

## 6.2.4 Frequency of Observation

### (1) Frequency of River Water Level Gauging

In principal, the daily gauging of the river water level is done at all the stations registered by DWA. Daily observations are done two (2) times a day, in morning and in evening. The average of these two data is recorded as a daily water level. The recording of river water level is executed, in principal, during the rainy season (from December to May).

### (2) Frequency of Flow Measurement

The flow measurement is done at all the stations where it is necessary to know flow discharge. In principle, the frequency of flow measurement at each station is twice a year (once in wet season, once in dry season). To execute effective measurements with the limited budget, the frequency of measurements will be decided on the basis of the standard shown in Table-6.6 and classified by the importance of station. Refer to Table-6.7.

Table-6.6 Frequency of Flow Measurement

Classification	Minimum Frequency	Standard Frequency
Class - A	Twice / Year	Twice / Year
Class - B	Once / Year	(Once / wet season) (Once / dry season)
Class - C	Once / 2 years	
Class - D	Closed at the moment	

### (3) Frequency of Sediment Sampling and Analysis

The sediment sampling and analysis are done at the stations selected among the registered stations and other points. The sediment sampling and analysis are executed at the time of flow measurement with the same frequency of flow measurement.

### (4) Frequency of Water Quality Investigation

#### <Investigation by Regional Hydrological Office>

This investigation is carried out twice a year (in wet and dry seasons) by the observation team at the hydrometric stations of Class A belonging to the Office and the other problematic points.

#### <Investigation by Hydrological Section>

This investigation is carried out twice a year (in wet and dry seasons) by the water quality investigation team belonging to the Hydrological Section in Lusaka at all the hydrometric stations of Class A in Zambia.

### 6.2.5 Classification of Hydrometric Stations

The hydrometric stations covered by this plan are all the stations registered in DWA, belonging to each of the Regional Hydrological Offices and are specified as follows. (Refer to Fig.-6.5)

- 1) Station No. and Name
- 2) Regional Hydrological Office in Charge
- 3) Observation Items
  - Daily water level : (all stations)
  - Recording water level : Yes or No
  - Flow measurement : Yes or No
  - Sediment sampling and analysis: Yes or No
  - Water quality : Yes or No
  - Others (meteorology etc.) : Yes or No
- 4) Classification : A or B or C or D

The classification of station is decided according to the importance of station in view point of discharge calculation, availability of rating curve and number of discharge measurement, as shown in Table-6.7.

The Class-A station is an important station to know the discharge of main stream channel. At this Class-A station, periodic measurements of discharge, sediment and water quality besides daily water level observation should be executed.

When the Class-D station, temporally closed at the moment, re-opens, the classification for this stations should be done according to the standard shown in Table-6.7. In Table-6.8 the numbers of stations for each Regional Hydrological Office are shown. Details are given in the Supporting Report.

Table-6.7 Classification of Hydrometric Stations

Evaluation	Items	Score	Standard of Classification
Class of River	Main	0	<Class-A>: Main channel and operational
	Sub	1	
	Local	2	
Operation	Open	0	<Class-B>: Total score = 0, 1, 2
	Close	1	
Availability of Rating Curve	No	0	<Class-C>: Total score = 3, 4
	Yes	1	
Number of Discharge Measurement	Few	0	<Class-D>: Closed station at the moment
	Many	1	

Table-6.8 Number of Hydrometric Stations

Regional Hydrological Office	Total	Auto. Recording	Flow Measurement	* Sedi. & Water Quality	Classification			
					A	B	C	D
1) Lusaka	33	1	20	2	2	9	9	13
2) Copperbelt	33	3	16	4	4	4	8	17
3) N/Western	36	0	15	2	2	1	12	21
4) Western	17	0	11	2	2	5	4	6
5) Southern	35	2	11	2	2	5	4	24
6) Eastern	20	0	18	4	3	10	5	2
7) Northern	34	0	31	2	2	8	21	3
8) Luapula	35	0	24	2	2	8	14	11
[Total]	243	6	146	19	19	50	77	97

[Note] \* The number shows the number of hydrometric stations for sediment sampling and water quality test, it does not include the number of other measurement points.



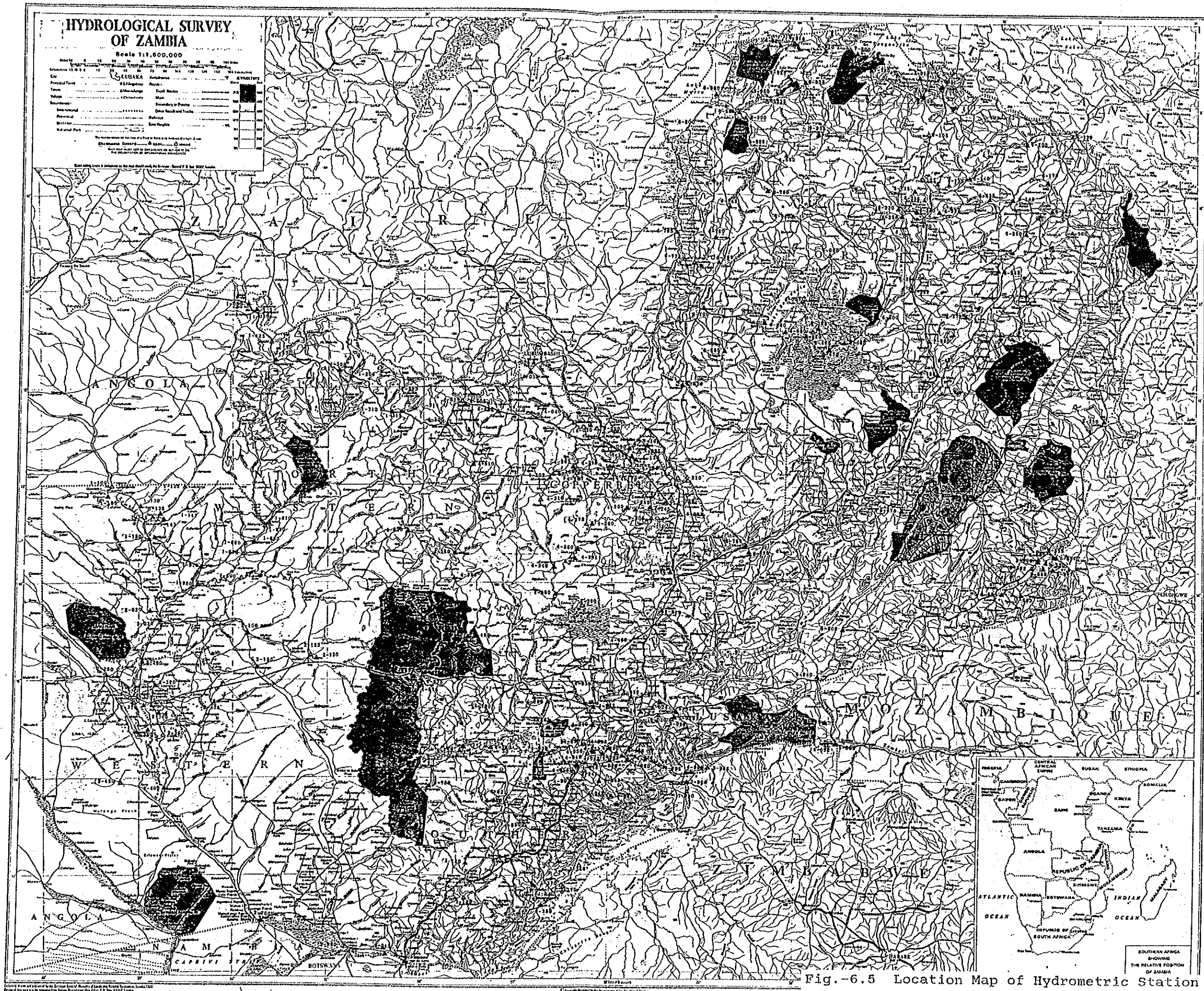


Fig.-6.5 Location Map of Hydrometric Station In Zambia



## 7 RECOMMENDATION

### (1) Recognition and Enlightenment of Importance of Hydrologic Observation

There is a proverb "Those who control rivers control nations" in China. This is proved by the fact that the advanced nations in the world are flourishing by receiving the benefit of water resources development.

Water resources development brings various benefits such as supply of drinking water, industrial water and irrigation water, generation of hydroelectric power and so on. It is indispensable and essential theme for social and economic development. In connection with the development of water resources, there are other important themes to be solved: conservation of groundwater, water quality and environment. Groundwater, being closely related to the river water, is precious water resources as well as river water. Contamination of river water, being caused by the growth of cities and industries, is problem in view point of water use. The recent global environmental phenomena: acid rainfall, drought and flood, are brought to the fore.

The above mentioned development of water resources and conservation of groundwater, water quality and environment, become important themes for the future development of Zambia. To take measures for these themes, the hydrological observation is fundamental and indispensable. It is not too much to say that the hydrological observation, executed correctly and continuously, is the most important factor to secure the future prosperity of Zambia.

"The Ministry of Energy and Water Development" responsible for water resources development and "The Department of Water Affairs" in charge of hydrologic observation in Zambia, should first recognize the importance of hydrologic observation. Next, they should try bring about an awareness of the importance of this to the related agencies and to each generation of the population through official publications, mass-communication and so on. This is one of the effective means to educate the young generation in the schools using educational materials, who are to bear the destiny of Zambia in their shoulders, about the importance of water resources development and hydrologic observation.

### (2) Improvement of Hydrological Observation System

The useful hydrological data are those which are continuously and exactly collected and processed by effective organizations. In this view point, the present system of hydrological observation in Zambia should be improved. The Study Team recommend that DWA establish the substantial system for hydrological observation according to the plan proposed by the Study Team, considering the following matters.

### 1) Clarification of Duties and Responsibilities

To fulfill the hydrological activities without fault, it is necessary to clarify the duties and responsibilities of each organization and personnel as shown in the plan discussed above. According to this clarification, the leader of each organization can clearly check and direct the activities of his organization and the subordinate organization he has to manage or supervise.

### 2) Reinforcement of Observation Team

Almost all the field activities for hydrological observation are carried out by the observation team in Regional Hydrological Office. To reinforce the team, the following shall be executed.

- Improvement of the technical level of team leaders
- Supply of necessary transport and equipment for hydrological observation
- Assignment of back-up personnel for each gauge reader to avoid lack of data due to gauge reader unavailability
- Improvement of maintenance technology in Regional Office

### 3) Adoption of Annual Plan and Annual Report

All the hydrological activities should be done according to the annual plans prepared by DWA Hydrological Section and each Regional Hydrological Office and approved by DWA Headquarters. Each organization has to report the annual activities and data. Each regional Office reports the activities and data to DWA hydrological Section. DWA Hydrological Section has to compile the reports from the Hydrological Offices and report the activities including the results of hydrological analysis to DWA Headquarters.

A regular half-year meeting of the officers in DWA Hydrological Section and officers in Regional Hydrological Offices is recommended for the above purposes.

### 4) Improvement of System for Hydrological Analysis

To improve the present system for hydrological analysis, DWA Hydrological Section should apply the following hydrologic database developed by the Study Team.

- Data processing of discharge measurement: (DB-01, DB-02)
- Preparation of discharge rating curves : (DB-03, DB-04)
- Preparation of W/L - discharge tables : (DB-05, DB-06)
- Calculation of discharge correlation : (DB-07)
- Calculation of station's flow regime : (DB-08)
- Calculation of river flow balance : (DB-09)



#### 5) Periodic Observation of Water Quality

There has been no periodic observation of water quality for the rivers. However, it is necessary, with the view of securing good water in quality for water use to carry out the periodic observation of river water quality at the designated points.

#### 6) Establishment of Planning Section

Apart from hydrological observation, establishment of new Plan and Design Section in DWA is recommended from the view point of effective use of hydrological observation data. This section is responsible for preparation of water resources development plans and designs. The leader of this section is expected to be water engineer qualified in civil engineering, hydraulics and hydrology. It can be considered to employ a foreign expert qualified in water resources development. His duty is to give technical advice to the existing Hydrological Section and the proposed Planning Section.

#### 7) Reciprocation of Hydrologic Information with International Agencies

The Zambezi River is an international river passing through 6 countries. The hydrologic observation and water resources development for the Zambezi River are executed by each country's agency and international organizations. It will be necessary to reciprocate hydrologic information and adjust development plans with these bodies when the water resources development in the main channel of Zambezi River will be prepared by Zambia.

#### 8) Sufficient Staffing and Introduction of Schematic Training System

The personnel proposed in the Plan should be secured with the DWA's best efforts. Schematic training for all the personnel engaged in the hydrological observation, including new staff, is necessary on regular basis. Especially, the training of observation team leaders and the members for hydrological analysis is essential.

#### 9) Repletion of Budget

To establish the organization and to execute the activities proposed in the Plan, DWA should try to secure the repletion of the budget.

### (3) Utilization of Water Resources

In this Study, the outline of potential surface water resources in the Study Area have been comprehended, and abundant and unutilized water resources have been found. The ground water, prevailing universally through Zambia, is also a precious water resources. These abundant and universal water resources are expected to be developed considering the following situations in Zambia.

- The population of Zambia in the beginning of 21st century is estimated to be around 10.7 million on the basis of the latest census data. The increment of population during the coming decade will about 3 million. To cope with these increasing population, supply of drinking water in urban and rural areas will be essential.
- To promote agricultural development, the current main target of the Government, development of irrigation water is inevitable.
- Due to the increment of population, improvement of living standards and development of the country, the demand for electricity will be increased.

As mentioned above, the demand for water resources development is expanding. The background to advance the development of water resources in the Study Area and Zambia is already prepared.

The project of water resources development will bring not only such direct and indirect economic benefit as water supply and hydroelectric power generation after the completion of project, but also produce such other economic benefit as evocation of effective demand, income redistribution, employment promotion and increase of revenue through taxation in the implementation period of projects. To develop water resource is to secure requisitions for living, and is essential in view of civil minimum.

It is recommended that planning for comprehensive water resources development should be started in order to meet the various demands by utilizing the rich water resources to secure comfortable living standards and prosperity in Zambia.

THE MASTER PLAN STUDY ON HYDROLOGIC OBSERVATION SYSTEMS  
OF THE MAJOR RIVER BASINS IN ZAMBIA

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[ A P P E N D I C E S ]

- Appendix - A Technical Transfer
- Appendix - B Scope of Work
- Appendix - C Minutes of Meeting



THE MASTER PLAN STUDY ON HYDROLOGIC OBSERVATION SYSTEMS  
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Appendix - A

T E C H N I C A L   T R A N S F E R



APPENDIX - A

TECHNICAL TRANSFER

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2.1 Phase 1 .....	3
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6. CONTINUATION OF HYDROLOGICAL OBSERVATION .....	9





## 1. INTRODUCTION

The Study, the first step in preparation of the overall plan for water resources development in Zambia, is designed to achieve the following objectives.

- 1) To strengthen the hydrologic observation systems in Study Area to utilize the data for future planning of water resources development.
- 2) To make a rough estimation of water resources potential through the study of river water flow based on existing and new hydrologic data.

In addition, this study is also designed to transfer technology to the Zambian counterparts through the execution of study.

The transfer of technology mainly in hydrology to the Zambian counterparts through the execution of study was one of the important purposes of the Study.

During the Study both in field and in office, the transfer of technology was carried out by the Team through on-the-job training, training course in Japan and special lecture.

## 2. ON-THE-JOB TRAINING

On-the-job training is the most effective way for transfer of technology since the technology can be transferred to the counterparts through daily practice of engineering activities on the exact matters.

The transfer of knowledge through on-the-job training was carried out to the counterparts, the related engineers and technicians of the project by the Japanese experts in each engineering field during execution of the work.

The Japanese experts and the Zambian counterparts who were involved in the Study are shown in Table-2.1.

Table-2.1 Japanese Experts and Zambian Counterparts

Position	Phase	Name of Japanese Experts	Name of Zambian Counterparts	
			Engineer	Others or Technician
Team Leader	Phase 1	Y.Nakagawa	A.Mumeka	
	2	-ditto-	V.N.Kasimona	
	3	-ditto-	T.Mulipukwa	
Hydro.Analyst	Phase 1	M.Watanabe	C.Chileshe	Mrs.Mwelwa
	2	-ditto-	-ditto-	-ditto-
	3	-ditto-	-ditto-	-ditto-
Hydrologist	Phase 1	H.Kanamura	B.Silungue	Miss.Sanjase
	2	T.Watanabe	-ditto-	S.Z.Sakala
	3	-ditto-	-ditto-	W.Chisala
Hydrogeologic Analyst	Phase 1			
	2	H.Oura	A.Maseka	
	3			
Topographic Survey	Phase 1	Y.Ishigami	H.Shikazwe	
	2			
	3			
Water Quality	Phase 1			
	2	T.Oshio	R.C.Mulenga	L.Mwitwa
	3			

The transfer of knowledge was carried out through the scope and contents of work by each phase by the use of explanation, discussion, questions, etc.. Details will be described as follows.

## 2.1 Phase 1

Period : Dec.1989 - Mar.1990

---

- (1) Establishment of Hydrometric Reference Point
  - Selection of Hydrometric Observation Points
  - Collection and Arrangement of Existing Data
- (2) Observation Network
  - Establishment of Hydrological Observation Team
- (3) Execution of Topographic Survey
  - Leveling Survey for Establishment of Bench Mark
  - Cross Sectional Survey of River
  - Relative Position Survey between Bench Mark and Base Point
  - Leveling Survey for Water Level Gauge
- (4) Installation and Adjustment of Observation Stations
  - Installation of Automatic Water Level Recorder (6 stations)
  - Adjustment of Automatic Level Recorder (Float Type and Pressure Type)
- (5) Hydrologic Observation in Study Area
  - Establishment of Hydrological Observation Teams (Refer to Fig.-2.1)
  - Demonstration of Discharge Measurement Method
- (6) Preparation of Hydrologic Database
  - <Data Filing System>
    - Daily River Water Level
    - Flow Measurement Data by Measurement
    - Flow Measurement Data by Station
  - <Data Analyzing System>
    - Flow Measurement Data
    - Daily and Monthly Discharge
    - River Flow Pattern
- (7) Training Course in Japan
  - Introduction of Water Resources in Japan
  - Visit to Dam Sites
  - Hydrological Observation System in Japan
- (8) Preparation of Progress Report (1)
- (9) Biweekly Meeting
  - Advice for Hydrological Observation Technics
  - Preparation of Discharge Measurement Trip
  - Calculation of Discharge Observation Results in the Field

## 2.2 Phase 2

Period : May 1990 - Mar.1991

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- (1) Hydrologic Observation in Study Area
  - Technical advice for Discharge Observation during Rainy Season in the Field
- (2) Observation Well
  - Measurement Method of Well Water Level in the Field
- (3) Investigation of Water Quality
  - Demonstration in the field
  - Test in Laboratory
  - Consideration of Results
- (4) Study of Existing Hydrologic Observation Data
  - Input Method using a computer
  - Output Method using a computer
- (5) Collection and Analysis of Existing Reservoir Data
  - Calculation of Inflow, Outflow, Rainfall and Evaporation using Existing Data
  - Graphic Analysis Method using a computer
- (6) Preparation of Hydrologic Database
  - <Data Filing System>
    - Daily River Water Level
    - Hourly River Water Level
    - Daily Well Water Level
    - Flow Measurement Data by Measurement
    - Flow Measurement Data by Station
    - Daily Well Water Level
  - <Data Analyzing System>
    - Discharge Rating Curve (Type-1)
    - Discharge Rating Curve (Type-2)
    - Dairy and Monthly Discharge
    - Hourly Discharge
    - Discharge Correlation Analysis
    - Flow Regime
    - River Water Balance
    - Reservoir Water Balance
    - Correlation between River and Well Water Level
- (7) Computer Training
  - Computer Operating System
  - Calculation using Lotus 1-2-3 software
- (8) Training Course in Japan
  - Introduction of Water Resources in Japan
  - Visit to Dam Sites
  - Hydrological Observation System in Japan
- (9) Meeting on Interim Report

- (10) Preparation of Progress Report (2)
- (11) Biweekly Meeting
  - Advice for Hydrological Observation Technics
  - Preparation of Discharge Measurement Trip
  - Calculation of Discharge Observation Results in the Field

### 2.3 Phase 3

Period : June 1991 - Mar.1992

---

- (1) Hydrologic Observation in Study Area
  - Technical Advice for Discharge Measurement in the Field
- (2) Collection and Analysis of Existing Reservoir Data
  - Calculation of Inflow, Outflow, Rainfall and Evaporation using Existing Data
  - Graphic Analysis Method using a computer
- (3) Analysis of River Flow using Database
  - <Data Filing System>
    - Daily River Water Level
    - Hourly River Water Level
    - Daily Well Water Level
    - Flow Measurement Data by Measurement
    - Flow Measurement Data by Station
    - Daily Well Water Level
  - <Data Analyzing System>
    - Discharge Rating Curve (Type-1)
    - Discharge Rating Curve (Type-2)
    - Daily and Monthly Discharge
    - Hourly Discharge
    - Discharge Correlation Analysis
    - Flow Regime
    - River Water Balance
    - Reservoir Water Balance
    - Correlation between River and Well Water Level
- (4) Computer Training
  - Computer Operating System
  - Calculation using Lotus 1-2-3 software
- (5) Preparation of a Master Plan for Hydrologic Observation Systems
  - Discussion for Organization of DWA
  - Observation Network Plan
- (6) Special Lecture for a Hydrologic Database System
  - Demonstration for Hydrological Database System to Technician in DWA
- (7) Meeting on Draft Final Report
  - Explanation and Discussion of results of the Study

### 3. TRAINING COURSE IN JAPAN

In order to understand the situation of hydrological engineering in Japan and to give trainees a fundamental and professional knowledge of hydrological engineering.

Two training courses were arranged by JICA as shown in Table-3.1.

Table-3.1 Training Course in Japan

	Phase 1	Phase 3
Period of Training	One month 19/Mar/90 - 20/Apr/90	One Month 20/May/91 - 19/Jun/91
Name of Trainee	Deputy Director Mr. L.L.Mbumwae	Water Engineering Assistant Mr.J.Mwanza and Mr.H.Sikazwe
Contents of Training	<ul style="list-style-type: none"> <li>-Hydrological Observation System in Japan</li> <li>-Use of Computer in Hydrological Data Processing and Analysis</li> <li>-Modern Water Resources Developments in Hydraulic Power, Irrigation and Water Supply</li> <li>-Land and Water Management Schemes</li> <li>-Hydropower, Dams, and Other Facilities in Japan</li> <li>-Introduction of Hydrological Equipment in Japan</li> <li>-Introduction of Water Development Plan in Japan</li> <li>-Discussion of Water Development Plan in Zambia</li> </ul>	

#### 4. SPECIAL LECTURES

The special lecture, as integral part of transfer of technical knowledge, was carried out to mainly engineers and technicians who were not involved in the Project by Japanese Expert during Phase 3.

The lecture consists of the following three (3) subjects;

<u>Subject</u>	<u>Lecture</u>
- Outline of the Study	T.Watanabe
- Basic operation know-how for computer	-ditto-
- Hydrological Database System	-ditto-

## 5. ACHIEVEMENT

The technical transfer through the Study (from Dec/1989 to Mar/1992) was given to the Zambian counterparts, the related engineers and technicians of the Project by the Japanese Experts in each engineering field.

The main targets for the technical transfer on each Phase were shown as follows;

### <Phase 1 & 2>

To become skillful in hydrological observation skill in the Field for hydrologist, assistant engineers and technicians.

### <Phase 3>

To become skillful in hydrological data arrangement and hydrological analysis using a computer for chief hydrologists and hydrologists.

Thus, technical transfer became skillful in each engineering field. The items of achievement are shown as follows;

### <Phase 1>

- 1) Topographic Survey
- 2) Installation and Adjustment of Automatic Level Recorder
- 3) Discharge Measurement Technic in the field
- 4) Study of Water Resources Plan in Japan

### <Phase 2>

- 1) Discharge Measurement Technic in the field
- 2) Investigation and Measurement of Well Water Level
- 3) Basic Arrangement for Hydrological Observation Data using a computer
- 4) Collection and analysis for Existing Reservoir Data
- 5) Study of Advance Hydrological Observation Plan in Japan

### <Phase 3>

- 1) Practical Arrangement for Hydrological Observation Data using a computer
- 2) Analysis of River Flow using a computer



## 6. CONTINUATION OF HYDROLOGICAL OBSERVATION

### (1) The Point at Issue

There are some problems awaiting solution in hydrological section in DWA. Attention is first directed to manage the following activities;

- 1) Continuation of hydrological observation
- 2) Improvement of data processing and archiving
- 3) Repletion of hydrological analysis knowledge
- 4) Maintenance of equipment and station
- 5) Realization of inside staff training
- 6) Publication of Hydrological Year Book

And other problems awaiting improvement are as follows;

- 1) Organization and responsibilities
- 2) Observation frequency
- 3) Observation stations

### (2) Continuation of Hydrological Observation in the Field

Almost all the field activities for hydrological observation are carried out by the observation team in Regional Hydrological Office. In order to reinforce the team, the following shall be carry out;

- Improvement of the technical level of the team leaders
- Supply of necessary transport and equipment for hydrological observation
- Assignment of back-up personnel for each gauge reader to avoid lack of data due to gauge reader unavailability
- Improvement of maintenance technology in Regional Office

### (3) Continuation of Hydrological Database

To continue the present system for hydrological analysis, DWA Hydrological Section should apply the following hydrological database using computer.

- Advance technic for computer operation
- Data processing of discharge measurement
- Preparation of discharge rating curve
- Preparation of W/L - discharge table
- Calculation of discharge correlation
- Calculation of station's flow regime
- Calculation of river flow analysis
- Assignment of back-up personnel for computer operator



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Appendix - B

S C O P E O F W O R K



SCOPE OF WORK

FOR

THE MASTER PLAN STUDY

ON

HYDROLOGIC OBSERVATION SYSTEMS

OF

THE MAJOR RIVER BASINS

IN

ZAMBIA


AGREED UPON BETWEEN

MINISTRY OF WATER, LANDS AND NATURAL RESOURCES

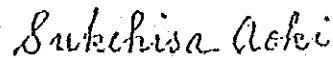
AND

JAPAN INTERNATIONAL COOPERATION AGENCY.

Lusaka, 26th November, 1980

  
Mr. C.J. Ng'wane

Acting Permanent Secretary  
Ministry of Water, Lands  
and Natural Resources



Mr. Sukehisa AOKI  
Team Leader of  
Preliminary Survey Team  
Japan International  
Cooperation Agency

## 1. INTRODUCTION

In response to the request of the Government of the Republic of Zambia (hereinafter referred to as "the Government of Zambia"), the Government of Japan has decided to implement the Master Plan Study on Hydrologic Observation Systems of the Major River Basins (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 programs of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Zambia.

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

## 2. OBJECTIVE OF THE STUDY

The objective of the study is to strengthen the hydrologic observation systems of the Zambezi and Kafue river basins in Zambia in order to utilize the data for future water resources development planning.

## 3. STUDY AREA

The study area will cover the Zambezi and Kafue River Basins

## 4. SCOPE OF THE STUDY

The Study shall include the followings:

### PART A: DATA COLLECTION AND REVIEW

- 1) national and regional socio-economy;
- 2) topographic and geology;
- 3) hydrology and meteorology;
- 4) water resources, water quality and water supply plan;
- 5) existing hydrologic and meteorologic facilities;
- 6) population and economic activities in the areas;
- 7) previous studies; and

B. A. J

- 8) others.

#### PART B: FIELD SURVEY

- 1) field reconnaissances
  - a. topography and geology;
  - b. water quality;
  - c. existing dams and reservoirs; and
  - d. existing observation stations.
- 2) survey
  - longitudinal profile and cross-section survey at selected observation points

#### PART C: INSTALLATION PLAN OF OBSERVATION FACILITIES, AND DATA PROCESSING

- 1) Installation planning in the basins;
- 2) Installation of facilities in the selected areas; and
- 3) Data processing

#### PART D: FORMULATION AND EVALUATION

- 1) Master Plan
  - a. data analysis, and
  - b. basin-wide network plan
- 2) Project evaluation
  - a. project evaluation; and
  - b. recommendations.

#### 5. STUDY SCHEDULE

The Study, in principle, shall be carried out in accordance with the tentative schedule shown in the attached sheet.

#### 6. REPORTS

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

- (1) Inception Report

S. U. J. A.

Twenty (20) copies at the commencement of the work in Zambia.

(2) Progress Report (1)

Twenty (20) copies within four (4) months after the commencement of the Study.

(3) Interim Report

Twenty (20) copies within fifteen (15) months after the commencement of the Study.

(4) Progress Report (2)

Twenty (20) copies within twenty-three (23) months after the commencement of the Study.

(5) Draft Final Report

Twenty (20) copies within twenty-eight (28) months after the commencement of the Study.

The Government of Zambia shall submit their comments within thirty (30) days after receipt of the Draft Final Report.

(6) Final report

Thirty (30) copies within thirty (30) days after the receipt of the comments on the Draft Final Report.

7. UNDERTAKINGS OF THE GOVERNMENT OF ZAMBIA

1. To facilitate smooth conduct of the Study, The Government of Zambia shall take following necessary measures:

- (1) to secure the safety of the Japanese Study Team;
- (2) to permit the members of the Japanese Study Team to enter, leave and sojourn in Zambia for the duration of their assignment therein, and exempt them from alien registration requirements 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 Zambia for the conduct of the Study;

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- (4) to exempt the members of the Japanese Study Team from Income tax and other charges of any kind imposed on or in connection with any emolument or allowance 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 remittance as well as utilization of the funds introduced into Zambia from Japan in connection with the implementation of the Study;
  - (6) to secure permission for entry into private properties or restricted area for the conduct of the Study;
  - (7) to secure permission to take data and documents (including photographs) related to the Study out of Zambia to Japan by the Japanese Study Team; and
  - (8) to provide medical services as needed and its expenses will be chargeable on the members of the Japanese Study Team.
2. The Government of Zambia 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 from gross negligence or willful misconduct on the part of the members of the Japanese Study Team.
  3. Department of Water Affairs, Ministry of Water, Lands and Natural Resources, the Government of Zambia (hereinafter referred as "DWA") shall act as counterpart agency to the Japanese Study Team and also coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.
  4. DWA shall, at its own expense, provide the Japanese Study Team with the following, if necessary, in cooperation with other relevant organizations:
    - (1) available data and information related to the Study;
    - (2) counterpart personnel;
    - (3) suitable office space with necessary equipment in survey area; and

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(4) credential or identification cards;

B. UNDERTAKINGS OF JICA

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

- (1) to dispatch, at its own expense, a study team to Zambia, and
- (2) to pursue technology transfer to the Zambian counterpart personnel in the course of the Study.

9. CONSULTATION

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

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ATTACHMENT

Tentative schedule:


Time flow	1988												1989												1990												1991																							
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11																							
Surveys	=																																																											
Preliminary survey	=																																																											
Planning of implementation program	=																																																											
Data collection and review	=												=																																															
Field survey	=												=																																															
Installation planning													=																																															
Installation plan													=																																															
Installation													=																																															
data collection and processing													=																																															
Formulation and evaluation													=												=												=																							
Reports	A <sup>1</sup> IC/R												A <sup>1</sup> P/R(1)												A <sup>1</sup> IT/R												A <sup>1</sup> P/R(2)												A <sup>1</sup> O <sup>1</sup> F/R											

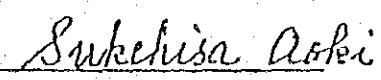
(REMARKS) IC/R: Inception Report P/R(1), (2): Progress Report(1), (2)  
 IT/R: Interim Report DF/R : Draft Final Report  
 O: SOSS : Final Report

work in Zambia =  
 work in Japan =

MINUTES OF MEETING  
ON  
THE MASTER PLAN STUDY  
ON  
HYDROLOGIC OBSERVATION SYSTEMS  
OF  
THE MAJOR RIVER BASINS  
IN  
ZAMBIA  
BETWEEN  
JICA PRELIMINARY SURVEY TEAM  
AND  
MINISTRY OF WATER, LANDS AND NATURAL RESOURCES

Lusaka, November 26th, 1988

  
\_\_\_\_\_  
L.L. Mbumwae  
Deputy Director  
DEPARTMENT OF WATER AFFAIRS  
Ministry of Water, Lands and  
Natural Resources

  
\_\_\_\_\_  
Mr. Sukehisa AOKI  
Team Leader  
Preliminary Survey Team  
Japan International  
Cooperation Agency

## 1. INTRODUCTION

In response to the request of the Government of the Republic of Zambia (hereinafter referred to as "the Government of Zambia"), the Government of Japan has decided to implement the Master Plan Study on Hydrologic Observation Systems of the Major River Basins (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 programs of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Zambia.

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

## 2. OBJECTIVE OF THE STUDY

The objective of the study is to strengthen the hydrologic observation systems of the Zambezi and Kafue river basins in Zambia in order to utilize the data for future water resources development planning.

## 3. STUDY AREA

The study area will cover the Zambezi and Kafue River Basins

## 4. SCOPE OF THE STUDY

The Study shall include the followings:

### PART A: DATA COLLECTION AND REVIEW

- 1) national and regional socio-economy;
- 2) topographic and geology;
- 3) hydrology and meteorology;
- 4) water resources, water quality and water supply plan;
- 5) existing hydrologic and meteorologic facilities;
- 6) population and economic activities in the areas;
- 7) previous studies; and.

*S. A., Jk*

DWA answered that, regarding increased gauging stations and equipment a request be forwarded to JICA for financial assistance in this respect.

4. The Team requested that all hydrological observations shall be carried out with expense of DWA. DWA agreed on the matter.

5. The Team explained that at least three(3) four wheel drive type vehicles shall be provided by DWA for the study.

On this point, DWA emphasized that due to the current economical situation prevailing in the country it would be practically impossible to provide the vehicles. Therefore a request to purchase the above vehicles is forwarded to JICA.

6. The Team requested that DWA shall provide one adequately equipped office room in the DWA building and each one desk in Moingu and Kitwe offices. DWA agreed on the matter.

S.A.

LIST OF ATTENDANCE1. Zambian Side

<u>Name</u>	<u>Designation</u>	<u>Office</u>
1. Lewis L. Mbumwae	Deputy Director	Water Affairs Department
2. Evis M. Siamachoka	Principal Hydrologist	Water Affairs Department
3. T.N. Ngwira	Senior Engineering Assistant	Water Affairs Department

2. Japanese side

<u>Name</u>	<u>Designation</u>	<u>Office</u>
1. Aoki Sukehisa	Team Leader	Ministry of Construction
2. Kadomatsu Takeshi	Member (Hydrologic/ Hydraulic)	ditto
3. Ojiro Kazuaki	Member (River Planning)	ditto
4. Ito <sup>on</sup> Yaki	Member (Study Planning)	JICA <del>ditto</del>
5. Shirakawa Osamu	Member (Meteorologic/ Hydrological Matters)	INA Civil Engineering Consultants Co. Ltd.
6. Kojima Ryosuke	Asst. Resident of JICA Zambia	Representative

S. R. *[Signature]*





THE MASTER PLAN STUDY ON HYDROLOGIC OBSERVATION SYSTEMS  
OF THE MAJOR RIVER BASINS IN ZAMBIA

FINAL REPORT  
M A I N

Appendix - C

M I N U T E S   O F   M E E T I N G



MINUTES OF MEETING  
ON  
INCEPTION REPORT  
ON  
THE MASTER PLAN STUDY  
ON HYDROLOGIC OBSERVATION SYSTEMS  
OF  
THE MAJOR RIVER BASINS  
IN  
ZAMBIA

BETWEEN  
JICA STUDY TEAM  
AND  
DEPARTMENT OF WATER AFFAIRS  
MINISTRY OF WATER, LANDS AND NATURAL RESOURCES

December 19th, 1989

Lusaka, Zambia

*J*

*S.A.  
C.R.W.K.*

According to Scope of Work for the master plan study on hydrologic observation systems of the major river basins in Zambia (hereinafter referred to as "Study") agreed upon between Ministry of Water, Lands and Natural Resources, Republic of Zambia and Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA send the team headed by Mr. Yoshio NAKAGAWA for Study (hereinafter referred as "Study Team") on December 1st from Japan.

Study Team had preliminary discussions with Department of Water Affairs, Ministry of Water, Lands and Natural Resources (counterpart agency for Study, hereinafter referred to as "DWA") and prepared Inception Report on Study dealing with the policy & strategy, methodology, organization, work schedule and so on.

The meeting on Inception Report was held on December 18th at the office of DWA among DWA, Study Team and JICA Advisory Committee headed by Mr. Sukehisa AOKI. The attendants list is shown in Attachment.

Study Team gave detailed explanation on the report. After substantial discussion, Inception Report was accepted by DWA with the following mutual understanding.

#### (1) Hydrologic Observation Points

DWA gave the following comments on hydrologic observation points executed in Study. However, the final decision of hydrologic observation points in Study will be made after the field reconnaissance planned by Study Team and mutual discussion between Study Team and DWA.

<a> DWA recommends that the hydrologic observation in Study should be done at the points where the stations are existed and/or the observation is stopped due to the financial problems. Study Team will repair the existing stations in order to effectively utilize the previous data.

<b> DWA requests Study Team to carry out the supplementary hydrologic observation at the just-upstream point of Luangwa Road Bridge on Luangwa river so that the total outflow from the Luangwa basin is roughly estimated.

<c> DWA explained that it is necessary to perform hydrologic observation at the Kalabo in the tributary, Luanginga river, because of its wide catchment area and importance of its basin.

#### (2) Water Quality Investigation

DWA requested Study Team to execute more extensive investigation of water quality not limited to copper item. This request will be replied after Study Team receiving more detailed proposal from DWA and consulting with JICA Head Office.

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(3) Undertaking of DWA

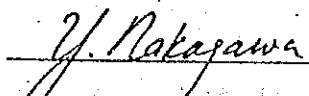
DWA will take prompt action in DWA's undertaking without delay according to the request from Study Team.

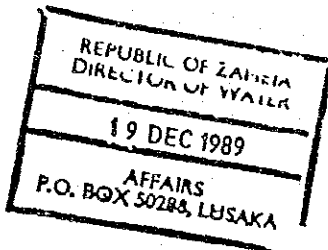
(4) Handing-Over of Study Equipment

JICA Side explained that the equipment for Study prepared by JICA will be handed over to DWA after completion of Study, if requested by DWA.

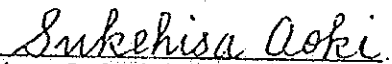
Agreed upon between

  
\_\_\_\_\_  
Mr. C.R.W. Kayombo  
Director  
Department of Water Affairs  
Ministry of Water, Lands and  
Natural Resources

  
\_\_\_\_\_  
Mr. Yoshio NAKAGAWA  
Team Leader  
JICA Study Team



Witnessed by

  
\_\_\_\_\_  
Mr. Sukehisa AOKI  
Chairman, JICA  
Advisory Committee

S a

J

ATTACHMENT: LIST OF ATTENDANTS

Japan International Cooperation Agency (JICA)

MR. S. AOKI	Chairman of Advisory Committee
MR. H. GOBOTA	Member of Advisory Committee
MR. E. CHO	Headquarters, Tokyo Japan
MR. Y. NAKAGAWA	Team Leader of Study Team
MR. M. WATANABE	Deputy Team Leader, & Hydrologic Analyst of Study Team
MR. H. KANAMURA	Hydrologist of Study Team

Department of Water Affairs (DWA)

MR. L.L. MBUMWAE	Deputy Director
MR. V.N. KASIMONA	Principal Hydrologist
MR. J.H. CHILO	Hydrologist
MRS. E.M. MWELWA	Hydrologist
MR. G. CHILESHE	Hydrologist
MR. B. SILUNGWE	Hydrologist
MISS. R.M. SANJASE	Hydrologist

Department of Meteorology

MR. W.K. SAKALA	Hydrometeorologist
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*J*

*S.A.*

*C.R.W.*

MINUTES OF MEETING  
ON  
INTERIM REPORT  
ON  
THE MASTER PLAN STUDY  
ON HYDROLOGIC OBSERVATION SYSTEMS  
OF  
THE MAJOR RIVER BASINS  
IN  
ZAMBIA

BETWEEN  
JICA STUDY TEAM  
AND  
DEPARTMENT OF WATER AFFAIRS  
MINISTRY OF WATER, LANDS AND NATURAL RESOURCES

November 13th, 1990

Lusaka, Zambia

*J.*  
*S.A.*

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According to the scope of work for "THE MASTER PLAN STUDY ON HYDROLOGIC OBSERVATION SYSTEMS OF THE MAJOR RIVER BASINS IN ZAMBIA (hereinafter referred to as "Study") agreed upon between Ministry of Water, Lands and Natural Resources, Republic of Zambia and Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA sent the team headed by Mr. Yoshio NAKAGAWA for Study (hereinafter referred to as "Study Team") on December 1st 1989 from Japan.

The Study is being implemented by the Study Team according to the Inception Report discussed on December 19th 1989 in cooperation with Department of Water Affairs, Ministry of Water, Lands and Natural Resources (counterpart agency for Study, hereinafter referred to as "DWA"). The Study Team prepared the Interim Report compiling the interim outcomes obtained throughout the Study up to the end of October 1990, and submitted the report to DWA on November 6th 1990.

The meeting on Interim Report was held on November 12th and 13th, 1990 at the office of DWA among DWA, Study Team, and JICA Advisory Committee headed by Mr. Sukehisa AOKI. The attendant list is shown in Attachment.

[1] The Study Team gave DWA the detailed explanation on the report. After discussion, Interim Report was accepted by DWA with the DWA's appreciation of Study's fruitful achievement and the following mutual understanding.

(1) Flow Measurement in Succeeding Period

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The frequency of flow measurement will be increased especially relating to such stations as ones which have few measurement data and ones which show discrepancy between measurement data and calculated discharge using the rating curve tentatively established in Interim Report.

(2) Interpretation of Water Quality

---

Not only test results obtained in this dry season and the next rainy season through the Study but also periodic water quality data being monitored by the government organization will be taken into consideration in the final interpretation of water quality test.

(3) Review of Rating Curves and Recalculation of Discharge

---

The discharge rating curves tentatively employed in Interim Report will be reviewed considering flow measurement data newly obtained in the succeeding period of Study. Using these reviewed discharge rating curves, the discharge at each station and river water balance will be recalculated.

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[2] Through the discussion of meeting, DWA, evaluating the useful achievement of Study, expressed the following requests to JICA. JICA side promised DWA to deliver the requests to JICA Head Office and recommended DWA to take formal aid procedure to realize the requests.

a) Following up Assistance

After completion of the Study, DWA requests JICA to continue financial and technical assistance to follow up DWA's activities in hydrological observation for a few years.

b) Training Components


In this Study, technical transfer of hydrologic observation and analysis are being carried out. DWA needs another component of technical training from JICA in the fields of planning, designing and construction regarding water resources development.

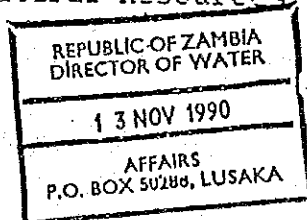
c) Comprehensive Study on Water Resources Development

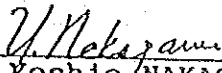
DWA recognizes that the water demand of domestic water use and irrigation etc. is increasing in Zambia and that the final outcome of this Study (outline of water resources potential) is useful for planning water resources development. Considering these situations, DWA wishes to start preparation of nation-wide water resources development master plan, in technical cooperation with JICA.

[3] In addition to the above descriptions, JICA side informed DWA that JICA can accept the training schedule in Japan for two trainees from DWA for about one month from the beginning of the next year, and DWA accepted it.

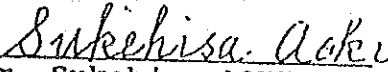
Agreed upon between

  
Mr. L.L. Mbunwae  
Acting Director  
Department of Water Affairs  
Ministry of Water, Lands and  
Natural Resources



  
Mr. Yoshio NAKAGAWA  
Team Leader  
JICA Study Team

Witnessed by

  
Mr. Sukehisa AOKI  
Chairman, JICA  
Advisory Committee

ATTACHMENT: LIST OF ATTENDANTS

Japan International Cooperation Agency (JICA)

---

MR. S. AOKI	Chairman of Advisory Committee
MR. T. FUKUDOME	Member of Advisory Committee
MR. E. CHO	Headquarter, Tokyo Japan
MR. Y. NAKAGAWA	Team Leader of Study Team
MR. M. WATANABE	Deputy Team Leader, & Hydrologic Analyst of Study Team
MR. H. KANAMURA	Hydrologist of Study Team
MR. T. WATANABE	Hydrologist of Study Team

Department of Water Affairs. (DWA)

---

MR. L.L. MBUMWAE	Acting Director
MR. J.J. MAK.WAYA	Acting Deputy Director
MR. V.N. KASIMONA	Principal Hydrologist
MR. M.M. MULIPUKAWA	Acting Principal Hydrologist
MR. C. CHILESHE	Officer in Charge in Hydrological Section
MRS. E.M. MWELWA	Hydrologist
MR. B. SILUNGWE	Hydrologist
MR. O.L. SANGULUBE	Senior Hydrogeologist

JICA ZAMBIA OFFICE

---

MR. K.TOMITA	Representative
--------------	----------------

*J*  
*S.A.*

*Ullman*

MINUTES OF MEETING  
ON  
DRAFT FINAL REPORT  
ON  
THE MASTER PLAN STUDY  
ON HYDROLOGIC OBSERVATION SYSTEMS  
OF  
THE MAJOR RIVER BASINS  
IN  
ZAMBIA

BETWEEN  
JICA STUDY TEAM  
AND  
DEPARTMENT OF WATER AFFAIRS  
MINISTRY OF ENERGY AND WATER DEVELOPMENT

February 26th, 1992

Lusaka, Zambia

CP  
(10)

According to the scope of work for "THE MASTER PLAN STUDY ON HYDROLOGIC OBSERVATION SYSTEMS OF THE MAJOR RIVER BASINS IN ZAMBIA (hereinafter referred to as "Study") agreed upon between Ministry of Water, Lands and Natural Resources (present Ministry of Energy and Water Development), Republic of Zambia and Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA sent the team headed by Mr. Yoshio NAKAGAWA for the Study (hereinafter referred to as "Study Team") on December 1st 1989 from Japan.

The Study has been implemented by the Study Team according to the Study program agreed upon in the Inception Report Meeting held on December 19th 1989 in cooperation with Department of Water Affairs, Ministry of Energy and Water Development (counterpart agency for the Study, hereinafter referred to as "DWA"). The Study Team prepared the Draft Final Report compiling all the outcomes obtained throughout the Study, and submitted the report to DWA on February 17th 1992.

The Study Team had a series of meetings with DWA to explain and discuss the results of the Study. The official meeting on the Draft Final Report was held on February 24th 1992 at the meeting room of Pamodzi Hotel, Lusaka among DWA, Study Team, and JICA Advisory Committee headed by Mr. Takashi KADOMATSU. The attendant list is shown in Attachment. The meeting concluded as follows:

[1] The Study Team gave DWA the detailed explanation on the report. After discussion, Draft Final Report was accepted by DWA with the DWA's appreciation of Study's useful achievement.

[2] The Draft Final Report accepted by DWA will be finalized by the Study Team with the following revisions, and be submitted to DWA until the end of March 1992.

- 1) To record the activities of DWA's counterpart personnel, the description of each counterpart's duty is given in the organization chart of the Study.
- 2) Typographical errors and ambiguous words are corrected.

[3] After the discussion on the report of the Study, DWA expressed the following requests to JICA. The Study Team and Advisory Committee promised DWA to deliver the requests to JICA Head Office, Tokyo.

1) Following-up of the Second Phase Study

-----  
DWA submitted the official request through NCDP to the Japanese Embassy for the technical aid of the National Water Master Plan Study which is the essential component to realize the schematic water development project in Zambia. At the moment, DWA has no response back on this from the Japanese Embassy. DWA requests JICA to follow up this matter as to commence the Master Plan Study as soon as possible.

2) Dispatch of JICA Expert

DWA recognizes that it is very important to reinforce the abilities of hydrological observation and water planning and design in DWA. DWA requests JICA to dispatch a JICA expert to give assistance and advice in this field.

3) Training Program

In this Study, technical transfer of hydrologic observation and analysis has been carried out. DWA makes much of this kind of training. DWA needs another component of technical training from JICA in the fields of planning, designing and construction regarding water resources development.

Agreed upon between

*[Handwritten signature]*

Mr. L.L. Mbunwae  
Director  
Department of Water Affairs  
Ministry of Energy and  
Water Development

REPUBLIC OF ZAMBIA  
DIRECTOR OF WATER  
26 FEB 1992  
AFFAIRS  
P.O. BOX 50288, LUSAKA

*[Handwritten signature]*  
Mr. Yoshio NAKAGAWA  
Team Leader  
JICA Study Team

Witnessed by

*[Handwritten signature]*  
Mr. Takeshi KADOMATSU  
Chairman, JICA  
Advisory Committee

*[Handwritten initials]*  
*[Handwritten initials]*

ATTACHMENT: LIST OF ATTENDANTS

Japan International Cooperation Agency (JICA)

---

MR. T. KADOMATSU	Chairman of Advisory Committee
MR. H. GOBOTA	Member of Advisory Committee
MR. T. NISHINO	Head Office, Tokyo
MR. Y. NAKAGAWA	Team Leader of Study Team
MR. M. WATANABE	Deputy Team Leader, & Hydrologic Analyst of Study Team
MR. T. WATANABE	Hydrologist of Study Team

Department of Water Affairs (DWA)

---

MR. L.L. MBUMWAE	Director
MR. M.M. MULIPUKWA	Principal Hydrologist
MR. C. CHILESHE	Officer in Charge in Hydrological Section
MRS. E.M. MWELWA	Hydrologist
MR. H. SIKAZWE	Regional Hydrological Officer
MR. R. MULENGA	Chemist
MR. V.N. KASIMONA	Project Coordinator of UNDP/WMO Project









