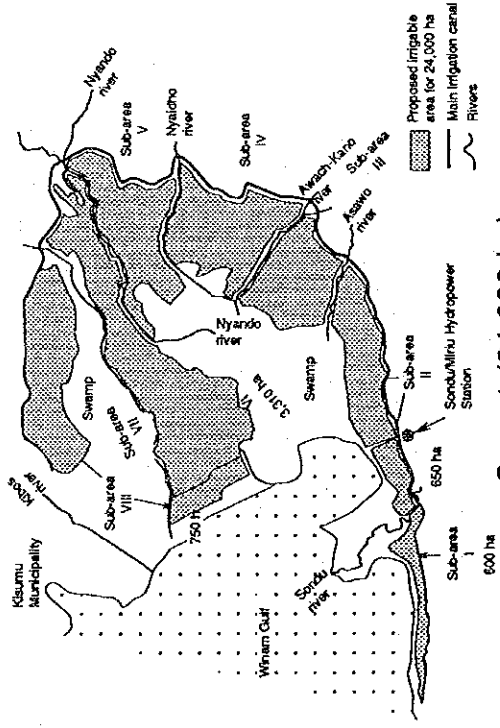
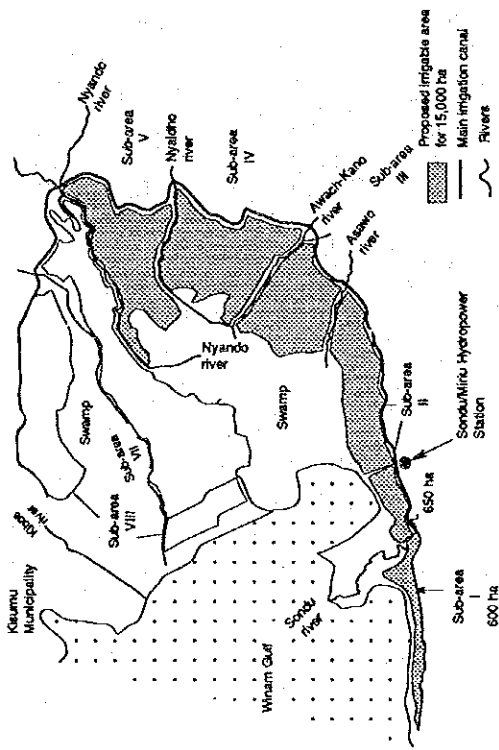


Case 1 (24,000 ha)



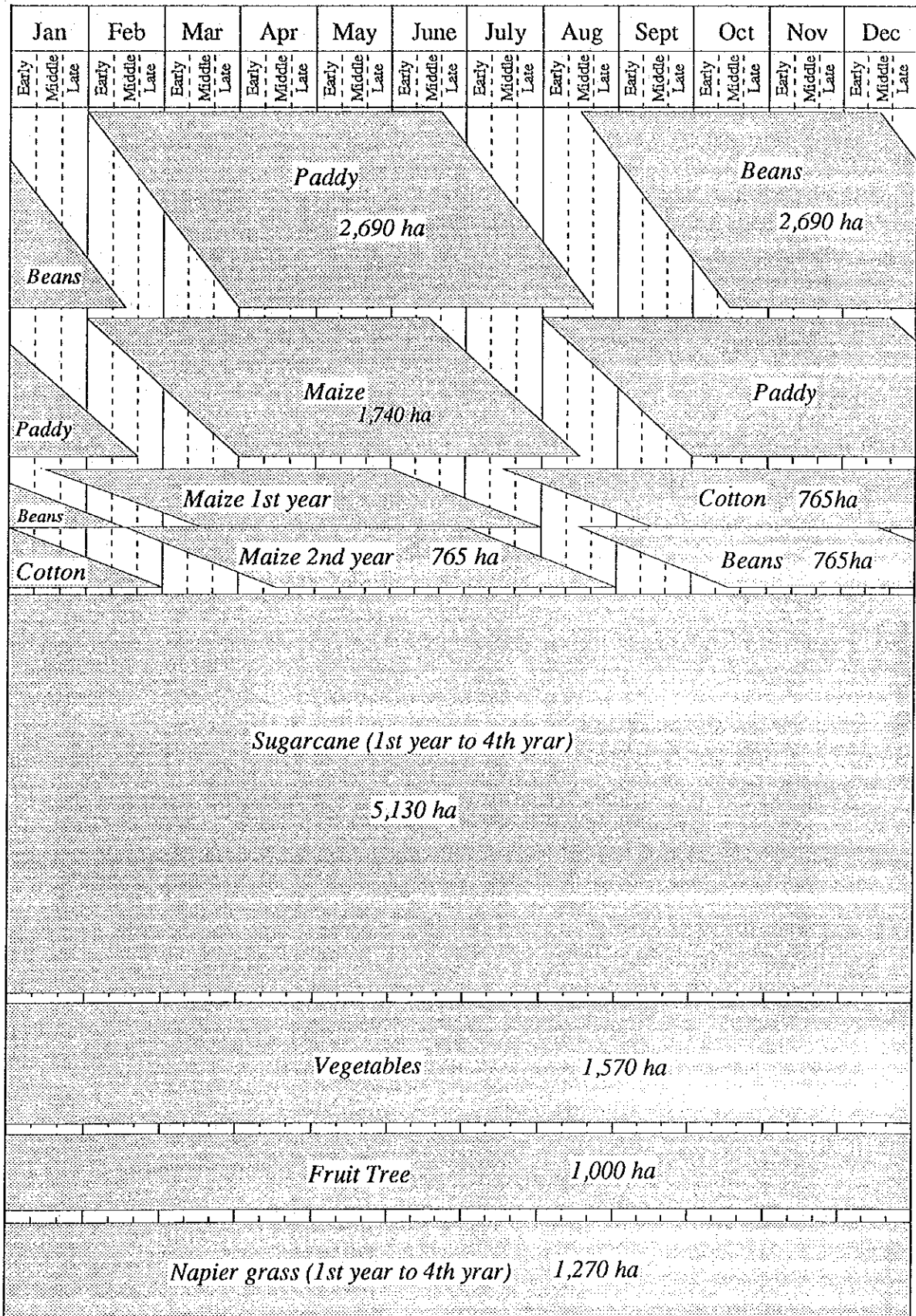
Case 2 (20,000 ha)

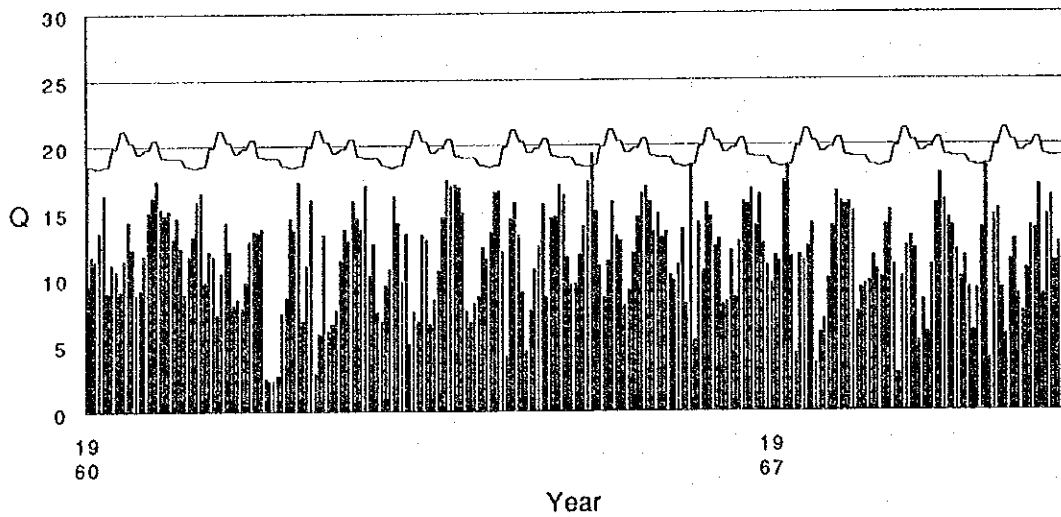


Case 3 (15,000ha)

Fig. 6.1 Location of Alternative Plans

Fig. 6.2 Proposed Cropping Calendar





Water Balance in the Project

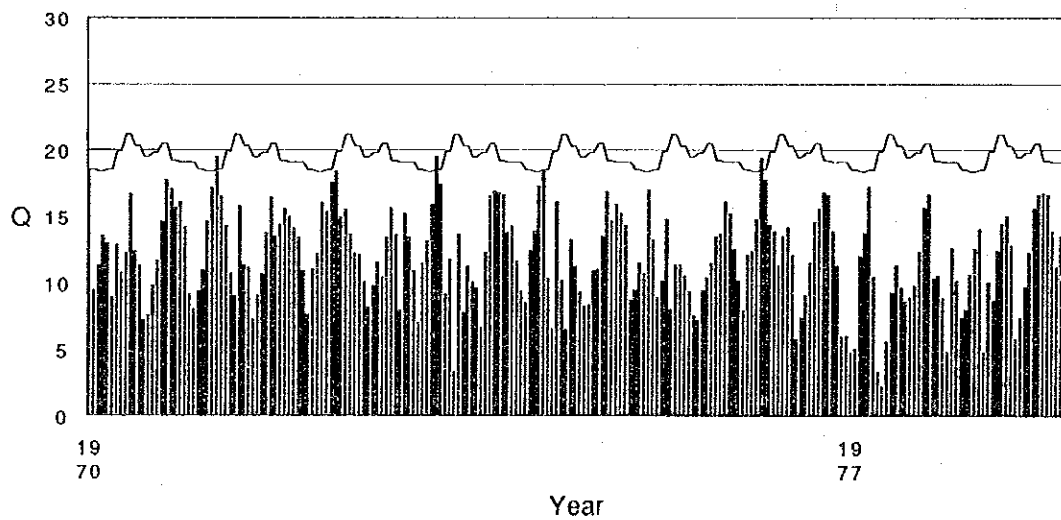
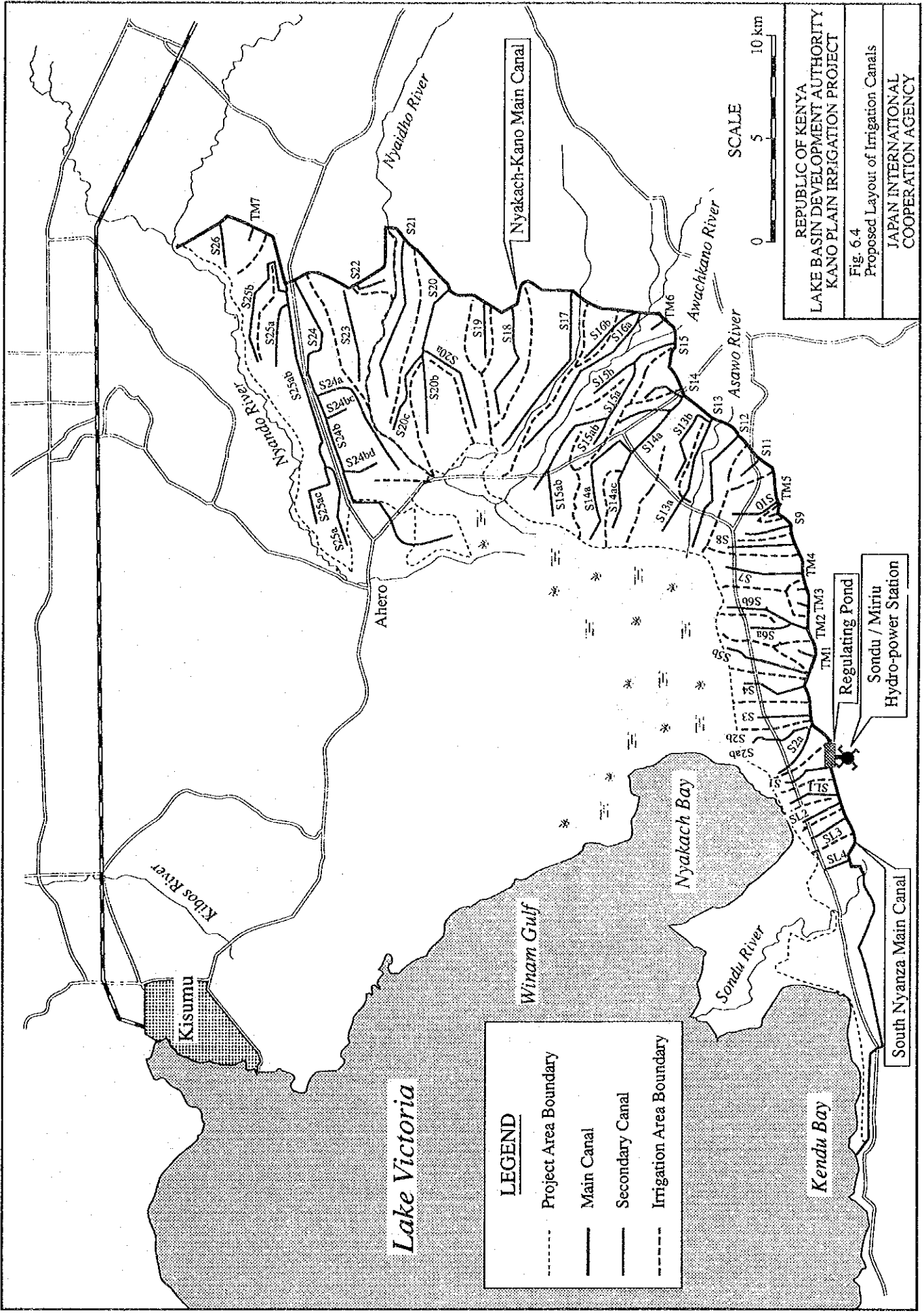


Fig. 6.3 Diversion Water Requirement of the Project

REPUBLIC OF KENYA KANO PLAIN IRRIGATION PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



REPUBLIC OF KENYA  
 LAKE BASIN DEVELOPMENT AUTHORITY  
 KANO PLAIN IRRIGATION PROJECT  
 Fig. 6.4  
 Proposed Layout of Irrigation Canals  
 JAPAN INTERNATIONAL  
 COOPERATION AGENCY

**LEGEND**  
 - - - - - Project Area Boundary  
 ——— Main Canal  
 ——— Secondary Canal  
 - - - - - Irrigation Area Boundary



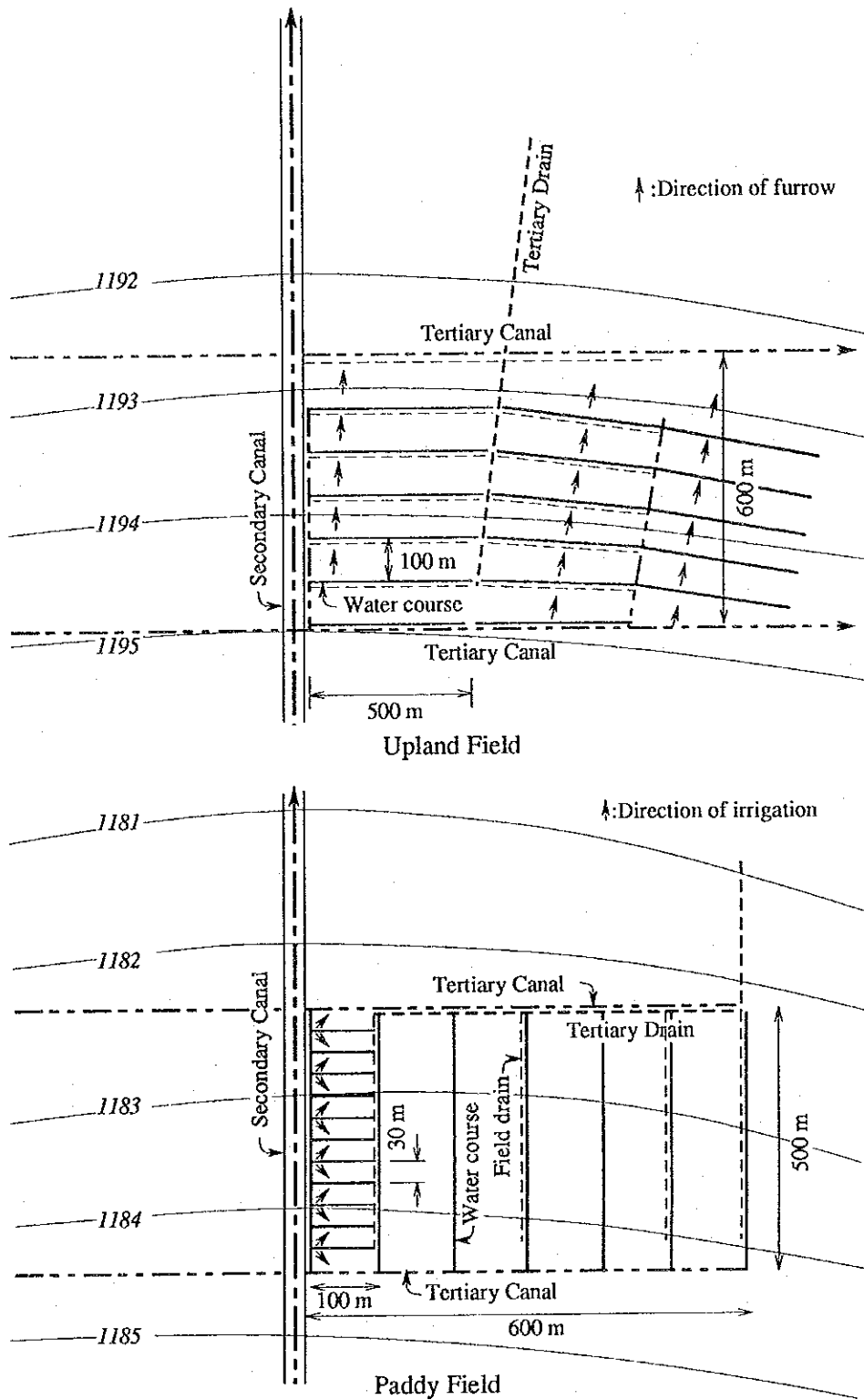


Fig. 6.6 Typical Configuration of a Tertiary System

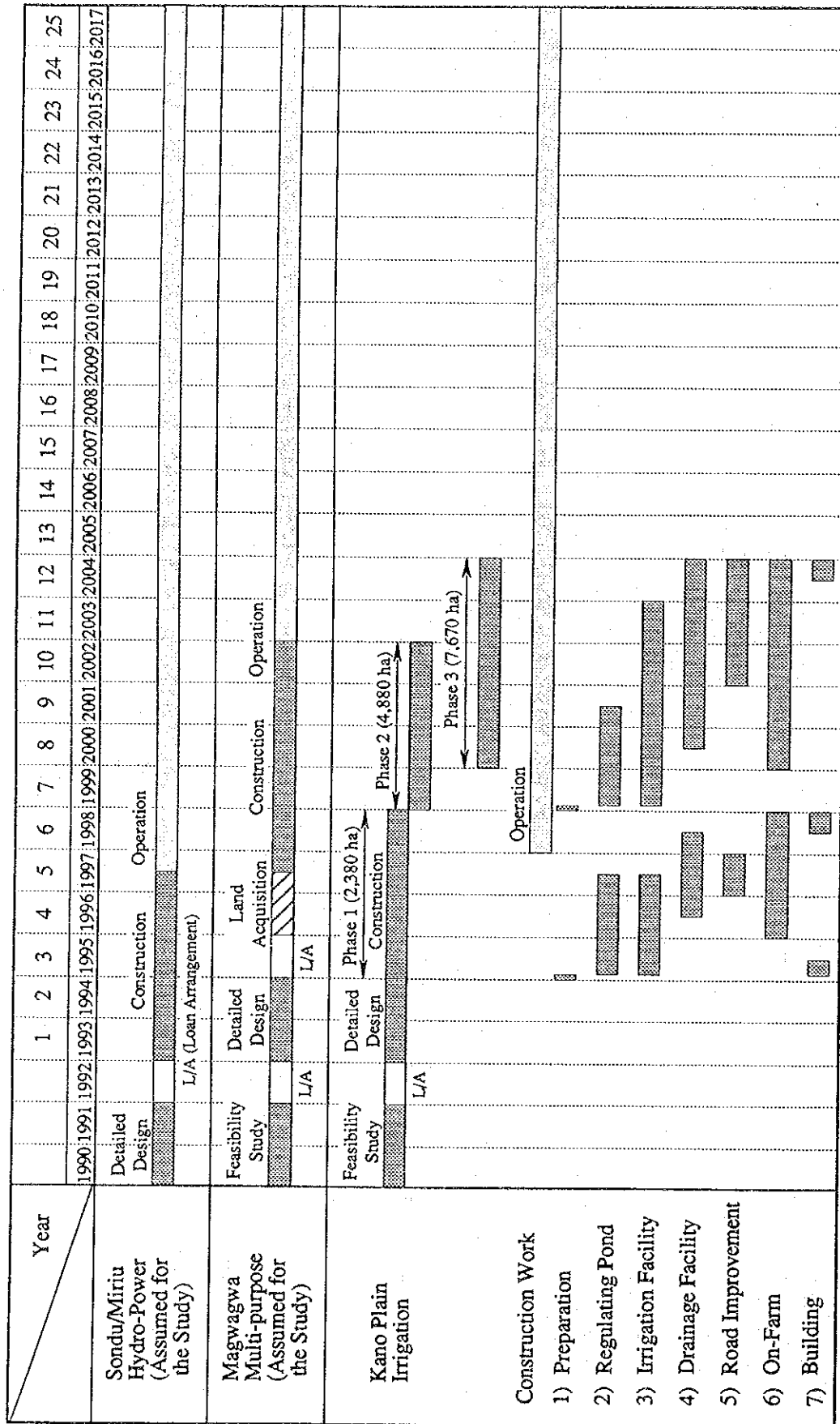
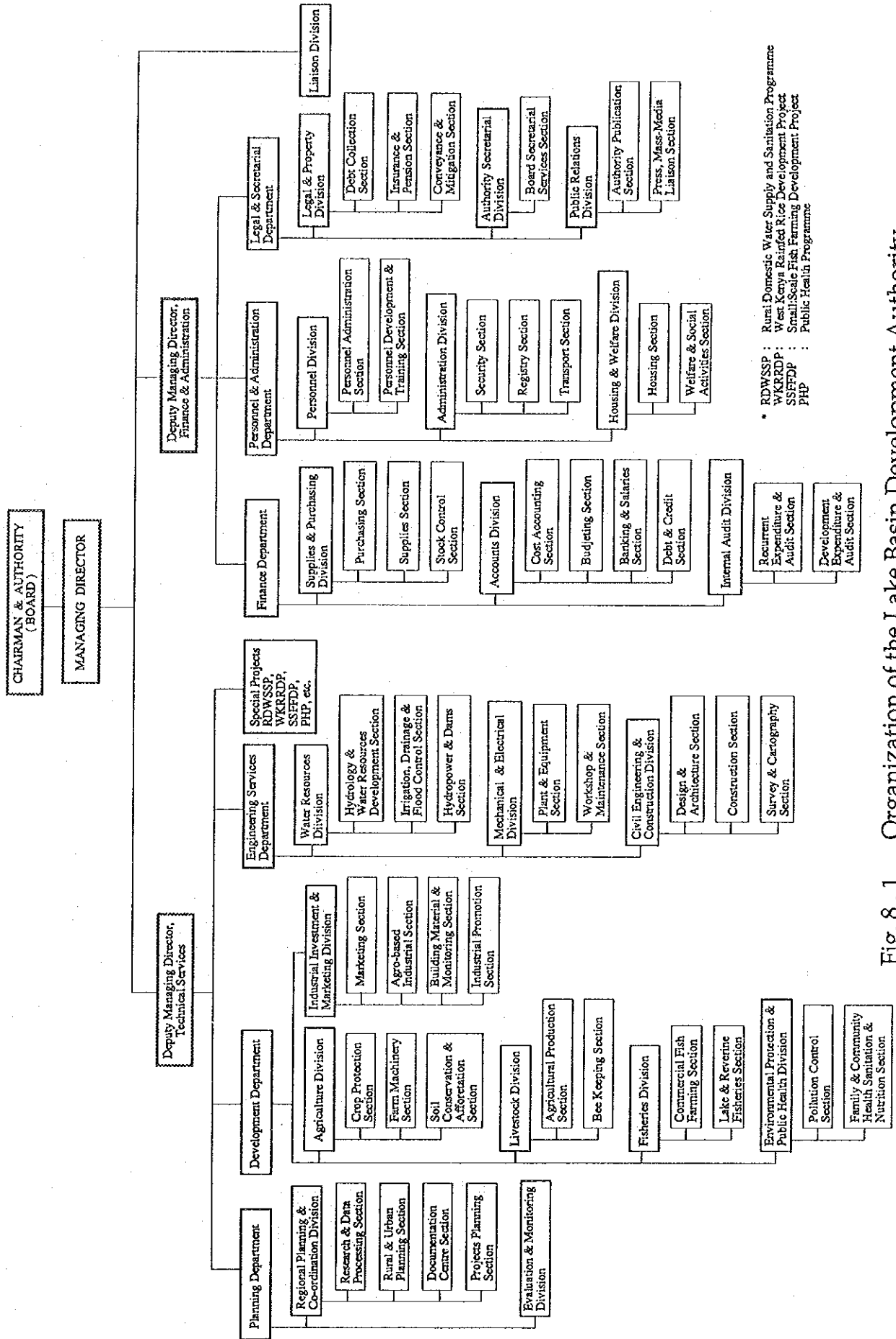


Fig. 7.1 Project Execution Time Schedule





\* RDWSSP : Rural Domestic Water Supply and Sanitation Programme  
 WKRRDP : West Kenya Rainfed Rice Development Project  
 SSFFDP : Small-Scale Fish Farming Development Project  
 PHP : Public Health Programme

Fig. 8.1 Organization of the Lake Basin Development Authority

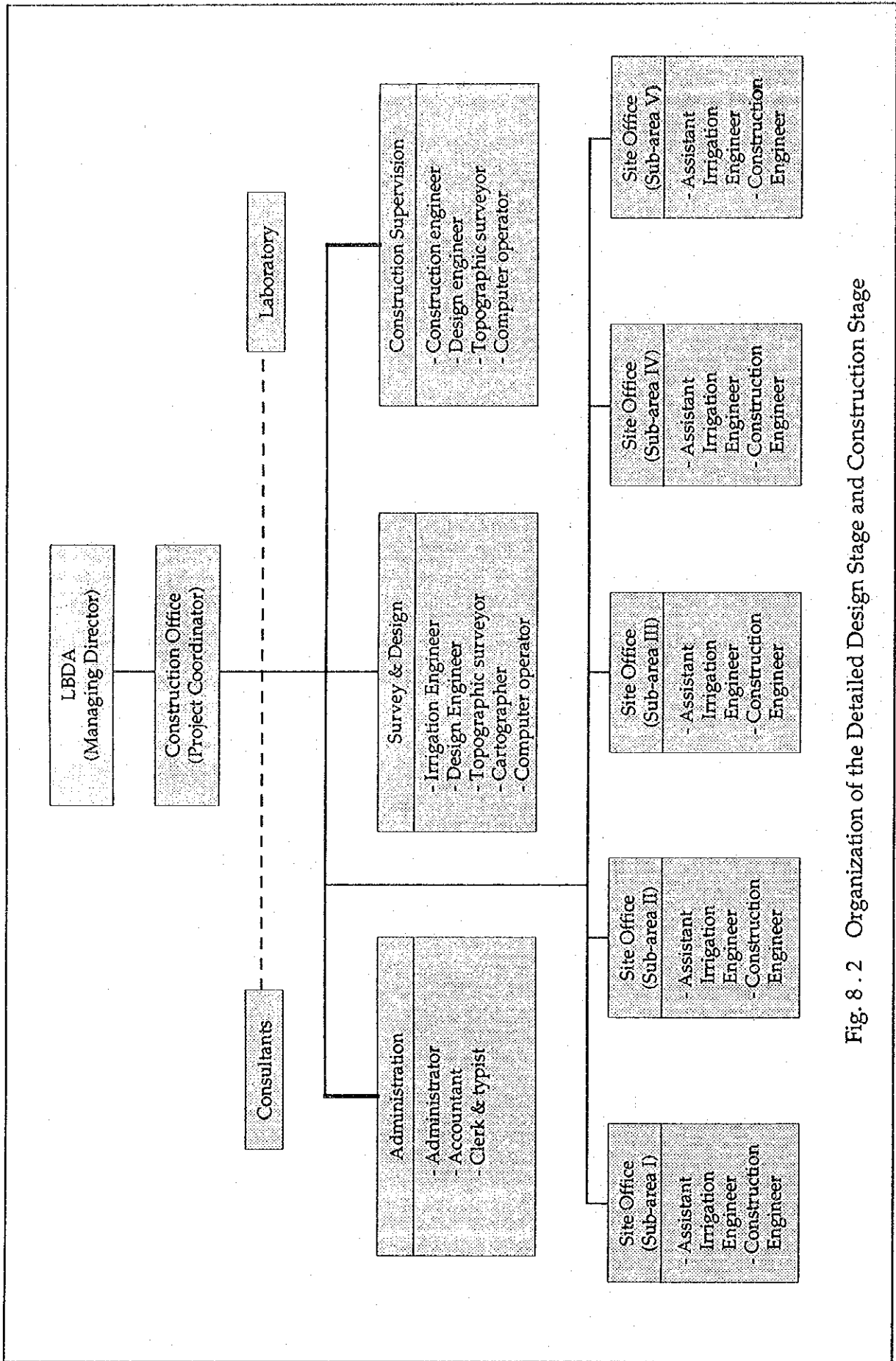


Fig. 8.2 Organization of the Detailed Design Stage and Construction Stage

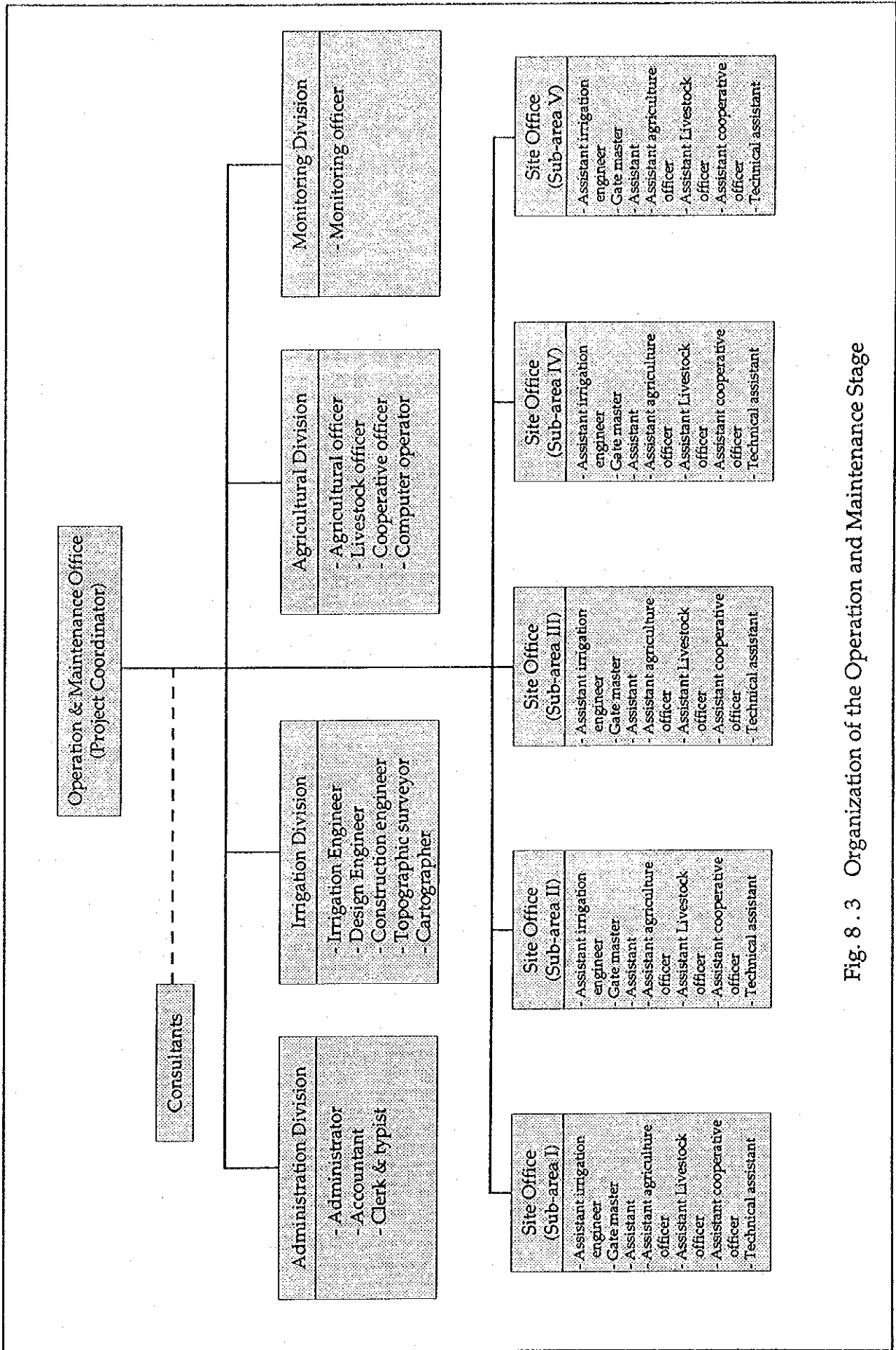
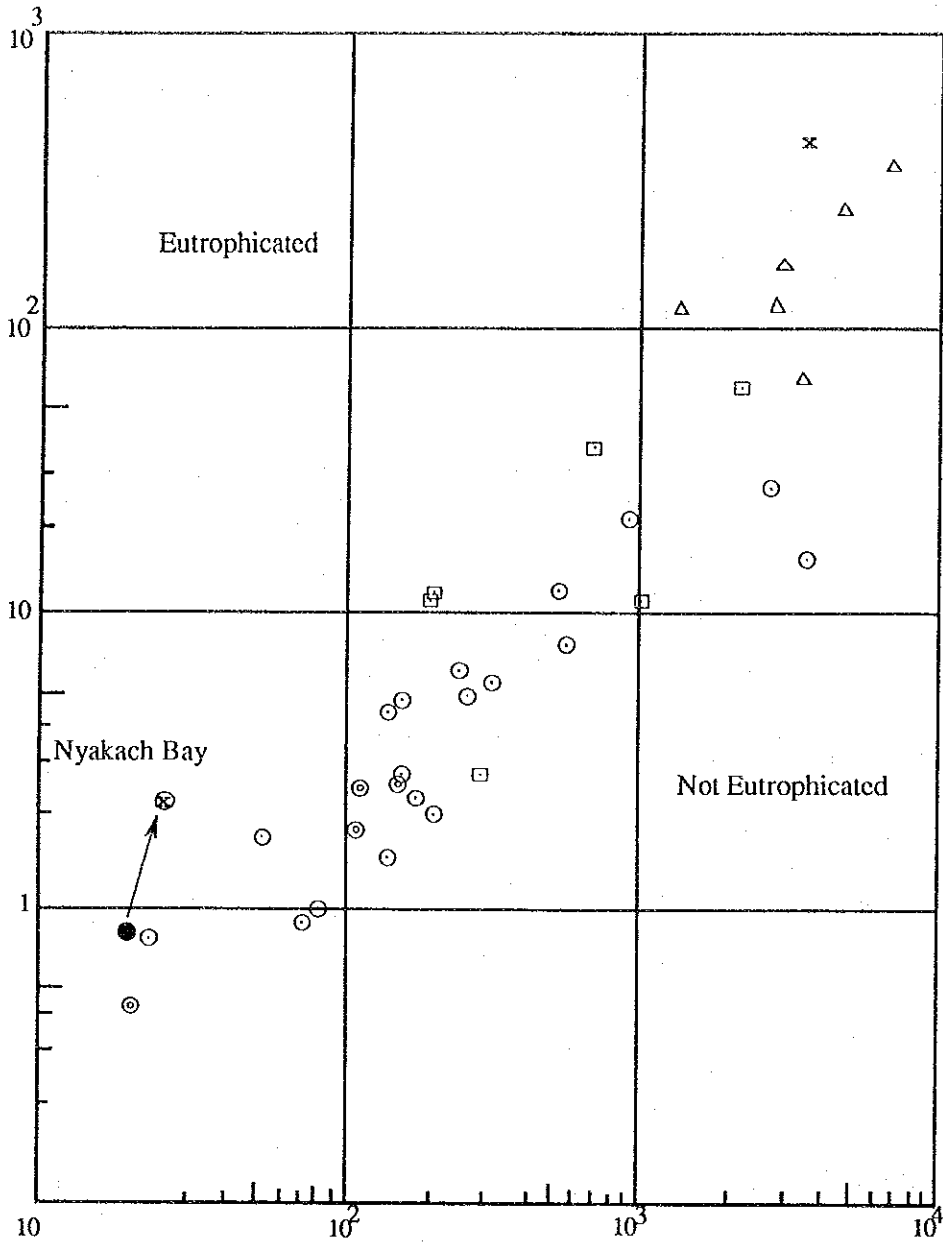


Fig. 8. 3 Organization of the Operation and Maintenance Stage



LEGEND

- Existing condition
- ⊗ With project condition
- ⊙ Not eutrophicated water body
- Slightly eutrophicated
- ◻ Moderately eutrophicated
- △ Eutrophicated
- × Heavily eutrophicated

Note: The background data in this figure are the cases in Japan quoted from the report prepared by the Japan Electric Power Research Institute.

Fig. 10 . 1 Possibility of Eutrophication of the Nyakach Bay

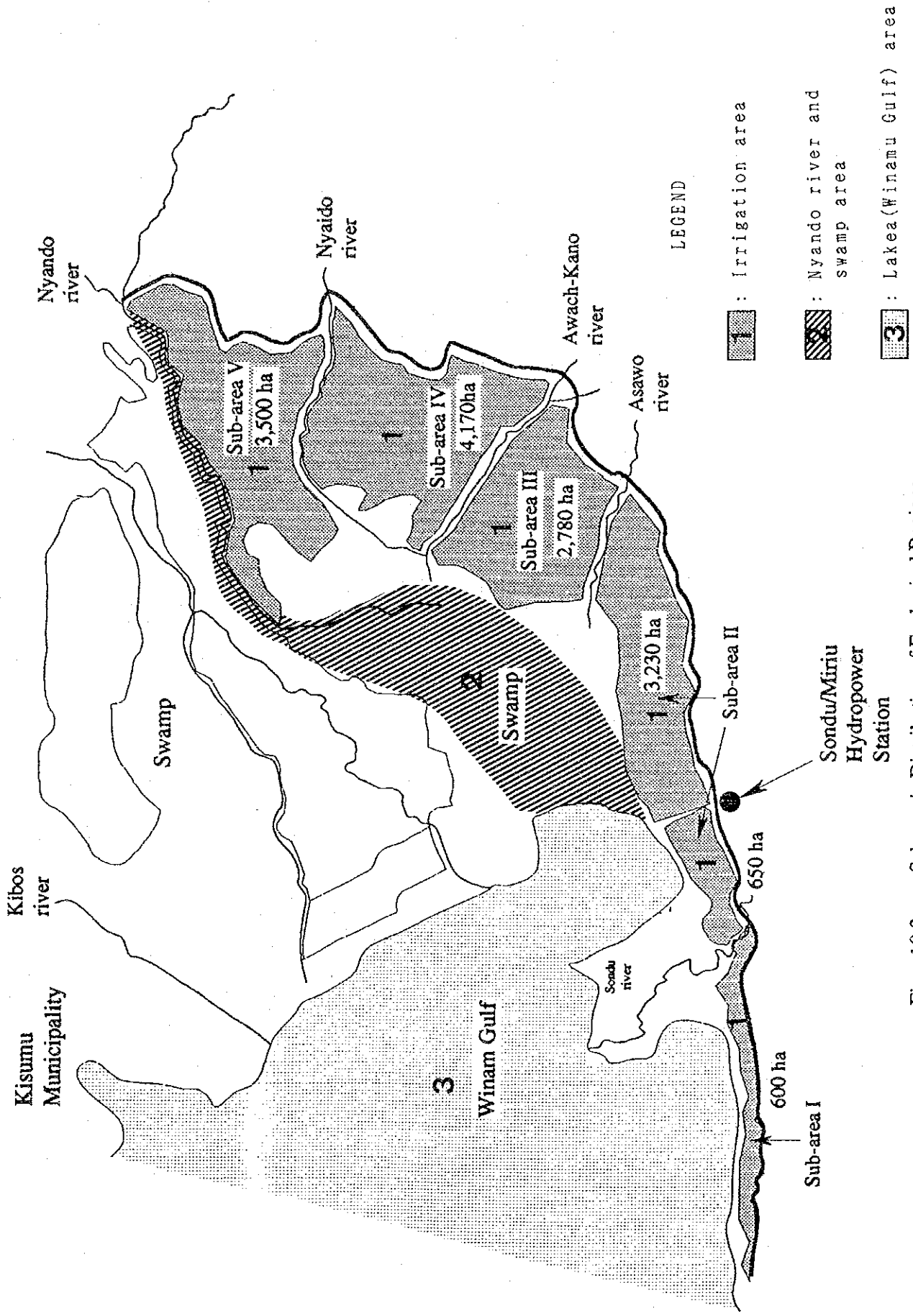


Fig. 10.2 Schematic Distribution of Ecological Regions



## ***Attachments***





MINUTES OF MEETING

ON

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY

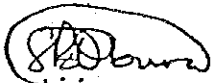
ON

KANO PALIN IRRIGATION PROJECT

IN

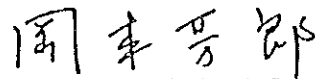
THE REPUBLIC OF KENYA

KISUMU 4TH AUGUST, 1989



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MR. S. B. OBURA  
MANAGING DIRECTOR  
LAKE BASIN DEVELOPMENT  
AUTHORITY (LBDA)



---

MR. YOSHIRO OKAMOTO  
LEADER OF CONTACT MISSION  
JAPAN INTERNATIONAL COOPERATION  
AGENCY (JICA)

## MINUTES OF MEETING

The Japanese Contact Mission (hereinafter referred to as "The Team") sent by the Japan International Cooperation Agency headed by Y. OKAMOTO visited the Republic of Kenya from July 28th to August 5th, 1989 for the purpose of discussion on the scope of work for the Feasibility Study on the Kano Plain Irrigation Project in the Republic of Kenya (hereinafter referred to as "The Study").

The Team had a series of discussions with representatives from Lake Basin Development Authority (hereinafter referred to as "the LBDA") and the Ministries concerned, and carried out satisfactory field inspection in the study area.

Both sides discussed on the draft Scope of Work attached in Annex I.

The main items of mutual understanding are as follows:-

### 1. STUDY AREA

The study is located in Kisumu and South Nyanza Districts of Nyanza province in Western Kenya and covers about 60,000 ha in the Kano and Nyakach Plains delineated by Kibos River up to Kendu Bay.

### 2. IRRIGABLE AREAS

The Project area will be selected from the study area. In the proposed project it is expected that 26,000 ha net will be irrigated in the Kano and Nyakach plains.

The earlier studies identified six sub-areas as follows:-

- |     |            |   |            |   |           |
|-----|------------|---|------------|---|-----------|
| (1) | Kendu Bay  | - | Sondu      | ) |           |
| (2) | Sondu      | - | Asawo      | ) | 8540 ha   |
| (3) | Asawo      | - | Awach Kano | ) |           |
| (4) | Awach Kano | - | Nyaidho    | ) |           |
| (5) | Nyaidho    | - | Nyando     | ) | 17070 ha. |
| (6) | Nyando     | - | Kibos      | ) |           |

From the field inspection the Team confirmed the six-sub areas which will be considered as the irrigable area utilizing the tailrace water from hydro-power schemes in the upstreams of the Sondu River and the waters of the Nyando river.

### 3. STUDY SCHEDULE

It is scheduled to implement the study in accordance with the tentative work schedule attached draft Scope of Work.

The Work - I for the topographic mapping work will be commenced on January 1990.

The Work - II and III for the full scale study will be carried out from August, 1990 to January, 1992.

### 4. PREPARATION OF TOPOGRAPHIC MAPS

The team stated that the mapping area is to cover the expected irrigable area of about 26,000 ha.

### 5. THE SCOPE OF WORK

The contact mission and the LBDA discussed and agreed with the contents of the draft scope of work. The two teams understood that on acceptance of the draft scope of work by JICA headquarters and express authority will be conveyed to Kenya for the scope of work to be signed by the JICA representative in Nairobi and the Managing Director LBDA.

6. The study team agreed to take into account the environmental aspects in the study based on available data

7. The team was requested and promised to convey the following to JICA HDQ for consideration.

- (i) to provide necessary equipment for the study.
- (ii) to provide vehicles for the JICA study team. It is requested that these vehicles and equipments will be handed over to LBDA at the completion of the study.

7. (iii) to accept a few counterpart personnel for training in Japan.
8. It is agreed that the final report be submitted 100 copies and the other report will be prepared 50 copies.

A MEETING BETWEEN THE LBDA AND JICA TO DISCUSS  
THE DRAFT SCOPE OF WORK ON KANO PLAINS IRRIGATION  
PROJECT ON 4TH AUGUST 1989

IN ATTENDANCE - LBDA TEAM:

1.	Mr. S. B. Obura	-	Managing Director
2.	Mr. S. M. Machooka	-	Deputy Managing Director (T.S.)
3.	Mr. J. O. Oduk	-	Irrigation Drainage Engineer
4.	Mr. P. A. Kabok	-	
5.	Mr. J. A. Ojuok	-	Surveyor
6.	Mr. J. Magudha	-	Marketing Expert
7.	Mr. M. Lihemo	-	Industrial Economicst
8.	Mr. G. M. Odoyo	-	Liaison Officer

JICA TEAM:

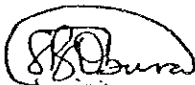
1.	Mr. Y. Okamoto	-	Team Leader
2.	Mr. Y. Okazaki	-	Member
3.	Mr. K. Iwata	-	Member
4.	Mr. K. Takemori	-	Member

SCOPE OF WORK  
FOR  
THE FEASIBILITY STUDY  
ON  
KANO PLAIN IRRIGATION PROJECT  
IN  
THE REPUBLIC OF KENYA

AGREED UPON BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
THE JAPAN INTERNATIONAL COOPERATION AGENCY

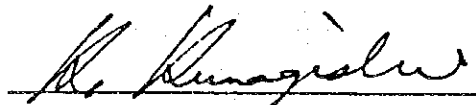
NAIROBI, KENYA

16TH NOVEMBER, 1989



MR. S. B. OBURA

MANAGING DIRECTOR,  
THE LAKE BASIN DEVELOPMENT AUTHORITY



MR. KENJI KUMAGISHI

RESIDENT REPRESENTATIVE OF JAPAN  
INTERNATIONAL COOPERATION AGENCY  
IN KENYA

## I . INTRODUCTION

In response to the request of the Government of the Republic of Kenya (hereinafter referred to as "the Government of Kenya "), the Government of Japan decided to conduct the feasibility study on the Kano Plain Irrigation Project( hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA" ), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Kenya.

The present document sets forth the scope of work with regard to the Study.

## II . OBJECTIVE OF THE STUDY

The objective of the study is to formulate an optimum development plan and to conduct the feasibility study on the Kano Plain Irrigation Project in connection with the hydropower development schemes in the Sondu River.

## III . OUTLINE OF THE STUDY

### 1. Study Area:



The study area covers about 60,000 ha in the Kano and Nyakach Plains Nyanza Province in Western Kenya.

2. Scope of the Study:

The Study will be divided into the following three works:

Work - I : Preparation of the topographic map on the scale of 1:5,000 covering the selected area.

Work - II : Data collection, survey, investigation and formulation of basic concept of the project.

Work - III : Formulation of a development plan.

Major work items of each stage are:

1. Work - I

(1) Topographic Mapping

(A) Aerial Photography of the area of about 600Km<sup>2</sup> on the scale of 1/20,000.

(B) Conduct ground control survey necessary for mapping.

(C) Preparation of topographic maps on the scale of 1/5,000.

2. Work - II

(1) Collect and review the existing data and information relevant to





the project.

(A) Natural condition

- (a) Topography
- (b) Meteorology and Hydrology
- (c) Geology and soil
- (d) Flooding and drought damages
- (e) Vegetation

(B) Agriculture

- (a) Land use and tenure
- (b) Cropping pattern
- (c) Crop and Rice yielding
- (d) Farmers' income productivity
- (e) Price and marketing system
- (f) Agro-economy and institution
- (g) Agricultural support system
- (h) Livestock
- (i) Existing institutions and organizations for farming and project implementation

(C) Agricultural infrastructure

- (a) Irrigation and drainage
- (b) Farm road
- (c) Land reclamation

(D) Social condition

- (a) Population
- (b) Socio-economy and social institution
- (c) Farmer's intention
- (d) Infrastructure



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(E) Programmes

- (a) Regional and national development plans relevant to the project

(F) Others

- (2) Conduct survey and investigations necessary for formulating a development plan of the project.

- (a) Meteorology and hydrology
- (b) Soil and land use
- (c) Agricultural survey
- (d) Irrigation and drainage survey
- (e) Farm road
- (f) Soil mechanics and geology
- (g) Agro-economic survey
- (h) Socio-institutional survey
- (i) Construction material and cost survey
- (j) Farmer's intention
- (k) Environmental Impact Assessment
- (l) Others

- (3) Formulate basic concept of the project

- (a) Delineation of the project area
- (b) Outline of agricultural development plan
- (c) Outline of irrigation and drainage plan
- (d) Basic layout of major facilities
- (e) Outline of water management



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(1) Formulate the development plan of the project on the basis of the results of the study on data and information collected through field survey and investigation in work - II .

(A) Formulation of the following plans

- (a) Final delineation of the project area
- (b) Land use and classification
- (c) Selection of crops, cropping pattern and farming
- (d) Agricultural infrastructure
  - Irrigation and drainage facilities
  - Farm road
  - Land reclamation
- (e) Farmer's training
- (f) Water Management
- (g) Environmental management plan
- (h) Others

(B) Preliminary design of the major structure

(C) Implementation schedule of the project

(D) Organization and institutional plan for operation and maintenance

(E) Estimation of the project cost and benefit

(F) Project evaluation

#### IV. STUDY SCHEDULE

The Study shall be executed in accordance with the attached tentative work schedule.



## V. REPORTS

JICA shall prepare and submit the following reports in English to the Government of Kenya.

(1) Inception Report :

Fifty (50) copies within one month after the commencement of the work.

(2) Interim Report :

Fifty (50) copies at the end of the work- II .

(3) Draft Final Report :

Fifty (50) copies at the end of the work-III .

(4) Final Report :

One hundred (100) copies within two (2) months after receiving the comments from Kenyan side on the Draft Final Report.

## VI. UNDERTAKING OF THE GOVERNMENT KENYA

1. To facilitate smooth conduct of the Study, the Government of Kenya will take necessary measures:

(1) to secure the safety of the Study team,

(2) to permit the members of the Japanese study team to enter, leave and sojourn in Kenya for the duration of their assignment therein, and exempt them from alien registration requirements during the period of the study and consular fees,

(3) to exempt the members of the Japanese study team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into Kenya for the conduct of the Study,



- (4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the Study,
  - (5) to provide necessary facilities to the Japanese study team for remittances as well as utilization of the funds introduced into Kenya from Japan in connection with the implementation of the Study,
  - (6) to secure permission for entry into private properties or restricted areas for the conduct of the Study,
  - (7) To secure permission for the Japanese study team to take all data documents related to the Study including photographs out of Kenya to Japan,
  - (8) to provide medical services as needed. Its expenses will be chargeable to members of the Japanese study team.
2. The Government of Kenya shall bear claims, if any arises against the members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese study team.
  3. The Lake Basin Development Authority ( hereinafter referred to as "LBDA") shall act as counterpart agency to the Japanese study team and also as coordinating body in relation with other governmental and non-governmental organization concerned for smooth implementation of the Study.
  4. LBDA shall, at its own expense, provide the Japanese study team with the following in cooperation with other agencies concerned:



- (1) available data and information related to the Study,
- (2) additional survey related to the Study, if necessary,
- (3) counterpart personnel to participate in the various activities for the Study,
- (4) suitable office space with necessary furniture in Nairobi and the Project site,
- (5) credentials or identification cards to the members of the study team.

#### VII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. to dispatch, at its own expense, study team to Kenya,
2. to pursue technology transfer to the Kenyan counterpart personnel in the course of the Study.



#### VIII. OTHERS



JICA and LBDA will consult with each other in respect of any matter that may arise from or in connection with the Study.



SRD

TENTATIVE WORK SCHEDULE

 : Activities in Kenya  
 : Activities in Japan

Description	Month In order																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
(1) WORK- I																													
(2) WORK- II																													
(3) WORK- III																													
(4) REPORT																													
A) Inception Report																													
B) Interim Report																													
C) Draft Final Report																													
D) Final Report																													

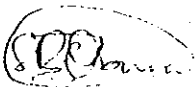


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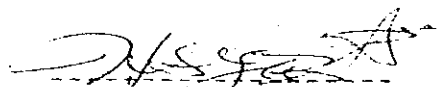
MINUTES OF MEETING  
ON  
THE FEASIBILITY STUDY  
OF  
THE KANO PLAIN IRRIGATION PROJECT

AGREED UPON BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

KISUMU - 9TH AUGUST, 1990



-----  
S. B. OBURA  
MANAGING DIRECTOR  
LAKE BASIN DEVELOPMENT AUTHORITY



-----  
H. YAMAMOTO  
LEADER  
JICA STUDY TEAM



MINUTES OF MEETING  
ON  
THE FEASIBILITY STUDY  
OF  
THE KANO PLAIN IRRIGATION PROJECT

DATE: 6th August and 7th August 1990  
PLACE: Boardroom of LBDA - Kisumu  
OBJECTIVE: The meeting was held to discuss the Inception Report on the Feasibility Study of the Kano Plain Irrigation Project.

INCEPTION REPORT:

Fifty copies of the Inception Report were submitted to the LBDA through JICA - Nairobi Office.

ATTENDANCE:

The list of attendance is as shown in Annex I and II.

OPENING REMARKS

Mr S M Machooka, Deputy Managing Director, Technical Services, and Chairman of the meeting, welcomed the Study Team and the representatives from JICA, Tokyo. He stated that the purpose of the meeting was to discuss the Inception Report prior to the commencement of the Feasibility Study.

BRIEFING BY STUDY TEAM LEADER

The Team Leader of the JICA Study Team, Mr H Yamamoto, briefed the meeting on the Inception Report and highlighted the following:

1. The objective of the Study is to formulate an optimal development plan of the Kano Plain Irrigation Project taking into account the development of Sondu/Miriu Hydropower and Magwagwa Dam projects.

2. The Inception Report deals with the plan of operation for the entire work of the feasibility study. It was also noted by the Team Leader that all figures and ideas described in the Inception Report were tentative because they were conceived based on the information in the pre-feasibility study done in May 1985.

#### COMMENTS AND REQUEST ON INCEPTION REPORT

The following comments and requests were raised:

1. LBDA mentioned that the final result of the feasibility study should be accepted to both LBDA and JICA as it is a collective responsibility.
  - JICA Study Team agreed.
2. LBDA mentioned training in Japan for Counterpart personnel as essential for the transfer of technology. In this connection, LBDA will select the personnel to send to Japan.
  - JICA representative has agreed to receive one person this year for training in Japan.
3. LBDA is still requesting that JICA submits 200 copies of the Final Report to LBDA.
  - JICA representative said that it was impossible to send 200 copies of the Final Report, because submission of 100 copies was agreed to in the Scope of Work between LBDA and JICA on 16th November 1989. The request, however, will be sent to JICA Headquarters.
4. LBDA agreed to provide Counterpart personnel for each expert of the JICA Study Team. In this connection LBDA requested JICA Study Team to provide curriculum vitae of their experts.
  - JICA Study Team accepted.
5. LBDA stated that the right bank of the Nyando River was part of the 26,000 ha and should be studied together with the rest of the project. In this connection the topographic mapping with a Scale of 1:5,000 should be produced for the said area.
  - The irrigable area will be preliminarily selected in the First Field Work. Based on the above

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selection, the area for mapping will be determined in Japan.

6. LBDA requested JICA to send all reports to LBDA Headquarters in Kisumu.

- JICA Study Team agreed.

7. LBDA agreed to prepare official letters to the authorities concerned to secure permission for entry into private properties or restricted areas during the course of the feasibility study. LBDA also agreed to prepare introductory letters for the JICA Study Team members.

- JICA Study Team appreciated.

#### OTHERS

1. Comments on the Reports:

LBDA and JICA Study Team agreed that comments on the Reports which will be submitted to the LBDA shall be sent to JICA Office in Nairobi within two weeks after submission of the Reports except for the draft final which should be submitted after one month.

2. Up-dating of Information:

LBDA and JICA Study Team agreed that information in the Inception Report will be up-dated in future reports.

3. Vehicles and Equipments:

As agreed in the Scope of Work signed in August 1989 JICA will provide two vehicles for the Study Team and some equipments which at the end of the Study will be handed over to LBDA.

4. After discussions between both parties the Inception Report was basically accepted by LBDA.

*Bi*

*PL*

ANNEX I

HANDING OVER OF THE INCEPTION REPORT TO LBDA

LIST OF PARTICIPANTS 6TH AUGUST 1990

LBDA TEAM

1. Mr S B Obura ..... Managing Director
2. Mr S M Machooka ..... Deputy Managing Director  
(Technical Services)
3. Mr Rautta-Athiambo ..... Deputy Managing Director  
(Finance & Administration)
4. Dr Onyango-Ogembo ..... Water Resources Engineer/  
Hydrologist
5. Mr James O Oduk ..... Irrigation/Drainage  
Engineer
6. Mr M O K'Oniala ..... Chief Engineer
7. Mr George A Odingo ..... Agronomist
8. Mr Solomon Kipsang' ..... Agronomist
9. Mr Godfrey M Mwangi ..... Civil Engineer
10. Mr George A Lusui ..... Ag. Surveyor
11. Mr John W Mburu ..... Civil Engineer

JICA F/S TEAM

1. Mr H Yamamoto ..... Team Leader, JICA Study  
Team
2. Mr M Kodama ..... Co-Team Leader,  
Irrigation/Drainage  
Engineer
3. Dr G Wada ..... Agronomist
4. Mr A Honda ..... Trainee

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ANNEX II

MEETING ON THE INCEPTION REPORT

LIST OF PARTICIPANTS

7TH AUGUST 1990

LBDA TEAM:

1. Mr S M Machooka ..... Deputy Managing Director  
(Technical Services)
2. Mr M O K'Oniala ..... Chief Engineer
3. Mr D L Mshila ..... Regional Planner
4. Mr J O Oduk ..... Irrigation/Drainage Engineer
5. Mr George A Odingo ..... Agronomist
6. Dr Onyango-Ogembo ..... Water Resources Engineer/  
Hydrologist
7. Mr Mburu J Wainaina ..... Civil Engineer
8. Mr Kabok P Aguko ..... Irrigation/Drainage Engineer
9. Miss R Mkok ..... Legal Officer
10. Miss B Munyendo ..... Bio-Chemist
11. Mr G A Lusui ..... Ag. Surveyor
12. Mr J M Okello ..... Civil Engineer
13. Mr Rautta-Athiambo ..... Deputy Managing Director  
(Finance & Admin.)

JICA F/S TEAM

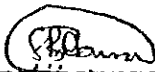
1. Mr S Tukamoto ..... JICA Co-ordinator
2. Mr H Yamamoto ..... Team Leader
3. Mr M Kodama ..... Co-Team Leader, Irrigation  
/Drainage Engineer
4. Dr G Wada ..... Agronomist
5. Mr A Honda ..... Trainee

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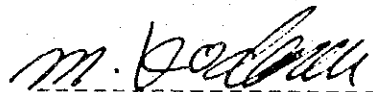
MINUTES OF MEETING  
ON  
THE PROGRESS REPORT NO.1  
OF  
THE FEASIBILITY STUDY  
OF  
THE KANO PLAIN IRRIGATION PROJECT

AGREED UPON BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
JICA STUDY TEAM

KISUMU - 24TH OCTOBER



-----  
S. B. Obura  
MANAGING DIRECTOR  
LAKE BASIN DEVELOPMENT AUTHORITY



-----  
M. KODAMA  
DEPUTY TEAM LEADER  
JICA STUDY TEAM

MINUTES OF MEETING  
ON  
THE PROGRESS REPORT NO.1  
OF  
THE FEASIBILITY STUDY  
OF  
THE KANO PLAIN IRRIGATION PROJECT

DATE: 24th October, 1990  
PLACE: Board room of LBDA - Kisumu  
OBJECTIVE: The meeting was held to discuss the Progress Report No.1 on the Feasibility Study of the Kano Plain Irrigation Project

PROGRESS REPORT:

Thirty copies of the Progress Report were submitted to the LBDA by the Study Team.

ATTENDANCE:

The list of attendance is as shown in Annex 1.

OPENING REMARKS:

Mr. Machooka, Deputy Managing Director, Technical Services, and chairman of the meeting, stated that since this was the end of the first field work which was mainly collection and analysis of the data it was only appropriate to request the Deputy Team Leader of the JICA Study Team to explain the progress they have made to date and highlight any difficulties that they may have encountered during this phase of the study.

BRIEFING BY THE DEPUTY TEAM LEADER:

The Deputy Team Leader, Mr. M. Kodama, briefed the meeting on the Progress Report No.1. The LBDA has accepted the Progress Report in general but raised the following points.

POINTS:

- (1) Population growth rate should have been mentioned in the Report.
- (2) Existing health facilities and schools should be clearly recorded to help in accessing future needs of the project.
- (3) Service road in the study area should also be noted and included in the development plan.
- (4) Although flood damage is difficult to quantify, it would

- have been better to include at least the estimated acreage of the areas under water, how many schools closed or destroyed, how many houses are swept, etc.
- (5) Frequency of the floods should have been also considered.
  - (6) How is the extra water brought from Sondu into the Kano Plain controlled particularly during the rainy season when Nyando floods.
  - (7) Crop husbandry practices should have been looked into, what kind of practices that must be adopted (not to depend too much on machinery)
  - (8) The Kano Plains is a water deficit area, hence competition exists between human beings, animals and irrigation. How has this been looked into.
  - (9) Transportation and marketing in the study area is currently not good and with the project will become even more necessary how is this taken care of.
  - (10) What kind of employment exists and what kind of employment will be created by this project.
  - (11) All data from this field work is going to be processed in Japan, how will Kenyan counterparts benefit from such analysis? Where is the technology transfer?
  - (12) Models used for analysis should be given to Kenyans for testing their suitability in Kenya.
  - (13) LBDA had requested JICA to provide overseas training in Japan for four Kenyans in the Inception Meeting, when will this be done?
  - (14) Environmentalist should come to Kenya in the Second Field Work so that environmental aspects will be considered before formulation of the agricultural development plan, which comes immediately after the Second Field Work.

ANSWER BY THE JICA STUDY TEAM:

- (1) The Study Team will mention the population growth rate in the next report.
- (2) The data which was provided by the LBDA on infrastructure and health facilities will be included in the next report.
- (3) Planning of farm road net-work will also be included in the study.
- (4) The flood control measures which includes quantifying flood damages is recommended to be undertaken by others since it requires a large investment cost. However, improvement of drainage conditions of the farm land will be included in this project.
- (5) Answered in (4).
- (6) The amount of water taken from the Sondu P/S is relatively small in comparison to the flood discharge of the Nyando river. Secondly, some appropriate water control structure will be planned to avoid waste of irrigation water.
- (7) Project will be based on the labour intensive method which will create a lot of employment and the Team will undertake to calculate it.
- (8) The water requirement of the human beings and animals are relatively very small compared to irrigation water requirement. Secondly, washing steps and cattle watering ponds will be provided along the main and secondary canals.



- (9) Answered in (3).
- (10) Answered in (7).
- (11) All data, information, parameters and models which are employed in the analysis in the Study will be described in the report for easy reference.
- (12) Answered in (11).
- (13) JICA representative agreed to receive one person this year for training in Japan as mentioned in the Minutes of Meeting of the Inception Report and further requests will be conveyed to JICA H/Q.
- (14) It was discussed in the former meeting and mutually agreed that the environmental data will be collected by other engineers and that the environmentalist will only process the data in the Third Field Work.

OTHERS:

LBDA confirmed to the JICA Study Team that it wishes to develop the entire 26,000 ha, in order to spread the benefit of irrigation to more people as opposed to another plan of irrigating only 15,000 ha for instance using the same quantity of water from Sondu, but with a higher percentage of paddy fields.

## LIST OF ATTENDANCE

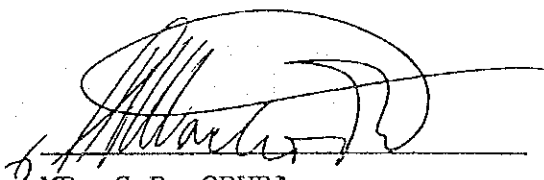
NAME	POSITION
<u>LBDA Team</u>	
S.B. Obura	Managing Director, LBDA
S.M. Machooka	Deputy Managing Director
M.O. Koniala	Chief Engineer/Team Leader
J.O. Oduk	Irrigation/Drainage Engineer
F. Odera	Geologist
L.M. Nyongesa	Hydrologist
M.J. Wainaina	Civil Engineer
J.O. Amayo	Marketing Officer
M.O. Akech	Ecologist
<u>JICA Study Team</u>	
M. Kodama	Deputy Team Leader, Irrigation/Drainage
N. Morioka	Agro-economy and project economy
A. Honda	Plan and design Engineer
K. Kondo	Meteoro-hydrology
A. Honda	Trainee
M. Suga	Worked in the field so absent in the meeting

THE FEASIBILITY STUDY  
OF  
THE KANO PLAIN IRRIGATION PROJECT

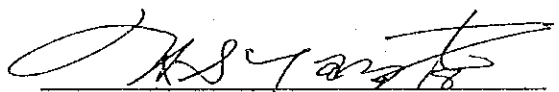
MINUTES OF MEETING  
ON  
THE INTERIM REPORT  
OF  
JICA STUDY TEAM

DISCUSSED BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

KISUMU - 4TH MARCH, 1991



MR. S.B. OBURA  
MANAGING DIRECTOR  
LBDA



MR. H. YAMAMOTO  
TEAM LEADER  
JICA STUDY TEAM

## MINUTES OF MEETING

1. Place of Meeting: LBDA Meeting Room
2. Date and Time: 2:30 thru 5:00 PM, February 28th, 1991, and 2:00 thru 5:00 PM, March 1st, 1991.
3. Attendant: As listed in ATTACHMENT
4. Agenda of Meeting: Briefing of Interim Report and Technical Discussion

On the first day, after the opening address by the Chairman (Deputy Managing Director of LBDA, Mr S.M Machooka), the JICA Study Team officially presented the Interim Report and gave a briefing of the Report. Then, the chairman picked out three(3) major items for discussion, that is the development area, additional mapping area, and the need of a pilot scheme for the project. But, the discussion was suspended until the following day, to allow the LBDA Team to study the report.

On the second day, the following matters were clarified through discussion and mutually agreed upon:

(1) Development area

The LBDA strongly requested that,

- i. the project should be developed to the maximum extent, depending on the available land and water resources endowed in the plain,
- ii. in due consideration of the economic feasibility and financial viability of the Project, the project size should be optimized as far as possible.

The study Team confirmed that the LBDA's view is in conformity to item 5 of the basic development concepts in Chapter 6 of the report. Both parties fully agreed to the concepts on the project formulation as presented in the study.

(2) Mapping area:

LBDA requested additional mapping of the area between the right bank of the Nyando river and the left bank of the Kibos river, as this was an integral part of the irrigable area measuring 26,000 ha.

In response to the request, the JICA officials explained that additional mapping of about 18,000 ha is being carried out based on the Report on Optimization's Study of Irrigation Development Area as prepared by the study team and submitted to LBDA in early January, 1991. Therefore, further additional mapping is not necessary based on this optimization plan as formulated by the Study Team.

LBDA accepted this explanation by the Study Team and noted with appreciation that JICA has already accepted additional mapping of some 18,000 ha over and above the agreed mapping area in the Scope of Work.

(3) Development of Pilot Scheme

LBDA enquired from the JICA officials for the implementation of a pilot scheme of about 1,500 to 2,000 ha in the project area, during the study period.

In response to the enquiry, the JICA officials explained that,

- i. Implementation of a pilot scheme is not included in this study according to the Scope of Work,
- ii. However, the Study Team should prepare a draft pilot scheme development plan, and submit it to the LBDA for discussion after approval by JICA.

(4) Promotion of the Project

With respect to the promotion of the project, the Study Team suggested that,

- i. In order to quickly implement the project in due consideration of the commencement of operation of the Sondu-Miriu Hydropower Station in June 1997, the project should be in the optimal scale and bankable.
- ii taking into account the project size and possible loan arrangements, the project should be stagewise implemented

The LBDA accepted these suggestions and requested the JICA officials to assist in the quick implementation of the 1st phase of the Project.

(5) Title of the Project

LBDA requested that the name of the project should be revised to read "Kano-Nyakach Plain Irrigation Project" in accordance with the delineated project area.

JICA officials explained that the project name was already registered with the Authorities concerned in the Japanese Government as "Kano Plain Irrigation Project", and therefore, the revision of the title of the project may be very difficult. But, the JICA officials promised to take up the matter with Tokyo.

In closing, the Chairman announced the official acceptance of the Interim Report submitted by the JICA Study Team and appreciated efforts made by the JICA officials and the Study Team for the completion of the 2nd field work.

## ATTACHMENT

## List of Participants

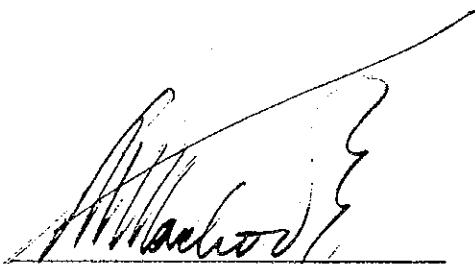
Name	Organization	Position
Mr. M. Machooka	LBDA	Deputy Managing Director
Mr. M.O. K'Oniala	LBDA	Chief Engineer/Team Leader
Mr. J.W. Mburu	LBDA	Civil Engineer
Mr. J.O. Oduk	LBDA	Irrigation/Drainage Engineer
Mr. Omondi Aketch	LBDA	Ecologist
Miss B. Munyendo	LBDA	Bio-chemist
Mr. Fred W. Odera	LBDA	Hydro-geologist
Mr. H. Yamamoto	JICA Team	Team Leader
Mr. M. Kodama	JICA Team	Irrigation Engineer
Dr. G. Wada	JICA Team	Agronomist
Mr. A. Honda	JICA Team	Structure Engineer
Mr. N. Morioka	JICA Team	Agro-economist
Mr. S. Tsukamoto	JICA Tokyo	
Mr. Y. Takahashi	JICA Nairobi	

FEASIBILITY STUDY  
ON  
THE KANO PLAIN IRRIGATION PROJECT


MINUTES OF MEETING  
ON  
SELECTION OF OPTIMUM DEVELOPMENT AREA

DISCUSSED  
BETWEEN  
THE LAKE BASIN DEVELOPEMENT AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

KISUMU - 9TH JULY, 1991



MR. S.M. MACHOOKA  
DEPUTY MANAGING DIRECTOR  
LBDA



MR. M. KODAMA  
DEPUTY LEADER  
JICA STUDY TEAM



## MINUTES OF MEETING

1. Place of Meeting: LBDA Board Room
2. Date and Time: 10:00 AM thru 1:10 PM, July 9th, 1991
3. Attendant: As listed in the attached annex
4. Agenda of Meeting: Briefing of the Study Result on Selection of Optimum Development Scale and technical discussion

After the opening address by the Chairman (Deputy Managing Director of LBDA, Mr. S.M.Machooka), the JICA Study Team officially presented the Study Result and gave a briefing on the report.

fr The following matters were clarified through discussion and mutually agreed upon:

(1) Crops

Possibility of including Robusta coffee and fruit trees on the higher grounds was raised by the LBDA. Study team agreed to examine this possibility during the next step of the study within the selected development area.

(2) Vegetable

s LBDA wanted to know why the acreage of vegetables was limited to 1,000ha only. They suggested that there were plans for improvement of infrastructures such as processing plant and international airport for export. Study team replied that such plans were not yet conclusive, and that 40,000tons of vegetables will be produced from 1,000ha in a year. This 40,000tons could be marketed in and around Kisumu by the existing structures. LBDA noted that any additional production will find a ready market outside the district on condition that improvement of the market channels and expansion of the agro-based processing of horticultural products will be given.

(3) Dairy

Study team showed the rough calculation of dairy production based on zero grazing. Several issues were raised by the LBDA.

- Yield of milk as estimated by the study team was too low.
- Calculation of dry matters for feeding was based only on the napier grass. While other sources (Barna grass etc.) could have been considered, with better result.
- LBDA felt the lactation period of 106 days was too short and suggested that 280 to 300 days were more appropriate.

## ATTACHMENT

### LIST OF ATTENDANTS

<u>Name</u>	<u>Position</u>
<b>LBDA</b>	
Mr. S.M. Machooka	Deputy Managing Director (Technical service)
Mr. J.O. Oduk	Irrigation and drainage engineer (Deputy leader LBDA)
Mr. J. Amayo	Marketing officer
Mr. L. Nyongesa	Hydrologist
Mr. M. Omondi	Environmentalist
Mr. O. Bala	Agronomist
Mr. J.W. Mburu	Structural engineer
Mr. R. Athiambo	Deputy Managing Director (Finance and administration)
<b>JICA Nairobi</b>	
Mr. Y. Takahashi	Assistant Resident Representative
<b>Study Team</b>	
Mr. M. Kodama	Irrigation and drainage, (Deputy leader)
Dr. G. Wada	Agronomy
Mr. N. Morioka	Agro-economy
Mr. Y. Iwai	Environmentalist
Mr. A. Honda	Structure plan
Mr. H. Nozoe	Cost estimate
Mr. T. Ujiie	Trainee

THE FEASIBILITY STUDY  
ON  
KANO PLAIN IRRIGATION PROJECT

Subject: Confirmation on Crops and Hectarage to be included in the Project for the Feasibility Study

Date: 10:00 AM to 11:30 AM, July 16th, 1991

Place: Office of Mr. S. M. Machooka,  
Deputy Managing Director (Technical Service), LBDA

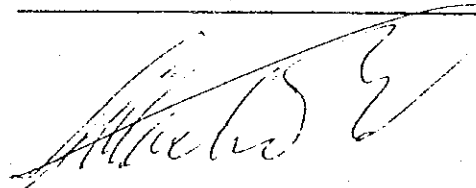
Attendant: LBDA  
Mr. S. M. Machooka (Deputy Director TS),  
Mr. M. O. K'Oniala (Chief Engineer, Team Leader),  
Mr. J. Magudha (Regional Planner)  
JICA Study Team  
Mr. H. Yamamoto (Team Leader),  
Dr. G. Wada (Agronomist),  
Mr. N. Morioka (Agro-Economist)

On the basis of the comments on "the Study Result on Selection of Optimal Development Area", the discussion was made between LBDA and JICA study team on crops and hectarage to be included in the project, and the both sides confirmed as follows:

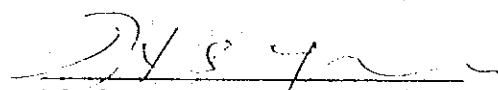
- (1) 770 ha of irrigated pasture (managed forage) is included for dairy farming by zero grazing system in the project, based on the higher return and the target of consumption of milk in the project area.
- (2) Robusta coffee is not included in the project owing to the low net production value.
- (3) 1,100 ha of vegetables is included in the project on the basis of the estimation of the future demand for fresh markets in Kisumu District and the surrounding area.
- (4) 1,200 ha for fruit tree is included in the project on the basis of the higher net production value and the capacity of the processing plant which is currently under promotion by LBDA.

Accordingly, the feasibility study will proceed on the basis of the crops and hectarage in the project area as follows,

Long rainy season	Short rainy season	Area
Paddy	Beans	2,270 ha
Maize	Paddy	1,290 ha
Maize	Cotton/Beans	2,430 ha
Maize	Groundnuts	270 ha
Sugarcane	Sugarcane	5,000 ha
Vegetables	Vegetables	1,100 ha
Fruit tree	Fruit tree	1,200 ha
Managed forage	Managed forage	770 ha
Pasture (Napier grass)	Pasture (Napier grass)	500 ha
<b>Total</b>		<b>14,930 ha</b>



Mr. S. M. Machooka  
Deputy Managing Director  
LBDA



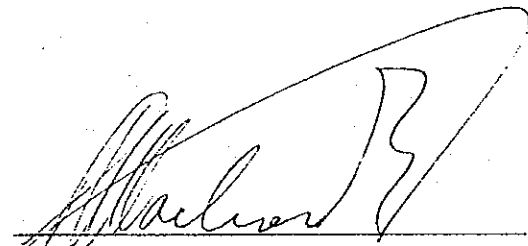
Mr. H. Yamamoto  
Team Leader  
JICA Study Team

FEASIBILITY STUDY  
ON  
THE KANO PLAIN IRRIGATION PROJECT

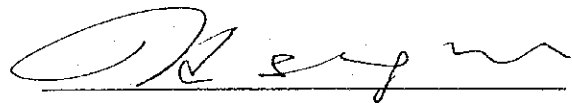
MINUTES OF MEETING  
ON  
PROGRESS REPORT 2

DISCUSSION  
BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

KISUMU - 1ST AUGUST, 1991



Mr. S. M. Machooka  
Deputy Managing Director  
LBDA



Mr. H. Yamamoto  
Team Leader  
JICA Study Team

## MINUTES OF MEETING

1. Place of Meeting : LBDA Board Room
2. Date and Time : 2:30 PM thru 4:30 PM, August 1st, 1991
3. Attendant : As listed in the attachment
4. Agenda of Meeting : Briefing of Progress Report 2 and technical discussion

The Team Leader of JICA Study Team, Mr. H. Yamamoto presented the Progress Report 2 and discussion was made between LBDA and JICA Study Team as follows:

### (1) Drainage

It was confirmed that in order to reduce direct pollution by agricultural inputs from the project the drained water from the irrigation field would not be released directly to the Lake, but into the swamp before reaching the Lake.

### (2) Organization

LBDA emphasized that the project has its own identity and no inter-ministerial steering committee is encouraged. It will have a project coordinator who will be responsible to the managing director, LBDA for policy matters, but remains fully in charge of day to day running of the project. Under the project coordinator, a project office would have various sections including engineering services, production activities, marketing, extension, etc.

### (3) Water Management

LBDA requested that the study team prepare proper comprehensive water management system to suit water demand of various cropping patterns proposed in the project. The study team suggested that LBDA undertake the training programme for water management for project personnel both local and foreign e.g. Mwea irrigation project in Kenya and Southeast Asian countries.

(4) Crop Combination of farmers

LBDA requested that the study team show return from various crop combination of the typical farmers in the project (model farm).

(5) Environmental Aspects

LBDA requested that the study team give estimated levels of pollution over a long period during the project life, particularly for Nyakach Bay. The team leader replied that the matter will be transferred to the environmental engineer for water quality, but he thinks that the data is not adequate for that kind of assessment. Further data collection is necessary to ascertain and estimate pollution levels over the long period.

LBDA asked the study team to consider the engineering design of facilities and specific measures to be undertaken during operation stage to control malaria and schistosomiasis.

(6) Fishery

LBDA mentioned that although fisheries is one of the important activities in the region, the study has not considered fisheries upto now. LBDA requested the study team to include the fishery in the project in collaboration with LBDA's Fishery Department. In addition to this, the environmental effect of the project on fishery should be studied. The study team replied that collection of data and information on fisheries is being undertaken in collaboration with LBDA.

(7) Additional Comments

It was further agreed that any additional comments from LBDA should be forwarded to JICA Nairobi Office until August 9th, 1991.

## LIST OF ATTENDANTS

<u>Name</u>	<u>Position</u>
<b>LBDA</b>	
Mr. S.M. Machooka	Deputy Managing Director (Technical Service)
Mr. Magudha	Regional Planner
Mr. J.O. Oduk	Irrigation and Drainage Engineer
Mr. J.W. Mburu	Structural Engineer
<b>JICA Study Team</b>	
Mr. H. Yamamoto	Team Leader
Mr. M. Kodama	Irrigation and Drainage Engineer
Dr. G. Wada	Agronomy
Mr. N. Morioka	Agro-economist
Mr. A. Honda	Structure Engineer
Mr. H. Nozoe	Design Engineer
Mr. N. Seno	Environmental Engineer
Mr. S. Kikuchi	Assistant to Environmental Engineer



FEASIBILITY STUDY  
ON  
KANO PLAIN IRRIGATION PROJECT

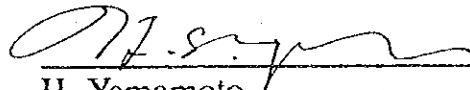
MINUTES OF MEETING  
ON  
DRAFT FINAL REPORT

DISCUSSED  
BETWEEN  
THE LAKE BASIN DEVELOPMENT AUTHORITY  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY  
IN  
KISUMU, 21ST NOVEMBER 1991



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S. B. Obura  
Managing Director  
Lake Basin Development Authority



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H. Yamamoto  
Team Leader  
JICA Study Team

## MINUTES OF MEETING

1. Place of Meeting : LBDA Board Room
2. Date and Time : 2:30 PM thru 5:00 PM, November 21st, 1991
3. Attendants : As listed in the attachment
4. Agenda of Meeting : Briefing on Draft Final Report and technical discussion

After the opening remarks by the Chairman, Deputy Managing Director of LBDA, Mr. S. M. Machooka, the Team Leader of JICA Study Team, Mr. H. Yamamoto presented the Draft Final Report which was followed by a discussion between LBDA and JICA Study Team on the above report.

LBDA observed that the report covers all the points that had been discussed and minuted during the presentation of the Progress Report No.1, Interim Report and Progress Report No.2. The structure of the report was therefore accepted.

However, the following comments were raised by LBDA;

### 1. Training;

This being a new kind of project in the region, training of staff, farmers and other relevant operators of the project in water management, irrigation farming methods, extension support services etc. is vital to the successful implementation of the project, and therefore the cost of this should be included in the project fund.

### 2. Fisheries;

The second paragraph of page 84 and the fifth paragraph of page 86 of the main text should read as indicated in the following comments submitted by the project coordinator of Development of Small Scale Fish Farming Project.

The second paragraph of page 84;  
Information about fish production in the Gulf and rivers have been collected from inquiries and questionnaires survey. The survey reports that the introduced Nile perch has increased in the Gulf whereas other indigenous species such as the tilapias, *Labeo victorianus* and *Barbus* spp., have decreased due to predation by Nile perch and fishing pressure. The ecosystem and species composition of the fish in the study area is still undergoing change at present.

the fifth paragraph of page 86;

Water quality deterioration and eutrophication may be increased due to use of fertilizer and agro-chemicals in the project area. Such ecological situation may affect behaviour of fish and fisheries.

JICA study team has undertaken to forward these comments to the environmental expert for consideration and inclusion into the report.

3. Farm labour price;

The current labour price of Ks.25/man-day is below the official price of Ks.38. An explanation of this difference is needed.

The study team stated that at the time of the report the labour price was Ks.25 as confirmed by the field survey. This reflects the situation of agricultural sector in the study area.

4. LBDA raised some issues which include construction of rice mill by LBDA, pricing procedure, environment and other aspects. These issues were examined during the meeting and they will be included in the final report.

## List of Attendants

Name	Organization	Position
Mr. S. M. Machooka	LBDA	Deputy Managing Director (Technical Services)
Mr. R. Athiambo	LBDA	Deputy Managing Director (Finance and Administration)
Mr. M. O. K'Oniala	LBDA	Chief Engineer/Team Leader
Mr. J. Magudha	LBDA	Regional Planner
Mr. J. W. Mburu	LBDA	Structural Engineer
Mr. O. Bala	LBDA	Agronomist
Dr. J. N. R. Olina	LBDA	Livestock Specialist
Mr. M. Omondi Akech	LBDA	Environmentalist
Miss B. Munyendo	LBDA	Bio-chemist
Mr. B. Aloo	LBDA	Public Relations Manager
Mr. M. O. Oyundo	LBDA	Head of Monitoring and Evaluation
Mr. F. M. Odok	LBDA	Project Coordinator, WKRRDP
Mr. A. P. Achieng	LBDA	Fisheries Specialist
Mr. Okulo Arum	LBDA	Senior Planner
Miss J. A. Opondo	LBDA	Planning Officer
Mr. G. A. Lusui	LBDA	Acting Surveyor
Mr. D. Arunga	LBDA	Project Coordinator, RDWSSP
Mr. H. S. Oyombe	LBDA	Development Manager
Mr. P. A. Kabok	LBDA	Irrigation and Drainage Engineer
Mr. H. Yamamoto	JICA Team	Team Leader
Mr. M. Kodama	JICA Team	Irrigation and Drainage Engineer
Mr. N. Morioka	JICA Team	Agro-economist
Mr. H. Hioki	JICA Tokyo	

## ***Appendix***



## Integrated Project Evaluation

### 1. Introduction

The three (3) projects, the Sondu/Miriu Hydropower Project, the Magwagwa Hydroelectric Power Development Project, and the Kano Plain Irrigation Project, have been formulated as the Sondu River Mutipurpose Development Project utilizing the same water resource of the Sondu River. According to the studies of the individual project, scale, excution and effects of the projects are affected each. An integrated project evaluation for the projects in terms of economic view point is carried out as follows:

### 2. Summary of Projects

#### (1) Sondu/Miriu Hydropower Project:detailed design completed in July 1991

The project is formulated as a run-of -river type with a regulating pond of power station which diverts the water of the Sondu river to the Kano-Nyakach plain through headrace tunnel to harness a water head of 197 m with a maximum plant discharge of 39.9 m<sup>3</sup>/sec. The installed capacity and annual average energy are 60 MW and 330.4 GWh. After the completion of the Magwagwa Hydroelectric Power Project, regulated river flow will enable to generate annual average energy of 367 GWh additionally.

#### (2) Magwagwa Hydroelectric Power Project:feasibility study completed in August 1991

The proposed dam site is located at the narrow gorge just after two major tributaries of the Sondu river merge in the upstream of the intake of the Sondu/Miriu Hydropower Project. Dam height, gross storage, active storage are 110 m, 808 x 10<sup>3</sup> m<sup>3</sup>, 701 x 10<sup>3</sup> m<sup>3</sup>, respectively. The installed capacity is 120 MW with the rated head of 170.4 m. 461.6 GWh of energy would be generated. In addition to this, regulated reiver flow will enable to generate more energy at the Sondu/Miriu hydropower station and to irrigate 14,930 ha of farm land in the downstream area.

#### (3) Kano Plain Irrigation Project:feasibility study completed in January 1992

Water from the Sondu/Miriu hydropower station would be regulated in the regulation pond (634 x 10<sup>3</sup> m<sup>3</sup>), and irrigate about 14,930 ha of farm land of Kano-Nyakach Plain. The Nyakach-Kano and South Nyanza main canal will supply irrigation water for paddy, other cereals, pulses, sugarcane, vegetables, fruits and fodder crops to supply food for the local people as well as to generate farm income and employ opportunity.

### 3. Integrated Project Evaluation

According to the studies and designs mentioned above, the cost and benefit of each project are summarized as follows;

(1) Sondu/Miriu Hydropower Project		
Economic construction cost	:	US\$98.0 million
Economic operation and maintenance cost	:	US\$0.98 million/year
Annual average energy production	:	330.4 GWh
Annual power benefit	:	US\$16.01 million

(2) Magwagwa Hydroelectric Power Project			
Economic construction cost	:	US\$246.10	million
Economic operation and maintenance cost	:	US\$2.46	million/year
Annual average energy production	:	461.6	GWh
Annual power benefit	:	US\$61.71	million
(3) Kano Plain Irrigation Project			
Economic construction cost	:	US\$129.20	million
Economic operation and maintenance cost	:	US\$0.84	million/year
Irrigable area	:	14,930	ha
Annual irrigation benefit	:	US\$22.93	million
(4) Total of the Projects			
Economic construction cost	:	US\$473.20	million
Economic operation and maintenance cost	:	US\$4.28	million/year
Annual average energy production	:	792.0	GWh
Irrigable area	:	14,930	ha
Annual benefit (power + irrigation)	:	US\$100.65	million

Economic internal rate of return (EIRR) and net present value of cost and benefit (at the discount rate of 10%) are calculated on the basis of the above economic cost and benefit, the project life of 50 years, disbursement schedule as shown Table 1, and summarized as follows:

	Sondu/Miriu (1)	Magwagwa (2)	Kano Plain (3)	Overall (1)+(2)+(3)
EIRR	12.6%	14.0%	13.2%	13.4%
NPV of benefit (US\$ 10 <sup>6</sup> )	108.0	232.7	85.6	426.2
NPV of cost (US\$ 10 <sup>6</sup> )	84.5	165.5	62.7	301.7
B-C (US\$ 10 <sup>6</sup> )	23.5	67.1	22.9	113.6
B/C	1.28	1.41	1.36	1.41

In addition to this, sensitivity analysis of the overall project in which three (3) projects are included, are examined under the following conditions in order to elucidate economic viability against possible change in the cost and benefit:

Conditions	Net Present Value (US\$ million)	EIRR (%)
(1) 10% increase of the capital cost	94.4	12.4
(2) 20% increase of the capital cost	64.2	11.6
(2) 10% decrease of the benefit	81.9	12.3
(2) 20% decrease of the benefit	39.3	11.2
(3) 10% cost up and 10% benefit down	51.7	11.4
(3) 20% cost up and 20% benefit down	-21.1	9.5

Even on the most unfavourable condition of 20% increase of the cost and 20% decrease of the benefit, the project still keeps EIRR of 9.5%.

Those results give the high economic viability of the overall project, showing 13.4% of EIRR and a net benefit of US\$ 114 million at the discount rate of 10%. The sensitivity analysis indicates that the overall project is rather sensitive to possible adverse effect in view of economic evaluation.









