Natural stones will be used for the main structure of the drops. A drop is divided into three steps to accelerate aeration and to give scenic variety to the river flow.

(b) Low Water Channel for Maintenance Flow (MFC)

A low water channel for maintenance flow is proposed for river water use such as washing and bathing. The depth of channel is set from 0.5 to 1.0 m and the capacity of the channel corresponds to the specific discharge of 0.01 $m^3/s/km^2$ for Jaro River and 0.1 $m^3/s/km^2$ for rivers in Ormoc City. Meandering like a natural stream is given to the improvement alignment. River banks of low water channel with a gentle stream are fixed with log piles or boulders. The floodwater channel is sodded with grass or covered with boulders.

(c) Maintenance Road along River

Maintenance roads are provided along both banks or on the earth dike, which may be used for strolling along rivers. If there is a space behind roads, tree planting is recommended for improvement of the scenery. Riverside trees clearly show the boundary of the river and private properties.

(d) Approach Steps to Waterfront

The river water is used by inhabitants nearby the river for domestic purposes. Therefore, approach steps to the waterfront are provided on the dike/retaining wall for easy access to the river water. Additionally, these steps will also help people become intimate with rivers.

(e) Materials for Structural Design

Natural construction materials such as wood or stone/boulder are to be used for structures as much as possible. The use of natural materials for the river structures will provide a refreshing view to onlookers.

3.2 River Improvement Plan

<u>Iloilo City</u>

(1) Jaro River

To minimize land acquisition and house evacuation, a combination of river improvement works and two diversion channels for flood discharge of Jaro River to the Iloilo Strait is proposed.

The distribution of design flood is arranged as below:

Stretch/River	Design Discharge (m^3/s)
Jaro River	
Jaro River Mouth - Diversion of La Paz Floodway	150
Diversion of La Paz Floodway - Diversion of Jaro Floodway	550
La Paz Floodway	400
Jaro Floodway	850
Tigum River	600
Aganan River	800

The design features of Jaro river improvement works are presented in Table 3.1, the proposed alignments and typical cross sections are shown in Fig. 3.4, and the proposed longitudinal profiles are also given in Fig. 3.5.

The details of river improvement and floodway plan for Jaro River are mentioned below:

(a) Design High Water Level

The design high water level is set at the same level as the existing ground level except the low-lying area at the river mouth to conform with the results of non uniform flow analysis.

(b) Alignment

To minimize land acquisition, the channel alignment for the existing river channel improvement works is set along the existing river course.

The outlet of Jaro Floodway is proposed at the existing drainage channel along the low-land area. The diversion point is determined at the confluence with Aganan River (STA. 16+250) through the alternative study in Section 3.5. The alignment of channel is proposed to be along the low-land in paddy fields to avoid the existing subdivisions.

The alignment of La Paz Floodway is designed considering the direction of the diverted water to assure smooth flow and minimize impacts to the proposed Iloilo Commercial Port.

(c) Riverbed Profile

The design riverbed of Jaro River follows the average existing riverbed. That of the floodway is derived from the elevations at the diversion point, the outlets' sea bottom and the length of the floodways.

The proposed longitudinal profiles for Jaro River and the floodways are as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
Jaro River			
River Mouth - Dversion of La Paz Floodway	4.02	- 2.0	1/5,000
Diversion of La Paz Floodway - STA. 10+000	5.98	- 1.2	1/2,500
STA. 10+000 - Diversion of Jaro Floodway	6.16	1.2	1/1,500
La Paz Floodway	0.60	- 1.4	1/2,500
Jaro Floodway	4.80	- 1.1	1/750
Tigum River	2.00	5.3	1/1,000
Aganan River	2.80	5.3	1/1,000

(d) Cross Section

A single cross-section is employed for the river improvement works and construction of floodways. A low water channel for river maintenance flow is provided at the middle reach (STA. 7+000 to STA. 12+000) from the environmental point of view. The capacity of the low water channel corresponds to the specific discharge of 0.01 $m^3/s/km^2$ and the depth is set at 1 m.

The basic dimensions of the channel sections are determined by non-uniform flow analysis as shown below:

Stretch	Bottom Width of Low Water Channel (m)	Total Width (m)
Jaro River		
River Mouth - Diversion of La Paz Floodway	-	*
Diversion of La Paz Floodway - STA. 10+000	15	36
STA. 10+000 - Diversion of Jaro Floodway	15	27
La Paz Floodway	-	30
Jaro Floodway	-	50
Tigum River	-	23
Aganan River	-	33

* Same as the existing river width.

(e) Related Structures

(i) Earth Dike

Earth dikes are provided at the downstream of Jaro River, the Jaro Floodway and the La Paz Floodway. The locations of earth dikes are given below:

Stretch	Length (m)	Ave. Height (m)
Jaro River		
River Mouth - Diversion of La Paz Floodway	2,800	1.2
Diversion of La Paz Floodway - STA. 10+000	10,760	2.7
STA. 10+000 - Diversion of Jaro Floodway	300	1.6
La Paz Floodway	1,200	2.6 - 4.6
Jaro Floodway	4,500	4.3
Tigum River	1,840	1.5
Aganan River	5,300	1.1
Total	26,700	

(ii) Revetment

A total of 11,900 m of Type A revetment and 1,600 m of Type B are provided to stabilize the water colliding front at the concave river bank and to protect the dike against erosion from turbulent flood flow. The locations of revetments are as follows:

Stretch	Length (m)	Ave. Height (m)
Jaro River		
Jaro River Mouth - Diversion of La Paz Floodway	400	3.0
Diversion of La Paz Floodway - Diversion of Jaro Floodway	9,000	6.0
La Paz Floodway	500	6.0
Jaro Floodway	600	4.8
Tigum River	1,150	6.0
Aganan River	1,100	6.0
Total	12,750	

(iii) Diversion Works for Jaro Floodway

The design discharge of 850 m^3/s which corresponds to 60% of the design discharge for Jaro River is diverted into the Jaro Floodway. In ordinary time, the whole discharge of Jaro River is diverted into the existing channel to maintain the current water uses in the downstream area.

Since the diversion point of Jaro Floodway is located near the confluence of Aganan River and Tigum River, the flow at the site is assumed to be turbulent. Therefore, two non-gated fixed weirs on the existing river channel and floodway are proposed for the stable discharge diversion of flood. The water level upstream of the diversion point is set at EL. 12.8 m which is the existing ground level of both banks, and the height of the weir is determined to be 4 m which gives a perfect overflow condition. To secure a stable flow at the upstream of weirs, the water stabilizing basin 150 m wide is employed.

(iv) Diversion Works for La Paz Floodway

To divert the design discharge of 400 m^3/s to La Paz Floodway, a fixed weir is constructed at the immediate downstream of the diversion point on the existing river channel. In addition to the weir, a separation dike is constructed elongating the right bank of Jaro River to assure the design discharge diversion. The crest elevation of the weir is set at EL. -0.5 m which is the same as the Mean Lower Water Level (MLWL).

(v) Groundsill

To stabilize the channel bed, groundsills are provided at the outlet of the floodway and diversion point of La Paz Floodway. A combination of log piles and boulder fill which is flexible against settlement is employed for the groundsills because the foundation of construction sites is assumed to be soft.

(vi) Sluice

Type A sluice with slide gate is provided at the drainage connecting point in the area provided with earth dike. The total number of sluices is assumed to be two (2) for the downstream of Jaro River. On the other hand, ten (10) Type B sluices with flapgates are employed to drain the local runoff at the embanked area.

(vii) Invert Siphon

Three (3) invert siphons will be constructed along Jaro Floodway at the crossing points with the irrigation channel. Two of the invert siphons have the capacity of 1.03 m^3/s each and the third has the capacity of 0.4 $m^3/$, corresponding to the existing irrigation channel capacity.

(viii) Bridges

Due to the widening of river channel and construction of floodways, it is necessary to replace some bridges and construct new ones. Replaced/newly constructed bridges are as follows:

Location	Length (m)	Width (m)
River (bridge replacement)		
(1) Ticudo Bridge	60	7
(2) Ledesco Bridge	60	7
Floodway (new bridge)		
(1) Jaro Floodway		
- STA. 0+300	70	7
- STA. 2+120	70	7
- STA. 4+090	70	7
(2) La Paz Floodway		
- STA. 0+400	70	7

A prestressed concrete bridge girder with a maximum length of 20 m and height of 1.0 m will be employed.

(2) Iloilo River (Main Channel)

River Improvement works composed mainly of dredging and construction of concrete and/or earth dike are required. The improvement section of Iloilo River is from the river mouth to Molo Bridge.

The design features of the Iloilo river improvement works are given in Table 3.2, the proposed alignment and typical cross sections of Iloilo River are shown in Fig. 3.6, and the proposed longitudinal profiles are also given in Fig 3.7.

The details of the river improvement plan for Iloilo River are given below:

(a) Design High Water Level (DHWL)

The design high water level at the river mouth is strictly confined by the wharf of Iloilo Port. The DHWL at the upper reach of Iloilo River is set at the same level as the existing ground level.

(b) Alignment

The channel alignment is planned along the existing river course. Both banks of the channel are set along the existing riverbanks, since the river width of Iloilo River is very wide.

(c) Longitudinal Profile

The Philippine Ports Authority (PPA) has been conducting maintenance dredging work for the Iloilo Port from the river mouth to STA. 2+400. Therefore, the design riverbed profile is proposed along the existing riverbed and connected to PPA's dredging scheme.

(d) **Cross Section**

A single cross-section with a side slope of 1 : 3 is employed for the dredging area. The channel bottom width which can accommodate the flood flow below the proposed DHWL was simulated by using the non-uniform flow analysis. As a result of the calculation, a 100 m channel bottom width for the port area, 80 m for the middle reach and 60 m at the Molo Bridge are selected.

(e) Related Structures

(i) Earth Dike

Earth dikes are provided at the fishpond area along Iloilo River. The length and height of earth dikes are given below.

Section	Length (m)	Height (m)
Left Bank		
- STA. 3+650 - STA. 5+100	1,350	2.5
- STA. 5+230 - STA. 6+650	1,450	2.5
Right Bank		
- STA. 4+950 - STA. 5+230	280	2.0
- STA. 5+750 - STA. 6+250	350	2.8
Total	3,430	

(ii) Concrete Dike

Since the DHWL is set at the existing ground level, it is necessary to raise the bank elevation to provide a freeboard. In the urban area along Iloilo River, a concrete dike is employed to minimize land acquisition and house evacuation.

The construction site of concrete dike is given below:

Section	Length (m)	Height (m)
Left Bank		
- STA. 0+000 - STA. 1+400	1,600	0.5
- STA. 2+780 - STA. 2+910	130	0.5
- STA. 3+300 - STA. 3+650	600	0.7
Right Bank		
- STA. 3+350 - STA. 4+850	1,400	1.0
- STA. 5+240 - STA. 5+800	550	1.0
- STA. 6+150 - STA. 6+600	500	2.0
Total	4,780	

(iii) Revetment

Type B revetment is adopted at the confluence of Mandurriao River where floodwaters collide. Total length of the revetment is 300 m and the average height is 3 m except a 10 m long concrete sheet pile.

(iv) Sluice

Sluice with flapgates is provided at the drainage connecting point to drain the land-side water in the area of dike. The total number of sluices is assumed to be five (5).

(v) Bridge

Due to the widening of river channel, it becomes necessary to reconstruct the road bridges. The bridge replacement is 110 m long and 7 m wide.

(vi) Bridge Protection

Protection works for the bridge pier foundation are provided at the foundation of bridge piers/abutments to be dredged lower than the existing foundation structures. The bridge protection works are made of steel sheet piles. The total area of bridge protection works is 1,200 m^2.

(3) Mandurriao River (Tributary of Iloilo River)

The design features of the Mandurriao river improvement works are presented in Table 3.3. The proposed alignment and typical cross-sections are shown in Fig. 3.8, and the proposed longitudinal profiles are also given in Fig 3.9.

(a) Design High Water Level (DHWL)

The design high water level is set to be the same as the existing ground level except the fishpond area at the river mouth where the flood water level is influenced by the water level of Iloilo River.

(b) Alignment

To minimize land acquisition and house evacuation, the channel alignment is set along the existing river course. The small meandering is, however, stretched to stabilize and smoothen flood flow.

(c) Longitudinal Profile

The design riverbed elevation of Iloilo River at the confluence is employed for the elevation at the river mouth which is 2 m deeper than the existing riverbed. The proposed longitudinal profile of the riverbed is summarized as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 4+000	4.00	- 3.19	1/1,300
STA. 4+000 - STA. 4+820	0.82	- 0.12	1/650

(d) Cross Section

A single cross-section is applied to minimize land acquisition. The features of the cross-section are determined by the non-uniform flow analysis.

Stretch	Width (m)	Side Slope (V : H)	Remarks
River Mouth - STA. 4+000	20	1 : 3.0	Dredging Area
		1 : 2.0	Embankment/ Excavation Area
STA. 4+000 - STA. 4+820	10	1 : 2.0	

(e) **Related Structures**

(i) **Earth Dike**

Earth dikes are provided along the entire river course where the bank elevation is lower than the required dike crest elevation. The total length of the earth dike is 9,400 m averaging 0.7 m high and having the maximum height of 2.0 m.

(ii) **Revetment**

A total of 2,000 m of Type B revetment with steel sheet piles for foundation and 1,100 m of Type A revetment with a height of 3 m are provided to stabilize the water colliding front at the concave river bank and to protect the dike against erosion from turbulent flood flow.

(iii) **Sluice**

A total of two (2) sluices with slide gate are provided at the drainage connecting point in the area. Another two (2) sluices with flapgate are provided on the earth dike to drain local runoff.

(iv) **Bridges**

Due to the widening of river channel, it becomes necessary to replace and construct bridges. Bridges to be reconstructed are as follows:

Location	Length (m)	Width (m)
Seminar Bridge, STA. 3+010	40	7
Street Bridge, STA. 3+210	40	7
Santa Rosa Bridge, STA. 4+090	40	7

Cebu City

(1) Bulacao River

The design features of Bulacao river improvement works are presented in Table 3.4, the proposed alignments and typical cross-sections are shown in Fig. 3.10, and the proposed longitudinal profiles are also given in Fig 3.11.

(a) Design High Water Level

The design high water level is set along the existing ground level which is about 2.5 m higher than the average riverbed.

(b) Alignment

To minimize land acquisition and house evacuation, the improvement is proposed to be aligned along the existing river course.

(c) Longitudinal Profile

The average riverbed profile is summarized as follows:

Section	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 1+400	1.40	- 0.50	1/200
STA. 1+400 - STA. 5+000	3.60	5.30	1/140

The flow velocity of each section is estimated to be higher than 3 m/s with a water depth of 2.5 m. Eight (8) drop structures, 1 m high, are provided along all the improvement sections to reduce the flow velocity to less than 3 m/s. The proposed riverbed slope is set at a half of the design riverbed slope. The basic dimensions such as height and number of drops are discussed in Section 5, Preliminary Design of Structures.

(d) Cross Section

Since the existing land use along the river is mainly the paddy field, a single cross-section channel without lining is employed from the hydraulic aspect as given below:

Stretch	Width (m)	Side Slope (V : H)	Remarks
River Mouth - STA. 1+400	33	1:2.0	with drops
STA. 4+000 - STA. 4+820	27	1:2.0	with drops

(e) Related Structures

(i) Earth Dike

Earth dikes are provided along the entire river course where bank elevation is lower than the required dike crest elevation. The total length of the earth dike is 1,400 m averaging 1.8 m high and having the maximum height of 2.5 m.

(ii) Revetment

A total of 680 m of Type A revetment with a height of 3 m is provided to stabilize the water colliding front at the concave river bank and protect both sides of drop structures against erosion by turbulent flood flow.

(iii) Drops

To control the flow velocity, a total of eight (8) drop structures are provided. The height of drops is set at more than 1.0 m, which will give a perfect overflow and a big decrease of flow energy. The location of drops is given below:

Stretch	Riverbed Slope		Height	Pitch
	Existing	Design	(m)	(m)
River Mouth - STA. 1+400	1/200	1/400	1.0	200
STA. 1+400 - STA. 2+650	1/140	1/280	1.0	140

(iv) Bridges

Due to the widening of river channel, it becomes necessary to replace the Inawayan Bridge into a 48 m long and 7 m wide bridge.

(2) Kinalumsan River

The design features of Kinalumsan river improvement works are given in Table 3.5. The proposed alignment and typical cross-sections are shown in Fig. 3.12, and the proposed longitudinal profiles are also given in Fig 3.13.

(a) Design High Water Level

The design high water level is set to be the same as the existing ground level of the riverine area. The depth of river channel is 3 m.

(b) Alignment

To minimize land acquisition and house evacuation, the alignment of the improved river channel is along the existing river course.

(c) Longitudinal Profile

The average riverbed profile is summarized as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 1+400	1.40	- 0.60	1/250
STA. 1+400 - STA. 4+000	2.60	5.00	1/100

The flow velocity of each section is estimated to be higher than 3 m/s with a 3 m water depth. Nine (9) drop structures, 1.5 m high, are provided along the section from STA. 1+400 to STA. 4+000 to reduce the flow velocity lower than 3 m/s. The proposed riverbed slopes are set at a half of the design riverbed slope. The basic dimensions such as height and number of drops are discussed in Section 5, Preliminary Design of Structures.

(d) Cross Section

Since the existing land use along the river is mainly residential, a channel with a retaining wall having a side slope of 1 : 0.5 is employed to minimize the land acquisition and number of houses to be evacuated. The following design features of cross-section are formulated by uniform flow calculation.

Stretch	Width (m)	Side Slope (V : H)	Remarks
River Mouth - STA. 1+400	22	1:0.5	---
STA. 4+000 - STA. 4+820	12	1:0.5	With drops

(e) Related Structures

(i) Retaining Wall

A total of 8,000 m of concrete retaining walls are provided for the channel works. The height of concrete wall including freeboard and foundation is designed at 4.3 m for the section from the river mouth to STA. 1+400 and 4.1 m for other sections.

(ii) Drops

To reduce flow velocity, a total of nine (9) drop structures are provided at the section between STA. 1+400 and STA. 4+000. The height of drops is set at more than 1.5 m which will give a perfect overflow. The pitch of drops is set at 300 m under the design riverbed slope of 1/400.

(iii) Bridges

Due to the widening of river channel, it is necessary to replace bridges. The bridges to be reconstructed are as follows:

Location	Length (m)	Width (m)
STA. 0+300	26	7.0
STA. 0+450	26	7.0
STA. 0+680	26	14.0
STA. 1+200	26	7.0
STA. 1+750	22	7.0
STA. 3+970	22	3.5

(3) Guadalupe River

The design features of the Guadalupe river improvement works are given in Table 3.6, the proposed alignments and typical cross sections are shown in Fig. 3.14, and the proposed longitudinal profiles are also given in Fig 3.15.

(a) Design High Water Level

The design high water level is set along the existing ground level which is about 3.5 m higher than the average riverbed.

(b) Alignment

To minimize land acquisition and house evacuation, the improved river channel is planned to be aligned along the existing river course.

(c) Longitudinal Profile

The average riverbed profile is summarized as follows:

Section	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 1+000	1.00	- 1.00	1/400
STA. 1+000 - STA. 2+000	1.00	1.50	1/200
STA. 2+000 - STA. 4+200	2.20	6.50	1/140

The flow velocity of each section is estimated to be higher than 3 m/s with a water depth of 3 m. Three (3) drop structures, 1.5 m high, are provided along the upstream from STA. 2+000 to reduce flow velocity. The proposed riverbed slope is set at 1/200 which is the design riverbed slope of the downstream section. The basic dimensions such as height and number of drops are discussed in Section 5, Preliminary Design of Structures.

(d) Cross Section

Since the existing land use along Guadalupe River is mainly residential, a channel lined by retaining wall with 1:0.5 side slope is employed to minimize land acquisition and the number of houses to be evacuated. The following design features of cross-section are derived by uniform flow calculation:

Stretch	Width (m)	Side Slope (V : H)	Remarks
River Mouth - STA. 1+000	25	1 : 0.5	
STA. 1+000 - STA. 2+000	18	1 : 0.5	
STA. 2+000 - STA. 4+200	18	1 : 0.5	With drops

(e) Related Structures

(i) Retaining Wall

A total of 6,400 m of concrete retaining walls are provided for the channel works. The height of concrete wall including freeboard and foundation is designed at 4.8 m.

(ii) Drops

To reduce flow velocity, a total of three (3) drop structures are provided at the section between STA. 2+000 and STA. 4+200. The height of drops is set at more than 1.5 m which will give a perfect overflow. The pitch of drops is set at 300 m under the design riverbed slope of 1/200.

(iii) Bridges

Due to the widening of river channel, it is necessary to reconstruct bridges. The bridges to be reconstructed are as follows:

Location	Length (m)	Width (m)
STA. 0+420	30	8.0
STA. 0+920	30	8.0
STA. 1+210	32	14.0
STA. 4+000	41	8.0

(4) Lahug River

The design features of the Lahug river improvement works are given in Table 3.7. The proposed alignment and typical cross-sections are shown in Fig. 3.16, and the proposed longitudinal profiles are also given in Fig 3.17.

(a) Design High Water Level

The design high water level is set along the existing ground level which is about 2.5 m higher than the average riverbed.

(b) Alignment

To minimize land acquisition and house evacuation, the alignment of the improved river channel is along the existing river course.

(c) Longitudinal Profile

The average riverbed profile is summarized as follows:

Section	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 1+000	1.00	- 0.60	1/400
STA. 1+000 - STA. 2+000	1.00	2.10	1/200
STA. 2+000 - STA. 3+000	1.00	6.65	1/120
STA. 3+000 - STA. 5+500	3.50	14.98	1/80

The flow velocity of each section is estimated to be higher than 3 m/s with a water depth of 3 m. Six (6) drop structures, 1 m high, are provided along the upstream from STA. 3+000 to reduce flow velocity. The proposed riverbed slope is set at 1/200 which is the design riverbed slope of the downstream section. The basic dimensions such as height and number of drops are discussed in Section 4, Structural Design.

(d) Cross Section

Since the existing land use along the river is mainly residential, a channel lined by retaining wall with a 1 : 0.5 side slope is employed to minimize land acquisition and the number of houses to be evacuated. The following design features of cross-section are derived by uniform flow calculation:

Stretch	Width (m)	Side Slope (V : H)	Remarks
River Mouth - STA. 1+000	20	1 : 0.5	
STA. 1+000 - STA. 2+000	14	1 : 0.5	
STA. 2+000 - STA. 3+000	11	1 : 0.5	
STA. 3+000 - STA. 5+500	11	1 : 0.5	With drops

(e) Related Structures

(i) Retaining Wall

A total of 8,000 m of concrete retaining walls are provided for the channel works. The height of concrete wall including freeboard and foundation is designed at 3.6 m.

(ii) Drops

To reduce flow velocity, a total of six (6) drop structures are provided at the section between STA. 3+000 and STA. 5+500. The height of drops is set at more than 1.0 m which will give a perfect overflow. The pitch of drops is set at 240 m under the design riverbed slope of 1/120.

(iii) Bridges

Due to the widening of river channel, it is necessary to replace the following ten (10) bridges:

Location of Bridges	Length (m)	Width (m)
STA. 0+000	21	14.0*
STA. 0+110	23	7.0
STA. 0+300	23	14.0
STA. 0+620	23	14.0
STA. 1+040	23	7.0
STA. 1+800	14	7.0
STA. 2+400	14	7.0
STA. 2+560	14	14.0
STA. 2+730	14	14.0
STA. 3+200	23	7.0

* With steel sheet pile protection.

(5) Subang Daku River

Since the catchment area of tributaries of Subang Daku River account for 45% of the river basin, the design discharge for river improvement is divided at the confluence of tributaries as follows:

Section	At / A (%)	Discharge (m^3/s)
River Mouth - STA. 3+200	100	200
STA. 3+200 - STA. 4+500	65	135
STA. 4+500 -	55	110

At : Catchment area of tributaries
A : Catchment area of Subang Daku River

The design features of the Subang Daku river improvement works are given in Table 3.8. The proposed alignment and typical cross sections are shown in Fig. 3.18, and the proposed longitudinal profiles are also given in Fig 3.19.

(a) Design High Water Level

The design high water level is basically set along the existing ground level as given below:

Section	Water Depth (m)
River Mouth - STA. 2+000	3.00
STA. 2+000 - STA. 3+000	2.50
STA. 3+000 - STA. 4+500	2.50
STA. 4+500 - STA. 5+540	2.50*

* The water depth of this section is set at 2.2 m to reduce the flow velocity to 3 m/s in the design channel section.

(b) Alignment

To minimize land acquisition and house evacuation, the improved river channel is planned to be aligned along the existing river course. A shortcut channel from STA. 0+300 to STA. 1+000 is proposed. The channel length to be improved is 540 m shorter than the existing channel length.

(c) Longitudinal Profile

The average riverbed profile is summarized as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
River Mouth - STA. 2+000	1.00	- 1.50	1/500
STA. 2+000 - STA. 3+000	1.00	1.92	1/250
STA. 3+000 - STA. 4+500	1.50	5.92	1/100
STA. 4+500 - STA. 5+540	1.04	20.42	1/50

The flow velocity upstream of STA. 3+000 is estimated to be higher than 4 m/s with a water depth of 2.5 m. Eighteen (18) drop structures, 1.0 m high, are provided at this section to reduce flow velocity. The proposed riverbed slopes are set at half of the design riverbed slope.

(d) Cross Section

Since the existing land use along the river is mainly residential, a channel lined by retaining wall with a 1 : 0.5 side slope is employed to minimize land acquisition and the number of houses to be evacuated. The following design features of cross-section are derived by uniform flow calculation:

Stretch	Width (m)	Side Slope (V:H)	Water Depth (m)	Remarks
River Mouth - STA. 2+000	27	1:0.5	3.0	
STA. 2+000 - STA. 3+000	26	1:0.5	2.5	
STA. 3+000 - STA. 4+500	16	1:0.5	2.5	With drops
STA. 4+500 - STA. 5+540	12	1:0.5	2.2	With drops

(e) Related Structures

(i) Retaining Wall

A total of 10,500 m of concrete retaining wall is provided for the channel works. Concrete walls, 4.3 m, 3.6 m and 3.3 m high including freeboard and foundation, are proposed for the section from the river mouth to STA. 2+000, for STA. 2+000 to STA. 4+500, and for STA. 4+500 to STA. 5+540, respectively.

(ii) Drops

To reduce flow velocity, a total of eighteen (18) drop structures are provided at the section between STA. 3+000 and STA. 5+5400. The location of drops is given below:

Stretch	Riverbed Slope		Height	Pitch
	Existing	Design	(m)	(m)
STA. 3+000 - STA. 4+500	1/100	1/200	1.0	200
STA. 4+500 - STA. 5+540	1/50	1/100	1.0	100

(iii) Bridges

Due to the widening of river channel, it is necessary to reconstruct bridges. The bridges to be reconstructed are as follows:

Location	Length (m)	Width (m)
STA. 0+150	30	14.0
STA. 1+350	30	14.0
STA. 2+640	32	3.5
STA. 2+688	30	3.5
STA. 3+750	30	3.5
STA. 4+060	32	3.5
STA. 4+720	32	3.5
STA. 4+840	41	14.0

Ormoc City

(1) Anilao River

The design features of the Anilao river improvement works are given in Table 3.9. The proposed alignment and typical cross-sections are shown in Fig. 3.20, and the proposed longitudinal profiles are also given in Fig 3.21.

(a) Design High Water Level

The design high water level is set at the same level as the existing ground level which is about 4 m higher than the average riverbed.

(b) Alignment

The channel alignment is basically set along the existing river course. A shortcut channel is proposed at the concave portion upstream of Anilao Bridge. The comparative study on channel alignment between a shortcut channel and the existing river improvement is discussed in Subsection 3.3.4.

(c) Riverbed Profile

The design riverbed of Anilao River follows the lowest existing riverbed as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
River-Mouth - STA. 0+800	0.8	- 1.50	1/250
STA. 0+800 - STA. 1+600	0.8	1.70	1/125
STA. 1+600 -		8.26	1/90

Since the water velocity becomes higher than 4 m/s upstream from STA. 0+800, drops are provided along this stretch to reduce the water velocity. The proposed riverbed slope along the stretch where the drops are provided is set at a half of the design riverbed slope.

(d) Cross Section

A single cross-section with maintenance flow channel is applied to Anilao River considering the environmental concerns. Both banks of the main channel is protected by the revetment from bank erosion since the flow velocity is estimated to be more than 3 m/s. The maintenance flow channel is designed as having the flow capacity of 20 m^3/s and gentle bank slope of 1 : 5. The features of the cross-section are determined by uniform flow as shown below:

Stretch	Width (m)	Height (m)	Side Slope (V:H)	Remarks
River mouth - STA. 0+800	45	4.0	1:2.0	
STA. 0+800 - STA. 1+600	45	4.0	1:2.0	w/ drops
STA. 1+600 -	45	3.7	1:2.0	w/ drops

Revetment is provided along the entire improved section to protect the river banks from erosion. Where the velocity of flood flow is more than 3 m/s, drops are provided.

(e) Related Structures

(i) Earth Dike

Earth dikes are provided along the river course where the bank elevation is lower than the required dike crest elevation. The location of earth dike is given below:

Stretch	Length (m)	Height (m)
STA. 0+000 - STA. 0+750	1,500	1.9 in max.
STA. 1+550 - STA. 1+850	300	2.0 in max.
Total	1,800	

(ii) Revetment

The water velocity of Anilao River becomes more than 3 m/s because of the steep riverbed slope. Revetments of wet masonry type are provided along the entire improvement sections to protect the dike against erosion by rapid flood flow. The total length of revetment is approximately 4 km and average height is 5 m including the foundation.

(iii) Sluice

Sluices with slide/flapgate are provided at the drainage connecting point in the area provided with earth dike. The total number of sluices is three (3). The location and basic dimensions of sluices are as given below:

Location	Dimension (H·B·L, m)	Remarks
STA. 0+200 (right bank)	1.2 · 1.2 · 16	Double box-culvert
STA. 1+000 (left bank)	1.2 · 1.2 · 16	Double box-culvert
STA. 0+400 (right bank)	D=0.8 · 10	Single box-culvert

(iv) Drops

To reduce flow velocity, drop structures are provided. The height of drops is set higher than 1.5 m which will give a perfect overflow. The location of drops is given below:

Section	Riverbed Slope		Height (m)
	Existing	Design	
STA. 1+010	1/125	1/250	1.75
STA. 1+550	1/125	1/250	1.75
STA. 2+650	1/90	1/180	1.50

(v) Slit Dam

In the disastrous flood of 1991, it was reported that a large quantity of floating logs which flowed down with debris increased the flood damage. As countermeasures against floating logs, two (2) slit dams are provided at the upstream of Anilao River. The dam sites are located at the end of the mountain area, one on the main river channel and the other on the tributary of Anilao River.

(vi) Bridges

With the widening of river channel, it becomes necessary to replace or extend the existing bridges and spillway. The bridges to be replaced are as follows:

Location	Length (m)	Width (m)	Remarks
Alegria Bridge, STA. 0+153	57	7	
Osmeña Ext. Bridge, STA. 0+500	57	7	Under construction
Anilao Bridge, STA. 1+040	57	7	

(2) Malbasag River

The design features of the Malbasag river improvement works are given in Table 3.10. The proposed alignment and typical cross-sections are shown in Fig. 3.22, and the proposed longitudinal profiles are also given in Fig 3.23.

The details of the river improvement plan for Malbasag River are discussed below.

(a) Design High Water Level

The design high water level is set at the same level as the existing ground level. The flood water level is calculated by the uniform flow formula since the riverbed slope is assumed to be steeper than the critical gradient.

(b) Alignment

The channel alignment is basically set along the existing river course. The small meandering is , however, stretched from the hydraulic aspect.

(c) Riverbed Profile

The design riverbed profile follows the lowest existing riverbed as follows:

Stretch	Length (km)	Riverbed Elevation (EL. m)	Slope
River-mouth - STA. 1+000	1.0	- 1.50	1/200
STA. 1+000 - STA. 2+500	1.0	4.00	1/100

Since the water velocity becomes higher than 4 m/s at the upstream from STA. 1+000, drops are provided to reduce the flow velocity. The proposed riverbed slope along the stretch where the drops are provided is set at a half of the design riverbed slope.

(d) Cross Section

A single cross-section with maintenance flow channel is employed. At the lower section, from STA. 0+000 to STA. 1+000, a retaining wall is employed to minimize land acquisition and the number of houses to be evacuated. Both banks of the main channel at the upper stream from STA. 1+000 are protected from bank erosion by the revetment since the flow velocity is estimated to be higher than 3 m/s. The maintenance flow channel is designed as having the flow capacity of 10 m^3/s and gentle bank slope of 1 : 5. The features of the cross-section are determined by uniform flow as shown below:

Stretch	Width (m)	Height (m)	Side Slope (V:H)	Remarks
River Mouth - STA. 1+000	35	3.0	1:0.5	
STA. 1+000 -	32	3.0	1:2.0	With drops

(e) Related Structures

(i) Earth Dike

Earth dikes are provided from the upstream of STA. 1+200, the end of the urbanized area. The location of earth dike is given below:

Stretch	Length (m)	Height (m)
Right Bank, STA. 1+200 - STA. 1+650	850	Max. 1.1
Left Bank, STA. 1+200 - STA. 1+650	400	Max. 1.5

(ii) Retaining Wall

At the urbanized area in the lower stretch, from the river mouth to STA. 1+200, a total 2,400 m of concrete retaining walls are provided for the channel works. The height of concrete wall is designed at 4.3 m including freeboard and the foundation of wall.

(iii) Revetment

The flow velocity reaches more than 3 m/s because of the steep riverbed slope. Therefore, revetments of wet masonry type are provided along the section from STA. 1+200 to STA. 2+050 to protect river banks from erosion by rapid flood flow. The total length of revetment is 1.25 km.

(iv) Sluice

Sluices with slide/flapgate are provided at the drainage connecting point in the area provided with earth dike. The total number of sluices is assumed to be four (4). The location and basic dimensions of sluices are as given below:

Location	Dimension (m)	Remarks
STA. 1+100 (right bank)	D=0.6 · 5	Single box-culvert
STA. 0+300 (right bank)	D=0.6 · 5	Single box-culvert
STA. 0+300 (left bank)	D=0.6 · 5	Single box-culvert
STA. 0+950 (right bank)	D=0.6 · 5	Single box-culvert

(v) Drops

To control flow velocity, drop structures are provided. The height of drops is set to more than 1 to 1.5 m high which will give a perfect overflow. The location of drops is given below:

Stretch	Riverbed Slope		Height
	Existing	Design	(m)
STA. 1+000	1/100	1/200	1.0
STA. 1+300	1/100	1/200	1.5
STA. 1+600	1/100	1/200	1.5
STA. 1+900	1/100	1/20	1.5

(vi) Slit Dam

In the disastrous flood of 1991, it was reported that the large quantity of floating logs which flowed down with debris increased the flood damage. As countermeasure against floating logs, one (1) slit dam is proposed upstream of the main river course at the end of the mountain area.

(vii) Bridges

Due to the widening of river channel, it is necessary to reconstruct existing bridges and the spillway. The bridges to be reconstructed are as follows:

Location	Length (m)	Width (m)	Remarks
Malbasag Bridge, STA. 0+230	33	7	
Spillway, STA. 0+500	33	7	Concrete Spillway

3.3 Alternative Plans

3.3.1 Jaro Floodway

<u>Diversion Discharge</u>

To determine the optimum scale of the Jaro Floodway, a comparative study on the diversion dischearge of the floodway is conducted. The basic dimensions of the alternatives are given in Table 3.11. The results of cost comparison are given in Table 3.12, and summarized as follows:

Case No.	Discharge (m^3/s)		Project Cost (mil. peso)		
	Main Stream	Floodway	Construction	Compensation	Total
Case 1	1,400	0	1,255	883	2,783
Case 2	1,000	400	1,154	699	2,422
Case 3	800	600	1,067	596	2,179
Case 4	550	850	912	453	1,795
Case 5	400	1,000	966	409	1,814

From the results of the study, the Jaro Floodway with the design diversion discharge of 850 m^3/s gives the minimum project cost among the alternatives.

Diversion Point and Alignment

Three (3) applicable routes of the proposed floodway are identified at the downstream of the confluence with Aganan River, as shown in Fig 3.24.

Route 1 The flood water is diverted at the confluence. This has the steepest channel slope and smallest channel section, but additional structures for the diversion have to be provided against the turbulent flow from the confluence.

Route 2 The flood is diverted between the locations of Route 1 and Route 3, has the longest channel length, but the existing river stretch to be improved is shorter than Route 3.

Route 3 The flood water is diverted at the lowest stream. This is expected to have the cheapest construction cost, but river improvement works corresponding to the flood discharge of 1,400 m^3/s are required.

The comparison of design features and construction cost of the three alternatives are summarized below.

Description	Route 1	Route 2	Route 3
Diversion Point	STA. 16+250	STA. 15+040	STA. 13+505
Floodway			
Length (m)	4,800	5,100	4,800
Slope	1/750	1/850	1/1,000
Channel Width (m)	50	40	60
Water Depth (m)	4.8	5.5	5.5
Flow Velocity	4.9	4.9	4.8
Const. Cost (mil. Peso)*	363	430	464
Main Construction Cost	280	343	369
Compensation Cost	83	87	95

* Construction cost for river improvement works from STA. 13+505 of Jaro River to the confluence with Aganan River. Details are given in Table 3.13.

From the result of cost comparison of alternatives, the Jaro Floodway is to be diverged at the confluence with Aganan River (Route 1, STA. 16+250).

3.3.2 La Paz Floodway

To identify the necessity of the La Paz Floodway for diverting the flood at STA. 4+020 of Jaro River, the construction costs with and without the floodway were compared. The costs are shown in Table 3.14, and summarized below:

Case No	Discharge (m^3/s)		Project Cost (mil. Peso)		
	Mainstream	Floodway	Construction	Compensation	Total
W/O Floodway	550	0	91.8	3.2	95.0
W/ Floodway	150	400	124.4	1.7	126.1

The La Paz Floodway will reduce the cost of river improvement works by approx. 75%, as shown in Table 3.3.4.

3.3.3 Dam on Guadalupe River

To reduce the flood discharge towards the downstream of Guadalupe River, a flood control dam is proposed at the upstream of the river as shown in Fig. 3.25. The dam site is selected at the lowest possible site which gives a hydraulic advantage, minimum compensation and appreciable dam foundation. The stage-capacity relation is presented in Fig. 3.26.

Since the catchment area of the dam accounts for 48% of the total catchment area, the maximum storage capacity is estimated to be 2,600,000 m^3 corresponding to the discharge regulation of 115 m^3/s at the base point (48% of design discharge), and the design discharge at the base point is 125 m^3/s. Therefore, a combination of dam and river improvement works is proposed for the alternative flood control plan of Guadalupe River.

The design features of the proposed dam are shown below:

Feature	Dimension	Remarks
Catchment Area	8 km^2	48% of river basin
Reservoir		
Total Storage Capacity	3,000,000 m^3	
Effective Storage Capacity	2,600,000 m^3	maximum inflow at one flood
Sediment Capacity	400,000 m^3	500 m^3/km/year x 100 year
Dam		
Dam Type	Concrete Gravity	
Dam Height	40 m	
Crest Length	400 m	
Volume	180,000 m^3	
Construction Cost	₱1,800 mil.	₱10,000/m^3

The construction cost of dam is estimated at 1,800 million pesos. On the other hand, the cost of river improvement works without dam is estimated at 160 million pesos. The river improvement plan without dam is more economical than with the dam.

3.3.4 Anilao River Shortcut

Upstream of the Anilao Bridge, the river channel bends to the right. The hydraulic character at this bending point during floods is estimated as below:

(1) Existing Channel Condition

- Channel width : $B = 30$ m
- Radius of alignment : $R = 20$ m
- Flow velocity : $V = 3.6$ m
- Froude number : $F = 0.69$
- Water depth : $h = 4$ m

(2) Hydraulic Character

(a) Rising of Water Surface

The rising of water surface at the bending portion of channel (Δh) is estimated at 2.4 m by the following formula:

$$\frac{\Delta h}{h} = 2 \cdot F^2 \cdot \left(\frac{B}{2R}\right) \cdot \left[\frac{3}{3 + \left(\frac{B}{2R}\right)^2}\right]$$

(b) Shear Velocity

A difference of shear velocity between a winding channel and the straight channel are given by the following formula:

$$\frac{u'_*}{u_*} = \sqrt{K}$$

$$K = 1 + \frac{3}{4}\sqrt{\frac{B}{R}}$$

where,

u'_* : Shear Velocity at winding channel

u_* : Shear Velocity at straight channel

The above calculation shows that the water level at the right bank rises to 2.4 m from the design water level and the riverbed may be eroded at the water colliding point. In addition, the foundation of Anilao Bridge is also affected by the turbulent flow at that portion. Therefore, the following countermeasures are necessary for the river improvement plan along the existing channel:

- Heightening of the dike on the right bank;
- Riverbed covering works;
- Replacement of Anilao Bridge; and
- Widening of channel width.

A comparative study on the channel alignment between the shortcut plan and the existing channel improvement plan was conducted. The plans of both alignments are shown in Fig. 3.27. As shown in Table 3.15, the construction cost of a shortcut channel is smaller than the cost of the existing channel improvement. Furthermore, the shortcut channel will provide a smoother flow than the existing channel. Therefore, a shortcut channel is employed at this section.

4. URGENT PLAN

4.1 Basic Conditions

4.1.1 Area for Urgent Plan

The area of the Urgent Plan covers the four (4) river basins of Jaro, Iloilo (Iloilo City), Anilao and Malbasag (Ormoc City).

4.1.2 Project Scale and Design Discharge

The project scale for the Urgent Plan is proposed to be a 20-year return period. The design discharges corresponding to a 20-year return period are shown below:

River Name	Design Discharge (m^3/s) (20-year Return Period)
Iloilo	
(1) Jaro River	1,000
- Tigum River	450
- Aganan River	550
(2) Iloilo River	
- Lower Section	400
- Upper Section	350
- Mandurriao River	70
Ormoc	
(1) Anilao River	460
(2) Malbasag River	250

Based on the project scale, the design discharges of river improvement works were estimated as presented in Fig. 4.1. They were derived from the river flood control measures described in Section 4.2.

4.2 River Improvement Area

The river improvement areas for the Urgent Plan of rivers in Iloilo and Ormoc cities were delineated, based on the phased implementation program formulated in coordination with the river improvement works in the Master Plan, as follows:

<u>Iloilo City</u>

(1) Jaro River

To confine a 20-year return period flood to the Iloilo Strait, a combination of Jaro Floodway construction and partial improvement of Jaro River is implemented in the Urgent Plan, since Jaro Floodway is proposed to carry the discharge of 850 m^3/s and the existing channel of Jaro River has the flow capacity of 250 m^3/s except at a few narrow sections in low-lying areas at the river mouth. The implementation of the Master Plan is, therefore, divided into two (2) phases, as mentioed below. The area of the Urgent Plan is shown in Fig. 4.2.

First Stage (Urgent Plan): The works consisting of the construction of Jaro Floodway and improvement of narrow sections to ensure a flow capacity of 150 m^3/s.

Second Stage (Master Plan): The works consisting of river improvement and construction of La Paz Floodway for a 50-year return period flood as in the Master Plan

(2) Iloilo River

Since the elevation of the existing river banks of Iloilo River is about EL. 2 m MSL and the tolerance from MSHHWL is only 90 cm, which is less than the required freeboard, the heightening of the river bank is required to assure the freeboard. On the other hand, the water level of flood with a 20-year return period under the existing condition is almost the same as the design highwater level corresponding to a flood of 50-year return period.

The works are divided into two (2) stages; the first stage consisting of the Urgent Plan as shown in Fig. 4.3 and the second stage consisting of the remaining works of the Master Plan, as follows:

First Stage (Urgent Plan): The works consisting of the construction of concrete and earth dikes, and demolition of the abandoned railway bridge to assure the flow capacity for a 20-year return period flood.

Second Stage (Master Plan): The works consisting of dredging and bridge protection works for the flood of a 50-year return period in the Master Plan.

The Urgent Plan for the Mandurriao river improvement works is prepared for the flood of a 20-year return period, which is the same as that of the Master Plan. Therefore, a phased implementation is not employed for Mandurriao River.

<u>Ormoc City</u>

(1) Anilao River

To secure the channel improvement area in the Urgent Plan, the same channel width as the Master Plan is adopted. A compound cross-section channel with high water channel revetments is employed. The Anilao river improvement work is implemented in two (2) stages, as follows. The cross-sections are shown in Fig. 4.4.

First Stage (Urgent Plan): The works consisting of the construction of compound cross-section channel with high water channel revetment, and construction of two (2) slit dams on the upstream reaches.

Second Stage (Master Plan): The works consisting of the excavation works for the high water channel to increase the flow capacity for a 50-year return period flood and construction of revetments for the low water channel as in the Master Plan.

(2) Malbasag River

The present land use along the channel improvement section for approx. 2 km is classified as below:

(a) Urbanized Area : Right bank, river mouth to STA. 1+400
Left bank, river mouth to STA. 0+400

(b) Rural Area : Right bank, the upstream from STA. 1+400

(c) Mountain Slope : Left bank, the upstream from STA. 0+400

From the above land use conditions, the river improvement work in the Urgent Plan is limited to widening of the right bank for the river section in the urbanized area from the river mouth to STA. 1+200. The phased implementation is formulated as below: The cross sections are shown in Fig. 4.5.

First Stage (Urgent Plan): The works for STA. 0+000 to STA. 1+200 section consisting of the construction of retaining wall at the right bank, compound cross-section channel works with high water channel revetment at the left bank and construction of maintenance water channel; and, for the section upstream of STA. 1+200, construction of compound cross-section with high water channel revetments at the right bank and low water channel excavation at the left bank, as well as construction of a slit dam on the upstream reaches.

Second Stage (Master Plan): The works for the STA. 0+000 to STA. 1+200 section consisting of the excavation work of high water channel and construction of retaining wall at the left bank; and, for the section upstream of STA. 1+200, excavation works for high water channels, construction of low water channel revetment at both banks and high water channel revetment at the left bank.

4.3 River Improvement Works

The following structures are required for the Urgent Plan based on the phased implementation of the Master Plan.

Iloilo City

(1) Jaro River

For the Urgent Plan of Jaro river improvement works, the improvement section is limited to the downstream of Aganan and Tigum rivers and the lower reaches of Jaro River. The construction of Jaro Floodway is also included. The structures related to the river improvement area are as follows:

(a) Earth Dike

The construction of earth dike is limited to the improvement stretch and a part of Jaro Floodway.

Stretch	Length (m)	Ave. Height (m)
Jaro River Mouth - La Paz Floodway	2,800	1.2
Jaro Floodway	4,500	4.3
Tigum River	1,840	1.5
Aganan River	5,300	1.1
Total	14,440	

(b) **Revetment**

Revetments are constructed for the bending portion of the improvement stretch and the outlet of the floodway.

Stretch	Length (m)	Ave. Height (m)
River Mouth - La Paz Floodway (Type B)	400	3.0
Jaro Floodway (Type A)	600	4.8
Tigum River (Type A)	1,150	6.0
Aganan River (Type A)	1,100	6.0
Total	3,250	

(c) Diversion Works for Jaro Floodway

The design discharge of the diversion weir at the river channel is reduced to 150 m^3/s in the Urgent Project. Therefore, the width of weirs are modified as below:

- ° To Jaro Floodway : 66 m
- ° To Jaro River : 12 m

(d) Groundsill

The groundsill is provided only at the outlet of Jaro Floodway.

- ° Jaro Floodway : 50 m

(e) Sluice

Totally, seven (7) sluices are to be constructed along the improvement stretch.

River	Location	Type*
Jaro River	STA. 1+350 Right	Type A1
	STA. 1+650 Left	Type A1
Tigum River	STA. 18+300 Right	Type B1.0
	STA. 18+350 Left	Type B1.0
	STA. 19+200 Left	Type B1.0
Aganan River	STA. 1+000 Right	Type B1.0
	STA. 1+650 Left	Type B1.0

* Type of sluice is to be referred to Subsection 5.2, Preliminary Design of Related Structures.

(f) Invert Siphon

Three (3) invert siphons are to be constructed for the irrigation channels crossing the Jaro Floodway.

Stretch Jaro Floodway	Diameter (m)
STA. 2+300	1.0
STA. 4+140	1.0
STA. 4+600	0.7

(g) Bridges

Two (2) new bridges are to be constructed for the major road crossing the Jaro Floodway.

Location Jaro Floodway	Length (m)	Width (m)
STA. 0+300	70	7
STA. 2+120	70	7

(2) Iloilo River

The Urgent Plan of Iloilo river improvement is composed mainly of heightening of both banks. The related structures of the Urgent Plan are as follows:

(a) Earth Dike

The earth dike is to be constructed in the same stretch as that of the Master Plan.

Stretch	Length (m)	Height (m)
Left Bank		
- STA. 3+650 - STA. 5+100	1,350	2.5
- STA. 5+230 - STA. 6+650	1,450	2.5
Right Bank		
- STA. 4+950 - STA. 5+230	280	2.0
- STA. 5+750 - STA. 6+250	350	2.8
Mandurriao River	9,400	0.7
Total	12,830	

(b) Concrete Dike

The concrete dike is to be constructed in the same stretch as that of the Master Plan.

Stretch	Length (m)	Height (m)
Iloilo River		
Left Bank		
- STA. 0+000 - STA. 1+400	1,600	0.5
- STA. 2+780 - STA. 2+910	130	0.5
- STA. 3+300 - STA. 3+650	600	0.7
Right Bank		
- STA. 3+350 - STA. 4+850	1,400	1.0
- STA. 5+240 - STA. 5+800	550	1.0
- STA. 6+150 - STA. 6+600	500	2.0
Total	4,780	

(c) Revetment

The revetments are to be constructed in the same length as that of the Master Plan for the Iloilo and Mandurriao rivers.

Stretch		Length (m)	Ave. Height (m)
Iloilo River	(Type B)	300	3.0
Mandurriao River	(Type A)	1,100	4.8
	(Type B)	2,000	2.0
Total		3,400	

(d) Sluice

The same number of sluice as that in the Master Plan is to be constructed.

River	Location	Type*
Iloilo River	STA. 4+850 Right	Type B0.6
	STA. 4+850 Left	Type A2
	STA. 5+220 Left	Type B1.0
	STA. 5+670 Left	Type A3
	STA. 6+000 Right	Type B0.6
Mandurriao River	STA. 1+700 Right	Type B1.0
	STA. 1+500 Left	Type A3
	STA. 2+450 Right	Type B1.0
	STA. 2+650 Left	Type A3

*: Type of sluice is to be referred to Sub-section 5.2.

(e) Bridges

One (1) bridge on Iloilo River and three (3) on Mandurriao River are to be constructed/reconstructed in connection with the construction of the river dike.

Location	Length (m)	Width (m)
Iloilo River		
- Molo Bridge, STA. 6+500	110	7
Mandurriao River		
- Seminar Bridge, STA. 3+010	40	7
- Street Bridge, STA. 3+210	40	7
- Santa Rosa Bridge, STA. 4+090	40	7

<u>Ormoc City</u>

(1) Anilao River

The Urgent Plan of Anilao river improvement works is carried out for the same stretch as that in the Master Plan, while the cross-section is scaled down for the Urgent Plan. The river structures included in the works are as follows:

(a) Earth Dike

The earth dike to be constructed is as below:

Stretch	Length (m)	Height (m)
STA. 0+000 - STA. 0+750	1,500	Max. 1.9
STA. 1+550 - STA. 1+850	300	Max. 2.0
Total	1,800	

(b) Revetment

The total length of high and low water channel revetments is 3,600 m and the average height is 5 m including the foundation.

(c) Sluice

Three (3) sluices are to be constructed at the following locations:

Location	Dimension (H·B·L, m)	Remarks
STA. 0+200 (right bank)	1.2 · 1.2 · 16	Double box-culvert
STA. 1+000 (left bank)	1.2 · 1.2 · 16	Double box-culvert
STA. 0+400 (right bank)	D=0.8 · 10	Single box-culvert

(d) Drops

The width of drop is set at 28 m which is the same as the low water channel.

Section	Riverbed Slope		Height (m)
	Existing	Design	
STA. 1+010	1/125	1/250	1.75
STA. 1+550	1/125	1/250	1.75
STA. 2+650	1/90	1/180	1.50

(e) Slit Dam

Two (2) slit dams are provided at the upstream of Anilao River. The dam sites are located at the end of the mountain area, one on the main river channel and the other on the tributary of Anilao River.

(f) Bridges

Three (3) bridges are to be reconstructed as follows:

Location	Length (m)	Width (m)	Remarks
Alegria Bridge, STA. 0+153	57	7	
Osmeña Ext. Bridge, STA. 0+500	57	7	Under construction
Anilao Bridge, STA. 1+040	57	7	

(2) Malbasag River

The Urgent Plan of improvement works for Malbasag River is carried out for the same stretch as that in the Master Plan, but the cross-section is scaled down in the Urgent Plan. The river structures included in the works are as follows:

(a) Earth Dike

The earth dike is to be constructed in the same stretch as the Master Plan.

Stretch	Length (m)	Height (m)
Right Bank, STA. 1+200 - STA. 1+650	850	Max. 1.1
Left Bank, STA. 1+200 - STA. 1+650	400	Max. 1.5

(b) Retaining Wall

At the urbanized area in the lower stretch of the right bank of Malbasag River, from the river-mouth to STA. 1+200, a total of 1,095 m of concrete retaining wall is provided. The height of concrete wall is designed at 4.3 m including freeboard and the foundation of wall.

(c) Revetment

Revetments at the lower section on the left bank are additionally required instead of the retaining wall in the Master Plan. The total length of revetments is 2,505 m and average height is 3.5 m including the foundation.

Stretch	Length (m)	Ave. Height (m)
River Mouth - STA.1+200, Left bank	1,095	3.0
STA. 1+200 to STA. 2+050, Both bank	1,410	3.0
Total	2,505	

(e) Sluice

Four (4) sluices are to be constructed along the earth dike portion.

Location	Dimension (m)	Remarks
STA. 1+100 (right bank)	D=0.6 . 5	Single box-culvert
STA. 0+300 (right bank)	D=0.6 · 5	Single box-culvert
STA. 0+300 (left bank)	D=0.6 · 5	Single box-culvert
STA. 0+950 (right bank)	D=0.6 · 5	Single box-culvert

(f) Drops

The width of drop is 23 m which is the width of the low water channel.

Stretch	Riverbed Slope		Height
	Existing	Design	(m)
STA. 1+000	1/100	1/200	1.0
STA. 1+300	1/100	1/200	1.5
STA. 1+600	1/100	1/200	1.5
STA. 1+900	1/100	1/20	1.5

(g) Slit Dam

One (1) slit dam is proposed upstream of the main river course at the end of the mountain area.

(h) Bridges

Two (2) bridges are to be reconstructed for the improvement stretch.

Location	Length (m)	Width (m)	Remarks
Malbasag Bridge, STA. 0+230	33.	7	
Spillway, STA. 0+500	33	7	

5. PRELIMINARY DESIGN OF STRUCTURES

5.1 Design Concept

The following basic design concepts are applied for the structures:

(1) Proposed structures are designed based on the project scale of a 50-year return period.

(2) The following design criteria and standards are to be applied:

- Design Guideline, Criteria and Standards for Public Works and Highways (BOD, DPWH, Philippines).
- Technical Standard for Rivers and Sabo Facilities, (Ministry of Construction of Japan).

(3) In designing structures, locally based structural materials will be used as much as possible;

(4) The structures are designed to meet the environmental requirement as mentioned in Section 3.2, Environmental Consideration.

5.2 Preliminary Design of Related Structures

Related structures are designed as described below.

(1) Earth Dike

Earth dikes are employed for low densely land-use areas, i.e., Anilao River and the upstream of Malbasag River in Ormoc City, Bulacao River in Cebu City, and Jaro River and Mandurriao River in Iloilo City.

The crown width of the dike is employed in accordance with the following design standards:

Design Discharge(m^3/s)	Width (m)
Less than 500	3.0
500 to 2,000	4.0

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

The side slopes of the dike is designed as 1:2 for the stability of dike slope. In case the height of embankment is higher than 4 m or/and flow velocity is more than 3 m/s, a 3 m wide step is provided on the slope. To prevent scouring of dike slope against surface flow, the land-side slope and high water channel slope are covered with grass.

The standard cross-section of earth dike is shown in Fig. 5.1. The embankment materials should meet the following conditions:

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

To identify sources of embankment materials for the earth dike, laboratory tests of proposed embankment materials were carried out. The results of the laboratory tests are discussed in the Supporting Report on Geology and Soil Mechanics. According to the test results, the embankment materials could be obtained from the following sites:

(a) Iloilo City

- Jaro River : Excavated materials at Jaro River and Jaro Floodway
- Iloilo River : Excavated materials at Jaro River
- Mandurriao River : Excavated materials at Jaro River

(b) Cebu City

- Bulacao River : Borrow pits for hardly weathered rock at the upstream of Kinalumsan River

(c) Ormoc City

- Anilao River : Excavated materials at Anilao River
- Malbasag River : Excavated materials at Malbasag River

(2) Concrete Dike

The concrete dike is applied mainly in the urbanized area along Iloilo River. The typical sections of concrete dike are shown in Fig. 5.2.

The concrete dike is a gravity wall type with log pile foundation. The bottom of wall is embedded 50 cm below the ground surface. At the water colliding front, a 6 m long steel sheet piles shall be provided instead of log piles to stabilize the foundation.

(3) Revetment

Revetments are adopted to stabilize the water colliding front at the concave portion of river bank and to protect the dike against erosion by turbulent flood flows. Depending on the water depth at the construction site, two types of revetments, as shown in Figs. 5.3 and 5.4, are employed for the slope protection works. Type A revetment is applied for the area where the design riverbed elevation is higher than EL. -1.0 m and Type B is applied for other areas.

Type A is categorized into high water channel revetment and low water channel revetment. Top of revetment is set at DHWL and the base concrete with log piles is embedded by 1.0 m from the design riverbed. The slope is covered with wet masonry.

Type B consist of wet masonry along the slope, base concrete and concrete sheet pile foundation in consideration of the diversion works during construction.

(4) Retaining Wall

Wet masonry type of retaining wall is applied to the densely populated areas where the right-of-way is limited, i.e., the rivers in Cebu City and the downstream of Malbasag River.

The retaining wall is a rubble concrete wall with a slope of 1:0.5, and base concrete with log piles is embedded 1 m below the ground surface. Crest of wall is obtained by adding freeboard to the design high water level. The typical sections are shown in Fig. 5.5.

(5) **Drops**

To reduce the flow velocity, drop structures are provided at stretches where flow velocity is more than 4 m/s. The height of drop is calculated by the following formula for the judgment of perfect overflow.

$$(h_2/h_c)^2 - (h_f/h_c)^2 = 3 - 2 x (h_c/h_2)$$

where;

h_2	:	water depth of downstream channel (m)
h_c	:	critical water depth (m)
h_f	:	minimum height of drop structure (m)

The required height of drop for the respective rivers are as follows:

River Name	Minimum Height (m)	Required Height (m)
Bulacao	1.0	1.0
Kinalumsan	1.3	1.5
Guadalupe	1.2	1.5
Lahug	0.5	1.0
Subang Daku	0.9-1.0	1.0
Anilao & Malbasag	0.9-1.4	1.5

The drop structure shall comprise a weir portion, apron at its downstream portion and riverbed protection in the upstream of the weir as well as in the downstream of the apron structure. In consideration of the environmental impact such as improvement of river scenery, boulders (D=50cm) are used for the weir portion and the other portion is covered with rubble concrete.

The typical design of drop and related structures is shown in Fig. 5.6.

(6) Approach Steps to Water Edge

The approach steps to river water front are constructed at some sections of Jaro River and rivers in Ormoc City. The width of steps is set at 10 m to utilize river spaces and 1 m for practical use. A typical design of steps is shown in Fig. 5.7.

(7) MFC Protection

From the environmental point of view, Maintenance Flow Channel (MFC) is provided for the Jaro River and the rivers in Ormoc City. This channel slope is covered with boulder riprap or fixed with log piles as shown in Fig. 5.8.

(8) Sluice

The following types of sluice are proposed in accordance with the dike construction:

Type A1	:	One slide gate, single box culvert of 1.0 m x 1.0 m ($Q<3.0$ m^3/s)
Type A2	:	Two slide gates, double box culvert of 1.0 m x 1.0 m (3.0 $m^3/s<Q<6.0$ m^3/s)

Type A3	:	Three slide gates, triple box culvert of 1.0 m x 1.0 m ($6.0\ m^3/s<Q<9.0\ m^3/s$)
Type B0.6	:	One flap gate, one RC pipe of 0.6 m diameter ($Q<0.7\ m^3/s$)
Type B0.8	:	One flap gate, one RC pipe of 0.8 m diameter ($0.7\ m^3/s<Q<1.0\ m^3/s$)
Type B1.0	:	One flap gate, one RC pipe of 1.0 m diameter ($1.0\ m^3/s<Q<2.0\ m^3/s$)

Type A with sluice gate is applied for the high embankment area and Type B is used under low water pressure. The design discharge of the sluice is estimated with the specific discharge of 10 $m^3/s/km$. The location of the sluice is shown in Fig. 5.9 and the standard design of sluice is presented in Figs. 5.10 and 5.11.

River Name	Type (Number)	Construction Site
Jaro River		
- Jaro River	Type A1	2
	Type B1.0 (1)	3
	Type B1.0 (2)	1
	Type B1.0 (3)	1
- Tigum River	Type B1.0 (1)	2
	Type B1.0 (2)	1
- Aganan River	Type B1.0 (1)	1
	Type B1.0 (2)	1
Iloilo River		
- Main Channel	Type A2	1
	Type A3	1
	Type B0.6	2
	Type B1.0	1
	Type B	5
- Mandurriao River	Type A2	2
	Type A3	1
	Type B1.0 (2)	2
Anilao River	Type A2	2
	Type B0.6	1
Malbasag River	Type B0.6	3

(9) Diversion Weir

(a) Jaro Floodway

Two fixed weirs are proposed as a diversion structure in the Jaro river channel and at the inlet of Jaro Floodway. These weirs are designed under the following concepts:

- To assure the design diversion of the flood discharge to the floodway, the weirs shall be designed to have a perfect overflow weir;
- To give a stable flow at the upstream of diversion weir, a water stabilizing basin of which Froude Number of the flood flow is less than 0.2 is provided; and

° An orifice is provided in the weir of Jaro River to facilitate maintenance flow to the downstream in ordinary time.

Based on the above concepts, the following basic dimensions of weirs were obtained. The drawing is given in Fig. 5.12.

Particulars	River	Floodway
Design Discharge	550 m^3/s	850 m^3/s
Water Level		
- Upstream	EL. 12.8 m	EL. 10.0 m
- Downstream	EL. 11.7 m	EL. 10.0 m
Base Elevation	EL. 9.3 m	EL. 9.3 m
Height of Weir	4.0 m	4.0 m
Width	44.0 m	66.0 m
Water Stabilizing Basin	B = 150 m	

(b) La Paz Floodway

A side-overflow weir diverting the floodwater from the La Paz Floodway to the original channel is proposed. Since the water level at the diversion point of the La Paz Floodway is a tidal area, the weir is designed as a submerged weir. The basic dimensions of the weir are given below. The standard design of diversion weir for La Paz Floodway is illustrated in Fig. 5.13.

Particulars	Dimensions
Design Discharge	150 m^3/s
Water Level	
- Upstream	EL. 2.12 m
- Downstream	EL. 1.68 m
Base Elevation	EL. - 1.2 m
Crest Elevation	EL. - 0.5 m
Height of Weir	0.7 m
Width	41.0 m

(10) Groundsill

Groundsill is provided at the diversion point of La Paz Floodway in the Jaro river channel and at the outlets of both floodways to stabilize the riverbed.

Since the construction site of groundsills is identified to be soft ground and located in the tidal reach, the groundsill shall be designed as flexible against settlement and easy to construct.

The main body of the groundsill is made of boulder pitting fixed by wooden form and log piles. The upstream and downstream portions of the main body are protected by gabion mattress. The standard design of groundsill is presented in Fig. 5.14.

(11) Slit Dam

To stop floating logs carried from upstream of the river, three (3) slit dams are provided at the end of the mountain area; two (2) on the main river channel of Anilao and Malbasag rivers and the other on the tributary of Anilao River.

These slit dams are constructed of steel pipes with concrete base/abutments. The height of steel pipe for slit dams is set at 5 m which is derived from the 3 m design water depth at the downstream, with 1 m screen loss and 1 m freeboard.

For the regular maintenance of slit dams, a 4 m wide gravel paved approach road to the slit dam sites is proposed. The approach road can be used also for the construction.

The location of slit dam sites and the typical design of slit dam is shown in Fig. 5.15.

(12) Invert Siphon

Since the Jaro Floodway runs across the Sta. Barbara Irrigation Channel, three (3) invert siphons are provided at the channel crossing points, STA. 2+290, STA. 4+100 and STA. 4+640. The basic design conditions of sluice are given below.

(a) Existing Irrigation Channel

Location	Design Discharge (m^3/s)	Channel Slope	Water Head (cm)	Velocity (V_1, m/s)
IS-1 (STA. 2+290)	1.03	1/500	18.6	0.8
IS-2 (STA. 2+290)	1.03	1/500	18.6	0.8
IS-3 (STA. 2+290)	0.40	1/500	18.6	0.8

(b) Design Condition

Flow Velocity in Siphon (V_2) : 1.2 m/s (1.5 times of channel velocity)

Head Loss:

- Inlet (hi) : $0.1 \cdot \frac{V_1^2}{2g}$

- Outlet (ho) : $0.9 \cdot \frac{(V_1 - V_2)^2}{2g}$

- Screen (hs) : $1.73 \cdot \sin 90 \cdot \left(\frac{d}{P}\right)^{3/4} \cdot \frac{V_1^2}{2g}$

- Pipe Friction (hf) : $124.5 \cdot \frac{0.012^2}{D^{4/3}} \cdot L \cdot \frac{V_1^2}{2g}$

where;

D	:	pipe diameter
P	:	pitch of screen
d	:	diameter of screen bars
L	:	length of pipe (= 93 m)

The results of calculation and the selected dimensions of invert siphons are as follows. A standard design of invert siphon is shown in Fig. 5.16.

Particulars	Pipe Diameter (m)	Velocity (m/s)	Total Head Loss (m)
IS-1	1.00	1.31	0.182
IS-2	1.00	1.31	0.182
IS-3	0.70	1.04	0.165

(13) Bridge

Due to river channel widening, it is necessary to replace/reconstruct the existing bridges. Prestressed concrete bridge girder, 20 m long at maximum and 1 m high, is employed for the replaced bridges. The width of a bridge is decided based on the number of lanes. The employed bridge width is as follows. A typical design of bridge is shown in Fig. 5.17.

Number of Lanes	Bridge Width
1	3.5 m
2	7.0 m
4	14.0 m

At the Lahug river mouth, a triple box culvert has been provided as the present outlet of the river. The top of the box culvert is used as landing stage and moored ships sometimes obstruct the flood flow. Therefore, the box culvert will be replaced by a bridge with steel sheet pile protection so as not to allow the mooring of ships. The drawing is presented in Fig. 5.18.

(14) Bridge Protection

Protection works of bridge pier foundation are provided, where the foundation of pier/abutment of bridge is excavated lower than the existing foundation works. The foundation protection is made of steel sheet piles as shown in Fig. 5.19.

ANNEX

ANNEX: STUDY ON RIVER MOUTH PROFILE AT JARO RIVER, JARO FLOODWAY AND LA PAZ FLOODWAY

A.1 Introduction

In the flood control plan for Jaro River, two (2) floodways are proposed to divert the flood discharge to the Iloilo Strait. This Annex is prepared to examine if the proposed works such as the improvement of Jaro River and the construction of floodways will cause any harmful or abrupt influence around the existing river mouth and the estuary of the proposed floodways.

Location

Locations of the study area are as follows (refer to Fig. A-1):

(1) Estuary of Jaro Floodway
(2) River Mouth of Jaro River Mouth
(3) Estuary of La Paz Floodway

Item of Study

The following items were examined by mathematical analysis:

(1) River mouth clogging by wave; and
(2) River mouth clogging by alongshore current.

Justification/evaluation was made if the existing condition is maintained with the implementation of the proposed project.

Condition of Analysis

The factors required for the analysis are as follows:

(1) Wave Prediction

Wave conditions are simulated by wind data as furnished by PAGASA. The period of the data is 31 years from 1961 to 1991, and the observation location is ROMEO ALEJANDRO (latitude 10.42N, longitude 122.34E). The dominant wind direction is NE - N during the dry season (November - April) and WSW - SSW during the wet season (May - October), which is shown in Fig. A-2. The strongest wind in the past 31 years blew in the NE direction and had a velocity of 45 m/s. Fetch distance is measured as the maximum length from offshore to the Jaro river mouth, which is 6 km. To apply the Sverdrup-Munk-Bretschngider's method (SMB Method), two kinds of wind waves can be linked. One is based on the correlation between fetch distance and wind speed, another is based on the correlation between fetch time and wind speed using Fig. A-3. Therefore, wind wave of one-third of the significant wave height ($H_{1/3}$) and one-third of the significant wave period ($T_{1/3}$)can be derived as follows:

Based on the Fetch distance,

$H_{1/3} = 2.6$ m
$T_{1/3} = 4.5$ sec,

and based on the Fetch time (assumed to be 1.0 hour),

$H_{1/3} = 3.3$ m
$T_{1/3} = 5.3$ sec.

Here, the SMB Method recommends choosing a small wave as the design wave, and other numbers are calculated below:

$Lo = 1.56 * To^2 = 31.59$ m
$Ho/Lo = 0.0823$

where,
Lo : design wave length
To : design wave period (4.5 sec)
Ho : design wave height (2.6 m)

(2) Bottom Slope

The bottom slope of the mouth/estuary is estimated on the bathymetric survey which was conducted in July, 1994. The result of bottom slope (i) at each location is shown below, and depth profile is shown in Fig. A-4.

Jaro Floodway Estuary	0.55 km	almost flat
Jaro River Mouth	0.12 - 0.67 km	1 : 285
	0.67 - 0.83 km	1 : 7.9
La Paz Floodway Estuary	0.0 - 0.4 km	1 : 207
	0.4 - 0.7 km	1 : 9.7

(3) Current

The current changes twice a day, with the direction of flood current varying from SW to NE and that of ebb current from NE to SW. The velocity of flood current is 1.23 m/sec and the ebb current, 1.59 m/sec. The source of data is Predicted Tide and Current Table 1994, Department of Environment and Natural Resource .

(4) Tide

The tidal levels are as follows:

	Based on EL.(m)	Based on MSL (m)
MSHHW	+1.655	+1.07
MHHW	+1.405	+0.82
MHW	+1.135	+0.55
MSL	+0.585	0.0
MLW	+0.045	-0.54
MLLW	-0.165	-0.75

Source: Iloilo City Engineer s Office

A.2 Examination of Coastal Morphology of River Mouth and Estuaries

<u>Jaro Floodway</u>

The proposed estuary of Jaro Floodway is located north of Jaro river mouth, and the coastal topography is in the cove area. The direction of coastline is from NW to SE. The beach processing is contributed by the sediment from Jaro River, the sediment is gently carried into the estuary by the alongshore current, and littoral deposition occurs with tidal reaction and wave. The bottom slope is almost horizontal until 0.55 km, changing to 1 : 100 from 0.55 to

2.0 km offshore. Wave intrusion around this area has the direction of NNW to NE during the dry season (refer to Fig. A-2). However, incident wave breaking is before the shallow dune and secondary wave breaking also occurs around the shoreline.

Jaro River Mouth

Geomorphology of Jaro river mouth is unstable, and this is caused by the transportation of flood and ordinary sediment. According to the topographic map in 1953 and aerial photographs in 1980 and 1987, the river mouth has shifted to the north (refer to Fig. 3.3, Interim Report, Oct. 1993). Seabed profile is 1 : 285 from river mouth to 0.55 km and 1 : 7.85 until 0.70 km. The narrowest part of Iloilo Strait faces further offshore where current velocity is faster and seabed slope is steeper than other locations. Based on the topographic map and by examining wind roses, the effective wind direction for Jaro river mouth is from S to NNE, which means wind wave at Jaro river mouth occur in the dry season and the dominant wind direction is NE.

The fastest wind velocity at NE is recorded at 45 m/s in the last 31 years, the fetch distance is measured at 6.0 km and the fetch time is assumed to be 1.0 hour. The wave hindcasting is simulated at H = 2.6 m, T = 4.5 sec and L = 31.5 m, using a design wave. Moreover, the limited breaking water depth for design wave is calculated to be 3.85 m. The water depth at 0.55 km from the Jaro river mouth is 1.9 m + 0.75m (MSL) = 2.85 m, which means that the design wave breaks before it reaches this location. On the other hand, the breaking limit of wave height at a water depth of 0.18 m, in front of the Jaro river mouth, is calculated as H=0.1 m (by using Figs. A-5 to A-7).

La Paz Floodway

La Paz F.W is located 2.0 km south of the Jaro river mouth, and the geomorphology is almost the same as the Jaro river mouth. The bottom slope from shoreline to 0.4 km is 1:207 and at 0.4 to 0.7 km it becomes 1:9.66. In addition, soil material is also the same as Jaro river mouth.

A.3 Conclusion

Considering the above conditions, the influence after construction of the proposed project is examined below:

(1) Jaro Floodway

Jaro Floodway only diverts the flood during the rainy season which occurs several times a year. At flood time, the river flow carries sediment to the offshore side and creates a water channel at the estuary for diversion. During ordinary time, the depth of the new water channel is equivalent to the depth of the neighboring seabed, being influenced by tides, alongshore current and waves. Therefore, the new water channel will become shallow and gradually disappear, and the cross-section profile of the estuary at the proposed Jaro Floodway is restored to its condition before the flood.

(2) Jaro River Mouth

Due to the diversion of flood discharge into the La Paz Floodway, the volume of sediment transport, flow velocity and river water level will be lowered. Therefore, the topographic change of the river mouth will become more stable with the construction of the floodway. In addition, Jaro river mouth may, in the future, have shoreline erosion by the shortage of sediment supply and seawater intrusion by decreasing of freshwater discharge. However, the southern side of Jaro river mouth will get a supply of sediment from the La Paz Floodway, and the discharge volume of freshwater is the same as the point beyond the La Paz Floodway because of the same situation with/without the construction of floodway. Thus, the problem will not cause any dramatic change to the area.

(3) La Paz Floodway

Since the existing force conditions are the same as Jaro river mouth, La Paz Floodway can be maintained in a similar manner as Jaro River, however, the difference of discharge volume will create a small profile change in the estuary of La Paz Floodway.

In conclusion, after construction of the two proposed floodways, there will be a temporary change at flood period; however, the profile of the three estuaries will remain stable. Thus, the project will not seriously influence the surrounding area but will maintain its original condition.

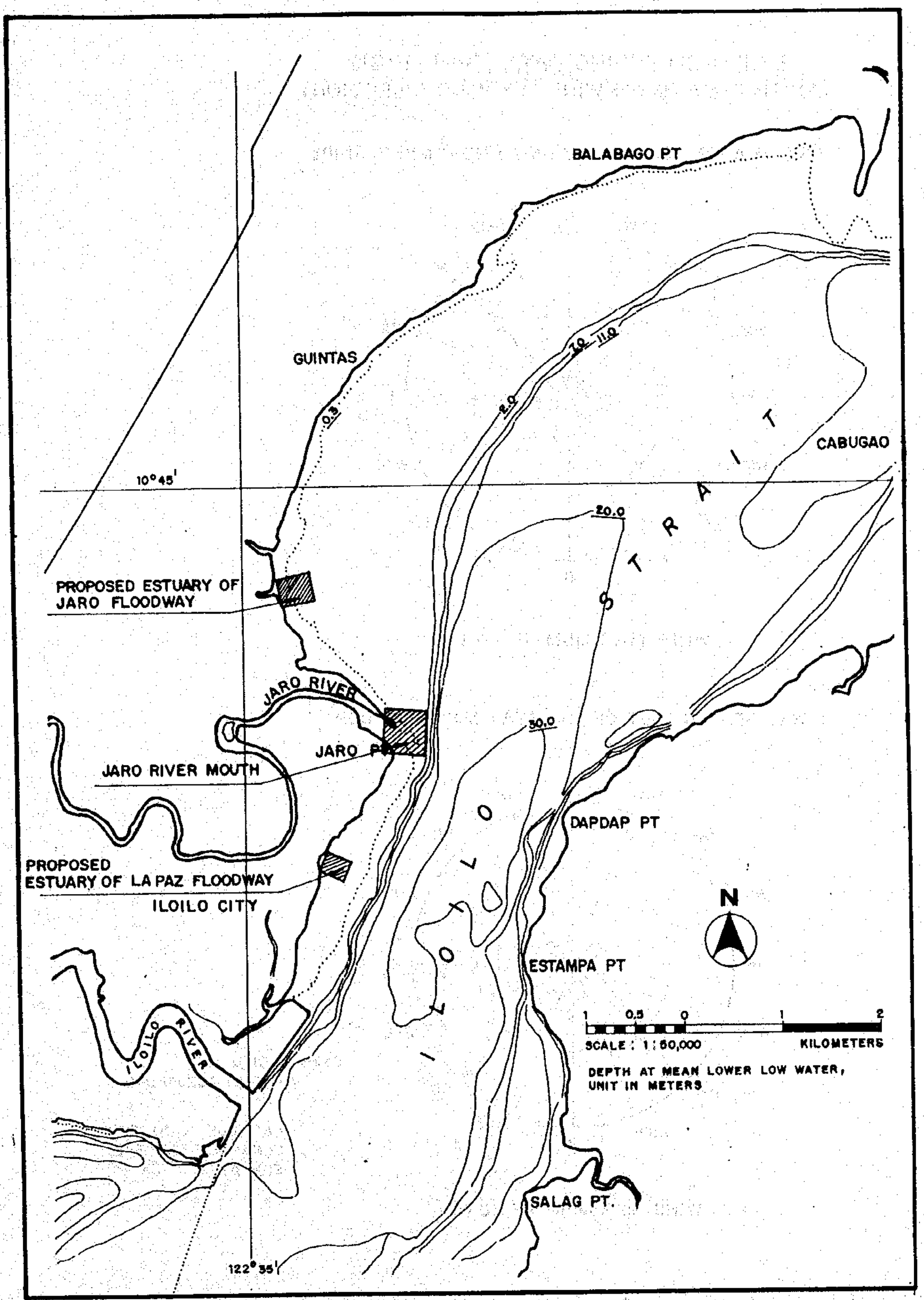
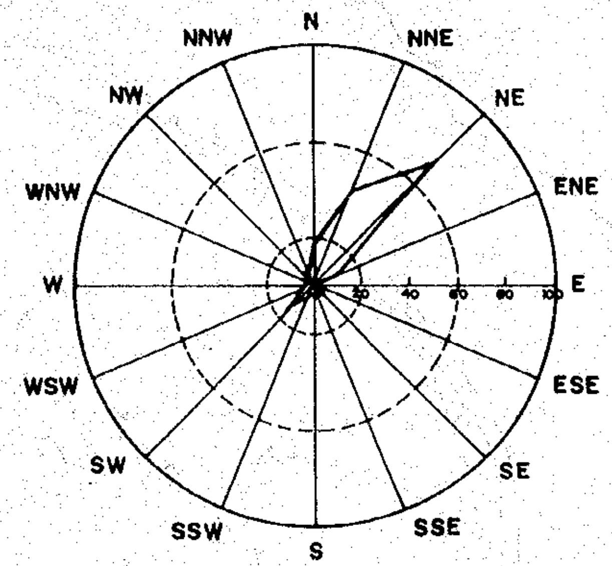


Figure A-1 LOCATION MAP

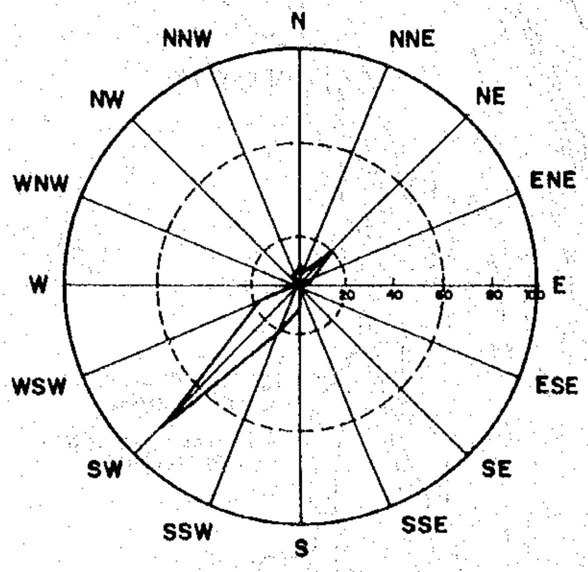
ILOILO CITY WIND DATA (1991–1961)
MONTHLY MAXIMUM WIND (BY WIND DIRECTION)

DRY SEASON (OUT OF 167 DATA) NOVEMBER-APRIL



WIND MAXIMUM N 45 m/s

WET SEASON (OUT OF 161 DATA) MAY-OCTOBER



WIND MAXIMUM SW 26 m/s

Source : ILOILO
ROMEO ACEJANDRO

LATITUDE 10.42 N
LONGITUDE 122.34E
ELEVATION 6.0 M

Figure A-2 WIND ROSE AT ILOILO CITY

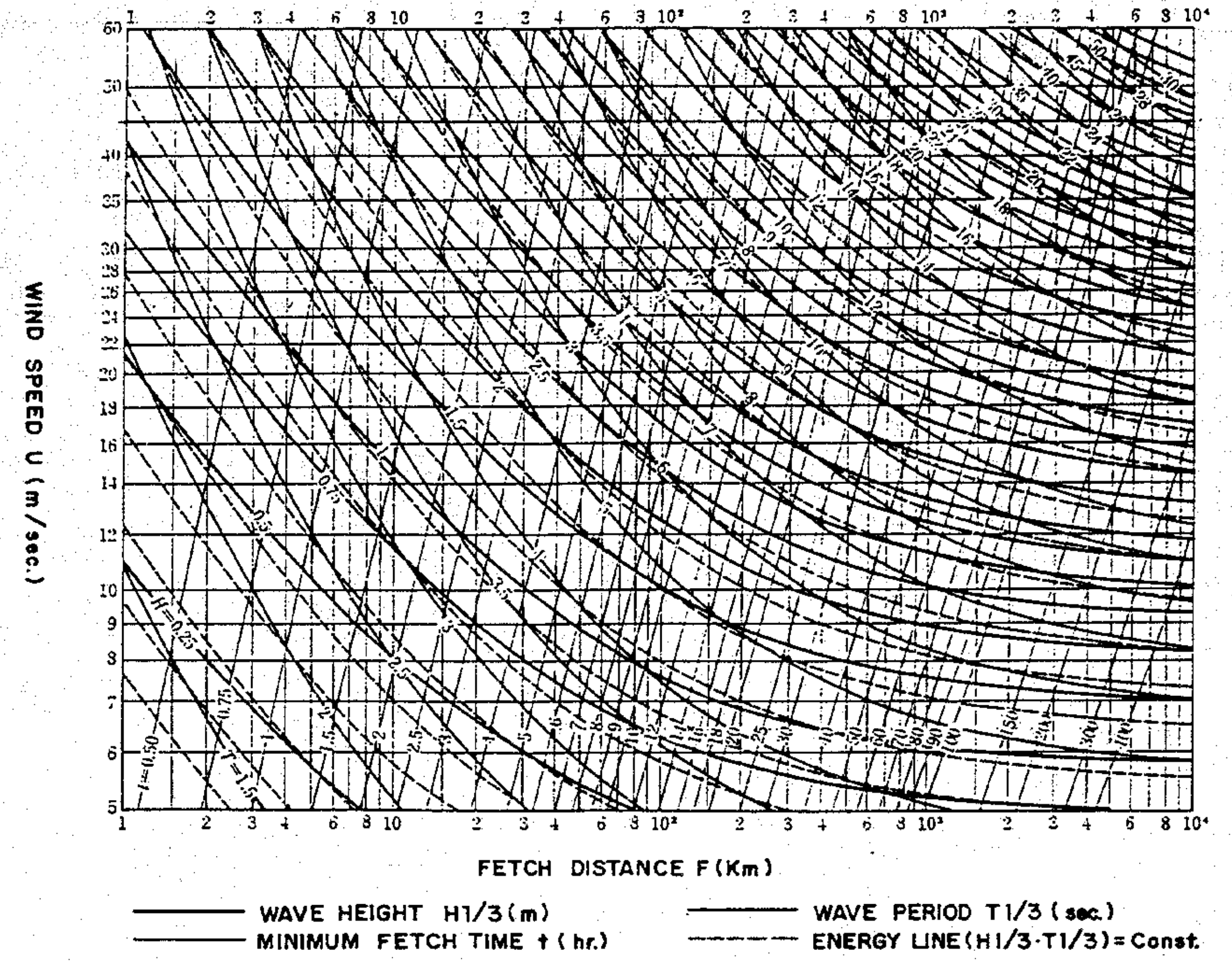
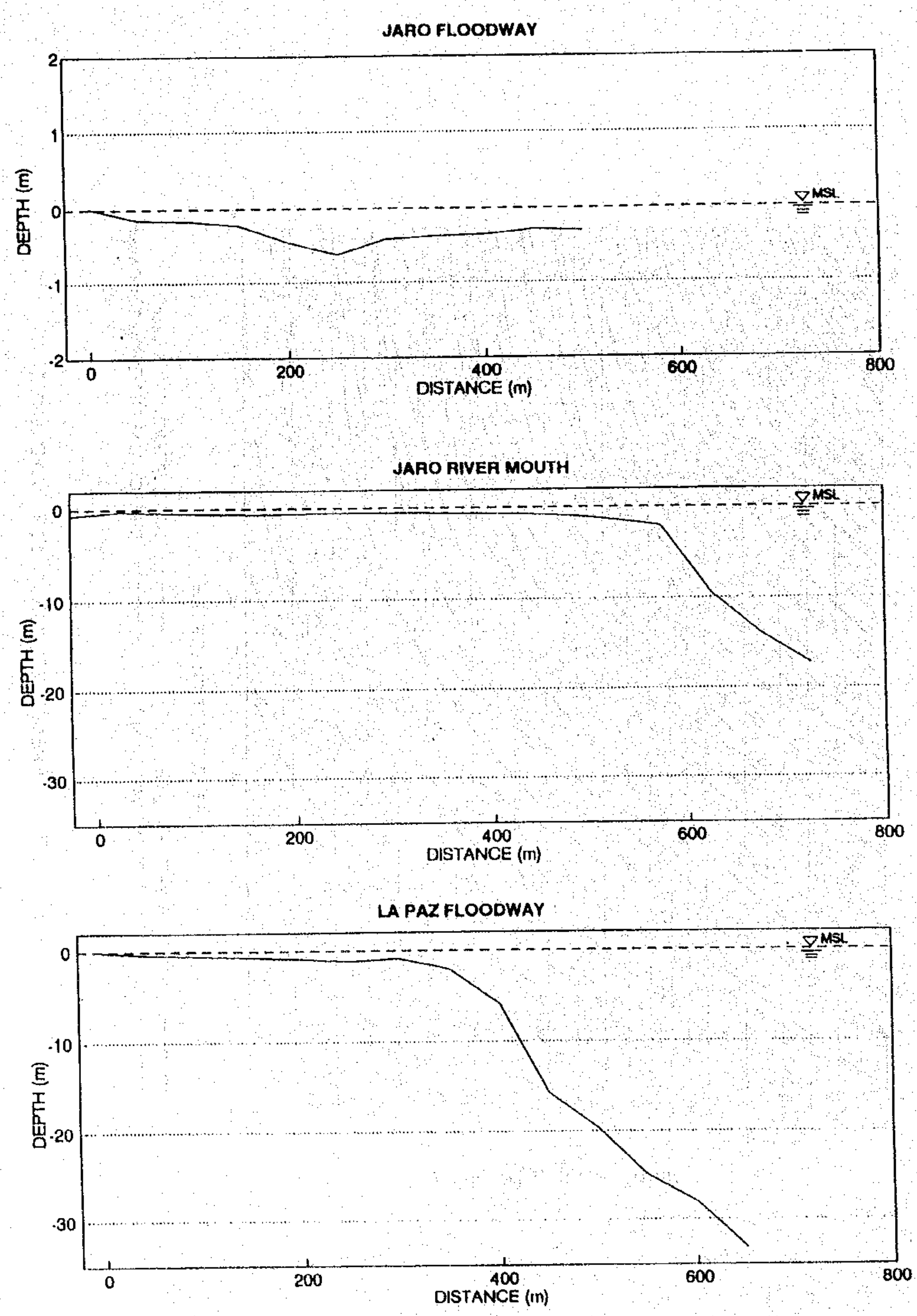


Figure A-3 PREDICTED CURVE FOR WIND WAVE



Source: Bathymetry Survey in July 1994, JICA

Figure A-4 LONGITUDINAL DEPTH PROFILE AT JARO RIVER

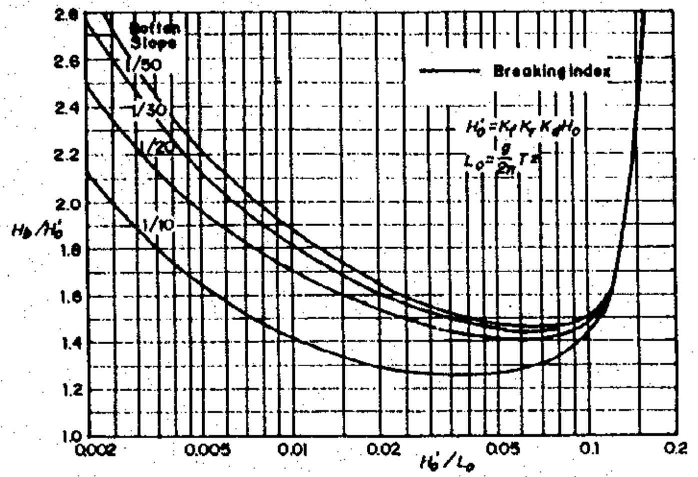


Figure A-5 CORRELATION BETWEEN BREAKING WATER DEPTH AND EQUIVALENT DEPTH OF WAVE HEIGHT

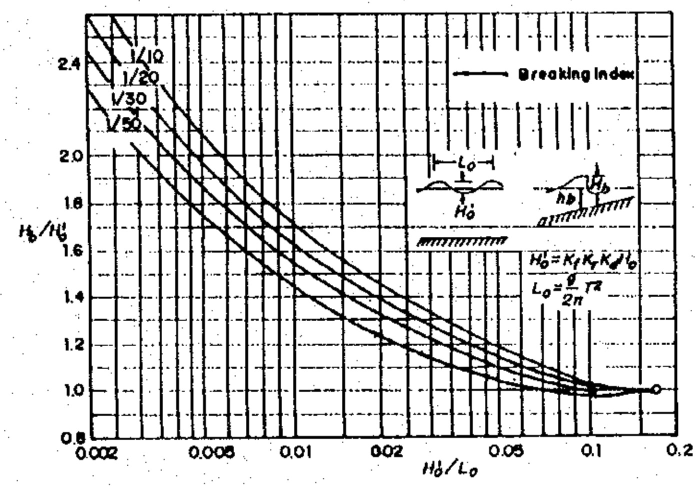


Figure A-6 CORRELATION BETWEEN BREAKING WAVE HEIGHT AND EQUIVALENT DEPHT OF WAVE HEIGHT

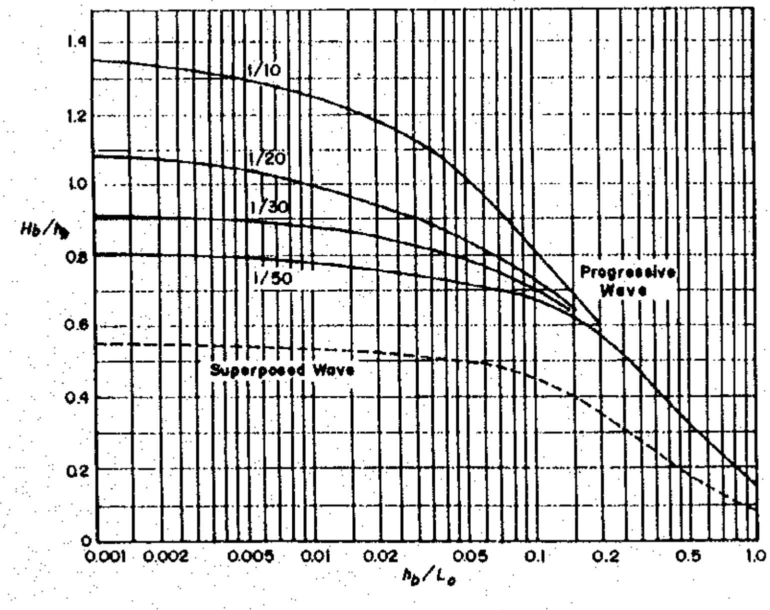


Figure A-7 CRITICAL WAVE HEIGHT OF PROGRESSIVE WAVE AND SUPERPOSED WAVE