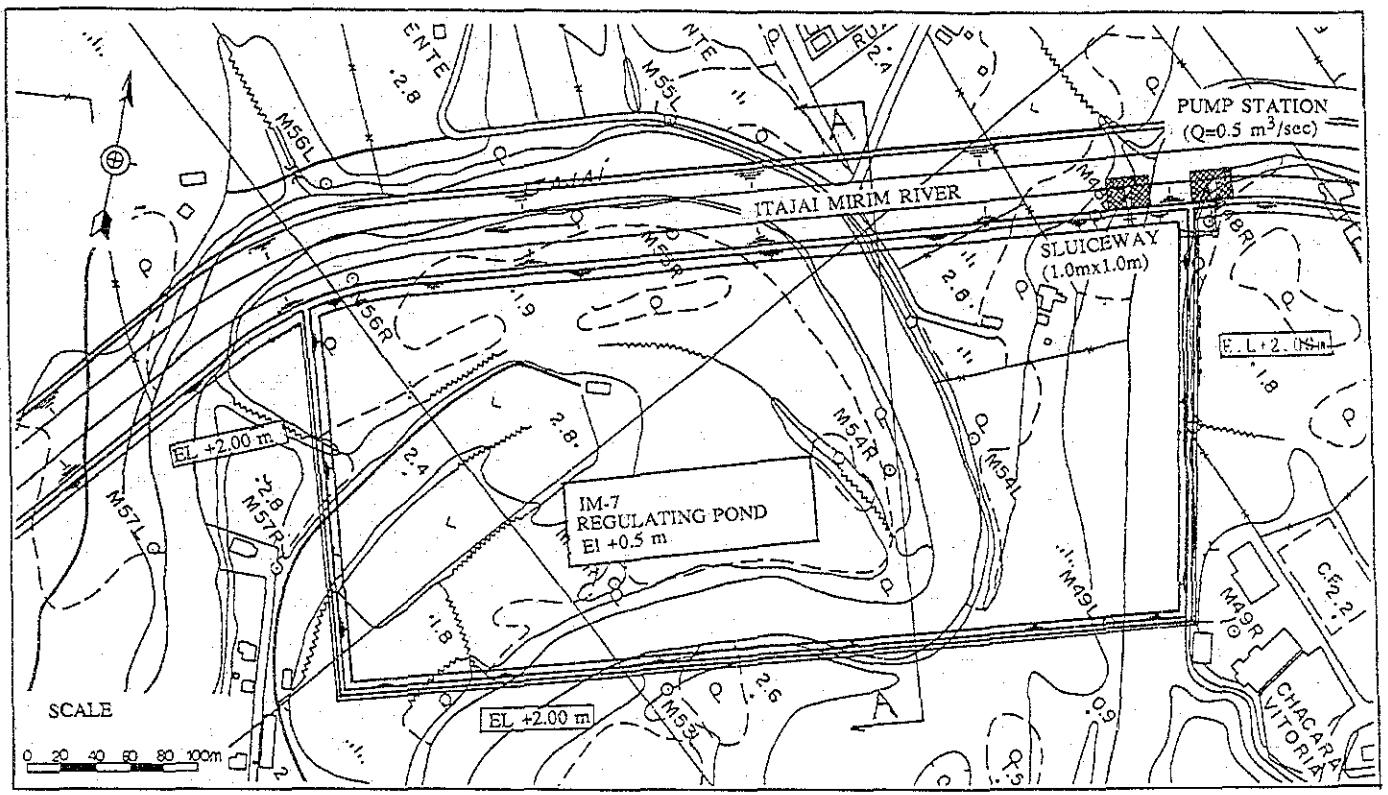
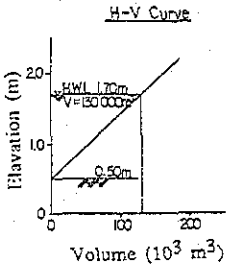


CAPACITY OF REGULATING POND

E.L (m)	Area (m2)	Volume (m3)
0.50	104600	0
1.70		130920
2.20	113600	185470
2.20	116300	



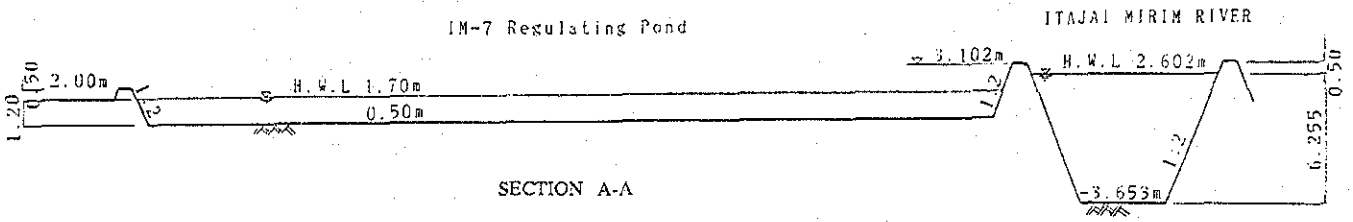
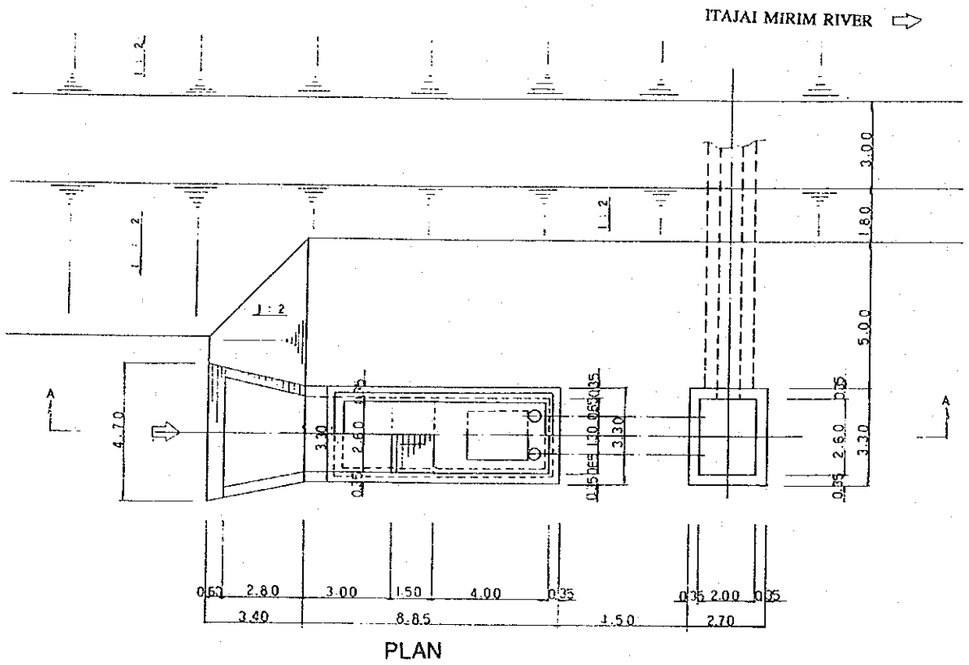
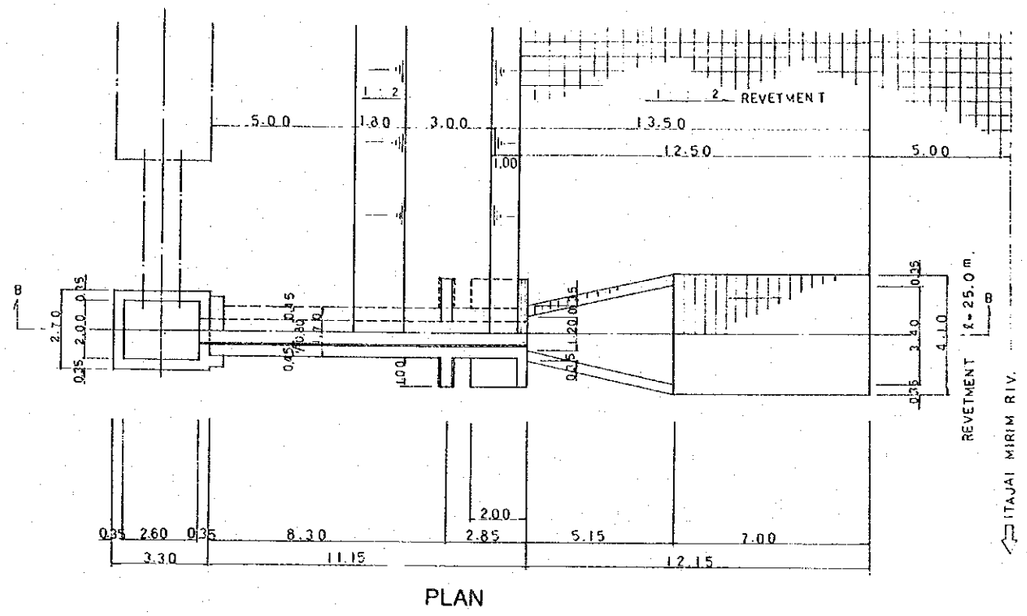


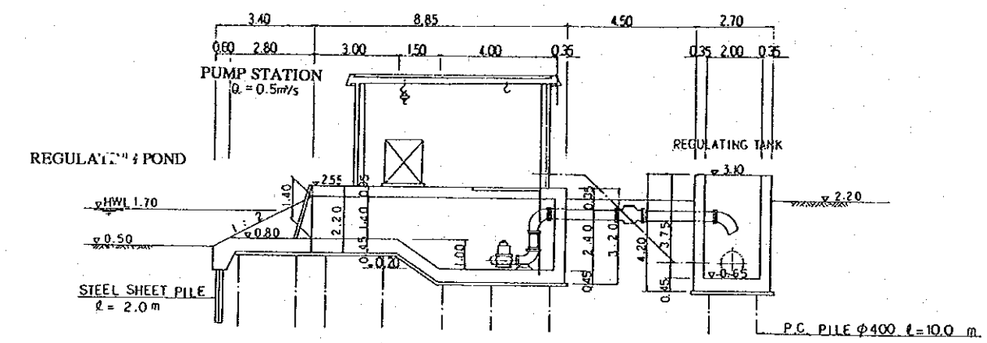
Fig.VI.4.11 GENERAL PLAN AND MAIN FEATURE OF IM-7 REGULATING POND



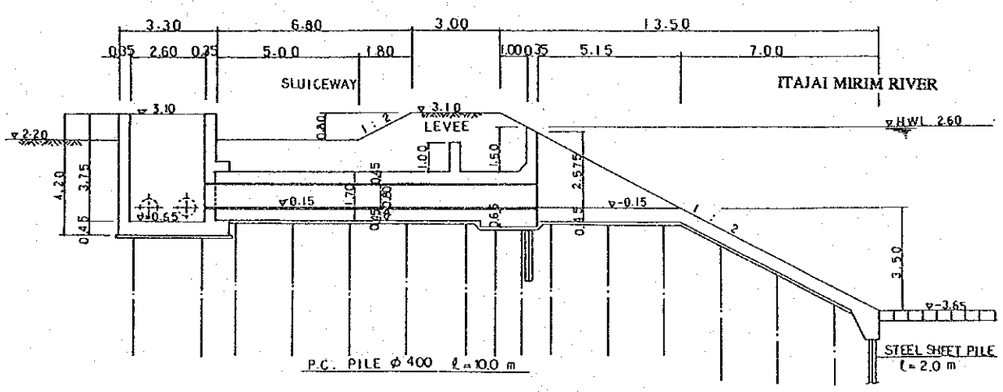
PLAN



PLAN



PROFILE (SECTION A-A)



PROFILE (SECTION B-B)

0 5 10 m

SCALE

Fig.VI.4.12 PUMP STATION OF IM-7 REGULATING POND

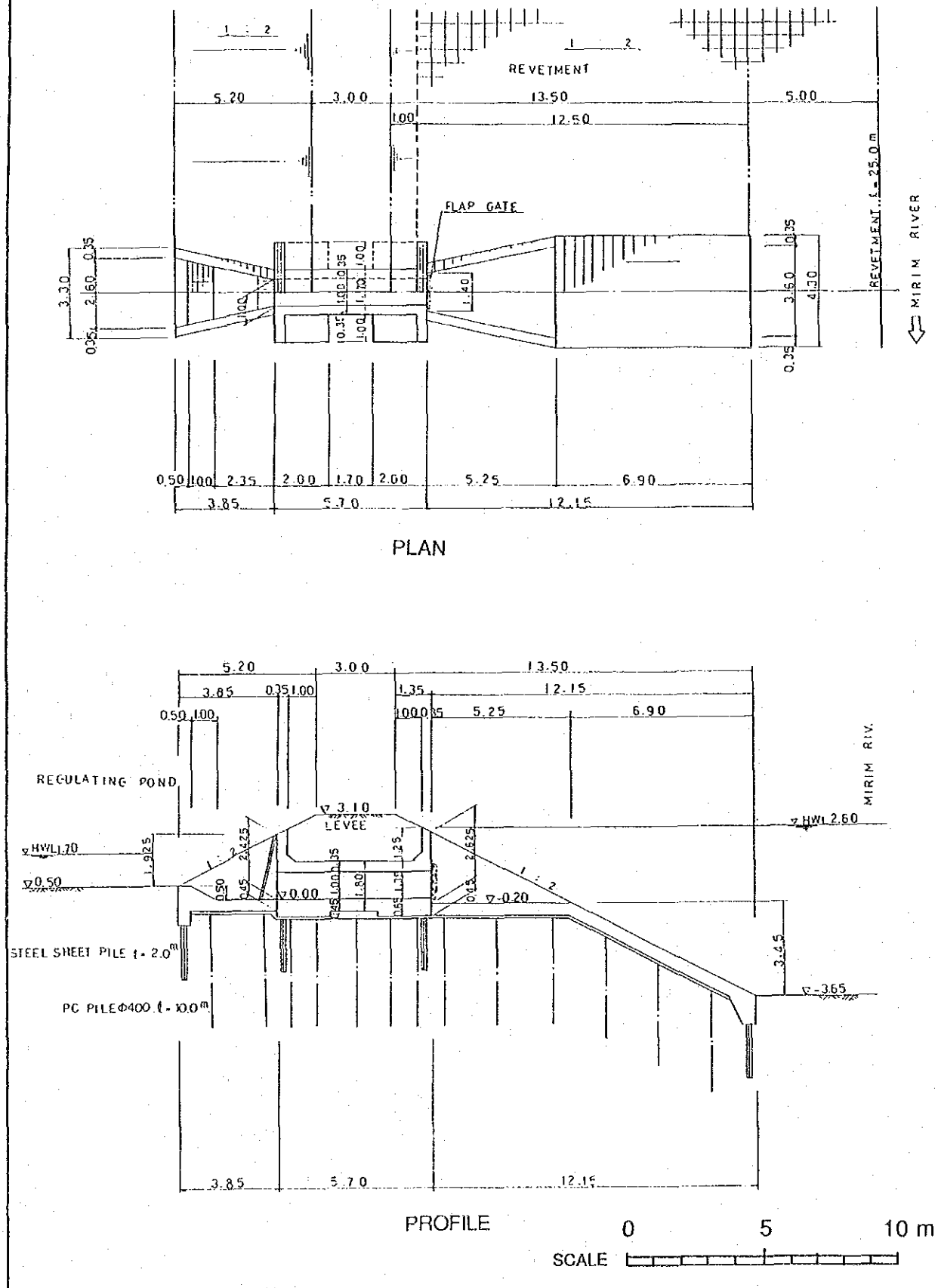
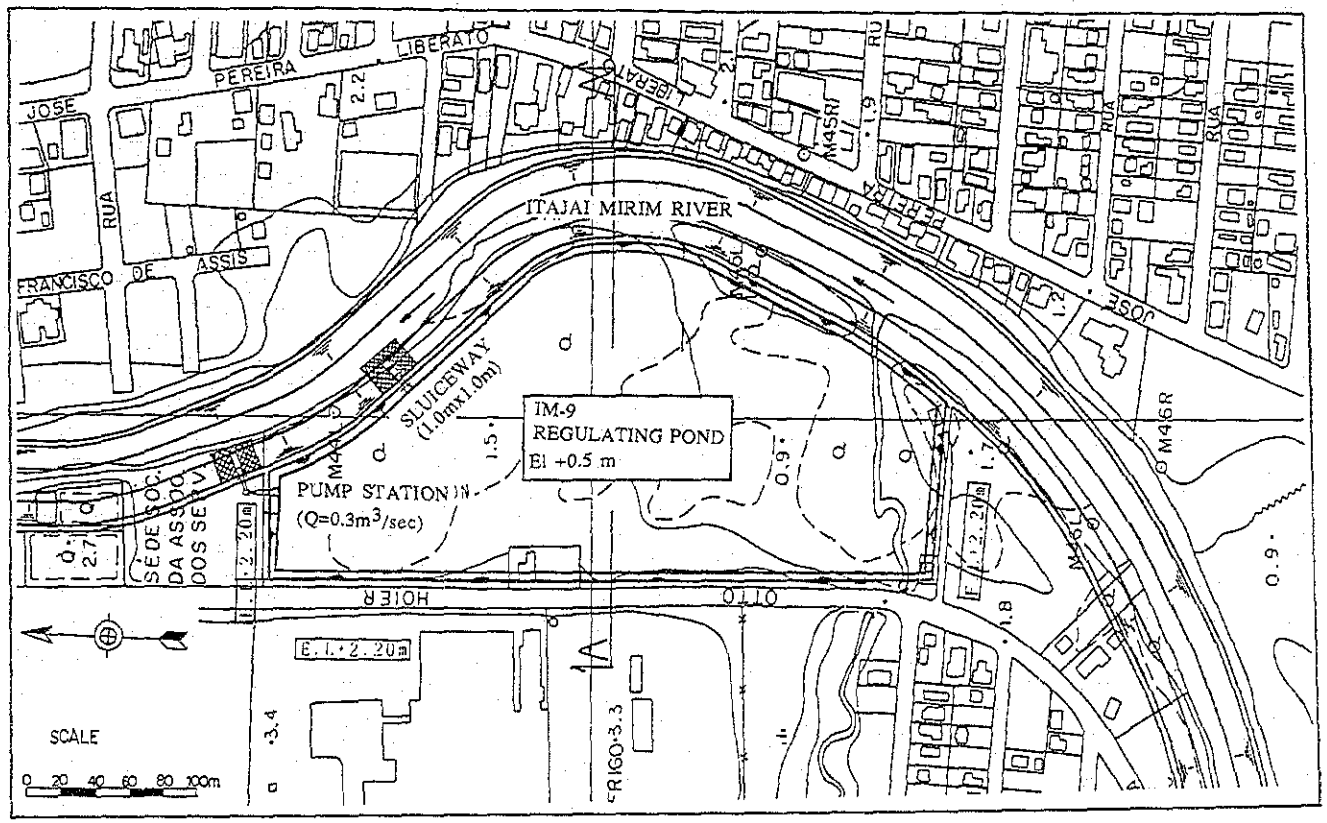
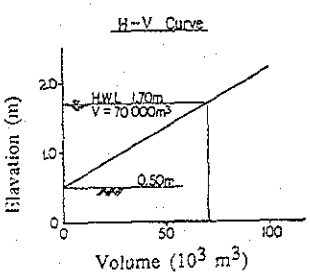


Fig. VI.4.13 SLUICEWAY OF IM-7 REGULATING POND



CAPACITY OF REGULATING POND

E.L (m)	Area (m2)	Volume (m3)
0.50	56100	0
1.70		70500
2.20	61400	99880
2.20	63200	



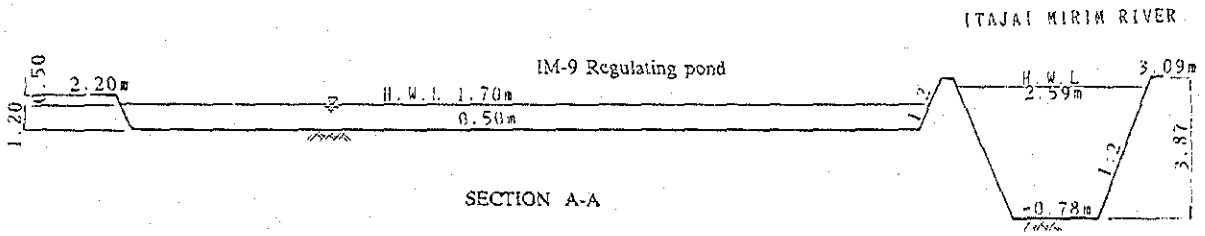
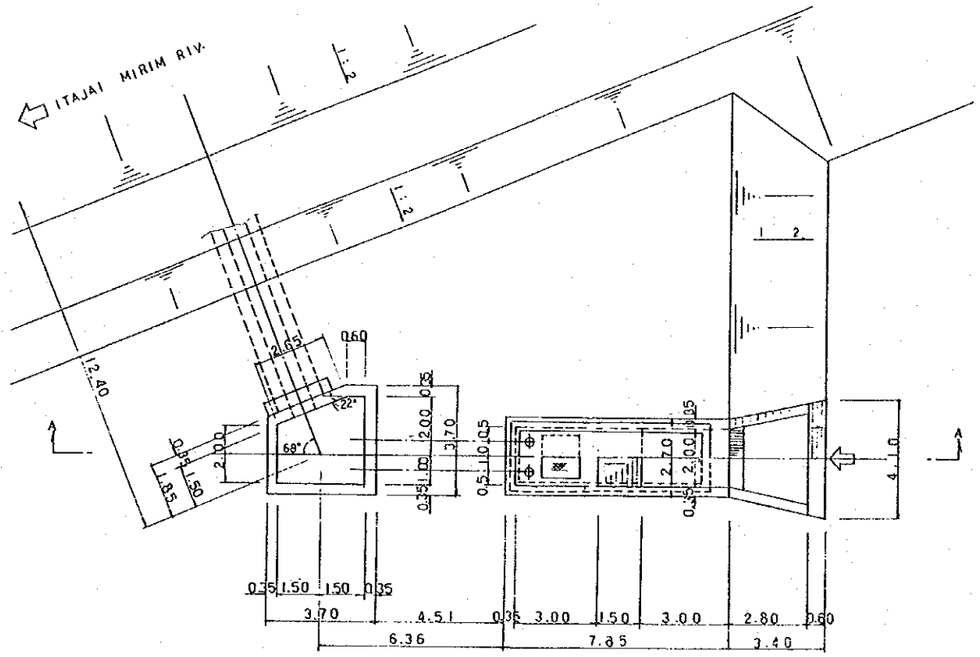
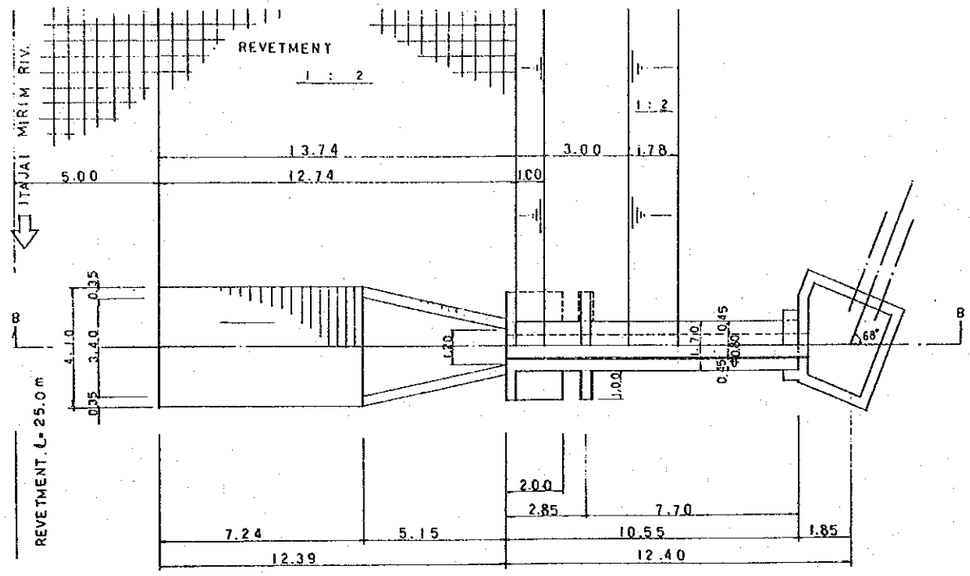


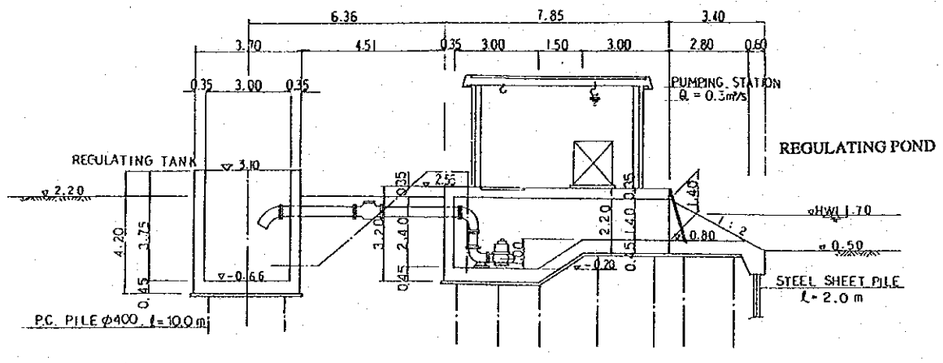
Fig.VI.4.14 GENERAL PLAN AND MAIN FEATURE OF IM-9 REGULATING POND



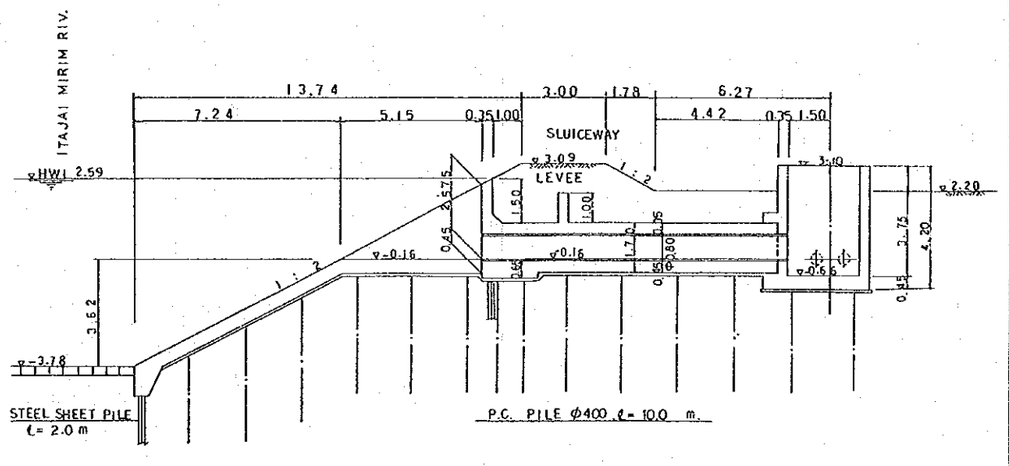
PLAN



PLAN



PROFILE (SECTION A-A)

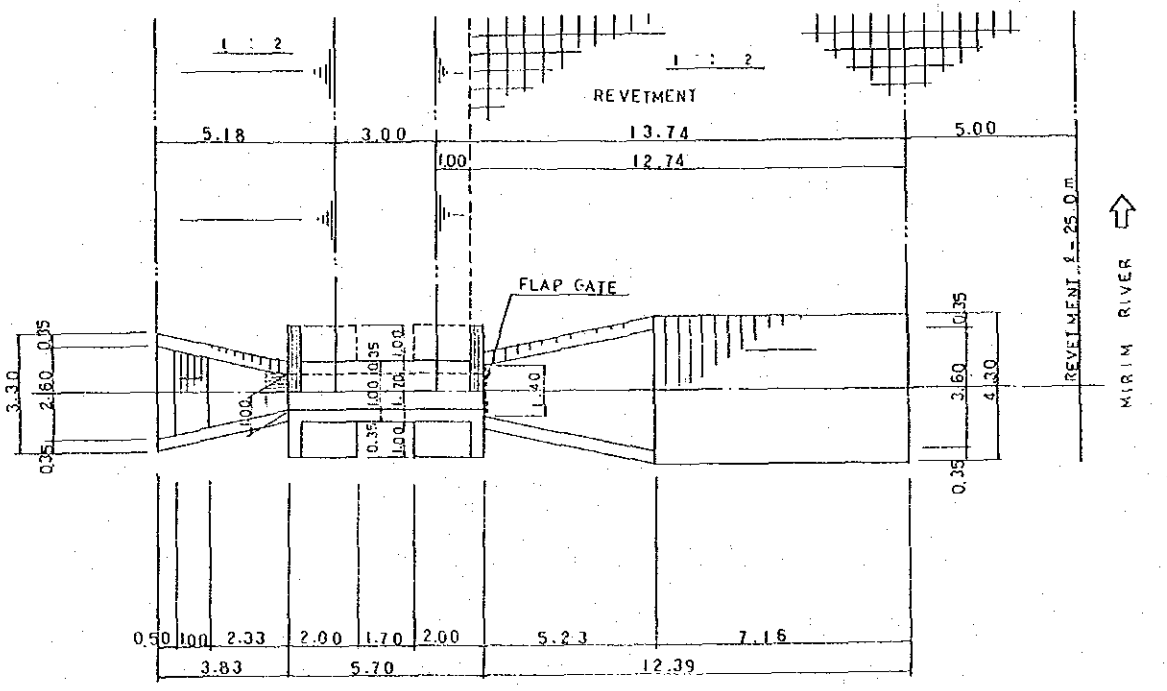


PROFILE (SECTION B-B)

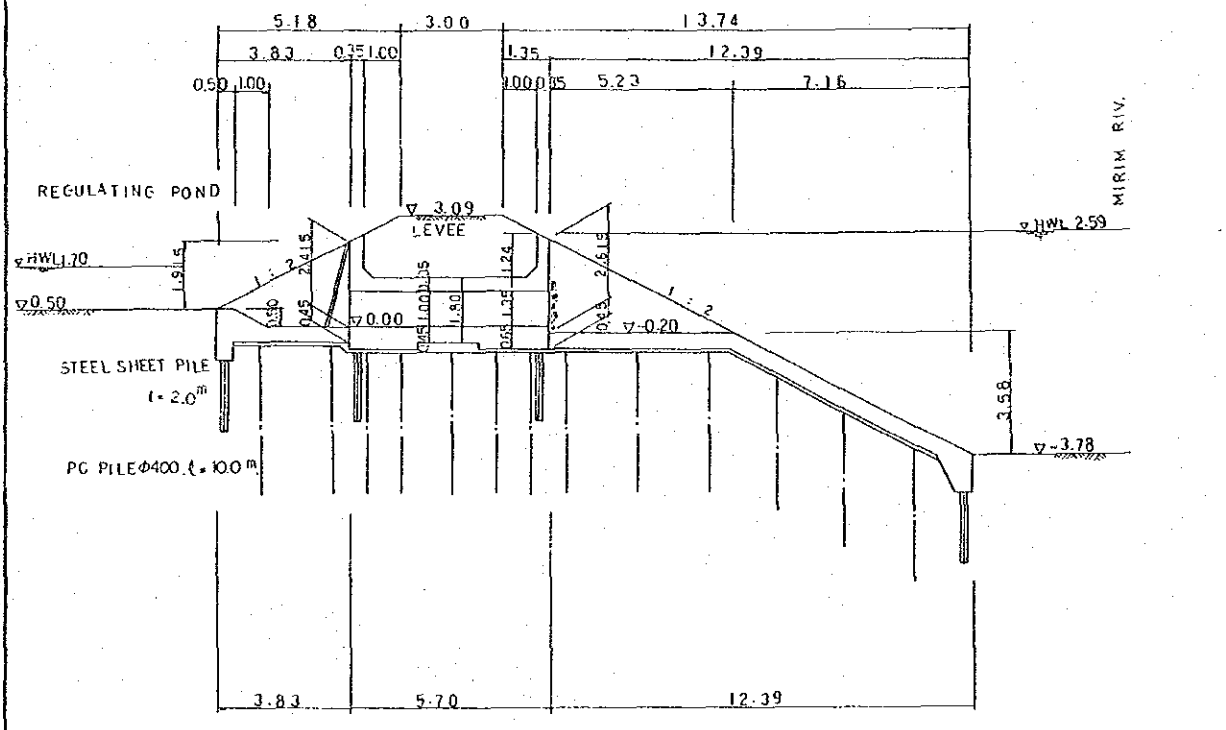
0 5 10 m

SCALE

Fig. VI.4.15 PUMP STATION OF IM-9 REGULATING POND



PLAN



PROFILE

0 5 10 m

SCALE

Fig.VI.4.16 SLUICEWAY OF IM-9 REGULATING POND

ANNEX VII.

ENVIRONMENTAL STUDY

ANNEX VII. ENVIRONMENTAL STUDY

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ANNEX VII. ENVIRONMENTAL STUDY

1. INTRODUCTION

1.1 Study Area

The study area covers the lower Itajai river basin and the Picarras river basin located adjacent thereto to the north involving urban areas of Itajai, Navegantes, Picarras and Penha.

Itajai city is located in the downstream reach of the Itajai river, occupying an area of 304 km^2. It is the second largest city in the basin with a population of around 101,000 in 1989 and is known as a fishing port.

Picarras city, having an area of 154 km^2 and a population of 6,000, is a famous tourist spot for sea bothers. During the summer season from December to February, the city is filled with 30,000 to 60,000 tourists.

Navegantes has an area of 97 km^2 and a population of 17,000. According to the municipal authorities, the beach is crowded with sea bathers during the summer season.

Penha has an area of 46 km^2 and a population of 13,000 and is located between Navegantes and Picarras.

1.2 Purpose of Study

The flood control plan for the project area comprising the river improvement works for the project stretch and construction of a floodway is established as stated in ANNEX VI of this Report, FLOOD CONTROL PLAN.

The main purpose of the study is to carry out the study on the environmental aspects for comparison of the proposed three alternative floodway routes and to perform the study on the matters to be contemplated for the implementation of the flood control project.

2. ENVIRONMENTAL STANDARDS OF FATMA AND WATER QUALITY IN STUDY AREA

2.1 Environmental Standards of FATMA

FATMA was established in 1975 as an agency of the state for the purpose of examination and approval for implementation of project regarding an impact on the air, water and landscape, etc. FATMA is now carrying out an administrative guidance based on the environmental laws put into force in 1980.

According to these laws, the quality of the river water is classified into four grades as shown in Table VII.2.1. The Itajai river is ranked as Grade 2.

Following the revision of the environmental laws of Brazil (CONAMA) in 1986, the state laws are also planned to be revised. The regulations relating to river and sea water quality are expected to be reviewed soon.

2.2 Water Quality in Study Area

2.2.1 Itajai main stream

(1) Existing Data

The data on water quality in the study area were collected from such organizations concerned as Blumenau and Gaspar Waterworks Bureau (SAMAE), National Department of Water and Electrical Energy (DNAEE), Santa Catarina Public Water Supply Corporation (CASAN), and Santa Catarina Environmental Authority (FATMA).

It is reported in SAMAE that, since factories and other buildings have recently increased in the upstream area of Indaial, two tests samples for water quality analysis were collected in the Itajai river at downstream of confluence with the Garcia river to examine heavy metals. The results showed the presence of mercury and lead of approximately 0.02 ppm. Since then, as a precautionary measure, the quality of the river water has been tested twice, but neither mercury nor lead were detected.

Since 1986, DNAEE has conducted water quality tests 2 to 3 times a year at 10 major water level gauging stations along the Itajai main stream and its tributaries as shown in Fig. VII.2.1 to detect the heavy metals . The results of the water quality analysis are as given in Table VII.2.2. Fig. VII.2.2 shows a concentration of cadmium (Cd),

lead (PB) and mercury (Hg), which are major harmful factors to the health of the human body.

As regards heavy metals, the value of mercury, cadmium and lead detected in the upstream areas of Rio do Sul or Indaial reached 100 times the standard value, while those metals were not detected in the midstream area at Blumenau and Gaspar. Whether this is caused by regular factory operations or by temporary phenomenon such as earth from mines is not clear. The value of mercury and cadmium detected at Ilhota is 100 times or more than the standard value, indicating that the Itajai river is contaminated either by industrial or mining activity.

Fig. VII.2.3 shows the values of BOD and fecal coliform related to the living environment. The amount of Colon Bacilli, detected in the most upstream region is twice the standard value. The lower river basins area such as Blumenau and Gaspar also show a value that is triple the standard value, indicating that pollution of the river through human waste is increasing.

The BOD value, or index of organic contamination in the upstream to midstream areas were generally within the standard value, however the BOD value at Ilhota was 7 ppm, which is slightly higher than the standard value. This shows the gradual increase in contamination of the water in a downstream direction.

(2) Water quality analysis made by the JICA Study Team

a) Water quality analysis of the Itajai river

Water sampling for the water quality analysis was conducted by the JICA Study Team at four places along the Itajai river, namely Indaial, Blumenau, Gaspar and at the existing bridge of BR-101 downstream of the inlet site of the Floodway-I. Sampling at the existing BR-101 bridge was done five times since November 1988 when the phase-I field survey work period started, and three times at the other three places since July 1989.

The results of the water quality analysis are shown in Table VII.2.3 and Fig. VII.2.3. Regarding the factors related to the human health, the concentration of lead was especially high. The level of lead in the stretch between Indaial and existing BR-101 bridge was measured to be 7 to 23 times the standard value.

Especially at the existing BR-101 bridge located close to the Floodway-I inlet site, the values of cadmium, chrome and mercury were also much higher than the standard value. As for the factors related to the living environment, the value of BOD and fecal coliform exceeded the standard value. This indicates that contamination through human waste is increasing in the reaches upstream of the Floodway-I inlet site.

b) Water quality analysis of the river bed material

The quality analysis of the river bed material was made for the samples collected at Blumenau in August 1989, and the results are shown in Table VII.2.4. The concentration of lead detected was 0.02 ppm to 0.93 ppm, and chrome being 0.004 ppm to 0.03 ppm. But cadmium, mercury and arsenic were not detected.

As seen from the above results, lead concentration in the river bed is increasing. It is considered that this is probably caused by the textile factories (Blumenau's major industry) or the glass factories.

2.2.2 Picarras coast

Water sampling for the sea water quality analysis was conducted at a place 10 km apart from the Picarras estuary toward Barra Velha, and at the Picarras river mouth for the period from November 1988 to August 1989. The results are shown in Table VII.2.5.

(1) Health factors

The most recent analysis, which was made for the samples collected at the Picarras river mouth in August 1989, indicated a concentration of 0.01 ppm of cadmium and 0.32 ppm of lead. Chrome and mercury were not detected. However, the past four analyses show high concentrations of chrome and mercury. For example, 1.7 ppm of lead equivalent to 172 times and 20 to 60 times the standard value concerning cadmium, chrome and mercury were detected as depicted in Fig. VII.2.5.

The concentration of mercury at the place at 10 km apart from the estuary showed 2.0 ppm in July 1989, which is 20,000 times the standard value. However it was not detected in the most recent analysis. The levels of cadmium and lead were as high as 0.009 ppm and 0.23 ppm, respectively. The analytical data itself may be questioned

as there are no pollution producing sources, such as factories along the Picarras coast. However, various measures against the pollution would have to be considered.

(2) Factors in the living environment

The analysis made in July 1989 indicated that the BOD value is 10 times the standard value, and the water quality along the coast cannot be said to be in good condition.

According to the past data on the Picarras coast, 7.5×10^4 MPN/100 ml of fecal coliform were detected. Incidentally, this value, as compared with the standard for Japanese resorts tabulated in Table VII.2.6, shows that the Picarras is unsuitable as beach coast. The pollution is thought to be caused mainly by sewage.

Since the tourist resort along the Picarras coast is a major source of income, appropriate measures for improving the water quality are needed.

3. PREDICTION OF ENVIRONMENTAL CHANGE CAUSED BY CONSTRUCTION OF FLOODWAY

3.1 General

The study on the environmental change caused by construction of the floodway was made to obtain the basis for selection of optimum plan among three alternatives.

On the basis of the field reconnaissance, the environmental factors which are likely to be seriously affected by construction of the proposed floodways were selected. They were recreation, fishery, landscape, area separation, inland navigation, coastal erosion and irrigation and drainage facilities. The influence to these items are assessed based on the available data and information,

The degree of the environmental impact for each of those items is summarized in Table VII.3.1 and explained hereinafter.

3.2 Recreation

(1) Present Condition

Picarras is famous for its beautiful beaches and is developed as a holiday resort city. Statistic showing the number of tourists visiting the city is not available. According to a city official, however, 30,000 to 60,000 people visit the beach during the summer season from December to March. Picarras has 7 hotels (1987), sanatoriums and restaurants along the coast. Many visitors from abroad also visit the resort. Thus, the tourist industry is a key one for Picarras.

There are no hotels or other type of accommodation in Navegantes. The number of visitors from abroad is few, although the beach is crowded with bathers during the summer season.

(2) Prediction

The river water of the Itajai is contaminated due to outflow of untreated sewage and industrial water containing much harmful heavy metal from factories. In the low flow condition of the Itajai river, high values of fecal coliform as well as lead, mercury and cadmium indicating 10 to 100 times the standard value were detected in the water quality analyses made up to now. Thus, the water quality of the river is in a quite unfavorable condition. Besides, the river water of the Itajai is in the muddy condition.

The river water of the Picarras, which flows into the Picarras coast is also polluted mainly by sewage.

If the construction of Floodway-I is realized, the sea water pollution in the Picarras coast is anticipated to be accelerated by contaminated and muddy water from the Itajai river. Thus, the construction of the Floodway-I will cause unfavorable environmental impact to the resort area of the Picarras coast, and it is considered that the Picarras will no longer be able to function as the resort.

Picarras receives many tourists from abroad as compared with Navegantes. A lowering of the image as the resort due to water pollution will decrease the number of tourists due to provision of Floodway-I, affecting the economy of the area.

Considering the present condition of the Navegantes coast as stated in the foregoing, the impact in case of Floodways-II and -III will be smaller as compared with the case of Floodway-III.

3.3 Fishery

(1) Present Condition

The statistics of the people involved in shrimp fishery in Itajai, Navegantes, Penha and Picarras are not available. However, 100 or more fishing boats involved in shrimp fishery are seen off the coast of Navegantes.

After a rainstorm, the water containing much mud from the Itajai river flows into the coastal area of Navegantes, forming a muddy area of 2 to 3 km in width and 5 km in length. Since the shrimp has a habit of shifting to different areas in order to avoid the muddy water under such a condition, the shrimp catch is said to decrease.

Shrimp fishery is also done along the coast of Picarras at water depth of 5 to 20 m. Due to the increase in tourist facilities in the area, however there are almost no fishermen in Picarras. The fishermen are said to come from the Penha area.

(2) Prediction

It will be unavoidable that the water containing much mud spreads to the coastal area to large extent after the rainstorm due to the construction of the floodway. The shrimp fishery is performed along the coasts of Itajai, Navegantes, Penha and Picarras at water

depth of 5 to 20 m. Among the fishery industries along the coast as stated in the foregoing, shrimp fishery will be influenced by muddy water from the floodway. However, degree of influence is unknown at this stage because it is not clear whether or not the mud water or particles attached to sand will exert any influence to diatomaceous and benthic organisms which the shrimp feeds on.

The extent of diffusion of the turbid water to be discharged from the Itajai river and proposed floodway to the Navegantes coast was studied through numerical simulation in ANNEX IV, COASTAL INVESTIGATION. It is assumed in this study that the flood peak of 2,000 m^3/sec which may occur once a year flows down through the floodway and Itajai river at the rate of 0.3 and 0.7 under the condition that tide water level is at the mean sea level of 0.067 m. The result of this study clarifies that the turbid water having suspended solid (SS) of 100 ppm extends up to the northern part of the proposed floodway site under the present conditions, and it is further extended up to about 3 km toward the northern area due to the construction of the floodway.

It is presumed that the extent of diffusion of the turbid water to be discharged through the floodway to the Picarras coast is about 3 km in width, which is the same as the case of the floodway to the Navegantes coast. Although it is considered that fishery activity has been carried out in additionally diffused areas, it seems that there are no objections for the fishery activity for both the Picarras and Navegantes coasts even if the floodway is constructed since the fishery activity is being carried out in river mouth of Itajai in spite of diffusion of turbid water discharged from the Itajai river.

3.4 Landscape

(1) Present Condition

The landscape along the proposed Floodway-I route consists mainly of agricultural land with sugarcane plantations in the stretch to around 3 km from the inlet site in the Itajai river. A landscape of relatively low mountain of 50 to 100 m in elevation extends along the route downstream therefrom and the sandy beach appears at the Picarras coast.

In Floodway-II, there is a hilly landscape on the left side, at about 4 km downstream of the inlet site which is followed by farming areas with houses scattered around. Finally the coastal straight landscape of Navegantes can be seen.

Although the landscape in the downstream route of Floodway-III is the same as that of Floodway-II, a town with a church and cemetery can be seen in the inlet portion.

(2) Prediction

In the Picarras coast where a jetty, the outlet facility of Floodway-I, is planned, the present landscape consists of a small island located near shore and a beautiful beach. Therefore, the artificial landscape created by construction of the floodway would damage the present natural scenery, which is a valuable tourism resource for Picarras. Thus, serious environmental impact to the present landscape is predicted for the case of Floodway-I.

On the Navegantes coast, the landscape of coastal line is not so excellent as compared with that for the Picarras. In addition, there are no hotels for tourists along the beach. Accordingly, the impact for landscape due to construction of the floodway will be not so serious as compared with the case of Floodway-I.

The jetty portion of Floodway-III is the same as Floodway-II. However, 140 m wide floodway constructed through the town area of Machados will drastically change the present view, but the impact will not be so serious as Floodway-I since it does not rely on the tourism.

3.5 Area Separation

(1) Present condition

In Floodway-I, sanatoriums and hotels are located at the downstream of the Picarras river.

In Floodway-II, various houses are scattered on farmland in the inlet portion on the Itajai river. On the Navegantes coast where jetty is planned, houses are very sparsely built.

In Floodway-III, a town centered around a church is located close to the inlet site. The jetty is planned to be provided at the same location as Floodway-II.

(2) Prediction

Since the roads connecting communities or farms will be separated by the construction of floodway in every alternative case, the social life will be influenced more or less. It

will be necessary to take appropriate measures including construction of new bridges or the replacement of roads. In view of the area separation, the environmental impact in case of Floodways-I and -III is predicted to be more serious due to separation of the urban areas of Picarras and Machados, as compared with that for Floodway-II.

3.6 Inland Navigation

(1) Present Condition

The ships navigating upstream of the existing BR-101 bridge in the Itajai river are mostly of small sand-dredging ones. Apart from the sight-seeing boats on the Blumenau-Gaspar route during the summer season, no other types are found. As for small boats, they are used as a means of transport by the residents along the river, or as grass carriers of animal fodder.

(2) Prediction

It is predicted that even after the streamflow of the Itajai river is diverted into the floodway channel, the present navigation activity will not be affected since the water depth of the Itajai river after river diversion to the floodway channel is unchanged due to almost constant high tidal level.

3.7 Coastal Erosion

(1) Present Condition

According to the city authorities, coastal erosion along the Picarras coast has increased during the last two decades. The beaches are gradually diminishing, especially around the Picarras river mouth. The beach in 1976 was over 50 m wide as shown in Photo VII.3.1, but it has been reduced to less than 10 m due to the coastal erosion as seen in Photo VII.3.2. Also, the coastal change is seen in Photos VII.3.3 and VII.3.4.

(2) Prediction

Floodway-I will supply sand to the beaches not only during flood, but also in the low flow condition. Since most of the sand conveyed through the flooding will be fine and in suspension, it will not be enough to renourish the beaches. While, due to the construction of the floodway at the Navegantes coast, it is predicted that the erosion takes place in the left side of the jetty owing to prevailing wave from SE direction but its extent will be relatively small.

3.8 Irrigation and Drainage

(1) Present Condition

It is planned that Floodway-1 route passes through the sugarcane area and pasture land in about 5 km long stretch from inlet. While, Floodways-II and III are aligned through pasture and forest/bush, excepting the inlet site in Floodway-III. The sugarcane along the Floodway-I is now cultivated by rainfed culture.

(2) Prediction

Due to the construction of Floodway-I, drainage canal for the sugarcane will be cut in several places. To cope with this situation, culvert to be provided under the levee for floodway and connection canal will have to be planned. No environmental impact is predicted for Floodways-II and III.

4. STUDY ON ENVIRONMENTAL ASPECT FOR CONSTRUCTION PLANNING

4.1 General

The environmental problems which may take place during the construction of river improvement structures and floodway are considered to be the influence to water pollution, animals and vegetation, air pollution, noise and vibration, land (sliding) and life (housing). Those environmental impacts during construction, which may be caused due to dredging and excavation of river channel and floodway, levee embankment and treatment of the excavated material are predicted as described hereinafter.

4.2 Water Pollution

Due to dredging and widening of the rive channel, water pollution in the Itajai river will temporarily increase, causing the temporary increase in artificial suspended soil (muddiness).

As for the proposed floodway, it is necessary to secure appropriate spoil bank areas for the excavated material in order to avoid water pollution of small streams originated from the left bank side hill.

4.3 Animals and Vegetation

The Itajai river with its riverside vegetation provides a breeding place and a habitat for aquatic life, such as fish and water fowls. Thus, the dredging and widening of the river will affect the animals and vegetation.

The change in the riverbed and the riverside will affect the habitat of fish and will deprive them of riverside vegetation. The fish and animals such as water fowls will have to search for another dwelling place.

Therefore, it is necessary to make a research of valuable animals and vegetation to grasp the degree of the influence on them, and depending on the results, an adequate measure will have to be adopted.

4.4 Air Pollution, Noise and Vibration

In order to reduce the air pollution caused by dust from the construction vehicles, and also the noise and vibration, it is necessary to water and clean the streets especially in

residential areas, and to limit the speed of the vehicles. The noise due to the construction works will have to be controlled by the regulations concerned.

4.5 Land (Sliding)

The land slide will take place due to erosion caused by rainstorm in the course of construction of floodway and widening of the river channel. In order to avoid such cases, appropriate bank protection such as sodding will become necessary.

4.6 Life (Housing)

For people residing along the riverside, the widening of the river and construction of the floodway will mean the loss of their houses. Discussions with the residents will be necessary regarding their new place of residence and administrative measures will become necessary.

Tables

Table VII.2.1 STANDARDS RELATING TO LIVING ENVIRONMENT IN RIVER

Class	Condition	Purposeof Water Use
1	Water treated by cleaning operation or without treatment.	Water supply, etc.
2	On class 2 waters the following limits or conditions are established	Water supply
	1) Floating matter including non-natural foam almost absent 2) Oil and grasses - almost absent 3) Substance which treatment taste or smell - almost absent 4) The presence of artificial colourants which are not removable by the conventional processes of coagulation, sedimentation and filtration, will not be permitted 5) The most probable number of coliform in total up to 5,000 being 1,000, the limit for those of foecal origin in a period of up to 5 consecutive weeks 6) BOD 5 days, 20°C up to 5 mg/l 7) DO in any sample not less than 5 mg/l and potentially hamful substances (maximum proportions) 8) (a) Ammonia:0,5 mg/l (b) Arsenic Total: 0.1 mg/l (c) Barium: 1.0 mg/l (d) Cadmium total: 0.01 mg/l (e) Chrome: 0.0005 mg/l (f) Cyanide: 0.2 mg/l (g) Copper: 1.0 mg/l (h) Lead: 0.1 mg/l (i) Tin: 2.0 mg/l (j) Phenols: 0.001 mg/l (k) Flourine: 1.4 mg/l (l) Mercury: 0.002 mg/l (m) Nitrate: 10.0 mg/l of N (n) Nitrite: 1.0 mg/l of N (o) Selenium: 0.01 mg/l (p) Zinc: 5.0 mg/l (q) Tenso active agents: 0.5 mg/l (r) Shinthetic organic chlorate biocides 1. Aldrin 0.001 mg/l 2. Chlordan 0.003 mg/l 3. DDT 0.05 mg/l 4. Dieldrin 0.001 mg/l 5. Endrin 0.00002 mg/l 6. Heptachloro 0.0001 mg/l 7. Lindano 0.0004 mg/l 8. Metoxicholoro 0.1 mg/l 9. Toxapheno 0.005 mg/l 10. Carbonate and phosphide organic composts 0.1 mg/l 11. Chloro - Phenox herbicides 2,4-D 0.02 mg/l (dichloro phenoxiocetic acid) 2,4,5-TP 0,03 mg/l (trichloro phenoxi proprionic acid) 2.4.5-T 0,002 mg/l (tricholoro phenoxi acetic acid)	Agricultural water Familiality to water
3	The same limits as class 2, are established with the following exceptions. 1) The Most Probable Number of coliform totals up to 20,000 being 4,000 the limit for those of foecal origin in 100 ml, for 80% or more in at least 5 samples collected in a period of up to 5 consecutive weeks 2) BOD / 5 days 20°C up to 10 mg/l 3) DO in any sample not less than 4 mg/l	
4	The following limits or conditions are established 1) Floating matter, including non-natural foam - virtually absent 2) Odour and aspects - not objectionable 3) Phenols: up to 1 mg/l 4) DO above 0.5 mg/l in any sample	

Source: Judicial Advisory Comitee in PATMA

Table VII.2.2 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY DNAEE (1/5)

Location : Adolfo Konder bridge site in Blumenau

No.	Analysed Item	Unit	Standard of FATMA	Date 1986 Apr.1	1986 Jun.25	1986 Oct.27	1987 Feb.17	1987 May 19	1987 Aug.18	1987 Nov.23	1988 Feb.22
(1)	Alcalinity	mg/l		19.4	24	13	8	20	13	17	15
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	-	ND	ND	ND	ND
(3)	Detergent	mg/l		0.005	4.7	0.04	-	0.02	0.04	0.1	0.04
(4)	Cadmium	mg/l	0.01	0.005	ND	ND	0.007	-	-	ND	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.01	ND	-	0.02	-	ND	1E-05
(7)	Fecal Coliform	NMP/100ml	1,000	26	75	2400	2400	1100	1100	-	8000
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	-	-	-	-
(9)	Conductivity	UMHO/cm		-	83.8	18	-	59	-	53.8	49.2
(10)	Colour	mgPt/l		313	35	60	200	225	350	100	175
(11)	BOD (5days)	mg/l	5	-	-	1.4	-	1.8	2.4	1.4	-
(12)	COD	mg/l		15	-	7.7	16.2	12.4	9.3	7.9	4.5
(13)	Hardness	mg/l		15.5	18	11	11.5	15	21	15	17
(14)	Phenol	mg/l	0.001	5	0.008	0.002	-	0.006	0.004	0.004	0.005
(15)	Phosphate	mg/l		-	0.15	0.08	1.5	0.24	0.07	0.12	0.16
(16)	Phosphoric ion	mg/l		0.28	0.2	-	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	ND	ND	-	0.001	-	ND	0.0003
(18)	Nitrogen Nitrate	mg/l	10	0.9	1.3	1.3	0.04	1.8	2.8	2	1.9
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.02	0.013	0.01	0.043	0.036	0.037	0.013
(20)	Nitrogen Amonium	mg/l		1.2	0.3	0.2	0.2	0.3	0.1	0.1	0.1
(21)	Oil and Grease	mg/l	A.A	9	10	13.7	3.8	13.5	10	10	10
(22)	DO	mg/l	5	6.8	8.2	7.9	8.7	9.4	10	7.3	8.2
(23)	pH			7.1	7.2	7	-	7.7	6.9	6.8	5.7
(24)	Suspended Solid	mg/l		-	2.2	2.6	62	87.6	101.2	20	61.6
(25)	Total Solid	mg/l		10	-	-	-	-	-	-	-
(26)	Water Temperature	°C		-	-	24	23	18	16	26	23
(27)	Air Temperature	°C		-	-	25	-	24	18	39	26
(28)	Turbidity	UFT		67	112	14	67	130	210	51	56

Location : Emilio Baumgarten bridge site in Indaial

	Analysed Item	Unit	Standard of FATMA	Date 1986 Mar.19	1986 Jun.18	1986 Sep.10	1987 Jan.14	1987 Jul.15	1987 Oct.20	1988 Jan.19
(1)	Alcalinity	mg/l		18.3	22	19	4	15	11	15
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		0.005	0.01	0.03	0.01	0.08	0.01	0.01
(4)	Cadmium	mg/l	0.01	0.005	ND	0.003	0.001	-	1	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.01	0.01	0.02	0.01	-	ND
(7)	Fecal Coliform	NMP/100ml	1,000	460	150	93	2400	1100	150	-
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	-	150	-
(9)	Conductivity	UMHO/cm		-	78	20	32.5	50.7	37	51
(10)	Colour	mgPt/l		312	35	45	700	100	250	175
(11)	BOD (5days)	mg/l	5	-	-	-	1.2	0.8	1.6	0.8
(12)	COD	mg/l		14	9.5	9.4	32.2	14.1	24.8	1.5
(13)	Hardness	mg/l		14.3	16	15	10	24	16	13
(14)	Phenol	mg/l	0.001	5	0.003	0.007	0.006	0.002	0.008	0.001
(15)	Phosphate	mg/l		-	0.05	0.13	0.53	0.08	0.29	0.21
(16)	Phosphoric ion	mg/l		0.31	0.12	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	0.0003	0.0002	-	-	0.1	0.0007
(18)	Nitrogen Nitrate	mg/l	10	0.9	1.7	2.2	2.2	3.4	3.9	2.9
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.021	0.066	0.017	0.029	0.026	0.065
(20)	Nitrogen Amonium	mg/l		0.1	0.2	ND	0.1	0.1	0.1	0.1
(21)	Oil and Grease	mg/l	A.A	94	16.8	15.4	10	10	10	10
(22)	DO	mg/l	5	7.5	8.8	8.2	7.2	9.3	9.5	-
(23)	pH			6.6	7.6	7.4	6.4	5.8	7.4	-
(24)	Suspended Solid	mg/l		-	2.6	2	379	22	150.8	156.3
(25)	Total Solid	mg/l		41	-	-	-	-	-	-
(26)	Water Temperature			-	19	20	25.5	18	18.5	29
(27)	Air Temperature			-	19	28	32	20	19	34
(28)	Turbidity	UFT		78	14	17	410	58	100	125

Notes : 1. ND ; not detected 2. AA ; Almost absent

Table VII.2.2 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY DNAEE (2/5)

Location : Gaspar

No.	Analysed Item	Unit	Standard of FATMA	Date 1986 Nov.25	Date 1988 Feb.23
(1)	Alcalinity	mg/l		20	17
(2)	Aldrin	Ug/l	0.001	ND	ND
(3)	Detergent	mg/l		0.1	0.05
(4)	Cadmium	mg/l	0.01	ND	ND
(5)	Carbonate	mg/l		-	-
(6)	Lead	mg/l	0.1	ND	ND
(7)	Fecal Coliform	NMP/100ml	1,000	-	8000
(8)	Total Coliform	NMP/100ml	5,000	-	-
(9)	Conductivity	UMHO/cm		55.7	56.2
(10)	Colour	mgPt/l		105	105
(11)	BOD (5days)	mg/l	5	0.8	-
(12)	COD	mg/l		9.3	6.3
(13)	Hardness	mg/l		-	-
(14)	Phenol	mg/l	0.001	15	18
(15)	Phosphate	mg/l		0.003	0.004
(16)	Phosphoric ion	mg/l		-	-
(17)	Mercury	mg/l	0.002	ND	ND
(18)	Nitrogen Nitrate	mg/l	10	2	1.7
(19)	Nitrogen Nitrite	mg/l	1	0.028	0.024
(20)	Nitrogen Amonium	mg/l		0.1	0.24
(21)	Oil and Grease	mg/l	A.A	10	10
(22)	DO	mg/l	5	6.3	7
(23)	pH			6.7	5.3
(24)	Suspended Solid	mg/l		29.2	68
(25)	Total Solid	mg/l		-	-
(26)	Water Temperature	°C		25	29
(27)	Air Temperature	°C		30	26
(28)	Turbidity	UFT		46	74

Location : Ilhota

	Analysed Item	Unit	Standard of FATMA	Date 1987 Feb.23	May 18	Aug.18	Nov.25
(1)	Alcalinity	mg/l		8	20	12	20
(2)	Aldrin	Ug/l	0.001	-	ND	ND	ND
(3)	Detergent	mg/l		-	ND	0.05	0.08
(4)	Cadmium	mg/l	0.01	0.0074	0.001	ND	1
(5)	Carbonate	mg/l		-	-	-	-
(6)	Lead	mg/l	0.1	ND	0.02	ND	ND
(7)	Fecal Coliform	NMP/100ml	1,000	27	460	53	-
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-
(9)	Conductivity	UMHO/cm		-	21	-	58.3
(10)	Colour	mgPt/l		200	130	200	135
(11)	BOD (5days)	mg/l	5	3.6	3.1	2	7.2
(12)	COD	mg/l		23.7	29.2	17.1	15.4
(13)	Hardness	mg/l		5	13	19	15
(14)	Phenol	mg/l	0.001	-	0.006	0.002	0.004
(15)	Phosphate	mg/l		1.6	0.06	0.15	0.18
(16)	Phosphoric ion	mg/l		-	-	-	-
(17)	Mercury	mg/l	0.002	ND	0.0001	ND	0.1
(18)	Nitrogen Nitrate	mg/l	10	0.2	4	2.7	1.9
(19)	Nitrogen Nitrite	mg/l	1	0.01	0.027	0.038	0.033
(20)	Nitrogen Amonium	mg/l		0.1	ND	0.1	ND
(21)	Oil and Grease	mg/l	A.A	6.4	10	10	10
(22)	DO	mg/l	5	8.2	9.3	9.1	6.1
(23)	pH			-	6.6	7.5	6.7
(24)	Suspended Solid	mg/l		74	110.6	140.4	51.6
(25)	Total Solid	mg/l		-	-	-	-
(26)	Water Temperature			23	17	16	26
(27)	Air Temperature			-	20	12	34
(28)	Turbidity	UFT		97	164	136	58

Notes : 1. ND ; not detected 2. AA ; Almost absent

Table VII.2.2 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY DNAEE (3/5)

Location : Ituporanga

No.	Analysed Item	Unit	Standard of FATMA	Date 1986 Apr. 8	1987 Jan.19	1987 Apr.22	1987 Jul.15	1987 Oct.19
(1)	Alcalinity	mg/l		23	10	20	15	17
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		0.05	0.02	0.4	0.09	ND
(4)	Cadmium	mg/l	0.01	0.005	-	-	-	-
(5)	Carbonate	mg/l		-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.01	0.01	0.01	ND
(7)	Fecal Coliform	NMP/100ml	1,000	3	2400	1100	1100	-
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	-
(9)	Conductivity	UMHO/cm		-	42.5	-	56.4	45.1
(10)	Colour	mgPt/l		375	350	35	130	225
(11)	BOD (5days)	mg/l	5	-	1.1	0.4	1.2	2.2
(12)	COD	mg/l		19	12.2	7.8	15.7	22
(13)	Hardness	mg/l		20.5	14	21	23	18
(14)	Phenol	mg/l	0.001	ND	0.012	0.006	0.002	0.007
(15)	Phosphate	mg/l		-	0.05	0.07	0.12	0.09
(16)	Phosphoric ion	mg/l		0.05	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	0.0346	-	-	0.1
(18)	Nitrogen Nitrate	mg/l	10	0.7	2.8	1.9	2.6	4.2
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.01	0.013	0.013	0.023
(20)	Nitrogen Amonium	mg/l		0.4	-	0.1	0.1	0.1
(21)	Oil and Grease	mg/l	A.A	6	10	10	10	11.1
(22)	DO	mg/l	5	6.4	9.7	7.5	8.9	9.2
(23)	pH			7.1	6.2	6.8	5.7	7.1
(24)	Suspended Solid	mg/l		-	230	20.2	1.2	328
(25)	Total Solid	mg/l		125	-	-	-	-
(26)	Water Temperature	°C		-	22	21	19	16
(27)	Air Temperature	°C		-	29	24.5	23	18
(28)	Turbidity	UFT		130	246	13	92	108

Location : Rio do Sul

	Analysed Item	Unit	Standard of FATMA	Date 1986 Apr. 7	1986 Jun.17	1987 Jan.19	1987 Apr.22	1987 Jul.15	1987 Oct.19	1988 Jan.18
(1)	Alcalinity	mg/l		22.1	23	9	17	15	10	13
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		0.05	0.01	0.05	0.03	0.1	0.01	0.02
(4)	Cadmium	mg/l	0.01	0.005	ND	-	0.001	-	ND	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.01	-	0.02	0.01	ND	10
(7)	Fecal Coliform	NMP/100ml	1,000	35	93	2400	1100	-	460	15
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	-	460	-
(9)	Conductivity	UMHO/cm		-	78	35.3	59.1	49.1	39.2	48.4
(10)	Colour	mgPt/l		312	90	250	45	130	175	175
(11)	BOD (5days)	mg/l	5	-	-	0.7	0.8	2.6	1.8	2
(12)	COD	mg/l		18	18.8	6.1	9.3	14.1	15.7	10.4
(13)	Hardness	mg/l		15.3	18	11	18	25	16	14
(14)	Phenol	mg/l	0.001	ND	0.009	0.011	0.001	0.004	0.003	0.004
(15)	Phosphate	mg/l		-	0.06	0.05	0.21	0.04	0.12	0.25
(16)	Phosphoric ion	mg/l		0.05	0.35	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	ND	0.031	-	-	0.3	0.0006
(18)	Nitrogen Nitrate	mg/l	10	0.8	0.9	2.7	2.1	2.7	5	2.1
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.074	0.013	0.052	0.036	0.026	0.047
(20)	Nitrogen Amonium	mg/l		0.4	0.1	-	0.4	0.1	0.1	0.2
(21)	Oil and Grease	mg/l	A.A	6	11.3	10	12.7	10	11.7	10
(22)	DO	mg/l	5	6	1.4	7.8	5.7	6.6	9.3	6.3
(23)	pH			7.6	6.4	6.3	6.6	5.5	7.3	5.9
(24)	Suspended Solid	mg/l		-	9.6	83	110	68.8	21.6	210.8
(25)	Total Solid	mg/l		55	-	-	-	-	-	-
(26)	Water Temperature			-	17.5	24	21	19	17	26.5
(27)	Air Temperature			-	16.5	27	25	25	19	28
(28)	Turbidity	UFT		67	24	154	20	88	111	150

Notes : 1. ND ; not detected 2. AA ; Almost absent

Table VII.2.2 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY DNAEE (4/5)

Location : Taio

No.	Analysed Item	Unit	Standard of FATMA	Date 1986 Apr. 9	1987 Jan.20	1987 Apr.21	1987 Jul.20	1987 Oct.20	1988 Jan.18
(1)	Alcalinity	mg/l		14.6	10	19	17	12	16
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		0.05	0.03	0.02	0.05	0.03	0.01
(4)	Cadmium	mg/l	0.01	0.005	-	-	-	ND	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	-	0.01	-	ND	ND
(7)	Fecal Coliform	NMP/100ml	1,000	12	2400	290	150	44	29
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	440	-
(9)	Conductivity	UMHO/cm		-	28.4	50.6	51.6	31.2	46.5
(10)	Colour	mgPt/l		25	100	45	35	105	125
(11)	BOD (5days)	mg/l	5	-	0.8	0.8	1.6	1	0.5
(12)	COD	mg/l		14	7.8	7.6	6.1	9.3	10.4
(13)	Hardness	mg/l		10.4	11	17	20	15	13
(14)	Phenol	mg/l	0.001	5	0.007	0.003	-	0.006	0.003
(15)	Phosphate	mg/l		-	0.07	0.1	0.07	0.04	0.13
(16)	Phosphoric ion	mg/l		0.05	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	0.0277	-	-	0.2	ND
(18)	Nitrogen Nitrate	mg/l	10	0.7	2	1.1	1.5	2.8	2.1
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.012	0.019	0.036	0.011	0.026
(20)	Nitrogen Amonium	mg/l		0.1	-	0.2	-	0.1	0.3
(21)	Oil and Grease	mg/l	A.A	10	10	10	10	10	10
(22)	DO	mg/l	5	7.3	6.8	5.9	8.3	8.6	8.9
(23)	pH			6.2	6.8	6.4	6.7	7.4	6
(24)	Suspended Solid	mg/l		-	44.6	2.1	20	53.6	83.6
(25)	Total Solid	mg/l		20	-	-	-	-	-
(26)	Water Temperature	° C		-	24	22	11	16	25
(27)	Air Temperature	° C		-	30	24	14	19	27
(28)	Turbidity	UFT		32	55	13	12	56	62

Location : Ibirama

	Analysed Item	Unit	Standard of FATMA	Date 1986 Apr. 2	1987 Jan.21	1987 Apr.22	1987 Jul.20	1987 Oct.19	1988 Jan.19
(1)	Alcalinity	mg/l		19.7	14	15	18	13	13
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		ND	0.02	0.03	0.07	ND	0.02
(4)	Cadmium	mg/l	0.01	0.005	-	0.001	-	ND	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.01	0.02	-	0.01	ND
(7)	Fecal Coliform	NMP/100ml	1,000	120	2400	1100	290	1100	-
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	1100	-
(9)	Conductivity	UMHO/cm		-	34.4	52.8	57.9	38.7	42.9
(10)	Colour	mgPt/l		375	50	70	75	175	175
(11)	BOD (5days)	mg/l	5	-	0.6	0.8	1.4	2	0.8
(12)	COD	mg/l		12	7.9	10.9	10.8	20.4	13.7
(13)	Hardness	mg/l		10	12	17	22	14	12
(14)	Phenol	mg/l	0.001	5	0.004	0.004	-	0.002	0.003
(15)	Phosphate	mg/l		-	0.08	0.14	0.04	0.05	0.16
(16)	Phosphoric ion	mg/l		0.05	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	0.023	-	0.0001	0.5	ND
(18)	Nitrogen Nitrate	mg/l	10	0.6	2.7	2	2	3.5	2.7
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.009	0.015	0.031	0.008	0.035
(20)	Nitrogen Amonium	mg/l		0.1	-	-	-	0.1	0.1
(21)	Oil and Grease	mg/l	A.A	10	10	10	10	10	10
(22)	DO	mg/l	5	7.5	9.3	-	8.5	9.2	-
(23)	pH			7.8	7.4	7.9	6.9	6.8	-
(24)	Suspended Solid	mg/l		-	6.6	38.2	42.4	12.4	112
(25)	Total Solid	mg/l		15	-	-	-	-	-
(26)	Water Temperature			-	25	23	18	17.5	28
(27)	Air Temperature			-	30	25	13	19	32
(28)	Turbidity	UFT		100	45	60	32	117	140

Notes : 1. ND ; not detected 2. AA ; Almost absent

Table VII.2.2 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY DNAEE (5/5)

Location : Timbo

No.	Analysed Item	Unit	Standard of FATMA	Date 1986 Mar.19	1986 Apr. 1	1986 Jul.10	1986 Oct.27	1987 Jan.14	1987 Apr.21	1987 Jul.15	1987 Oct.19	1988 Jan.19
(1)	Alcalinity	mg/l		19.6	19.6	20	14	9	18	16	12	6
(2)	Aldrin	Ug/l	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
(3)	Detergent	mg/l		0.05	0.05	0.04	0.06	0.01	0.03	0.06	0.1	0.03
(4)	Cadmium	mg/l	0.01	0.005	0.005	ND	ND	0.001	-	-	ND	ND
(5)	Carbonate	mg/l		-	-	-	-	-	-	-	-	-
(6)	Lead	mg/l	0.1	0.02	0.02	0.01	ND	-	0.01	0.01	ND	ND
(7)	Fecal Coliform	NMP/100ml	1,000	2400	2400	2400	2400	2400	1100	1100	-	-
(8)	Total Coliform	NMP/100ml	5,000	-	-	-	-	-	-	-	-	-
(9)	Conductivity	UMHO/cm		-	-	47	18	26.4	48	41.8	33.7	33.1
(10)	Colour	mgPt/l		250	250	35	75	350	45	35	105	175
(11)	BOD (5days)	mg/l	5	-	-	-	1.4	1.6	0.8	0.8	1.8	0.8
(12)	COD	mg/l		9	9	6.3	9.2	29.2	10.6	6.3	17.2	18.2
(13)	Hardness	mg/l		13.8	13.8	15	11	9	14	24	15	8
(14)	Phenol	mg/l	0.001	5	5	0.003	-	0.005	0.001	0.001	0.002	0.003
(15)	Phosphate	mg/l		-	0.29	0.08	0.06	0.44	0.13	0.04	0.12	0.1
(16)	Phosphoric ion	mg/l		0.29	-	0.16	-	-	-	-	-	-
(17)	Mercury	mg/l	0.002	0.001	0.001	ND	ND	-	0.0001	-	0.2	0.0005
(18)	Nitrogen Nitrate	mg/l	10	0.5	0.5	0.5	1.3	1.4	1.3	1	1.3	1.7
(19)	Nitrogen Nitrite	mg/l	1	0.02	0.02	0.012	0.015	0.011	0.03	0.011	0.013	0.021
(20)	Nitrogen Amonium	mg/l		0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.3
(21)	Oil and Grease	mg/l	A.A	98	98	35.6	10	10	10	10	10	10
(22)	DO	mg/l	5	7.3	7.3	8.3	8	7.5	7.4	9.5	9.2	-
(23)	pH			7	7	6.3	7.4	6.3	6.6	5.9	6.6	-
(24)	Suspended Solid	mg/l		-	12	2.6	3.4	146	14.9	10	2	83.2
(25)	Total Solid	mg/l		12	-	-	-	-	-	-	-	-
(26)	Water Temperature	°C		-	27	18	25	24	22	18	18	27
(27)	Air Temperature	°C		-	-	18	25	27	24	22.5	19.5	33
(28)	Turbidity	UFT		13	13	6.1	15	154	13	8	56	62

Location : Brusque

	Analysed Item	Unit	Standard of FATMA	Date 1987 Nov.24	1988 Feb.23
(1)	Alcalinity	mg/l		18	17
(2)	Aldrin	Ug/l	0.001	ND	ND
(3)	Detergent	mg/l		0.09	0.07
(4)	Cadmium	mg/l	0.01	1	ND
(5)	Carbonate	mg/l		-	-
(6)	Lead	mg/l	0.1	ND	ND
(7)	Fecal Coliform	NMP/100ml	1,000	-	30
(8)	Total Coliform	NMP/100ml	5,000	-	-
(9)	Conductivity	UMHO/cm		53.9	56
(10)	Colour	mgPt/l		35	45
(11)	BOD (5days)	mg/l	5	1.6	-
(12)	COD	mg/l		3.2	17.3
(13)	Hardness	mg/l		15	16
(14)	Phenol	mg/l	0.001	0.003	0.003
(15)	Phosphate	mg/l		0.05	0.06
(16)	Phosphoric ion	mg/l		-	-
(17)	Mercury	mg/l	0.002	ND	0.0002
(18)	Nitrogen Nitrate	mg/l	10	0.6	0.6
(19)	Nitrogen Nitrite	mg/l	1	0.008	0.01
(20)	Nitrogen Amonium	mg/l		0.1	ND
(21)	Oil and Grease	mg/l	A.A	10	10
(22)	DO	mg/l	5	8.1	7.8
(23)	pH			7.8	5.4
(24)	Suspended Solid	mg/l		5.6	12.8
(25)	Total Solid	mg/l		-	-
(26)	Water Temperature			23	25
(27)	Air Temperature			23	28
(28)	Turbidity	UFT		8.7	14

Notes : 1. ND ; not detected 2. AA ; Almost absent

Table VII.2.3 RESULT OF WATER QUALITY ANALYSIS CARRIED OUT BY JICA TEAM

(Unit : ppm)

No.	Analysed Item	Location and Date of Sample										
		Indaial		Blumenau		Gaspar		Existing Bridge of BR-101				
		17/07/89	2/8/89	18/07/89	2/8/89	18/07/89	2/8/89	29/11/88	18/01/89	22/02/89	30/03/89	2/8/89
(1)	pH	6.5	-	9.3	6.4	7.2	6.7	6.5	6.5	7.4	7.4	6.6
(2)	Water Temperature (°C)	16	15	18	15	18	15	22	26	26	29	15
(3)	Turbidity (uT)	10	57	7	55	12	65	-	-	-	-	-
(4)	As	ND	ND	ND	ND	ND	ND	0.0022	-	0.105	-	ND
(5)	Cd	ND	0.009	ND	0.001	ND	ND	0.008*	0.0002*	0.093*	0.058*	0.01*
(6)	Pb	0.5	ND	0.025	0.07	0.27	ND	2.271	0.0006	0.2995*	1.586*	ND
(7)	CN-	0.14	ND	0.39	0.16	-	0.11	ND	0.02	0.02	ND	ND
(8)	Cl-	18.5	1.2	5.1	2	4.3	2.4	1024	214.93	66	186	3.9
(9)	Total Cr	ND	ND	ND	ND	ND	ND	0.094*	0.0057	0.091*	3.005*	ND
(10)	BOD	4	4	4	4	4	4	3	4.5	7	2.5	4
(11)	COD	4	4	4	4	4	4	107.87	30.9	ND	62	4
(12)	Hg	ND	ND	ND	ND	ND	ND	0.091*	0.0021*	0.0012*	-	ND
(13)	Total N	10	-	-	-	-	-	-	-	-	-	-
(14)	DO	-	10	9.3	10.1	9	9.2	10.3	10.5	8	10	9.1
(15)	Salinity (%)	-	-	-	-	-	-	2.5	2.7	0.5	0.2	-
(16)	Conductivity	-	-	-	-	-	-	3800	3600	230	230	-
(17)	Fecal coliform	-	-	-	-	-	-	2.4x108*	2.4x108*	4.3x103*	ND	-
(18)	Total coliform	-	-	-	-	-	-	2.4x108*	2.4x108*	4.3x103*	-	-

Note : 1) ND; not detected
2) Values marked "*" surpase the standard in CONAMA.

Table VII.2.4 RESULT OF RIVERBED DEPOSIT QUALITY ANALYSIS IN BLUMENAU

(1) Result of dissolution test

Item	L1	L2	L3
Cd	ND	ND	ND
Pb	0.46	ND	0.93
Cr	ND	ND	ND
Hg	ND	ND	ND
As	ND	ND	ND

(2) Result of content test

Item	D1	D2	D3
Cd	ND	ND	ND
Pb	O.O2	0.014	0.02
Cr	0.02	0.004	0.003
Hg	ND	ND	ND
As	ND	ND	ND

Note : L1, L2, L3, D1, D2 and D3 are sampling numbers.

Table VII.2.5 RESULT OF WATER QUALITY ANALYSIS AT PICARRAS

Analysed Item	Location and Date of Sampling							
	River mouth of Picarras river						Itajuba Coast	
	29/11/89	18/01/89	22/02/89	30/03/89	17/07/89	2/8/89	17/07/89	2/8/89
Conductivity (unho/cm)	46,000	48,000	21,000	39,000	-	-	-	-
Salinity	3.0	3.5	1.45	2.35	-	-	-	-
Water Temperature (°C)	22	29	25	29	19	16	18.5	18
pH	7.9	8.0	7.6	8.0	7.5	7.1	7.9	8.2
Cl-	3,149	334.9	147.9	65.47	21,569	10,105	21.994	20.975
CN-	0.0	0.02	0.02	0.02	0.16	0.09	-	-
DO	8.2	8.0	9.8	8.2	8.1	7.4	7.7	8.3
BOD	1.0	2.0	8.0	3.5	55.6	3.6	71.4	17.9
COD	38.95	536.3	ND	45.0	320.0	8.0	4	32
Fecal colif.	ND	7.5x104*	9.3x103*	2.3x103*	-	-	-	-
Total colif.	ND	1.5x105*	4.3x103*	2.3x104*	-	-	-	-
Cd	0.003	0.0062*	0.125*	0.052*	ND	0.01	0.0008	0.0009
Pb	1,718*	0.0045	0.4599*	0.829*	ND	0,000	ND	0.23
Total Cr	0.58*	0,0176	0.360*	0.921*	ND	ND	ND	ND
Hg	0.0033*	0.0055*	0.0057*	-	ND	ND	2	ND
As	0.0015	-	0.047	-	ND	ND	ND	ND

Notes: 1) Values marked "*" surpase the standard in COMANA
2) ND; not detected

Table VII.2.6 STANDARDS ON WATER QUALITY RELATING TO A BATHING RESORT IN JAPAN

Item		Number of Coliform Groupes	COD	Oil	Transparency
Suitable	more comfortable	1,000 MPN/100ml or less	3ppm or less	ND	30 cm or more
	comfortable	1,000 MPN/100ml	3ppm or less	Detected	30 cm or more
Unsuitable		50,000 MPN/100ml or more	—	Oil is always observed	—

Source : Environment Agency (April 21st, 1980)

Table VII.3.1 COMPARISON OF ALTERNATIVE FLOODWAY ROUTES IN TERMS OF PREDICTED ENVIRONMENTAL CHANGE (1/2)

Item	Contents	Env.Impact	
		Floodway Route	Degree
Recre-ation	The Picarras coast, which has been developed as bathing resort, will be seriously damaged by polluted water from the Itajai river.	I	+++
	There are no hotel and other accomodation in the Navegantes coast. Then degree of impact will not be serious compared with the Picarras.	II	++
	As for the town of Machados in Floodway-III, an appropriate measure should be considered.	III	++
Fishery	The acreage of the diffusion of turbid water due to construction of the floodway is presumed to be almost the same for both the Picarras and Navegantes coasts. While the fishery activity is being carried out at the river mouth of the Itajai in spite of diffusion of turbid water discharged from the Itajai river. Considering this fact, it seems that there are no objection to the fishery activity for both the Picarras and Navegantes coasts even if the floodway is constructed.	I	++
		II	++
		III	++
Land scape	In Floodway-I, the landscape most likely to be influenced is the Picarras coast. Approximately 140 m wide and 1300 m long jetty will be seen protruding a right angle to the coast. The present landscape consists of a small island near shore therefore this new linear and artificial land scale will give unfavourable effect on the natural scenery.	I	+++
	In the Navegantes coast, the present view of beach is not so excellent and there is no tourist hotel along the beach. Thus, the impact on the view will be small as compared with Picarras.	II	+
	The jetty site in Floodway-III is almost same as Floodway-II. Although the landscape of the town of Machados will be split by about 140 m wide floodway creating a new view of the river, the town does not depend on the tourist industry, therefore it will not have the same effect as for Picarras in Floodway-I.	III	++

Remarks: Degree of Impact
+++ High; ++ Medium; + Low

Table VII.3.1 COMPARISON OF ALTERNATIVE FLOODWAY ROUTES IN TERMS OF PREDICTED ENVIRONMENTAL CHANGE (2/2)

Item	Contents	Env.Impact	
		Floodway Route	Degree
Area Separation	Floodway-I passes by the boundary between Picarras and Penha, however the coastal area is already separated by the Picarras river. By taking appropriate measures, such as constructing a bridge, the impact should be minimized.	I	++
	Floodway-II and III pass by the city of Navegantes. Although its route will not conflict with the present housing, Navegabtes city will be surrounded by water on all sides, so the replacement of road and construction of new bridge are needed.	II	++
	In Floodway-III, the community of Machados with a church and cemetery in the way will be split into two. An appropriate measures should be considered.	III	+++
Inland Navigation	As the natural flood diversion method will be adopted in all 3 Alternatives, the navigation of boats along the Itajai river will not be affected.	I	+
		II	+
		III	+
Coastal Erosion	The sand supplied by the floodway will mostly consist of suspended sand and it will not be adequate to renourish the beach. It is predicted that erosion takes place in the left side of jetty at the Navegantes coast but its extent is relatively small.	I	+
		II	+
		III	+
Irrigation and Drainage Facility	The major crop produced in the area for all 3 Alternatives is sugarcane except for the small paddy cultivation area in the downstream of the existing bridge of BR-101. The outstanding impact due to intrusion of sea water through floodway will not occur concerning the existing drainage system of sugarcane fields.	I	++
		II	+
		III	+

Remarks: Degree of Impact
+++ High; ++ Medium; + Low

Figures

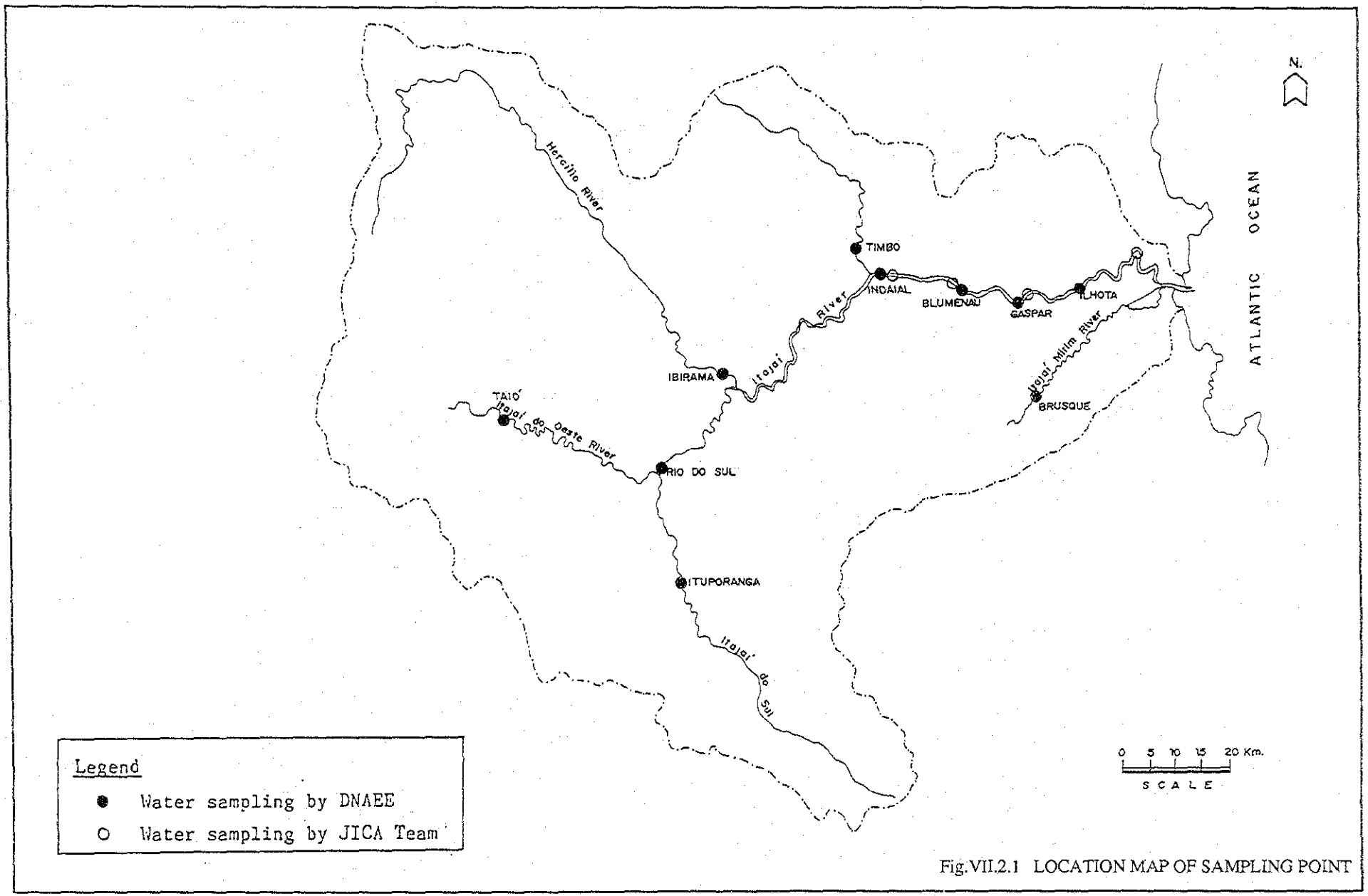
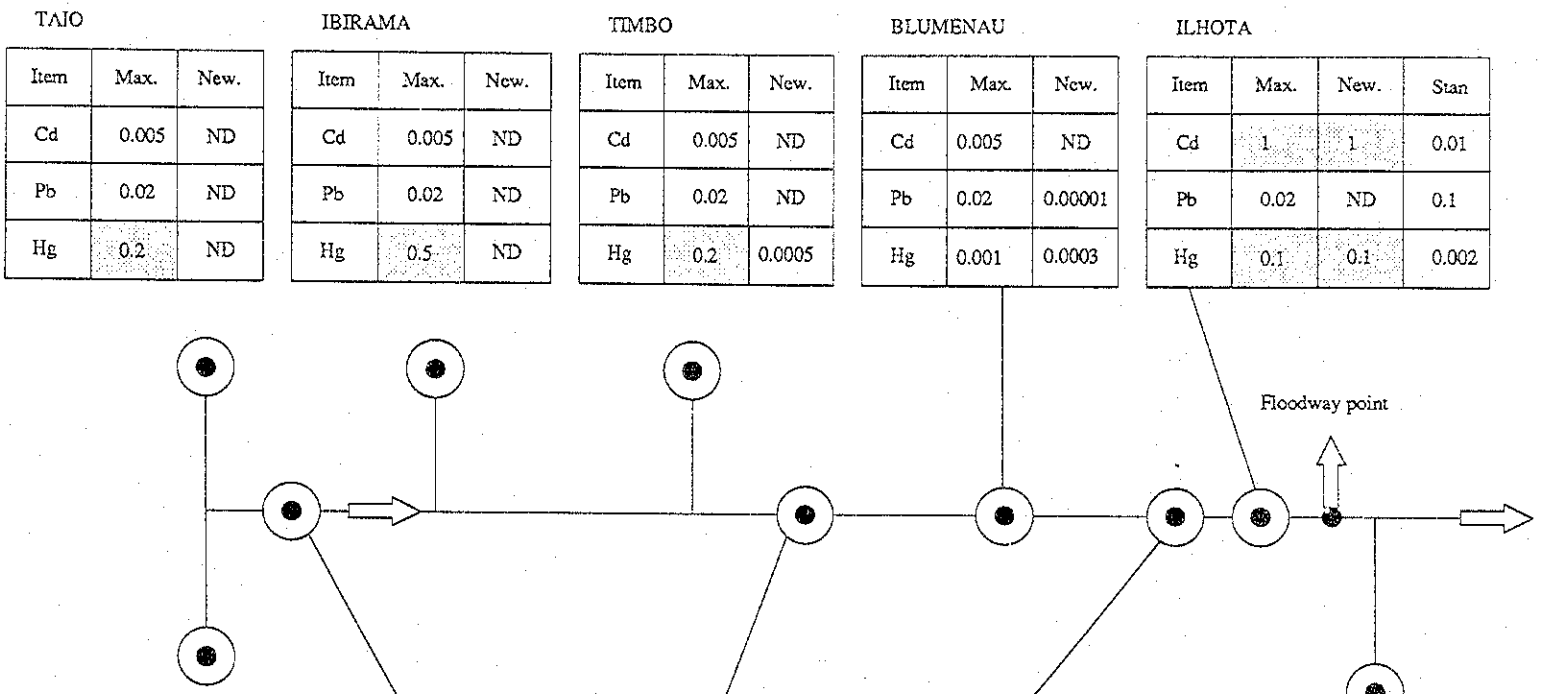


Fig.VII.2.1 LOCATION MAP OF SAMPLING POINT



TAIO		
Item	Max.	New.
Cd	0.005	ND
Pb	0.02	ND
Hg	0.2	ND

IBIRAMA		
Item	Max.	New.
Cd	0.005	ND
Pb	0.02	ND
Hg	0.5	ND

TIMBO		
Item	Max.	New.
Cd	0.005	ND
Pb	0.02	ND
Hg	0.2	0.0005

BLUMENAU		
Item	Max.	New.
Cd	0.005	ND
Pb	0.02	0.00001
Hg	0.001	0.0003

ILHOTA			
Item	Max.	New.	Stan
Cd	1	1	0.01
Pb	0.02	ND	0.1
Hg	0.1	0.1	0.002

ITUPORANGA		
Item	Max.	New.
Cd	0.005	—
Pb	0.02	ND
Hg	0.1	0.1

RIO DO SUL		
Item	Max.	New.
Cd	0.01	ND
Pb	10	10
Hg	0.3	0.0006

INDAIAL		
Item	Max.	New.
Cd	1	ND
Pb	0.02	ND
Hg	0.1	0.0007

GASPAR		
Item	Max.	New.
Cd	ND	ND
Pb	ND	ND
Hg	ND	ND

BRUSQUE		
Item	Max.	New.
Cd	1	ND
Pb	0.1	ND
Hg	0.0002	0.0002

Remarks

: shows that its value is higher than standard value.

— : shows that this item is not analysed.

Legend

⊙ : Sampling point

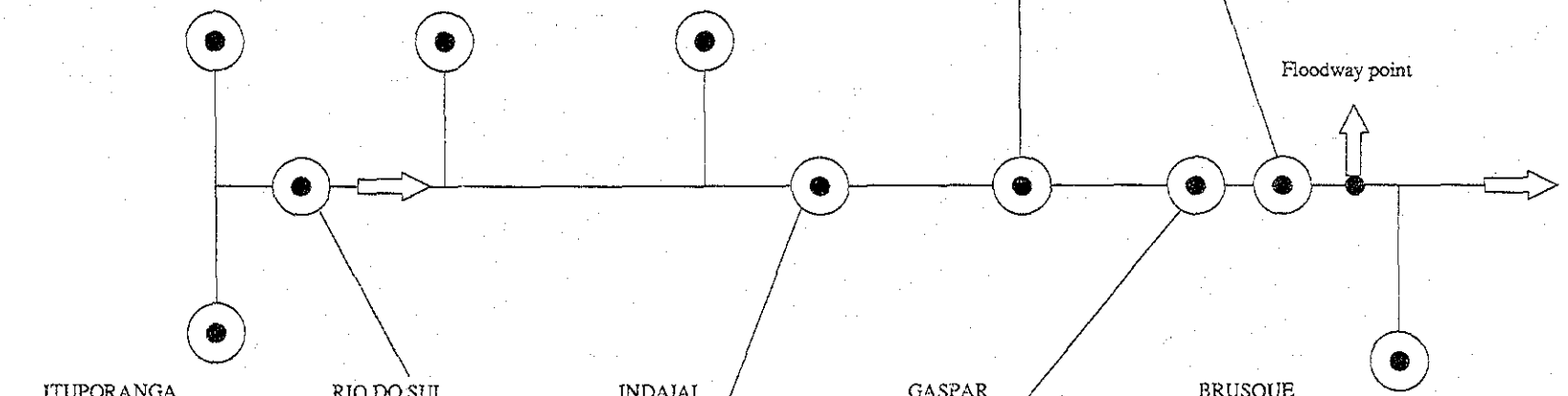
Max. : Maximum value ('86-88)

New. : Newest value

Stan : Standard value

Unit : ppm

Fig.VII.2.2 RESULT OF WATER QUALITY ANALYSIS ON Cd, Pb AND Hg CARRIED OUT BY DNAEE



TAIO

Item	Max.	New.
BOD	1.6	0.5
Fecal Caliform	2,400	29

IBIRAMA

Item	Max.	New.
BOD	1.4	0.8
Fecal Caliform	2,400	—

TIMBO

Item	Max.	New.
BOD	1.8	0.8
Fecal Caliform	2,400	—

BLUMENAU

Item	Max.	New.
BOD	2.4	—
Fecal Caliform	6,000	6,000

ILHOTA

Item	Max.	New.	Stan
BOD	7.2	7.2	5
Fecal Caliform	460	—	1,000

ITUPORANGA

Item	Max.	New.
BOD	2.2	2.2
Fecal Caliform	2,400	—

RIO DO SUL

Item	Max.	New.
BOD	2	2
Fecal Caliform	2,400	15

INDAIAL

Item	Max.	New.
BOD	1.6	0.3
Fecal Caliform	2,400	—

GASPAR

Item	Max.	New.
BOD	0.8	—
Fecal Caliform	8,000	8,000

BRUSQUE

Item	Max.	New.
BOD	1.6	—
Fecal Caliform	30	30

Remarks

: shows that its value is higher than standard value.

— : shows that this item is not analysed.

Legend

⊙ : Sampling point
Max. : Maximum value ('86-88)
New. : Newest value
Stan : Standard value

Unit

BOD : ppm
Fecal Coliform : MPN/100ml

Fig.VII.2.3 RESULT OF WATER QUALITY ANALYSIS ON BOD FECAL CALIFORM CARRIED OUT BY DNAEE

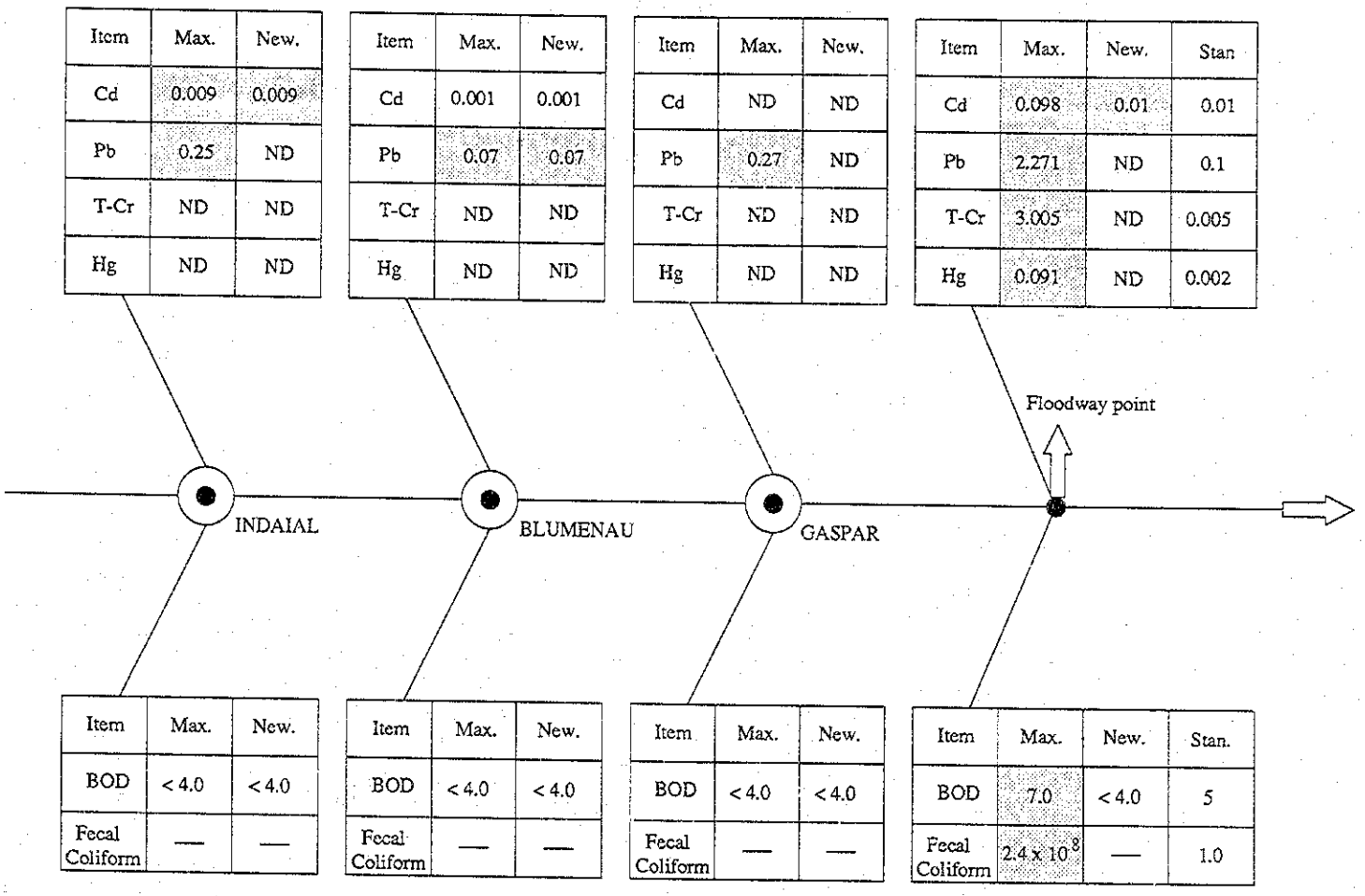


Fig.VII.2.4 RESULT OF WATER QUALITY ANALYSIS ALONG THE ITAJAI RIVER CARRIED OUT BY JICA TEAM

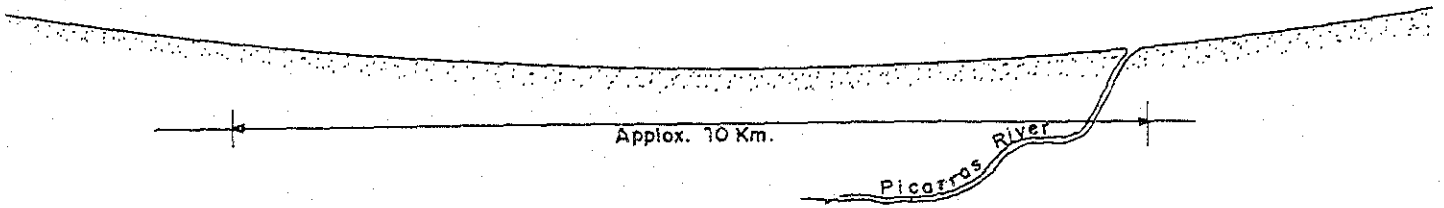
(ITEM RELATING TO HUMAN HEALTH)

Item	Max.	New.
Cd	0.001	0.001
Pb	0.07	0.07
T-Cr	ND	ND
Hg	ND	ND

⊙ Note : Stan is class 5 in brakish water.

Item	Max.	New.	Stan
Cd	0.098	0.01	0.01
Pb	2.271	ND	0.1
T-Cr	3.005	ND	0.005
Hg	0.091	ND	0.002

⊙ Note : Stan is class 7 saline water.



(ITEM RELATING TO ENVIRONMENT)

Item	Max.	New.	Stan.
BOD	7.0	< 4.0	5
Fecal Coliform	2.4×10^8	—	1.0

Item	Max.	New.	Stan.
BOD	55.6	3.6	< 4.0
Fecal Coliform	7.5×10^3	—	1×10^3

Remarks

: shows that its value is higher than standard value.

— : shows that this item is not analysed.

Legend

⊙ : Sampling point
Max. : Maximum value ('86-88)
New. : Newest value
Stan : Standard value

Unit

Cd, Pb, T-Cr, Hg, BOD : ppm
Fecal Coliform : MPN/100ml

Fig.VII.2.5 RESULT OF WATER QUALITY ANALYSIS ALONG THE PICARRAS COAST CARRIED OUT BY JICA TEAM

Photos

Photo.VII.3.1 PICARRAS SEASHORE (1976)

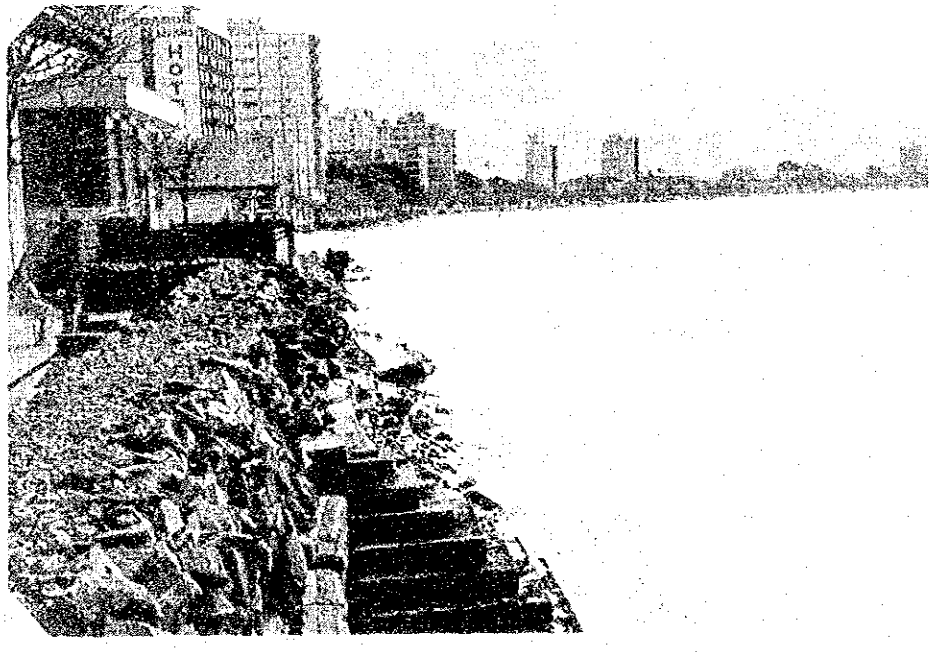


Photo.VII.3.2 PICARRAS SEASHORE (1989)

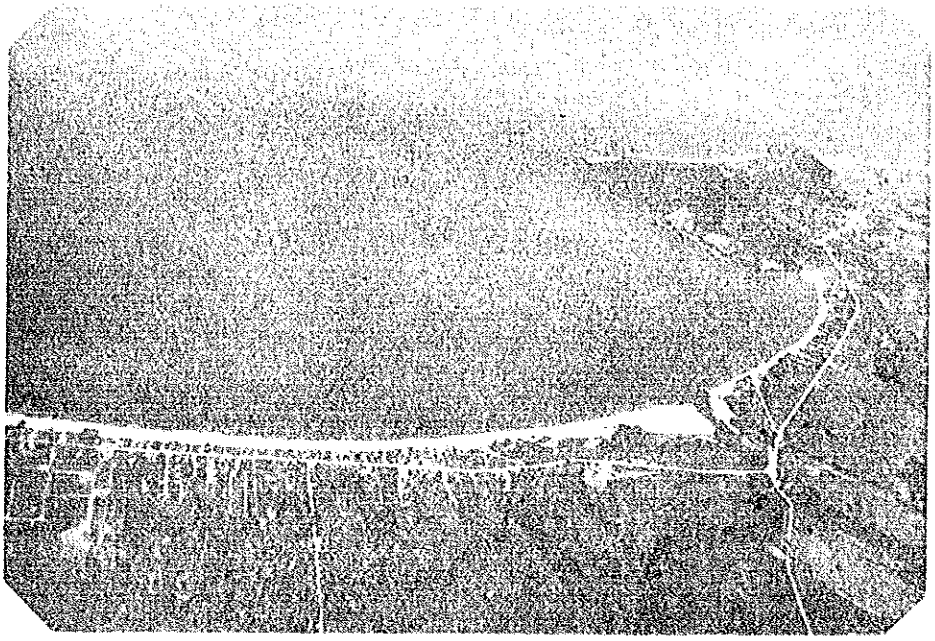


Photo.VII.3.3 PICARRAS SEASHORE (1954)

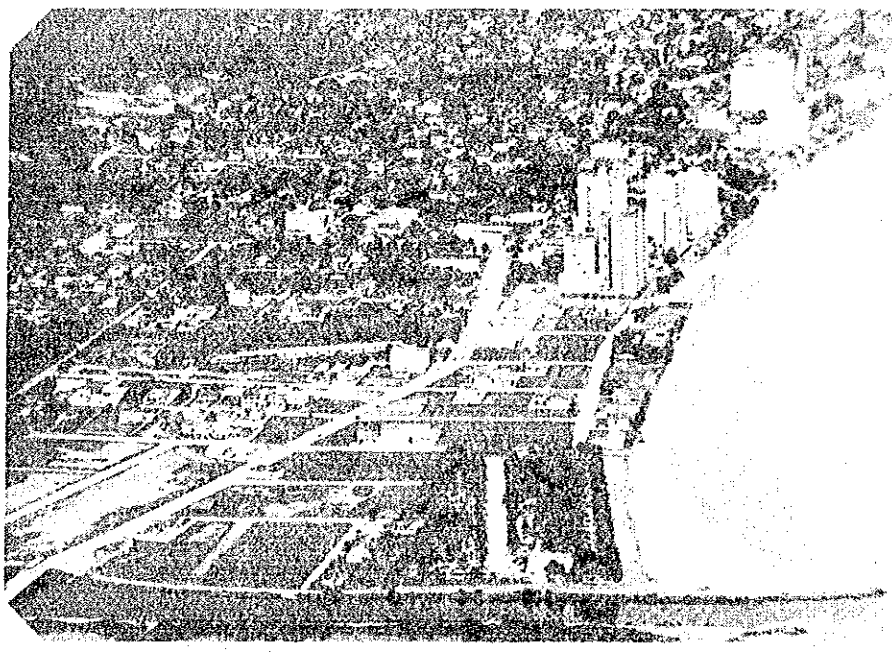


Photo.VII.3.4 PICARRAS SEASHORE (1989)

ANNEX VIII.

CONSTRUCTION PLAN AND COST ESTIMATE

ANNEX VIII. CONSTRUCTION PLAN AND COST ESTIMATE

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ANNEX VIII. CONSTRUCTION PLAN AND COST ESTIMATE

1. INTRODUCTION

This ANNEX VIII deals with a construction plan and cost estimate for the provisional plan to protect the lower Itajai river basin. The project works comprise the construction of the floodway, and river improvement works for the Itajai river stretch, Itajai Mirim stretch and its existing short-cut channel as well as urban drainage works for Itajai and Navegantes cities. Since majority of the project works are occupied by earthmoving work, the construction plan was worked out with emphasis on the effective utilization of the excavated material and minimization of a hauling distance.

2. CONSTRUCTION PLAN

2.1 Conditions for Construction

2.1.1 Site conditions

Site conditions affecting the execution of the construction works in the project area are as follows:

(1) Topography

The project area is located in the lowermost part of the Itajai river basin and involves the municipalities of Itajai and Navegantes. It is situated in the alluvial plain with ground elevation of 1 to 4 m.

(2) Meteo-hydrology

The project area belongs to subtropical zone, and climatically there is no distinct dry and wet seasons throughout a year.

The annual mean rainfall in the area is recorded at around 1,700 mm at Itajai gauge. The annual mean temperature is 20.1°C. Table VIII.2.1 shows meteo-hydrological features in the project area.

(3) Geology

The geology in the project area is characterized by the alluvial plain formed by the soft deposit layer with a depth of about 30 to 35 m and N value is in a range of 0 to 5. The foundation rock consisting of metamorphic sandstone and migmatite lies below its alluvial deposit.

(4) Access to the site

There are two existing main highways in the project area. One is national highway of BR-101, which is a trunk route for inland transportation between the north and south regions of Brazil, crossing the Itajai river at about 18 km upstream from the river mouth. The other is national highway of BR-470, located along the Itajai river and connecting major cities branching from the national road of BR-101 and BR-116. The effective width is 8.3 m and 7.2 m for BR-101 and BR-470, respectively with paving. The maintenance condition of these roads seems to be fair. The major road network is

constructed and maintained by DNER (Departamento Nacional de Estradas de Rodagem).

No railway line exists in the project area. There are three railway lines crossing the state, which consist of two north-south lines and one east-west line. The railway network is managed by DNEF (Departamento Nacional de Estradas de Ferro).

Navegantes airport situated in the project area has daily flights to the main cities of the country, having a runway with 1,745 m long and 45 m wide. The port is managed by EMBRAER (Empresa Brasileira de Aeronautica S.A.). Among the 22 airports which operate in the state, Florianopolis, Joinville and Navegantes are the major ones.

The Itajai maritime port is located in the right bank of the Itajai river mouth. The port handles sea cargos at one main dock of about 800 m long and 8.0 m draught depth for mooring of 20,000 DWT class ships. The port is equipped with lifting facilities of 20 ton class jib cranes and 37 ton class fork lifts. The sediment deposit in the port is regularly dredged by PORTOBRAS to sustain its function.

A car ferry port is located close to the Itajai river mouth, connecting Itajai and Navegantes cities. The loading capacity of ferry boat is about 20 to 30 tons. The ferries are being operated at about 30 minutes intervals and can run across the river in about 10 minutes navigation time at present.

(6) Power supply

In the project area, CELESC (Centrais Eletricas de Santa Catarina S.A.) supplies electric power by the following distribution network at present.

Transmission Line	Voltage (kV)	Length (km)	Transmission Capacity (kVA)	
			5% Drop	Maximum
ILHOTA - ITAJAI	69	10.7	60	63
ILHOTA - PICARRAS	138	32.0	93	160
ITAJAI - CAMBORIU	69	16.2	27	40
ITAJAI-II - ENTR.ILHOTA - TIJUCAS	138	7.0	160	160
ITAJAI - PICARRAS	69	16.9	16	27
FPOLIS - ITAJAI-II	138	80.1	41	160
BIGUACU - ITAJAI-II	138	69.9	44	160

(7) Communication

TELESC operates the modern telephone services in the state, connecting all districts including the project area. Majority of them also have telex and international dialling services. The whole state is served by the post office. There are 18 medium-wave radio stations and 10 frequency modulation (FM) radio stations in the basin, and also 2 TV broadcasting stations and 8 TV transmission stations in the basin.

(8) Construction materials

Major construction materials required for the construction works will be cement, steel bar, formed steel, rock and aggregates, wooden material, concrete piles, explosives, fuel and lubricants. A sufficient quantity and quality of these materials are obtainable from the domestic market in Brazil. In the project area, one portland cement factory and four ready mixed concrete factories are operating as listed in Table VIII.2.2. Oil company depots are also situated in the project area. A local supplier producing 4 kinds of aggregates at Camboriu, which is about 20 km apart from the project area, has an aggregate plant with 400 t/hr in production capacity. At the site, approximately 50 million tons of rock are exploitable in total according to the supplier. It is recommended that fine aggregate is obtained from the upstream area of the Itajai river from the point of view of quality.

Rock material for the jetty construction and other structures will be obtained from a quarry site in Queimadas situated between the BR-470 and the BR-101. The rock material is sufficient in quantity and quality according to the results of the geotechnical evaluation. Hauling distance is about 4 km from this quarry to the proposed site of the jetty of the selected Floodway-II. Of the construction materials mentioned above, steel materials and explosive will be procured outside the state. The following shows the expected supply sources of the construction materials.

Materials	Sources
- Cement	- Cement factory in Itajai
- Steel material	Iron manufacturers;
	- "COSIPA" Companhia Siderurgica Paulista - Cubatao, Sao Paulo
	- "CSN" Companhia Siderurgica Nacional - Volta Redonda, Rio de Janeiro
	- "USIMINAS" Usina Siderurgica de Minas Gerais - Ipatinga, Minas Gerais
	- "Mendes Junior" - Minas Gerais or other equivalent
- Rock material	- Queimadas quarry, Navegantes
- Coarse aggregate	- Camboriu
- Fine aggregate (sand)	- Itajai river
- Wooden material	- Santa Catarina state
- Concrete pile	- Santa Catarina state
- Explosives /1	- Sao Paulo
- Fuel/lubricants	- Itajai or Santa Catarina state

Note /1 : License application will be required from the following agencies concerned.

1) Ministerio do Exercito
2) Ministerio das Minas e Energia
3) Departamento Nacional de Producao Mineral

(9) Construction plant and equipment

Major equipment required for the construction works will be mainly of dredger, crane, earth moving and concreting equipment with standard or average capacity. Most of these equipment is available in the domestic market in Brazil. Some of the equipment manufacturers have branch stores or dealers in the state.

(10) Labour source

Sufficient number of common labourers will be recruited in the project area, Itajai, Navegantes and Picarras without seasonal variation. Skilled and semi-skilled laborers would be employed from Florianopolis, Itajai and Blumenau.

2.1.2 Mode of construction

In order to implement the project work within the limited construction period, it is herein proposed to execute the project works by an international contract system. In consideration of the scale of the works and contract amount in case of the international contract basis, the construction works will be divided into the following two (2) packages.

Package-A : River improvement works of the Itajai river, Itajai Mirim river and Itajai Mirim short-cut channel and urban drainage works
Package-B : Construction of floodway with jetty

The bill of quantities contract system will be applied upon international open competitive bid accompanied with the prequalification of bidders. The fund required for implementation of the project will be allocated by the national budget and supporting loan from an international financing agency. Throughout the implementation period, the project will be managed and administrated by DNOS, headquarter and 14-a branch office, in association with an international engineering consulting firm.

2.1.3 Work items and quantities

The construction work items and their quantities are tabulated in Table VIII.3.1. The major work items are summarized as follows;

	Work Items	Unit	Quantity
1.	Itajai river (23 km)		
(1)	Dredging of riverbed	cu.m	8,156,000
(2)	Levee embankment	cu.m	743,900
(3)	Parapet wall concrete	cu.m	19,700
2.	Floodway (9 km)		
(1)	Excavation,common	cu.m	4,343,200
(2)	Excavation,rock	cu.m	150,000
(3)	Dredging	cu.m	3,006,800
(4)	Levee embankment	cu.m	140,000
(5)	Riverbed protection	sq.m	5,400
(6)	Wet masonry	sq.m	11,200
(7)	Slope protection, riprap	sq.m	5,200
(8)	Relocation road	lin.m	2,100
(9)	Bridge construction	nos.	3
(10)	Jetty, dredging in seabed	cu.m	544,000
(11)	Jetty , embank. core stone	cu.m	510,000
(12)	Jetty, filter and armor stone	cu.m	795,000
(13)	Deformed concrete block, 16 tons	nos.	3,675

	Work Items	Unit	Quantity
3.	Itajai Mirim river (8 km)		
(1)	River dredging	cu.m	151,400
(2)	Channel excavation	cu.m	180,400
(3)	Levee embankment	cu.m	725,400
(4)	Bridge heightening	set	4
4.	Itajai Mirim short-cut Channel (4 km)		
(1)	River dredging	cu.m	227,100
(2)	Channel excavation	cu.m	53,200
(3)	Levee embankment	cu.m	137,900
(4)	Parapet wall concrete	cu.m	610
5.	Urban drainage works		
(1)	Excavation (channels, ponds and others)	cu.m	360,000
(2)	Embankment (Filling of low lands, channels and ponds)	cu.m	270,000
(3)	Pumping station, ($Q = 0.3\ m^3/s$)	place	2
(4)	Pumping station, ($Q = 0.5\ m^3/s$)	place	2
(5)	Drainage sluice	place	5
(6)	Flap gate	set	14

2.1.4 Preparatory works

Since the project area is located in urban area, there are many public utilities which are to be utilized for the project implementation. Those are existing roads, transportation, power supply system, seaport and airports, communication system and so on. Consequently, preparatory works required for the project implementation will be the construction of access and construction roads, temporary buildings, communication system and arrangement of spoil bank. A plan of those works is as follows;

(1) Access and construction roads

Existing road network (national, state and rural roads) is available mostly for the access and construction roads. It will be required to construct the access and construction roads at several places along the Itajai river for approaching and arranging the site for dredging work. A total length of the new roads is estimated at about 6 km for the left bank for 6 places and one km for the right bank for 2 places. The national road of BR-470 will be utilized mainly as the construction road of the floodway.

(2) Temporary building

Temporary buildings are planned to be constructed in the project site for the smooth execution of the construction works. Those are site offices, quarters, material

warehouses, repair shop, laboratory and others. Required area for those buildings is estimated at about 3,000 m^2 and 5,000 m^2 for packages-A and B, respectively.

(3) Communication system

Communication facilities will be required for smooth operation of the construction site. TELESC's public telephone line would be extended to the respective site office for the contractors. Handy talky is useful within the construction site.

(4) Arrangement of spoil banks

The spoil banks to accommodate a huge amount of dredged/excavated materials of the river channels and floodway are selected in the pasture, sugarcane and/or bush lands and locally low land areas along the channels and floodway.

2.2 Major Construction Works

2.2.1 Basic consideration for construction planning

In making the study on the construction plan and schedule, the following basic conditions and assumptions were applied in consideration of the topography, meteo-hydrology, geology and site conditions as described in the preceding paragraphs.

(1) Based on the daily rainfall records at Itajai gauge as well as the annual number of Sunday and national holidays in the country, annual workable days for construction works were set at 250 days in which rainfall intensity is less than 10 mm per day. The daily working hour is set at 8 hours excluding the dredging work of rivers and coast for which 2 shifts operation with 15 hours will be applied.

(2) The construction works should be conducted without obstruction of operation function for the existing public or private utilities such as harbour, navigation of ships and ferry transportation.

(3) Conventional method and type of equipment are principally applied, considering the characteristics of the construction works.

(4) Hourly production rate of major equipment is estimated as tabulated in Table VIII.2.3 to meet the site conditions using the following swelling and shrinkage factors of the materials.

Material	Loose/Bank	Embank/bank
Common	1.25	0.88
Coarse sand & gravel	1.15	1.02
Rock	1.60	1.15

2.2.2 River improvement works of Itajai main stream

Major construction works for river improvement works in the Itajai main stretch comprise river dredging, levee construction and construction of parapet wall in the river stretch close to the urban area. The construction plan of these works is as follows;

(1) River dredging

The river dredging of about 8.2 million m^3 is planned for the 23 km long project stretch of the lower Itajai river. The river conditions in the project stretch are 180 to 350 m of river width, 6.71 m in water depth and 0.37 m/sec in average water velocity. About 8 km long dredging stretch in the downstream part of the objective stretch is located in the urban area of Itajai and Navegantes cities. It will be difficult to provide the spoil banks of dredged material in this area. In the upstream 15 km long stretch, the zone of both banks is pasture, sugarcane, bush lands and locally low land area. It is planned that the huge amount of dredged material will be utilized effectively for the land reclamation in the urban or semi-urbanized area and/or the above mentioned locally low land area under the following criteria;

- Filling of locally low elevation area to cope with the urban drainage plan as far as possible,
- Spoiling to the locally low land area of pasture, sugarcane and or bush lands, and
- Minimization of the hauling distance.

Fig. VIII.2.1 shows the proposed spoil banks of the dredged material from the Itajai river. Those banks are located in the right bank of the Itajai river with a hauling distance of less than one km from the stretch to be dredged. Earthmoving plan for the river improvement works is summarized in Table VIII.2.4 and Fig. VIII.2.2. The dredging of the channel is planned to be conducted by floating type pump suction dredger based on the soil characteristics of the river bed material which consists mostly of sandy silt or silty clay. The required capacity and number of dredger are planned as follows;

Working conditions;

(1) Dredging volume : 8,156,000 m^3 (bank measure)
(2) Operation hour : 18,000 hrs (5 years x 300 days x 12 hrs/day)
(3) Soil condition : Sandy silt or silty clay with N value of 0 to 5
(4) Discharge distance : 500 to 1,000 m

Daily production rate required;

8, 156,000 m^3/1, 500 days = 5, 437 ≒ 5, 440 m^3/days

Capacity of dredger;

$Q=q \cdot E \cdot j \cdot T$

where, Q = Daily dredging volume in m^3/day
q = Hourly production capacity of dredger per 1,000 PS with diesel driven : 200 m^3/h
E = Working efficiency : 0.8
j = Coefficient of net working hour : 0.8
T = Daily operation hour of dredger : 15 h/day

The required capacity of dredger is estimated at 1,920 m^3/day. Based on this figure, three units of 1,100 PS class pump suction type dredger are planned to be applied to this work.

(2) Levee embankment

The levee embankment of about 0.75 million m^3 will be carried out in parallel with the dredging work using light class bulldozer, loader, dump truck and compactor. The embankment materials will be obtained from the dredged materials and/or borrow pits along the Itajai river. In utilization of the dredged materials, drying-up of the soils will be required using raking equipment.

(3) Construction of parapet wall

The required concrete volume of concrete parapet wall to be constructed along the river is estimated at about 20,000 m^3 in total for 2,520 m and 8,830 m in total length of the left and right banks, respectively. Concrete pump car of 60 m^3/h class will be used for pouring the concrete. Ready mixed concrete will be utilized for the required concrete.

Major equipment required for the construction works and its use schedule are shown in Tables VIII.2.5 and VIII.2.6.

2.2.3 Construction works of floodway

Major construction works of the floodway are excavation, levee embankment, river bed protection at inlet portion, relocation of the existing road, bridge construction and construction of jetty at the outlet portion. The construction plan of these works is as follows;

(1) Excavation work

It is planned to construct about 9 km long floodway with bottom width of 50 m and one km long jetty. The required excavation volume is estimated at about 7.5 million m^3. This huge amount of the excavated material is planned to be utilized mainly for land reclamation in locally low land areas located in the left bank of the Itajai river as shown in Fig. VIII.2.1. The hauling distance is about 2 km on an average as shown in Table VIII.2.4 and Fig. VIII.2.2.

It is planned that about 6 km long upstream stretch of the floodway is excavated using single engine motor scraper. Regarding its about 4 km long downstream stretch, dredging work method using floating type pump suction dredger is planned to be employed based on the site and geological conditions and technical and economical point of view. The construction volume of the respective methods is as follows;

- Excavation by dry method using motor scraper : 4.5 million m^3
- Excavation by wet method using dredger : 3.0 million m^3

The required capacity and number of equipment are as follows;

(i) For excavation by dry method

Hourly production ; 520 m^3/hr (4,500,000 m^3/5 years x 250 days x 7 hr/day)

Number of equipment ;

Type ; Motor scraper with 23 m^3 class

Number ; 9 units (520 m^3/hr/60 m^3/hr/unit)

(ii) For excavation by wet method

Hourly production	;	200 m^3/hr (3,000,000 m^3/4.3 years x 300 days x 12 hrs/day)
Hauling distance	;	1 km (temporary stock piling)
Number of equipment	;	
Type	;	Pump suction dredger with 1,100 PS
Number	;	One unit

Table VIII.2.4 shows the summary of earthmoving plan for floodway construction.

(2) Levee embankment

The construction work of the levee embankment of about 140,000 m^3 will be executed using earth material obtained from excavation of the floodway in parallel with the excavation work. It is planned that the earth material is directly hauled to the embankment site and that compaction is performed by tire type roller after spreading.

(3) River bed protection work

About 20 m long ground sill supported by concrete pile with 300 mm in diameter and 15 m in length and protected by concrete block at its up and downstream portions is planned to be constructed at the inlet portion of the floodway. The piling work will be executed using diesel driven hammer. A 30 ton class crawler type crane will be used for installation work of the concrete block and other lifting works.

(4) Relocation of the existing road and bridge construction

About 2,100 m long existing BR-470 road is planned to be relocated in the early stage of construction works of the floodway. The embankment materials of about 88,000 m^3 will be obtained from the channel excavation. The materials for subbase and base courses of the road are planned to be procured by the local supplier. Tire type compaction equipment will be used for the embankment work.

Three new bridges are planned to be constructed crossing the floodway channel. Among those bridge, two bridges, No.1 and No.2 bridges, are designed to have a width of 9.8 m. The No.2 bridge is skew one with 3 spans by 40 m for the purpose of relocating BR-470 road. The No.1 bridge consists of 5 spans by 35 m at Navegantes coast. The remaining new bridge is the same span as that at Navegantes

coast and its effective width is 4 m. The bridge construction will be conducted in the early stage of the construction works of the floodway. Detour route will be provided during the bridge construction works. Foundation RC pile of 400 mm in diameter will be driven by diesel pile hammer. Ready mixed concrete will be used for the substructure and superstructure concrete. Two units of 50 tons class crawler crane will be required for the installation stage of bridge beams. Hydraulic jacks will be planned for the PC cable tensioning.

(5) Construction of jetty

A jetty structure is planned to be constructed at the outlet of the floodway. Feature of the jetty structure is as follows;

- Type of structure : Rock rubble mound
- Length, right : 1,158 m
  left : 898 m
- Levee height : +6.2 m at the toe
- Crest width : 10 m
- Side slope : 1:2

The jetty construction comprises the embankment of core, filter and armor stones, slope protection by deformed concrete blocks and dredging of the seabed as listed below.

- Embankment, core stone (1-80 kg/piece) : 510,000 m^3
- Filter and armor stone (0.3-16 tons/piece) : 795,000 m^3
- Deformed concrete block, 16 tons/piece : 3,675 nos.
- Dredging (under and inside jetty) : 544,000 m^3

The stone embankment materials for the jetty are planned to be obtained from Queimadas quarry site located between the national roads of BR-101 and BR-470 with a hauling distance of about 4 km as shown in Fig. VIII.1.1. Rock mass of this quarry consists of gneiss and migmatite which have a sufficient hardness for the outlet facility of the floodway.

The 5 m^3 class wheel type loader and 30 tons class dump trucks will be used for loading and transportation of the materials. The rocks are spread and compacted directly by 30 tons class bulldozer towards sea side after the dredging of the embankment place is finished. No special facilities such as temporary or floating piers are provided for the construction of the jetty. Installation of 16 tons deformed concrete

blocks will be carried out using 50 tons class crawler crane from the crest of jetty. These blocks will be manufactured at the site of Navegantes coast using ready mixed concrete.

The dredging of seabed in the jetty will be conducted by two steps. First step is the dredging under portion of the jetty which will be carried out alternately with the embankment work. The dredging in the first step will be conducted using dragline or clamshell from the toe of partially completed jetty considering the tidal conditions.

Second step is the dredging of inside the jetty that will be carried out using floating type of pump suction dredger having about 1,100 PS class capacity. The construction work will be conducted after the completion of the jetty embankment. The dredged materials are planned to be transported to the locally low land area selected by urban drainage plan, located in the left bank of the Itajai river. Hauling distance is estimated at about 3 to 4 km.

Major equipment required for the construction works and its use schedule are shown in Tables VIII.2.5 and VIII.2.6, respectively.

2.2.4 River improvement works of Itajai Mirim river

The river improvement works in the Itajai Mirim river comprise river dredging, excavation of channel, levee embankment and heightening of the existing bridges. The construction plan of these works is as follows;

(1) River dredging

The dredging work of the riverbed of about 150,000 m^3 will be carried out by floating and portable type pump dredger having about 30 m^3/h class and 150 PS capacity on the condition that the work period amounts to 2-year or 7,200 hours. This dredger will also be used for the dredging work of Itajai Mirim short-cut channel. The dredged material will be used for filling up the locally low land area along the Itajai Mirim river after drying up.

(2) Excavation of channel

The excavation of about 180,000 m^3 in the meandering river channel portion will be carried out by combination of bulldozer, crawler loader, dragline and dump truck.

Swamp type equipment will be used taking into account the trafficability of the site. The excavated materials will be utilized as the embankment materials of the levee.

(3) Levee embankment

The embankment volume of the levee is estimated at about 730,000 m^3. The embankment material will be obtained from excavated material of the river channels and borrow pits along the river. The excavated material is directly hauled to the embankment site. The compaction work will be carried out by tire type roller considering the soil properties.

(4) Heightening of existing bridges

In order to cope with the design high water level in the river, four existing road bridges crossing the river will be obliged to be heightened as follows;

Name of bridge	Dimension of existing bridge (m)			Heightening (m)
	Length	Width	Span	
Nova Brasilia	45.9	7.85	3	1.6
Sao Vicente	52.0	11.1	3	1.2
Adolfo Konder	131.0	13.4	4	1.7
Jose Gall	45.0	9.0	3	2.4

The works will be conducted one by one to minimize the traffic jam. The heightening works will be carried out in such a way that superstructure will be removed before pier and abutment foundation are heightened using hydraulic jacks and supporting materials. After completion of these works, the superstructure will be reconstructed. A half year is allocated for heightening of one bridge. A temporary bridge will be provided for heightening work of the Adolfo Konder bridge during the work execution.

2.2.5 Improvement work of Itajai Mirim short-cut channel

The improvement works required for this channel are dredging of riverbed, widening of channel, levee embankment, and construction of parapet. The improvement works of this channel will be carried out in the later stage of construction period after completion of the Itajai Mirim river improvement works.

(1) Channel dredging

About 230, 000 m^3 of channel dredging will be carried out using pump dredger of 150 PS class in capacity which is planned to be shifted from the Itajai Mirim improvement works. The dredged materials will be used for levee embankment after drying up at temporary stock yards.

(2) Widening of channel

The widening work of the channel of about 60,000 m^3 will be carried out using the equipment shifted from the river improvement sites of the Itajai Mirim. The excavated material will also be utilized for the embankment of the levee.

(3) Levee embankment

The levee embankment of about 140,000 m^3 will be carried out using the same equipment as that used for levee construction works in the Itajai Mirim river.

(4) Construction of parapet wall

A 320 m long concrete parapet wall of 0.5 to 1.0 m in height is planned to be constructed along the channel. Required concrete volume is about 610 m^3. Ready mixed concrete will be used for the wall concrete.

2.2.6 Urban drainage works

The drainage works in the Itajai city consist of construction of regulating pond with sluice way, short-cut channel in the Murta river and pumping station. The construction plan of these works is as follows;

(1) Regulating ponds

The regulating ponds are planned to be constructed at four places in the Itajai city as tabulated below.

Drainage Area	Capacity of Ponds (m^3)	Major Works	
		Excavation (m^3)	Embankment (m^3)
IR-4	13,000	9,100	2,500
IR-6	200,000	46,000	12,000
IM-7	130,000	130,000	-
IM-9	70,000	33,000	12,000
Total	413,000	218,100	26,500

Swamp type and light class equipment will be used for the earthmoving works. Excavated materials at the ponds will be used as the embankment material after drying up.

The construction of sluice way comprises excavation, piling, revetment by concrete blocks, riverbed protection and flap gate installation. These works will be conducted by combination of man-power and equipment.

(2) New drainage channel of Murta river

A 1,060 m long drainage channel construction comprises the channel excavation, filling of low land area and concrete works. Swamp type backhoe will be used for the excavation. Excavated material will be used for filling the low land area.

(3) Pumping station

The following drainage pumping stations are planned to be installed in the Itajai city;

Drainage Area	Discharge (m^3/s)	Pump Type	Unit	Diameter	Head
IR-4	0.5	Submersible	2 (0.25 m^3/s)	400 m/m	2.3 m
IR-6	0.5	"	2 (0.25 m^3/s)	400 m/m	3.4 m
IM-7	0.5	"	2 (0.25 m^3/s)	400 m/m	2.6 m
IM-9	0.3	"	2 (0.15 m^3/s)	300 m/m	2.6 m

The civil works comprise excavation, piling, revetment and riverbed protection. The works will be conducted in dry condition of the site. Required equipment for those works will be swamp type bulldozer and backhoe, diesel pile hammer and concrete

pump car. Ready mixed concrete will be used. The pump installation will be done using truck crane.

2.3 Construction Time Schedule

Fig. VIII.2.3 shows a proposed implementation schedule of the project. The construction works of the project are scheduled to be conducted during ten years including 5 years required for the prerequisite works such as the feasibility study, detailed design, financing, and tendering. Fig. VIII.2.4 shows the proposed construction time schedule. The construction works by contract system of Packages-A and B are scheduled to commence simultaneously. The improvement works of the existing short-cut channel will be executed,following the river improvement works of the Itajai Mirim river. The urban drainage works will be executed in parallel with the improvement works of the existing short-cut channel.

3. FINANCIAL COST ESTIMATE

3.1 Conditions for Cost Estimate

The construction cost of the project works is estimated under the following conditions;

(1) Price level : September, 1989

(2) Exchange rate : 1US$ = NCz$3.78 = ¥140

(3) The construction cost consists of 3 main items, namely direct cost, indirect cost and contingency. The direct cost is estimated based on the required work items and quantities derived from the feasibility design. The indirect cost includes the cost of land acquisition and house evacuation, government administration cost and engineering service cost for detailed design and supervision. The physical contingency is counted into direct and indirect costs accordingly. The price contingency is estimated for escalation on the financial cost estimate.

(4) The direct cost for civil works is estimated by multiplying the unit cost by the corresponding work quantity, excluding work items whose costs are estimated on the lump sum basis. The preparatory works and minor work items are estimated on the lump sum basis with a certain percentage of main works. The unit cost for each work item consists of the cost of construction materials, labour and equipment. The contractor's indirect cost is incorporated in the unit cost for each work item.

(5) Labour's daily charge is estimated including the social charge (Leis sociais) of 142% as tabulated in Table VIII.3.1.

(6) Unit prices of construction materials were canvassed at site as tabulated in Table VIII.3.2.

(7) The equipment cost consists of the depreciation and interest cost, maintenance and repair cost and management cost which are estimated based on the purchase cost and durable life of the said equipment as shown in Table VIII.3.3. Salvage value of 10% was considered. With regard to the operation and maintenance cost of equipment, operator's charge was incorporated in the labour cost, and fuel and lubricant cost was incorporated in the material cost.

(8) In determining the percentage of foreign and local currencies of the direct construction cost, the following values were applied introducing a concept of "indirect foreign currency" that means those goods produced using imported production facilities.

Cost Items	F.C./L.C. contributions
a. Equipment, 100% imported	
- Depreciation and interest	100% F.C.
- Maintenance, spareparts,	100% F.C.
- Labour	100% L.C.
- Management	100% L.C.
b. Equipment produced in Brazil (including knockdown system)	
- Depreciation and interest	80% F.C., 20% L.C.
- Maintenance, spareparts	80% F.C., 20% L.C.
- Labour	100% L.C.
- Management	100% L.C.
c. Construction materials, imported	100% F.C.
d. Construction materials, produced domestically	50% F.C., 50% L.C.
e. Labour	100% L.C.

(9) 30% of direct cost is assumed to be the contractor's indirect cost (contractor's overhead and profit) and added to the direct cost in the unit cost of each work item.

(10) The cost for land acquisition and compensation of the houses or buildings was estimated on the unit cost basis as shown in Table VIII.3.4. The unit cost was decided on the basis of the prevailing cost for land, houses or buildings. The compensation cost for the pumping facilities for irrigation use was estimated as the lump sum cost based on the replacement cost of such facilities.

(11) An allowance of 5% of the total direct cost is estimated as the administration cost for the implementation of the project, which is wholly of local currency portion.

(12) Engineering service cost is estimated at 9% of the total direct cost for detailed design and construction supervision.

(13) Physical contingency is provided to cope with the unpredictable physical conditions and estimated at 15% of total cost.

(14) Price contingency is provided for implementation of the project. Price contingency for financial cost is estimated at 3% per annum for the foreign and local currency portions.

The priced bill of quantities for direct construction cost which is derived under the conditions mentioned above is shown in Table VIII.3.5.

3.2 Financial Cost and Annual Disbursement Schedule

The direct construction cost divided into foreign and local currency portions was estimated by multiplying the work quantities by the respective unit costs. The estimated financial cost for the proposed provisional plan is presented in Table VIII.3.6 and summarized as follows;

(Unit: 10^3 US$)

Cost Items	F.C.	L.C.	Amount
- Direct cost (Construction cost including preparatory works)	42,900	28,600	71,500
- Indirect cost (Land acquisition, administration and engineering service cost)	5,148	17,212	22,360
- Contingency (Physical and price contingency)	19,356	16,834	36,190
Total	67,404	62,646	130,050

The construction cost of each package is estimated at about US$ 48 million for Package-A, US$ 53 million for Packages-B and US$ 29 million for cost of prerequisite works. Based on the construction time schedule shown in Fig. VIII.2.4, the annual disbursement schedule is prepared as given in Table VIII.3.7. The annual investment cost ranges from about US$13 million to US$30 million.

3.3 Operation and Maintenance Cost and Replacement Cost

Annual operation and maintenance cost required after completion of the construction works was estimated to be 35.75 thousand US$ which is equivalent to 0.5% of the total direct construction cost. The replacement cost for the mechanical works such as flap gate, pump and screen was estimated at about one million US$, which is required to be disbursed at 15 years in interval after completion of the project construction.

4. PRELIMINARY COST ESTIMATE FOR MID-TERM AND LONG-TERM FLOOD CONTROL PLANS

This Chapter describes the results of the preliminary cost estimate for the mid-term (25-year probable flood) and long-term (50-year probable flood) flood control plans in the lower Itajai river basin. As discussed in Section 4.5 of ANNEX VI, FLOOD CONTROL PLAN, the floodway channel with a river bed width of 50 m which is proposed in the present provisional plan is planned to be widened to 85 m and 135 m in the mid-term and long-term plans, respectively in order to cope with the larger magnitude floods.

The river improvement works for the project stretches, consisting mainly of excavation and dredging of river channel and construction of levee/parapet wall along the river channels, are contemplated to be completed in the construction stage of the previsional plan to meet the design water levels in the long-term plan. Hence, the main construction works required for the mid-term and long-term plans will be excavation and dredging for widening the floodway channel as well as extension works for the related structures such as bridge, ground sill and slope protection works as shown in Tables VIII.4.1 and VIII.4.2. It is planned that the earth materials to be produced from widening of the floodway channel are used to heighten the low elevation areas extending along the Itajai Mirim river.

Assuming that the mid-term and long-term plans are to be stage - wisely implemented after completion of the previsional plan, the direct construction costs for the mid-term and long-term plans are estimated at 21 and 42 million US$, respectively as shown in Tables VIII.4.1 and VIII.4.2. Their financial project costs excluding price contingency are shown in the following table.

Cost Items	Amount (US$ thousand)	
	Mid-term Plan	Long-term Plan
- Direct cost (Construction cost including preparatory works)	21,000	42,000
- Indirect cost (Administration and engineering service cost)	2,940	5,880
- Physical contingency	5,064	7,183
Total	29,004	55,063

Note; 1. The construction cost for the mid-term and long-term plans means the additional cost required for the respective plans and the cost for preceding plan is not included.

Tables

Table VIII.2.1 METEO-HYDROLOGICAL FEATURES IN THE PROJECT AREA

(1) Number of rainy days at Itajai

Classification	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
0 mm	14	13	16	16	20	21	19	22	18	18	17	15	209
0-5 mm	10	8	7	7	6	4	6	5	6	6	6	8	79
5-10 mm	4	2	3	2	2	2	2	1	2	2	2	3	27
10-20 mm	1	3	2	3	1	1	2	2	2	2	2	3	24
20-30 mm	1	1	1	1	1	1	1	1	1	1	2	1	13
> 30 mm	1	1	2	1	1	1	1	0	1	2	1	1	13
Rainy days	17	15	15	14	11	9	12	9	12	13	13	16	156

Remark : Figures show average values for a period from 1976 to 1989.

(2) Monthly rainfall at Itajai

(Unit : mm)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
182	196	199	117	108	104	114	118	124	148	135	152	1697

Remark : Figures show average values for a period 1968 to 1989.

(3) Mean monthly discharge

(Unit : cms)

River	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Itajai	306	335	300	206	328	294	422	422	307	434	379	363	353
Short-cut channel	37	38	31	25	32	28	43	37	30	42	36	38	34
Itajai Mirim	2.7	2.7	2.2	1.8	2.3	2.0	3.1	2.6	2.1	3.0	2.6	2.7	2.5

Remark :
Figures are estimated on the basis of the discharge records at Indaial and Brusque for a period from 1976 to 1989.

(4) Mean sea water level

(Unit : EL.m)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
0.00	0.13	0.02	0.28	0.11	0.10	0.27	0.24	0.10	0.05	0.01	0.02	0.11

Remark :
Figures show monthly average of water level records at Itajai harbour for a period from 1983 to 1989.

(5) Flow velocity along the objective river stretches

(Unit : m/s)

River	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Itajai	0.33	0.35	0.32	0.21	0.34	0.31	0.43	0.43	0.32	0.46	0.40	0.39	0.37
Short-cut channel	0.42	0.40	0.34	0.24	0.33	0.30	0.41	0.37	0.32	0.46	0.40	0.42	0.36
Itajai Mirim	0.04	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.03

(6) Minimum water depth

(Unit : m)

River	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Itajai	6.60	6.73	6.62	6.88	6.71	6.70	6.87	6.84	6.70	6.65	6.61	6.62	6.71
Short-cut channel	1.90	2.03	1.92	2.18	2.01	2.00	2.17	2.14	2.00	1.95	1.91	1.92	2.01
Itajai Mirim	2.20	2.33	2.22	2.48	2.31	2.30	2.47	2.44	2.30	2.25	2.21	2.22	2.31

Table VIII.2.2 CEMENT AND READY MIXED CONCRETE FACTORY IN ITAJAI

	Name of Factory	Plant Capacity
A.	Ready mixed concrete factory	
	1. CONCREBRAS S/A ENGº DE CONCRETO. Rua : Morro do Boi s/n Bal. Cam. Fone: 661031	40 m^3/h
	2. CONSTRUTORA DE COMERCIO H SCHULTZ Rua: Acre, 130 Bal. Camb. Fone: 664155	20 m^3/h
	3. CASETEX CONCRETO E CONST. CIVIL LTDA. Rua: Jose Alves Cabral s/n Bal. Camb. Fone: 661230	100 m^3/h
	4. CONCRETEIRA PAULO CASECA LTDA. Avenida do Estado s/n Bal. Camb. Fone: 663300	30 m^3/h
B.	Cement Factory	
	COMP. CATARINENSE DE CEMENTO PORTLAND Avenida Castelo Branco, 1135 Bairro Salseiros Itajai Fone: 461022	1900 tons/day

As of 1989

Table VIII.2.3 PRODUCTION RATE OF MAJOR EQUIPMENT ESTIMATED

	Equipment		Production Rate	
1.	Pump dredger	1100 PS, 400ø mm	200 m^3/h	(L ≤ 1,000 m)
2.	Pump dredger	150 PS, 200ø mm	30 m^3/h	(L ≤ 500 m)
3.	Motor scraper	23 m3 class	60 m^3/h	(L ≤ 2,000 m)
4.	Bulldozer	32 t class	200 m^3/h	(fine)
		32 t class	190 m^3/h	(coarse)
		32 t class	100 m^3/h	(rock)
		20 t class	100 m^3/h	(excavation)
		20 t class	200 m^3/h	(spreading)
		20 t class	80 m^3/h	(compaction)
		16 t class	80 m^3/h	(excavation)
		16 t class	150 m^3/h	(spreading)
		16 t class	60 m^3/h	(compaction)
5.	Wheel loader	5 m^3 class	340 m^3/h	(fine)
		5 m^3 class	260 m^3/h	(coarse)
		5 m^3 class	130 m^3/h	(rock)
		2 m^3 class	110 m^3/h	(fine)
		2 m^3 class	80 m^3/h	(coarse)
		2 m^3 class	40 m^3/h	(rock)
6.	Tractor loader	2.2 m^3 class	110 m^3/h	(fine)
		2.2 m^3 class	80 m^3/h	(coarse)
		2.2 m^3 class	45 m^3/h	(rock)
7.	Tire roller	10 t class	100 m^3/h	
8.	Dump truck	32 t class	40 m^3/h	(4 km, coarse)
		32 t class	30 m^3/h	(4 km, rock)
		32 t class	50 m^3/h	(2 km, coarse)
		32 t class	40 m^3/h	(2 km, rock)
		15 t class	20 m^3/h	(4 km, coarse)
		10 t class	30 m^3/h	(0.5 km)
9.	Dragline	1.0 m^3 class	40 m^3/h	

Table VIII.2.4 SUMMARY OF EARTHMOVING PLAN

Dredged/Excavated Material			Method of Treatment			Average hauling
Classification	Location	Volume *1	Mode of Utilization	Area	Volume *2	Distance
A. Dredging	Itajai River	8,156,000 m3	(1) Levee embankment materials	Itajai Riv.	850,000 m3	500 m
			(2) Filling materials of low land area	IR-4	1,800,000 m3	1,000 m
			(3) Filling materials of low land area	IR-6	5,506,000 m3	1,000 m
			(Amount)		8,156,000 m3	
	Floodway	3,006,800 m3	(1) Filling materials of low land area	IL-1	1,250,000 m3	3,500 m
			(2) Filling materials of low land area	IL-2	1,756,800 m3	2,500 m
			(Amount)		3,006,800 m3	
		480,000 m3	(1) Filling materials of low land area	IL-1	480,000 m3	4,000 m
(Subtotal)		11,642,800 m3			11,642,800 m3	
B. Excvavation	Floodway	4,343,200 m3	(1) Levee embankment materials	Floodway	160,000 m3	200 m
			(2) Filling materials of low land area	IL-3	4,183,200 m3	2,000 m
			(Amount)		4,343,200 m3	
(Total)		15,986,000 m3			15,986,000 m3	

Notes *1: Bank measure
*2: Required volume in loose measure

Table VIII.2.5 MAJOR EQUIPMENT REQUIRED

	Equipment		Required Unit
1.	Pump dredger	diesel, 1100 PS, 400ø mm	4
2.	Pump dredger	diesel, 150 PS, 200ø mm	1
3.	Motor scraper	self propelled, 23 m^3	12
4.	Bulldozer	32 t w/ripper	5
5.	Bulldozer	20 t	3
6.	Bulldozer	16 t, swamp	2
7.	Wheel loader	5 m^3	2
8.	Wheel loader	2 m^3	4
9.	Tractor loader	2 m^3	2
10.	Pump truck	32 t	2
11.	Pump truck	15 t	6
12.	Pump truck	10 t	5
13.	Tire roller	10 t	4
14.	Dragline/clamshell	1.0 m^3	2
15.	Concrete pump car	60 m^3/h	2
16.	Backhoe, swamp	1.0 m^3	2
17.	Crawler crane	50 t	2
18.	Motor grader	3.7 m	2
19.	Tire roller	10 t	1
20.	Crawler drill	hydraulic, 10 m^3/min., 50 - 120 cm/min.	3
21.	Air compressor	7 kg/cm^2, 25 m^3/min.	2
22.	Diesel pile hammer	3 t	1
23.	Truck crane	20 t	1
25.	Hydraulic jack	200 t	4

Table. VIII.2.6 MAJOR EQUIPMENT USE SCHEDULE

1994

Description	J	F	M	A	M	J	J	A	S	O	N	D
I. Itajai River												
(1) dredger, 1,100 PS		3	3	3	3	3	3	3	3	3	3	3
(2) Bulldozer, 20 t			2	2	2	2	2	2	2	2	2	2
(3) Loader, wheel 2 m3			2	2	2	2	2	2	2	2	2	2
(4) Dump truck, 10 t			2	2	2	2	2	2	2	2	2	2
(5) Tire roller, 10 t			2	2	2	2	2	2	2	2	2	2
(6) Concrete pump car, 60 m3/h												
II. Floodway												
(1) Dredger, 1100 PS		1	1	1	1	1	1	1	1	1	1	1
(2) Motor scrper, 23 m3 (u/s. 6 km)		9	9	9	9	9	9	9	9	9	9	9
(d/s. 4 km)		3	3	3	3	3	3	3	3	3	3	3
(3) Bulldozer w/ripper, 32 t												
(4) Loader, 5 m3								2	2	2	2	2
(5) Dump trunk, 32 t								5	5	5	5	5
(6) Dump trunk, 15 t								6	6	6	6	6
(7) Dragline/cramshell, 1.0 m3								1	1	1	1	1
(8) Crawler crane, 50 t									1	1	1	1
(9) Bulldozer, 32 t	1	1	1	1	1	1						
III. Itajai Mirim river												
(1) Dredger, 150 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Bulldozer, 16 t, swamp	1	1	1	1	1	1	1	1	1	1	1	1
(3) Loader, 2 m3							2	2	2	2	2	2
(4) Dump truck, 10 t							5	5	5	5	5	5
(5) Dragline, 1 m3	1	1	1	1	1	1	1	1	1	1	1	1
(6) Tire roller, 10 t							2	2	2	2	2	2
IV. Itajai Mirim Short-cut Channel												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Damp truck, 10 t												
(5) Dragline, 1.0 m3												
(6) Tire roller, 10 t												
(7) Concrete pump car, 60 m3/h												
V. Urban Drainage Works												
(1) Backhoe, 1.0 m3												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Dump truck, 10 t												
(5) Tie roller, 10 t												
(6) Concrete pump car, 60 m3/h												

1995

Description	J	F	M	A	M	J	J	A	S	O	N	D
I. Itajai River												
(1) dredger, 1,100 PS	3	3	3	3	3	3	3	3	3	3	3	3
(2) Bulldozer, 20 t	2	2	2	2	2	2	2	2	2	2	2	2
(3) Loader, wheel 2 m3	2	2	2	2	2	2	2	2	2	2	2	2
(4) Dump truck, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
(5) Tire roller, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
(6) Concrete pump car, 60 m3/h												
II. Floodway												
(1) Dredger, 1100 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Motor scrper, 23 m3 (u/s. 6 km)	9	9	9	9	9	9	9	9	9	9	9	9
(d/s. 4 km)	3	3	3	3	3	3	3	3	3	3	3	3
(3) Bulldozer w/ripper, 32 t												
(4) Loader, 5 m3	2	2	2	2	2	2	2	2	2	2	2	2
(5) Dump trunk, 32 t	5	5	5	5	5	5	5	5	5	5	5	5
(6) Dump trunk, 15 t	6	6	6	6	6	6	6	6	6	6	6	6
(7) Dragline/cramshell, 1.0 m3	1	1	1	1	1	1	1	1	1	1	1	1
(8) Crawler crane, 50 t	1	1	1	1	1	1	1	1	1	2	2	2
(9) Bulldozer, 32 t												
III. Itajai Mirim river												
(1) Dredger, 150 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Bulldozer, 16 t, swamp	1	1	1	1	1	1	1	1	1	1	1	1
(3) Loader, 2 m3	2	2	2	2	2	2	2	2	2	2	2	2
(4) Dump truck, 10 t	5	5	5	5	5	5	5	5	5	5	5	5
(5) Dragline, 1 m3	1	1	1	1	1	1	1	1	1	1	1	1
(6) Tire roller, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
IV. Itajai Mirim Short-cut Channel												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Damp truck, 10 t												
(5) Dragline, 1.0 m3												
(6) Tire roller, 10 t												
(7) Concrete pump car, 60 m3/h												
V. Urban Drainage Works												
(1) Backhoe, 1.0 m3												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Dump truck, 10 t												
(5) Tie roller, 10 t												
(6) Concrete pump car, 60 m3/h												

1996

Description	J	F	M	A	M	J	J	A	S	O	N	D
I. Itajai River												
(1) dredger, 1,100 PS	3	3	3	3	3	3	3	3	3	3	3	3
(2) Bulldozer, 20 t	2	2	2	2	2	2	2	2	2	2	2	2
(3) Loader, wheel 2 m3	2	2	2	2	2	2	2	2	2	2	2	2
(4) Dump truck, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
(5) Tire roller, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
(6) Concrete pump car, 60 m3/h												
II. Floodway												
(1) Dredger, 1100 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Motor scrper, 23 m3 (u/s. 6 km)	9	9	9	9	9	9	9	9	9	9	9	9
(d/s. 4 km)	3	3	3	3	3	3	3	3	3	3	3	3
(3) Bulldozer w/ripper, 32 t												
(4) Loader, 5 m3	2	2	2	2	2	2	2	2	2	2	2	2
(5) Dump trunk, 32 t	5	5	5	5	5	5	5	5	5	5	5	5
(6) Dump trunk, 15 t	6	6	6	6	6	6	6	6	6	6	6	6
(7) Dragline/cramshell, 1.0 m3	1	1	1	1	1	1	1	1	1	1	1	1
(8) Crawler crane, 50 t	1	1	1	1	1	1	1	1	1	1	1	1
(9) Bulldozer, 32 t												
III. Itajai Mirim river												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3	2	2	2	2	2	2	2	2	2	2	2	2
(4) Dump truck, 10 t	5	5	5	5	5	5	5	5	5	5	5	5
(5) Dragline, 1 m3												
(6) Tire roller, 10 t	2	2	2	2	2	2	2	2	2	2	2	2
IV. Itajai Mirim Short-cut Channel												
(1) Dredger, 150 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Bulldozer, 16 t, swamp	1	1	1	1	1	1						
(3) Loader, 2 m3				2	2	2	2	2	2	2	2	2
(4) Damp truck, 10 t				5	5	5	5	5	5	5	5	5
(5) Dragline, 1.0 m3	1	1	1	1	1	1						
(6) Tire roller, 10 t				2	2	2	2	2	2	2	2	2
(7) Concrete pump car, 60 m3/h												
V. Urban Drainage Works												
(1) Backhoe, 1.0 m3							2	2	2	2	2	2
(2) Bulldozer, 16 t, swamp							1	1	1	1	1	1
(3) Loader, 2 m3												
(4) Dump truck, 10 t												
(5) Tie roller, 10 t												
(6) Concrete pump car, 60 m3/h												

1997

Description	J	F	M	A	M	J	J	A	S	O	N	D
I. Itajai River												
(1) dredger, 1,100 PS	3	3	3	3	3	3	3	3	3	3	3	3
(2) Bulldozer, 20 t	2	2										
(3) Loader, wheel 2 m3	2	2										
(4) Dump truck, 10 t	2	2										
(5) Tire roller, 10 t	2	2										
(6) Concrete pump car, 60 m3/h			1	1	1	1	1	1	1	1	1	1
II. Floodway												
(1) Dredger, 1100 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Motor scrper, 23 m3 (u/s. 6 km)	9	9	9	9	9	9	9	9	9	9	9	9
(d/s. 4 km)	3	3	3	3	3	3	3	3	3	3	3	3
(3) Bulldozer w/ripper, 32 t	1	1	1	1	1	1	1	1	1	1	1	1
(4) Loader, 5 m3	2	2	2	2	2	2	2	2	2	2	2	2
(5) Dump trunk, 32 t	5	5	5	5	5	5	5	5	5	5	5	5
(6) Dump trunk, 15 t	7	7	7	7	7	7	7	7	7	7	7	7
(7) Dragline/cramshell, 1.0 m3	1	1	1	1	1	1						
(8) Crawler crane, 50 t	1	1	1	1	1	1						
(9) Bulldozer, 32 t												
III. Itajai Mirim river												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3	2	2	2	2	2	2						
(4) Dump truck, 10 t	5	5	5	5	5	5						
(5) Dragline, 1 m3												
(6) Tire roller, 10 t	2	2	2	2	2	2						
IV. Itajai Mirim Short-cut Channel												
(1) Dredger, 150 PS	1	1	1	1	1	1	1	1	1	1	1	2
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3	2	2	2									
(4) Damp truck, 10 t	5	5	5									
(5) Dragline, 1.0 m3												
(6) Tire roller, 10 t	2	2	2									
(7) Concrete pump car, 60 m3/h		1	1									
V. Urban Drainage Works												
(1) Backhoe, 1.0 m3	2	2	2	2	2	2	2	2				
(2) Bulldozer, 16 t, swamp	1	1	1	1	1	1	1	1				
(3) Loader, 2 m3				1	1	1	1	1	2	2	2	2
(4) Dump truck, 10 t									5	5	5	5
(5) Tie roller, 10 t									2	2	2	2
(6) Concrete pump car, 60 m3/h												

1998

Description	J	F	M	A	M	J	J	A	S	O	N	D
I. Itajai River												
(1) dredger, 1,100 PS	3	3	3	3	3	3	3	3	3	3	3	3
(2) Bulldozer, 20 t												
(3) Loader, wheel 2 m3												
(4) Dump truck, 10 t												
(5) Tire roller, 10 t												
(6) Concrete pump car, 60 m3/h	1	1	1	1	1	1	1	1	1	1		
II. Floodway												
(1) Dredger, 1100 PS	1	1	1	1	1	1	1	1	1	1	1	1
(2) Motor scrper, 23 m3 (u/s. 6 km)	9	9	9	9	9	9	9	9	9	9	9	
(d/s. 4 km)	3	3	3	3	3	3	3	3	3	3	3	
(3) Bulldozer w/ripper, 32 t												
(4) Loader, 5 m3												
(5) Dump trunk, 32 t												
(6) Dump trunk, 15 t												
(7) Dragline/cramshell, 1.0 m3												
(8) Crawler crane, 50 t												
(9) Bulldozer, 32 t												
III. Itajai Mirim river												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Dump truck, 10 t												
(5) Dragline, 1 m3												
(6) Tire roller, 10 t												
IV. Itajai Mirim Short-cut Channel												
(1) Dredger, 150 PS												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3												
(4) Damp truck, 10 t												
(5) Dragline, 1.0 m3												
(6) Tire roller, 10 t												
(7) Concrete pump car, 60 m3/h												
V. Urban Drainage Works												
(1) Backhoe, 1.0 m3												
(2) Bulldozer, 16 t, swamp												
(3) Loader, 2 m3	2	2	2	2	2	2	2	2				
(4) Dump truck, 10 t	5	5	5	5	5	5	5	5				
(5) Tie roller, 10 t	2	2	2	2	2	2	2	2				
(6) Concrete pump car, 60 m3/h									1	1		

Table VIII.3.1 LABOUR WAGES (8 HOURS/DAY)

	Description	US$/day
1.	Foreman	17.0
2.	Operator for dredger	10.0
3.	Operator for equipment	9.0
4.	Assistant operator	6.5
5.	Driver	8.0
6.	Mechanic	12.0
7.	Electrician	11.0
8.	Welder	7.5
9.	Carpenter	7.1
10.	Concrete worker	5.0
11.	Mason	5.0
12.	Steel worker	6.0
13.	Semi-skilled labour	5.0
14.	Common labour	4.5
15.	Plumber	6.2
16.	Rigger	6.1
17.	Blaster	6.1
18.	Surveyor	6.0
19.	Office incharge	15.0
20.	Blacksmith	6.1

Note: 1) Social charge/duties (Encargos Sociais or Leis Sociais) of 142% was included in the daily wage.

2) Monthly minimum base salary is NCz$249.48 (source: INFORMADOR 15/9/89).

3) Working hour of one shift is 8 hours per day (8:00 - 12:00 and 14:00 - 18:00).

4) Overtime work is 20%, 50% and 100% up of base wage for night, midnight and holiday, respectively.

Table VIII.3.2 UNIT PRICES OF CONSTRUCTION MATERIALS

1 US$ = NCz$ 3.78 (at the end of Sep. '89)

No.	Items	Unit	Unit price (US$)
1.	Portland cement	t	56.00
2.	Portland cement (50 Kg)	bag	4.00
3.	Reinforced steel bar (round)	t	500.00
4.	Reinforced steel bar (deformed)	t	577.00
5.	Shaped steel	t	504.00
6.	Tempered wire	kg	1.0
7.	Gasoline	l	0.22
8.	Alcohol	l	0.16
9.	Diesel oil	l	0.11
10.	Engine oil	l	0.98
11.	Grease	kg	1.59
12.	Electric power	kw/h	0.04
13.	Readymixed concrete	m^3	64.00
14.	Aggregate, crushed ascreemed	m^3	8.50
15.	Sand, washed	m^3	5.80
16.	Gravel	m^3	6.00
17.	Asphalt, straight	t	70.00
18.	Timber	m^3	5.50
19.	Plywood	m^3	9.00
20.	Dynamite	kg	0.8
21.	Metal bit, 30 ø	pc	5.00
22.	R. C. pile, 350 x 350 mm	m	12.40

Table VIII.3.3 HOURLY COST OF MAJOR EQUIPMENT

Equipment		Purchase cost (US$)	Durable life hour	Depre. cost *1 (US$)	M/R *2 ratio (%)	M/R *3 cost (US$)	Mana-ge. *4 (US$)	Hourly cost (US$)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)
1. Pump dredger	1100 PS	2,500,000	28,000	80.4	60	53.6	6.3	140.2
2. - do -	150 PS	600,000	21,000	25.7	60	17.1	2.0	44.9
3. Motor scraper	23 m3	600,000	10,500	51.4	60	34.3	4.0	89.7
4. Bulldozer	32 t	260,000	9,000	26.0	70	20.2	2.0	48.2
5. - do -	20 t	160,000	9,000	16.0	70	12.4	1.2	29.7
6. - do -	16 t, swamp	110,000	8,400	11.8	70	9.2	0.9	21.9
7. Wheel loader	5 m3	350,000	9,000	35.0	70	27.2	2.7	6.5
8. - do -	2 m3	105,000	9,000	10.5	70	8.2	0.8	19.5
9. Tractor loader	2 m3	115,000	9,000	11.5	70	8.9	0.9	21.3
10. Dump truck	32 t	285,000	8,000	32.1	80	28.5	2.5	63.1
11. - do -	15 t	90,000	9,000	9.0	70	7.0	0.7	16.7
12. - do -	10 t	54,000	6,000	8.1	70	6.3	0.6	15.0
13. Tire roller	20 t	54,000	5,600	8.7	50	4.8	0.7	14.2
14. Dragline/clamshell	1.0 m3	350,000	7,000	45.0	60	30.0	3.5	78.5
15. Concrete pump car	60 m3/h	125,000	4,800	23.4	70	18.2	1.8	43.5
16. Back hoe	1.0 m3	140,000	9,000	14.0	50	7.8	1.1	22.9
17. Crawler crane	50 t	350,000	8,400	37.5	70	29.2	2.9	69.6
18. Motor grader	3.7 m	93,000	9,000	9.3	50	5.2	0.7	15.2
19. Tire roller	10 t	50,000	5,600	8.0	50	4.5	0.6	13.1
20. Crawler drill, hydraulic	10 m3/min. 50-120 cm/min.	178,000	4,000	40.1	40	17.8	3.1	61.0
21. Air compressor	20 m3/min.	57,000	6,300	8.1	50	4.5	0.6	13.3
22. Diesel pile hammer with base machine	3 t	250,000	3,600	62.5	60	41.7	4.9	109.0
23. Truck crane	20 t	160,000	7,000	20.6	30	6.9	1.6	29.0
24. Hydraulic jack	200 t	7,000	4,800	1.3	60	0.9	0.1	2.3

Notes *1: Depreciation Cost (C) = (a) x 0.9/(b)
*2: Maintenance & repair ratio against purchase cost
*3: Maintenance & repair cost. (e) = (a) x (d)/(b)
*4: Management cost (f) = (a) x 0.07/(b)

Table VIII.3.4 BREAKDOWN OF LAND ACQUISITION AND COMPENSATION COST

Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
1. Itajai River				
1.1 Land				
(1) Farm, irrigated	sq.m	222,800	3.0	668,400
(2) Farm, non-irrigated	sq.m	714,600	2.0	1,429,200
(3) Non-farm	sq.m	0		
1.2 Building				
(1) Urbanized	nos.	0		
(2) Non-urbanized	nos.	0		
1.3 Replacement of water pipes				
(1) ø 250 mm	m	250	200.0	50,000
(2) ø 200 mm	m	300	300.0	90,000
1.4 Replacement of pumps for irrigation water use	L.S.		-	300,000
Total of 1.				2,537,600
2. Floodway				
2.1 Land				
(1) Farm, irrigated	sq.m	40,300	3.0	120,900
(2) Farm, non-irrigated	sq.m	1,448,900	2.0	2,897,800
(3) Non-farm	sq.m	281,700	1.5	422,550
2.2 Building				
(1) Urbanized	nos.	0		
(2) Non-urbanized	nos.	59	12,000	708,000
Total of 2.				4,149,250
3. Itajai Mirim River				
3.1 Land				
(1) Farm, irrigated	sq.m	0		
(2) Farm, non-irrigated	sq.m	248,100	2.0	496,200
(3) Non-farm	sq.m	0		
3.2 Building				
(1) Urbanized	nos.	10	18,000	180,000
(2) Non-urbanized	nos.	269	12,000	3,228,000
3.3 Replacement of water pipes attached to bridges				
(1) ø 180 mm	m	50	150.0	7,500
(2) ø 300 mm	m	135	200.0	27,000
Total of 3.				3,938,700
4. Itajai Mirim Short-cut Channel				
4.1 Land				
(1) Farm, irrigated	sq.m	0		
(2) Farm, non-irrigated	sq.m	66,500	2.0	133,000
(3) Non-farm	sq.m	4,000	1.5	6,000
4.2 Building				
(1) Urbanized	nos.	0		
(2) Non-urbanized	nos.	30	12,000	360,000
Total of 4.				499,000
5. Urban Drainage Works				
5.1 Land	sq.m	406,000	3.0	1,218,000
Total of 5.				1,218,000
Total				12,342,550 (12,350,000)

Table VIII.3.5 PRICED BILL OF QUANTITIES FOR DIRECT CONSTRUCTION COST (1/3)

Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
I. General Items				
(1) Access & construction roads	L.S	-	-	500,000
(2) Temporary building	L.S	-	-	200,000
(3) Power supply system	L.S	-	-	60,000
(4) Communication system	L.S	-	-	20,000
(5) Care of water	L.S	-	-	50,000
(6) Miscellaneous works	L.S	-	-	30,000
Total of I				860,000
II. River Improvement Works				
1. Itajai River				
(1) Dredging of river bed	cu.m	8,156,000	2.0	16,312,000
(2) Levee				
(2-1) Stripping	sq.m	498,100	0.3	149,430
(2-2) Embankment	cu.m	743,900	5.0	3,719,500
(2-3) Sodding	sq.m	275,700	0.3	82,710
(3) Parapet wall				
(3-1) Stripping	sq.m	25,800	0.3	7,740
(3-2) Concrete placement	cu.m	19,700	100.0	1,970,000
(4) Gabion Matress	sq.m	1,100	10.0	11,000
(5) Miscellaneous works 3% of (1)-(4)	L.S.	-	-	667,571
Total of Item 1				22,919,951
2. Floodway				
(1) Channel excavation				
(1-1) Excavation, common	cu.m	4,343,200	3.0	13,029,600
(1-2) Excavation, rock	cu.m	150,000	8.0	1,200,000
(1-3) Dredging	cu.m	3,006,800	2.0	6,013,600
(2) Levee				
(2-1) Stripping	sq.m	98,500	0.3	29,550
(2-2) Embankment	cu.m	140,000	4.0	560,000
(2-3) Sodding	sq.m	51,700	0.3	15,510
(3) River bed protection				
(3-1) Excavation, common	cu.m	11,500	3.0	34,500
(3-2) R.C. pile ø300	m	860	30.0	25,800
(3-3) Steel sheet pile type II	ton	130	700.0	91,000
(3-4) Concrete placement	cu.m	6,000	100.0	600,000
(3-5) Rubble stone foundation	cu.m	850	10.0	8,500
(3-6) Concrete block	sq.m	4,500	30.0	135,000
(3-7) Wet masonry	sq.m	11,200	10.0	112,000
(4) Ground sill				
(4-1) Excavation, common	cu.m	600	3.0	1,800
(4-2) Concrete placement	cu.m	100	100.0	10,000
(4-3) Wet masonry	sq.m	650	10.0	6,500
(4-4) Gabion matress	sq.m	70	10.0	700
(5) Slope protection, riprap	sq.m	5,200	8.0	41,600
(6) Relocation road				
(6-1) Stripping	sq.m	40,900	0.3	12,270
(6-2) Excavation, common	cu.m	59,800	3.0	179,400
(6-3) Embankment	cu.m	88,000	4.0	352,000
(6-4) Subbase & base courses	cu.m	6,400	20.0	128,000
(6-5) Asphalt pavement	sq.m	25,600	8.0	204,800
(7) No.1 bridge construction, newly				
(7-1) Excavation, common	cu.m	64,100	4.0	256,400
(7-2) Concrete, superstructure	cu.m	800	100.0	80,000
(7-3) Concrete, substructure	cu.m	760	100.0	76,000
(7-4) R.C. pile ø400	m	280	40.0	11,200
(7-5) P.C. cable (12- ø12.4)	ton	37	3,000.0	111,000
(7-6) P.C. cable (12- ø5)	ton	7	3,000.0	21,000
(7-7) Asphalt pavement	sq.m	1,300	8.0	10,400
(7-8) Approach road	m	190	200.0	38,000
(7-9) Wet masonry	sq.m	850	10.0	8,500

Table VIII.3.5 PRICED BILL OF QUANTITIES FOR DIRECT CONSTRUCTION COST (2/3)

	Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
(8)	No.2 bridge construction, newly				
	(8-1) Excavation, common	cu.m	55,700	4.0	222,800
	(8-2) Concrete, superstructure	cu.m	600	100.0	60,000
	(8-3) Concrete, substructure	cu.m	1,000	100.0	100,000
	(8-4) R.C. pile ø400	m	720	40.0	28,800
	(8-5) P.C. cable (12- ø12.4)	ton	25	3,000.0	75,000
	(8-6) P.C. cable (12- ø7)	ton	13	3,000.0	39,000
	(8-7) Asphalt pavement	sq.m	1,300	8.0	10,400
	(8-8) Wet masonry	sq.m	2,000	10.0	20,000
(9)	New rural road bridge construction	L.S.	-	-	220,000
(10)	Jetty				
	(10-1) Dredging	cu.m	544,000	2.0	1,088,000
	(10-2) Core stone	cu.m	510,000	7.0	3,570,000
	(10-3) Armor stone	cu.m	795,000	6.5	5,167,500
	(10-4) Deformed concrete block, 16 ton	nos.	3,675	600.0	2,205,000
(11)	Miscellaneous works 3% of (1)-(10)	L.S.	-	-	1,086,334
	Total of Item 2				37,297,464
3.	Itajai Mirim River				
(1)	Dredging of river bed	cu.m	151,400	2.0	302,800
(2)	Excavation, common				
	(2-1) River channel	cu.m	14,300	3.0	42,900
	(2-2) Short-cut portion	cu.m	166,100	3.0	498,300
(3)	Levee				
	(3-1) Stripping	sq.m	398,100	0.3	119,430
	(3-2) Embankment	cu.m	725,400	5.0	3,627,000
	(3-3) Sodding	sq.m	268,700	0.3	80,610
(4)	Heightening of existing bridges				
	(4-1) Nova Brasilia, H=1.6 m	L.S.	-	-	70,000
	(4-2) São Vicente, H=1.2 m	L.S.	-	-	60,000
	(4-3) Adolfo Konder, H=1.7 m	L.S.	-	-	100,000
	(4-4) Jose Gall, H=2.4 m	L.S.	-	-	80,000
(5)	Miscellaneous works 3% of (1)-(4)	L.S.	-	-	149,431
	Total of Item 3				5,130,471
4.	Itajai Mirim Short-cut Channel				
(1)	Dredging of river bed	cu.m	227,100	2.0	454,200
(2)	Excavation,common	cu.m	53,200	3.0	159,600
(3)	Levee				
	(3-1) Stripping	sq.m	102,000	0.3	30,600
	(3-2) Embankment	cu.m	137,900	5.0	689,500
	(3-3) Sodding	sq.m	54,300	0.3	16,290
(4)	Parapet wall				
	(4-1) Stripping	sq.m	590	0.3	177
	(4-2) Concrete placement	cu.m	610	100.0	61,000
(5)	Miscellaneous works 3% of (1)-(4)	L.S.	-	-	42,341
	Total of Item 4				1,453,708
	Total of II				66,801,595

Table VIII.3.5 PRICED BILL OF QUANTITIES FOR DIRECT CONSTRUCTION COST (3/3)

Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
III. Urban Drainage Works				
1. Regulating Ponds				
(1) Excavation, common	cu.m	258,000	3.0	774,000
(2) Embankment	cu.m	28,000	4.0	112,000
(3) Sodding	sq.m	23,000	0.3	6,900
(4) Miscellaneous works 3% of (1)-(3)	L.S.	-	-	26,787
Total of Item 1				919,687
2. Sluice Way in Regulating Ponds				
(1) Excavation, common	cu.m	3,000	3.0	9,000
(2) Concrete placement	cu.m	280	100.0	28,000
(3) Steel sheet pile type II	ton	19	700.0	13,300
(4) R.C pile ø400, l=10m	nos.	136	400.0	54,400
(5) Revetment, concrete block	sq.m	1,100	30.0	33,000
(6) River bed protection, gabion	sq.m	450	10.0	4,500
(7) Flap gate, 1.0m x 1.0m	place	5	20,000.0	100,000
(8) Miscellaneous works 3% of (1)-(7)	L.S.	-	-	7,266
Total of Item 2				249,466
3. New Drainage System of Murta River				
(1) Excavation, common	cu.m	85,000	3.0	255,000
(2) Filling of low land area	cu.m	210,000	4.0	840,000
(3) Concrete placement	cu.m	3,800	100.0	380,000
(4) Miscellaneous works 3% of (1)-(3)	L.S.	-	-	44,250
Total of Item 3				1,519,250
4. Pumping Station				
(Civil Works)				
(1) Excavation, common	cu.m	5,000	3.0	15,000
(2) Concrete placement	cu.m	490	100.0	49,000
(3) Steel sheet pile type II	ton	17	700.0	11,900
(4) R.C pile ø400, l=10m	nos.	162	400.0	64,800
(5) Revetment, concrete block	sq.m	550	30.0	16,500
(6) River bed protection, gabion	sq.m	750	10.0	7,500
(7) Hume pipe, ø800	m	45	35.0	1,575
(Electro-mechanical works)				
(8) Submergible pump, Q=0.5 cu.m/s	sets	6	80,000	480,000
(9) Submergible pump, Q=0.3 cu.m/s	sets	2	60,000	120,000
(10) Screen	ton	0.4	3,000	1,200
(11) Electric motors	lot	1	330,000	330,000
(Building works)				
(12) Building for IR-4 pump station	sq.m	30.0	150	4,500
(13) Building for IR-6 pump station	sq.m	30.0	150	4,500
(14) Building for IM-7 pump station	sq.m	30.0	150	4,500
(15) Building for IM-9 pump station	sq.m	30.0	150	4,500
(16) Miscellaneous works 3% of (1)-(15)	L.S.	-	-	33,464
Total of Item 4				1,148,939
Total of III				3,837,342
Total of I to III				71,498,937 (71,500,000)

Table VIII.3.6 SUMMARY OF FINANCIAL COST

(Unit: US$ thousand)

Cost Items	F.C.	L.C.	Amounts
I. Package-A	28,703	19,134	47,837
a) Direct construction cost	20,250	13,500	33,750
b) Physical contingency	3,037	2,024	5,061
c) Price contingency	5,416	3,610	9,026
II. Package-B	31,805	21,202	53,007
a) Direct construction cost	22,650	15,100	37,750
b) Physical contingency	3,398	2,265	5,663
c) Price contingency	5,757	3,837	9,594
III. Prerequisite works	6,896	22,310	29,206
a) Land acquisition and compensation cost	0	12,350	12,350
b) Government administration	0	3,575	3,575
c) Engineering service	5,148	1,287	6,435
d) Physical contingency	773	2,582	3,355
e) Price contingency	975	2,516	3,491
Grand Total	67,404	62,646	130,050

Notes : (1) Construction work of Package-A and B is as follows:

Package-A : River improvement work in the Itajai river, Itajai Mirim river and existing short-cut channel and drainage work in Itajai and navegantes cities.

Package-B : Floodway construction work

: (2) Physical contingency is estimated as 15% of direct construction cost and price contingency is also estimated using price escalation rate of 3% for F.C. and L.C. per annum

Table VIII.3.7 ANNUAL DISBURSEMENT SCHEDULE

(Unit : US$ thousand)

Work Item	Fiscal Year 1991 F.C.	1991 L.C.	1992 F.C.	1992 L.C.	1993 F.C.	1993 L.C.	1994 F.C.	1994 L.C.	1995 F.C.	1995 L.C.	1996 F.C.	1996 L.C.	1997 F.C.	1997 L.C.	1998 F.C.	1998 L.C.	Total F.C.	Total L.C.	Grand Total
I. Package-A																			
a) Direct construction cost	0	0	0	0	0	0	2,943	1,962	3,950	2,633	5,669	3,780	4,525	3,016	3,163	2,109	20,250	13,500	33,750
b) Physical contingency	0	0	0	0	0	0	441	294	593	395	850	567	679	452	474	316	3,037	2,024	5,061
Sub-total	0	0	0	0	0	0	3,384	2,256	4,543	3,028	6,519	4,347	5,204	3,468	3,637	2,425	23,287	15,524	38,811
c) Price contingency	0	0	0	0	0	0	539	359	882	588	1,499	999	1,388	925	1,108	739	5,416	3,610	9,026
Total of item I	0	0	0	0	0	0	3,923	2,615	5,425	3,616	8,018	5,346	6,592	4,393	4,745	3,164	28,703	19,134	47,837
II. Package-B																			
a) Direct construction cost	0	0	0	0	0	0	4,082	2,722	5,873	3,915	6,097	4,064	5,201	3,468	1,397	931	22,650	15,100	37,750
b) Physical contingency	0	0	0	0	0	0	612	408	881	587	915	610	780	520	210	140	3,398	2,265	5,663
Sub-total	0	0	0	0	0	0	4,694	3,130	6,754	4,502	7,012	4,674	5,981	3,988	1,607	1,071	26,048	17,365	43,413
c) Price contingency	0	0	0	0	0	0	748	499	1,311	874	1,612	1,074	1,596	1,064	490	326	5,757	3,837	9,594
Total of item II	0	0	0	0	0	0	5,442	3,629	8,065	5,376	8,624	5,748	7,577	5,052	2,097	1,397	31,805	21,202	53,007
III. Prerequisite works for construction																			
a) Land acquisition and compensation cost	0	0	0	6,175	0	6,175	0	0	0	0	0	0	0	0	0	0	0	12,350	12,350
i) River improvement and drainage works	0	0	0	4,100	0	4,100	0	0	0	0	0	0	0	0	0	0	0	8,200	8,200
ii) Floodway construction	0	0	0	2,075	0	2,075	0	0	0	0	0	0	0	0	0	0	0	4,150	4,150
b) Government administration	0	475	0	475	0	475	0	430	0	430	0	430	0	430	0	430	0	3,575	3,575
c) Engineering service	1,374	342	686	172	0	0	494	124	710	178	834	208	710	178	340	85	5,148	1,287	6,435
Sub-total	1,374	817	686	6,822	0	6,650	494	554	710	608	834	638	710	608	340	515	5,148	17,212	22,360
d) Physical contingency	206	123	103	1,023	0	998	74	83	107	91	125	96	107	91	51	77	773	2,582	3,355
Sub-total	1,580	940	789	7,845	0	7,648	568	637	817	699	959	734	817	699	391	592	5,921	19,794	25,715
e) Price contingency	96	57	73	727	0	960	90	101	159	136	220	169	218	186	119	180	975	2,516	3,491
Total of item III	1,676	997	862	8,572	0	8,608	658	738	976	835	1,179	903	1,035	885	510	772	6,896	22,310	29,206
Grand total	1,676	997	862	8,572	0	8,608	10,023	6,982	14,466	9,827	17,821	11,997	15,204	10,330	7,352	5,333	67,404	62,646	130,050
Total of F.C. and L.C.	2,673		9,434		8,608		17,005		24,293		29,818		25,534		12,685		130,050		

Remarks :
Construction work of Package-A and B is as follows:

Package-A : River improvement work in the Itajai river, Itajai Mirim river and existing short-cut channel and drainage work in Itajai and Navegantes cities

Package-B : Floodway construction work

Table VIII.4.1 DIRECT CONSTRUCTION COST FOR MID-TERM PLAN

Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
A. General Items	L.S.			300,000
B. River Improvement works				
1. Floodway				
(1) Channel excavation				
1) Excavation, common	cu.m	69,000	4	276,000
2) Excavation, rock	cu.m	62,000	10	620,000
3) Dredging	cu.m	2,969,000	6	17,814,000
(2) Ground sill				
1) Concrete block	sq.m	900	300	270,000
2) Slope protection, riprap	sq.m	600	10	6,000
(3) Slope protection, riprap	sq.m	5,200	10	52,000
(4) No.2 bridge construction (Extension)				
1) Excavation, common	cu.m	1,500	4	6,000
2) Concrete, superstructure	cu.m	400	100	40,000
3) Concrete, substructure	cu.m	300	100	30,000
4) R.C. pile, 400 mm dia.	lin.m	400	40	16,000
5) P.C. cable (12-12.4 mm)	ton	17	3,000	51,000
6) P.C. cable (12-7 mm)	ton	9	3,000	27,000
7) Asphalt pavement	sq.m	500	8	4,000
8) Wet masonry	sq.m	1,300	15	19,500
Sub total				19,531,500
(5) Miscellaneous works 5% of (1)-(4)	L.S			976,575
Total				20,508,075
2. Itajai Mirim Short-cut Channel				
(1) BR-101 bridge construction, newly				
1) Excavation, common	cu.m	3,700	4	14,800
2) Concrete, superstructure	cu.m	700	100	70,000
3) Concrete, substructure	cu.m	760	100	76,000
4) R.C. pile, 400 mm dia.	lin.m	275	40	11,000
5) P.C. cable, 12-12.4 mm	ton	30	3,000	90,000
6) P.C. cable, 12-5 mm	ton	6	3,000	18,000
7) Asphalt pavement	sq.m	1,100	8	8,800
8) Approach road	lin.m	180	500	90,000
9) Wet masonry	sq.m	850	15	12,750
Sub total				391,350
(2) Miscellaneous works, 5% of (1)				19,568
Total				410,918
Ground Total				20,918,992 (21,000,000)

Notes : (1) Construction method
Dredging materials will be used as for the filling materials of low land area along the Itajai Mirim river.
Excavation, common, channel : Clamshell, 1 unit
Excavation, rock, channel : Grab dredger, 1 unit
Dredging : Cutter suction dredger, 1 (3-shift), 1100 PS
Concrete block : Floating crane
Piling : Diesel pipe hammer
(2) Construction period : 3 years

Table VIII.4.2 DIRECT CONSTRUCTION COST FOR LONG-TERM PLAN

Work Items	Unit	Quantity	Unit Price (US$)	Amount (US$)
A. General Items	L.S.			300,000
B. River Improvement works				
1. Floodway				
(1) Channel excavation				
1) Excavation, common	cu.m	126,600	4	506,400
2) Excavation, rock	cu.m	113,600	10	1,136,000
3) Dredging	cu.m	5,441,700	7	38,091,900
(2) Slope protection, riprap	sq.m	5,200	10	52,000
(3) Miscellaneous works 5% of (1)-(4)	L.S			1,989,315
Total				42,075,615 (42,000,000)

Notes : (1) Construction method
Dredged materials will be used as the filling materials of low land area along the Itajai Mirim river.
Excavation, common, channel : Clamshell, 1 unit
Excavation, rock, channel : Grab dredger, 1 unit
Dredging : Cutter suction dredger, 1 (3-shift), 1100 PS
(2) Construction period : 5 years

Figures

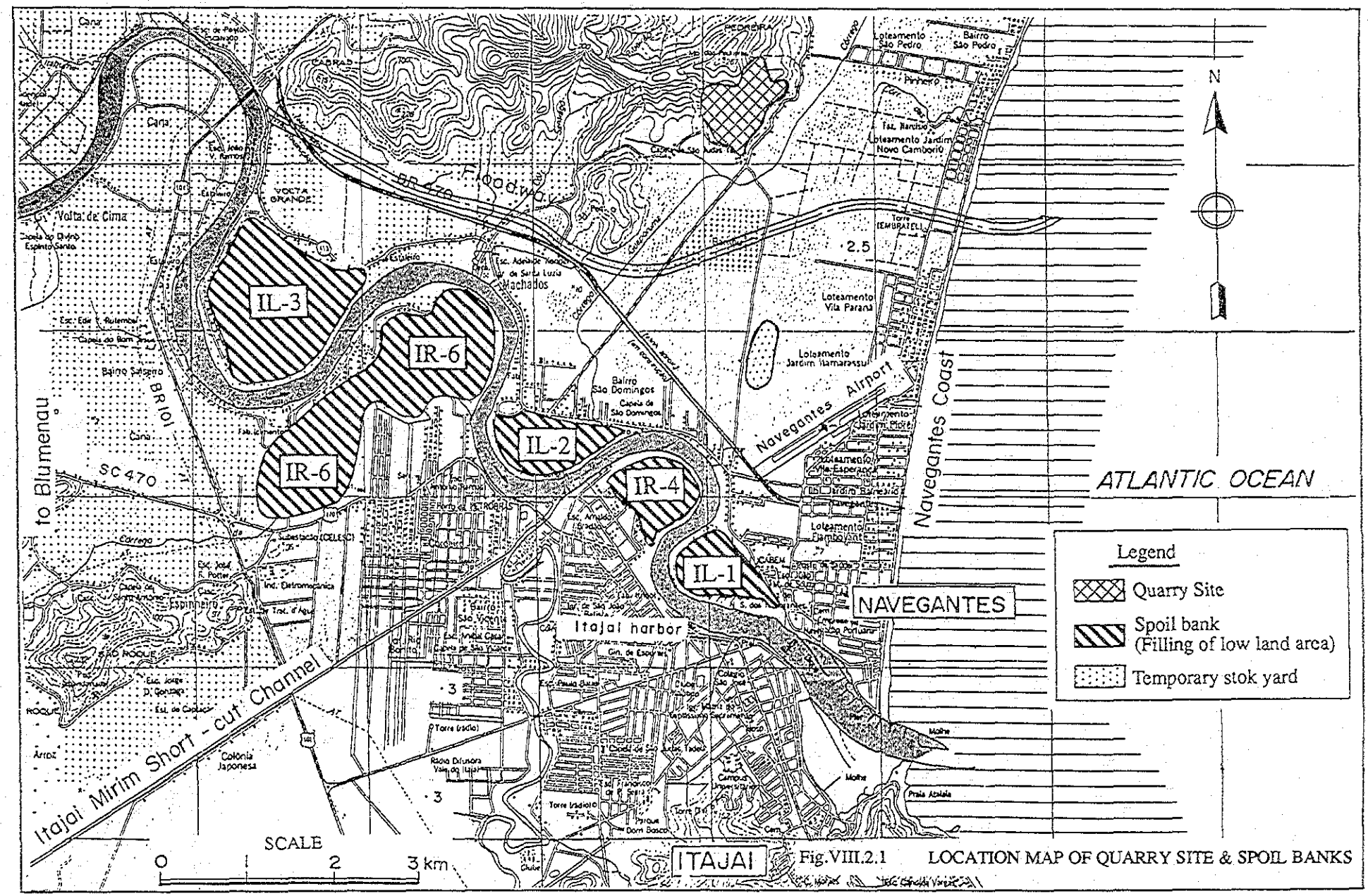

Fig.VIII.2.1 LOCATION MAP OF QUARRY SITE & SPOIL BANKS

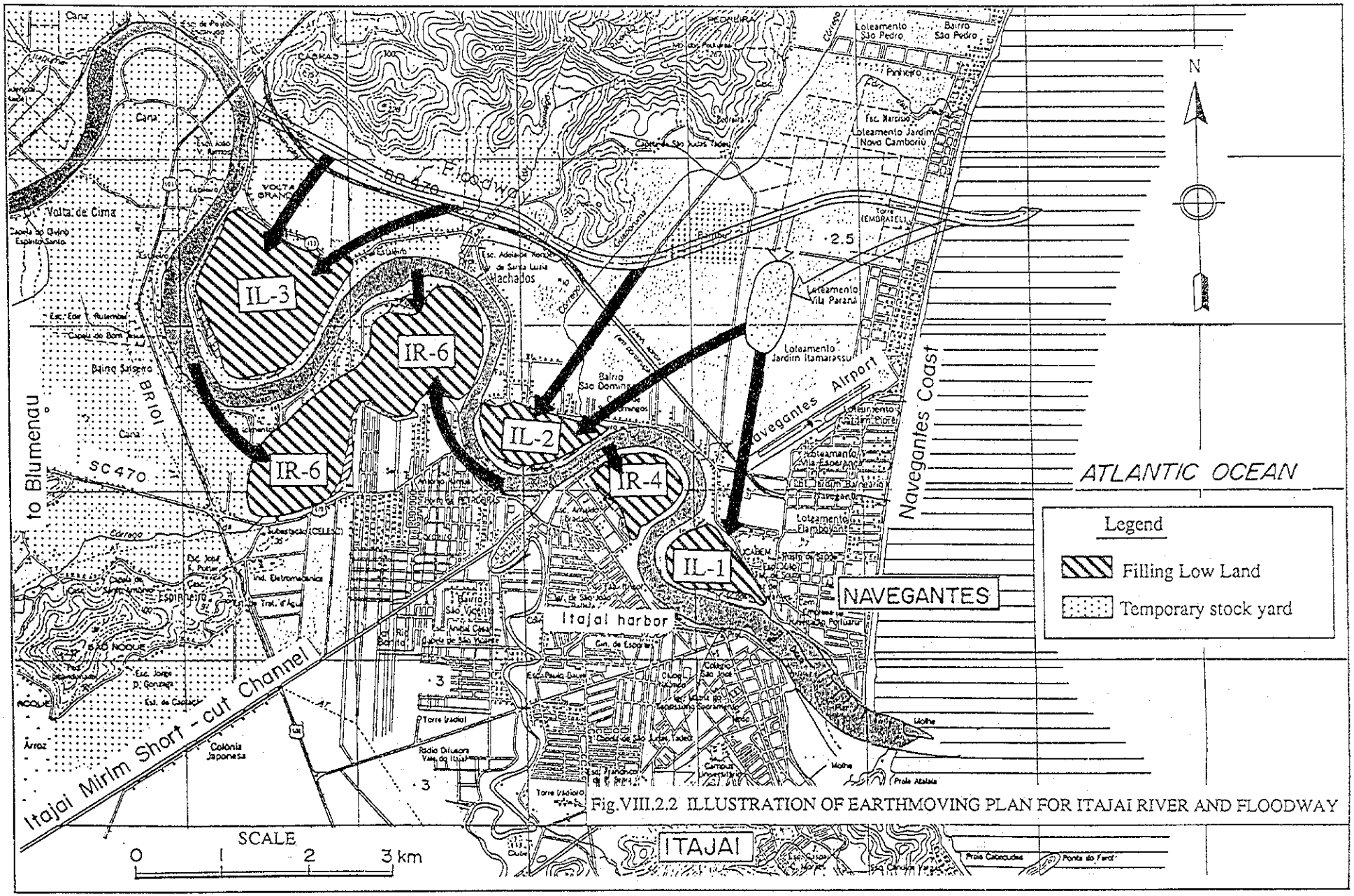

Fig.VIII.2.2 ILLUSTRATION OF EARTHMOVING PLAN FOR ITAJAI RIVER AND FLOODWAY

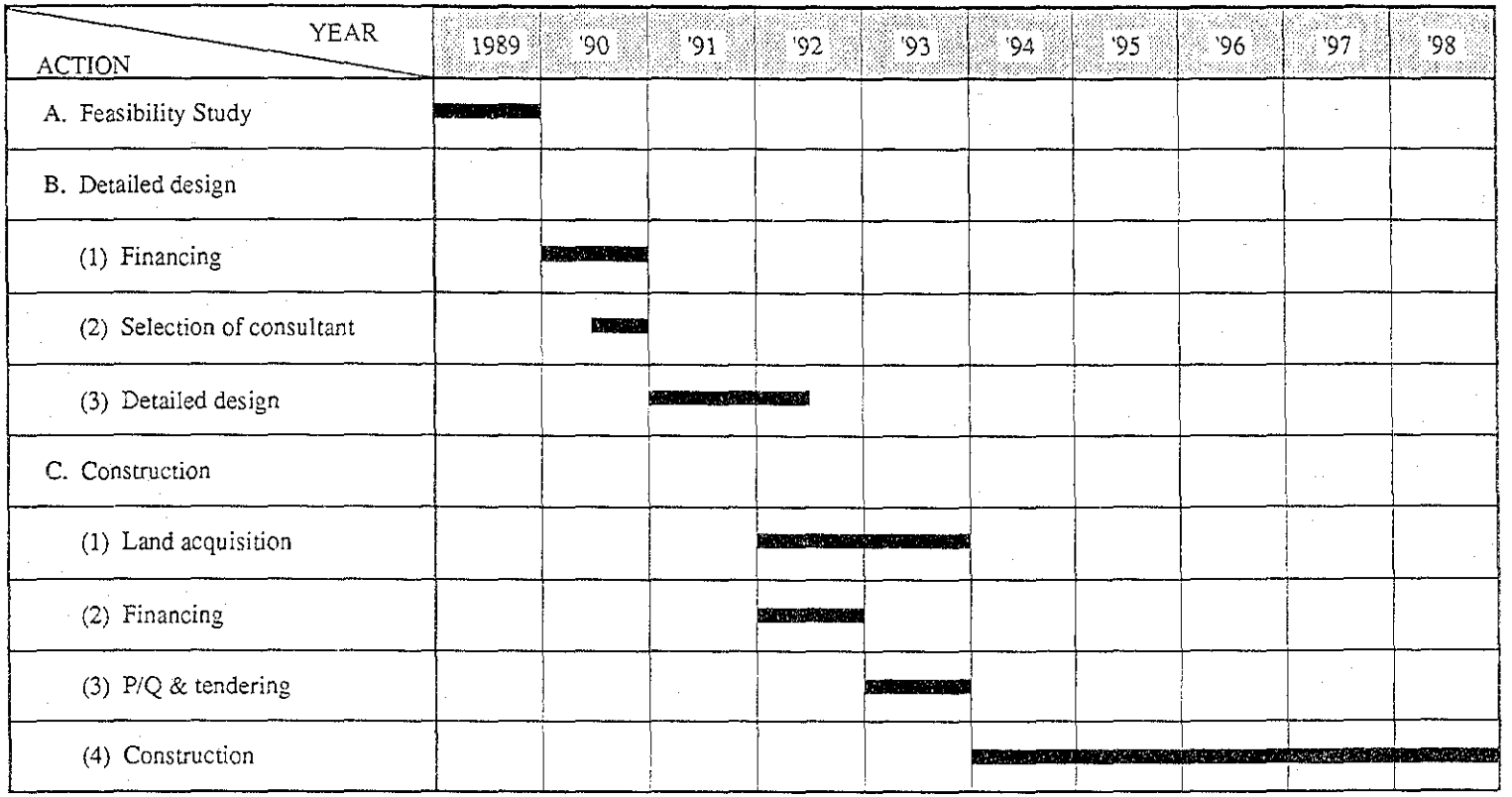

Fig. VIII.2.3 IMPLEMENTATION SCHEDULE FOR FLOOD CONTROL PROJECT