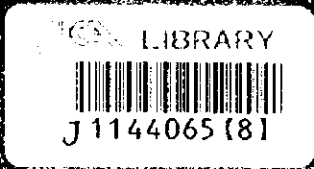


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF ECONOMIC COOPERATION
RESEARCH AND ECONOMIC RESEARCH CENTER OF JAPAN

WORLD SITUATION
ON
ALBANI ABASA PREGED CONTROL PERODISCI
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ALBANIA

GENERAL REPORT
NO. 198 IN
SPECIAL REPORT FOR RESEARCH
OF
ECONOMIC RESEARCH
CENTER OF JAPAN

March 1983



ALBANIAN ECONOMIC RESEARCH
CENTER OF JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
REGION 14 ADMINISTRATION
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

FINAL REPORT
VOLUME IV
SUPPORTING REPORT
OF
PHASE II STUDY
(FEASIBILITY STUDY)

MAY 1998

NIPPON KOEI CO., LTD.
NIKKEN CONSULTANTS, INC.

LIST OF REPORTS

- EXECUTIVE SUMMARY (*In Japanese*)
- VOLUME I EXECUTIVE SUMMARY (*In English*)
- VOLUME II MAIN REPORT (*In English*)
- VOLUME III SUPPORTING REPORT OF PHASE I STUDY
(MASTER PLAN STUDY) (*In English*)
- VOLUME IV SUPPORTING REPORT OF PHASE II STUDY
(FEASIBILITY STUDY) (*In English*)
- VOLUME V DATA BOOK (*In English*)



1144065 [8]

Applied Exchange Rate US\$ 1.0 = Birr 6.8 = Japanese Yen 114.7 (As of June 1997)
--

**THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

**SUPPORTING REPORT
OF
PHASE II STUDY
(FEASIBILITY STUDY)**

TABLE OF OVERALL CONTENTS

- CHAPTER 1 : INTRODUCTION**
- CHAPTER 2 : PRESENT CONDITION OF PROJECT AREA**
- CHAPTER 3 : RIVER AND ROAD SURVEY**
- CHAPTER 4 : FLOOD CONTROL PLAN**
- CHAPTER 5 : URBAN DRAINAGE PLAN**
- CHAPTER 6 : DESIGN OF FACILITIES**
- CHAPTER 7 : CONSTRUCTION PLAN AND COST ESTIMATE**
- CHAPTER 8 : ORGANIZATION AND INSTITUTION**
- CHAPTER 9 : PROJECT COST**
- CHAPTER 10 : SOCIAL AND ENVIRONMENTAL ASSESSMENT**
- CHAPTER 11 : ECONOMIC EVALUATION**
- CHAPTER 12 : IMPLEMENTATION PLAN**

**THE STUDY ON ADDIS ABABA
FLOOD CONTROL PROJECT**

CHAPTER 1

INTRODUCTION

**THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

CHAPTER 1 INTRODUCTION

Contents

1. INTRODUCTION	1-1
1.1 General	1-1
1.2 Composition of Report	1-1

1. INTRODUCTION

1.1 General

This is the Supporting Report of the Phase II Study (Feasibility Study) for the Study on Addis Ababa Flood Control Project in the Federal Democratic Republic of Ethiopia. This Report is prepared in accordance with the Scope of Works for the said Study agreed on October 11, 1996 between the Region 14 Administration of the Government of Ethiopia and the Japan International Cooperation Agency (JICA) responsible for the implementation of technical cooperation programs of the Government of Japan.

1.2 Composition of Supporting Report

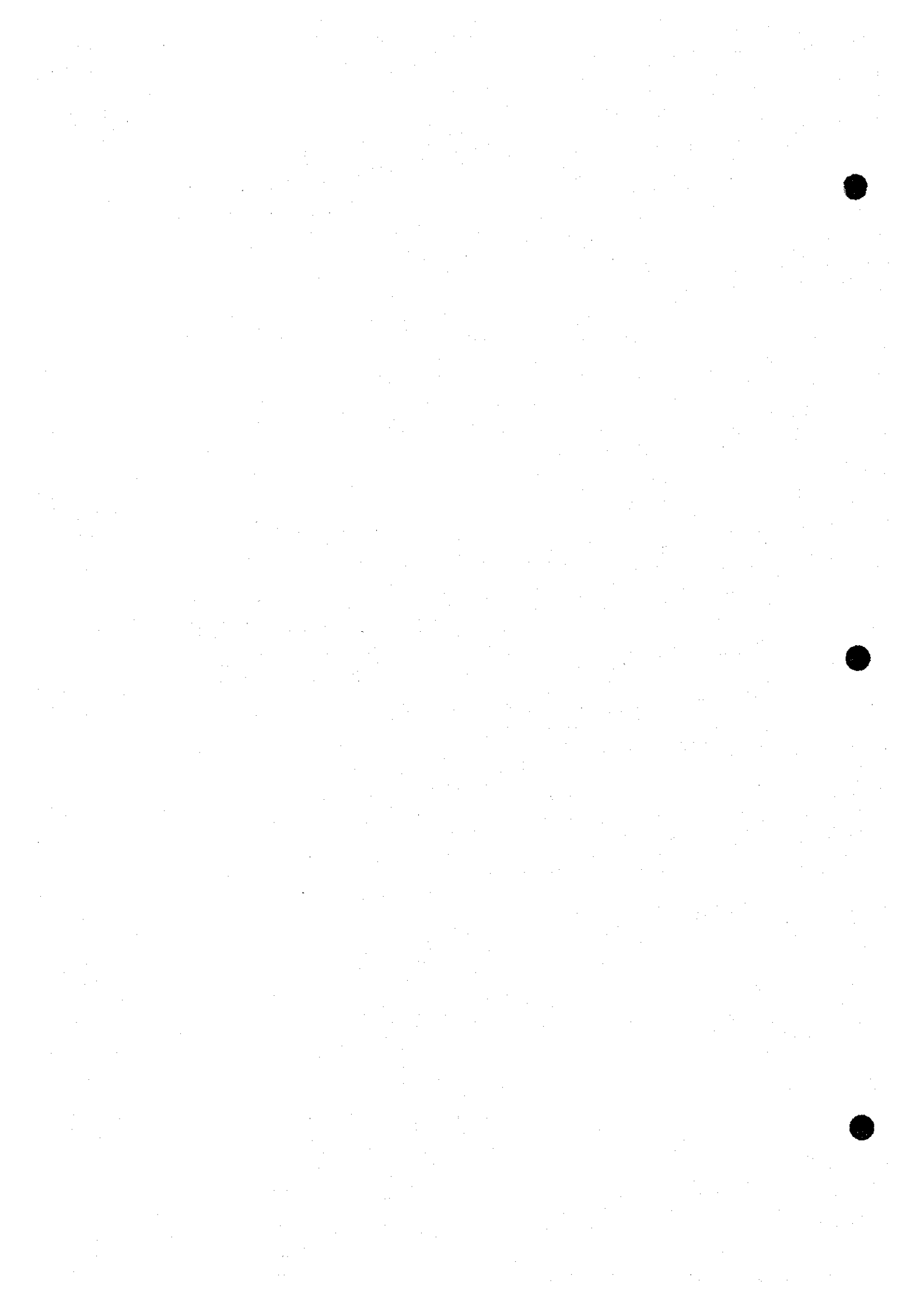
The composition of this Supporting Report of the Phase II Study (Feasibility Study) is as follows.

CHAPTER 1	: INTRODUCTION
CHAPTER 2	: PRESENT CONDITION OF PROJECT AREA
CHAPTER 3	: RIVER AND ROAD SURVEY
CHAPTER 4	: FLOOD CONTROL PLAN
CHAPTER 5	: URBAN DRAINAGE PLAN
CHAPTER 6	: DESIGN OF FACILITIES
CHAPTER 7	: CONSTRUCTION PLAN AND COST ESTIMATE
CHAPTER 8	: ORGANIZATION AND INSTITUTION
CHAPTER 9	: PROJECT COST
CHAPTER 10	: SOCIAL AND ENVIRONMENTAL ASSESSMENT
CHAPTER 11	: ECONOMIC EVALUATION
CHAPTER 12	: IMPLEMENTATION PLAN

**THE STUDY ON ADDIS ABABA
FLOOD CONTROL PROJECT**

CHAPTER 2

**PRESENT CONDITION OF
PROJECT AREA**



**THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

CHAPTER 2 PRESENT CONDITION OF PROJECT AREA

Contents

2. PRESENT CONDITION OF PROJECT AREA	2-1
2.1 Rivers and Related Structures	2-1
2.1.1 General.....	2-1
2.1.2 Present Conditions of Rivers and Related Structures.....	2-1
2.1.3 Calculated Water Levels for Various Probable Floods.....	2-9
2.2 Urban Drainage	2-10
2.2.1 General.....	2-10
2.2.2 Northern Basin	2-10
2.2.3 Eastern Basin.....	2-11
2.2.4 West-Southern Basin	2-13
2.3 Social and Environmental Condition	2-16
2.3.1 Bantiyketu River.....	2-16
2.3.2 Bantiyketu Regulating Pond Site.....	2-17
2.3.3 Kostre Regulating Pond Site.....	2-18
2.3.4 Kechene Weir Site	2-19

List of Tables

2.1.1	Inventory of Existing Facilities in Riparian Areas	2-20
-------	--	------

List of Figures

2.1.1	Location Map on Existing Facilities Along Bantiyketu River	2-23
2.1.2	Features of Lower Kebena and Bantiyketu Rivers	2-29
2.1.3	Features of Lower Kechene River	2-30
2.1.4	Location Map of Proposed Site of Kostre Regulating Pond	2-31
2.1.5	Location Map of Proposed Site of Kechene Weir	2-32
2.1.6	Features of Upper Kechene Rivers	2-33
2.1.7	Longitudinal Profile - Kebena River	2-34
2.1.8	Longitudinal Profile - Bantiyketu River (1/2)	2-35
2.1.9	Longitudinal Profile - Bantiyketu River (2/2)	2-36
2.1.10	Longitudinal Profile - Kechene River (1/2)	2-37
2.1.11	Longitudinal Profile - Kechene River (2/2)	2-38
2.2.1	Objective Area of Urban Drainage Improvement	2-39
2.2.2	Outline of Existing Urban Drainage System	2-40
2.2.3	Location Map of Street Inlets around Abiot Square	2-41

2. PRESENT CONDITION OF PRIORITY PROJECT AREA

2.1 Rivers and Related Structures

2.1.1 General

A reconnaissance of the priority projects area was made in the initial stage of the second work in Ethiopia for Phase 2 Study. Objective rivers of the site reconnaissance are as follows.

- Lower Kebena river : Bole railway bridge to confluence with the Bantiyketu river,
- Bantiyketu river : Confluence with the Kebena to Finfine bridge including Bantiyketu Regulating pond site,
- Lower Kechene river: Filwiha bridge to upstream of 4th bridge (2.8 km),
- Lower Kostre river: Kostre retarding pond site, and
- Upper Kechene river: Kechene weir site.

2.1.2 Present Conditions of Rivers and Related Structures

Figure 2.1.1 shows a location map of rivers and related structures. The river profiles and dimensions of the structures are shown in Figures 2.1.2 to 2.1.3 and Table 2.1.1, respectively.

(I) Lower Kebena River

A total length of this reach from Bole bridge to the confluence of the Bantiyketu is around 0.8 km. Major river channel conditions of this reach are summarized below.

Reach	Length (m)	Average gradient of river bed	Width/depth (m)
Bole bridge – Confluence with Bantiyketu	812	1/100	25/8

In this reach, ground elevations of the left bank is entirely low than those of the right. Floods that exceed the channel capacity are accordingly subject to overflow towards the left riparian areas. There are many houses on the left bank however these houses have

been protected by floodwall. The river channel just upstream of the Bole bridge is prone to bank erosion.

Major existing river and related structures are summarized as follows:

- Floodwalls,
- Railway bridge (1 bridge),
- Road bridge (1 bridge),
- Sewerage pipe with manholes, and
- Water supply pipe.

(2) Bantiyketu River

A total length of the Bantiyketu river from the confluence to the Filwiha bridge is around 4.5 km. Major river channel features of the Bantiyketu are as follows.

Reach	Length (m)	Average gradient of river bed	Width/depth (m)
Confluence with Kebena – Intake weir	608	1/150	18/5
Intake weir – Bantiyketu bridge	1,916	1/150	20/5-3
Bantiyketu bridge – Finfine bridge	658	1/115	25/3
Finfine bridge – Filwiha bridge	12,68	1/140	18/4

1) Confluence to Intake Weir

The left bank of this reach is low lands and utilized as vegetable fields. Water for the vegetable fields is supplied through an existing intake weir. There is no house in the riparian areas in this reach.

2) Intake Weir to Bantiyketu Bridge

There exists a natural retarding basin in the upstream of the intake weir. A part of the retarding basin in the left bank is designated as a city park. The natural retarding basin

is to be kept as it is at the present condition. Such natural retarding basin functions as a buffer in the emergency case especially towards the lower reaches.

Around an aqueduct with foot-pass in the upper part of this reach, river width has been considerably constricted. The flood flow is subject to overflow towards the right side that is low lands and residential area extends over.

3) Bantiyketu Bridge to Finfine Bridge

In this reach of the Bantiyketu, there exist many houses on the right riparian area. Such houses are prone to flooding. On the other hand, a continuous floodwall on the left has been constructed to protect ECA area. There exists a drainage culvert from ECA area at the middle point of this reach.

The photo below shows a view just upstream from the Bantiyketu bridge.



4) Finfine Bridge to Filwiha Bridge

The dense building complexes locate on the left bank of this reach. Complexes have been privately guarded by floodwalls. However, there exist portions prone to

overtopping. Accordingly, flood flow that exceeds channel capacity overtops towards the right riparian areas through these portions.

A drainage culvert from the right riparian area is joined with the Bantiyketu just downstream of the 7th bridge in Ghion Hotel area. The size of the culvert is around 2.7 m in high and 2.7 m in wide.

Just upper point of the bridge (9th bridge) to Ghion Hotel, a building laid across the river channel is being constructed. The works are to provide 2 lanes-box culvert having a dimension of 7 m in high, 6.5 m in wide and 75 m in long per each. The flow area of the culverts is around 1.5 times of the average flow area in the lower and upper reaches.

An open area of the grasslands extends over the left bank just below the Filwiha bridge. A part of this open area is to be modified as a regulating pond to decrease a peak of the flood to the downstream reaches. The foundation rock at the proposed site of the regulating pond is considered to be basalt, the same as the rock outcropped at the adjacent riverbed and to lie as deep as the outcropping rock at the riverbed. The proposed site is underlain by a sewerage pipe of AAWSA which is to be relocated.

An overview of the proposed site of the Bantiyketu regulating pond is presented below.



Major existing river and related structures are summarized below.

- Floodwalls,
- Intake weir (2 weirs),
- Road bridge (11 bridges),
- Aqueduct with foot-pass (1 set),
- Drainage culvert (2 major culverts and others),
- Sewerage pipe with manholes, and
- Water supply pipe.

In connection with the construction of the Bantiyketu regulating pond, Master Plan Development & Inspection Department, Region 14 Administration has been developed the following two projects. Both the projects are presently of planning stage.

- a) Construction of Fly-over connecting Ras Danitew Street and Yohanis Street
 - Fly-over is to be constructed along the proposed regulating pond.
 - Detail route and design are to be studied and conducted after finishing of the feasibility study on the priority projects.
- b) Construction of public park in and around the Proposed Regulating Pond
 - Two parks are to be constructed as model parks in Addis Ababa.
 - The proposed regulating pond area is one of the above model parks. For the year of 1997/98, detailed design is to be conducted.
 - The park in the pond area is to be prepared as a multipurpose public park for recreation, festival, open theater, exhibition, and so on.
 - Details are to be studied after finishing the feasibility study on the priority project.

Both the above projects are desired to carry out jointly with the construction of the pond. A close coordination between the said Department and AFCPO is needed for their project implementations.

(3) Lower Kechene River

The lower Kechene from the confluence with the Bantiyketu to the upstream of the bridge (2nd bridge) having a total length of 2.8 km is running through the dense residential areas. Both the banks of this reach are low in elevation, especially in the area between the 1st and 2nd bridges. Accordingly, those riparian areas are prone to inundation.

To solve this problem, AFCPO has a plan to construct floodwall on both the sides for an approximate length of 300 m. The urgent works of the above are summarized below.

a) Work Items

- Construction of floodwall: 300 m in long on the left side and 340 m, on the right side.
- Repair of bridge abutment of 2nd bridge and its foot protection.

b) Construction Cost

- About 2.9 million BIRR

c) Tentative Implementation Schedule

- Tendering: by the end of February 1998
- Commencement of construction works: March 1998
- Construction Period: 6 months

The major channel features of this reach are as follows.

Reach	Length (m)	Average gradient of river bed	Width/depth (m)
Fifine bridge – 3rd bridge	1,506	1/65	15/6
3rd bridge – Upstream of the 4th bridge	1,296	1/45	25/8

The following are the existing river and related structures in the lower Kechene river:

- Floodwalls,
- Road bridge (2 bridges),
- Sewerage pipe manholes, and

- Drainage culvert (2 major culverts and others).

(4) Kostre Regulating Pond Site

The proposed site of the regulating pond locates on the left bank in the lower reach of the Kostre that of the right tributary of the Kechene river. The proposed site has been utilized as a football ground for inhabitants. The total area of the football ground is around 8,000 m². There is no house in the proposed site, as shown in Figure 2.1.4. The facilities to be removed are 1 set of goal post of football ground only.

The foundation rock at the proposed site of the regulating pond is considered to be basalt, the same as the rock outcropped at the adjacent riverbed and to lie as deep as the outcropping rock at the riverbed.

The photo below presents an overview of the proposed site from the upstream.



(5) Kechene Weir Site

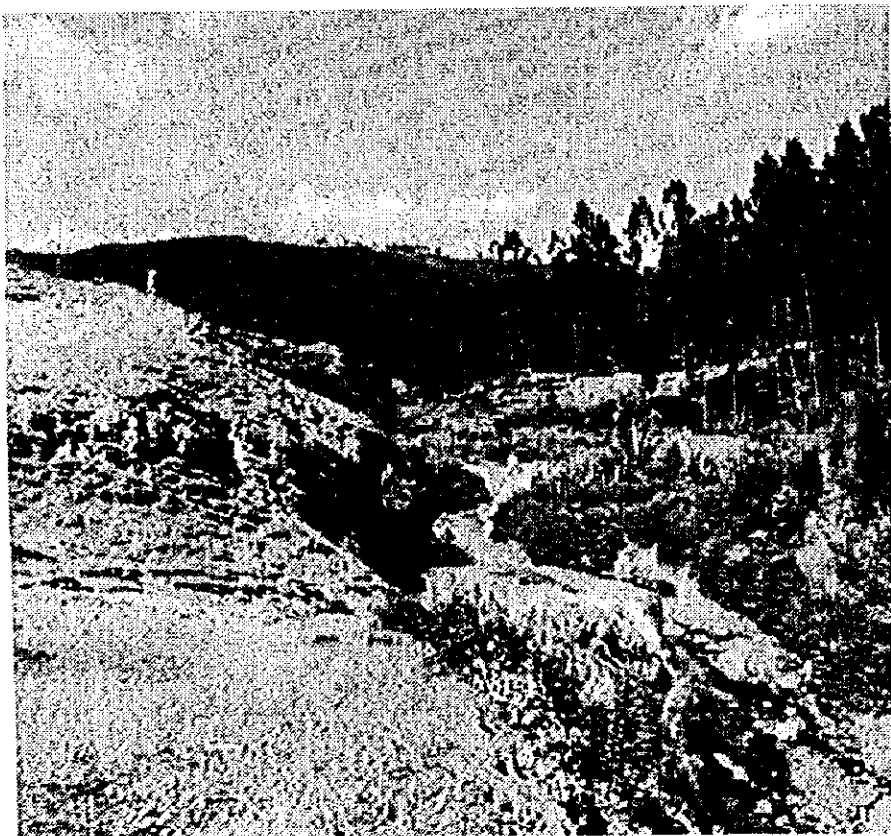
The proposed site of the Kechene weir locates just upstream of the Kechene bridge in the upper Kechene river. The river channel at the proposed site is wide valley. It

seems that there are 4 to 5 houses to be affected by backwater in the reservoir of the proposed weir.

Geologically, the proposed weir axis is underlain by basalt, without distinct joints/cracks and sufficiently hard to be suitable for foundation of the weir. The basalt is overlain with sandstone at the left abutment and tuff at the right abutment, both of which are highly weathered and jointed and as deep as about 5 m from the ground. Figures 2.1.5 and 2.1.6 show the proposed site of the weir and channel profile, respectively. The major dimensions of the river channel around weir site are as follows.

Point	Length (m)	Average gradient of river bed	Width/depth (m)
Around axis of weir	1,200	1/25	30-80/12

A view of the proposed site from the downstream is presented below.



2.1.3 Calculated Water Levels for Various Probable Floods

Present carrying capacity of the objective river stretches was evaluated by hydraulic analysis using the results of the river cross section survey conducted from December 1997 to January 1998. The results were compiled into longitudinal profiles and water surface profiles for probable flood as seen in Figures 2.1.7 to 2.1.11.

The stretch of the Kebena from the Bole railway bridge to the confluence of the Bantiyketu indicates carrying capacity more than probable 10-year flood except the heavily scoured section located around 100 to 200 m downstream from the confluence.

In the Bantiyketu, the major part of the surveyed stretch shows carrying capacity for probable 2-year flood. The flood protection walls are therefore constructed along the river in residential or commercial areas. These are mainly seen in the downstream section of the Bantiyketu No. 3 bridge (2.2 to 2.8 km) and the upstream section of the Finfine bridge (4.0 to 5.3 km).

The Kechene shows sufficient carrying capacity for probable 30-year flood in general. However, the stretch between the confluence of the Bantiyketu and the Kechene No. 2 bridge (5.3 to 5.8 km) indicates lower carrying capacity for probable 10-year flood or less at a few locations.

2.2 Urban Drainage

2.2.1 General

The objective area of urban drainage in the present study is the run-off basin which drains to the Bantiyketu river in the reaches from the Finfine bridge up to the confluence of the Kechene and Kurtume rivers. The area is shown in Figure 2.2.1.

Regarding the existing drainage system in the objective area, no information, no data, no drawings are available at Region 14 Administration other than a past feasibility study report on the flood protection and storm sewer system. The title of the study is "FLOOD PROTECTION AND STORM SEWER SYSTEM OF ADDIS ABABA. The study was conducted in 1982 by the technical assistance of the French government.

The said report presents the outline of the storm sewer system in some part of Addis Ababa at that time. But this does not always give the good location map of the existing drainage system of the objective area in the present study.

Based on the field reconnaissance, the outline of location of the existing drainage system in the objective area is estimated from the locations of street inlets along the streets found in the field, and is shown in Figure 2.2.2.

The following are the description on the present conditions of the existing drainage of each basin in the objective area.

2.2.2 Northern Basin

(1) Drainage Conditions and Characteristics

The northern basin of the objective area is the area in the north of Saba Square on the Churchill Avenue. The area is a strip in the direction of north to south as shown in Figure 2.2.1. The northern boundary of the area is around the Saint-Georges Cathedral in front of the Municipality of Addis Ababa.

The rainfall in this area is collected into an underground drainage pipe through street inlets with curb opening along the avenue and drained to the Kurtume river before

joining the Bantiyketu river. But since the street inlets along the Churchill Avenue are limited in numbers, the sizes are not sufficient and the inlets are clogged with various garbage and soil at places, greater part of the run-off in the area flows on the Churchill Avenue and is collected into the low-lying area around the Addis Ababa Stadium and Abiot Square. And due to the insufficient conditions of the drainage facilities to the Bantiyketu river from the area, the collected water becomes stagnant in the area and blocks the traffic in the center of Addis Ababa often in rainy seasons.

(2) Inundation Damage

Since this basin has a rather steep slope to the south and the rainwater in this area all goes to the low-lying area around the Addis Ababa Stadium and Abiot Square, no inundation damage occurs in this basin.

2.2.3 Eastern Basin

The eastern basin is the area on the left side of the Bantiyketu river in the objective reaches. The area is further divided into three sub-basins: sub-basin-E1, sub-basin-E2 and sub-basin-E3 from their drainage characteristics.

(1) Sub-basin-E1

1) Drainage Conditions and Characteristics

This area is a strip along the Menelik II avenue in the direction of north to south as shown in Figure 2.2.1. The rainfall in this area is collected into an underground drainage pipe through street inlets with curb opening along the avenue and drained to the Bantiyketu river. The outlets of the drainage to the Bantiyketu river are concrete culverts of the dimension of about 0.5 m x 0.5 m under the Finfine bridge on the both sides.

But due to the same reasons in the northern basin, greater part of the run-off in the area flows on the Menelik II avenue and passes over the Finfine bridge and is collected into the low-lying area in front of the Abiot Square.

And due to the insufficient conditions of the drainage facilities to the Bantiyketu river from the area, the collected water becomes stagnant in the area and blocks the traffic in the center of Addis Ababa often in rainy seasons.

2) Inundation Damage

Since this basin has a rather steep slope to the south and the rainwater in this area all goes to the low-lying area around the Abiot Square, no inundation damage occurs in this basin.

(2) Sub-basin-E2

1) Drainage Conditions and Characteristics

This area is an area where the Sheraton hotel is under construction in the center of the sub-basin as shown in Figure 2.2.1. The Sheraton hotel is now constructing drainage facilities consisting of road side ditch and underground pipe along the Taitu Street to drain the rainfall in the northern part of the hotel complex. The drainage facilities also drain the rainfall in the area on the northern side of the Taitu Street in front of the hotel. The new drainage facilities by the Sheraton hotel are to be connected with the existing drainage system to the Kechene river.

Accordingly the rainfall in this sub-basin is to be drained along the Taitu Street to the Kechene river or along the Yohanis Street to the Bantiyketu river.

The rainwater in this area other than that drained to the Kechene river along the Taitu Street, is collected in front of the Finfine National Restaurant mainly along the Yohanis Street. There exists a drainage culvert under the Yohanis Street with the dimension of about 1 m x 0.5 m down to the crossroads in front of the Finfine National Restaurant. Since the Yohani Street is ascending to the direction of the Bantiyketu river with a distance of about 100m, the collected rainwater is drained by underground drainage pipes with the dimensions of 0.6 m and 0.8 m in diameter respectively through the grassland on the downstream side of the Filwiha Bridge.

The drainage pipe of 0.8 m in diameter was constructed by the Municipality and the other of 0.6 m in diameter was constructed by the Finfine National Restaurant.

But due to the reasons that street inlets with curb opening are insufficient in numbers and size, the collected water becomes stagnant near the Finfine National Restaurant.

2) Inundation Damage

In 1995 or 1996 due to flooding from the Bantiyketu river and drainage congestion in the area, pumping equipment of the said restaurant was submerged and became out of order. During the ordinary rainy season, the parking area of the said restaurant was damaged due to drainage problem. The rainwater collected in front of the said restaurant usually continues to be stagnant for about one month.

(3) Sub-basin-E3

This area is an area surrounded by the Yohanis Street and the Menelik II Avenue as shown in Figure 2.2.1. In this area, the palace of the president of the Federal Democratic Republic of Ethiopia and the Ghion Hotel are located. Since the area has natural slope to the direction of the Bantiyketu river and the ground height is rather high, this area has basically no serious drainage problem.

2.2.4 West-southern Basin

The west-southern basin is the area on the right side of the Bantiyketu river in the objective reaches. The rainfall in this area are all collected to the low-lying area along the Bantiyketu river around the Addis Ababa Stadium and the in front of the Abiot Square and due to the above-mentioned reasons, the collected water becomes stagnant and blocks the traffic in the center of the Addis Ababa often in rainy seasons..

The area is also further divided into three sub-basins: sub-basin-WS1, sub-basin-WS2 and sub-basin-WS3 from their drainage characteristics. The locations are shown in Figure 2.2.1.

(1) Sub-basin-WS1

1) Drainage Conditions and Characteristics

This area is the area surrounded mainly by the Churchil Avenue, the Tesema Aba Kemaw Street, and the Ras Abebe Aregay Street. The drainage from this area converges to the crossroads of the Yohanis Street and the Ras Danitew Street. The existing drainage system seems to drain the run-off in this area through an underground drainage pipe to the Bantiyketu river just downstream of the confluence of the Kechene and Kurtume rivers. But due to the same reasons mentioned above, greater part of the run-off goes to the direction of the Abiot Square along the Ras Danitew Street and becomes stagnant near the Addis Ababa Stadium and Abiot Square.

2) Inundation Damage

Since this basin has a rather steep slope to the east and the rainwater in this area all goes to the low-lying area around the Abiot Square, no inundation damage occurs in this basin.

(2) Sub-basin-WS2

1) Drainage Conditions and Characteristics

This area is the area surrounded mainly by the Ras Abebe Aregay Street, Ras Danitew Street and the Ras Mekonin Avenue. The drainage in this area converges around the Addis Ababa Stadium and is drained to the Bantiyketu river through the drainage system along the road on the northern side of the Stadium and along the Ras Danitew Street. But due to the same reasons mentioned above, the collected water becomes stagnant around the Stadium and often disturb the traffic around there during rainy season.

2) Inundation Damage

The collected water around the Addis Ababa Stadium gradually goes on to the Ras Danitew Street and then flows to the area around the Abiot Square. Accordingly the

inundation continues for about 1 to 3 hours often during rainy season causing the damage of the road pavement and disturbing the traffic in the area.

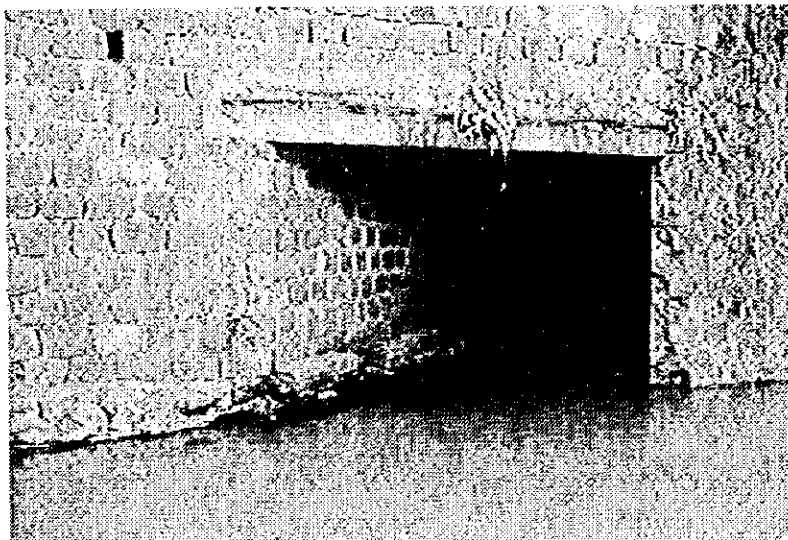
(3) Sub-basin-WS3

1) Drainage Conditions and Characteristics

This area is the area surrounded mainly by the railway and the Ras Mekonin Avenue. The drainage in this area converges around the Abiot Square and is drained to the Bantiyketi river through the street inlets with curb opening or grating and the culvert.

The existing drainage system from the low-lying area in front of the Abiot Square to the Bantiyketu river consists of street inlets with curb opening or grating along or in the center of the street, underground drainage pipes and underground drainage culvert to the Bantiyketu river. The street inlets around the Abiot Square are more than 50 in numbers with the dimensions of 0.2 m x 0.4 m to 1 m x 1m. In addition, there exists the drainage ditch with grating in the Abiot Square with the width of about 0.3 m. The outlet of the culvert to the Bantiyketu river has the dimension of about 2.7 m x 2.7 m. The outlet is located about 20 m downstream of the bridge of the Ghion Hotel that is located behind the Ethiopian Tourism Commission about 270 m upstream of the Finfine bridge.

The photo of the outlet of the culvert is shown below:



The culvert itself does not seem to have any problem. But due to the reasons that the street inlets along the street in front of the Abiot Square are insufficient in the size and many of the inlets are clogged with garbage and soil, the collected water in front of the Abiot Square becomes stagnant in the area and blocks the traffic in the center of Addis Ababa often in rainy seasons. The locations of street inlets around the Abiot Square are shown in Figure 2.2.3.

2) Inundation Damage

Every year often in rainy season, the low-lying area in front of the Abiot Square is inundated for about 30 minutes. When the rainfall is especially heavy during rainy season, inundation becomes serious to the extent that the traffic is blocked.

The old immigration office located in front of the Abiot Square often suffers from inundation damage since the office building is located rather low-lying place. When the rainfall is heavy, the basement of the building is submerged up to the window height and the rooms can not be used. The cars parking in the backyard of the building were once washed away due to inundation by flooding or drainage problem.

2.3 Social and Environmental Conditions

2.3.1 Bantiyketu River

(1) Social Environment

Along the upstream reaches of the Bantiyketu river upstream of the Asmara Road, the surrounding area is the most important area in Addis Ababa. Politically and economically very important organs are located. They are Congress Hall of Federal Government, Headquarter of Military Force, Ministry of Defense, the palace of the president of the Federal Government, Ministry of Foreign Affairs, Railway Station, General Post Office, Africa Hall, the offices of ECA, UNDP, UNICEF, ILO, UNESCO, Hilton hotel, Ghion hotel, and others.

Besides the Africa Avenue leading to the international Bole Airport, the Asmara road eading to Asmara, the Debra Zeit road leading to Debra Zeit, Ras Biru Avenue leading to Djibouti meet in this area.

Along the downstream reaches of the Bantiyketu river downstream of the Asmara Road, the surrounding area is mainly residential area. US Aid office is located along the Bantiyketu river on the right side very close to the river in this area.

In the area around the confluence with the Kebena river, there exists the Mackelawi Park including the agricultural testing ground.

In the area near the confluence with the Kebena river, the embassies of Djibouti and Zimbabwe are located rather close to the Kebena river upstream of the Bole road. In the area along the Bantiyketu river, there exist no historical heritage nor cultural assets.

The water intake exists near the Mackelawi Park for vegetable irrigation. Water use by local people along the river is scarcely found. There exist no fishing rights.

(2) Natural Environment

Since the water quality of the Bantiyketu river is very much deteriorated especially during dry season, there exist no important flora and fauna. There exist no important landscape along the river.

2.3.2 Bantiyketu Regulating Pond Site

(1) Social Environment

The proposed Bantiyketu regulating pond site is located on the left side of the Bantiyketu river just downstream of the confluence of the Kechene and Kurtume rivers. The present situation of the area is an open area of grass land. Hot spring site is located just downstream side of the area. On the left side of the area, the Finfine National Restaurant is located. Addis Ababa Tennis Club is located on the downstream side of the area. The Ghion Hotel as one of the main hotels of Addis Ababa is located on the further downstream side of the Tennis Club.

This site is located very close to the central area of the Addis Ababa. The site is facing the Yohanis Street which connects the Mennelik II Avenue and the Ras Dantew Street, all of which play an important role for city traffic in the city. The Yohanis Street has

four-lane roadway paved with asphalt, median strip with some kinds of vegetation and the sidewalks of stone pavement on both sides. The width of roadway is 8.7 m on one side, the width of the median strip is 5 m and the width of sidewalk is 4 m on one side. The volume of wheeled traffic is very heavy and pedestrians are many all day long.

There exist neither water right nor fishing rights.

(2) Natural Environment

There exist neither flora nor fauna to be preserved. There exist no important landscape at the site.

2.3.3 Kostre Regulating Pond Site

(1) Social Environment

The present situation of the proposed Kostre regulating pond site is a football ground for the people around the site. The surrounding area of the site is a residential area of middle-class and low-cost houses. The density of houses around the site is not dense.

In the area, there exist no historical nor cultural assets. There exist neither water right nor fishing rights. Water use by local people around the area is scarcely found.

The site is facing the Dejazmach Haile Silase Street and Grez Inke Silase Bantydagn Street. The Dejazmach Haile Silase Street has a roadway paved with asphalt and sidewalks of stone pavement on both sides. The roadway is 8.3 m wide and the sidewalk is 2.7 m wide. The Grez Inke Silase Bantydagn Street is paved with asphalt with the width of 5.8 m. The shoulders of the road are about 1 to 2 m wide.

The site is rather far from the center of the city and accordingly the volume of wheeled traffic is not heavy except at commuter time.

(2) Natural Environment

There exist no flora nor fauna to be preserved. There exist no important landscape at the site.

2.3.4 Kechene Weir Site

(1) Social Environment

On the right side of the proposed Kechene Weir site, there exists the graveyard of Medhane Alem. This is the graveyard for the villagers around the area for the Orthodox Christians. On the left side of the site, there exist a village of Wereda 10. The houses of the village are located on the rather highland along the Kechene river but some houses are located rather close to the river on the lowland. These houses are mainly low-cost houses.

In the area, there exist no historical nor cultural assets. There exist no water right nor fishing rights. Water use by local people around the area is washing.

The approach road to the site is Abere Gizaw Street. The road is paved with asphalt with the width of 4m. The shoulders of the road are existing on both sides with the width of about 1 to 2 m. Since the area is located in rather rural area, the volume of wheeled traffic is light.

(2) Natural Environment

There exist neither flora nor fauna to be preserved. There exist no important landscape along the river.

Table 2.1.1 Inventory of Existing Facilities in Riparian Areas (1/3)

River Name	Facility	Name of Facility	Location	Type/Material	Dimensions	Remarks
Kebena	Bridge	Bole Railway Bridge	Downstream from Bole Road	Steel Truss	5m wide x 15m long; One span	
	Flood Wall	Bole Bridge	Bole Road	RC T-beam	30m wide x 10m long; One span	Owned privately
			Along left and right banks immediately downstream from the confluence of the Kebena and the Bantayketu rivers	Wet Masonry		
	Water Supply Pipe		In areas along both banks of rivers	Galvanized Steel, Ductile Iron, PVC		Owned by AAWSA
	Severage Pipe		(ditto)	PVC		Owned by AAWSA
Bantayketu	Bridge	Bantayketu 1st Bridge	In a vegetable garden owned by the Kebena and Bulbula Vegetable Growers Association	Concrete Box Culvert	8m wide x 15m long; Two lanes	
		Bantayketu 2nd Bridge	(ditto)	RC T-beam	2m wide x 15m long; One span	A bridge for pedestrian only
		Bantayketu 3rd Bridge		RC T-beam	10m wide x 15m long; One span	
		Bantayketu Bridge	Asmera Road (Jomo Kenyatta Avenue)	Stone Masonry Arch	30m wide x 15m long; One span	
		Fimfine Bridge	Menelek II Avenue	RC T-beam	20m wide x 50m long; Three spans	
		Bantayketu 6th Bridge	Within premises of Ghion Hotel	A steel bridge with a wooden slab	1m wide x 10m long; One span	Owned by Ghion Hotel; A bridge for only pedestrians between Ghion Hotel and National Hotel
		Bantayketu 7th Bridge		RC T-beam	6m wide x 10m long; One span	Owned by Ghion Hotel
		Bantayketu 8th Bridge		RC T-beam	6m wide x 10m long; One span	Owned by Ghion Hotel
		Bantayketu 9th Bridge	Leading to the entrance of Ghion Hotel	RC T-beam	6m wide x 10m long; One span	Owned by Ghion Hotel
		Bantayketu 10th Bridge	Leading to Addis Ababa Tennis Club	Steel Truss	4m wide x 10m long; One span	
		Filwaha Bridge	Yohannis Street	RC slab	30m wide x 10m long; One span	

Table 2.1.1 Inventory of Existing Facilities in Riparian Areas (2/3)

River Name	Facility	Name of Facility	Location	Type/Material	Dimensions	Remarks
	Flood Wall		Along left and right banks of the river	Wet Masonry		Privately owned flood walls except those along left banks downstream from Bantayketu 3rd Bridge which are under construction as of December 1997. Funded by the Kebele 34, the Region 14 Office and ESRDF (Ethiopian Social Rehabilitation and Development Fund)
	Irrigation Intake Weir	Bantayketu 1st Irrigation Intake Weir	In a vegetable garden owned by the Kebeba and Bulbula Vegetable Growers Association	Wet Masonry	2.5m high x 20m long	Owned by the Kebeba and Bulbula Vegetable Growers Association
		Bantayketu 2nd Irrigation Intake Weir	Downstream from Bantayketu 3rd Bridge	A mound of cobbles across the river		Made and owned privately
	Water Supply Pipe		In areas along both banks of the river	Steel, Galvanized Steel, Ductile Iron, PVC		Owned by AAWSA
	Sewerage Pipe		(ditto)	PVC		Owned by AAWSA
	Aqueduct for Water Supply with a Pedestrian's Bridge		Downstream from Bantayketu 3rd Bridge	Steel Truss		Owned by AAWSA
	Outlet of Local Rain Water Drainage		Along both banks of the river	Wet Masonry, Concrete		
	Outlet of Local Sewerage System		Along both banks of the river, immediately downstream from Bantayketu 3rd Bridge	Wet Masonry, Concrete		
	Riverbed Protection Works		Immediately upstream from Bantayketu 3rd Bridge	Reinforced Concrete		
	Foundation of Parking Lot		Within premises of Ghion Hotel; Immediately upstream from Bantayketu 9th Bridge	Concrete Box Culvert	5m wide x 10m long; Two lanes	Owned by Ghion Hotel

Table 2.1.1 Inventory of Existing Facilities in Riparian Areas (3/3)

River Name	Facility	Name of Facility	Location	Type/Material	Dimensions	Remarks
Kechene	Bridge	Kechene 1st Bridge	Taitu Street	RC slab	10m wide x 9m long; One span	
		Kechene 2nd Bridge	Wendmensch Street	RC slab	6m wide x 10m long; One span	
		Kera Bridge	Colson Street	Stone Masonry Arch	10m wide x 9m long; One span	
		Iri Bekentu Bridge	General Wingate Street	Stone Masonry Arch	10m wide x 6m long; One span	
		Ras Mekonen Bridge	Adwa Avenue	RC slab	20m wide x 6m long; One span	
		Flood Wall	Along left and right banks	Wet Masonry		
		Outlet of Local Rain Water Drainage System	Along right bank of the river, near the Wendmensch Street	Wet Masonry, Concrete		
Kurume	Bridge	Kurume 1st Bridge	Taitu Street	RC slab	8m wide x 2m long; One span	

Note : AAWSA is the abbreviation of Addis Ababa Water and Sewerage Authority

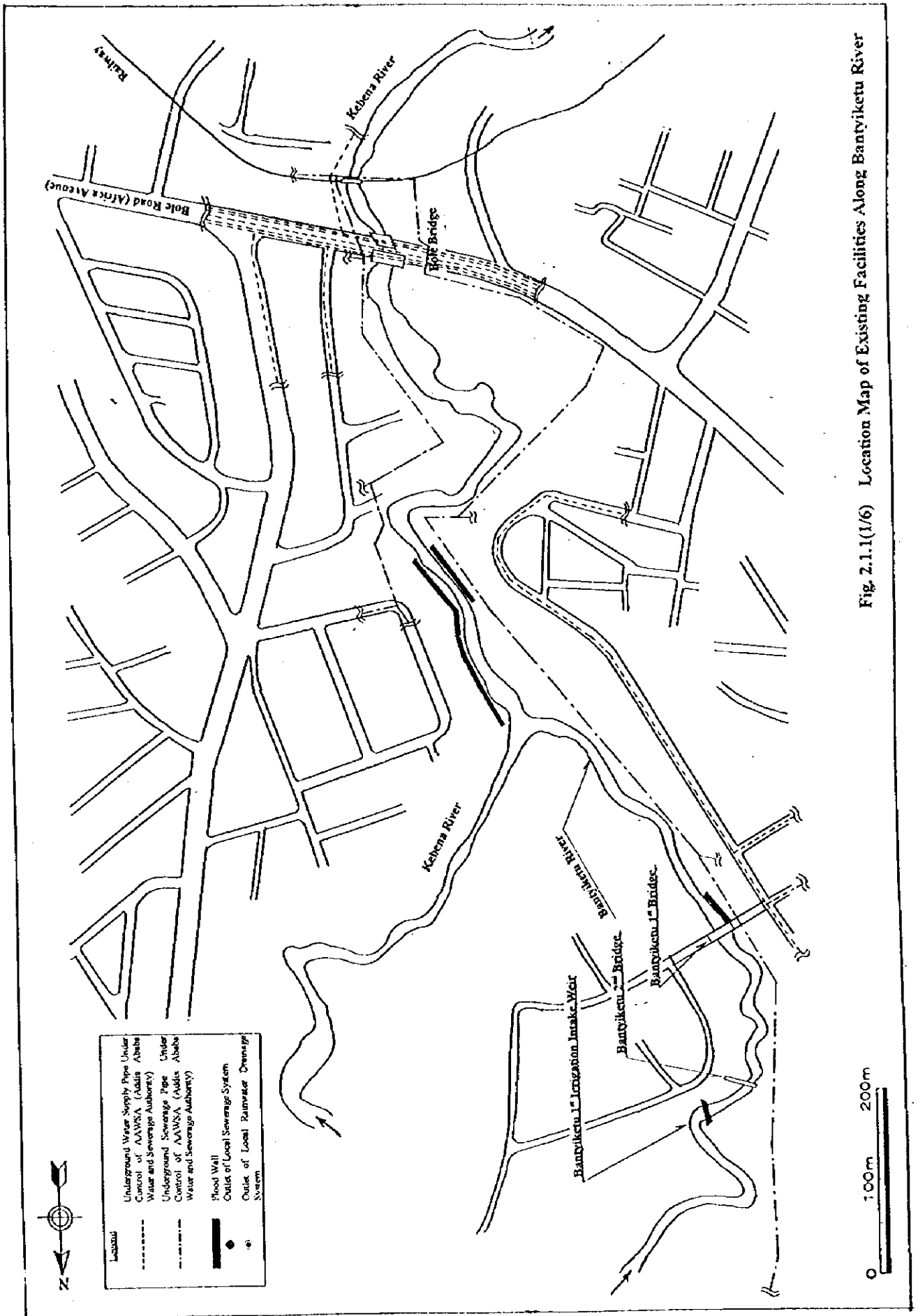


Fig. 2.1.1(1/6) Location Map of Existing Facilities Along Bantayketu River

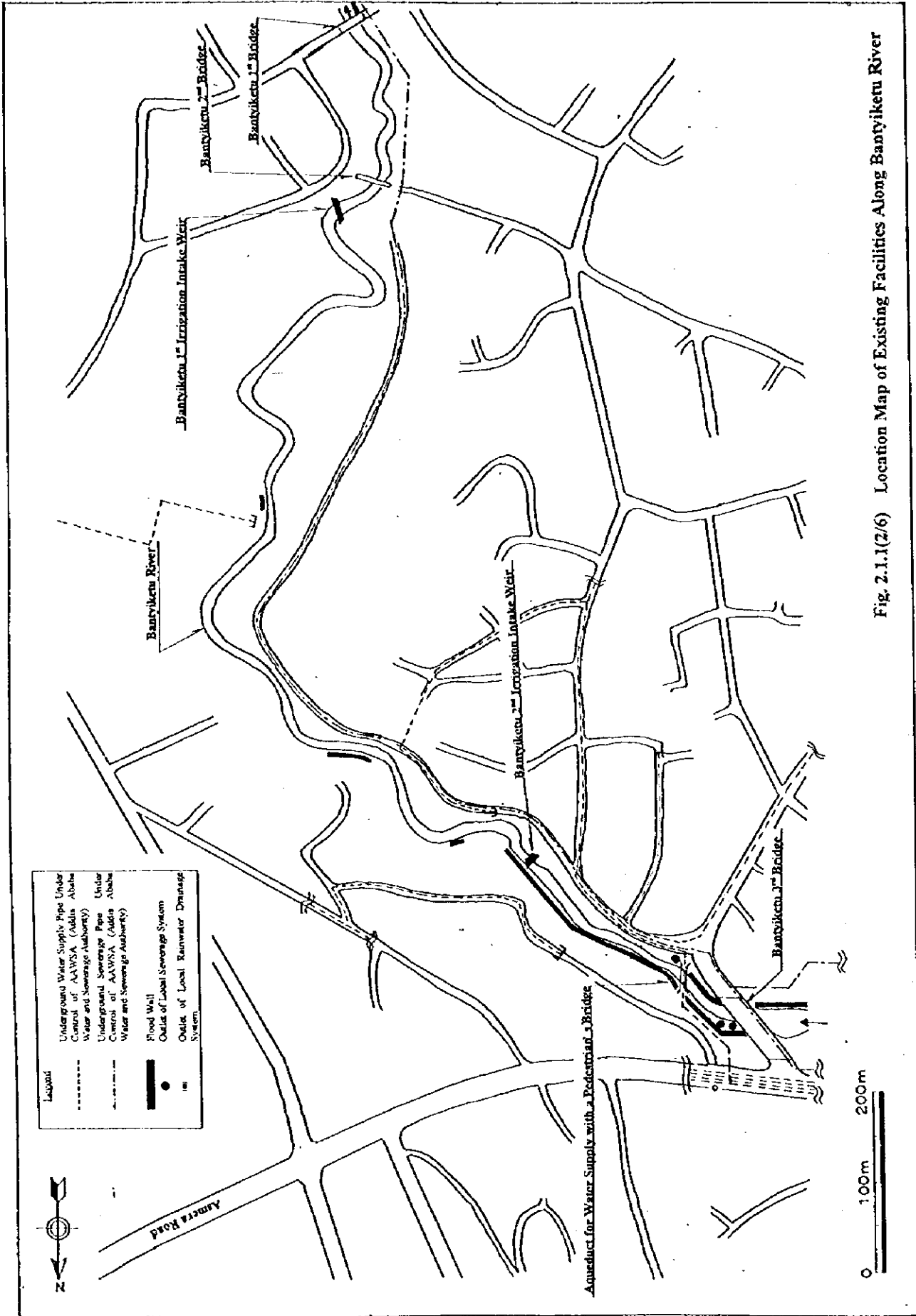


Fig. 2.1.1(2/6) Location Map of Existing Facilities Along Bantuyiketu River

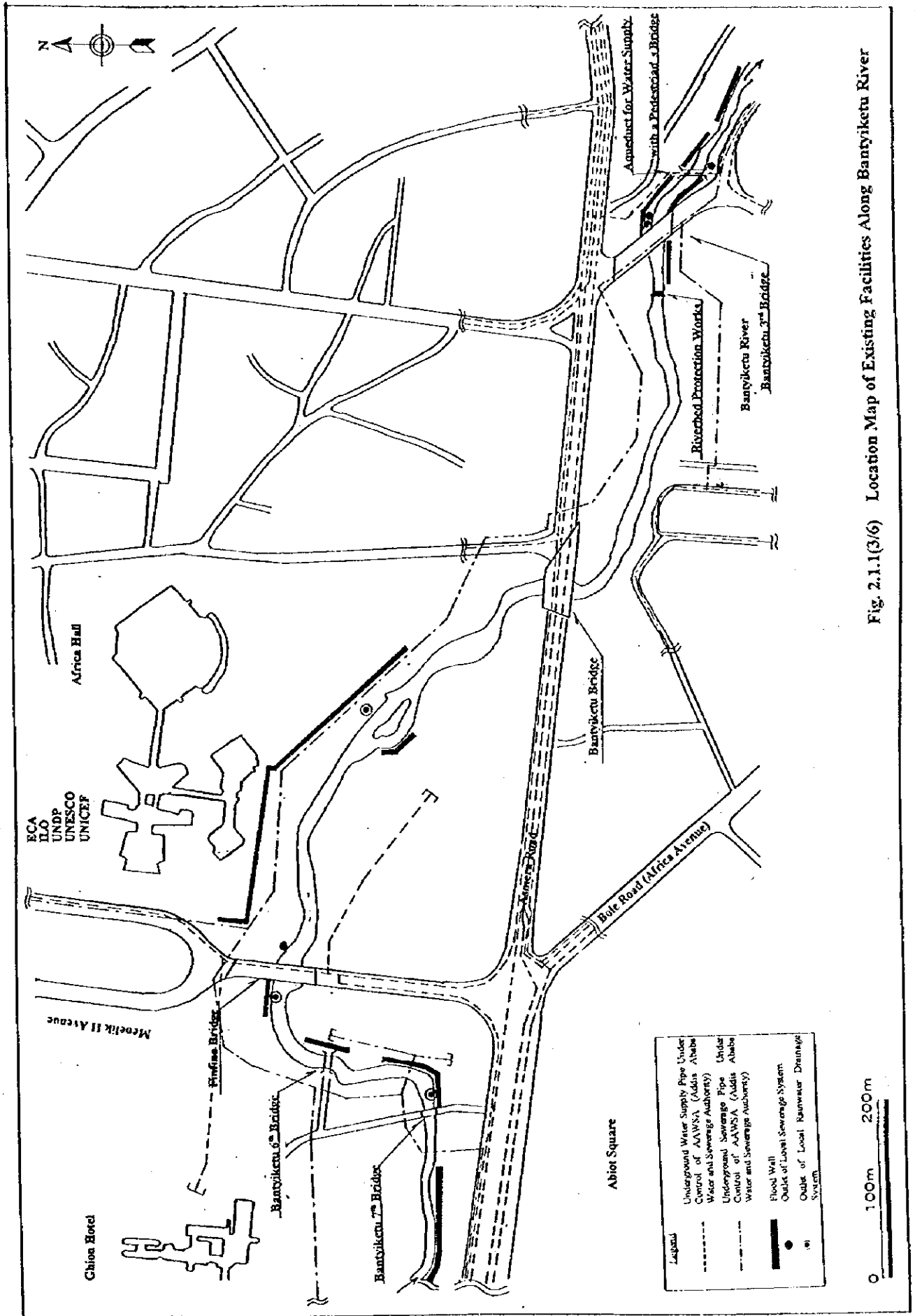


Fig. 2.1.1(3/6) Location Map of Existing Facilities Along Bantayketu River

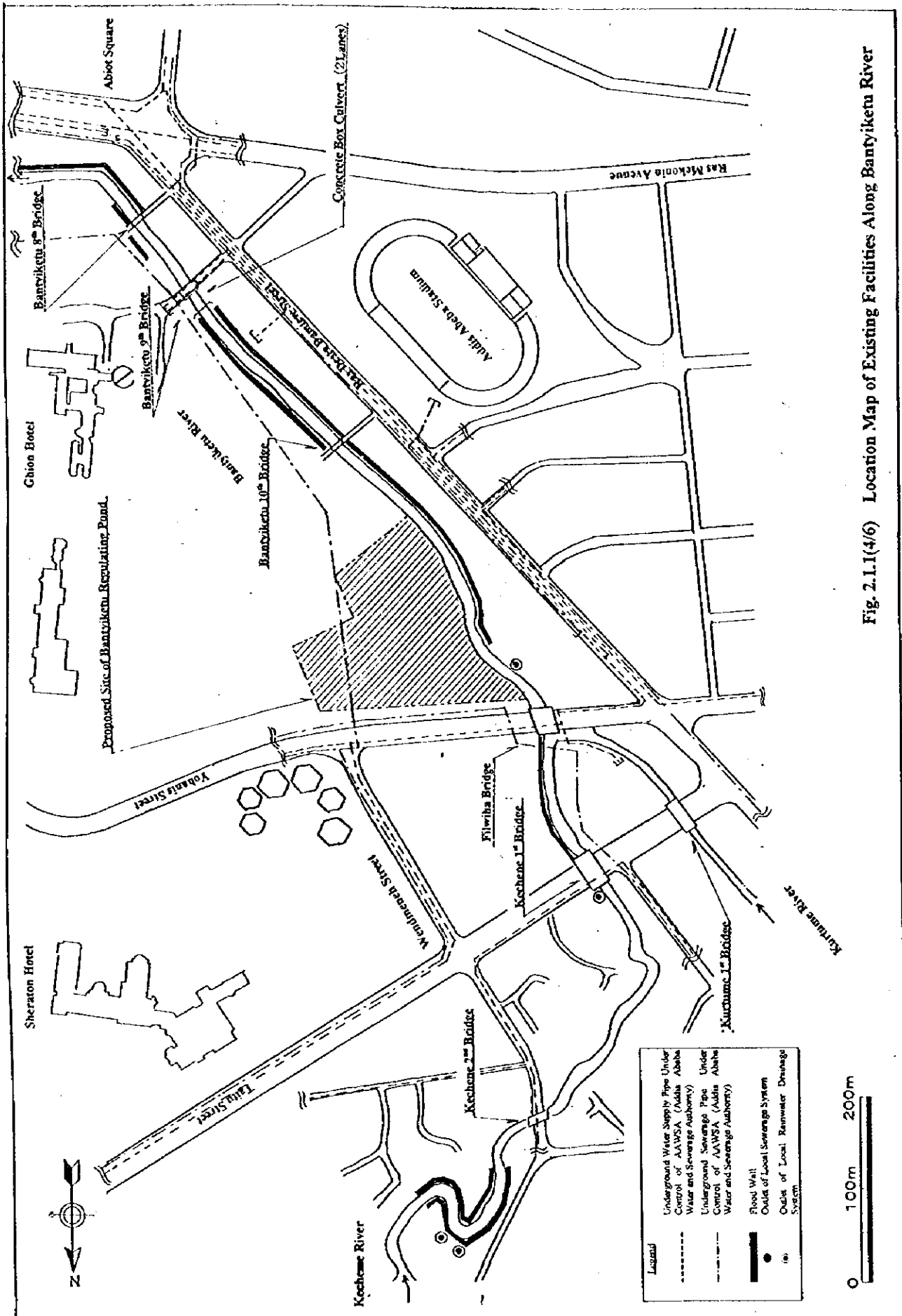


Fig. 2.1.1(4/6) Location Map of Existing Facilities Along Bantiyketu River

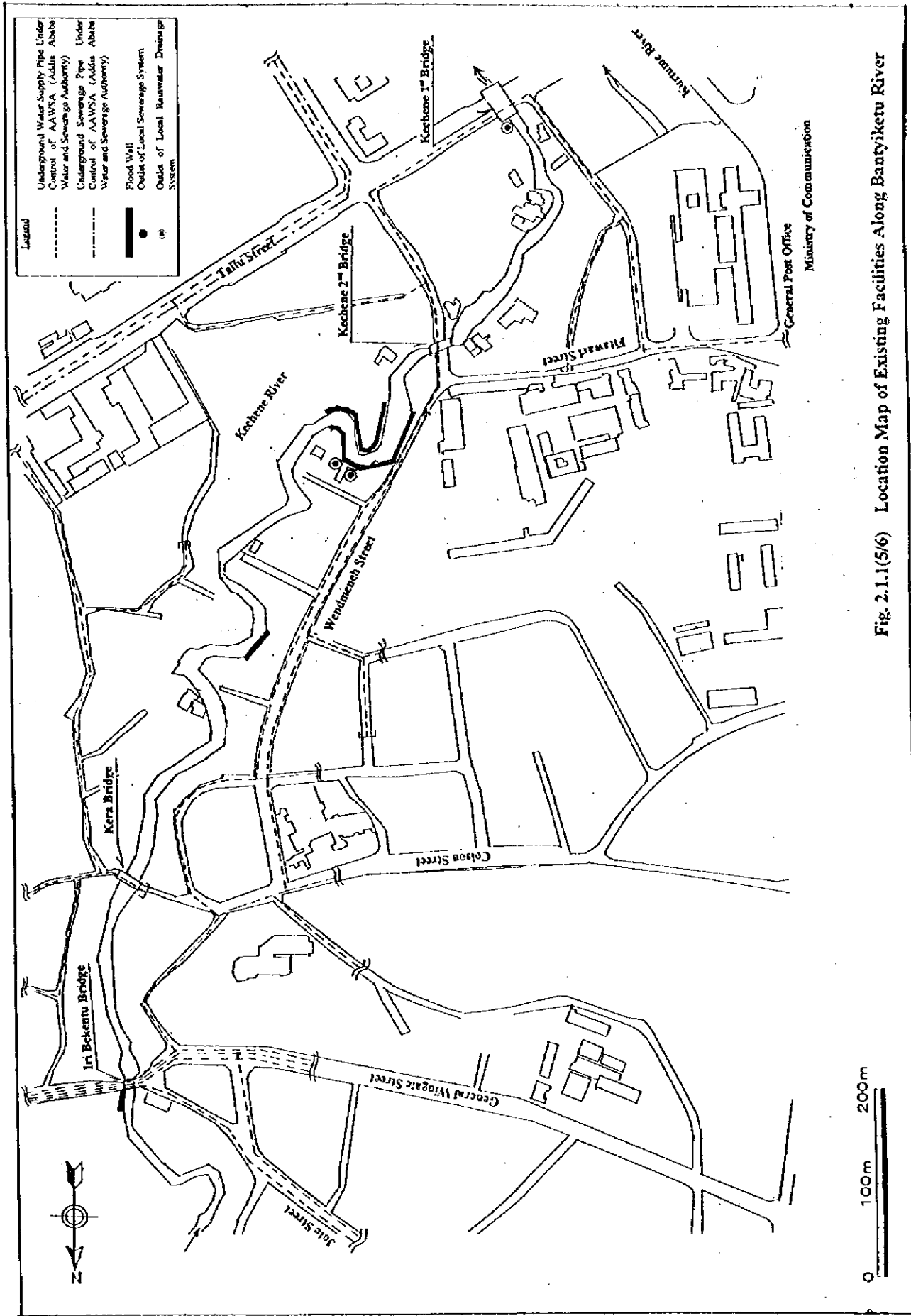


Fig. 2.1.1(5/6) Location Map of Existing Facilities Along Bantayikeru River

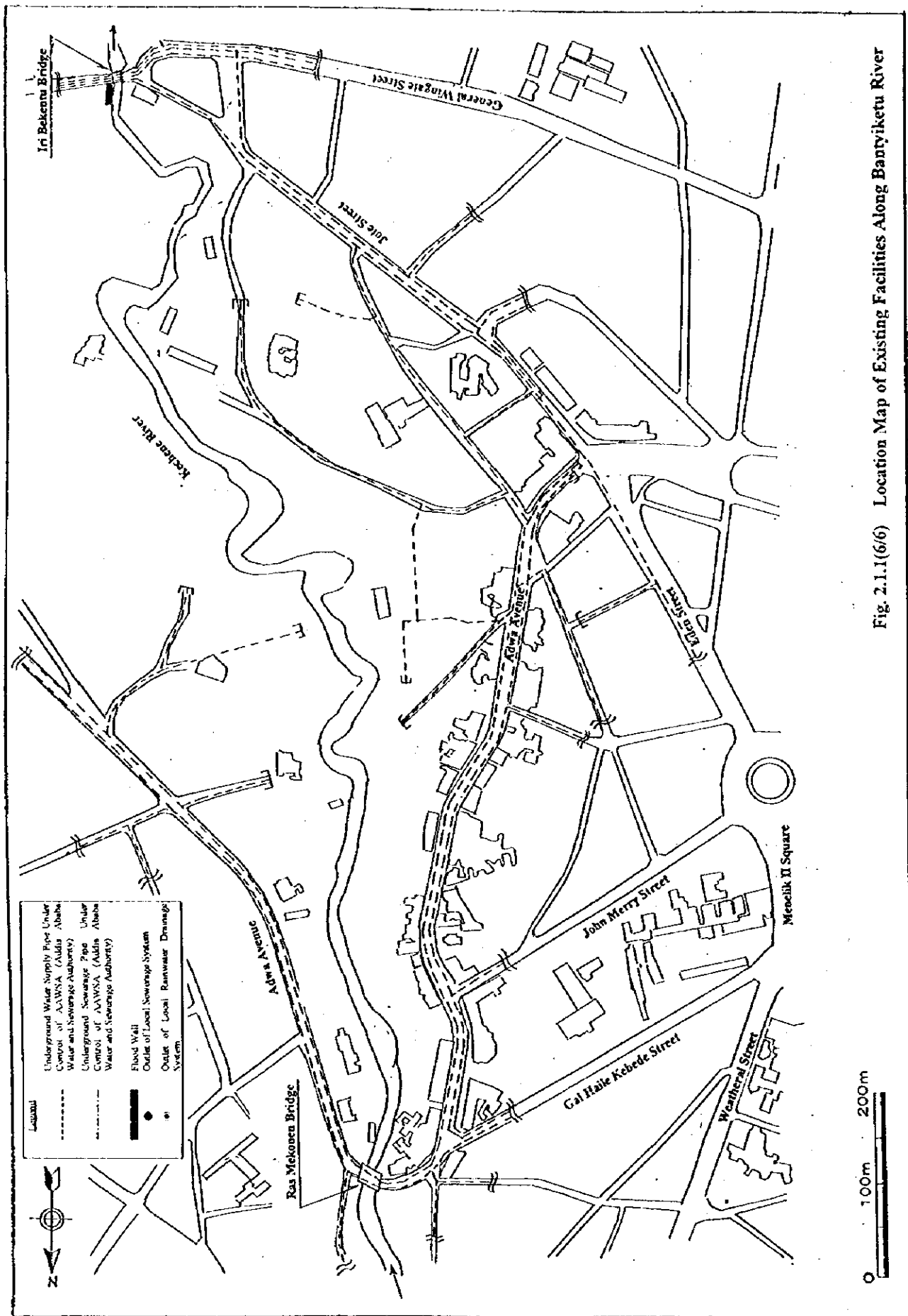


Fig. 2.1.1(6/6) Location Map of Existing Facilities Along Bantyketu River

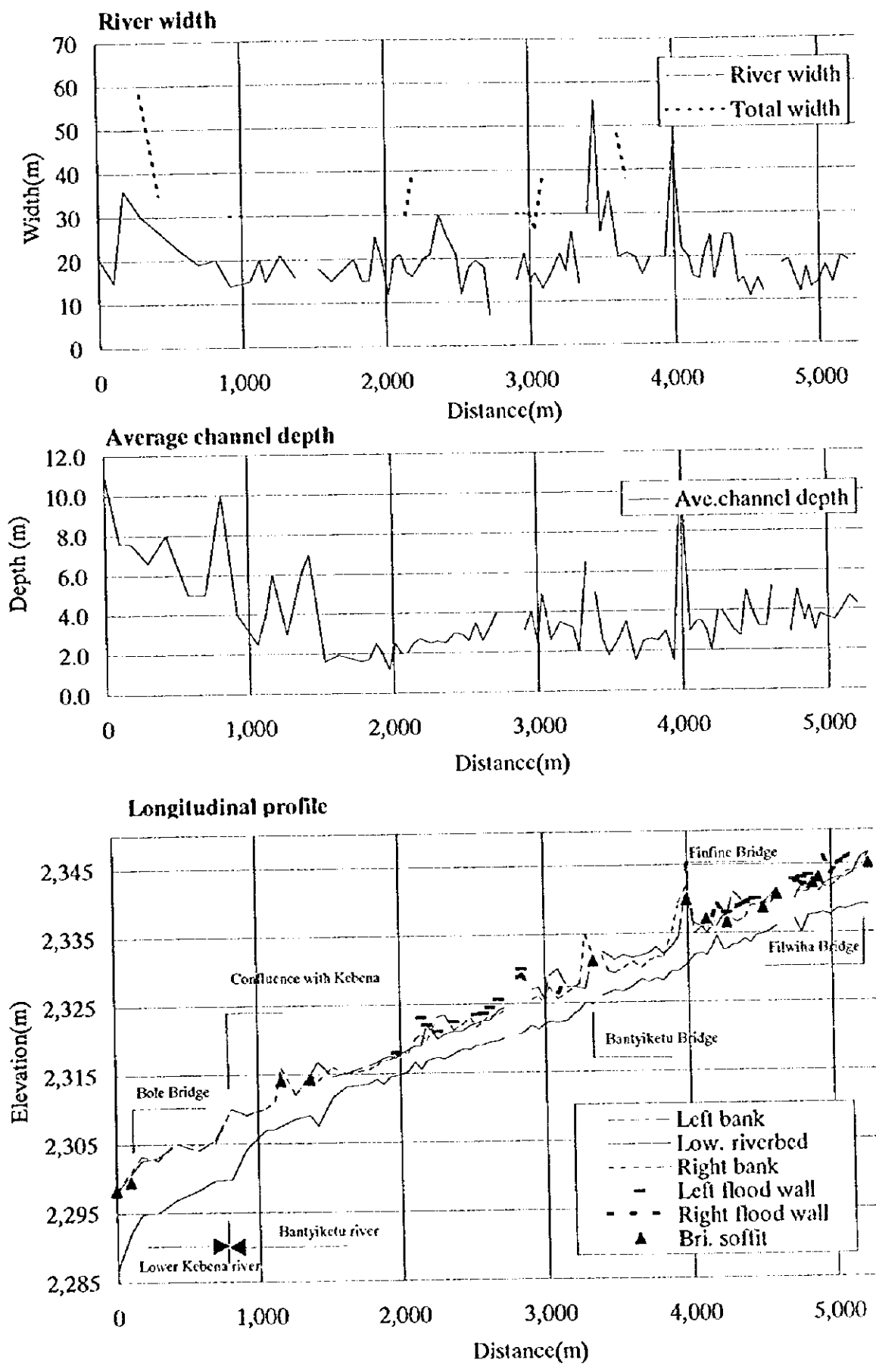


Figure 2.1.2 Features of Lower Kebena and Bantyketu Rivers

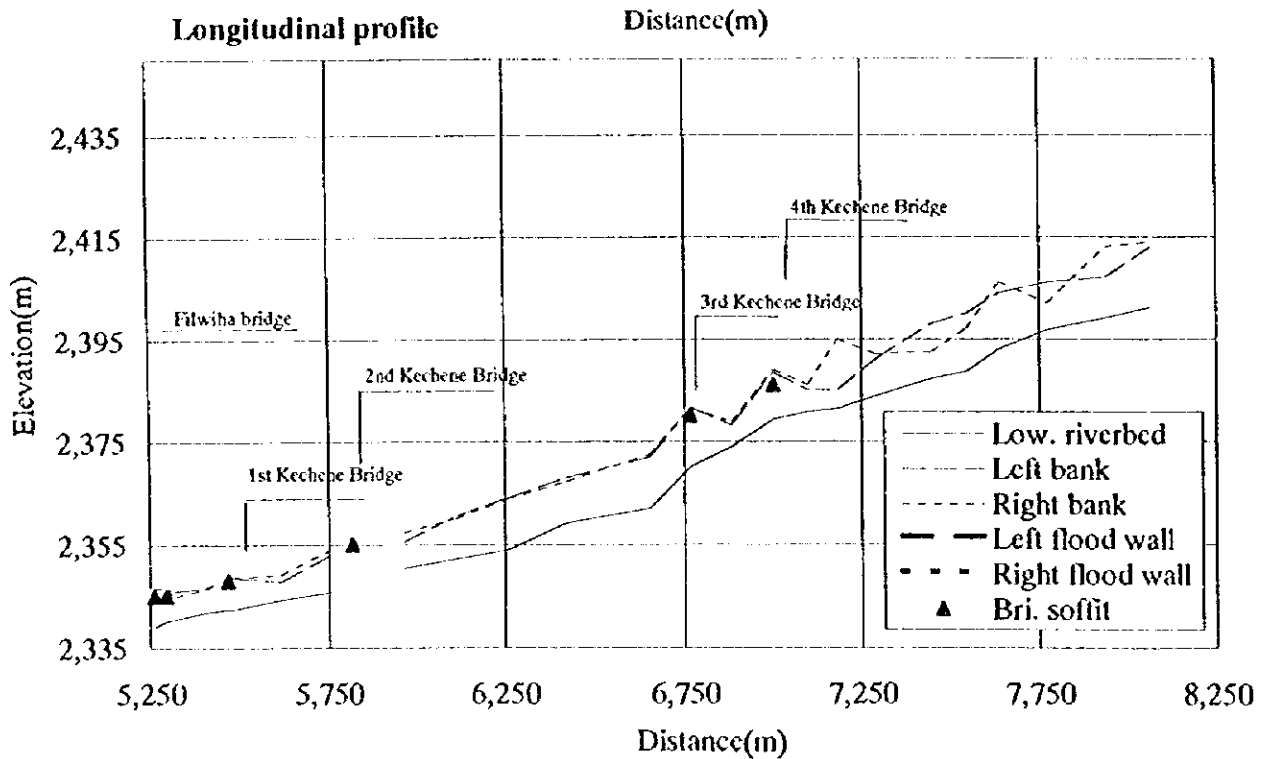
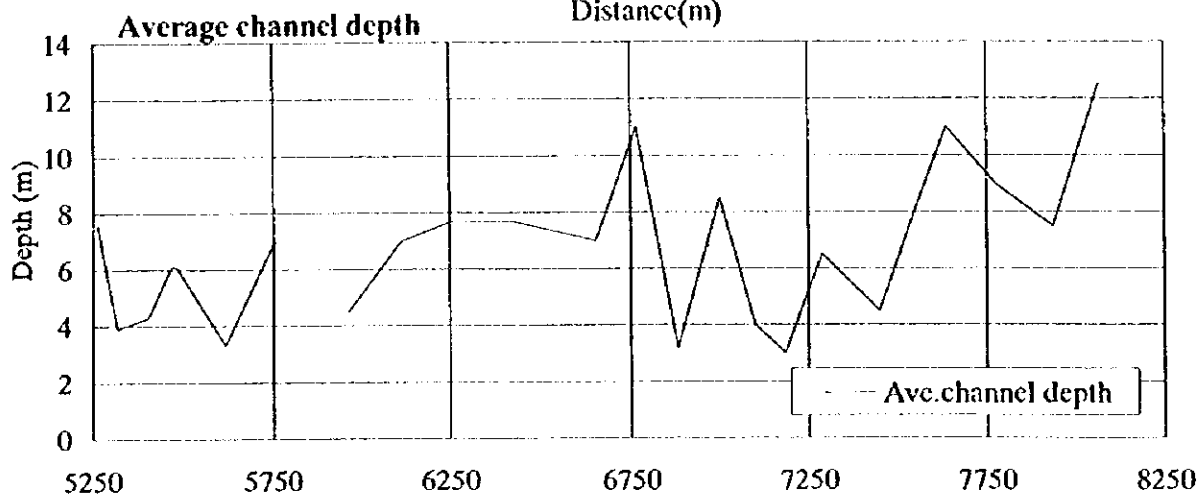
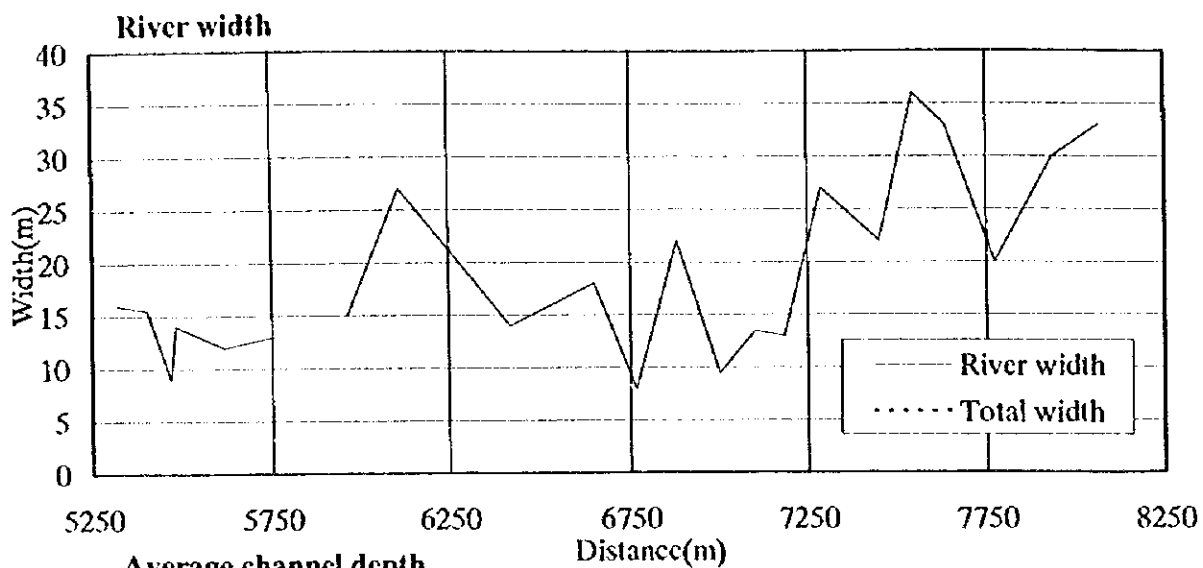


Figure 2.1.3

Features of Lower Kechene River

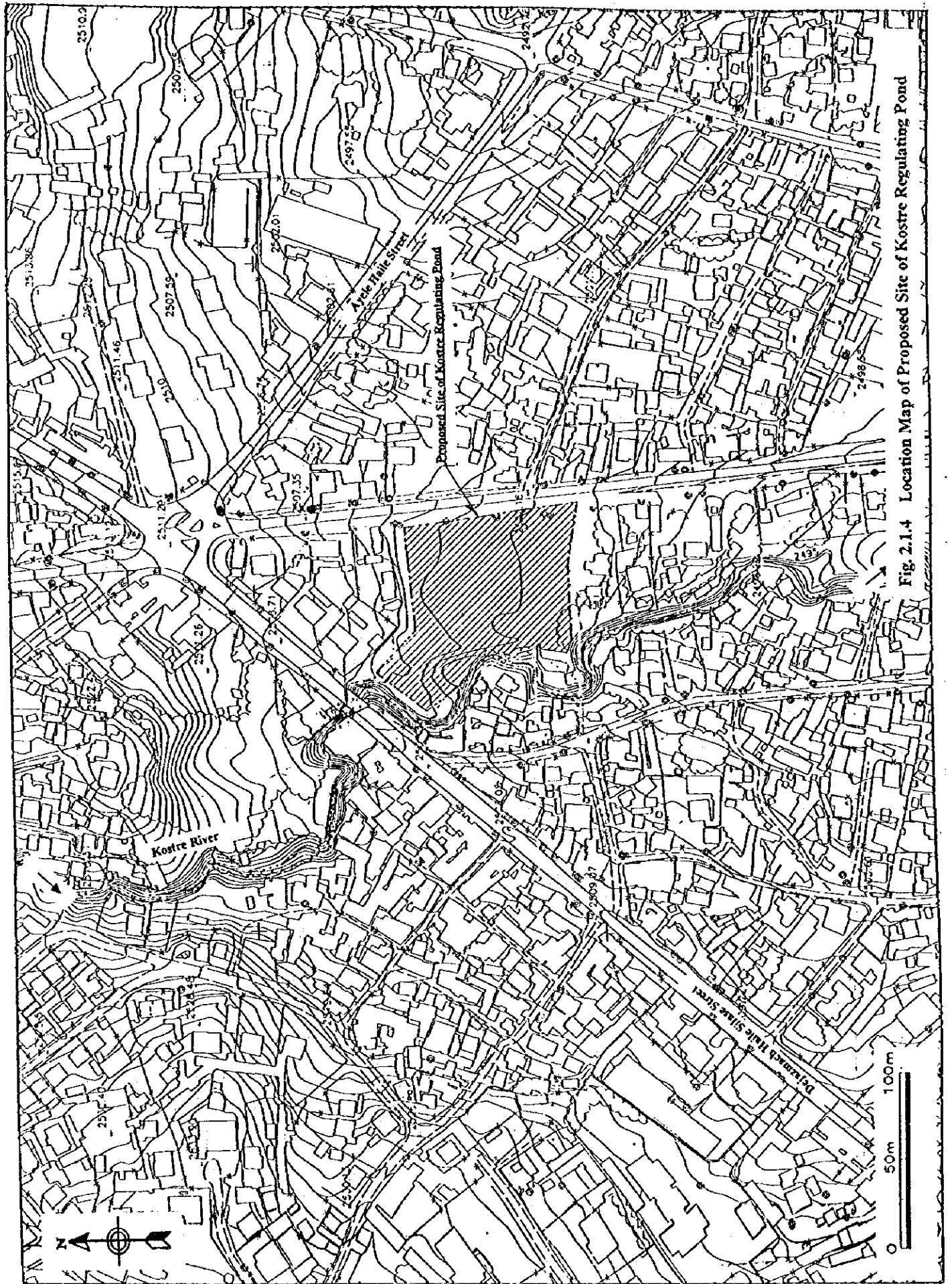


Fig. 2.1.4 Location Map of Proposed Site of Kostre Regulating Pond

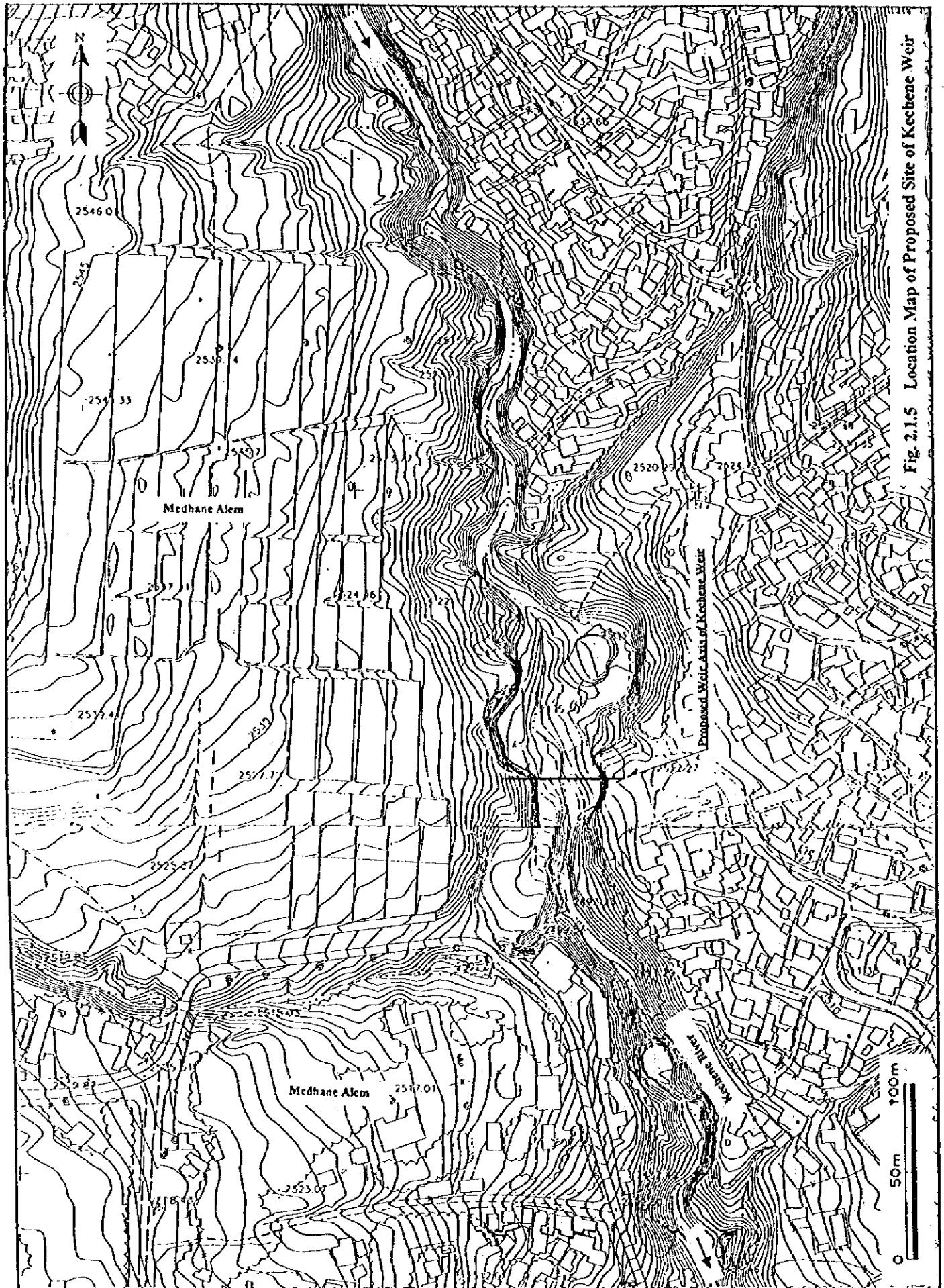


Fig. 2.1.5 Location Map of Proposed Site of Kechene Weir

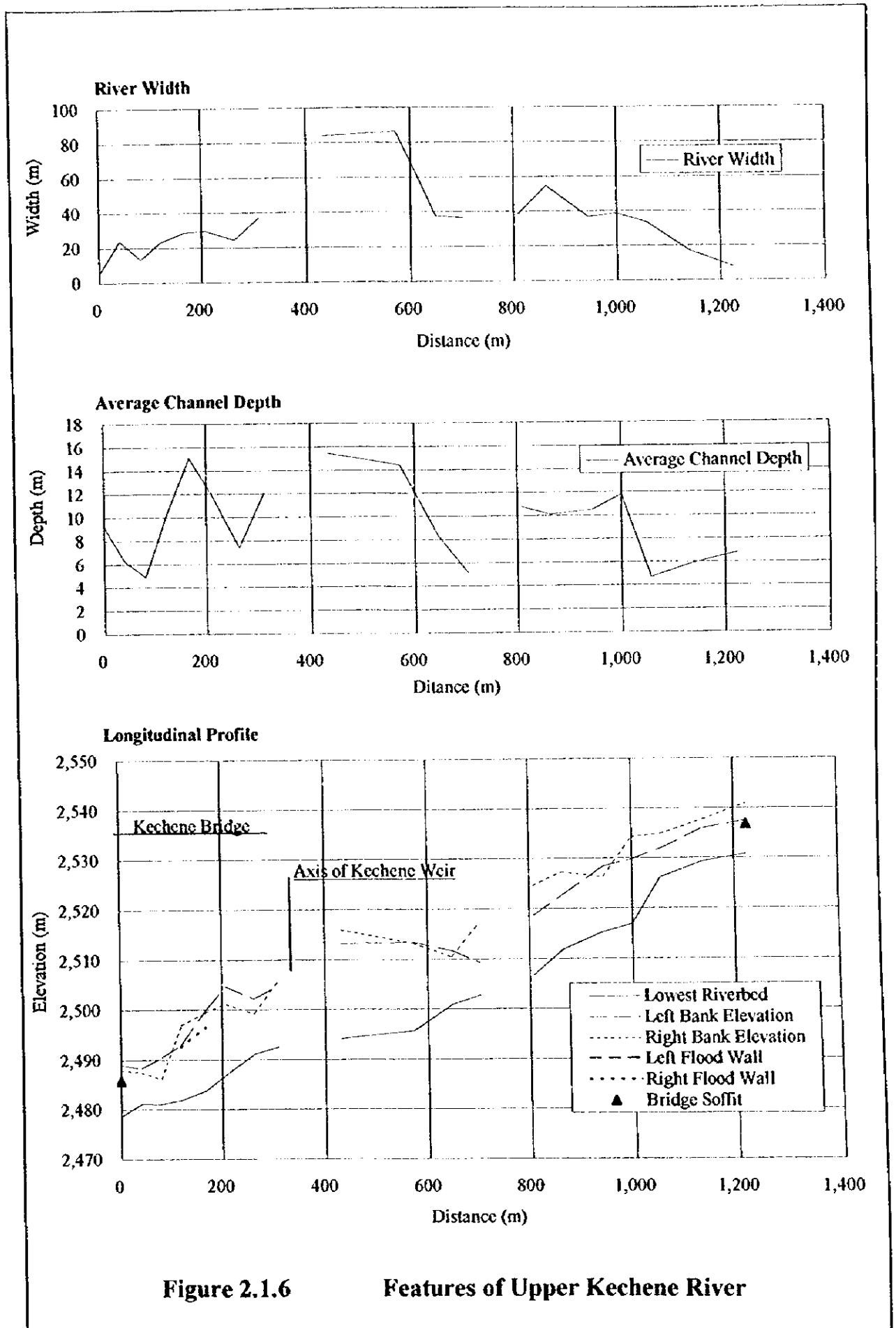


Figure 2.1.6

Features of Upper Kechene River

Longitudinal Profile - Kebena

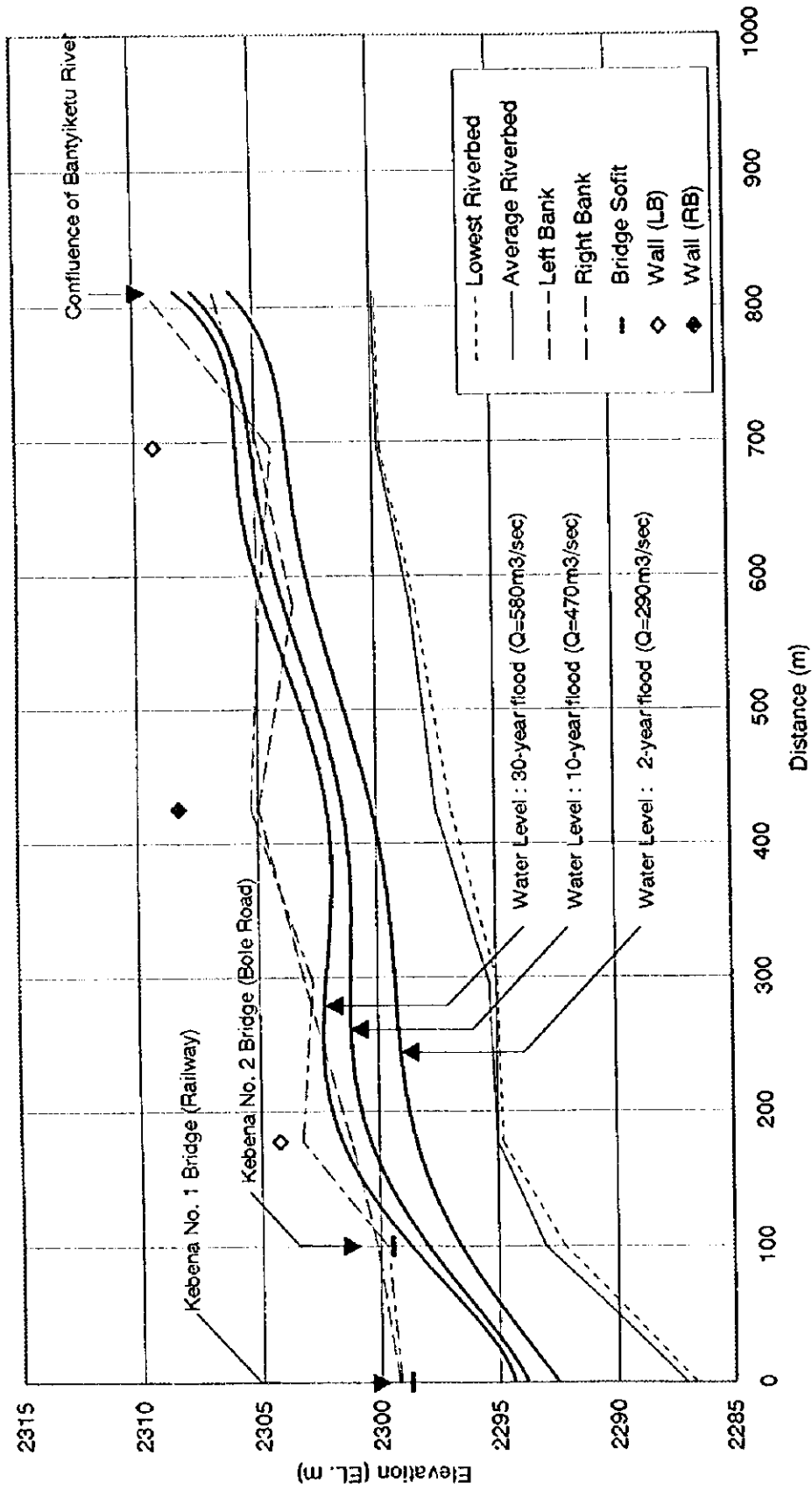


Figure 2.1.7 Longitudinal Profile - Kebena River

Longitudinal Profile - Bantiyketu (1)

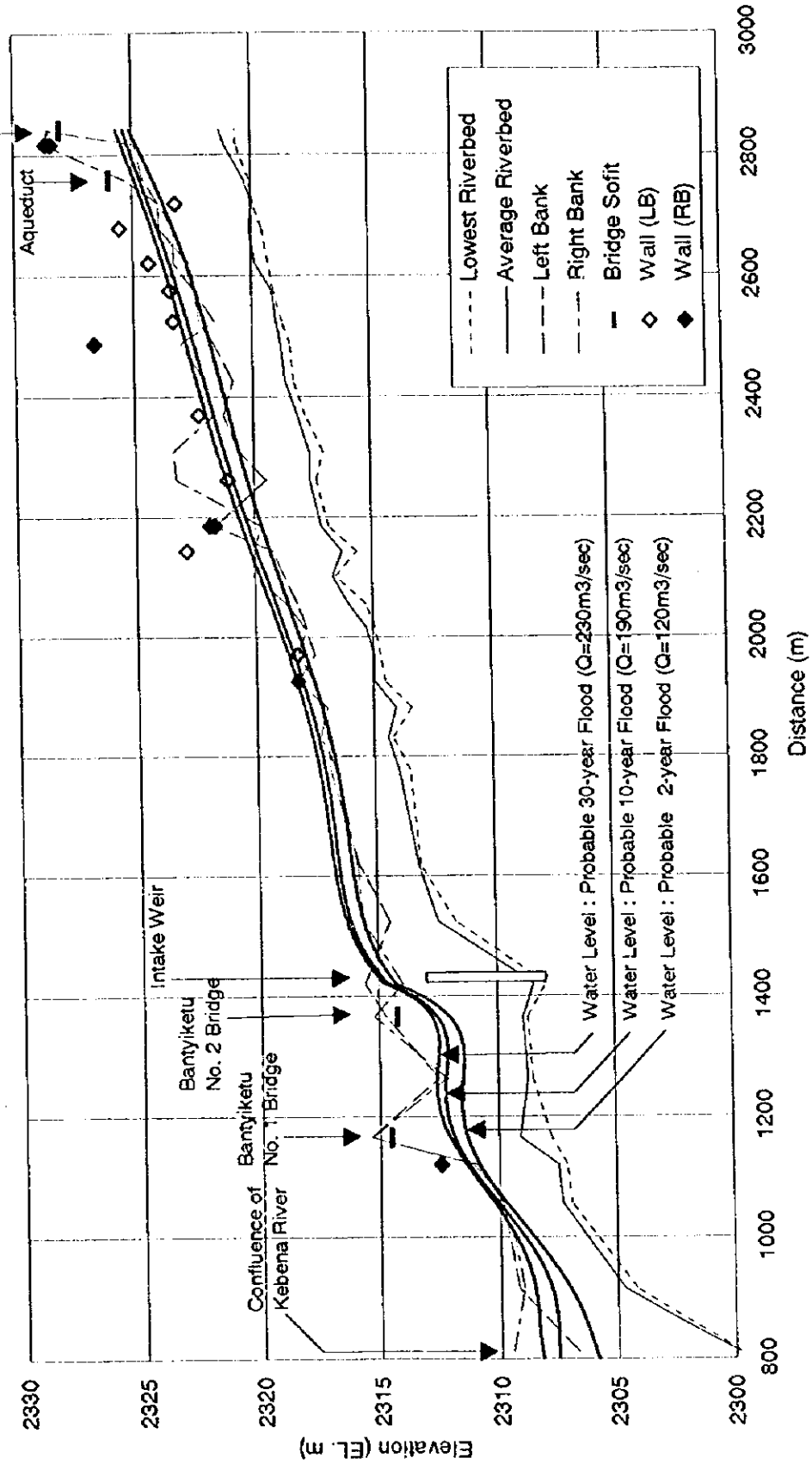


Figure 2.1.8 Longitudinal Profile - Bantiyketu River (1/2)

Longitudinal Profile - Bantiyketu (2)

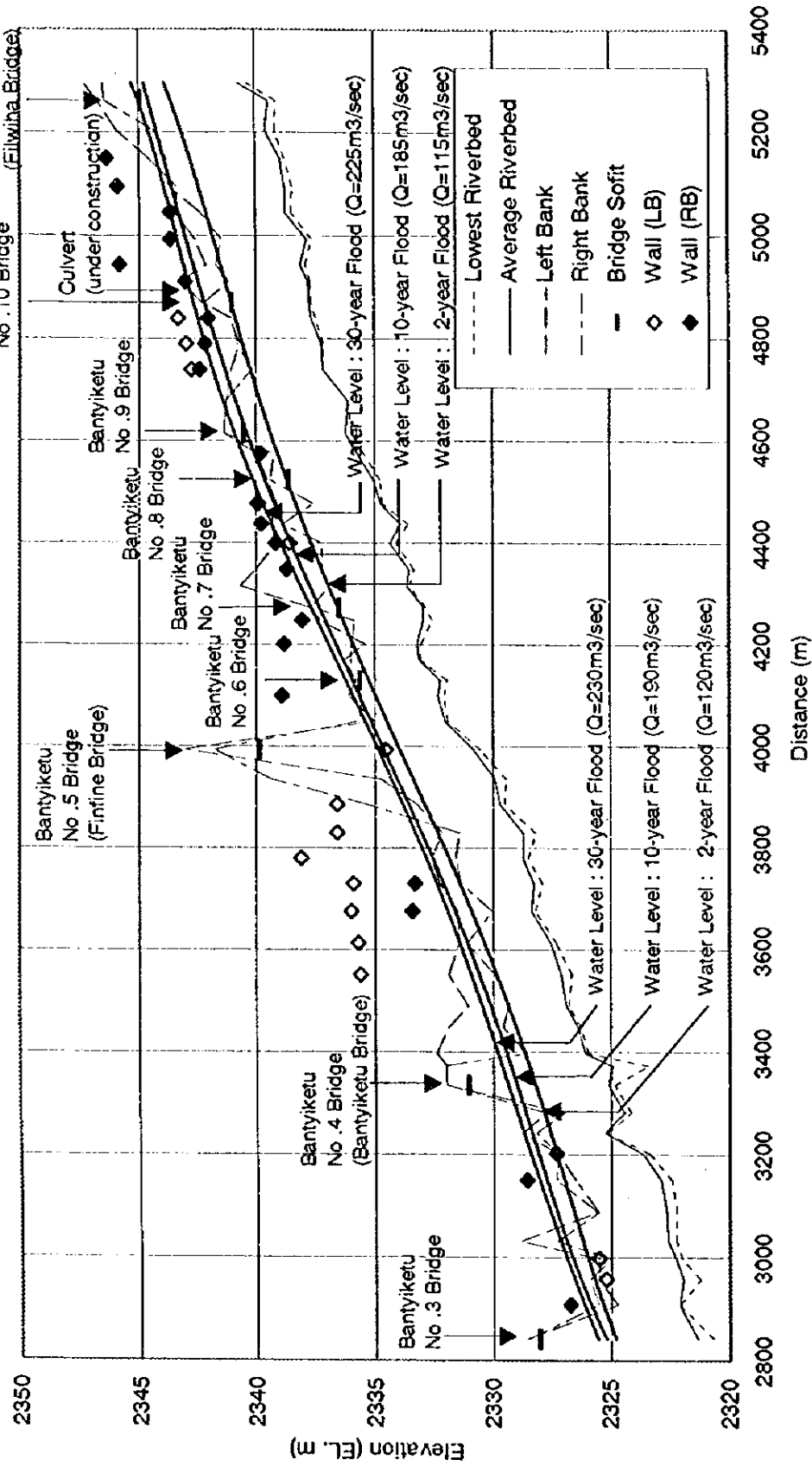


Figure 2.1.9 Longitudinal Profile - Bantiyketu River (2/2)

Longitudinal Profile - Kechene (1)

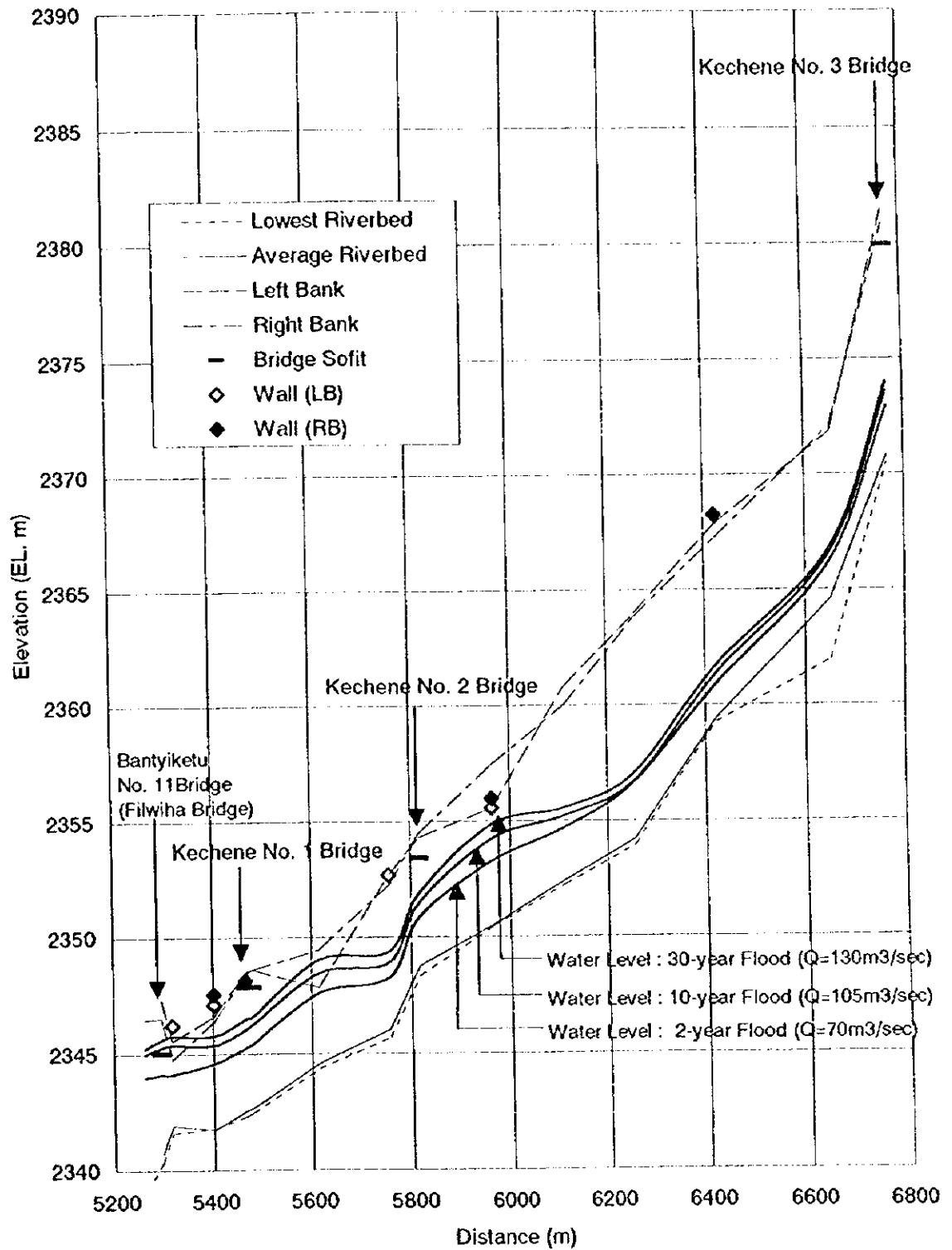


Figure 2.1.10 Longitudinal Profile - Kechene River (1/2)

Longitudinal Profile - Kechene (2)

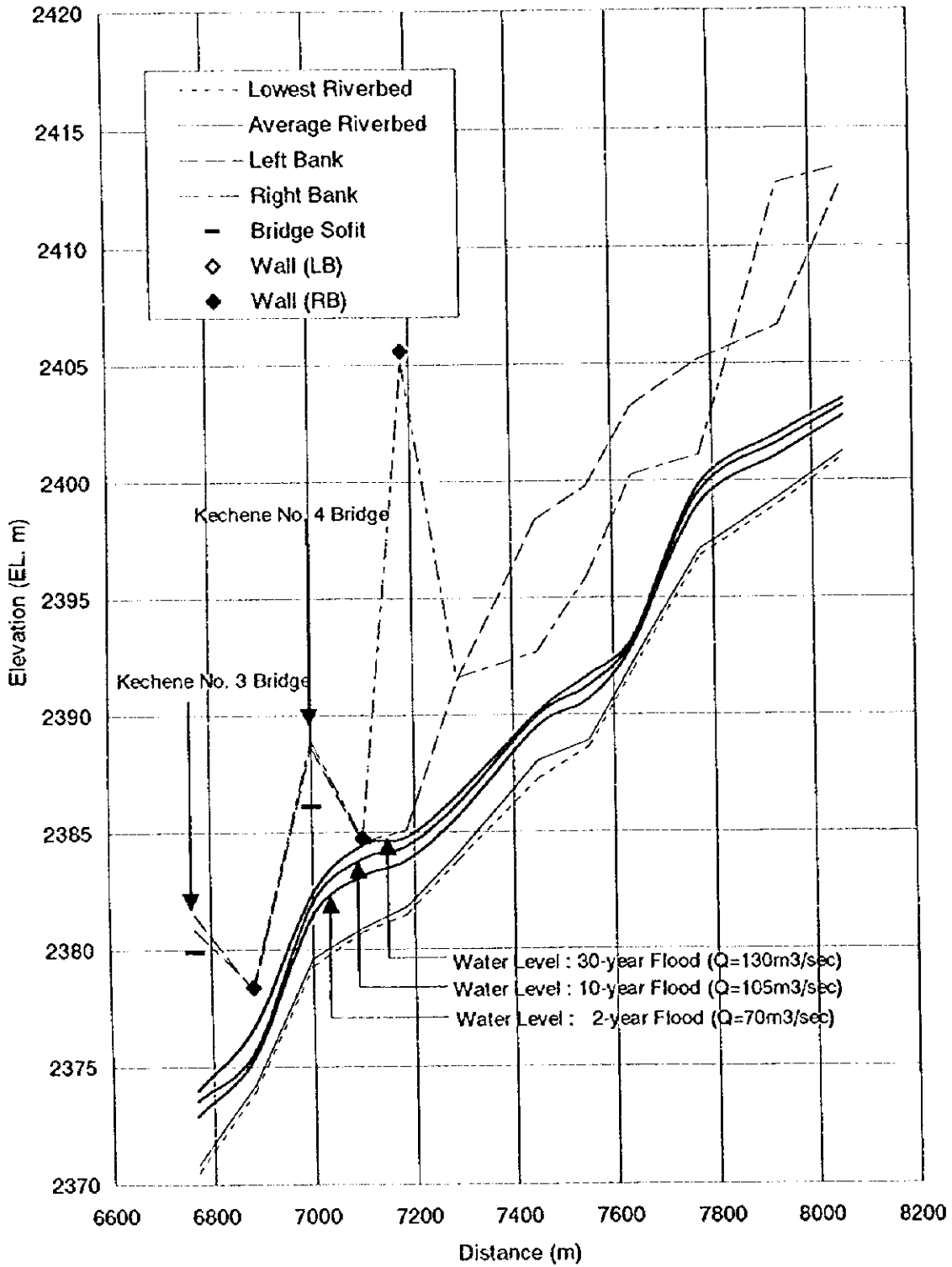


Figure 2.1.11 Longitudinal Profile - Kechene River (2/2)

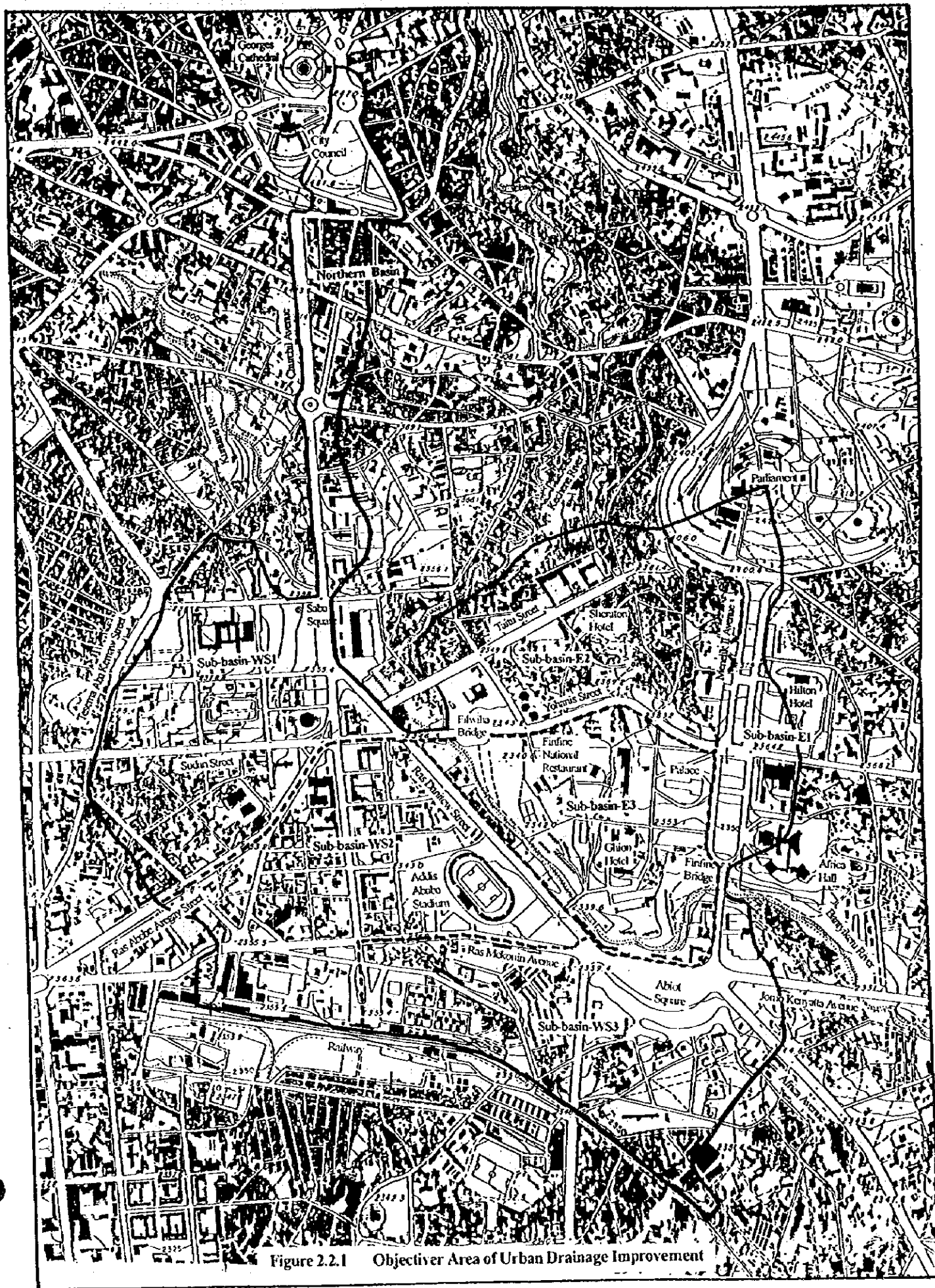


Figure 2.2.1 Objectiver Area of Urban Drainage Improvement



Figure 2.2.2 Outline of Existing Urban Drainage System

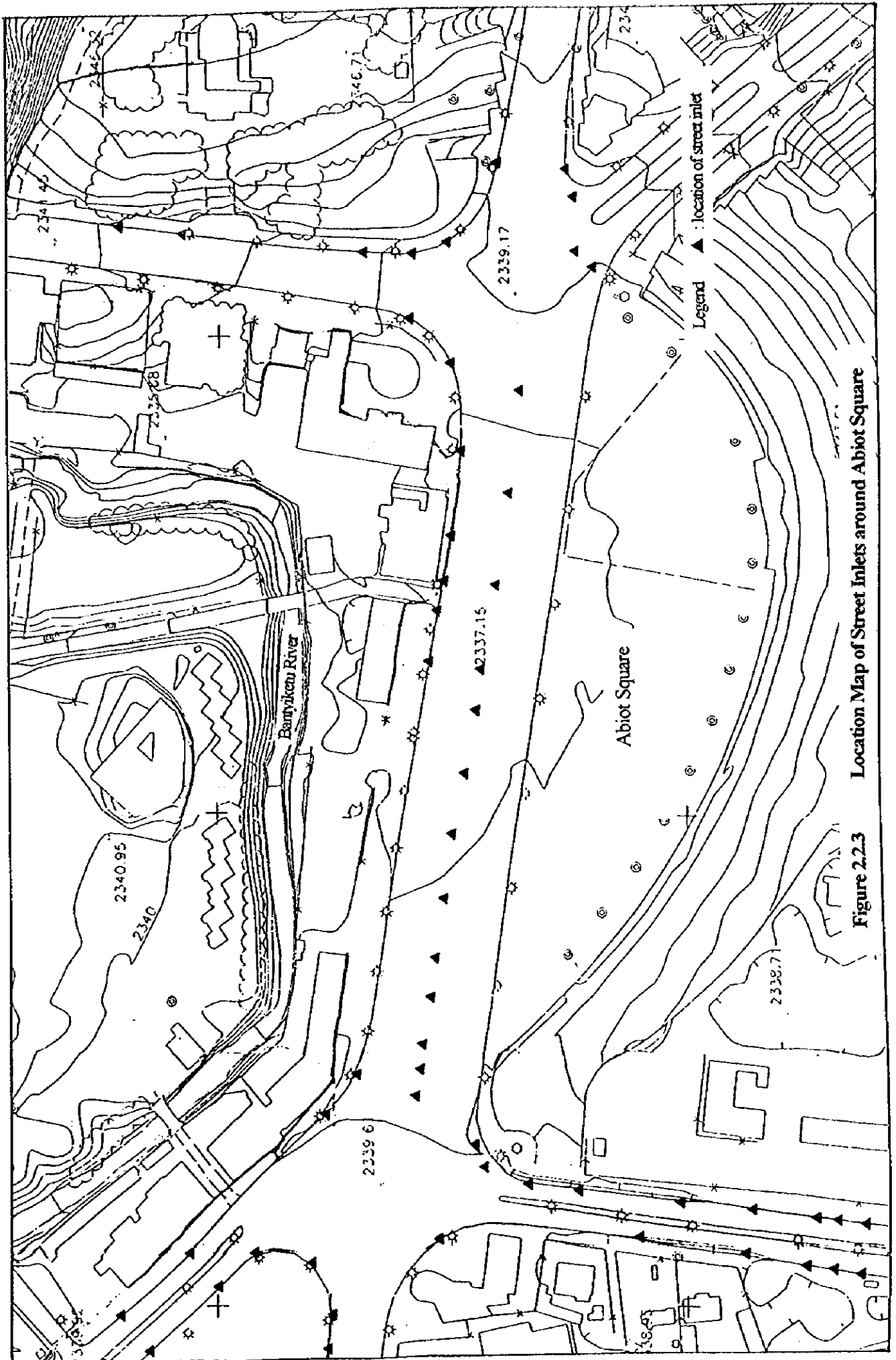


Figure 2.2.3 Location Map of Street Inlets around Abiot Square