DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

THE GOVERNMENT OF THE REPUBLIC OF THE PHILIPPINES

BASIC DESIGN STUDY REPORT
ON
FLOOD MITIGATION PROJECT IN ORMOC CITY
IN
THE REPUBLIC OF THE PHILIPPINES

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING CO., LTD

CENTRAL CONSULTANTS CO., LTD

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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on Flood Mitigation Project in Ormoc City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent a study team to the Philippines from December 9, 1996 to December 29, 1996.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss the draft basic design, and as this result, the present report was finalized.

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

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

March, 1997

Kimio FUJITA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

March, 1997

We are pleased to submit you the Basic Design Study Report on Flood Mitigation Project in Ormoc City, Republic of the Philippines.

The study was conducted by the consortium of CTI Engineering Co., Ltd. and Central Consultants Co., Ltd., under a contract to JICA, during the period from December 4, 1996 to March 31, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration on the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

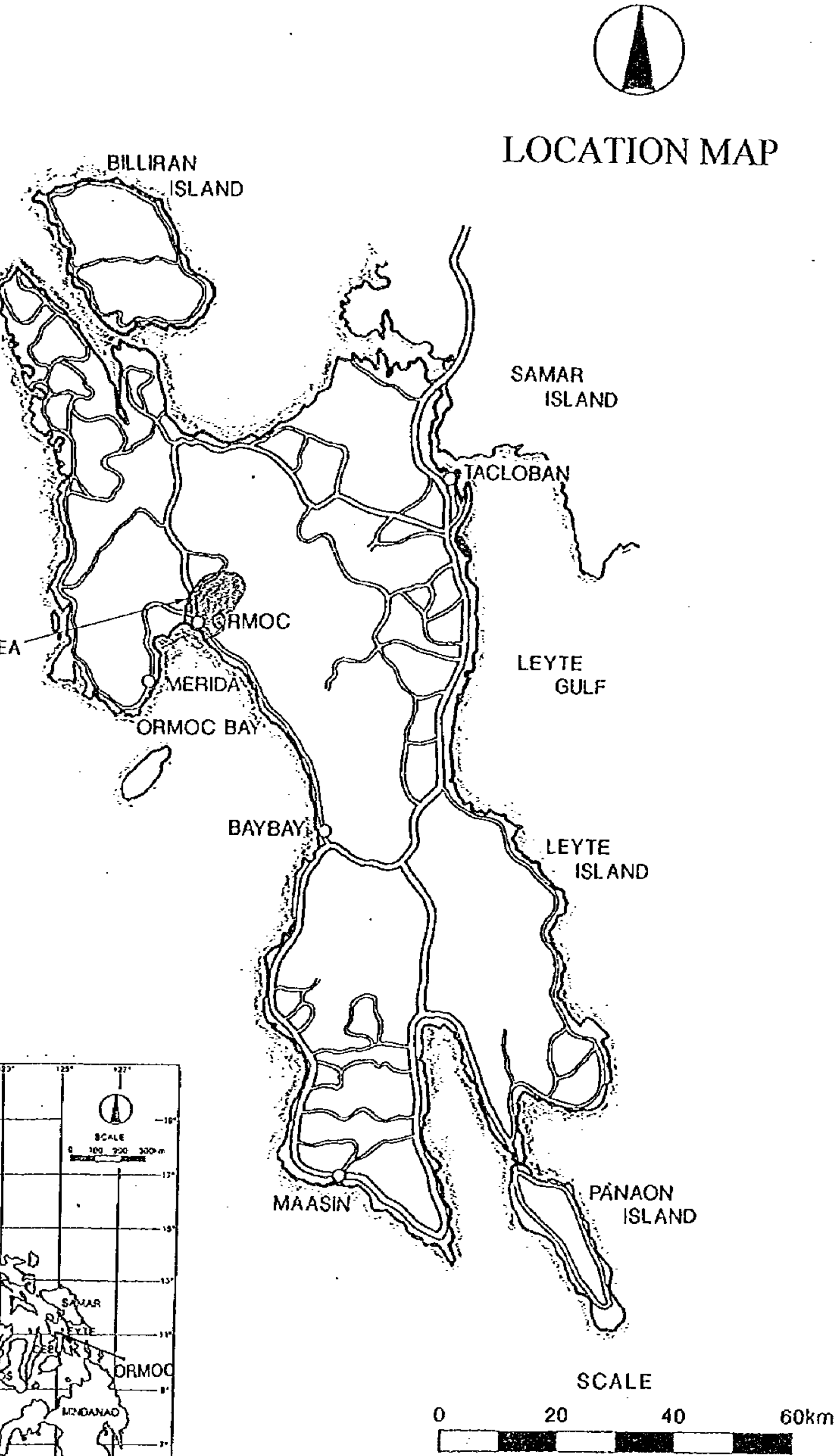
We hope that this report will contribute to the further promotion of the project.

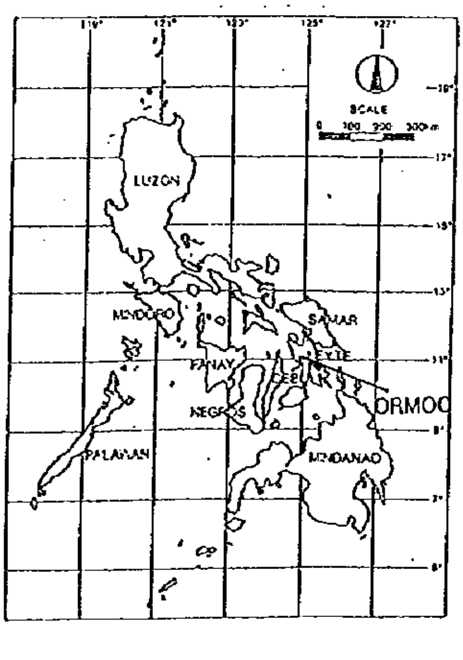
Very truly yours,

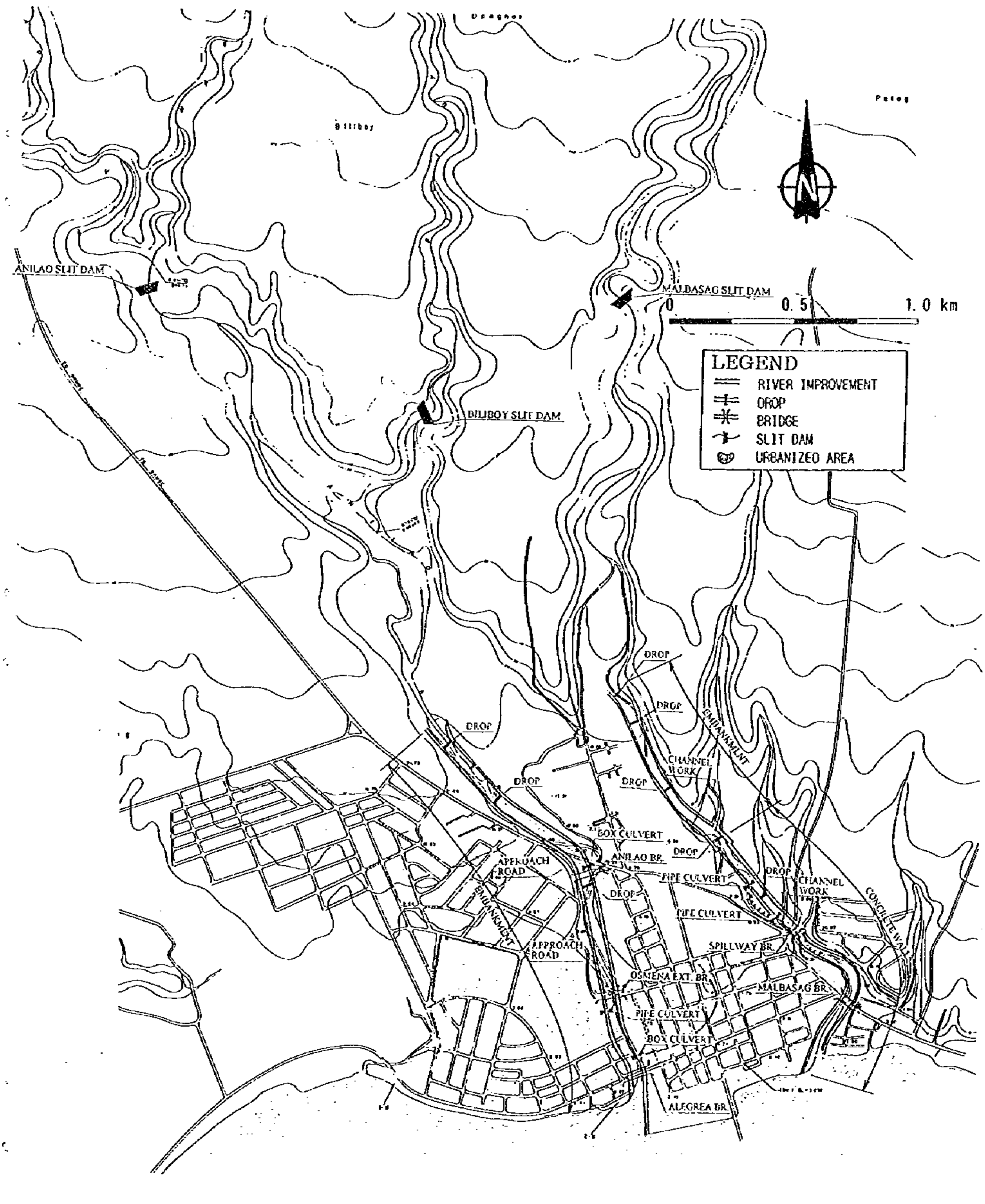
Makoto MIGITA
Project Manager
Basic Design Study Team
on Flood Mitigation Project
in Ormoc City

CTI Engineering Co., Ltd.
Central Consultants Co., Ltd.
Consortium

LOCATION MAP






ANILAO SLIT DAM
MALBASAG SLIT DAM
BILIBOY SLIT DAM
0
0.5
1.0 km
LEGEND
RIVER IMPROVEMENT
DROP
BRIDGE
SLIT DAM
URBANIZED AREA
DROP
EMBANKMENT
CHANNEL WORK
BOX CULVERT
ANILAO BR.
APPROACH ROAD
PIPE CULVERT
CONCRETE WALL
SPILLWAY BR.
OSMENA EXT. BR.
MALBASAG BR.
BOX CULVERT
ALEGREA BR.
O R M O C B A Y

STUDY AREA

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LIST OF FIGURES

ABBREVIATIONS

AGENCIES/ORGANIZATIONS

ADB	:	Asian Development Bank
BOD	:	Bureau of Design, DPWH
DENR	:	Department of Environmental and Natural Resources
DPWH	:	Department of Public Works and Highways
EMB	:	Environmental Management Bureau
GOP	:	Government of the Philippines
GOJ	:	Government of Japan
IBRD	:	International Bank for Reconstruction and Development
JICA	:	Japan International Cooperation Agency
LGU	:	Local Government Unit
LWUA	:	Local Water Utility Administration
NAMRIA	:	National Mapping and Resources Information Authority
NCR	:	National Capital Region, DPWH
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Evaluation Commission
NIA	:	National Irrigation Administration
NGO(s)	:	Non-Governmental Organization(s)
NPC	:	National Power Corporation
NPCC	:	National Pollution Control Commission
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistical Office
NWRB	:	National Water Resources Board
OCD	:	Office of Civil Defense, Department of National Defense
OECF	:	Overseas Economic Cooperation Fund, Japan
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PMO	:	Project Management Office, DPWH
PPA	:	Philippine Ports Authority
RDC	:	Regional Development Council

ACRONYMS

A/P		Authorization to pay
B/A		Banking Arrangement
BOD	:	Biological Oxygen Demand
DBMS	:	Database Management System

ECC	:	Environmental Compliance Certificate
ECP	:	Environmentally Critical Project
ECA	:	Fnvironmentally Critical Area
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
E/N	:	Exchange of Notes
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
ICC		Investment Coordination Committee
MSL	:	Mean Sea Level
MSHHWL	:	Mean Spring Higher High Water Level
PD	:	Project Description
P.D.	:	Presidential Decree
PREMIUMED	:	Program for Essential Municipal Infrastructure, Utilities, Maintenance and Engineering Development
VA	:	Value Added Tax

MEASURES/SYMBOLS

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
g, gr.	:	gram
kg	:	kilogram
t, ton	:	metric ton
m^2	:	square meter
ha, has	:	hectare(s)
km^2	:	square kilometer
l, lt., ltr	:	liter
m^3	:	cubic meter
s, sec	:	second
min.	:	minute
hr	:	hour
yr	:	year

mm/hr	:	millimeter per hour
m/s	:	meter per second
km/hr	:	kilometer per hour
mg/l	:	milligram per liter
m^3/s	:	cubic meter per second
$m^3/s/km^2$	:	cubic meter per second per square kilometer
%	:	percent
¥	:	Japanese Yen
₱	:	Philippine Peso
$	:	US Dollar

CHAPTER 1. BACKGROUND OF THE PROJECT

The geographical location and the meteorological conditions of the Philippines make it fragile to flood disasters. Losses due to frequent flood disasters have been the serious obstacles to sustainable development, and the Government of the Republic of the Philippines has been making efforts to mitigate flood damage, aiming at providing a safer and a more pleasant living condition for the Filipino people. Most of the expenditures for flood control have been, however, directed to metropolitan areas or the big river basins, and flood control works for small and medium size rivers have not been appropriately provided.

In the above circumstances, Ormoc City was attacked by Typhoon Uring on November 5, 1991. The typhoon brought tremendous damage to the city, accounting for approximately 8,000 deaths and missing, 14,000 houses destroyed and about 600 million pesos of estimated total damage. This disaster was called in the Philippines as the "Ormoc Tragedy of 1991," because of the huge number of deaths and missing people.

Some rehabilitation works have been undertaken by the Government, but these were only the reconstruction of damaged structures such as bridges and dikes. Improvement works on the Anilao and Malbasag rivers have not been carried out, so that the flood control capacity of these rivers still remains in the same condition as before the disaster in November 1991. Therefore, Ormoc City is still exposed to the menace of disastrous floods.

"The Study on Flood Control for Rivers in the Selected Urban Centers" was conducted by JICA from 1993 to 1994, and Ormoc City was selected as one of the high priority projects. Then, in December 1995, the Government of the Republic of the Philippines made a request for Grant Aid from the Government of Japan for "The Flood Mitigation Project in Ormoc City" (hereinafter called "the Project") based on the results of the above Study.

The Government of Japan has decided to determine the feasibility of the Project under Japan's Grant Aid and entrusted the "Basic Design Study on Flood Mitigation Project in Ormoc City" (hereinafter called "the Study") to the Japan International Cooperation Agency (JICA), the agency in charge of implementing the technical assistance program of the Government of Japan.

This Report has been prepared, based on the project site-survey as well as data collection in the Philippines and the analysis in Japan conducted by the Study Team headed by Mr. Masayuki Watanabe, Development Specialist, Institute for International Cooperation, JICA, which was dispatched to the Philippines from December 4 to 29, 1996. The Report is to explain the contents and implementation plan of the Project under Japan's Grant Aid", as well as to confirm the mutual understandings regarding the basic design of the Project.

CHAPTER 2. CONTENTS OF THE PROJECT

2.1 Objective of the Project

The objectives of the Project are as follows:

(1) To secure human lives and people's properties of Ormoc City from the flood with a return period less than 50-year ,not to repeat such a disastrous flood damage as brought by Tyhoon Uring in November 1991 because of the innundation of Anilao and Malbasag rivers; and

(2) To conserve and improve the river environment since both Anilao and Malbasag rivers are closely related to a daily common life of the resident of Ormoc City. Also to generate a great impact to other urban centers as a model project to mitigate flood damage and improve the river environment.

The aim of the Basic Design Study is to formulate the Project to satisfy the conditions for Japan's Grant Aid. The Study is divided into three stages; namely, (1) field survey (December 4, 1996 to December 29, 1996); (2) analysis in Japan (December 30, 1996 to March 5, 1997); and (3) explanation of the Draft Basic Design Report (March 6,1997 to March 14, 1997).

It is important for both the Government of the Philippines and the Government of Japan to understand that at this stage of the Study, no commitment is made from Japan concerning the realization of the Project under the Grant Aid Scheme. The Final Report will serve as a guide for the Japanese Government to decide whether or not the Project can be executed under the Grant Aid. The basic concepts, scale, contents and related items, in case that the Project is executed under Grand Aid, are also to be decided from the results of the Study.

2.2 Basic Concept of the Project

Flood Damage by 1991 Flood (Typhoon Uring)

According to the hydrological data, typhoons with rainfall of more than 100 mm attacked Ormoc City about ten times from 1982 to 1991. Among them, Typhoon Uring in November 1991 was the biggest and it brought the most disastrous flood damage as indicated in Fig. 2.2.1.

Even though Ormoc City made a great effort after floods to rehabilitate/repair the damaged infrastructures such as roads, bridges, and river/drainage improvement works at the amount of about 50 million pesos in the five years from 1992 to 1996, the works were limited to small scale and far from appropriate flood control countermeasures to release Ormoc City from flood damage.

Flood Damage by 1991 Flood (Typhoon Uring)

Item of Damage	Damage Amount
1. Person	
1.1 Dead	4,922 Persons
1.2 Missing	3,000 Persons
2. House/Building	
2.1 All Destroyed	2,850 Houses
2.2 Destroyed Partially	10,910 Houses
3. Commercial Damage	49.0 Million Pesos
4. Livestock Damage	6.0 Million Pesos
5. Agricultural Damage	3,800 ha, 43.0 Million Pesos
6. Fishery Damage	0.9 Million Pesos
7. Public Infrastructure	
7.1 Road	286.0 Million Pesos
7.2 Rivers/Drainage	188.0 Million Pesos
7.3 Bridges	48.0 Million Pesos
TOTAL	620.9 Million Pesos

Source: Ormoc City

2.2.1 Basic Concept of the Project

The flood discharge in November 1991 was, from the flood mark in the channel, estimated at about 600 m^3/s in Anilao River and about 300 m^3/s in Malbasag River, which corresponds to almost 50-year return period. This enormous flood discharge was attributed to the dam-up of flow because of clogging by floating logs from the mountainous areas.

On the other hand, the Anilao and Malbasag river channels at their bank-full capacities may confine only the flood discharge of 2 to 5-year return period in the present condition. Both river channels are steep and the flow velocity is very high, resulting in the strong and destructive flood flow along the rivers.

Taking the above characteristics into consideration, the proposed works for the Project may have to be consisted of the following three components: (1) River improvement of the Anilao and Malbasag rivers to confine the flood discharge of 50-year retun period in the channel; (2) Construction of slit dams to stop/collect floating logs that flow down from the mountainous area; and (3) Reconstruction of bridges not to cause clogging by floating logs, and to fit them with the new river alignment.

Above proposed works would secure human lives and peoples properties of Ormoc City from the damage caused by the flood less than 50-year return period,however,a further well-arranged flood defence/evacuation system is needed to be ensured by Ormoc City after completion of the Project, since the Project is not designed to cope with the flood more than 50-year return period.

In the design, conservation and/or improvement of river environment is also taken into consideration, because the river water is at present utilized for washing, bathing, swimming, livestock water, etc., and the riverine is also closely related to the daily life activities of the residents.

Taking the nature of the Project into consideration, the fundamental components are based on the following basic concepts:

(1) River Improvement

River improvement is to be made to safeguard Ormoc City from floods of a 50-year return period, by widening the channel and setting the high water level in almost the same elevation as the ground level of both banks. Hydraulic drops will be provided to both Anilao and Malbasag river channels, not only to decrease the flow velocity of floods but also to improve the river environment.

Drainage sluices and culverts are to be provided along the dike to drain the rainwater and domestic sewerage water of inland areas, and not to allow the reverse flow of floodwaters by providing sluice gates, when needed.

(2) Slit Dams

In the upstream of both Anilao and Malbasag rivers, 3 slit type dams (2 dams for Anilao and 1 dam for Malbasag) are to be provided to stop the floating logs and prevent the recurrence of serious damage like that caused in November 1991 because of clogging by logs.

(3) Bridges

All of the five (5) major bridges will be reconstructed so that they will not cause clogging by floating logs, adopting the appropriate length of span and clearance.

2.2.2 Major Changes between Request and Basic Design

Major changes are made on the request for grant aid by the Government of the Philippines based on the field survey from December 4, 1996 to December 29, 1996 and the basic design study, as discussed below.

(1) River Improvement

Channel width is widened at the meandering stretches in the downstream of Malbasag River to avoid problems caused by the water level raising of meandering flood flow and the scouring of channel bed.

Sluices and culverts are to be reconstructed in order to promote the smooth drainage of inland water and domestic sewerage water. Gates are to be provided for two sluices at just upstream of Anilao Bridge (left bank) and just upstream of Algeria Bridge (left bank).

(2) Slit Dam

In the request for Grant Aid, slit dam sites are the same as those in the study conducted by JICA in 1994. Sites are changed in this present Study to increase the control effect on floating logs, as discussed below.

(a) Anilao River

In the study in 1994, two dams were proposed in the upstream of Anilao main river. In the basic design study, however, one dam is in the upstream of Anilao main river and the other dam is in Biliboy River, so as to enhance the stopping effect on floating logs.

(b) Malbasag River

Dam sites are changed to about 1 km downstream from the sites proposed in the 1994 Study.

(3) Bridge

In the basic design study, the possibility of repairing and/or strengthening of the present bridges was investigated, but all of the five (5) bridges were finally determined to be reconstructed as proposed in the 1994 study.

2.3 Basic Design

2.3.1 Design Concept

In the basic design for river channels, related river structures and bridges are performed based on the following concepts.

(1) River Improvement and Measures for Floating Logs

With a careful study on the causes of the 1991 flood damage and the characteristics of the present river channels, the policy of river improvement and measures for floating logs are determined. The results of the 1994 Study are reviewed as well, and the original design is revised if necessary, focusing on the following items:

(a) Identification of the area requiring river improvement and measures for floating logs.

(b) Proper alignment of river channel, considering measures against super-elevation at bending portion and serious local scouring.

(c) Proper longitudinal profile and cross sectional form of river channel including connecting measure at upstream and downstream ends.

(d) Proper measure to prevent floating logs from flowing down to the downstream area and sediment control if necessary.

(e) Others (Plan for river mouth and Plan for land fill)

(2) River Structures and Slit Type Dam

Prior to the basic design of river structures and slit type dams, the appropriate definitive plan is formulated through justification of the previous plan and the study on proposed location, scale/size, and safety of structures. As to the slit type dam, construction site, type of structure and size are determined by confirming the effectiveness of the structure through a comparative study.

(3) Bridge and Road

In the 1994 Study, all of the existing bridges were proposed to be reconstructed. A further study on all proposed bridges is performed in the basic design study with regard to the necessity of reconstruction and the possibility of reutilization of structural members. After these are confirmed, the basic design is carried out including the design of approach roads to the bridges and the detour plan during construction.

(4) Operation and Maintenance Management

Based on the evaluation of the current operation and maintenance management of the project executing agency, necessary proposal regarding this issue is made by the Consultant.

For the operation and maintenance (O&M), two measures are conceivable; namely; direct O&M measures for structures and measures for legal and institutional aspects such as the regulation of land use along riverbanks, the disposal of floating logs, the promotion of waste disposal, evacuation system and so on. The role-sharing of O&M management is proposed as follows:

Measures for Structure	District Engineering Office, Region VIII, DPWH
Measures for Legal and Institutional Aspects	Ormoc City

(5) Structural Design

The structural Design is to be made based on the careful study on the topographical, geological and hydrological characteristic of the basin and river channel, cause of the previous flood damage, adaptable construction materials and construction method, conservation of sustainable river environment and operation and maintenance after completion, as well as other social and economical aspects.

In the subject Project, following aspects were taking into consideration in the structural design by paying the special attention to the cause of past biggest flood damage brought by Typhoon Uring in November 1991.

(a) Not only to confine the flood discharge in the river channel at the downstream but also to stop/control the floating logo in the middle/upper reach by which the destructive damage was caused at the time of Typhoon Uring in November 1991.

Also, the excavation system was adapted in the river channel improvement by setting the high-water level almost equivalent to the ground surface elevation of the landside area in order to decrease the damage potential.

(b) To secure the structural stability/safety against expected forces of not only common structural loads but also natural active forces such as flood flow at the meandering portion, earthquake, floating logs, wave and so on.

(c) Improvement of river environment taking into consideration of actual river utilization of river water, free open space, scenic river view and so on.

(d) Use of locally productive/available construction materials as much as possible.

(e) Easy maintenance and operation after completion taking into consideration of the current managing capability of the related offices.

(f) Use of authorized proper design standard/manual of the Philippines as much as possible. In case of inappropriate provision and/or unavailability, authorized international standard will be adapted.

2.3.2 Basic Design

(1) River Improvement

Based on the existing river characteristics and past flood conditions, the river improvement plans for Anilao and Malbasag are as defined below.

(a) Improvement Stretch

(i) Anilao River

According to the flood plain survey, the flood inundation occurred, at the time of Typhoon Uring in November 1991, at the point of approximately 1.8km upstream from the river mouth where the river terrace starts and hence the flow capacity abruptly decrease towards down stream. Since no houses or facilities are observed in the vast flood plain at the upstream of the inundation point, the improvement stretch is proposed from the river mouth to Section ST. 1+930.

The improvement Stretch at about 1.93km from the river mouth, which was proposed in the feasibility study done by JICA in 1993, deems to be pertinent and identified adequate in the subject design.

(ii) Malbasag River

Topographic characteristic and river condition as well as land use of Malbasag River are almost similar to those of Anilao River. Flood inundation was at the time of Typhoon Uring in November 1991, occurred at the point of approximately 2.0km upstream from the river mouth, where the channel is meandered and channel width is narrow and the ground elevation of landside area is low. At present, concrete type dike is provided and channel width is widened at this point under the financial assistance of Asian Development Bank (ADB).

The improvement stretch was set, based on the flood plain survey, from the river mouth to Section ST. 1+850 where the concrete type of dike was constructed under ADB assistance. The upper reach of Section ST. 1+850 was not included since the only a few houses are observed and the landuse is a small scale of paddy field and/or forest.

(iii) Countermeasures for Floating Logs

The improvement stretch of Anilao and Malbasag rivers was determined to be implemented in the downstream stretch of the flood inundation point at the time of November 1991 flood where the landuse are highly developed and the houses are congested.

However, since flood damage of November 1991 flood was caused by the floating logs which flows down from the middle/upper mountainous area, slit type of sabo dams are to be provided to stop/control the floating logs. (Two dams in Anilao river and one dam in Malbasag river)

(b) Basic Conditions for River Improvement

Taking into consideration of the topographical, geological and hydrological characteristics as well as other aspects like a cause of inundation of the previous flood, construction materials/method, conservation of river environment. etc., the basic conditions for the river improvement was determined as follows.

(i) Improvement is fundamentally made by excavation system as well as by widening the channel to increase the flow capacity.

Considering the susceptibility of Anilao and Malbasag rivers for floating logs, three slot type of dams (two dams for Anilao river and one dam for Malbasag river) will be provided.

(ii) To minimize the flood damage potential, the design high water level is set lower than the elevation of the existing river banks.

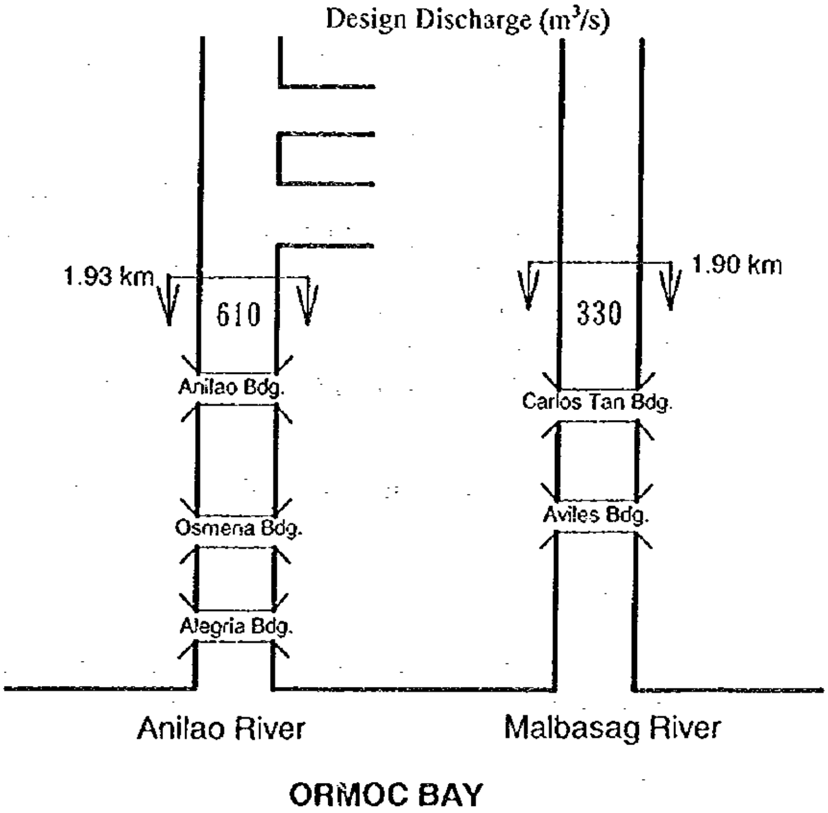
(c) Design Scale and Design Flood Discharge

The river improvement works are designed on the scale of a 50-year return period for the following reasons:

(i) In the 1991 flood, the flood peak discharges are estimated at 600-700 m^3/s in the Anilao River and 250-300 m^3/s in the Malbasag River, which correspond to 40 to 50-year return period, although the discharges may be regarded as a sort of dam-breach discharge.

(ii) According to the JICA Study in 1993, the project costs for the river improvement between the master plan (project scale: 50-year) and the urgent plan (project scale: 20-year) show a small difference of 20%, so that applying the master plan to this project is not an over-investment.

The design discharge for the project is estimated as graphically shown below.



(d) Channel Alignment

The channel alignment is designed based on the following conditions:

(i) Conforming to the existing alignment to minimize house evacuation, land acquisition and construction cost as well as considering the agreeable consensus by the residents ;

(ii) Providing a smooth flow with less meandering of channel alignment since the improvement stretch is short and channel bed gradient is steep ;

(iii) Maintaining the same channel width as much as possible to attain the uniform channel flow during floods ; and

(iv) Allowing the curvature of the channel to be at least 5 times the water surface width and the angle of bend to be more than 90 degrees.

Especially, attention was paied on the following aspects to determine the alignment of Anilao and Malbasag river.

(i) Anilao River

Existing bending alignment with almost 90 degrees at the just upstream of Anilao bridge was modified to obtaining the smooth flood flow with less meandered channel by shifting the alignment to the northern side of the existing river alignment

(ii) Malbasag river

The existing alignment of the section is controlled by topographical conditions and social constraints. Therefore, the alignment is designed to conform with the existing one, resulting in the ratio of curvature becoming 3 times. Accordingly, the super-elevation of design discharge is estimated to be 24.5 cm at the concave side of bend; hence, the dike crown in this side is raised by 25 cm.

The proposed channel alignment of Anilao and Malbasag rivers are shown in Figs. 2.3.1 and 2.3.2.

(e) Longitudinal Profile

The longitudinal profiles of the Anilao and Malbasag rivers are designed as mentioned below and shown in Figs. 2.3.3 and 2.3.4.

(i) Design Riverbed

Existing channel bed gradient in the improvement stretch is steep, 1/100 to 1/150 for Anilao river and 1/80 to 1/150 for Malbasag river. In order to reduce the tractive force in the channel, the existing channel bed profile is to be made gentler by providing hydraulic drops in the channel.

The rate of the proposed riverbed gradient to the existing one is basically set at less than 0.5, since the big change of channel bed gradient from the existing one causes the scouring / sediment problems and is not recommended from the viewpoint of bed stability, while the riverbed elevations of both at rivermouth and at the upstream end of the improvement stretch are determined to conform with the existing lowest riverbed elevation to avoid the excessive excavation

Hydraulic drop is set not only to attain a gentle channel bed profile but also to realize a steady and uniform flow in the channel. The height of hydraulic drop is designed not to exceed 1.5m height above the channel bed in order to ensure riverbed stability.

The interval of drops is determined as follows :

$$L = \frac{m \cdot n}{m - n} \cdot h \text{ or } L1 = (2 \approx 6)xB$$

Where,

$L, L1$: interval of hydraulic drops

h	:	head of hydraulic drop
B	:	width of river channel
$1/m$	:	existing riverbed slope
$1/n$	:	proposed riverbed slope

Interval of Hydraulic Drops

River	h (m)	m (m)	n (m)	B (m)	L (m)	$L1$ (m)
Anilao	1.50	100	250	58	250	116 to 348
Malbasag	1.50	80	200	47	200	94 to 282

Based on the above design concepts, the longitudinal profiles of riverbed in the Anilao and Malbasag rivers are designed as follows:

Riverbed Profile of Anilao River

Section	Length (m)	Elevation (EL. m)	Gradient
River Mouth to AN.09+55	952.0	-1.50 to 2.308	1/250
AN.09+55 to AN 14+50	507.2	3.808 to 5.837	1/250
AN.14+55 to AN.18+00	341.8	7.373 to 10.736	1/180
AN.18+00 to AN.18+30	30.0	10.736 to 11.70	Transition

Riverbed Profile of Malbasag River

Section	Length (m)	Elevation (EL. m)	Gradient
River Mouth to MA.09+68	875.0	-1.00 to 3.375	1/200
MA.09+68 to MA 20+00	918.8	4.875 to 15.469	1/200
MA.20+00 to MA.20+47.2	47.2	15.469 to 16.70	Transition

(ii) Design High Water Level

The design high water level is equivalent to the average elevation of the adjoining ground. The mean high water spring in the Ormoc Bay is EL.+1.15 m, while the high water levels of river channel are EL.+2.50 m for Anilao River and EL.+2.00 m for Malbasag River.

(f) Cross Section

(i) Type

A single trapezoidal cross section is principally employed for the following reasons:

- The single cross section is advantageous because a smaller width could assure the same flow area as the compound cross section, resulting in minimized compensation such as house evacuation and land acquisition.

- The construction cost and maintenance cost of the single cross section are smaller than those of the compound cross section.

To ensure the stability of riverbank, a side slope of 1:2 (vertical to horizontal) is adopted for both the Anilao and Malbasag rivers except for the lower stretch of Malbasag River. The lower stretch of Malbasag River is located in the congested urban area with many houses/buildings. A steep riverbank slope of 1:0.5 (vertical to horizontal) is adopted for the purpose of minimizing compensation. The water depth is designed equivalent to that of the existing river channels. The maximum flow velocity is limited to less than 4.0 m/s, while revetment shall be provided for the protection of riverbank from the flow velocity of more than 3.0 m/s.

Based on the above considerations, the dimensions of channel cross section are determined as tabulated below.

Dimensions of Channel Cross Section of Anilao River

Stretch	Width* (m)	Water Depth (m)	Side Slope (V:H)
River Mouth to AN.09+55	61.8	4.0	1:2
AN.09+55 to AN.14+50	61.8	4.0	1:2
AN.14+50 to AN.18+00	60.6	3.7	1:2
(Note) *: The width of channel is taken from bank to bank.			

Dimensions of Channel Cross Section of Malbasag River

Stretch	Width* (m)	Water Depth (m)	Side Slope (V:H)
River mouth to MA.09+68	38.2	3.0	1:0.5
MA.09+68 to MA.20+00	44.8	3.0	1:2
(Note) *: The width of channel is taken from bank to bank.			

The design cross sections of the Anilao and Malbasag rivers are as shown in Figs. 2.3.5 and 2.3.6.

(ii) Width

The width of river channel is determined by referring to the relation between flood discharge and width of channel as tabulated below.

Relation between Flood Discharge and Channel Width

Flood Discharge (m^3/s)	Width of Channel (m)
300	40 to 60
500	60 to 80
1,000	90 to 120
2,000	160 to 220
5,000	350 to 450
Source: "Standards of River Planning", Ministry of Construction, Japan	

The design widths of both rivers are as follows, which are about 1.6 times wider than the average width of the existing ones. The channels should be stable with the design river width.

Design Channel Width

River	Design Discharge (m^3/s)	Width of Channel (m)
Anilao River	610	60 to 62
Malbasag River	330	39 to 45

(iii) Dike

The standard section of dike is determined according to the design flood discharge with a freeboard. Major dimensions of the proposed dike are as below:

Type and Dimensions of Dike

River	Type of Dike	Freeboard (m)	Crown Width (m)	Side Slope (V:H)
Anilao River Mouth to AN.18+30	Earth Dike	1.0	4.0	1:2
Malbasag River Mouth to MA.12+54	Concrete Wall	0.8	3.0	1:0.5
MA.12+54 to MA.20+47	Earth Dike	0.8	3.0	1:2

(v) Hydraulic Calculation

Based on the dimensions of proposed channels determined above, hydraulic parameters are obtained by uniform flow calculation. Results are tabulated below. As to the roughness coefficient, 0.035 is employed in consideration of the condition of riverbed materials and steep riverbed slope.

Hydraulic Calculation Results for Anilao River

Stretch	Riverbed Slope	Flow Area (m^2)	Hydraulic Radius (m)	Velocity (m/s)	Discharge (m^3/s)
River Mouth to AN.09+68	1/250	168.28	2.830	3.758	632.4 > 610
AN.09+68 to AN.18+00	1/180	151.12	2.600	4.189	633.1 > 610

Hydraulic Calculation Results for Malbasag River

Stretch	Riverbed Slope	Flow Area (m^2)	Hydraulic Radius (m)	Velocity (m/s)	Discharge (m^3/s)
River Mouth to MA.09+68	1/200	94.680	2.339	3.560	337.1 > 330
MA.09+68 to MA.20+00	1/200	96.120	2.243	3.462	332.8 > 330

The flow velocities of both river channels turn out to be bigger than the velocity of 3.0 m/s. Therefore, revetment shall be provided for the whole stretch of the rivers.

(vi) Maintenance Flow Channel

Anilao and Malbasag rivers are featured as urban rivers which serve not only for flood control but also for river water use of inhabitants in Ormoc City. The rivers have abundant water quantity in non-flooding time and water quality is good. The current river utilization shall be considered in the improvement works.

A maintenance flow channel is, therefore, provided in the river channel as shown in the channel cross sections in Figs. 2.3.5 and 2.3.6. The channel shape and dimensions are designed based on the mean maximum daily discharge and the existing cross section of low water channel, as shown below:

Dimensions of Maintenance Flow Channel

River	Channel Bed Width (m)	Channel Depth (cm)	Side Slope	Discharge (m^3/s)
Anilao	12	80	1:5	17
Malbasag	10	60	1:5	10

(g) River Mouth Treatment

(i) Anilao River

Sandbars extend from the edge of the left bank to the off-shore sea, forming a gentle bend in front of the river mouth as presented in Fig. 2.3.7. Their surface elevation is not high so that they are submerged during high tide. Further, the sandbars are flushed out during floods.

A small scale sediment deposit is also observed on the sea bed in front of the right shore dike. However, flood flow is not affected by this sediment since its surface elevation is almost equal to that of the riverbed. Therefore, there is no possibility of river mouth clogging either by sandbars or sediment. Only channel/sea bed excavation (elevation EL.-1.50m) along the left river/shore dike is proposed in the river improvement works. (Refer to Fig. 2.3.8)

(ii) Malbasag River

Since the dominant direction of off-shore current is south to north, the sandbars develop in the same direction, extending in front of the river mouth as shown in Fig. 2.3.7. Although the sandbar at the left bank extends closely to the right bank, the water channel is maintained without clogging. These sandbars at the river mouth are expected to be flushed out during floods. For the smooth flood flow the riverbed/sea bed is to be excavated up to the elevation of EL.-1.00m along the right river/shore dike as shown in Fig. 2.3.9.

(h) Land Fill

The existing meandering sections are improved by straight or gently curved alignment so that the sections are required to be filled after the closing works in order to protect dikes and the area behind the dikes from scouring and piping induced by flood flow.

Anilao River	ST.0+900 to ST.1+200, Left bank L=300 m
Malbasag River	ST.0+700 to ST.1+100, Right bank L=400 m

(i) Others

(i) Countermeasure against Extra Flood

In general, revetment, as a means of riverbank protection, is provided on the riverbank/dike up to the design high water level. However, a revetment is provided for the whole area of side slopes up to the dike crown for Anilao and Malbasag rivers because both rivers could have rapid and turbulent flows, and floating logs and sediment. The dike crown is also provided with gravel pavement, and the inland side slopes with sodding.

(ii) Local Scouring

Some countermeasures are taken for the following portions prone to serious local scouring.

Along Concave Side of Meander Bend

Revetment is embedded at least 1.0 m below the design riverbed and foot protection is provided on the riverbed at the toe portion of revetment.

Around Bridge Pier

The footing is placed 2.7 m below the design riverbed. This embedding depth is considered enough to cope with serious local scouring.

Upstream and Downstream of Hydraulic Drop

A concrete cut-off is provided at both end portions of main body and its embedding depth (from riverbed to the lower end of cut-off) is 2.0 m or longer.

(iii) Considerations on River Environment

Anilao and Malbasag rivers are featured as urban rivers which serve not only for flood control but water supply for irrigation and municipal water. In addition to these purposes, the rivers serve for providing river water and open space to local residents in adjacent areas. In the river improvement, the following points shall be taken into account:

- Preservation of clean water quality;
- Creation of better scenic view and pleasant open space; and
- Easy access to the waterfront.

(2) Riparian Structure

(a) Earth Dike

The design features of the earth dike are shown in the following table, and its standard cross-section is shown in Fig. 2.3.10.

Design Dimensions of Earth Dike

	Anilao River	Malbasag River
Freeboard	1.0 m	0.8 m
Crest Width	4.0 m	3.0 m
Dike Slope	1:2.0	1:2.0
Extra Embankment	10 cm	10 cm

The embankment materials should meet the following requirements:

Grain Size Distribution	15% to 70% silt and clay content
Moisture Content	less than 50%
Specific Gravity	approximately 2.5 t/m^3

According to the laboratory test of proposed embankment materials conducted in the JICA Study, the excavated material of the river channel could be used as embankment materials.

(b) Maintenance Flow Channel

A gentle slope (1:5) is given to the channel slopes considering access to the water edge. The channel is covered with boulder riprap to stabilize the channel alignment.

(c) Revetment

Since the flow velocity is more than 3 m/s, the river slope shall be covered with a wet stone masonry type revetment. At the back of the wet stone masonry, back fill concrete 10 cm thick and back fill gravel 25 cm thick are provided to ensure the strength and safety of the revetment.

The foundation of the revetment is embedded 1 m below the riverbed and covered with gabion mattress. To release the ground water from the back side of the revetment, a PVC pipe drain is installed in every 4 m^2 of revetment.

At the tidal area in the river mouth of the Anilao River, a steel sheet pile type revetment is applied to be free from the stream and tide diversion. The structural drawings of revetment are presented in Figs. 2.3.11 and 2.3.12.

(d) Leaning Wall

Concrete leaning wall is applied to the downstream sections of Malbasag River, where the riparian area is densely populated and hence the right-of-way is limited. The leaning wall is constructed of plain concrete with a slope of 1 : 0.5, and the foundation of the wall with 2 m long log piles is embedded 1 m below the riverbed.

Crest elevation of wall is set by adding freeboard to the design high water level. The typical sections are shown in Fig. 2.3.12.

(e) Hydraulic Drops

The drop structure comprise a main body portion, apron at its downstream portion, and riverbed protection in the upstream of the main body as well as in the downstream of the apron structure. The length of apron and riverbed protection is calculated by the Bligh's Formula. As the results of calculation, 5 m of apron length and 15 m of riverbed protection length were obtained.

Bligh's Formula adopted to determine the apron length is as shown below.

$$W = 0.60 \cdot Co \cdot D^{\frac{1}{2}}$$

$$L = 0.67 \cdot Co \cdot (Hd \cdot g)^{\frac{1}{2}}$$

where ; W : length of Apron (m)

L : length of River Bed Protection (m)

Co : Coefficient (0.6 for sand and gravel)

D : Heitht of Hydraulic Drop (m)

Hd : Height between Crown of Hydraulic Drop and Apron (=D)

g : Unit Discharge ($m^3/s/m$)

Demension of Hydraulic Drops

Item	Anilao R.	Malbasag R.
(1) Apron	—	—
1.1 Coefficient (Co)	6.00	6.00
1.2 Height (D)	1.50m	1.50m
1.3 Length of Apron (W)	4.41m	4.41m
(2) Bed Protection	—	—
2.1 Unit Discharge (g)	12.20$m^3/s/m$	11.00$m^3/s/m$
2.2 Height (Hd)	1.50m	1.50m
2.3 Length (L)	17.20m	16.33m

In consideration of the environmental impact such as the improvement of river scenery, boulders (diameter is around 50 cm) are used for the main body portion, and other portions are covered with rubble concrete.

The typical design of drop and related structures is shown in Fig. 2.3.13 to 2.3.15.

(f) Drainage Facilities

(i) Drainage Plan

There are totally 10 drainage areas where storm-water is discharged to the Anilao and Malbasag rivers as shown in

Fig. 2.3.16. Among them are two (2) major drainage areas connecting to Anilao River and also two (2) to Malbasag River. Other small drainage areas with a catchment area of less than 10 ha are two (2) relating to Anilao River and four (4) to Malbasag River.

The two (2) major drainage areas are provided with a box culvert to discharge storm-water to Anilao River and the other two (2) of Malbasag River are connected by an open channel. Pipe culverts are employed for outlets of small drainage areas to drain not only storm-water but also sewage water from the houses.

(ii) Design of Drainage Outlet

The drainage outlets along the rivers are given in the table below.

Design of Drainage Outlet

River Side	Name of Outlet	Area (ha)	Discharge*1 (m^3/s)	Location		Type of Outlet
				Sta. No (m)	Description	
Anilao Right Bank	AR-1	3.0	0.5	AN.10+00	U of Anilao Br.	φ 600 Pipe culvert
				AN.09+12	Lila Ave.	φ 1000 Pipe culvert
				AN.04+90	U of Osmeña Br.	φ 1000 Pipe culvert
				AN.04+30	Existing outlet	φ 600 Pipe culvert
				AN.01+60	U of Alegria Br.	φ 1000 Pipe culvert
				AN.01+45	Existing outlet	φ 600 Pipe culvert
Anilao Left Bank	AL-1	28.0	15.5*2	AN.10+08	U of Anilao Br.	Box culvert (2m×2m×2unit)
	AL-2	6.6	1.1	AN.04+90	U of Osmeña Br.	φ 1000 Pipe culvert
				AN.03+80	Existing outlet	φ 600 Pipe culvert
				AN.03+20	Existing outlet	φ 600 Pipe culvert
	AL-3	32.0	5.4	AN.02+20	U of Alegria Br.	Box Culvert (1.5m×1.25m×2unit)
Malbasag Right Bank	MR-1	7.0	1.2	MA.13+24		φ 600 Pipe culvert
				MA.11+25		φ 1000 Pipe culvert
	MR-2	8.8	1.5	MA.07+20	U of Carlos Tan Br.	φ 1000 Pipe culvert
	MR-3	2.0	0.4	MA.02+60	U of Malbasag Br.	φ 1000 Pipe culvert
				MA.00+10	Existing outlet	φ 600 Pipe culvert
Malbasag Left Bank	ML-1	76.0	12.8	MA.13+60		Open channel
	ML-2	144.0	24.2	MA.07+20	U of Carlos Tan Br.	Open channel
	ML-3	4.5	0.8	MA.04+10	Existing outlet	φ 600 Pipe culvert
				MA.02+60	U of Malbasag Br.	φ 600 Pipe culvert

Note *1 : Specific Discharge = 16.8 $m^3/s/km^2$ (5-year return period).
*2 : Including the discharge of irrigation channel (10 m^3/s).
U : Upstream

(iii) Basic Design of Drainage Facilities

Box Culvert

A box culvert is adopted for outlets AL-1 and AL-2. Thickness of each member of the box culvert is as follows:

Side wall and top slab	35 cm
Base slab	40 cm
Center wall	30 cm.

Wing walls 3 m wide and 1.0 m higher than height of box culvert are provided at inlet and outlet. Since the invert elevations of these box culverts are lower than the design high water level, sluice gates are installed to prevent counterflow. A spindle type steel slide gate and manual operation system are employed for the gate.

To prevent piping, steel sheet piles 3 m long are provided at the outlet, and a cut-off wall at the center for the box culvert with gates.

The general plans of outlets AL-1 and AL-3 are shown in Figs. 2.3.17 and 2.3.18.

Pipe Culvert

RC pipe, factory produced, is used for the pipe culverts. To attain easier maintenance of the culvert, the design diameter of pipe is larger than 60 cm. The base of pipe is fixed with 20 cm thick sand bedding and the pipe is installed with gravel filling for the lower half portion on account of the foundation condition and thickness of cover soil. The standard design of the pipe culvert is shown in Fig. 2.3.19.

Drainage Ditch

At the inland toe of the dike, a drainage ditch is provided to prevent erosion by stormwater running along the toe of dike. The ditch is lined by wet-stone masonry. The features of the ditch are:

Bottom width	30 cm
Slope	v : h = 1 : 0.5
Thickness of lining	150 mm

(g) Maintenance Road

On the crest of dike, a 3-m gravel-paved road is constructed for maintenance and strolling along the rivers.

(h) Steps

Approach steps to the waterfront are constructed at about 200 m intervals, connecting to the existing road. The width of steps is set at 1.2 m for practical use and 15 m at the upstream of the Anilao Bridge to ease utilization of the river area. A typical design of steps is shown in Figs. 2.3.20 and 2.3.21.

(3) Slit Dam

In the disastrous flood of 1991, it was reported that a large quantity of floating logs with debris had increased the flood damage. These floating logs clogged the river channel and dammed up the flood water at the Anilao Bridge and some narrow sections of Malbasag River. The impounded flood water flowed down at once and flashed out of the city area when the dams of floating logs were breached.

To prevent a recurrence of the same tragedy, it is required to control the floating logs at the upstream of the urban area. For this purpose, a sabo dam of permeable type which is referred to as "slit dam" is proposed to be constructed.

(a) Planning Condition

(i) Sediment Discharge

Through the site investigation and analysis of the topographical and geological conditions, existing land use, vegetation and riverbank erosion, the conditions of sediment discharge are summarized as follows:

- The young volcanic cone in the mountain area is covered with thick vegetation. It is assumed that sediment yield from the mountain area is very low.

- Since the hilly area is covered with thick grass and palm tree or sugarcane plantation, the volume of sheet erosion at the hilly area is assumed very small.

- Main causes of sediment production of the rivers are shallow slope failures and gully erosions on the riverbank. However, no large scale failure/erosion on the riverbank was observed.

- No debris flow was observed in the mountainous area, especially the hilly area in the middle reaches where the river gradient is estimated at 1/100 to 1/40.

- Mud-flow deposit, 2 m high at its lowest end, was observed in Biliboy River 500 m upstream from the confluence with Anilao River.

(ii) Estimate of Volume of Floating Logs

The volume of floating logs during a flood was estimated based on the condition of bank and sheet erosions on site as presented below:

Fomula to estimate the floating logs is as follows :

① Floating Logs by Collaspe of Slope

$$Rs = Rsk + Rsc$$

$$Rsk = \alpha \cdot Dk \cdot A$$

$$Rsc = \alpha \cdot Dk \cdot A$$

$$Vs = 0.8(0.04 \cdot Rsk + 1.26 \cdot Rsc)$$

② Floating Logs by Errosion of River Bank

$$Rr = Rrk + Rrc$$

$$Rrk = W/_{1,000} \cdot Lr \cdot Cc$$

$$Rrc = W/_{1,000} \cdot Lr \cdot Cc$$

$$Vr = 0.9(0.04 \cdot Rrk + 1.26 \cdot Rrc)$$

where ;

A	:	Basin Area (km^2)
B	:	Mean Width of Basin (km)
L	:	Mean Length of Basin (km)
W	:	Length under High Water Level (km)
Lr	:	Length Mountain Torrent (km)
Dk	:	Shrub Tree Density of Basin (nos/km^2)
Dc	:	Palm Tree Density of Basin (nos/km^2)
Ck	:	Shrub Tree Density in Mountain torrent (nos/km^2)
Cc	:	Palm Tree Density in Mountain Torrent (nos/km^2)
Rs,Rr	:	Number of Logs
Vr, Vs	:	Number of Run-off Floating Logsn

Estimated Volume of Floating Logs

(Unit: No.)

River	Shrub	Palm Tree
Anilao River	1,069	4,289
Malbasag River	728	2,389
Total	1,797	6,678

On the other hand, the DENR Region VIII Office had carried out a site survey after the 1991 flood and presented the number of residual floating logs in the river channel and flood plain area, as summarized in the table below:

Number of Residual Floating Logs in 1991 Flood

(Unit No.)

River	Shrub	Palm Tree
Anilao River	200	1,031
Malbasag River	95	357
Total	295	1,388
Source: Technical Assessment of the Causes of the Ormoc City Flood (DENR, Region VIII, Dec. 1991)		

The actual number of floating logs is assumed to be more than a few times of the number of residual floating logs. Comparing the residual number of floating logs to the estimated amount, the estimated amount shows 5 times of the residual floating logs. Therefore, it is assumed that more than 5 times of residual floating logs had flown down the rivers.

(iii) Sabo Plan

As the 1991 flood had proven, a sabo plan is formulated on the concept of control and mitigation of floating logs instead of sediment discharge, while the sediment control plan is partly applied in Biliboy River where the mud-flow deposit may flow down to the main river course of Anilao River. The sabo plan is, therefore, formulated of a permeable sabo dam (slit type) to control and mitigate floating logs.

(b) Selection of Sabo Dam Site

(i) Proposed Site

Totally, eight (8) sabo dam (slit type) sites are selected for comparison and formulation of the most effective sabo plan as described below, and location of the dam sites are shown in Fig. 3.2.22.

Anilao River (A-1 to A-4 site)

The river channel consists of the wide river terrace from the upstream end of the river improvement section up to the confluence with Magasao River, the second tributary of Anilao River. In Anilao River, four (4) dam sites are identified to be suitable for controlling floating logs. They are (A-1) and (A-3) on Anilao main river, (A-2) on Magasao River and (A-4) on Biliboy River.

From the view of controlling all possible floating logs, (A-4) site is the most effective for the floating logs from the Biliboy River.

On the other hand, the combined sites of (A-1)+(A-2) and Site (A-3) are compared for their effectiveness in controlling the floating logs from both main river and Magasao River and economic efficiency.

The construction cost and effect of the proposed sites in the Anilao river basin is as shown below:

Comparison of Dam Sites for Anilao River

Item		Unit	Dam Site / River				
			A-1	A-2	Total	A-3	A-4
			ANILAO	MAGASAO	A-1+A-2	ANILAO	BILIBOY
a. Work Quantity	Steel Slits	ton	29	14	43	59	32
	Concrete	m^3	607	384	992	1,312	2,135
	Excavation	m^3	3,253	1,840	5,093	4,337	3,036
	Maintenance Road	m	300	100	400	200	150
b. Volume of Floating Logs		m^3	1,850	750	2,600	2,600	1,951
c. Construction Cost		mil. Yen	30	14	45	50	46
	e/c	Yen/m^3	16,288	19,171	17,120	19,218	23,703

In the comparison study, although construction cost of (A-3) is about 10% higher than the total construction cost of (A-1)+(A-2), (A-3) site is selected because of accessibility to the site and the efficiency to stop the floating logs.

Malbasag River (M-1 to M-4 site)

Since there is no large tributary along Malbasag River, the site is located on the main river. Four (4) dam sites are identified along Malbasag River, namely (M-1) to (M-4) from upstream on account of the topographical and geological conditions.

The construction cost and effect of the proposed sites in the Malbasag river basin is shown in the following table:

Comparison of Dam Sites for Malbasag River

Item		Unit	Dam Site			
			M-1	M-2	M-3	M-4
a. Work Quantity	Steel Slit	ton	25	38	43	43
	Concrete	m^3	683	870	849	1,733
	Excavation	m^3	2,662	2,916	3,370	5,576
	Maintenance Road	m	500	500	500	200
b. Compensation Works			Protection works 300m	Protection works 300m	Protection works 300m; Paddy field; Water Pipe	Protection works 300m; Water Pipe
c. Volume of Floating Logs		m^3	1,884	2,101	2,396	2,690
e. Construction Cost		mil. Yen	34	42	45	51
	e/c	Yen/m^3	17,894	19,996	18,608	19,118

From the following reasons, (M-3) is selected as the Malbasag slit dam site:

- Gullies and slope failures which are main sources of the floating logs were observed at the upstream section of (M-3) after the 1991 flood.
- The turbid water during construction will not affect the municipal water intake.
- The compensation works are only relocation of water pipe and an indemnity of 1 ha of paddy fields after disaster (no need to purchase).

(c) Basic Design of Steel Slit Dam

(i) Type of Steel Slit

To control the floating logs, a steel slit type dam (permeable type dam) is applied to the river traction area in accordance with the "Technical Guideline for Countermeasures of Floating Logs, Japan". The criteria for selection of steel slit type is given below:

Criteria for Selection of Steel Slit Type

Channel Condition			Type
Colliding Force by Tree and Flow	Diameter of Boulder	Passage of Boulder and Tree	
strong ⇓ weak	large ⇓ small	difficult ⇓ easy	A Type D or C Type V or h Type

A-type of steel slit is employed for the following reasons:

- A-type is the most suitable against strong colliding force and big boulders, since size of boulders is more than 1 m, length of trees is 10-15 m and water velocity is estimated at more than 4 m/s.
- Since A-type slit is structurally simple, it is possible to manufacture it in the Philippines and easy to install.
- The work of removing the deposited floating logs and maintenance of the structure are easier than those of other types of steel slit because of no cross beam.
- A-type steel slit is the most common type of steel slit in Japan.

(ii) Basic Design

Design of Slit

The height of slit is designed taking the higher one of either assuring enough capacity for floating logs or adding 1 m of freeboard to the water depth of the design flood. The design height of slit is estimated at 3 m for all three dams, as shown below:

Height of Slit

Item		Unit	Anilao	Biliboy	Malbasag
a. Capacity	Volume of FL	m^3	2,600	1,950	2400
	Slit Height	m	1.96	2.73	2.31
b. Water Depth	Discharge	m^3/s	510	200	320
	Water Depth	m	1.98	1.45	1.91
	Slit Height	m	2.98	2.45	2.91
Height of Slit		m	3.00	3.00	3.00

The height of overflow section is designed equivalent to the overflow water depth once the slit is closed by floating logs or debris. The height of overflow section (H_w) is calculated as below:

Height of Overflow Section

		Unit	Anilao	Biliboy	Malbasag
Discharge	Q	m^3/s	510	200	320
Width of Overflow Section	B_1	m	56.5	31.5	41.5
Width of Water Surface	B_2	m	62.3	36.0	46.7
Coefficient of Discharge	C		0.6	0.6	0.6
Overflow Depth	H_w	m	2.9	2.3	2.6
Note: $Q = 2/15C(2g)^{1/2}(3B_1+2B_2)H_w^{3/2}$					

Design of Apron and Channel Protection

The lengths of apron and channel protection are determined by the Bligh's Formula:

$$W > 0.6\ Co \times D^{1/2}$$

$$L > 0.67\ Co\ (D \times q)^{1/2}$$

where,

W : length of apron (m)

L : total length of apron and riverbed protection works (m)

Co : creep ratio (Co = 6 for gravel)

D : height of slit (m)
q : unit discharge ($m^3/s/m$)

The following formula is applied to determine the length of apron and height of endsill:

$$W = (1.5\sim2)(D+h)$$

$$H = (1/3\sim1/4)D$$

where,

W : length of apron (m)
H : height of endsill (m)
D : height of slit (m)
h : overflow water depth (m)

The lengths of apron and protection works are calculated for 3 slit dams as below:

Length of Apron and Channel Protection

		Anilao	Biliboy	Malbasag
Apron	W	10.0	15.0	10.0
Channel protection	L	20.0	20.0	20.0
Height of Endsill	D	--	1.5	--

The general plan of three (3) slit dams are shown in Fig. 2.3.23 to 2.3.25.

(4) Bridge/Road

(a) Basic Planning Concept

The following is the basic planning concept for the planning of project bridges, taking present condition in the construction industry in the Philippines into account, including natural conditions at project sites, the availability of materials and machinery, and maintenance and operation abilities.

(i) Considering the maintenance and rehabilitation capabilities in the Philippines, the bridge will be made of concrete, which is easy to maintain.

(ii) In the bridge construction process, local materials will be used as much as possible.

(iii) Superstructures, substructures and foundation types will be selected to enable reduction in construction period, construction costs and maintenance/operation costs.

(iv) Since the Philippines is in an active seismic zone, it is necessary to consider the aseismicity of all bridge structures.

(v) Approach roads for five bridges are designed up to the transition points.

(b) Determination of Design Conditions

Design conditions were determined based on discussions with officials from the Department of Public Works and Highways (DPWH) as follows:

(i) Design Standards

The following standards were used in the design of project bridges:

- Guidelines, Criteria and Standard for Public Works and Highways, Vol. I & II
- National Structural Code of the Philippines (NSCP), 3rd Edition, Vol. 1 & 2
- American Association of State Highway and Transportation Officials (AASHTO)
- American Concrete Institute (ACI-318-83)
- American Institute of Steel Construction (AISC)

(ii) Basic Design Method for Structures

Under the basic design method, structures are designed to safely withstand the strongest possible sectional force caused by an unfavorable combination of loads working on the structures.

(iii) Design Load and External Force

Live Load (LL)

In accordance with the AASHTO standard, the following is used as the live load of a vehicle:

MS-18 (HS-20)

Seismic Load (EQ)

The seismic load working on a bridge is calculated based on the requirements of AASHTO Part 1-A (Specification for designing structures resistant to earthquake effects, AASHTO).

EQ - 0.1 (DL + 0.5 x LL)

where,

DL = Dead load

LL = Live load

Dead Load (DL)

The dead load is calculated based on the weight of the following construction materials, including the weight of the structures themselves:

Unit Weight of Construction Materials

(Unit: kN/m^3)

Material	Unit Weight	Material	Unit Weight
Reinforced Concrete	24	Cement Mortal	21
Prestressed Concrete	24	Timber	8
PlainConcrete	23	Soil	18
Structural Steel	77	Gravel	19
Cast Iron	71		

Earth Load (E)

Unit weight of soil $\gamma = 18\ (N/m^3)$

Angle of internal friction $\phi = 30°$

(iv) Material

Deformed Bars

The specification for deformed bars is taken from ASTM A615.

Grade 40 fy = 275.80 Mpa

Concrete for Structures

Standard Strength of Concrete

(Uni : Mpa)

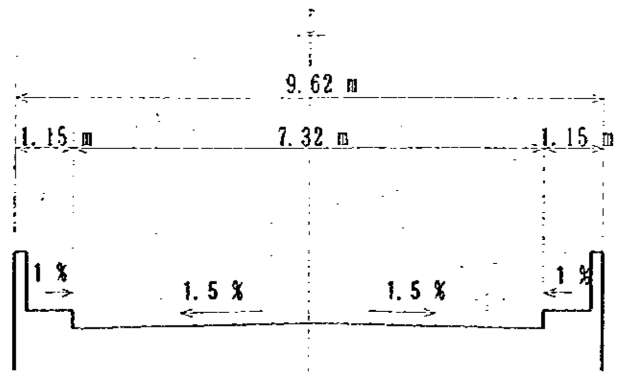
Item	Prestressed Concrete	Reinforced Concrete
Main Girder	34	
Cross Beam	34	
Slab		21
Abutment, Pier and Retaining Wall		21
Pile		28

Note: Minimum compressive strength @ 28-day compressive strength, fc' = 21 Mpa
Allowable stress is based on the ACI Code Standard.

(c) Planning of Bridges

(i) Cross Section of Bridges

The cross section of each project bridge is determined as follows:



Cross Section of Bridges

(ii) Determination of Bridge Length

Bridge length is determined according to the cross section of improved rivers, as shown below (refer to Figs. 2.3.26 and 2.3.27):

Planned Length of Bridges

Anilao River			Malbasag River		
Bridge Name	Length(m)	Angle*1	Bridge Name	Length(m)	Angle
Alegria	63.668	71°	Malbasag	40.760	90°
Osmeña	60.200	90°	Carlos Tan	40.760	90°
Anilao No. 2	60.200	90°			

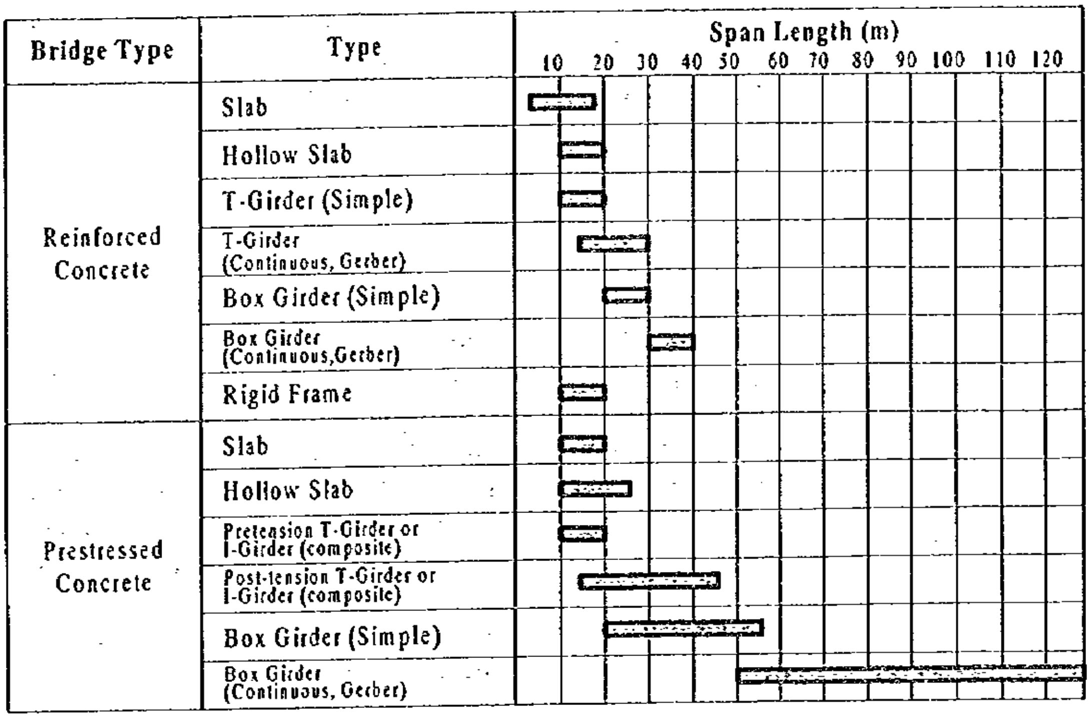
Note: *1: Angle between channel alignment and bridge center line.

(iii) Determination of Type of Superstructure

In the Philippines, cement and reinforcing bars are commonly fabricated and high-quality aggregate can be obtained easily at rivers. Accordingly, a concrete superstructure shall be adopted.

"Concrete" includes reinforced concrete (RC) and prestressed concrete (PC), the use of which depends on the length of the span (see "Bridge Type and Adopted Span").

Bridge Type and Adopted Span



The lengths of the Anilao Bridge and the Malbasag Bridge are 60 m and 40 m, respectively, and the span length ranges from 20 m to 40 m. If a span is 20 m in length, not only PC beams, but also RC beams can be considered as the superstructure type. Note that RC beams cannot be fabricated using the pre-cast method, in which beams are made beforehand in situ, so it would be difficult to complete the works within the established construction period with RC beams. Accordingly, PC beams are selected as superstructure for all bridges. The types of PC beams shall be classified depending on the span length required for each river.

Comparison of Bridge Type

Anilao River (Length of Bridge = 60 m)	Malbasag River (Length of Bridge = 40 m)
First Alternative PC Composite I-Girder, 2 spans	First Alternative PC Composite I-Girder, 1 span
Second Alternative PC Composite I-Girder, 3 spans	Second Alternative PC Composite I-Girder, 2 spans

In comparing bridge types, such characteristics as cost, construction work and maintenance were considered with respect to the superstructure, substructure and foundation. As a result, a PC-Composite-I-girder of three spans was selected for three bridges on the Anilao River and a PC-Composite-I-girder of two spans was selected for two bridges on the Malbasag River.

In terms of structural form, a continuous girder shall be adopted in consideration of earthquake resistance and vehicle operation. Composite girders shall be connected by RC to formulate the continuous girder because it can be erected easily and the construction period can therefore be reduced.

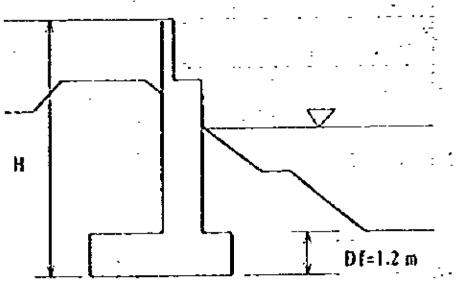
(iv) Type of Substructure

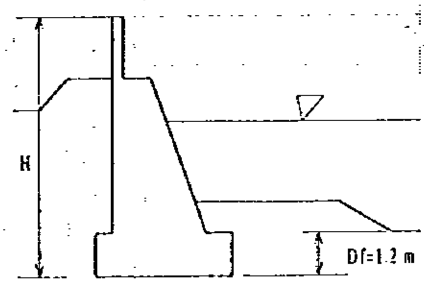
Abutment Types

The abutment type is determined based on the type of superstructure and its reaction force, and the working position of earth pressure against the backside of the abutments. The height of abutment is determined considering such elements as the design elevation of the superstructure, the depth of the supporting bedrock and the embedment depth of the bottom part taking into account the erosion by river water. (The selection of abutment type based on the height of the abutment is mentioned in the table below.)

In the Project, the height of the abutment body of the Anilao Bridge and the Malbasag Bridge is determined as follows:

Abutments on Anilao River	Abutments on Malbasag River
Converted T type	Semi-gravity type





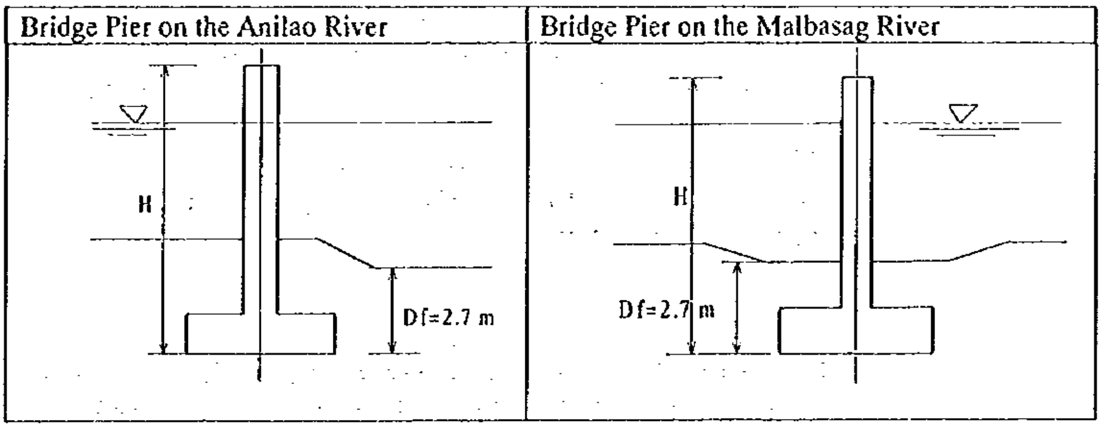
Design of Abutments

For the abutments of three bridges on the Anilao River, the height shall range from 7 m to 8 m, and the reversed T-type abutment be adopted.

For the abutments of two bridges on the Malbasag River, the height shall range from 6 m to 7 m, and the semi-gravity type should be adopted in accordance with the revetment in front of the abutment, even though the reversed T-type abutment is applicable for its height.

Pier Type

Type of piers used for bridges on the Anilao River is determined based on the depth of river, current velocity, current direction and influence of the pier on the flow area. The pier height shall range from 6 m to 7 m, and the wall-type piers with cantilevered beams shall be used taking into account the economical and landscaping points of view, since water passes shall be stabilized after the river improvement.



Design of Piers

The bridge pier on the Malbasag River is as high as that on the Anilao River (5 m~6 m), and a wall-type pier with cantilevered beams shall be adopted.

(v) Foundation Type

Foundation type can be determined based on the position of the bedrock, topographical and geological conditions, the construction method used, and structural characteristics.

<u>Alegria Bridge</u>

This bridge is located approximately 200 m from the estuary. Boring work was executed at three points: on both riverbanks and at the center of the river. The boring work on riverbanks was carried out to a depth of 20 m, and coral layers, which can be the supporting layers for foundation piles, were observed 19 m from the ground level. On the other hand, boring work at the center of the river was carried out to a depth of 15 m, but supporting bedrock was not observed. Even though the average N-value of layers at the center of the river is rather less than that of riverbanks, the layer is a combination of a sand layer with pebbles and a sandy silt layer, which is similar to conditions on riverbanks. Therefore, the supporting bedrock is supposed to be located at the same depth as the riverbanks, and a pile foundation is selected as the foundation type.

Osmeña Bridge

This bridge is located about 500 m from the estuary. Boring work was executed at three points; i.e., on both riverbanks and at the center of river. The boring work on the right riverbank was carried out only up to 10 m from the ground level, and no supporting bedrock could be found. On the other hand, boring work on the left riverbank and at the center of the river was carried out up to 15 m in depth, and a supporting bedrock was observed 10 m from the ground level. The layer condition is similar to that of the Alegria Bridge site, i.e., a combination of a sand layer with pebbles and a sandy silt layer. Accordingly, a pile foundation is selected as the foundation type.

Anilao Bridge No. 2

At this location, boring work was executed on the riverbanks only. The boring work on the left riverbank and the right riverbank was carried out up to 10 m and 15 m in depth, respectively. On the left riverbank, the layer more than 5 m from the bottom of the abutment is a combination of silty clay and pebbles with an N-value greater than 40. Hence, it is possible to employ a spread footing foundation. On the other hand, since the supporting bedrock on the right river ibank was observed at 10 m from ground level, a pile foundation is selected as the foundation type. The depth of the supporting bedrock at the center of the river was estimated from the boring data on both riverbanks, and a pile foundation is employed.

Malbasag Bridge

This bridge is located about 250 m from the estuary and boring work was executed on both river ibanks. Since the supporting bedrock (a sand layer with pebbles having an N-value greater than 40) was observed at a comparatively shallow depth, i.e., 5 m from the bottom of the abutment, a pile foundation is employed.

Carlos Tan Bridge

This bridge is located about 1 km from the estuary, and boring work was executed on both riverbanks. On both riverbanks, a supporting bedrock with an N-value greater than 40 was observed at a shallow depth, i.e., more than 8 m from the bottom of the abutment. Hence, spread footing foundations are employed as the foundation types.

As described above, two types of foundations, i.e., a spread footing foundation and a pile foundation, are employed. Since the reaction force from the superstructures are relatively small and the length of required piles are within a range of 6 m to 12 m, RC piles with diameters of 0.3 m to 0.45 m are employed as follows:

Foundation Pile Planning (Anilao River)

(Unit: m)

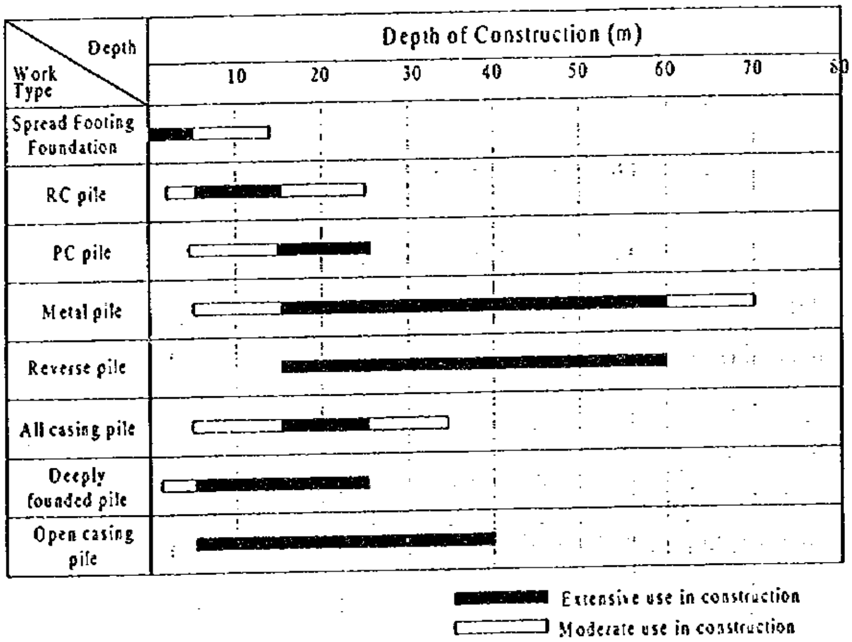
Bridge Name	Left Abutment A1			Pier P1			Pier P2			Right Abutment A2		
	Dia.	No.	Length	Dia.	No.	Length	Dia.	No.	Length	Dia.	No.	Length
Alegria	0.40	32	13	0.45	36	11	0.45	36	12	0.40	32	15
Osmeña	0.40	32	8	0.40	36	8	0.40	36	8	0.40	32	8
Anilao No. 2	Spread Footing			0.40	36	3	0.40	36	5	0.40	32	8

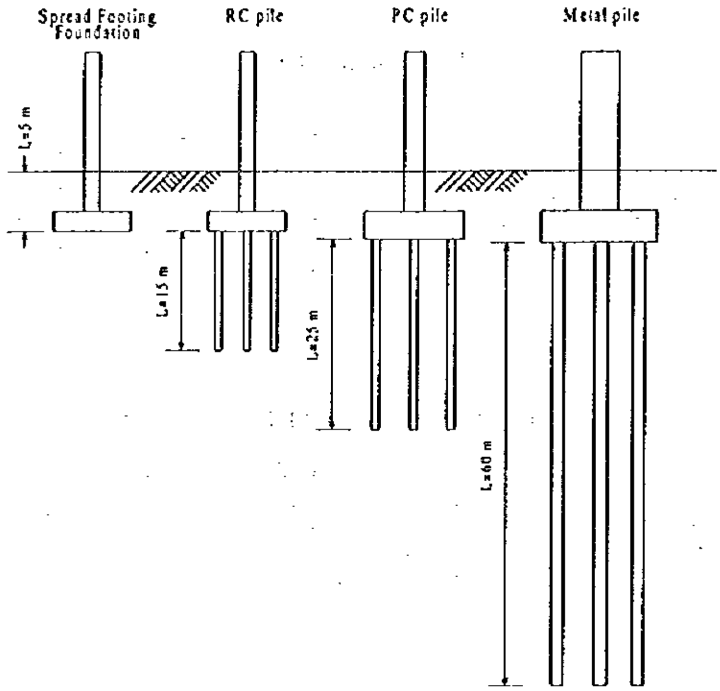
Foundation Pile Planning (Malbasag River)

(Unit: m)

Bridge Name	Left Abutment A1			Pier P1			Right Abutment A2		
	Dia.	No.	Length	Dia.	No.	Length	Dia.	No.	Length
Malbasag	0.30	28	6	0.30	24	6	0.30	28	6
Carlos Tan	Spread Footing			Spread Footing			Spread Footing		

Table of Foundation Type Selection





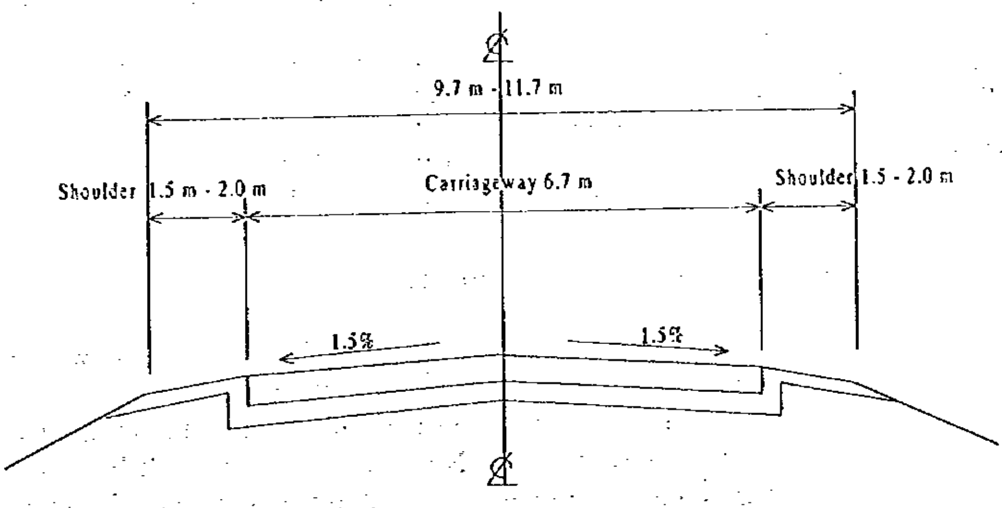
(d) Approach Road Design

(i) Geometric Design Standard

Geometric Design Standard

Item	National Road	Regional Road
Design speed V (km/hr)	50	30
Vertical curve (m)		
Concave curve radius	800	250
Convex curve radius	700	200
Vertical curve length	70	60
Maximum gradient (%)	7.0	8.0
Cross slope (%)	1.5	1.5
Shoulder width (m)	1.5~2.0	1.5

(ii) Typical Cross Section

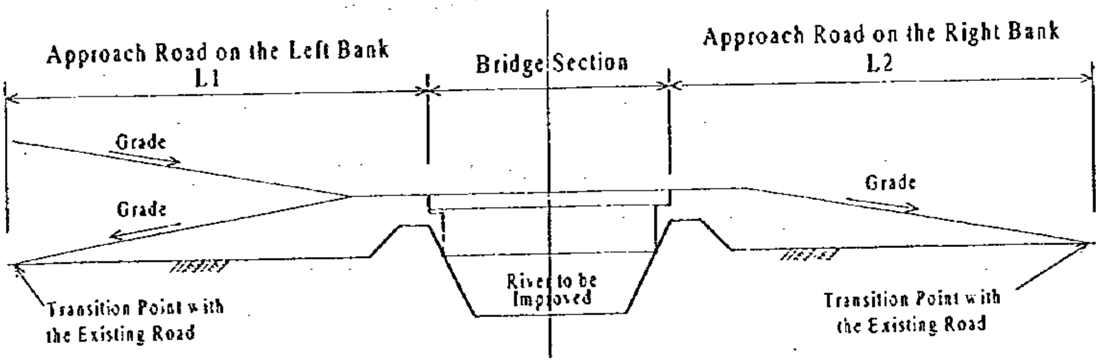


Typical Cross Section

(iii) Approach Road Planning

The superstructure of the new bridges shall be constructed 1.5 m above the top of the improved embankment, but this distance shall be greater if the top of the improved embankment is higher than the elevation of the existing road. Thus, an approach road connecting the existing road and a bridge shall be required.

The approach road is designed to connect from a bridge to the existing road according to the geometric design standard by the following manner:



Design of Approach Road

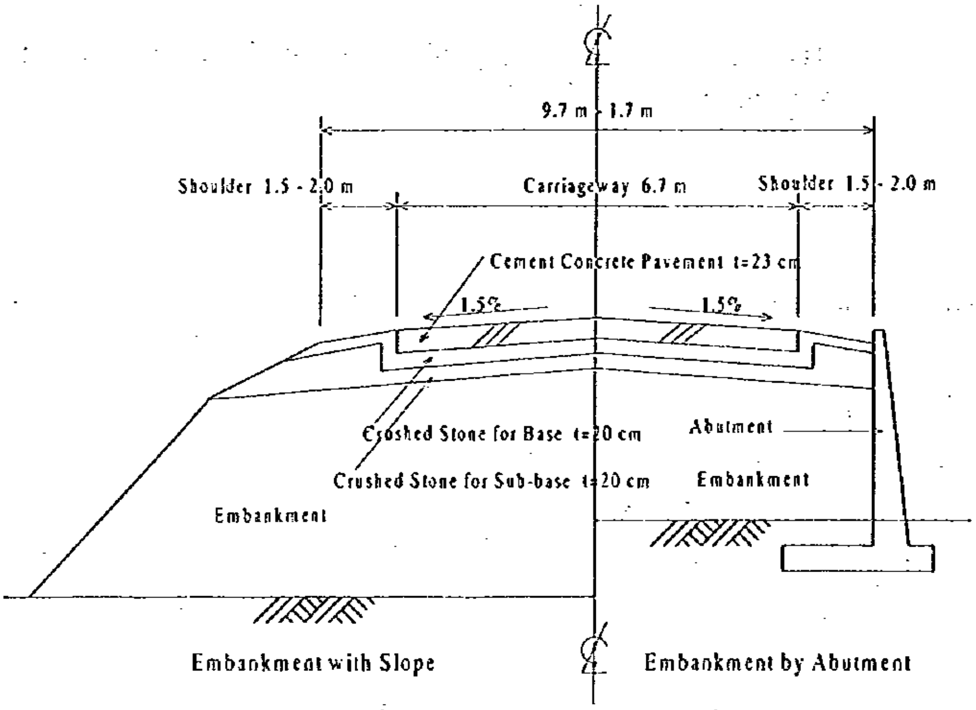
Gradient and Length of Approach Road

Name of Bridge	Design Speed V=(km/hr)	Left Bank		Right Bank		Total Length (m)
		Gradient (%)	Length L1 (m)	Gradient (%)	Length L2 (m)	
Alegria	50	5.508	97.0	6.596	97.0	194.0
Osmeña	30	7.245	35.0	7.245	35.0	70.0
Anilao No. 2	50	5.145	55.0	3.350	40.0	95.0
Malbasag	50	7.008	40.0	7.814	25.0	65.0
Carlos Tan	30	0.000	37.0	7.980	52.0	89.0

(iv) Structure of Approach Roads

For an approach road, construction of an embankment with slope is economical, if the right of way width is sufficient. However, approach roads, except on the right bank of the Osmeña Bridge, the left bank of Anilao No. 2 Bridge and the left bank of Carlos Tan Bridge, require planning within the existing road width; hence, embankments with retaining walls shall be adopted.

For the structure of retaining wall, the reversed T-type, gravity type or stone masonry type can be used. For the project, the reversed T-type and gravity type, in which the walls can be relatively vertical, shall be adopted. If more than 1.5 m of retaining wall from the existing ground level is required, the reversed T-type shall be used. The gravity type shall be adopted for the remaining cases.



Cross Section of Approach Road

CHAPTER 3. IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The Project is implemented under the Japanese Grant Aid scheme based on the following basic concepts.

(1) Purpose of the Project

The flood that occurred in the Anilao and Malbasag rivers, caused by Typhoon Uring on November 5, 1991, brought tremendous damage to Ormoc City, accounting for approximately 8,000 deaths and missing. Since the disaster, some rehabilitation works have been undertaken by the Government of the Philippines, but they are far from satisfactory countermeasures for flood control. Since under the present circumstances Ormoc City is still exposed to the menace of disastrous floods like the one in November 1991, the Project is implemented under Japan's Grant Aid to mitigate the flood damage to people's lives and properties, and to improve the urban environment and the people's living standard.

(2) Procurement of Consultant

After the signing of the Exchange of Notes (E/N) between the Government of the Philippines and the Government of Japan, the Department of Public Works and Highways (DPWH) of the Government of the Philippines will execute a contract with a Japanese Consultant, for the detailed design, tendering, and supervision of construction of the Project.

(3) Procurement of Contractor

The construction works will be undertaken by a Japanese contractor selected through the evaluation of tenders, based on a construction contract with the DPWH.

(4) Implementing Agency of Recipient Country

The principal for this Project is the DPWH, Government of the Republic of the Philippines, and the Project Management Office for Major Flood Control and Drainage Project (PMO-MFCP) is to bear the actual responsibility for the whole Project from the detailed design through the project completion and transfer to the maintenance and operation thereafter. In addition, the Regional Office No. 8 of DPWH as well as Ormoc City will assist the PMO-MFCP as the cooperating agencies.

(5) Use of Local Contractor and Construction Materials

In Ormoc City there are some local contractors who have experiences in the field of river improvement works, roads and bridges. They can be used as subcontractors on the subletting scheme. As to construction materials/equipment necessary for the Project, they will, in principle, be procured locally as much as possible. If the materials or equipment are not available or cannot be supplied from the local market, procurement from other eligible countries is to be taken into consideration.

(6) Transfer of Knowledge

In this Project some unique structures not currently found in the Philippines are proposed. They are the slit type dams and hydraulic drops with environmentally desirable features and scenic view. In constructing these structures, transfer of knowledge will be made with regard to their design, construction method and maintenance, by experts who are familiar with river engineering and dam structures through the on-the-job training during the spot supervision.

(7) Phasing of Construction

The Project is to consist of the construction of slit dams in the upstream of the Anilao and Malbasag rivers, the improvement works of the two rivers, and the construction of river structures and bridges in the downstream area, involving a total construction period of about 39 months.

For the efficient execution of construction and the achievement of immediate flood control effect, the Project is to be carried out by dividing it into two construction phases as follows:

Phase 1	Construction of slit dams (3 places) and bridges (5 places)
Phase 2	River improvement works for Anilao and Malbasag rivers

3.1.2 Implementation Conditions

In the implementation of the Project, attention shall be paid to the following three (3) points:

<u>Government Regulations</u>

(1) Environmental Clearance Certificate (ECC)

The ECC has already been issued by DENR, with the following condition:

(a) The Memorandum of Agreement (MOA) should be concluded among DPWH, DENR and the City of Ormoc.

(b) The necessary funds for the right-of-way acquisition and associated compensation should be guaranteed.

(c) The environmental monitoring plan should be submitted to NEDA and approved.

(2) Clearance of Investment Coordination Committee (ICC)

For any change in project cost, it is necessary to request clearance from the Investment Coordination Committee (ICC) through NEDA.

Compensation

For the smooth implementation of the Project, the inhabitants to be affected are relocated, and private land necessary for the Project will be acquired prior to the commencement of construction works.

Construction

(1) Construction and Environment

The Anilao and Malbasag rivers flow through the urban area of Ormoc City, providing a pleasant river environment such as free open space and clean water to the inhabitants living in the surrounding area. River water is highly utilized by the people because of its good water quality; hence, special care shall be taken to maintain the clean river water condition during construction. Besides, construction is to be undertaken in the congested city area and the city environment may be affected by dust and noise caused by heavy construction equipment. Therefore, special care is to be made to reduce such undesirable effects.

(2) Borrow Pit and Spoil Bank

Through the discussion with the officials of Ormoc City, several sites have been proposed for borrow pits and spoil banks necessary for the Project. These sites are government-owned land so that there should be no problem on land acquisition and compensation. Before the start of the construction works, however, confirmation should be made again as to which site is preferable.

(3) Safe Construction Management

The Project is mainly composed of earth works such as the excavation and embankment in the river area, and construction sites are subject to flash floods in the rainy and typhoon seasons. To establish a safe construction management system, some measures to predict flood occurrence and to evacuate workers, equipment and materials are required. They are (a) the observation of rainfall in the upstream area, (b) the reinforcement of safety of temporary works, and (c) the emergency evacuation plan for workers, construction equipment and materials.

3.1.3 Construction Plan

Basic Conditions

Project works and their major dimensions are given below:

Project Works and Major Dimensions

Project Works	Major Dimensions
(1) River Improvement	
(a) Anilao River Design Discharge Improvement Stretch (Diking) Revetment Hydraulic Drop Sluice Pipe Culvert	 610 m^3/s (50-year Return Period) 1,930 m (1,930 m) 3,830 m 3 sites (Height: 1.5 m) 2 sites with Sluice Gate ϕ600 : 5 sites, ϕ1000 : 4 sites
(b) Malbasag River Design Discharge Improvement Stretch (Diking) Retaining Wall Revetment Hydraulic Drop Pipe Culvert	 330 m^3/s (50-year Return Period) 1,920 m (1,920 m) 2,240 m 1,460 m 5 sites (Height: 1.5 m) ϕ600 : 4 sites, ϕ1000 : 3 sites
(2) Slit Dam	
(a) Anilao River Dam Number *1 Dam Type	 2 sites (Main: 1, Tributary: 1) Slit Type: 1, (Gravity+Slit) Type: 1
(b) Malbasag River Dam Number *1 Dam Type	 1 site (Main River) Slit Type
(3) Bridge*2	
(a) Anilao River Bridge Number Bridge Type	 3 sites PC Type
(b) Malbasag River Bridge Number Bridge Type	 2 sites PC Type

Note: *1 : Number of dams are the same, but location of dam sites are changed.
*2 : All bridges are reconstructed.

River Improvement

(1) Construction Conditions

Construction works are performed in line with the following conditions.

(a) Construction Period

River improvement works comprise earth works such as excavation or embankment, and the construction of revetment, hydraulic drops, sluices, drainage outlets and approach steps. All these construction works are executed in the second stage construction period of 2 years.

(b) Working Day

Ormoc City has a continuous rainfall throughout the year with a little variation between the dry and rainy seasons. The ground in the construction area is composed mostly of sandy materials rather than clay. With permeable ground conditions the productivity of earth works is not lowered even under rainfall. Besides, a large volume of construction works need to be completed in a period of 2 years. Taking all these conditions into account, the construction works shall be performed continuously throughout the year. However, construction works are to be suspended when rainfall is more than 5 mm/day for earth works and 10 mm/day for other works.

(c) Arrangement of Construction Work

The channel excavation, dike embankment and construction of revetment are carried out from the downstream toward upstream for pursuing early flood control effectiveness, while the channel excavation is carried out prior to embankment.

Of all construction works, channel excavation and revetment works have a large work volume and require a long construction time. To complete all works before the target date, the earth works and revetment construction in the Anilao and Malbasag rivers should be commenced simultaneously in an early stage of the construction period.

(d) Impact to the River Flow

In planning the temporary cofferdams in the river channel, the effective flood flowing area of the existing channel should be maintained. The negative impact of cofferdam to the flood flow should be avoided as well.

(e) Access to the Site

Construction access roads with a width of more than 6 m are provided along both riverbank.

(f) Spoil Bank and Borrow Pit

(i) Spoil Bank

Ormoc City had suggested the following locations suitable for spoil bank areas.

Possible Spoil Bank Area

Location	Area
Right bank of Anilao River: the vacant land behind junior high school near the Osmeña Extension Bridge	0.75 ha.
The vacant land next to the District Office	0.35 ha.
The right side shore at the Anilao river mouth	0.60 ha.

All of these areas are located within 2 km from construction sites and are linked to the main roads as shown in Fig. 3.1.1.

(ii) Borrow Pit

For the embankment materials, excavated soils at the riverbanks and materials from borrow pits, if necessary, are used. The locations are shown in Fig. 3.1.1 and the distances between proposed borrow pits and job sites are estimated to be less than 2 km.

(g) Environmental Aspects during Construction

(i) Water Pollution

Since the river water of both Anilao and Malbasag rivers is utilized for the daily common life, careful attention should be paied not to cause the pollution during the construction period.

(ii) Noise and Dust

Also, the construction work is conducted in the central area of Ormoc City, attention on the environmental aspects such as noise of construction machine, dust by dump truck transportation, etc.

(2) Construction Method

(a) Earthwork

The construction works are as enumerted below:

(i) Preparation of access road;
(ii) Clearing and grubbing of the job site;
(iii) Channel excavation, hauling, shaping of the excavated slope;
(iv) Stripping, embankment (Spreading and compacting);
(v) Shaping of the embankment surface;
(vi) Gravel pavement of the dike crown; and
(vii) Sodding of the inland side slope.

The following construction methods are employed.

(i) The channel excavation is basically carried out in the dry ground condition.

(ii) Earth works such as excavation and embankment are assumed to use 0.6 m^3 backhoe, 10-ton dump truck, 21-ton bulldozer, 21-ton vibrator roller and so on.

(iii) Excavated materials are used for embankment as much as possible. For the lower reaches of both rivers, embankment is performed with borrowed material, because sandy materials are dominant in the reaches.

(iv) The mountain slopes in the midstream of Malbasag River is assumed to mainly consist of soft rocks, so that large size breakers are required for excavation.

(b) Revetment

Revetment works are as enumerated below:

(i) Site preparation and temporary cofferdam;
(ii) Excavation, shaping of the slope;
(iii) Log pile driving and base concrete;
(iv) Bedding of crusher run;
(v) Placing of backing concrete;
(vi) Stone pitching and concrete grouting; and
(vii) Top concrete and partition wall.

The construction method is as described below:

(i) The construction site is enclosed with cofferdam for the purpose of dry work. Since the water depth in the channel, except the river mouth, is estimated to be less than 1.5 m, sand bags are used for cofferdam. The top elevation of cofferdam shall be higher than the water level of the flood with a 3-year return period.

(ii) Since revetment works at the river mouth are affected by tide, steel sheet piles are used for the cofferdam. The top elevation of cofferdam shall be higher than the highest high water spring (EL+1.15m).

(iii) Ready mixed concrete is used for concrete works of structures.

(c) Hydraulic Drop

The works are as enumerated below:

(i) Site preparation, access road and temporary cofferdam;
(ii) Excavation for concrete structures;
(iii) Leveling concrete;
(iv) Form work, placing re-bar and concrete for main body;
(v) Placing of filter cloth and riverbed protection works;
(vi) Concrete placing for sidewall; and
(vii) Stone masonry work for revetment.

The construction method is described below:

(i) A part of the construction site is enclosed by cofferdam and the riverflow is diverted to a temporary channel to facilitate work in dry condition.

(ii) The cofferdam is made of sandbags or sheet piles, and water inside the cofferdam is discharged by pumps.

(e) Sluice

The sluice works are as enumerated below:

(i) Site preparation, access road and temporary cofferdam;
(ii) Excavation for foundation;
(iii) Driving steel sheet pile and placing leveling concrete;
(iv) Form work, placing re-bar and placing concrete for culvert;
(v) Blockout, jointing work and gate concrete;
(vi) Concrete for wing walls and breast walls;
(vii) Backfilling around culvert and embankment for dike;
(viii) Stone masonry work; and
(ix) Installation of gate, lift and maintenance bridge.

The construction method is as described below:

(i) Cofferdams are provided in the riverside channel as a part of dike for flood control purpose. The height of cofferdam shall be higher than the existing adjacent riverbank height.

(ii) A spread foundation is adopted for the sluice main body after the foundation ground is confirmed and foundation treatment is made.

(iii) The main box culvert is made with separate parts, bottom slab, side walls and top slab by placing ready mixed concrete.

(iv) Gates, lifts, steel maintenance bridges and other miscellaneous steels are fabricated in local factories and are installed at sites with crane.

(3) Others

(a) Temporary Storage Yard

Temporary storage yards are necessary for the manufacture of bridge girders, to store construction materials and so on during the construction period. Available places along the rivers are the lands acquired for river channel at bending portions of the Anilao and Malbasag rivers. The existing approach roads to the bridges are used as well during bridge construction.

(b) Supply of Water and Electricity

River water for construction use is supplied by pumps and electricity is supplied by generators at the site.

(c) Demolition and Removal of Obstructions at Construction Sites

Since the following existing structures are obstructions to the construction works, they are required to be demolished before the commencement of construction works:

(i) Wet stone masonry type and concrete gravity type revetment;
(ii) Dike protection with gabion mattress and riprap; and
(iii) Concrete pavement and side ditches.

(d) Countermeasure against Flood during Construction

Floods are likely to occur immediately after rainfalls because the river channels are very steep and the catchment areas are small. It is, therefore, important to foresee floods by using hydrological data so as to execute safer construction works. The following are to be considered during the construction:

(i) Observation of hydrological data (rainfall and water level) and prediction of floods.

(ii) Confirmation of work progress and site conditions when flood is predicted.

(iii) Establishment of emergency evacuation plan for workers, construction equipment and materials.

(iv) Preparation of flood prevention/fighting plans on temporary cofferdam.

Slit Dam

(1) Quantity of Major Works

The quantity of major works of slit dams is shown in the table below.

Quantity of Major Works

	Unit	Anilao	Biliboy	Malbasag
Excavation	m^3	5,400	4,900	4,000
Concrete	m^3	1,700	3,700	1,200
Steel Slit	ton	51.4	32.5	43.3

(2) Sequence of Construction

The typical work sequence of slit dam construction is as follows:

(a) Preparatory Works: Construction of access roads, clearing of sites;

(b) Diversion of River: Construction of cofferdam and diversion channel, if necessary;

(c) Excavation of foundation;

(d) Form works and concrete placement of base concrete and main body;

(e) Erection of slit frame;

(f) Placement of block-out concrete;

(g) Grouting of steel slit frame; and

(h) Painting of steel slit frame.

(3) Access Road

The access road to the construction site is proposed as a permanent structure because the road will be used as maintenance road for slit dams after construction. The access road shall be designed as follows:

(a) Connect to the site from the upstream of dam.
(b) Limit the road slope to less than 10%.
(c) Design a total road width of 4.0 m including 50 cm shoulder.
(d) Provide gravel pavement.

(4) Diversion of River

For the construction of steel slit dams, a diversion channel is provided to divert the river water. The design discharge of diversion channel is set at the mean maximum daily discharge of which specific discharge is estimated at 1 $m^3/s/km^2$. The estimated design discharge is as follows:

Anilao slit dam	17 m^3/s
Biliboy slit dam	7 m^3/s
Malbasag slit dam	10 m^3/s

The cofferdam is constructed by using the excavated materials at site and the upstream surface is covered with clay to prevent leakage.

For the construction of the remaining abutment of Biliboy slit dam, reinforced concrete pipes are provided at the main dam body for diversion with a flow capacity of 7 m^3/s at the water head of 3 m. Four (4) pipes with a diameter of 0.8 m each will be provided.

Bridge/Road

(1) Basic Concept

Construction work will be carried out by three parties according to the following plan:

Construction Plan for Bridges and Roads

	First Party	Second Party	Third Party
First Stage	Alegria Bridge (Anilao River)	Anilao Bridge No. 2 (Anilao River)	Carlos Tan Bridge (Malbasag River)
Second Stage	Osmeña Bridge (Anilao River)	Malbasag Bridge (Malbasag Bridge)	-

(2) Construction Work

The construction of bridges will be carried out in the following construction stages, and the total construction period is 15 months:

(a) Preparation work
(b) Demolition of existing bridges (substructures and superstructures)
(c) Construction of substructures (including excavation of riverbed)
(d) Construction of superstructures
(e) Construction of approach roads

(3) Construction Method

Construction method for the project bridges is planned as follows:

(a) Preparatory Work

Preparatory works will consist of the construction of detours or temporary roads and bridges. Since most of the project bridges are reconstructions of existing bridges, it will be necessary to provide detours. Detour roads or temporary roads shall be constructed at least 25 m away from the construction site of new bridges for safety reasons, because the construction area shall extend to 20 m on both upstream and downstream from the center of the bridge.

(i) Detour on Anilao River

On the detour for two bridges, i.e., the Alegria and Osmeña bridges, a spillway bridge will be constructed on the minor bed of the river and embankments will be constructed on the flooding basin for normal water levels. However, to secure an alternative route when the spillway bridge is impassable due to increasing water level, construction of the two bridges will not start at the same time so that the remaining bridge can be used as detour for the bridge under construction.

(ii) Detour on Malbasag River

Due to the narrow river width and deep water depth, an ordinary temporary bridge will be constructed parallel to the existing Malbasag Bridge as a detour. On the other hand, since a spillway bridge exists at the proposed site of Carlos Tan Bridge, the same type of spillway bridge will be constructed near the proposed site and utilized for detour.

(b) Demolition Work

Prior to the construction of bridges, existing bridges should be demolished. Bridges to be demolished and their related structures are as follows:

List of Demolition Works

Name of Bridge	Structures to be Demolished	Contents
Alegria Bridge	Superstructure and substructure of bridge	PC main girder: 8 units × 28m RC main girder: 4 units × 15m RC slab: 9m × 71m Abutment: 2 units Pier: 2 units
Osmena Bridge	- ditto -	RC main girder: 8m × 20m RC slab: 9m × 4m Abutment: 2 units Pier: 1 unit RC piles
Anilao Bridge No. 2	None	-
Malbasag Bridge	Superstructure and substructure of bridge	RC main girder: 4 units × 20m RC slab: 9m × 20m Abutment: 2 units
Carlos Tan Bridge	Spillway Bridge	Concrete: 9m ××21m × 1.5m

Of the above bridges, the Government of the Philippines intends to reutilize the superstructures of the Alegria and Osmeña bridges. Hence, main girders will be removed and stored near the construction sites. To remove these main girders without damaging them, slabs will be demolished by a cutter, and girders will be lifted by a combination of two cranes.

Other structures such as abutments and piers will be demolished by large-size beakers (Backhoe, 0.6 m^3). At the same time, existing foundation piles will be filled, unless they become obstacles for the newly constructed foundation bases or planned excavation of riverbed.

(c) Substructure Work

(i) Cofferdam Work

Steel sheet-piles will be used for the cofferdam work for piers and abutments. Two sets of sheet piles will be utilized for each bridge. The formation level (level to execute the construction) will be determined for each cofferdam and work will be executed based on that level. The excavation depth from the formation level will be about 4.90 m for piers and about 2.6 m to 3.2 m for abutments.

Hence, the length of steel sheet piles shall be about 6 m and 8 m for abutments and the pier, respectively, with an embedded depth of at least 3 m from the excavated bottom. In addition, the waling work for steel sheet pile cofferdams will be planned as a single waler for abutments and double walers for piers.

Since steel sheet piles utilized for cofferdam work can be reutilized for foundation work on river revetments, Type III steel sheet-piles will be used.

(ii) RC Pile Driving Work

In consideration of the depth up to the bearing layer and the value of the reaction force caused by the superstructure, foundation piles will be precast reinforced concrete piles (300×300 mm to 450×450 mm). A diesel pile hammer (2.5 tons) and a crawler crane (35 tons) will be used for the driving of piles. As with cofferdam work, pile driving work will be executed based on the formation level.

Determination of the Formation Level

Name of Bridge	Construction Site	Existing Level of Riverbed (m)	Planned Level of Riverbed (m)	Formation Level (m)
Alegria	AN.1+64.00	0.700	-0.848	0.200
Osmena	AN.4+82.50	1.000	0.444	1.400
Anilao No. 2	AN.9+83.00	3.000	3.920	4.900
Malbasag	MA.2+56.00	0.400	0.202	1.000
Carlos Tan	MA.7+04.00	2.600	2.202	3.000

(d) Superstructure Work

(i) Preparation of Main Girders

Two alternatives can be considered for the preparation of main girders, i.e., construction of main girders at a yard near the construction site, and procurement of ready-made main girders from a well-equipped factory. There is a factory that can construct PC girders on Cebu Island. After comparing the two alternatives, the procurement of girders from the factory in Cebu is jedged to be cheaper. Hence, girders will not be constructed on site.

In this case, however, a structural engineer with good knowledge of PC girders should supervise the progress and quality of girder construction at critical times during construction, thus reducing the level of dependence on the factory. Constructed main girders will be transported by a trailer with a separate dolly and truck crane (60 tons). (City of Cebu - Cebu Port - Ormoc Port - Construction sites)

(ii) Main Girder Erection Work

Main girders will be erected by a truck crane (80 tons) and lifted from the formation level (river location). Since the weight of each main girder is about 20 tons, it is possible to lift them with an 80-ton truck crane.

(iii) Cross Beam Construction Work

Prior to the construction of slab, cross beams (end cross beams and intermediate cross beams) will be constructed. For construction of cross beams, cross prestressing for PC wires 7T12.7 will be executed. Jacks, anchorage equipment, PC wires, sheaths and grouts will be procured from a PC factory. In addition, as with the construction of main girders, a structural engineer should supervise the cross prestressing work.

(e) Construction of Approach Roads

Every approach road will have a retaining wall structure, except for the right bank of the Anilao Bridge No. 2 where the alignment of river will be shifted. Since it is impossible to open the bridge for traffic unless approach roads are completed, the construction of approach roads should either be commenced prior to or simultaneously with the bridge construction work. It is therefore necessary to use methods that shorten the construction period for approach roads as much as possible.

(f) Removal of Surplus Soil

Sandy surplus soil generated from the excavation of riverbeds and the construciton of substructures will be utilized for the embankment material. Other types of soil will be dumped at designated locations.

Volume of Surplus Soil

Name of Bridge	Volume (m^3)
Alegria Bridge	–
Osmena Bridge	4,074
Anilao Bridge	11,113
Malbasag Bridge	1,636
Caarlostan Bridge	7,692
Total	50,685

3.1.4 Consultant Services

The detailed design, tendering and construction supervision will be undertaken by a Japanese Consultant on behalf of the Government of the Republic of the Philippines. All these works are executed based on a contract between the Government of the Philippines and the Consultant. The Consultant will take all necessary actions for the smooth implementation of the Project such as close coordination and discussion with both the Government of the Philippines and the Government of Japan.

(1) Scope of Work

(a) Detailed Design

The detailed design works to be carried out by the Consultant are as itemized below. The detailed design work for Phase-1 and Phase-2 requires 4.0 months each. The items of work are as follows:

(i) Discussion with the implementing agency and field survey;

(ii) Detailed design for river channels and structures (design calculation, drawings and specifications);

(iii) Detailed construction plan and cost estimate of the Project;

(iv) Preparation of tender documents;

(v) Comparison between Basic Design (B/D) and Detailed Design (D/D) results, and assessment of D/D; and

(vi) Discussion of D/D results with the implementing agency.

(b) Tendering

Based on discussions with the implementing agency in the Philippines as to the tendering method and the schedule of the Project, the Consultant will undertake the necessary works for tendering on behalf of the Government of the Philippines. The Consultant will also assist the implementing agency in the tender evaluation and selection of the suitable tender. The tendering will commence immediately after the detailed design work, and completed in about two (2) months.

The major works of tendering are as follows:

(i) Invitation to tender;
(ii) Pre-qualification of construction contractors;
(iii) Pre-tender conference, site visit, and tender closing and opening;
(iv) Evaluation of tender; and
(v) Award of construction contract.

(c) Construction Supervision

Construction periods necessary for Phase-1 and Phase-2 are 15 and 24 months, respectively. The scope of work of the construction supervision to be undertaken by the Consultant is as follows:

(i) Review and approval of survey results;

(ii) Approval of working drawings made by contractor;

(iii) Control of work program and quality control;

(iv) Tests and inspections; and

(v) Delivery of works, issuance of certifications and submission of reports.

(2) Executing Structure

(a) Execution Method

In consideration of the construction period, project site and volume of work items, one civil engineer will be assigned to the jobsite office as a regular supervisor during the entire construction period, and will play the role of representative of the implementing body of the project. In addition, for the effective supervision on the spot, experts on each engineering field will be assigned based on the commencement of the project and the completion of major structures. The fields of expertise will include river engineering, hydro-structure and bridge engineering.

In supervising the Project, the Consultant will maintain close coordination with the implementing agency (PMO-MFCP, DPWH), Ormoc City and the Contractor. Periodical reports to the JICA office in Manila will be made as well.

(b) Manning Schedule

The proposed manning schedule for the successful supervision of the Project is as shown below.

Consulting Services and Required Expertise

Classification of Work	Contents of Work	Field of Expertise
Detailed design (Phase-1 & Phase-2)	Site survey Detailed design Tender documents	Team leader (Civil Engineer) River Eng., Bridge Eng. Spec Writer, Cost Estimator
Tendering (Phase-1 & Phase-2)	Invitation to tender Pre-qualification, Site visit Tender close and open, Tender evaluation	Team leader (Civil Engineer) Civil Engineer
Supervision Phase-1 Bridge and slit dam	Regular supervision Spot supervision (Transfer of knowledge)	Civil Engineer Team Leader (Civil Engineer) Dam Engineer, River Engineer and Bridge Engineer
Supervision Phase-2 River improvement	Regular supervision Spot supervision (Transfer of knowledge)	Civil Engineer Team Leader (Civil Engineer) River Eng. & Structural Engr.

3.1.5 Procurement Plan

(1) Procurement of Construction Equipment

Procurement of construction equipment is based on the following concept:

(a) Local procurement is given priority, unless quantity, time of delivery and quality pose a big problem; and

(b) Even if a machine is imported from other countries, it is easy to procure it at the local market (local procurement).

Since Ormoc is one of the main supply locations of rock and sand, construction equipment for earth works and masonry works are well provided. Some equipment of large capacity are not available in Ormoc, but they can be provided from Manila and Cebu. Therefore, the procurement schedule of construction equipment are as shown below.

Equipment Procurement and Location

Construction Equipment	Standard and Capacity	Location of Procurement
Backhoe	$0.6m^3$	Ormoc and Manila
Jumbo Breaker	Attached to Backhoe	Ormoc and Manila
Bulldozer	15t, 21t	Ormoc and Manila
Dump Truck	10t	Ormoc and Manila
Roller	1t	Ormoc
Tamper	100kg	Manila
Crawler Crane	35t	Ormoc and Manila
Truck Crane	25t, 80t, 120t	Manila
Vibro Hammer	60kw	Ormoc and Manila
Diesel Hammer	3.5kw	Ormoc and Manila
Waterjet	$150kg/cm^2$	Ormoc and Manila
Compressor	$3.5m^3/min$	Manila
Concrete Breaker	20kg	Manila
Road Roller	10t	Manila
Motor Scraper	$3.1m^3$	Manila
Pump Car	$60m^3/h$, $110m^3/h$	Ormoc
Generator	20KVA, 150KVA, 200KVA	Ormoc and Manila
Concrete Mixer	$0.1m^3$	Ormoc and Manila
Water Pump	150m/m, 200m/m	Ormoc and Manila
Welding Machine	300A	Ormoc and Manila

All construction equipment can be arranged in the Philippines. It is not necessary to provide them from other countries.

(2) Procurement of Construction Materials

Procurement of construction materials is based on the following concept.

(a) Local procurement is given priority, unless quantity, time of delivery and quality pose a big problem.

(b) Even if a material is imported from other countries, it is easy to procure it at the local market (local procurement).

Among the construction materials to be used for the Project, combustibles, sands/stones and log/timber could be procured in Ormoc City and its vicinity. On the other hand, concrete, iron and some chemicals are to be procured in Cebu City and Metro Manila area or to be imported from Japan due to their quantity and quality. The procurement of construction materials is summarized as shown below:

Procurement of Construction Materials

Materials	Standard	Location of Procurement			
		Ormoc	Cebu	Manila	Japan
1. Combustibles		*			
2. Sand and Stones		*			
3. Concrete					
Portland Cement	40kg	*			
Ready Mixed Concrete	210kg/cm², 25 mm	*			
Ready Mixed Concrete	210kg/cm², 10mm	*			
Ready Mixed Concrete	210kg/cm², 40mm	*			
Prestressed Concrete Pile	D=300,600,800,1000 mm	*			
Reinforced Concrete Pile	0.3x0.3, 0.4x0.4		*		
Form Tie		*			
Non-Shrinkage Mortar				*	
PC Girder	III type l=19.8m		*		
Elastic Joint Filler	t=10mm			*	
Geotextile	t=50, w=70mm			*	
4. Log and Timber		*			
5. Iron					
Reinforcing Bars, Round	grade33, 25mm	*			
Reinforcing Bars, Deformed	grade40, 25mm	*			
Sluice Gate 1			*		
Sluice Gate 2			*		
Steel Sheet Pile					*
H-Beam					*
PC Steel Wire					*
Tendon					*
Live and Anchor					*
Elastomeric Bearing Pads					*
Slit			*	*	
Guard Rail			*	*	
6. Chemical					
PVC Pipe	D=50, 75, 100, 150, 200mm		*		
7. Other					
Gabion Mattress	0.5m*1.2m			*	
Name Plate				*	
Sodding Grass		*			

3.1.6 Implementation Schedule

The whole Project is assumed to require 4 years from the detailed design to the completion of construction. The detailed implementation schedule is shown in Fig. 3.1.2 and summarized below.

Implementation Schedule

Item of Work	Schedule
I. E/N and Contract	
II. Detailed Design	
(a) Phase-1 (Construction of Slit Dams and Bridges)	June 1997 - Sep. 1997 (4.0 months)
(b) Phase-2 (River Improvement Works)	May 1998 - Aug. 1998(4.0 months)
III. Tendering and Contracting	
IV. Construction	
(a) Phase-1 (Construction of Slit Dams and Bridges)	Dec. 1997 - Mar. 1999 (15.5 months)
- Preparatory Works/Temporary Works	
- Bridge Construction	
- Slit Dam Construction	
- Delivery of Works	
(b) Phase-2 (River Improvement Works)	Apr. 1999 - Mar. 2001 (24.0 months)
- Preparatory Works/Temporary Works	
- River Improvement (Anilao River)	
- River Improvement (Malbasag River)	
- Delivery of Works	

The work period of the detailed design and tendering for each phase is as shown below (refer to Fig. 3.1.2):

Work Period of Detailed Design and Tendering

Item of Work	1st Phase	2nd Phase
Detailed Design	4.0 months	4.0 months
Tendering and Contracting	2.0 months	2.0 months
Construction	15.5 months	24.0 months

3.1.7 Obligation of Recipient Country

Based on the Minutes of Meeting dated December 17, 1996, the allotment of project works is agreed as follows:

(1) Allotment of Responsibility for Project Execution

For the execution of the Project, role-sharing between the governments of Japan and the Philippines may be considered, as summarized below.

(a) Share of Responsibility Assumed by the Government of Japan

(i) Consulting tasks such as the detailed design, tendering and construction supervision for the Project.

(ii) Construction of proposed river channels and facilities, including relocation work for public facilities existing in the right of way of the construction site such as water pipe, sewer, electric pole/line and so on.

(iii) Procurement of construction materials/equipment including maritime and inland transportation and insurance.

(iv) Preparation of maintenance and operation manual for the facilities and rivers, and technical guidance.

(b) Share of Responsibility Assumed by the Government of the Philippines

(i) Speedy implementation of all administrative measures required for the execution of this Project, including exemption from all taxes and customs tariffs.

(ii) Repair of existing access roads damaged during and after the construction, if necessary.

(iii) Provision of a system for operation, maintenance and management, including personnel and budget allocations.

(iv) Assurance of the smooth completion of immigration/entrance formalities for Japanese engineers assigned to the Philippines in connection with the execution of the Project, granting exemption from taxation and assuring their safe stay in the Philippines.

(2) Obligation of the Government of the Philippines

Based on the allocation of project works between the Government of the Philippines and the Government of Japan, the obligations of the Government of the Philippines in the project works are summarized as follows:

(a) Early obtaining of the ECC and ICC;
(b) Smooth implementation of compensation works;
(c) Customs tax, and cost of storage for more than 7 days;
(d) Maintenance of existing roads;
(e) All taxes related to the Project;
(f) Disposal and treatment of bombs, if necessary; and
(g) Operation/maintenance works after construction.

3.2 Operation and Maintenance Plan

3.2.1 Operation and Maintenance Plan

Basic Concept

Operation and maintenance after completion of the Project is indispensable to assure the beneficial effects/functions of project facilities for a long time. On the other hand, since the river is closely related to the daily common life of the nearby residents, the river environment is to be kept clean and comfortable by paying careful attention to aspects such as waste disposal in river channels and trees on dikes.

From the above viewpoints, the "Operation and Maintenance of Structures" is undertaken by the execution body which is the "District Engineering Office, Leyte II, Region VIII, DPWH", and the "Operation and Maintenance of River Environment" is undertaken by the administrative execution body which is "Ormoc City". The organizations of these public bodies are shown in Fig. 3.2.1 to Fig. 3.2.5.

Operation and Maintenance of Structures

(1) River Channel

Sedimentation and scouring of channel bed will not only weaken the riparian structures but also decrease the flow capacity of the channel. (Periodical patrolling activity and early repairing/rehabilitation are needed.)

(2) Dike

Since crown of dike is designed for use as maintenance road, the surface is to be maintained well so as not to cause problems on patrolling activities in the rainy season.

Leakage of water is the most serious problem and this is generally caused by the following reasons:

(a) Different qualities of soil and/or voids because of poor mixture of soil for dike material.

(b) Permeable layer at the foundation of dike.

(c) New alignment stretch shifted from the old alignment of e river.

(d) Riparian structure site such as sluice and culvert crossing the dike.

(e) The inland ground elevation of stretch h is low compared with the channel bed.

(f) Void because of small animals such as mouse, mole, etc.

In the Project, the high water level (H.W.L.) is set at almost the same elevation as the inland ground so that the possibility of leakage is low. However, the meandering stretch which shifted from the old alignments of the Anilao and Malbasag rivers (especially, the stretch at Anilao Bridge) is required to be checked by periodical patrol.

(3) Revetment

Wet masonry type of revetment is provided for the front slope of the dike. Therefore, voids, cracks and subsidence at the back side of masonry works are difficult to be identified, so that periodical/precise inspection is required.

Collapse of revetment weakens the strength/safety of dike so that early repair work is needed.

Foot protection for the revetment is also important. When the foot protection work is exposed because of scouring, immediate repair should be made.

(4) Hydraulic Drop

Hydraulic drops are provided not only to change the gradient of the channel bed from a steep to a gentle one but also to protect the bank/channel bed by controlling the flow direction of the river.

Generally, in the dissipator and bed protective work at the front apron of the main body of the hydraulic drop, abrasion and crack are often observed. Therefore, appropriate maintenance/repair is needed.

Since the uneven subsidence of the foundation of main body will cause fissures and cracks of concrete, careful attention should be paid.

(4) Sluice/Culvert

Sluice and culverts which are constructed in cross-section passing through the dike are provided to promote the smooth drainage of rainwater in the landslide area and the domestic sewerage water.

Gates will be installed for two sluices (one upstream of Anilao Bridge and the other upstream of Algeria Bridge) to prevent the reverse flow of floodwater. This gate is usually opened but should be closed when the river water level is higher than the inland water level. Thus, operation of the gate should be secured, especially in rainy season.

(5) Slit Dam

Steel slit is commonly designed as maintenance free and no repairing is required. However, the following items should be taken cared of periodically.

Corrosion, especially rust of steel, should be taken cared of. (Painting is needed to be done once in a few years.)

Since steel slit is considerably weak to overload, especially to excessive shock/impact by huge rocks and/or floating logs which flow down from the upstream, these rocks and floating logs should be removed immediately after every flood.

No sedimentation in the upstream of dam will be found because sediment is transported to the downstream passing through the slit. When excessive and/or irregular sedimentation is found, the sediment shall be removed.

Among the above items, most critical is the "removal of rocks and floating logs after flood", because the rocks and floating logs will cause clogging of the slit and will result in the dam up of flood flow. Periodical patrolling and early removal should be assured.

In addition to the above, since the foundation of main body of the dam, abutment, bed protection works in the front apron are constructed of concrete, irregular subsidence, crack, damage/injury of the concrete and also bed scouring at the downstream of dam should be checked and countermeasures provided.

(6) Bridge

Five (5) river bridges (3 bridges in Anilao River and 2 bridges in Malbasag River) are to be reconstructed.

Bridge foundations, abutments and piers are all constructed inside of the channel, so that the negative impacts as mentioned below are to be checked by periodic patrolling and countermeasures are to be provided immediately.

Due to excessive load and super-annuation of the structure, crack of concrete, irregular subsidence of pier and abutment, and scouring around the pier are often found. These will not only shorten the life of structure but also disturb the smooth flow of flood in the channel and negatively affect riparian structures such as dike, revetment, foot protection works, etc.

Also, because of the irregular subsidence of dike slope/revetment, void sbetween slope and abutment are often found. These will cause leakage of the dike, so that early repair is needed.

As for approach roads which are constructed to provide a retaining wall on both sides of the road, subsidence, cracks and other damage/injury are to be repaired immediately.

Environmental Maintenance

(1) Land Use Regulation

Since there exists the "River Law" in Japan, the territorial boundary of rivers is legally determined, and any land utilization and/or development within the boundary is needed to be approved by the Government. On the contrary, because there is no similar law or regulation, the land side areas of Anilao River and Malbasag River are fully occupied by residential houses in the downstream and by the paddy fields or coconut farms in the middle reaches.

One of the biggest reasons of the serious damage by Typhoon Uring experienced in November 1991 is the dam-up of flood flow because of the clogging of river channel by floating logs from the middle/upper reaches. The slit dams to be constructed in the project will stop the logs from the upper reaches, but will not stop the logs from the middle reaches between the upper end of channel improvement and the slit dam site. When excessive land use/development is attained in the middle reaches, the potential of floating logs at the time of floods is also increased.

Therefore, it is recommended that not only periodic inspection but also the appropiate municipal ordinance for excessive land use/development be enacted by Ormoc City.

(2) Waste Disposal in River Channel

The river water of both Anilao and Malbasag rivers is at present clean and utilized for daily life activities such as washing cloths, swimming, livestock washing and others. Thus, waste disposal in the river channel has to be prohibited.

According to the site reconnaissance, waste disposal is common especially in the downstream stretch of both rivers, and daily patrolling and more strict inspection may be needed. (Since waste disposal and pollution of river environment could not be coped only by patrolling activity, garbage collection and treatment system is recommended to be established and consistently implemented.)

(3) Tree Planting in the Riparian Area

After the completion of river improvement, the dike crown will be used as the operation and maintenance road. However, for the daily life of nearby residents, it will be used as communication/stroll road, and planting of suitable trees is recommended. Also, the old river channel at the upstream of the Anilao Bridge, which is filled up with the excavated soil material, is to be utilized for open space.

(4) Establishment of Evacuation System

River improvement of Anilao and Malbasag River is designed with a 50-year return period. However, there still exists the possibility that a flood exceeding the scale of 50-year return period may occur after the completion of the Project.

Therefore, an evacuation system is recommended to be established. The system shall consist of an information dissemination system to the public, preparation of shelter (school, community center, church, etc.), and an evacuation procedure among the respective communities.

Also, role and function as well as information network in emergency cases should also be assured among the city office, hospitals, police stations, fire defense offices and other related public offices.

3.2.2 Operation and Maintenance Cost

Development of O/M Activity

Demarcation of the operation and maintenance (O/M) activities are as follows:

Maintenance of Structures	District Engineering Office, Leyte II, Region VIII, DPWH
Environmental Maintenance	Ormoc City

(1) District Engineering Office, Leyte II, Region VIII, DPWH

For successful O/M works, at least one river structural engineer and one bridge engineer shall be added to the operation and maintenance section, and actual operation and maintenance will be done by the following system:

Periodic Patrolling	District Engineer's Office (Once a month/after floods)
Periodic Checking of Structures	Consultants (Once a year)
Detailed Checking of Structures	Consultants (Once every 5 years)
Periodic Repairing of Structures	Consultants (Once a year)
Big Scale Repair Work	Consultants (When needed)

(2) Ormoc City

To promote the construction of the project, Ormoc City had already organized the "Ormoc City JICA Project Task Force" which consists of 8 sections.

To take care of the environmental maintenance, 3 sections as mentioned below are recommended to continue operations even after the completion of the project.

Environmental and Sanitation Section	For waste disposal and Planting Trees
Program Implementation Section	Land Use Regulation, River Park Construction and Evacuation System
Information and Dissemination Section	Information Dissemination and Enlightenment of the Public concerning the above items

Cost Estimate for Operation and Maintenance Works

Operation and maintenance costs required for the maintenance of structures are estimated as below and details are in Annex 5. The cost for environmental maintenance will be estimated by Ormoc City depending on the facilities/structures to be be developed by the city government.

Operation and Maintenance Cost

Item		Amount (pesos)	Remarks
1. Administration Cost		245,000	Every year
2. Annual Inspection of Structures		94,000	Once a year
3. Detail Inspection of Structures		184,000	Once in 5 years
4. Annual Maintenance of Structures		504,000	Once a year
5. Periodic Maintenance of Structures			
5-1 Short Term		799,000	Once in 5 years
5-2 Long Term		1,447,000	Once in 20 years
Total	Every year	1,700,000	1 + 2 + 4
	Once in 5 years	938,000	3 + 5-1
	Once in 20 years	1,447,000	5-2