main canal's alignment	All months	15 months
4.Land leveling	Dry Season（Apr to Nov）	8 months

As shown in the above table, the relocation of the alignment of the main canal has the longest construction period. Since the other three works can be carried out in parallel, the construction period of the four rehabilitation works will be 18 months in total as shown below:

Relocation of main canal（15months）＋Preparatory works（1 month）＋Water running test （2 months） = 18 months

In the Project, the most important issue is to place the beneficiaries' agreement for the land re-allocation under the responsibility of GOM. It is required that the agreement be completed before the construction works. Therefore, this project shall be implemented by dividing E/N into detailed design and construction works, and the arrangement that the agreement be completed during the detailed design. Also, the

E/N for the implementation of construction works shall be signed after confirming the beneficiaries' agreement.

2.2.1.9 Policy on Environmental Conservation

According to the guidelines for environmental impact assessment issued by Department of Environmental Affairs (DEA), Ministry of Forestry, Fisheries and Environmental Affairs, EIA is mandatory for the following projects:

1) Agriculture drainage projects of more than 1 ha.
2) Irrigation schemes designed to serve more than 10 ha.
3) Land development for the purpose of agriculture on greater than a 20 ha land holding.
4) Agricultural projects necessitating their resettlement of 20 or more families. Any change form one agricultural land use to another on greater than a 20 ha land holding.
5) Use of more than 1 ton of fertilizer per hectare per annum on greater than a 20 ha landholding except for lime application.
6) Use of the following concentrations of pesticides on greater than a 5 ha holding:
   i) more than 5 l/ha of ultra low volume pesticides per application; or
   ii) more than 1 l/ha of aerial application of pesticides; or
   iii) more than 20 kg/ha for each application of granular pesticides.
7) Construction of fish-farming or ornamental pond(s) where the capacity is greater than 100 cubic meter or where there is any direct discharge from a fish pond to a receiving water body.
8) Any proposal to introduce fish species in an area where they do not presently exist.

It was confirmed to DEA that EIA is not required for the Project, since the Project is a rehabilitation project for the existing irrigation system (refer to Appendices-4, 4-4 Minutes of Discussion). However DEA commented the project may be implemented in line with the Environmental Management Plan. DOI and Lilongwe ADD have already prepared Environmental Management Plan together with Environmental Monitoring Plan and submitted them to DEA (refer to Appendices-6). Thus, these two plans will be followed during the implementation of the project to conserve the environmental conditions.

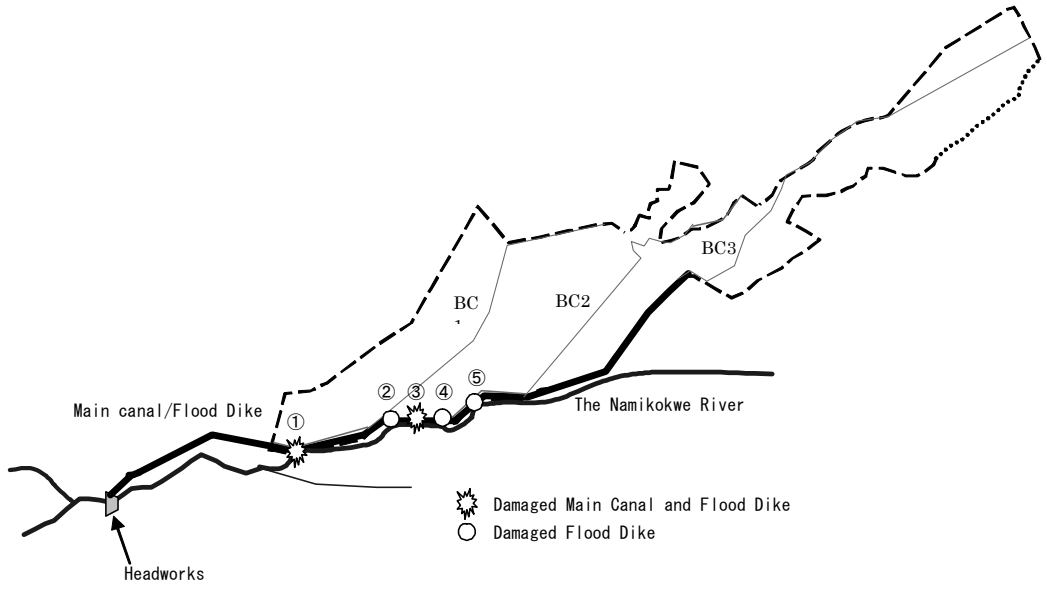
2.2.2 Basic Design

2.2.2.1 Overall Concept of Basic Design

(1) Causes of Flood Damage and Measures Against Flood Damage

The irrigation of the System (800 ha) commenced in 2000, although unprecedented floods in January 2002 seriously damaged the flood protection dike-inspection road, and main canal running along the dike. After this damage, the flood protection dike and main canal were rehabilitated as part of the follow-up cooperation by GOJ. However, even after the rehabilitation works, floods reoccurred, damaging the dike and inspection road and main canal in numerous locations. The flood-damaged sites are shown in the following figure:

Table Flood-damaged Site and Present Status



Location of the main canal damaged by flood

Damaged Sites	Distance from Headworks	Time when Facilities were damaged	Damage	Present Status
①	1.8 km	March 2003	Flood protection dike collapsed, and concrete lining (50 m long) of the main canal running along the dike was broken.	The dike has not been repaired and vehicles still can not pass on the dike.
②	3.0 km	Dec 2001 to Feb 2002	Vehicles could not pass on the dike.	Temporary detour road has been constructed.
③	3.2 km	Dec 2001 to Jan 2002	Weir constructed by farmers was broken and the dike and main canal were destroyed.	Temporary canal, river protection works, spur dike and detour road were constructed under follow-up cooperation in 2002.
④	3.4 km	Dec 2001 to Feb 2002	Vehicles could not pass on the dike.	River protection works with gabion mattress and detour road were constructed under a follow-up cooperation in 2002.

⑤	3.9 km	Feb 2003	The river course approached the dike closely and floods seriously eroded and destroyed the dike. Finally, Vehicles could not pass on the dike.	River protection works to protect the dike from being eroded is under construction by GOM. The road has not been repaired and vehicles still can not pass on the dike.

Based on the technical information of previous field investigations carried out in December 2004 and January 2005, the following river protection measures against floods have been executed:

1) History of the River Course

The history of the river course of the Namikokwe River, which flows adjacent to the irrigation area, is summarized as follows:

i) From 1992 to 1996, some 1.5 km downstream point from the headworks, the river was divided into three branches, namely the Namikokwe River, Mtanda River, and Chikonbe River.

ii) In August 1997, there were irrigation canals upstream of the present System and the farmers took water for the canals from the Namikokwe River providing temporary weir.

iii) After the construction work, the temporary weir was removed and the river water flowed down to the Namikokwe River.

iv) The Namikokwe River moved gradually closer to the flood protection dike, developing its channel scale and degrading its riverbed.

v) The river courses became integrated and concentrated into the Namikokwe River.

2) Present Condition of the Catchment Area

The Namikokwe River originates in the western highland area (elevations from 1200m to 1400m) and flows into Lake Malawi (elevation 474m). The surface of the catchment is covered mainly with a thick weathered layer, with granite and hard clay layers being exposed periodically. This geological formation is easily eroded.

The upper reach of the river has nowadays been particularly developed for farming and transmigration. Upland crops, such as maize, potatoes and vegetables have been cultivated not only in the flat area but also on the steep mountain slopes. The road leading to the upper basin from the Project has been damaged in many areas with embankments or excavations. Although the river in the upper basin is very steep, the valley has a remarkably low gradient.

In the rainy season, the river conveys sufficient water and sediment to cause

sedimentation problems downstream.

To a point some 3.5 km upstream of the headworks, the flow is still rapid with a slope of 1/30 to 1/60. Downstream, the river gradient reduces suddenly to a slope of 1/300 and an alluvial plain suitable for irrigation appears. A huge swampy land spreads across the plain and the river and discharges into Lake Malawi.

3) Causes of Flood Damage

According to the original basic design, when discharges in the Namikokwe River exceed the design flow of 170 m^3/s at the headworks, the flood overtops the flood protection dike. This, however, has not occurred. The river course has approached the dike, and the river bed along the dike has been deeply scoured. The latter has resulted in a lowering of the river bed with slope failure and finally collapsing as shown in the following figures:

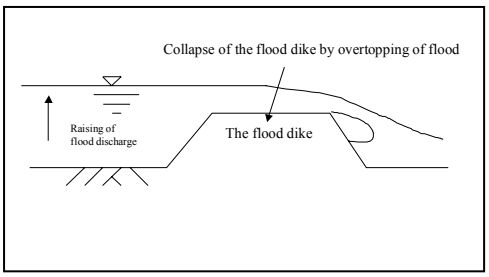


Figure Assumed collapse of the flood protection dike

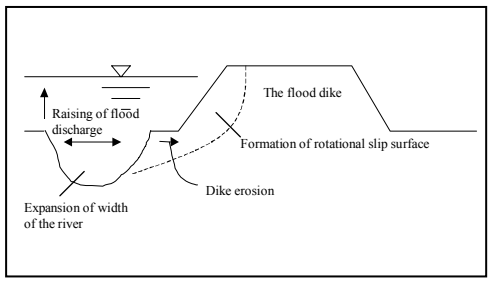


Figure Actual collapse of the flood protection dike by the flood

Based on a review and examination of the history of the river course, topographic conditions of the damaged sites, and river bed materials, the causes of flood damage can be determined as follows:

i) The river course has been integrated and concentrated into the Namikokwe river.

ii) When a flood occurred in the past, it discharged into the three river courses as well as across their flood plains. The flood depth was shallow and the tractive force of floods was not strong. Recently the tractive force of floods has become much stronger as the river course has been integrated and concentrated into the Namikokwe river.

iii) Furthermore, the river bed materials are sand and clay, which are easily washed away by floods. Consequently, the river bed has been degraded by a maximum depth of 7 m.

iv) Hard clay materials exist in the sand foundation in the river. When a flood hits this the flow direction can be easily redirected, striking the flood protection dike. Although riverbank erosion and meandering are observed, this river course from the headworks to the damaged sites may be maintained as the river has been

lowered by 7 m (at maximum) and is relatively fixed.

v) The river is meandering and eroding the river bank and, in some cases, approaching the flood protection dike. The adjacent river bed has been scoured by floods causing the dike near the eroded riverbed to collapse due to slope failure. The concrete lining of the main canal running along the dike has also collapsed, causing failure of the irrigation water delivery.

4) Opinion of the Beneficial Farmers on the Protection Measure against Floods

During the 3rd Basic Design Study, workshops were held for BC-1, BC-2, BC-3 (BC: Branch Canal) farmers to confirm their opinions for the measures. On the other hand, questionnaire surveys were conducted to stakeholders to obtain quantitative data. The results of those surveys are shown in Appendices-7 and the result of the workshop is summarized as follows:

Table Summary of Farmers' Opinions

Farmers	Summary of Farmers' Opinion
BC-1	The river course should be shifted and the existing main canal should be rehabilitated and utilized. Land re-allocation is difficult if main canal is shifted.
BC-2	The shifting of the main canal is acceptable. Land reallocation could be done if the main canal is shifted.
BC-3	The shifting of the main canal is acceptable. Regarding land re-allocation, both opinions (difficult and possible) were observed if the main canal is shifted.

5) Measures Against Flood Damage

The flood-damaged sites are located in the upstream part of the System as shown in the following figure and measures against flood damage have been prepared placing priority on those sites.

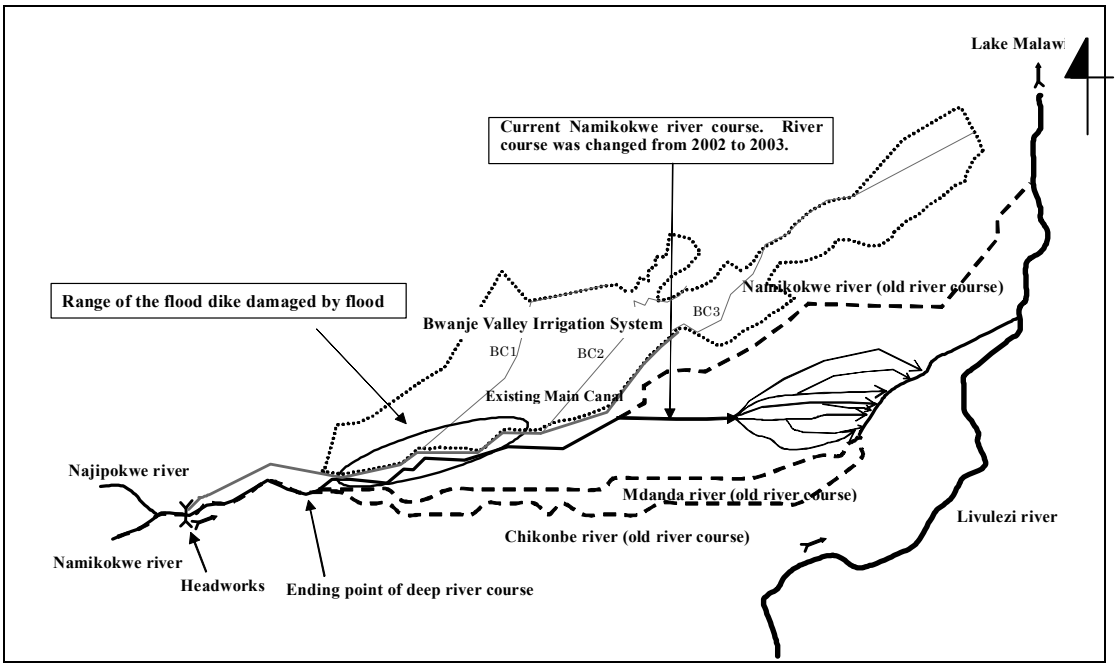


Figure History of Changing of Namikokwe River Course

Based on a review of the causes of flooding, three alternative measures have been formulated for protection of the irrigation area against floods, namely i) New River Construction Works, ii) Main Canal Relocation Works, and iii) River Bank Protection Works. The outlines of the three alternative measures are as follows:

i) New River Construction Works

This alternative is to move the present river course, which is close to the flood protection dike, to the southern area.

ii) Main Canal Relocation Works

This alternative is to shift the main canal's alignment to a place away from the river course in the System.

iii) River Bank Protection Works

This alternative is to i) protect the flood protection dike using a revetment on the left bank and ii) rehabilitate the existing main canal and inspection road.

As a result of comprehensive evaluation from the viewpoints of O&M, safety, opinions from farmers, and construction costs, measures of Main Canal Relocation Works have been selected as a recommended alternative (refer to Table 2-1). Meetings and discussions with GOM and the cooperative have been held in order to explain the recommended alternative after which measures of Main Canal Relocation Works were agreed. As a result, the area to be reinforced for disaster prevention against floods under the requested Japanese assistance is 590ha.

(2) Range of the Requested Japanese Assistance

The Japanese assistance comprises: i)the headworks rehabilitation works, ii)the settling basin rehabilitation works, iii)the main canal relocation works, iv)the leveling works, and v)Soft Component Program (technical assistance for land re-allocation, water management strengthening, and flood damage mitigation and repair measures). Details are given in the following table:

Table Range of the Requested Japanese Assistance

	Item	Bwanje Valley Irrigation System (Original Plan, 800ha)	Bwanje Valley Irrigation System	
			590ha Area	210ha Area
	Planting Plan	Rainy Season：Paddy Dry Season：Maize (145ha)	Rainy Season：Paddy Dry Season：Maize (145ha)	Rainy Season：Maize
Design for Facilities	1. Irrigation & Drainage Works			
	Irrigable Area	800 ha	590ha	210ha (water supply to upland crops)
	Headworks (fixed weir)	1no.	**1no.(rehabilitation)**	Utilization of the same structure in the left column
	Settling Basin	1no.	**1no.(rehabilitation)**	-ditto-
	Irrigation Canals Main Canal	6.8 km	(existing) 1.0 km **(new) 5.8 km**	(existing) 5.8 km
	Branch Canals	14.8 km	(existing)10.5 km **(new) 1.8 km**	(existing) 4.3 km **(new) 1.2 km**
	Tertiary Canals	60.8 km	(existing)43.5 km **(new) 0.8 km**	(existing) 17.3 km
	Drainage Canals	17.3 km	(existing)14.2 km **(new) 1.0 km**	(existing) 3.1 km **(new) 3.0 km**
	Inspection Road	13.7 km	(existing)10.0 km **(new) 5.8 km**	(existing) 3.7 km
	Flood Protection Dike／Road	7.8 km	(existing) 2.0 km	(existing) 5.8 km
	Area for Land Leveling	800 ha (leveled: 203ha) (planned: 597ha)	590 ha (leveled 171ha) **(planned 419ha)**	210 ha (leveled 32ha) (planned 178ha)
	2. Rural Infrastructure			
	Rural Road (Headworks～M10)	2.3 km	(existing) 2.3 km	
	Rural Water Supply (Borehole and Hand Pump)	13nos.	(existing) 13 nos.	
	3. Post-harvest facilities			
	Ricemill (100-120kg/hr)	4nos.	(existing) 4 nos.	
Soft Component		—	**1)Land Reallocation Assistance** **2)Water Management Strengthening Assistance** **3)Flood Damage Mitigation and Repair Measures Assistance**	

:Range of the Requested Japanese Assistance

(3) Design Consideration for Setting a Grade for Facilities and Materials

The contents of i)the headworks rehabilitation works, ii)the settling basin rehabilitation works, iii)the main canal relocation work and iv)the leveling works are described hereinafter. The design standards and/or references used for the design works are the Design Standard for the Land Reclamation ("Headworks" and "Canal Structures"), the Ministry Act for River Control Facilities, the Technical Standard for River Erosion Control and Torrential Improvement, the Guidance for Design of Ground Sill, the Guidance for Design of Sluiceway on Soft-foundation, and other relevant design standards or references.

1) Headworks Rehabilitation Works

In the headworks rehabilitation works, the following rehabilitation/improvement works shall be executed:

Table Design Plan of Headworks Rehabilitation Works

Structure	Present Condition	Design Plan
① River Slope/Bed Protection Works on Downstream Apron of the Headworks	In the original design, the downstream river bed elevation was EL.517.8m. The riverbed elevation reduced to EL.515.5m as of March of 2005. Due to such scouring of the riverbed, the downstream water surface cannot be maintained so that no suitable hydraulic jump is formed as designed. And a partial collapse of the river slope/bed protection works is being observed.	A combination of hydraulic dissipating by drop structures and water cushion shall be adopted. A concrete structure is designed for the drop structures. For the protection of the energy dissipater pond as a water cushion, rock blocks are to be placed because rocks could be obtained at lower price than concrete blocks for river bed protection.
② Operation Bridge	The flood on Feb 1 2003 (Q=460m^3/s) overflowed the operation bridge.	The operation bridge shall be raised.
③ Sluiceway Gate	Since the gates are manually operated, it is rare to lift the gates over the flood water level. Hence, flowing materials overflowing the gates hit and damage the spindles.	A wall shall be set between the gate and the operation deck, and works to ensure water tightness shall be made on the upper edges of the gates to protect the spindle.
④ Intake	As no operation deck was installed at the intake, it is difficult to remove flowing materials. As a result, such conditions reduce the intake discharge.	An operation deck shall be installed for easy cleaning of the screens.
⑤ Conducting Wall at the Upstream Sluiceway	When the sluiceway gates are open, it takes some time to form supercritical flow in the upper sluiceway because the conducting wall is low and river water enters the sluiceway over the wall.	The conducting wall shall be raised to ensure supercritical flow forms at an early stage.

2) Settling Basin Rehabilitation Works

Taking the present condition of the settling basin and the need to alleviate farmers' operation and maintenance, the following design is planed:

Table Design Plan of Settling Basin Rehabilitation Works

Present Design	Present Condition	Design Plan
① Nos. of Settling Conduits	As the number of the existing conduits is only one (1), all water during the flushing time is drained to the river and no water supply to the main canal is intercepted.	The number of conduits shall be two (2) or more, so as not to intercept the water supply to the main canal.
② Removal Method of Sediment	In the original design, the height difference between the design intake level (EL.519.30m) and the downstream river bed (EL.517.80m) is only 1.5m. Therefore, sediment has to be removed manually. This work is a rather hard burden on farmers. It also does not remove sediment at the proper time or with sufficient manpower and results in sediment entering the main canal.	As the downstream riverbed has reduced to EL.515.5m from EL.517.8m, a head difference of around 4m, natural flushing of sediment by gravity shall be adopted to reduce the burden for sediment removal and the time for flushing.
③ Minimum Particle Size	In the original design, the minimum particle size is 0.3mm. However, a huge amount of river material less than 0.3mm is entering the main canal and being deposited.	According to the results of the grain size analysis of the sediment in the settling basin and main canal, a minimum particle size of 0.2mm shall be adopted to avoid sediment harmful to water flow in the main canal.

The figure to the right shows the results of the grain size analysis at the settling basin (No.1), the bifurcation in the middle section (No.2), and the ending point of the branch canal at the downstream section (No.3). At the point of the settling basin, 90% of the sediment exceeds 0.2mm and harmful sedimentation can be avoided by its exclusion. Therefore, 0.2mm was adopted as minimum particle size.

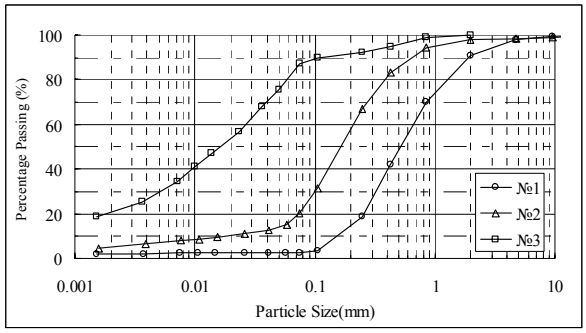


Figure Result of the Grain Size Analysis at the Settling Basin

In view of the following reasons, the existing settling basin shall be demolished and a new one constructed:

- As it is necessary to form supercritical flow in order to realize natural flushing by gravity, the longitudinal slope of the sediment conduit should be steepened from present conditions. As a result, the base elevation shall be lower than in the existing conduits.
- As the design dimensions of the sediment conduits and discharge pipe are to be revised, the majority of the existing structure cannot be reused.

3) Main Canal Relocation Works

It is proposed to shift the main canal north of the river course in the project area to avoid risk of future flood damage to the main canal.

The irrigation area and land use plan will be modified from original plan as shown in the following table and proposed cropping pattern is shown in Figure 2-1:

Table Irrigation Area and Land Use Plan

	Original Plan		New Plan			
			590ha Area		210ha Area	
Season	Rainy	Dry	Rainy	Dry	Rainy	Dry
Irrigation Area	800ha	145ha	590ha	145ha	210ha	—
Farm Land Use	Paddy field	Upland field (Maize)	Paddy field	Upland field (Maize)	Upland field (Maize)	—

Irrigation to the 210 ha area will be continued through the existing main canal. As there will be still risks of flood damages and disconnection of the water supply in the existing main canal in the 210 ha area in the future, supplemental irrigation will be applied for those fields through the existing main canal.

In the design, 1)Design intake discharge, 2)Design discharge for the new main canal are formulated as follows:

Table Design Plan of Main Canal Relocation Works

Issue	Basic Plan
1) Design intake discharge	The original intake discharge is Q= 1.14 m^3/s for the 800 ha area. In the project, the design intake discharge was again adopted as 1.14 m^3/s as in the design, so as to irrigate the 210 ha area.
2) Design discharge for the new main canal	The following two methods can be considered as an irrigation method to supply water for the 590 ha area and the 210 ha area. Method-1 : Continuous irrigation to both areas Method-2 : Rotational irrigation between the two areas In the case of alternative 1, conveyance loss may be increased in comparison with the original plan because both main canals would be used at the same time and the total length of the main canals (original and new) would be longer than the original. Additionally, the new main canal would have no capacity to flow at 1.14 m^3/s if the existing main canal is damaged by floods in the future. Therefore, in order to avoid such an unfavorable condition, a rotational irrigation method shall be applied to minimize the conveyance loss, the burden for gate operations, and construction cost (see Table 2-2). The rotation cycle is planed as three (3) days for 590 ha and one (1) day for 210 ha out of four (4) days, in line with the original rotation cycle (4 days) and based on the capacity of tertiary canal. The design discharge for the new main canal is calculated as follows: 1.42 l/sec/ha × 590ha × 4/3 ÷ 1000 = 1.12 m^3/s 1.12 m^3/s is equivalent to 1.14 m^3/s, which is the design discharge for the existing main canal. Therefore, 1.14 m^3/s is applied for the design discharge for the new main canal.

4) Land Leveling Works

The land leveling works have been executed for 47.8 ha under the first Japanese Grant Aid and 155.1 ha by GOM.

According to the relocation of the main canal, the original area of 800 ha will be divided into 590 ha and 210 ha. The progress condition of each area is given in the following table (refer to Figure 2-2):

Table Progress in Land Leveling Works Unit : ha

Category	590 ha Area	210 ha Area
1. Leveling Completed	171	32*1
2. Leveling Required	419	178
1) Lesser degree	146	38
2) Middle degree	179	112
3) Greater degree	94	28
Total	590	210

Data Source: Project O&M Office (590ha area), JICA Expert (210 ha area), March 2005
Note: *1) The area of leveling completed in the 210 ha area includes the field area for construction for the new main canal.

The main issues to be considered for the design are: 1) demarcation of responsible area under Japanese grant aid assistance and GOM, and 2) leveling grade. The issues are to be studied as follows:

Table Design Plan of Land Leveling Works

Item	Basin Plan
1) Demarcation of responsible area under Japanese assistance and GOM	Demarcation of responsible area is listed below, since 210 ha area will be irrigated under the responsibility of GOM. Japanese assistance : 590 ha area GOM : 210 ha area
2.Leveling grade	±7.5 cm in line with equivalent to the land leveling done by GOM.

2.2.2.2 Basic Design

(1) Summary of Basic Design

The basic design for the rehabilitation works for irrigation facilities carried out by the requested Japanese assistance is summarized in the following table.

Table Summary of Basic Design

Rehabilitation Works	Basic Design
1. Rehabilitation of Headworks	River Slope/Bed Protection Works below the Downstream Apron Construction of drop structure and ground sill with sheet pile Construction of concrete slope protection Operation Bridge Raising bridge (0.5m) and rehabilitation of Connective Road Sluiceway Gate Construction of suspending wall and heightening gates Intake Installation of operation deck and suspending wall Conducting Wall at the Upstream Sluiceway Raising conducting wall to EL. 518.80m
2. Rehabilitation of Settling Basin	Sediment Conduit Length: 31.0 m, Width: 1.5m x 3 nos., Slope: 1/60 Discharge Pipe Length: 35.0 m, Width x Height: 1.0m x 1.0m, Slope: 1/38 Flush Gate : 1.0m x 1.0m x 3 nos. Control Gate : 1.2m x 0.5m x 3 nos. Spillway Gate : 1.0m x 1.25m x 1 no.
3. Relocation of Main Canal	Main Canal Length: 5.8km, Design Discharge: 1.14 ~0.53 m^3/s Branch Canal Length: 3.0km, Design Discharge: 0.33 ~0.18 m^3/s Tertiary Canal Length: 0.8km Raising Existing Canal Height Length: 10.2km, Raising Height:10cm~20cm Canal Related Structure Gate Structure, Bifurcation, Turnout, Drop, Culvert, Drainage Culvert, Footbridge, Washing Basin, Field Inlet, Division Box Drainage Canal Length: 4.0km, Design Discharge: 0.04~0.37 m^3/s Inspection Road Length: 5.8km, Width: 5.0m (Width of Pavement 3.0m)
4. Land Leveling	Lesser Degree Leveling Area: 146 ha Middle Degree Leveling Area: 179 ha Greater Degree Leveling Area: 94 ha (Total 419ha)

Details are described below.

(2) Basic Design for Rehabilitation of Headworks

1) Design Condition and Dimension

Item	Dimension	Remarks
① Design Flood Discharge	460 m^3/s	Recorded maximum discharge（460 m^3/s、Feb.1, 2003）.
② Design High Water Level	HWL 522.50m	Original Design : EL.521.79m. HWL 522.50m is the same as the top elevation of the design dike.
③ Design Intake Discharge	1.14 m^3/s	As well as the original design.

Item	Dimension	Remarks
④ Weir Type	Fixed Weir	As well as the original design.
⑤ Crest Elevation	EL.519.40m	As well as the original design. The design intake water level is WL 519.30m.
⑥ Height × Length of Weir	4.5m×50m	As well as the original design.
⑦ Design Intake Water level	WL 519.30m	As well as the original design.

2) Dimensions of Structures

Structure	Determination of Dimensions
① River Slope/Bed Protection Works below the Downstream Apron of the Headworks	①As the present river bed elevation（EL 515.5m）has become lower than the elevation of the existing river bed protection work (EL 517.8m) due to scouring, all of the protection work shall be removed. ②The existing river slope protection work shall also be removed because its tail section connects the river bed protection work. ③Drop structures shall be set just below the weir body to dissipate the energy of the water overflowing the weir (width=50m). Referring to the Design Standard for the Land Reclamation "Headworks" and relevant construction records in Japan, the apron length (L) is three (3) times or more the drop height (h), in principle. ④In case one drop structure is adopted, excavation work may bad affect the existing weir. Three drops shall be adopted for excess of river water. (1st drop: h=2.0m、L=7.0m, 2nd drop: h=2.5m、L=8.0m, 3rd drop: h=2.0m、L=6.0m) ⑤The apron elevation of the 3rd drop shall be EL 510.0m. The elevation of the downstream river bed is EL 515.0m. ⑥Transition work shall be made between the end point of the 3rd drop to the existing downstream river bed (EL 515.0m). ⑦The material for the transition shall be rocks, from the viewpoint of cost saving. ⑧At the endpoint of the transition, sheet piles (type III, L=3m) or a ground sill shall be driven to the foundation in order to avoid causing river bed lowering upstream. ⑨Considering that the Namikokwe River turns left at an angle of 20 degrees at a point 53.3m downstream from the end of the weir and the range of river slope protection work for the outlet of the discharge pipe from the settling basin, river bed protection (rocks) after the ground sill shall be set for 103m on the river center line.
② Operation Bridge	①The raised section of the bridge shall be 0.5m because no space for an approach to the bridge is available at the left bank. By raising the bridge, it is possible to avoid washing away of the bridge by floods because the flow area increases substantially on both sides and the increase in flood water level is rather small. ②The upper surface of the present bridge is EL 523.0m and the crest elevation of the retaining wall is EL 522.50m. As the present height difference between them is 0.5m, the future height difference shall be 1.0m after rehabilitation. The design slope shall be 10%.
③ Sluiceway Gate	① The top elevation of the gates is EL 519.2m. On the contrary, the crest elevation is EL 519.4m. Taking such conditions into account, the top elevation of the gates shall be raised 0.30cm to EL 519.5m considering the design safety of 0.10m.

Structure	Determination of Dimensions
	②To protect the spindles against flowing material, a suspending wall shall be set.
④ Intake	①An operation deck (w=1.00m) shall be set to remove floating material caught at the screens. The sill elevation of the intake structure is EL 518.8m and the intake water level is WL 518.3m. The height from the sill of the intake to the upper surface of the deck is to be designed to be (design water depth 50cm) + (freeboard 0.5m) + (the thickness of the deck 25cm) =125cm. Behind the operation deck, a suspending wall shall be set behind the operation deck. ② The height of the screens is (design water depth 50cm)+(freeboard 50cm)=100cm.
⑤ Conducting Wall at the Upstream Sluiceway	The top elevation of the conducting wall is EL 518.5m and 70cm higher than the base elevation of the sluiceway and 30cm lower than the sill elevation of the intake. If the top elevation of the conducting wall is made higher than the sill elevation of the intake, the intake velocity may become faster because the inflow comes only from the sluiceway. Taking such conditions into account, the crest of the conducting wall shall be raised 30cm in order to avoid the problem of intake and to create supercritical flow immediately in the sluiceway.

(3) Basic Design for Rehabilitation of Settling Basin

1) Design Condition and Dimension

Item	Dimension	Remarks
① Design Intake Water Level	HWL 519.3m	This design condition is the same as the original one
② Design Flood Water Level	HWL 522.5m	-ditto-
③ Design Intake Discharge	1.14 m^3/s	-ditto-
④ Sediment Removing Method	Natural flushing by gravity	Existing settling basin: Removal of sediment by manpower
⑤ No. of Sediment Conduits	More than one	Existing settling basin: one conduit
⑥ Minimum Particle Size	0.2mm	Existing settling basin：0.3mm
⑦ Width	1.2m	This design condition is the same as the original

2) Examination of the number, width and length of sediment conduits

The number of sediment conduits shall be more than one (1) considering the advantage of utilization of water and operation/maintenance. As the discharge is Q=1.14 m^3/s (relatively low), the appropriate number is two or three.

Taking into account the operation and maintenance (especially cleaning in the conduits) of the sediment conduits, the minimum width should be 1.5m. Referring to the Design Standard for the Land Reclamation “Headworks”, the following alternatives are examined:

Table Comparison of Three Alternatives for Sediment Conduits

Item	①Alternative-1	②Alternative-2	③Alternative-3
1) Width (B)	1.5m	1.5m	2.0m
2) No. of conduits (n)	2	3	3
3) Water Depth (H)	1.92m	1.92m	1.92m
4) Length (L)	67.0m	31.0m	21.0m
5) Total Volume	323m^3	266m^3	251m^3

The features of each alternative are given in the following table:

Table Feature of Three Alternatives

Alternative	Feature	Judgment
①Alternative-1 (B1.5m×2nos.)	As the length of the sediment conduits increases, the flushing time will also become longer. The location of the inlet of the discharge pipe is set at the lowest position so that the length of the river slope/bed protection works will become the longest among the alternatives. The cost of gates is the lowest, but the total construction cost is the highest when including the cost for the additional river slope/bed protection work.	△
②Alternative-2 (B1.5m×3nos.)	The flushing time is generally shorter than for Alternative-1. The number of gates is three, but the size of the structure can be downsized as well as the river slope/bed protection works.	○
②Alternative-3 (B2.0m×3nos.)	The flushing time is the shortest among the alternatives. The size of the additional river slope/bed protection work is also the smallest. The width of the conduit is 2.0m so that the size of gate will become larger and the cost will also increase.	△

From the above examination of the alternatives, Alternative-2 shall be adopted because it enables the flushing of sediment in a short time and it has the lowest construction cost.

3) Dimensions of Structures

The dimensions of the structure are examined in the following table:

Structure	Determination of Dimensions
① Sediment Conduit	①The width of the conduit shall be 1.5m from the viewpoint of operation and maintenance. ②The design for the width and height of the sedimentation conduit shall be made based on the Design Standard for the Land Reclamation "Headworks". As the settling basin has three sedimentation conduits, the design discharge for one conduit is q = 1.136/3 = 0.379m^3/s. The square of the critical friction velocity "u_{*c}" of the minimum particle size dc=0.02cm is calculated by the Iwagaki Formula as follows: $u_{*c}^2 = \tau c/\rho = 8.41 \times dc^{11/32} = 8.41 \times (0.02)^{11/32} = 2.192$ $K = \tau c/\rho i = 2.192/(1/60) = 132 cm^2/sec^2 = 0.0132\ m^2/sec^2$ Where, τc: Critical tractive force (tf/m2), ρ: Density of water (t/ m^3), i: Slope of the sedimentation conduit Assuming $\alpha = 1.2$, it is required to obtain h, which leads to a calculation result of 1.5m as the width (B) of the sedimentation conduit. When h is 1.42m, $B = (h^2 + \alpha Q^2/kh^2)^{0.5} - h$

Structure	Determination of Dimensions
	$=[1.42^2+1.2\times0.379^2/(0.0132\times1.42^2)]^{0.5}-1.42$ $=1.494$ m Assuming that a) the water level at the completion point of sedimentation is WL 519.17m、b) the base level at the completion point of sedimentation is EL 517.50m, and the c) sedimentation is 0.25m, the water depth at the completion point of sedimentation is 519.70-517.50-0.25=1.42. According to Sedimentation Theory ("Headworks", P329), the length of the sedimentation conduit (m) is calculated by the following formula: $L=Kh/vg\times u=KQ/Bvg$ Where, K:1.5～2.0 (safety coefficient) h: Water depth on the surface of sedimentation at the completion point of sedimentation (m), B: Width of sedimentation conduit(m)、u=uc: Critical tractive force, vg: Critical sedimentation velocity (m/s), q: Design discharge for one conduit (m^3/s) It is given that a) K is 1.75(middle value), b) Q is 0.379 m^3/s and c) B is 1.50m. Vg could be obtained from the minimum particle size (0.2mm) and Figure 19-1. As a result, Vg was determined as 0.01m/s. Then, $L=Kh/Vg\times u=KQ/BVg$ $=1.75\times0.379/(1.50\times0.01)$ $=44.217m\Rightarrow45.0m$ The volume of the settling basin is calculated by the following formula: $V=\{(519.17-517.50)\times1.50+\{519.17-(517.50+45/60)\}\times1.50\}\times1/2\times45.0\times3$ nos. $=262.2m^3$ ③In the above calculation, it is possible to set EL 517.00m as the elevation of the base of the conduit at the completion point of sedimentation from the intake water level (EL 515.0m) and the design river bed (EL 515.0m). Accordingly, the water depth at the completion point will be 519.70-517.00-0.25=2.45m or 50cm deeper than the original design. In case the width is the same as the original design, the length of the conduit could be shortened. Assuming that the length of the conduit is 31m, the volume of the settling basin is given by the formula: $V=[(519.17-517.00)\times1.50+\{519.17-(517.00+31/60)\}\times1.50]\times1/2\times31.0\times3$ nos. $=266.677m^3$ This calculation result is nearly equal to that of the original design. Therefore, the design length and design width of the sediment conduit shall be 31m and 1.5m respectively. The water depth at the completion point of sedimentation shall be 2.45m (bed elevation: EL 517.00m). ④ At the front of each sediment conduit, a weir shall be set for channelizing.
② Spillway	To prevent entering of excess discharge during floods, a spillway shall be set beside the sediment conduits. The width shall be 1m taking its construction into consideration. As it is difficult to exclude sediment from the headrace due to its shape, the spillway shall be extended and connected to the headrace to remove sediment. A gate shall be set at the point from the headrace to the spillway.
③ Discharge Pipe	The discharge pipe shall be aligned diagonally to the river instead of making a right angle to the river center line. The river bed elevation at the outlet of the discharge pipe is EL 515.00m. In order to avoid clogging with sediment, the sill elevation at the end of the discharge pipe is EL 515.40m. As a result, the slope of the discharge pipe is 1/38 so that the removal of sediment can be made by supercritical follow. The internal dimension is 1.00m×1.00m, which is the minimum internal space for construction.

Structure	Determination of Dimensions
④ Measurement Facilities	①At the end point of the sediment conduits, flush gates (watertight at four sides) shall be installed. Each gate's dimension is B1.00m × H1.00m in accordance with the internal dimensions of the discharge pipe. ②A broad-crested weir shall be installed at the appropriate point between the sediment conduits and the beginning point of the main canal. ③When the intake discharge is low in dry seasons, it is necessary to concentrate discharge to one sediment conduit for shortening flushing time. To realize such a condition, a control gate of B1.20m × H0.50m (watertight at three sides) shall be set at each broad-crested weir.

(4) Basic Design for Relocation of Main Canal

1) Basic Design Conditions

Item	Design Condition	Remarks
1)Designed intake discharge	1.14m^3/s	Same as original design
2)Irrigation area	590ha	Due to shifting the main canal the project area is to be 590 ha
3)Unit water requirement	1.42 lit/s/ha	Same as original design
4)Maximum allowable velocity (main canal)	1.5 m/s	Same as original design
5)Maximum allowable velocity (branch canal)	1.0 m/s	Same as original design
6)Maximum allowable velocity (tertiary canal)	0.6 m/s	Same as original design
7)Minimum allowable velocity (main/branch canal)	0.5 m/s	Same as original design
8)Minimum allowable velocity (tertiary canal)	0.3 m/s	Same as original design

2) Basic Design

<table>
<tr><th>Facilities</th><th>Determination of Basic Design</th></tr>
<tr><td>1. Main Canal</td><td>
1) New Main Canal

The main canal should be designed taking the topography and the required water levels at the beginning points of the branch canals into consideration. The canal type will be concrete lined as for the original design.

The hydraulic properties at each section in the new main canals are summarized below:

Table Hydraulic Properties of the New Main Canal
<table>
<tr><th>Canal Section</th><th>BC4 – BC4+300m</th><th>BC4+300m – BF1</th><th>BF1 – BF2</th><th>BF2 – IP9</th></tr>
<tr><td>1) Canal Type</td><td>Flume</td><td>Concrete Lining (Type A)</td><td>Concrete Lining (Type A)</td><td>Concrete Lining (Type B)</td></tr>
<tr><td>2) Design Discharge (m^3/s)</td><td>1.14</td><td>1.14</td><td>0.81</td><td>0.53</td></tr>
<tr><td>3) Bed Width (m)</td><td>2.00</td><td>1.00</td><td>1.00</td><td>0.80</td></tr>
<tr><td>4)Canal Height（m）</td><td>1.25</td><td>1.00</td><td>1.00</td><td>0.70</td></tr>
<tr><td>5) Slope</td><td>1:1</td><td>1:1</td><td>1:1</td><td>1:1</td></tr>
<tr><td>6) Roughness Coefficient</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td></tr>
<tr><td>7) Location (m)</td><td>0-300</td><td>300-2,575</td><td>2,575-4,093</td><td>4,093-5,773</td></tr>
<tr><td>8) Length (m)</td><td>300</td><td>2,275</td><td>1,518</td><td>1,680</td></tr>
<tr><td>9) Gradient</td><td>1/500</td><td>1/500</td><td>1/330</td><td>1/260</td></tr>
<tr><td>10)Water Depth (m)</td><td>0.43</td><td>0.53</td><td>0.39</td><td>0.32</td></tr>
<tr><td>11) Velocity (m/s)</td><td>1.33</td><td>1.41</td><td>1.49</td><td>1.46</td></tr>
</table>
Note: BC4:Beginning point of the new main canal（diversion point to the existing main canal）
BF1,2:Bifurcation
IP9: End point of the new main canal (confluence point to the existing main canal)

The existing main canal will be utilized in the section between the end of the settling basin and the beginning of the new main canal (L=333 m). To increase gradient from 1/2,400 (original gradient) to 1/500 (designed gradient) the flume wall and canal bed will be raised using concrete.

2) Canal Height Raising Works

At the end point of the new main canal (IP9) it will join with the existing main canal. From IP9 to the end point of the existing main canal (the beginning point of BC-3), the original discharge is Q = 0.39 m^3/s （1.14m^3/s x 273ha / 800ha) and canal height: H = 0.6m. In the Project, design discharge will be Q = 0.53m^3/s (1.14m^3/s x 273ha / 590ha) and required canal height will be H =0.7m (canal type B). Therefore, in this section concrete blocks (Type1、h=10cm) are put on the top of the lining canal to raise canal height.

Table Design of Canal Height Raising Works for the Main Canal
<table>
<tr><th rowspan="2">Canal</th><th colspan="2">Original Design</th><th colspan="2">New Design</th><th rowspan="2">Raising Height (m)</th></tr>
<tr><th>Q (m^3/s)</th><th>H (m)</th><th>Q (m^3/s)</th><th>H (m)</th></tr>
<tr><td>Main Canal (L=570m) (N0.62+50-No.68+20)</td><td>0.39</td><td>0.60</td><td>0.53</td><td>0.70</td><td>0.10</td></tr>
</table>
</td></tr>
</table>

2. Branch Canal

1) New Branch Canal

After shifting the main canal, several turnouts on the branch canals will be excluded from the Project area and cannot divert water to the tertiary canals in the Project area. To supply irrigation to those areas new branch canals and turnouts shall be constructed. Only for No.1 and No.2 branch canals will construction works be required. The beginning points of two branch canals will be set on the new main canal, and at the end the new branch canals will join with the existing branch canals.

The hydraulic properties of the new branch canals are summarized as follows:

Table Hydraulic Properties of the New Branch Canal

Canal Name	Branch Canal No.1	Branch Canal No.2
Canal Section	BF1-Confluence Point to the Existing Branch Canal No.1	BF2-Confluence Point to the Existing Branch Canal No.2
1)Canal Type	Concrete Lining (Type C-1)	Concrete Lining (Type C-1)
2)Discharge(m^3/s)	0.33	0.28
3)Bed Width(m)	0.60	0.60
4)Canal Height(m)	0.70	0.70
5)Slope	1:1	1:1
6)Roughness Coefficient	0.015	0.015
7)Location(m)	0 - 960	0 - 880
8)Length(m)	960	880
9)Gradient	1/600	1/600
10)Water Depth(m)	0.36	0.33
11)Velocity(m/s)	0.97	0.93

2) Canal Height Raising Works

The branch canal shall be designed under a rotational irrigation system because at present the farmer cooperative applies it at the branch canal level. In this case the capacity of downstream parts of each branch canal shall be increased to the same size as for the upstream parts. To increase the capacity, the canal height will be raised by putting concrete blocks (Type1、h=10cm) on the top of the lining canal.

In addition, in the upstream parts of the branch canal No.3 the original discharge is Q = 0.39 m^3/s（1.14 m^3/s x 273ha / 800ha） and canal height is H = 0.6m. In the new design the discharge will be Q = 0.53 m^3/s（1.14 m^3/s x 273ha / 590ha） and required canal height will be H =0.7m (canal type B).

The hydraulic calculations of the original and new design are summarized as follows:

Table Design of Canal Height Raising Works for the Branch Canals

Branch Canal	Original Design		New Design		Raising Height (m)
	Q(m^3/s)	H(m)	Q(m^3/s)	H(m)	
Branch Canal No.1 (L=570m) (No.22+70-No.48+54)	0.21	0.50	0.33	0.60	0.10
Branch Canal No.2 (L=2,584m) (No.22+51-No.44+46)	0.18	0.50	0.28	0.60	0.10
Branch Canal No.3 (L=3,060m) (No.0+00-No.30+60)	0.39	0.60	0.53	0.70	0.10
Branch Canal No.3 (L=1,780m) (No.30+60-No.48+40)	0.39	0.50	0.53	0.70	0.20

3) Extension of the Existing Branch Canal in the 210ha Area

In the 210ha area, the new main canal cut several tertiary canals so that some areas cannot be irrigated. To save these areas, the end of the branch canals shall be extended to supply water to these tertiary canals. To save the construction cost brick lining shall be applied.

The hydraulic properties of the extension parts of those canals are shown in the following table:

Table Hydraulic Properties of the Extension Parts of the 210 ha Branch Canals

Canal	Extension of the Existing Branch Canal No.1	Extension of the Existing Branch Canal No.2
1)Canal Type	Brick Lining (Type D)	Brick Lining (Type D)
2)Discharge(m^3/s)	0.21	0.18
3)Bed Width(m)	0.50	0.50
4)Canal Height(m)	0.50	0.50
5)Slope	1:1	1:1
6)Roughness Coefficient	0.015	0.015
7)Location	No.0(No.22+31.49 of BC-1) – No.5+02	No.0(No.19+65.01 of BC-2) – No.6+70
8)Length	500	670
9)Gradient	1/200 – 1/290	1/260 – 1/210
10)Water Depth(m)	0.23 – 0.25	0.22 – 0.21
11)Velocity	1.30 – 1.13	1.12 – 1.21

3. Tertiary Canal

Several tertiary canals are intercepted by the new main canal. These tertiary canals are to be extended and field inlets shall be installed as shown in the following table:

Table Extended Length and Number of New Field Inlets for the Tertiary Canals

Branch Canal	Tertiary Canal	Extended Length(m)	No. of New Field Inlets
BC-1	BC-1-7L	54	1
	BC-1-5R	119	3
	BC-1-6R	91	2
	BC-1-7R	90	2
BC-2	BC-2-6L	96	1
	BC-2-14R	117	3
	BC-2-15R	117	3
	BC-2-16R	117	3

The canal type will be unlined earth. Bed width is 0.40m, and canal height is 0.50m, in line with the original design.

4. Irrigation Canal Related Structures

A gate structure will be provided at the diversion point to the new main canal and the existing main canal to control irrigation water flow for the both areas.

On the main and branch canals the same structures (bifurcation, turnout, drop, culvert, drainage culvert, footbridge) will be provided. In addition the following structures will be provided:

1) Washing basin

Considering the farmers' request, washing basins shall be provided on the main canal near the villages. The step-type washing basin will be applied.

2) Division box

Division boxes shall be provided on the branch canals in the 210 ha area. To save construction costs, stop logs will be used to control water instead of steel gates.

On the extended tertiary canals, field inlets shall be provided on the tertiary canal at every field plot. These will be constructed by using pre-cast concrete with PVC pipe of 150 mm. A check structure will be provided just downstream of field inlet for regulating irrigation water level.

General features of irrigation canal related structures are as follows:

Table General Features of Irrigation Canal Related Structures

Name of Structure	590 ha Area				210 ha Area		Total
	Main Canal	Branch Canal		Tertiary Canal	Branch Canal		
		No.1	No.2		No.1-A	No.2-A	
Gate Structure	1	-	-	-	-	-	1
Bifurcation	2	-	-	-	-	-	2
Turnout	-	7	6	-	-	-	13
Drop	5	-	-	-	-	-	5
Culvert	4	1	-	-	-	1	6
Drainage Culvert	3	-	-	-	-	-	3
Footbridge	18	1	1	-	-	-	20
Washing Basin	4	-	-	-	-	-	4
Field Inlet	-	-	-	18	-	-	18
Division Box	-	-	-	-	2	2	4

5. Drainage Canal

Drainage canals were provided to collect excess water in the field and from the outside and drain to the outside area. The excess water is collected by the tertiary drainage canals, provided along the tertiary irrigation canals, and flows into main drainage canals. There are four existing main drainage canals (DC1, DC2, DC3, and DC4) at present.

After shifting the main canal, as well as irrigation system, the existing drainage canals will be also separated into the 590 ha area and the 210 ha area. In order to avoid disconnection of the drainage system, new drainage canals will be provided. The alignment of the new drainage canals is along the new main canal.

Basic design conditions are as follows;

1) Unit area drainage discharge : 7.64 l/s/ha
2) Canal type : trapezoidal earth canal
3) Maximum allowable velocity: 0.75 m/s
4) Mean velocity formula : Manning formula
5) Roughness coefficient : 0.030
6) Design water level : 0.20m below from ground elevation

The hydraulic properties of the new drainage canals are calculated as below:

Table Hydraulic Properties of the New Drainage Canals

Area	Drainage Canal	Design Drainage Discharge (m^3/s)	Length (m)	Gradient	Base Width (m)
590 ha area	Drainage Canal No.2-A	0.05	660	1/220	0.40
	Drainage Canal No.3-A	0.04	290	1/250	0.40
210 ha area	Drainage Canal No.2-B	0.30	1630	1/260	0.60
	Drainage Canal No.3-B	0.37	1410	1/300	0.60

The following drainage canal related structures will be also provided:

Table Drainage Canal Related Structures for the New Drainage Canals

Structure	590 ha Area		210 ha Area		Total
	Drainage Canal No.2-A	Drainage Canal No.3-A	Drainage Canal No.2-B	Drainage Canal No.3-B	
Drainage Drop	0	0	0	2	2
Drainage Culvert	0	0	1	1	2

6. Inspection Road

1) Design Condition

Inspection roads will be provided along the main canal for the operation and maintenance of canals and transportation of farm products and inputs. Based on the original design, design condition is determined as follows:

a) Road width
   Total width : 5.00 m
   Pavement width : 3.00 m
b) Minimum embankment : Minimum embankment is 0.60m from the ground surface
c) Pavement
   Material : Crushed weathered stone
   Thickness : 0.20m
d) Slope of embankment : 1:1.5

	2） Length of Inspection Road Length of the inspection road newly constructed will be 5770 m. 3） Related Structure Culverts will be provided at two crossing points of the existing main canal.

(5) Basic Design for Land Leveling

1) Basic Design Conditions

Item	Design Condition	Note
1) Tolerance of Land Leveling	±7.5cm	Based on the original design
2) Target Area of Lesser Degree Leveling	146 ha	Based on the field survey
3) Target Area of Middle Degree Leveling	179 ha	Based on the field survey
4) Target Area of Greater Degree Leveling	94 ha	Based on the field survey

2) Basic Design

Category of Land Leveling	Method of Leveling
1) Lesser Degree Leveling Area	According to the sampling survey results, the field conditions in this category are summarized as below: 1) The land is generally utilized for paddy field. 2) The difference of ground surface elevation between the highest point and the lowest point in the lot is less than ±10 cm. 3) The levee was constructed. 4) There is configuration in small parts of target area. Based on the field conditions mentioned above, land leveling works for this category are grading the surface of small configured parts. The land leveling works will be carried out as follows: 1) In the rainy seasons before the land leveling works, no land re-allocation was done. Therefore, the area requiring land leveling shall be identified based on field reconnaissance and interviews of land cultivators at that time. 2) A minimum unit of lot is a net area surrounded by farm band according to the present farm land block. 3) Land leveling works shall be executed. As the undulation of the land is less than ±10 cm, simple land leveling (cut and fill on the surface soil, and trimming of the land) shall be done. 4) After completion of land leveling works, the level condition of the field shall be checked.
2) Middle Degree Leveling Area	According to the sampling survey results, the field conditions in this category are summarized as below: 1) The undulation of the land is less than ±15 cm. 2) The levee was constructed. 3) There is configuration in overall parts of the target area.

	Based on the field conditions, land leveling works for this category comprises grading the surface of the whole target land. The land leveling works will be carried out as follows: 1) Land leveling shall be performed for the whole area. 2) Land leveling shall be executed. As the undulation of the land is less than ±10 cm, simple land leveling (cut and fill on the surface soil, and trimming of the land) shall be done. 3) Minimum unit of lot will be 0.08 ha in net area surrounded by farm band according to the present farm land block. 4) After completion of land leveling works, the level condition of the field shall be checked.
3) Greater Degree Leveling Area	According to the sampling survey results, the field conditions in this category are summarized as below: 1) The land is not leveled and ground surface is sloped and the levee has not been constructed. 2) The area along the tertiary canal is higher than water surface in the canal. 3) Trees are found in some areas. Based on the field conditions, land leveling works for this category comprise construction of the levees and leveling of surface and foundation. One (1) lot has 0.4 ha on average. Taking the present plot plan, additional levee shall be constructed to make small plots by dividing the present plot. As cutting depth may be deep and sand layers exists 30 cm to 90 cm under the ground, surface soil shall be re-used. Though there are several trees in the area, no removal shall be done to save cost and time. The land leveling works are summarized below: 1) Surface soil shall be removed at first and returned finally for re-use. 2) Levees will be constructed to make a lot of 0.08 ha. 3) Trees in the field will not be removed to minimize cost and time. 4) After completion of land leveling works, the level condition of the field shall be checked.
4) Survey Works	In order to determine the designed land elevation at each lot, the elevation of original ground surface shall be surveyed. This survey work will be carried out during construction periods.

2.2.3 Basic Design Drawings

In accordance with the basic design described in Section 2.2.2, the basic design drawings for the rehabilitation works have been prepared and attached to this Report.

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

- The executing agency of GOM is MOAFS.
- The implementation plan is based on finishing all works by the end of February 2008.

- Only after GOJ and GOM have signed an Exchange of Notes (E/N) for Detailed Design will MOAFS commence preparation of the Implementation. MOAFS will i) undertake part of the detailed design of the rehabilitation of the irrigation facilities, ii) acquire agreement on land re-allocation from farmers, and iii) acquire all land necessary for the construction.
- The Project includes construction works in the existing Bwanje Valley irrigation system and delivery of water to the existing irrigation area must not cease during this period. The implementation plan is therefore based on guaranteeing delivery of irrigation water to the area during construction.
- In general, the works in the river for rehabilitation of the headworks will be undertaken during the dry season. In order to minimize flood damage to the headworks and maintain a dry construction site, a flood-diversion channel must be constructed on the right bank of the headworks.
- The land leveling must be done in the rainy season in order to ensure paddy cultivation in the paddy field is not disturbed.
- After relocation of the main canal and land leveling are completed, an irrigation water delivery test must be carried out to verify adequacy of the design and construction.
- After completion of construction works, all rehabilitated/constructed facilities will be turned over to MOAFS.

2.2.4.2 Implementation Condition

1) Observance of Labor Laws, etc.

The contractor must properly manage labor to provide an adequate safety control plan and prevent disputes/conflicts related to employment and working conditions for local labor. In all circumstances, the contractor shall abide by the labor laws and regulations in force in Malawi.

2) Irrigation Water Delivery during Construction Period

In order to guarantee irrigation water to the downstream area, irrigation water will have to be conveyed by the existing main canal. Hence, during the construction period the newly constructed and existing main canal will not be connected. After all the related structures and new main canal are constructed, both canals will be connected. At crossing points of the existing canal and the new road, concrete pipes, etc. will be provided in order to maintain irrigation water delivery to the downstream area. If irrigation water is disrupted, information on the period and areas affected

must be conveyed to related farmers and their consent on the disruption obtained.

3) Procurement of Construction Materials and Equipment

Construction materials available in Malawi include concrete aggregate, boulders/cobble stones, sand, timber, fuels and cement. Some construction equipment is also available but the number and types of equipment are limited. Therefore, some construction materials and equipment will be procured from South Africa or Japan. The procurement plan for them will be determined after considering the periods or days required for transportation, loading and unloading, custom clearance and other factors.

4) Land Acquisition

The relocation of the main canal will require additional land, which is located outside the project area. This includes land for the new main canal (around 17 ha), the temporary yard, and land temporarily needed for the flood diversion channel (around 5 ha). The land acquisition will have to be undertaken by GOM. The farmers providing land for the new main canal alignment will be considered in the land re-allocation to offset their losses.

5) Traffic Safety

The contractor for the construction of the Project will frequently use the existing road located in the project area. In order to avoid local traffic accidents, the following measures will be undertaken:

- Enhancing careful and safe driving with a sign board indicating construction site and period
- Using the newly constructed road along with new main canal and limiting entry of third party vehicles to the construction site of the main canal by providing obstacles and safety ropes
- Expanding a narrow road used frequently by local people
- Providing traffic safety facilities, such as traffic safety lights and ropes for drivers and local people

6) Environmental Nuisance Caused by Construction

In general, a contractor will produce or cause: i) noise, ii) dust, iii) vibration with heavy equipment, and iv) equipment accidents during the construction period. There are no facilities or buildings affected by noise and vibration as a result of the construction works, but it will be necessary to consider farmers during the evening. Thus, construction will not be permitted at night and to minimize dust the contractor

must sprinkle water on roads to be used. In order to prevent construction equipment accidents, the following measures will also be implemented:

- Training of drivers and operators regarding driving safe of equipment;
- Frequent safety meetings;
- Assignment of experienced mechanics who frequently check the equipment mechanically.

2.2.4.3 Scope of the Works

The scope of the works to be undertaken by GOJ and GOM will be as follows:

Table Scope of Works between GOJ and GOM

Works and Facilities to be Provided by GOJ	Works and Facilities to be Provided by GOM
- The following works stated in "Basic Design": 1. Rehabilitation of the headworks 2. Improvement of the settling basin 3. Relocation of the main canal 4. Land leveling - Temporary works（site office, accommodation, temporary yard, etc.） and construction and dismantling of temporary access road	- Rehabilitation/construction of the existing main canal, river protection and spur dike

2.2.4.4 Construction Supervision

(1) Preparation of Detailed Design and Tender Documents

Prior to the implementation of the Project, the detailed design and preparation of tender documents will be carried out. Immediately after the signing of the E/N, the consultant will be contracted with GOM and the consultant will commence detailed design. The consultant should discuss the design, implementation schedule of the works, land acquisition and land re-allocation with MOAFS during the detailed design. The main works necessary for the detailed design are as follows:

(a) Additional survey (additional survey based on Basic Design)

- Topographic survey of the headworks and settling basin areas
- Canal route survey of the new main canal to be relocated
- Borrow area and quarry site survey (embankment materials, concrete aggregate, etc.)

(b) Detailed design

- Design based on the survey results
- Hydraulic model test to define riverbed protection works downstream of the

headworks

- Cost estimate based on the detailed design

(c) Preparation of tender documents

- Preparation of tender design drawings
- Preparation of tender documents of construction works

(2) Tendering and Construction Supervision

After preparation of the detailed design and tender documents for construction, the tender for selection of a contractor will be conducted. After the contract has been concluded for the construction works, the consultant will initiate the following construction supervision:

(a) Evaluation and approval of construction drawings

- Evaluation and approval of the construction drawings, application for commencement of the works, sampling of materials, specifications of the equipment, etc. will be submitted by the contractor

(b) Construction progress and quality control

- Checking and guidance of the construction plans and time schedule, progress and quality control of the construction works and necessary inspection of the construction methods

(c) Approval for payment to the contractor

- Checking and evaluation of the performance of the works necessary for issuing payment certificates and completion certificate to the contractor

2.2.4.5 Quality Control Plan

Since specific quality control standards or criteria for construction works of irrigation canals and structures are not available in Malawi, construction supervision standards of the Ministry of Agriculture, Forestry and Fisheries of GOJ will be applied to the construction of the Project. In Lilongwe there are laboratories of the Ministry of Transport and Public Works (MOTPW) of GOM operating concrete and soil mechanical tests.

The daily tests must be carried out by the contractor, with the consultant reviewing and examining the test results in accordance with the specifications. The main items of the quality control test plan in the Project are shown in the following table:

Table Quality Control Test Plan

Material	Check Item	Standard	Frequency	Method
1.Concrete				
Cement	Type		Delivery time	Inspection
	Quality	JIS R5210	300 ton/time	Accredited laboratory
Admixture	Quality	JIS A6204	Delivery time and before usage	Mill certificate
Aggregates	Gradation	Concrete specifications	600 m^3/time and every quarry site	Attendance to test
	Unit weight	Coarse aggregates: more than 1.25 kg/l	Every quarry site and quality of the material	Attendance to test
		Fine aggregates: more than 1.45 kg/l		
	Specific gravity and % of water absorption of fine aggregates	Specific gravity: more than 2.5 % of water absorption: less than 3.5%		
	Specific gravity and % of water absorption of coarse aggregates	Specific gravity: more than 2.5 % of water absorption: less than 3.0%		
	Abrasion loss	Less than 40%		Accredited laboratory
	Washing test of aggregates	Fine aggregates: less than 5% Coarse aggregates: less than1%		
	Clay and friable particles volume	Fine aggregates: less than 1% Coarse aggregates: less than 0.25%		
	Organic materials of sand	JIS A1105		
	Stability	Fine aggregates: less than 10% Coarse aggregates: less than12%		
	Alkali-aggregate reaction	ASTMc289-66		
Mixing	Surface moisture of fine aggregates		One time/day and at time of rainfall	Attendance to test
	Slump	JIS A1101	Two times/day （morning and afternoon）	
	Air void	JIS A1116		
	Compressive strength test	JIS A1108	When concrete placement volume is less than 50 m^3, one time is necessary. When concrete placement volume is more than 50m^3, two times is necessary.	Attendance to test
2.Embankment				
Soil material	Density	JIS A1202	Every material	Attendance to test
	Gradation	JIS A1204		
	Liquid and plastic limits	JIS A1205		
	Optimum moisture	JIS A1210		
Construction	Trail embankment	More than 95% of maximum dry density		
	Water content	+-5% of optimum moisture content	200 m/time, 3 points at cross-sectional area	Attendance to test
	Field density	More than 95% of maximum dry density		
3.Reinforcing bars, gates, etc.			Every lot	Mill certificate

2.2.4.6 Procurement Plan

Construction materials are available in Malawi, such as cement, aggregates, timber, forms, and fuel, will be procured in Malawi; other materials not available in Malawi will be procured from South Africa. Steel sheet piles, however, will only be procured

from Japan since these are more economical than those available in South Africa.

Table Procurement of Construction Materials

Material	Procurement in Malawi	Procurement from Japan	Procurement from South Africa	Reason	Import Route
Cement	○			Locally available	Blantyre－Site
Aggregates	○			Locally available	Kamvula－Site
Reinforcing bars			○	Bars locally available are imported from South Africa, but the available volume is limited	South Africa－Zimbabwe －Mozambique－Malawi
Timber, forms	○			Locally available	Lilongwe－Site
Steel sheet piles		○		No production in Malawi and SSP from Japanese are cheaper	Japan － South Africa － Zimbabwe － Mozambique －Malawi
Fuel	○			Locally available	Lilongwe－Site
Steel gates			○	No manufacturing in Malawi	South Africa－Zimbabwe －Mozambique－Malawi

Construction equipment is available in Malawi. However, as the type and number are limited, most equipment for the Project will be procured from South Africa. Equipment such as generators and submersible pumps will be purchased by the contractor for the construction of the Project because of economic reasons.

Table Procurement of Construction Equipment

Equipment	Capacity	Procurement	Malawi	Japan	South Africa
Bulldozer	15 ton	Lease			○
Bulldozer	21 ton	Lease			○
Swamp bulldozer	16 ton	Lease			○
Swamp bulldozer	20 ton	Lease			○
Backhoe	0.6 m^3	Lease			○
Backhoe	1.0m^3	Lease			○
Tractor shovel	1.7 m^3	Lease	○		
Dump truck	10 ton	Lease	○		
Truck crane	25 ton	Lease			○
Truck crane	160 ton	Lease			○
Crawler crane	50 ton	Lease			○
Concrete mixer	0.5 m^3	Lease			○
Agitator truck	4.5 m^3	Lease			○
Tire roller	8-20 ton	Lease			○
Road roller	10-20 ton	Lease	○		
Motor grader	3.1 m	Lease	○		
Vibratory roller	0.8-1.1 ton	Purchase			○
Tamper	60-100 kg	Purchase			○
Vibratory hammer	65 kW	Lease			○
Breaker	1300 kg	Lease			○
Submersible pump	150 mm	Purchase			○
Generator	10 kVA	Purchase			○
Generator	45 kVA	Purchase			○
Generator	60 kVA	Lease			○
Generator	200 kVA	Lease			○

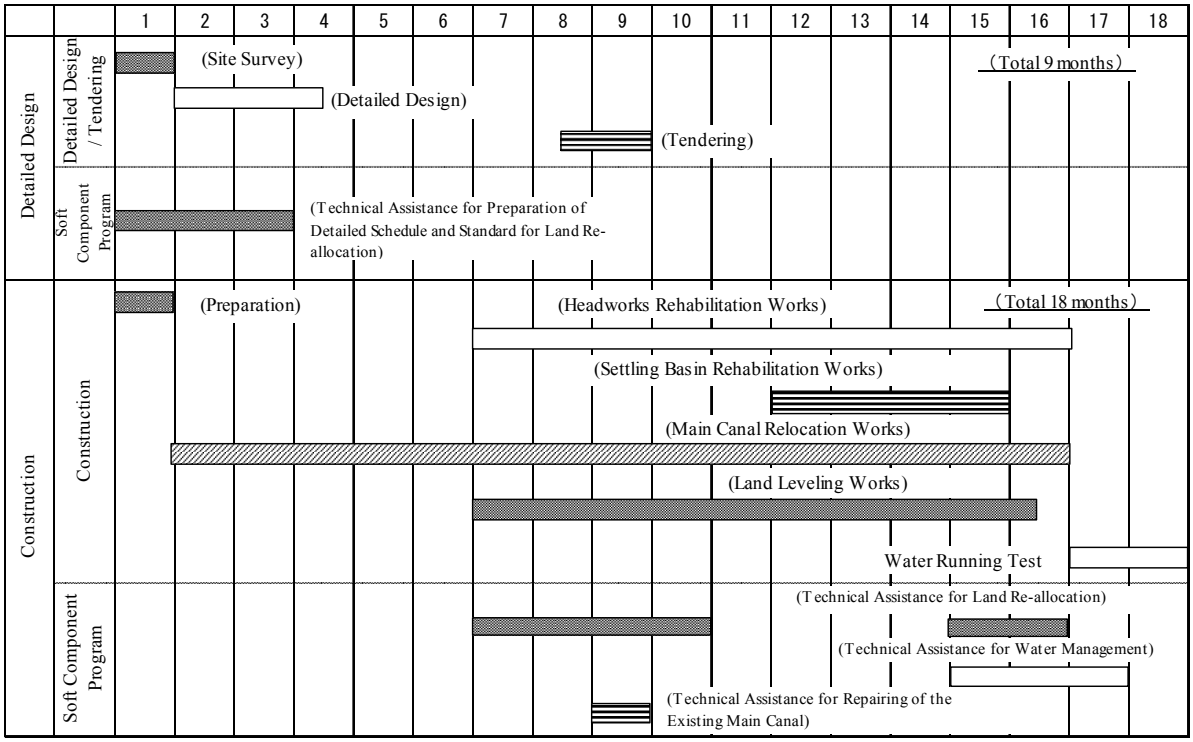
2.2.4.7 Implementation Schedule

The consulting services under the grant aid project will only be commenced after the Exchange of Notes (E/N) has been signed. After E/N covering the detailed design has been signed, the consultant will initially undertake the detailed design. In parallel,

GOM will secure agreement on land re-allocation from all farmers in the Project area. Subsequently, the E/N covering tendering, construction supervision and civil works will be signed and the consultant will start tendering for civil works. Detailed design and tendering is scheduled to be finished within nine (9) months.

After the contract between GOM and the contractor is signed, construction works will be started. Following completion of construction, irrigation water delivery tests will be carried out and the quality of constructed facilities verified. The implementation schedule is shown in the following figure.

Figure Implementation Schedule



2.3 Obligations of Recipient Country

2.3.1 Items to be Undertaken by Recipient Country

(1) Items to be Undertaken by Recipient Country

In implementing the Project, MOAFS as an executing agency in the GOM should undertake the following activities:

a) provide necessary documents and information for the Project

b) secure the land for construction of canals and roads, and the land for construction of temporary site office, storage/deposit for building materials

c) secure the budgeting measure and staff for Project implementation by MOAFS

d) open bank account in Japan, including bearing the banking cost and handling charge

e) arrange for tax exemption for machinery and materials procured in accordance with the Exchange of Notes and proceed with necessary formalities for customs clearance
f) arrange for tax exemption for any taxes such as customs tax, inland duties and other financial surcharges imposed on the Japanese, in accordance with the Exchange of Notes
g) support Japanese Nationals' entry and stay for fulfillment of the contract in accordance with the Exchange of Notes
h) authorize approval, permission, authorization, etc. for Project implementation
i) implement an effective O&M works program for the rehabilitated irrigation facilities under Japan's Grant Aid Scheme
j) take speedy action in coordinating any claims related to Project implementation from any third person or concerned non-beneficiaries
k) secure the safety for Japanese Nationals from any conflict, riot, trouble, insurrection, mines, etc.
l) acquire approval on environmental issues, etc., if necessary.

(2) Supplementary for Obligations of the Recipient Country

1) Items on construction of the facilities

Arrangements for land acquisition for the following sites must be completed in time to conclude a contract with the selected civil contractor:

a. The new settling basin, the new main canal and the inspection road;
b. The temporary site office;
c. The storage/deposit for materials.

2) Items on Land Re-Allocation

In order to carry out land re-allocation thoroughly and distribute the land fairly to the beneficiaries during the Project period, the following procedures must be completed before the implementation of the Project:

- Registration on the farmers' cooperative member list of farmers intending to participate in land re-allocation;
- Acquisition of their agreement on land re-allocation.

2.3.2 Practicability of GOM's Obligations

(1) Official Procedures Required for Project Implementation

MOAFS has experience on implementation/management of "the Project for Bwanje

Valley Smallholder Irrigation Development (1997-1999)" and "the Follow-up Cooperation for the Bwanje Valley Irrigation Development Project (2002-2003)". Thus, MOAFS has experience in the proceedings necessary for the official formalities of the Project.

(2) Land Acquisition

Land acquisition for the overall area in the Bwanje Valley irrigation system was previously completed. Therefore, in this Project necessary land acquisition only applies to the site for the new canal while land re-allocation is to take place in the overall area, including the site for the new canal during the Project. Therefore, GOM has explained that land acquisition is not a significant matter in the Project. Due to these reasons, it can be assumed that GOM can handle land acquisition issues.

2.4 Operation and Maintenance Plan

2.4.1 Government Policy for O&M of the Irrigation System

The Ministry of Agriculture and Irrigation (current Ministry of Agriculture and Food Security) announced the "National Irrigation Policy and Development Strategy" in June 2000, which included the principle of operation and maintenance of the irrigation facilities. This is stipulated in the strategies as outlined below:

- The governing principle in irrigation management will be the full ownership of irrigation schemes by the beneficiaries through their legally constituted local organizations
- All operation, maintenance and replacement costs are to be borne by the beneficiaries of irrigation schemes.

Under this principle, the strategy mentions that management of government schemes is to be transferred to their beneficiaries. The role of the government in the irrigation O&M is stated as training of government staff, research and extension services for irrigated agriculture, group formation and organization at community level, and training and motivating farmers, and so on, in the strategy.

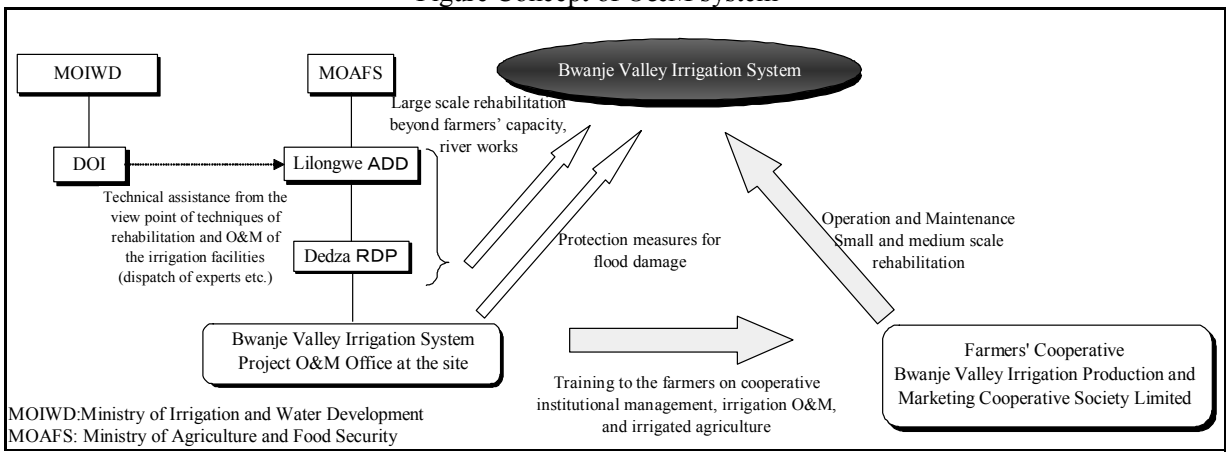
The government of Malawi enacted the "Irrigation Act" in 2001. This act states local community participation in development and management of irrigation and also stipulates that the minister may enter into an irrigation management agreement with an irrigation management authority providing for: 1) management plan, and 2) assistance to be provided by the government for proper management of irrigation.

2.4.2 Operation and Maintenance Plan

(1) Operation and Maintenance System

According to the original plan, five years after commencement of the system the irrigation facilities and operation and maintenance of the system are to be transferred to the farmers' cooperative. However, the farmers' cooperative now receives assistance from the GOM, with this assistance being ongoing considering the capacity of the cooperative. Therefore the plan is to transfer one part of the facilities and operation and maintenance to the farmers' cooperative. Involvement of the GOM (DOI, Lilongwe ADD, Dedza RDP, and project O&M office at the site) to the system is also continuing. The concept of the system is outlined below:

Figure Concept of O&M system



In principle, as for the irrigation facilities, the government owns the headworks, main canal and branch canals. Tertiary canals and other facilities below tertiary level are to be transferred to the farmers' cooperative. The breakdown of O&M roles between the government and the farmers' cooperative are shown in the following table:

Table O&M Roles Between the Government and the Farmers' Cooperative

Institutions		Roles
Government	DOI	Technical assistance from the view point of techniques of rehabilitation and O&M of the irrigation facilities (dispatch of experts etc.)
	Lilongwe ADD	Large scale rehabilitation beyond farmers' capacity, river works, strengthening of farmer's organization, irrigation technique and farming practice assistance
	Dedza RDP	Ditto
	Project O&M Office at the site	Training for farmers at the site level on cooperative institutional management, irrigation O&M, irrigated agriculture, protection measure for flood damage
Farmers' Cooperative		O&M of irrigation facilities, small and medium scale rehabilitation

Lilongwe ADD and Dedza RDP are to strengthen the farmer's organization and assist in irrigation technique and farming practices, usually through the project O&M office at the site (and directly, if necessary). They will also conduct large-scale rehabilitation and river works if required, with the assistance by DOI, based on information from the project O&M office at the site. The roles of the project O&M office at the site and the farmers' cooperative are mentioned in (2) and (3) below.

In order to clarify the O&M system of the irrigation system after completion of the project, in accordance with the government policy and act it is necessary to prepare an irrigation management agreement between the government and farmers' cooperative. This covers ownership of the facilities and operation and maintenance and includes the contents of the table mentioned above.

(2) Project O&M Office at the Site

The project O&M office, which has already been established at the site, continues to conduct training for farmers. The size of the office is comparable to present with technical staff to be assigned as follows.:

- Project manager 1 person
- Agricultural Extension Development Officer (AEDO) 3 persons

The project manager is responsible for the overall system and three AEDOs assigned under the project manager are basically in charge of branch canals in both the 590 ha and 210 ha areas (refer to the following table).

Table AEDO in Charge of Each Branch Canal

590 ha Area	210 ha Area
BC1 : 1 AEDO BC2 : 1 AEDO BC3 : 1 AEDO	BC1 : 1 AEDO who is in charge of BC1 in 590 ha area BC2 : 1 AEDO who is in charge of BC1 in 590 ha area Remaining 1 AEDO is in charge of following-up of other 2 AEDOs.

At least one out of four technical staff is recommended to have knowledge of irrigation techniques.

The main tasks of the project O&M office at the site are as follows.

- Training of farmers on cooperative institutional management
- Training of farmers on irrigation O&M
- Training of farmers on irrigated agriculture
- Taking protective measures against flood damage

Staff in the project O&M office will patrol the river periodically due to the continuous risk to the existing main canal; they will also train the farmers. Regarding setting of spur dikes and rehabilitation works of the flood protection dike and main canal should the river approach the dike and cause damage, the project O&M office will discuss these matters with the farmers' cooperative. If these works are judged to be large-scale rehabilitation based on the discussion, the office will request Dedza RDP and Lilongwe ADD to undertake construction works.

In order to ensure sustainability of the government system, an O&M budget should be prepared by the government. According to the plan mentioned above, the O&M budget is estimated to be 1,782,000MK/year (refer to Table 2-3). The government could maintain the existing office size, which has a budget of only around 4% of the 2004/5 total recurrent budget (40,973,950 MK) of Dedza RDP. This suggests future budgets could be prepared.

(3) Farmers' Cooperative

The overall operation and maintenance of the Bwanje Valley irrigation system is conducted by the farmers' cooperative. The current approach to operation and maintenance will form the basis of the O&M plan after the Project.

1) Organization

The planned organization of the farmers' cooperative is basically similar to the current organization although a new organization for the 210 ha area has to be established in the farmers' cooperative. The structure of the new organization for this area will have a similar structure to the existing one (block and farmer's club). The planned organization chart is shown in Figure 2-3.

It will be necessary to re-organize the water management organization by restructuring block and farmer's club after the land is re-allocated to the farmers and the number of farmers is fixed. Similarly, the water management organization in the 210 ha area is required to be organized.

2) Operation and Maintenance Plan of the Irrigation Facilities

The current approach to operation and maintenance will basically be adopted. One modification will be a water guard who will be in charge of headworks and settling basin. This additional position is included so that the management system of headworks, including protection measures for floods, will be established.

3) Distribution of Irrigation Water to the 210 ha Area

In the 210 ha area, upland cropping is recommended (such as maize cultivation)

because the existing main canal still has a risk of flood damage. The distribution plan of irrigation water between the 590 ha and 210 ha areas is based on a rotational irrigation method (3 days to 590 ha, 1 day to 210 ha). A detailed plan will be decided through discussions in the farmers' cooperative under the assistance of staff of the project O&M office.

4) Operation and Maintenance Budget

The operation and maintenance budget is estimated based on the following assumptions:

- Minimum operation and maintenance cost for the irrigation facilities
- Minimum office cost of the farmers' cooperative
- Collection of water fee as the only source of revenue

The results of the estimation are shown in Table 2-4 and summarized as follows:

Table Maintenance Budget per Year for Project O&M Office

(a) O&M Cost	365,400MK
(b) Collection of water fee	459,375MK
Difference (b-a)	93,975MK

Therefore, it can be concluded that the farmer's cooperative could continue to operate and maintain the Bwanje Valley irrigation system if the water fee could be collected and well managed.

2.5 Estimated Project Cost

Under Japan's Grant Aid Scheme, the Project cost is estimated to be 973 million Japanese Yen, in accordance with the work demarcation between the Japanese and Malawi sides and based on the conditions outlined in (3) below. This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

(1) Japanese Side

Estimated Project Cost 973 Million Japanese Yen

Item			Project Cost (Million Japanese Yen)		
Facilities	Rehabilitation work of headworks	River slope protection work, river bed protection work, sluiceway gate improvement, raising height of the operation bridge	317	814	814
	Improvement work of settling basin	Demolishing of the existing settling basin, sediment conduit, discharge pipe	37		
	Relocation work of the main canal	Main and branch canal, tertiary canal, irrigation canal related structure, drainage inspection road	299		
	Land leveling work		161		
Detailed Design, Construction Supervision, Technical Guidance			159		

(2) Malawi Side

Item	Amount (MK)	JPY equivalent (Million Japanese Yen)
1)Crop compensation for land acquisition	758,000	0.8
2)Bank handling charge	2,121,000	2.1
3)Implementation of land reallocation	524,000	0.5
4)Repair work of the existing main canal	1,672,000	1.7
Total	5,075,000	5.1

(3) Condition of Cost Estimate

1) Time of Cost Estimate March, 2005

2) Exchange of Rate 1 US$ = ¥107.03

1 MK = ¥0.99

3) Schedule Detailed design and construction period as shown in Implementation Schedule

4) Others The Project shall be implemented in accordance with the regulations and system of Japan's Grant Aid Scheme

2.6 Other Relevant Issues

2.6.1 Basic Plan for Soft Component Program

(1) Necessity for Soft Component Program

1) Land Re-Allocation Assistance

Since the main canal will be relocated from the existing to new alignment, 210 ha will receive irrigation water from the existing main canal located adjacent to the river. Therefore, safety against floods of the irrigation facilities in this 210 ha area is lower than in the 590 ha area.

Also, from the Basic Design study the land allocation in 1999 was primarily along administrative boundaries. This has been one of the major causes of the unfair land allocation and has resulted in paddy field developed in 1999 not being fully utilized.

The land issue is very important from a farming viewpoint. Therefore, in order to improve land allocation, a re-allocation will be needed to ensure an equal distribution for all farmers. The farmers' cooperative has already organized a land allocation committee, which will be an implementation body in this process. Thus, strong assistance to the farmers' cooperative is essential under the Soft Component Program to encourage farmers to commence crop farming after completion of the Project.

2) Water Management Strengthening Assistance

a) Water Management Organization

The water management and O&M of irrigation facilities are carried out by the farmers' cooperative with technical assistance of government staff. Under the Project, the boundaries and areas of tertiary blocks, which are a unit of the water management organization (farmers' club, etc.), will be modified. Members of farmers in each tertiary block will be revised based on the re-allocated land. Therefore, the water management organization will also need to be re-organized under the Soft Component Program.

In the 210 ha area, irrigation will be continued and the irrigation facilities will have to be maintained. In addition, gate operation and water distribution to the 210 ha area (the existing main canal) and the 590 ha area (the newly constructed main canal) will be necessary. Since these will be implemented by the farmers' cooperative, the water management organization of 210 ha will also need re-organizing. Assistance for these works will have to be provided under the Soft Component Program.

b) Water Management and O&M of Facility Strengthening

The outstanding problems and constraints associated with water management and

O&M of the existing irrigation facilities, which have been identified by the Basic Design Study, are summarized as follows:

- The water management and O&M of tertiary canals are not properly done
- Scouring sluice gates and intake gates of the headworks have been mistakenly operated during normal irrigation and flood periods.

In order to carry out equal water delivery to all the area, strengthening of the present water management system at the tertiary canal level is essential. Furthermore, the following are also necessary:

- Preparation of O&M manual for scouring sluice gates and intake gates of the headworks
- Training of staff at project O&M office, the farmers' cooperative (members of water management committees) and water guards employed by the farmers' cooperative to strengthen their capability in water management

Concurrently, the overall water management system of the new irrigation layout will have to be re-organized through a new water management organization. In order to achieve this, the present water management system will be used as much as possible and will be effectively incorporated into the new water management system. Assistance in this strengthening will be provided under the Soft Component Program.

c) Improvement of Water Fee Collection System

The farmers' cooperative is collecting water fees from farmers, however, the collection rate is only between 10% and 30% per annum. The major reason for such a low rate is flood damage to the main canal resulting in some dependent farmers not receiving adequate water. Currently, the water fee is being collected and managed by only one clerk employed by the farmers' cooperative. Therefore, it is also important to strengthen this system.

Taking the financial status of the farmers' cooperative into account, it is possible that profits obtained from sales of milled rice are reserved and spent for annual O&M expenses. However, basically O&M expenses of the irrigation facilities should be covered by the water fee, which is the income related to operation of the facilities. Thus, strengthening of the financial status of the cooperative is necessary through improvement of the collection system.

3) Flood Damage Mitigation and Repair Measures Assistance

The 210 ha area will be irrigated by the existing main canal. Since the unprecedented flood in 2001, the existing main canal and riverbed protection facilities have been

temporarily rehabilitated through follow-up cooperation of GOJ. GOM has also carried out repair works. This is not sufficient and additional rehabilitation of the canal with road is still required. In addition, the existing main canal with road running near the Namikokwe River needs additional rehabilitation and improvement works for protection from flood damage, including riverbed protection and spur dike rehabilitation works.

GOM is responsible for maintenance of the irrigation facilities for the 210 ha area, however, it is requesting that GOJ provide technical assistance for these rehabilitation works. This would permit government staff to become acquainted with flood damage mitigation and repair measures through the Soft Component Program. They could then undertake rehabilitation and repair works independently to ensure irrigation of the 210 ha area is continued even if the irrigation facilities are damaged by future floods.

(2) Purpose of the Soft Component Program

Assuming the GOM continues its supervisory activities of the farmers' cooperative even after the Project is completed, the purposes of the Soft Component Program are as follows:

- As a result of the land re-allocation, equitable land re-allocation to the farmers in the Bwanje Valley Irrigation System will be continued and properly maintained.
- Proper water management including O&M of the facilities will be continued by the farmers' cooperative under guidance of GOM, and a stable and fair irrigation water supply will be maintained.
- The risk of flood damage to the existing main canal will be mitigated and its use maintained.

(3) Expected Output of the Soft Component Program

The following outputs are expected from the implementation of the Soft Component Program:

1) Land Re-Allocation Assistance

Output 1) Land registration list and cadastral maps, which are basic information for proper water management, will be prepared for the 590 ha area.

Output 2) The management and implementation capacity of staff of the project O&M office and farmers' cooperative (executive members

and land allocation committee) will be improved allowing them to independently carry out land re-allocation and monitoring and updating of basic information.

Output 3) The land in the 590 ha area be equitably allocated to benefit farmers as a result of proper implementation of land re-allocation by the farmers' cooperative (land allocation committee), TA, and Dedza District commissioner.

2) Water Management Strengthening Assistance

Output 1) Based on the new irrigation layout and updated list of farmers allocated land, the new water management organization will be set up in the farmers' cooperative.

Output 2) Capacity of staff in the project O&M office, the farmers' cooperative (executive members, water management committee, block, farmer's club and water guard) for implementation of the water management and O&M of irrigation facilities will be improved.

Output 3) New water fee collection system will be established and capacity of staff in the project O&M office for water fee collection will be improved. The farmers' cooperative (executive member and clerk) will then be able to properly collect and manage the water fee.

3) Flood Damage Mitigation and Repair Measures Assistance

Output 1) Government staff (DOI, Lilongwe ADD, and the project O&M office) will obtain flood damage mitigation and repair measures.

Output 2) The existing main canal damaged by floods will be rehabilitated by construction and/or rehabilitation of a bypass canal with road, river protection works and spur dike, mitigating the risk of flood damage to the irrigation facilities.

(4) Means of Verification to Assess the Achievements Defined as Expected Output

The achievements resulting from the expected outputs described above will be assessed through the following verifications:

1) Land Re-Allocation Assistance

Output 1) Land registration list and cadastral maps, which are basic information for proper water management, will be prepared for the 590 ha area.

Verification 1) Output 1) will be verified by checking the accuracy and adequacy of information shown in the land registration list and cadastral maps

and, through interviews with farmers allocated land and staff of the farmers' cooperative, whether the farmers' cooperative manages and updates information.

Output 2) The management and implementation capacity of staff of the project O&M office and farmers' cooperative (executive members and land allocation committee) will be improved allowing them to independently carry out land re-allocation and monitoring and updating of basic information.

Verification 2) Output 2) will be verified by checking adequacy of information filing status and interviews with staff of the farmers' cooperative on how to monitor and update the information.

Output 3) The land in the 590 ha area be equitably allocated to benefit farmers as a result of proper implementation of land re-allocation by the farmers' cooperative (land allocation committee), TA, and Dedza District commissioner.

Verification 3) Output 3) will be verified by an ocular inspection and field interview with farmers allocated land based on the land registration list and cadastral map. In particular, this should verify whether farmers with previous rights to cultivate land continued to farm the same land or not.

2) Water Management Strengthening Assistance

Output 1) Based on the new irrigation layout and updated list of farmers allocated land, the new water management organization will be set up in the farmers' cooperative.

Verification 1) Output 1) will be verified by checking the member list and name of leaders, and interviews with member farmers on the new water management organization in the farmers' cooperative.

Output 2) Capacity of staff in the project O&M office, the farmers' cooperative (executive members, water management committee, block, farmer's club and water guard) for implementation of the water management and O&M of irrigation facilities will be improved.

Verification 2) Output 2) will be verified by checking actual water management and O&M performance, such as operating gates of headworks and settling basin and maintenance of canals in the field according to the manuals to be prepared (refer to (5)).

Output 3) New water fee collection system will be established and capacity of

staff in the project O&M office for water fee collection will be improved. The farmers' cooperative (executive member and clerk) will then be able to properly collect and manage the water fee.

Verification 3) Output 3) will be verified by checking the actual water fee collection system and performance with those outlined in the manuals to be prepared (refer to (5)) through testing and interviewing staff in the project O&M office and farmers' cooperative. In addition, the collection rate will be monitored as an effectiveness assessment.

3) Flood Damage Mitigation and Repair Measures Assistance

Output 1) Government staff (DOI, Lilongwe ADD, and the project O&M office) will obtain flood damage mitigation and repair measures.

Verification 1) Output 1) will be verified by confirming that staff (DOI, Lilongwe ADD, the project O&M office) are acquainted with knowledge and know-how for mitigation of flood damage to irrigation facilities and the repair measures both in the field and office.

Output 2) The existing main canal damaged by floods will be rehabilitated by construction and/or rehabilitation of a bypass canal with road, river protection works and spur dike, mitigating the risk of flood damage to the irrigation facilities.

Verification 2) When the rehabilitation is finished, it will be confirmed that the rehabilitated bypass canal with road, river protection, and spur dike will function as designed.

(5) Activities of the Soft Component Program

In order to achieve the above purpose and output, the Soft Component Program will include the following activities:

1) Land Re-Allocation Assistance

1. Registration of farmers for land re-allocation (by GOM)
2. Training of personnel concerned with land re-allocation (by GOM)
3. Acquisition of agreement from farmers on land re-allocation (by GOM)
4. Preparation of the detailed implementation plan and standards for land re-allocation:
   a. Review and examination of detailed implementation plan and standards
   b. Meetings and interviews with relevant stakeholders to obtain their opinions, and to finalize the detailed implementation plan and standards based on the

results of the meetings and interviews

5. Implementation of the land re-allocation, and preparation of land registration list and cadastral maps:
    a. Preparation of list of re-allocated land to qualified member farmers (draft) and new land registration list (draft)
    b. Acquisition of farmers' agreement on the list of re-allocated land to qualified member farmers (draft)
    c. On-site land re-allocation witnessed by farmers' representatives
    d. Preparation of cadastral maps
    e. Progress monitoring and supervision of land re-allocation in the field
    f. Consulting services if any (such as addressing disputes among farmers and necessity of coordination with TA, Dedza district commissioner)

2) Water Management Strengthening Assistance

1. Re-organization of the present water management organization
2. Capacity building of water management and O&M of facilities
    a. Preparation of new water management plan
    b. Preparation of water management manual
    c. Preparation of O&M manual
    d. Training of water management and O&M of facilities
3. Establishment of new water fee collection system
    a. Strengthening of water fee collection organization
    b. Training in water fee collection

3) Flood Damage Mitigation and Repair Measures Assistance

1. Assistance for construction of bypass canal with road of the existing main canal, river protection works and spur dike
2. On-the-job training of flood damage mitigation and repair measures
3. Preparation of manual for flood damage mitigation and repair measures

(6) Assignment of Personnel for the Soft Component Program

As coordination of schedule between Soft Component Program and the construction works is very important and it difficult to find a local consultant who has a

experience of land re-allocation, advice and assistance in the implementation of the Soft Component Program will be provided by a Japanese consultant selected by JICA.

(7) Implementation Schedule of the Soft Component Program

The implementation schedule of the Soft Component Program is shown in Figure 2-4.

(8) Outputs of Submission of the Soft Component Program

The consultant will prepare the following as the main outputs of the submission of the Soft Component Program, in addition to a completion report to be submitted to GOJ and GOM:

- Detailed implementation plan and standard for land re-allocation
- Land registration list/cadastral map
- Water management manual
- Operation and maintenance manual
- Manual on water fee collection
- Manual on flood damage mitigation and repair measures

(9) Obligations of GOM for the Soft Component Program

The obligations of GOM and the farmers' cooperative will be as follows:

1) Land Re-Allocation Assistance

Land re-allocation is the responsibility of GOM with JICA assisting GOM in its implementation. Before JICA commences assisting in land re-allocation, GOM is strongly requested to complete the following to ensure its success:

- Registration of farmers for land re-allocation
- Acquisition of agreement from farmers on land re-allocation
- Training of personnel concerned with land re-allocation, such as the study and review of similar land re-allocation cases in other irrigation projects in Malawi

After completion of land re-allocation, farmers to which land has been re-allocated will have to commence operations on their land and monitor use of the re-allocated land. Technical assistance and guidance to farmers will have to be continued by GOM and particularly staff at the project O&M office (one project manager and three agricultural extension development officers) to ensure proper activities of the

cooperative continue.

2) Water Management Strengthening Assistance

Water management strengthening will be made under the Soft Component Program to ensure equitable irrigation water distribution by the cooperative. In order to secure the further sustainability of O&M of the irrigation system, the farmers' cooperative must be activated. This would include further strengthening the financial status of the farmers' cooperative. For this, continued assistance from GOM is essential to the farmers' cooperative.

3) Flood Damage Mitigation and Repair Measures Assistance

It is important for the GOM to maintain the system allowing immediate assigning of construction equipment by measures acquired through the Soft Component Program, particularly if floods were to occur. Furthermore, GOM must prepare the budget for these activities.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

The project will be implemented by Japan's Grant Aid System. The irrigation system will be rehabilitated and maintained to provide a stable supply of water to the field. The followings are the direct and indirect effects of the rehabilitation of the project facilities.

(1) Direct effects

Expected Direct Cost

Present Condition and Problems	Rehabilitation Plan	Effects and Improvement Level
In the System (800 ha) the headworks and main canal have been damaged by recent floods. At the settling basin, there is a problem of sand inflow to the main canal because there has not been timely removal of sediment because of the dependence on manpower. There are also several areas where no water is supplied due to incompletion of land leveling. In addition, regarding the farming practice and operation, there are problems of inequitable land distribution, improper water control in some areas and insufficient countermeasures for the damaged main canal parts	-Headworks rehabilitation works -Settling basin rehabilitation works -Main canal relocation works -Land leveling works -Components of software aspects (land re-allocation, water management strengthening and establishment of flood damage mitigation and repair measures)	1) Future flood risk will be reduced in the 590 ha area which is going to be irrigated through the new main canal 2) Stable irrigation water will be provided and the cropped area will be 590 ha in the rainy season and 145 ha in the dry season in the 590 ha area which is going to be irrigated through the new main canal. 3) Competence of government staff for flood damage mitigation and repair measures will be improved and the possibility of upland farming with the supplementary irrigation will rise in the 210 ha area. 4) Capacities and techniques for operation and maintenance of irrigation facilities by government staff and farmers' cooperative will be improved through guidance of operation and maintenance of irrigation facilities to government staff and farmers' cooperative.

(2) Indirect effects

Expected Indirect Effects

Expected Indirect Effects	Contents
Stabilization of Agriculture Products and Stability of Productivity	The production of rice in the rainy seasons and maize in the dry seasons could be stabilized and increased through reliable utilization of the irrigation facilities as a result of the Project.
Increase of Farm Income	By the stabilization of agriculture production and increase in productivity, the farmers could obtain surplus products to sell and thus increase their income.
Contribution to Rural Poverty Reduction	The increase of farmers' income contributes to the rural poverty reduction.

(3) Beneficiaries

Through the implementation of the Project, the number of beneficiaries is estimated

at 2,000 households or 10,000 people.

(4) Accomplishment Index

- Irrigated area

The actual irrigated area in the rainy season in the 590 ha area is expected to increase to 590 ha from the 250 ha that was recorded in 2004 before the Project.

The evaluation of project effects will be investigated and monitored one year after the completion of the Project. The indices for evaluation will be based on a) reports prepared by MOAFS and b) monitoring records made by the operation office at the site.

3.2 Recommendations

After the rehabilitation of the irrigation facilities affected by floods and implementation of soft component programs (land reallocation assistance, water management strengthening assistance and flood damage mitigation and repair), the production basis will be restored.

To realize and maintain the long-term effect of the Project, GOM should make the following self-efforts:

(1) Equitable Land Reallocation

After realization of equitable land reallocation by GOM under the soft component program, continuous control of land possession will be needed. GOM should guarantee equitable land cultivation rights to farmers continuously in the Project area. For the rights, principally, no administration boundaries will be adopted.

(2) Operation and Maintenance of Existing Main Canal

After the completion of the Project, the disaster function of the irrigation facilities could be improved so that they are expected to alleviate damage by future floods. The existing main canal, however, will still be weak against large-scale floods, even after the repair works. As damage is expected to some extent during floods, the operation office and farmers' cooperative should carry out monitoring and repair works continuously. During the rainy season in 2004, a diversion channel was constructed from the Namikokwe River to the right bank side to alleviate flood damage to the Project area and to supply irrigation water to the right bank area. However, sediment

from the upstream tends to be deposited and builds up in the channel because the channel bed of the diversion channel at the beginning point is higher than that of the Namikokwe River and the longitudinal slope of the bed is gentler than that of the Namikokwe. This fact indicates that it is important to consider the relationship between the diversion channel and the Namikokwe River for continuous operation and maintenance.

(3) Improvement of Technology of Irrigated Farming

During the construction of the irrigation facilities under the initial grant aid from Japan from 1997 to 1999, most farmers carried out only inundation agriculture farming practice. After the introduction of a modern irrigation system (the Bwanje Valley Irrigation System), the farmers have gradually developed their own farming practices. The implementation of the Project is expected to alleviate the risk of damage by floods and to supply irrigation water sufficiently to the paddy fields for full-scale irrigation farming. Accordingly, the improvement of the farmers' farming practices, especially in irrigation farming technology, is important for the next stage.

One option for improving irrigation farming technology is to utilize the Kilimanjaro Agricultural Training Centre, which is now expanding its activities to countries neighboring Tanzania. This Project area is one of the selected training areas. In the past, the staff of the operation office and selected farmers were dispatched to Tanzania and trained in irrigation farming technology. Several facilitators have visited the area and analyzed the present problems with farmers in the area.

GOM needs to utilize such training systems to improve farming practices. To realize the ultimate goal of increasing agricultural production through the continuous operation and maintenance of the irrigation facilities and improvement of farming practices, it is important for the operation office to support the farmers with JOCV volunteers for rice cropping.

(4) Need to Strengthen Farmers Cooperative

Apart from O&M of facilities and water management, the most important activities are rice milling/selling and strengthening of the farmers' cooperative for future development. In addition, the financial status, motivation of farmers' cooperative members (farmers), and sustainable management of the irrigation system will be ensured.

At present, the farmers' cooperative is selling its own brand of rice under the name "Bwanje Valley Rice" at their office. This is a most profitable enterprise, but they can only cope with small-scale operations and could not respond to a large-scale offer of rice from a market. Achievement of stabilized irrigation productivity and full-scale rice milling facilities is expected to bring much profit and return to the farmers in the Project area through the sale of rice. Therefore, GOM needs to maintain the operation office to support the above activities of the farmers' cooperative.

(5) Demarcation of Responsibility for O&M of Irrigation Facilities

According to the government's policies and legislation concerning the irrigation sector, i) O&M of irrigation facilities is executed by beneficiaries themselves in principle and ii) an agreement indicating the contents of the support by the government for O&M of irrigation facilities should be prepared for proper O&M. However, responsibility for O&M of the irrigation facilities has not been clearly demarcated between the government and the farmers' cooperative. In conclusion, when the irrigation facilities are renovated after the completion of the Project, including land leveling, an irrigation management agreement is recommended to be prepared, and responsibility for the possession and O&M of the facilities should be clearly demarcated.

TABLES

Table 2-1 Comparison of Three Alternative Measures for Protection of the Irrigation System against Floods

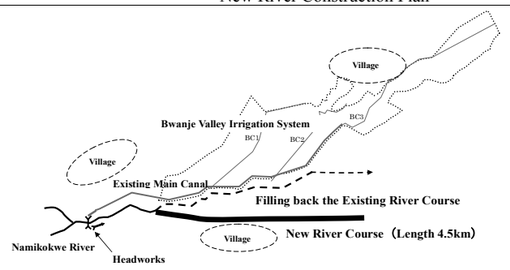
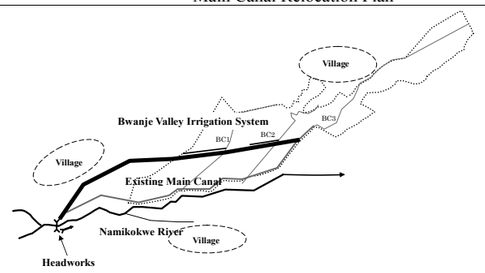
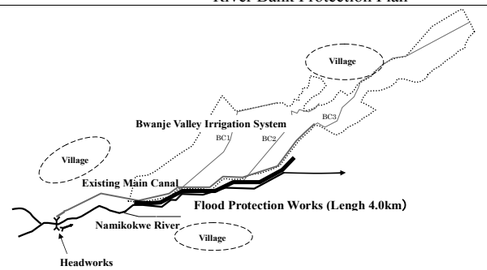
Items	Alternative-1 New River Construction Plan		Alternative-2 Main Canal Relocation Plan		Alternative-3 River Bank Protection Plan	
General Layout						
Contents of Construction Works	This alternative is to contruct new river for shifting the river at 300 m to the south. The existing river shall be backfilled. The contents of works are listed below. (1) New river construction works (width: 50m, length: 4.5km) (2) Backfilling the existing river (length: 4.0km) (3) Rehabilitation of the existing main canal and the inspection road		This alternative is to shift the main canal at 500m to 1.0 km to the north. The contents of works are listed below. (1) Construction of a new main canal (length: 6.0km) (2) Construction of new branch canals (length: 1.8km) (3) Construction of a new inspection road (length: 6.0km)		This alternative is to protect the exsiting flood protection dike. The protection works shall be made of gabion to follow changing river bed. The contents of works are listed below. (1) River bank protection works through provision of gabion mattresses (slope length: 7.0m, total length:4.0km) (2) Rehabilitation of the existing main canal and the inspection road	
Security against Flood Damages A: High B: Middle C: Low	B	(1) A risk of flood damage for the main canal will be reduced/. (2) It is extremely difficult to control the river course. Floods may cause lower the riverbed, erode the riverbank, and change the river course easily. Therefore, floods may damage households (300 nos.) and farm land at the right bank area. In 2003/04 the river changing works were partially carried out by GOM. The GOM diverted the river to the new one by constructing diversion dam. However the new river bed was elevated due to sedimentation, and the river flow was finally returned to the existing river due to and collaption of diversion dam by flood. This fact shows that controling river is very difficult and this alternative is not certain measure of flood protection.	A	(1) The irrigation system will be well secured against floods since the new main canal will be moved at 500 m to 1.0 km apart from the river. (2) The existing main canal still has a high risk of flood damage.	B	(1) The river protection works can protect the irrigation area from changing river course. (2) The existing river are very close to the existing main canal. If the river protection work will collapse due to washing out of backfill sand and scouring foundation by floods, this will lead to collapse of the main canal. Wire mesh of gabion mattresses will be easyly deteriorated due to abration within 5-10 years, and the function of protection will also decrease. This may cause collaption of the protection works and the existing main canal.
Opinion of the Stakeholders A: Consistent B: Middle C: Not consistent	A	(1) This alternative is consistent with the opinion of the Malawi government, which has tried to change the river course and also with the opinion of farmers and other stakeholders. (2) Farmers living in the right bank area are anxious about flood damages.	B	(1) Some BC-2 and -3 farmers agreed to this alternative because most of their plots will remain in the 590ha area, which will be irrigated by the new main canal. (2) There are opposing opinions among the BC-1(BC:Branch Canal) farmers who possess plots in the 210ha area that will not be irrigated by the new main canal.	B	(1) This alternative coincides with the major opinion of the stakeholders that they want to use the existing main canal continuously. (2) Some of the stakeholders are anxious that the main canal might be damaged again because it is located close to the river.
Difficulty of Construction A: Relatively easy B: Middle C: Relatively difficult	A	(1) Major construction works are earth work which is relatively simple. (2) The construction works can be done during the dry season in principal.	B	(1) Temporary water distribution will be required during the construction period, since the works will include the relocation of the main canal and be carried out inside the farm plots. (2) The construction works can be done during both the dry season and rainy season.	C	(1) Some difficult works, such as dewatering, are required during the installation of gabion matresses. (2) Construction works could be done in dry season since most of the works should done inside the river side.
Manpower, Cost, and Technical Difficulties for Maintenance Works of the Flood Protection A: Not difficult B: Middle C: Difficult	B	The river condition such as river bank erosion and lowering of riverbed should be periodically monitored until the river channel is stabilized. In case the river approaches the main canal, it will require certain measures, e.g. providing spur dike, which are relatively large burden for the goverment and the farmers. Annual maintenance cost is estimated to be US$19,000.	A	It will not require much maintenance of flood protection for the new main canal since the irrigation system will be secured from floods. However it will require the repairing and protection works for the existing main canal, when it was damaged. Annual maintenance cost is estimated to be US$5,000.	C	The condition of the river protection works should be monitored and they should be repaired periodically. Deteriorated wire mesh of the gabion mattresses may require periodical repair. A large labor force is required to maintain the protection works (its whole length is 4.0km). Annual maintenance cost is estimated to be US$22,000.
Construction Cost A: Low B: Middle C: High	C	US$7.4 million	A	US$3.4 million	C	US$6.7 million
Beneficial Area A: Same as the original area B: Smaller than the original area	A	800ha (same area as the original area)	B	The 590ha area will be irrigated through the new main canal. Since the 210ha area will be irrigated through the existing main canal, this area has a risk of flood damage.	A	800ha (same as original area)
Evaluation and Ranking	②	If the river course became stable, security against flood damage would be high. However there is no guarantee that the new river will not change direction and it requires periodical monitoring and maintenance works. In addition, the construction cost is the highest of the three alternatives.	①	This alternative could achieve high security against floods with the least construction cost. It is necessary to gain consensus of the farmers who possess plots in the 210ha area.	③	This alternative is a certain measure to protect the irrigation area from the changing river course. However, as the main canal faces the river directly, the irrigation function may stop suddenly in case of flood damage to the main canal. This alternative requires high construction cost and a large maintenance burden.

Table 2-2 Comparison of Continuous and Rotational Irrigation Method

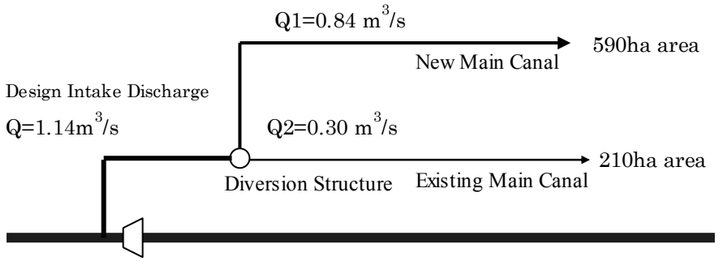
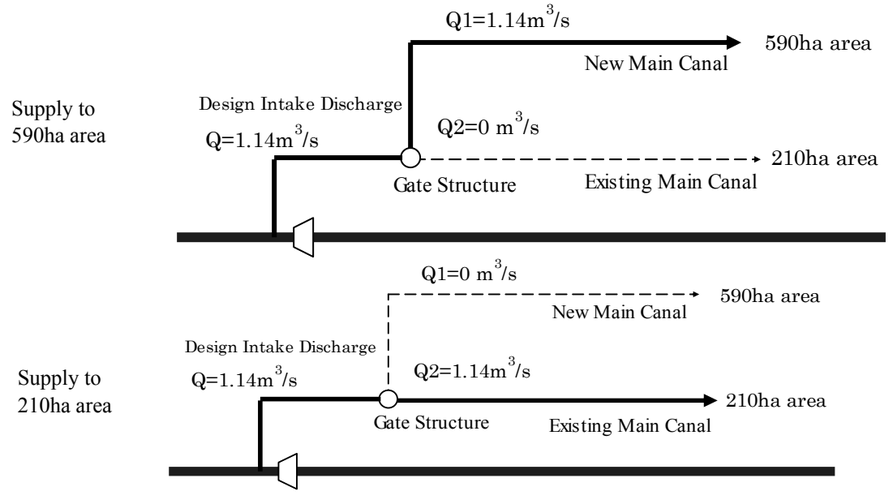
Items	Alternative-1 Continuous Irrigation Method		Alternative-2 Rotational Irrigation Method	
Canal Layout				
Supply Method	Irrigation water will be simultaneously supplied continuously to both the 590ha area and the 210ha area. Design discharge of the canals will be determined by their command areas, and diversion structures, such as a dividing wall distributor and overflow weir, will be installed to divert a constant amount of water at the diversion points.		Water will be supplied to the 590ha area and the 210ha area separately. Division gates will be installed and irrigation water will be controlled manually.	
Irrigation Efficiency A: High B: Low	B	Supplying water simultaneously to two irrigation canals makes the total supply length longer and the conveyance loss higher. As the number of turnouts will increase from 87 to 100, operation loss will become higher. There is a risk that those conveyance/operation losses will cause water shortage in the fields.	A	As irrigation water is supplied to the canals separately, the supply length will not be changed and it will not increase conveyance loss. The number of turnouts will be 70 in the 590ha area and 30 in the 210ha area. As they will not be operated simultaneously, operation loss will not become higher.
Water Management A: Relatively Easy B: Relatively Difficult	B	Because the diversion structures will divert water automatically, their operation is not difficult. As the diversion structures determine the water supply, the flow rate cannot be controlled even if demand should change because of cropping intensity and weather condition. Three water guards are operating the diversion works. Number of the turnouts will increase and it will require more operation works.	A	Gate operation will be required but it will not be difficult because of its simple structure. The canal has enough capacity and it will enable flexible water management. The number of turnouts to be operated simultaneously will decrease and it will reduce the work of the water guards.
Risk of Flood and Mis-operation A: Low Risk B: High Risk	B	There is a risk that irrigation water will overflow the canal and damage the canal embankment if there are incorrect water release or the existing main canal is damaged by flood. A spillway and diversion channel must be installed upstream to reduce the risk.	A	When the existing main canal is damaged while supplying water to 210ha area, the diversion structure will be operated to divert water to the 590ha area. Mis-operation of the diversion works will not cause a big damage to the irrigation system.
Construction Cost	US$ 3.3 million	The construction cost of the canal is relatively low because a minimal canal section is required. But it is necessary to include construction cost for the spillway and the diversion channel, and the overall cost will be equivalent to the cost of Alternative-2.	US$ 3.3 million	The construction cost for the canal will be higher than for Alternative-1 because the canal section will be designed for the rotational supply. But this option does not require the cost of a spillway and diversion channel.
Evaluation	②	This alternative cannot be highly recommended because, i) construction cost will be the same as for Alternative-2, ii) the system does not enable flexible water management, and iii) irrigation efficiency will be lower.	①	This alternative is strongly recommended because of the flexibility of water management, increased irrigation efficiency, ease of operation of turnouts, and reduced risk of flood damages.

Table 2-3 Maintenance Budget per Year for Project O&M Office

Salary						
Project Manager		250,000 MK/Y	1 人			250,000 MK
AEDO		160,000 MK/Y	3 人			480,000 MK
Cowherd		54,000 MK/Y	8 人			432,000 MK
	sub-total				subtotal	1,162,000 MK
Direct cost						
Per diem and other allowance*						310,000 MK
Fuel for Motorcycle	for Project Manager and AEDO	5,000 MK/M	4 人	12 M/Y		240,000 MK
Other expences at site office**						70,000 MK
	sub-total				subtotal	620,000 MK
Total					total	1,782,000 MK

Source: Dedza RDP office

*:Staffs' allowance and accomodation and others are estimated.

**: Same expence caluculated in cooperative budget in Table 5-2 is applied.

Table 2-4 Irrigation O&M and Office Maintenance Budget per Year in the Farmers' Cooperative

Cost				
Hiring Cost				
Water Guard	2,300 MK/month*1	4 Person	12 month	110,400 MK
Cleark for accounting	3,000 MK/month*1	1 Person	12 month	36,000 MK
Watchman	1,500 MK/month*1	3 Person	12 month	54,000 MK
sub-total				200,400 MK
Others				
Maintenance for irrigation facilities*2	1 LS			95,000 MK
Other office cost*3	1 LS			70,000 MK
sub-total				165,000 MK
Total				365,400 MK
Income				
Water fee collection				
Summar season	590 ha		50 MK/0.08ha	368,750 MK
Winter season	145 ha		50 MK/0.08ha	90,625 MK
Total				459,375 MK
Balance (Income-Cost)				93,975 MK

*1 Data from cleark in cooperative office

*2 Including cost for lubricant for gate, and dredging of sand, slashing of main canal and others. This cost comes form Cooperative Annual Budget 2003/2004

*3 Minimum items required by irrigation O&M, including stationary, meeting cost, electricity and others are considered. This estimation is based on the average of the actual expenditure spent in 2003/2003, 2003/04 and 2004/05. Other costs can be coverd by income of other activities

FIGURES

Figure 2-1 Proposed Cropping Pattern