

7.2.4 Facility Planning

The facilities for the alternative [B2-1] (Complete Dike) and the alternative [B2-3] (Submerged Dike $H = \text{MSL} + 6 \text{ m}$) are planned taking into consideration of hydraulic aspects, construction cost as well as environmental effects. The facilities are the dike, foot protection, revetment for the dike, the bypass waterway and the revetment for bank protection in the Rio Grande Channel.

In case of the submerged dike, a mound type closing dike with a crown width of 12m is designed with a gabion mat for the safety against the overflow velocity of about 3 m/s over the crown. The dike slopes of 1:1.8 and 1:3 at the upstream and downstream sides are applied respectively, considering the stability of gabion.

For the closing dike, a rock fill mound type is selected from the viewpoint of utilizing local materials of low cost and easiness of maintenance. The crown width of 10 m and side slopes of 1:1.5 at both upstream and downstream is selected considering past experiences of these types of works.

In both cases, foot protection dike is also designed at both upstream and downstream sides to enhance the stability of the dike.

As a result of construction of complete closing dike, the transportation of fishing boats would be totally disturbed. To solve this problem, waterway with navigation lock is designed.

The extent of revetment of about 4,000m long is determined based on the hydraulic aspects considering the velocity change between before and after the dike construction. A revetment is built along the bank where velocity after construction of the dike would be greater than the present maximum velocity of 1.4 m / s. Fig. S-7-2 and Fig. S-7-3 show typical structures of closing dike and revetment.

7.2.5 Cost Estimation for Structural Measure

The project costs for the proposed structural measures B2-1 and B2-3 are estimated as US\$101.1 million and US\$ 129.1 million respectively. Annual operation and maintenance cost is assumed as 0.5% of each direct construction cost and estimated as US\$ 0.37 million and US\$ 0.48 million respectively.

Table S.7.2 Project Cost for Structural Measures (Alternative B2-1 and B2-3)

Item	Complete Closing Dike (Million US\$)	Submerged Dike (Million US\$)
A. Direct Cost	74.9	95.6
- Closing Dike	(66.1)	(86.8)
- Revetment	(8.8)	(8.8)
B. Indirect Cost	11.2	14.4
- Administration Cost (5 % of A)	(3.7)	(4.8)
- Engineering Service Cost (10 % of A)	(7.5)	(9.6)
C. Physical Contingency (20 % of A)	15.0	19.1
Total	101.1	129.1

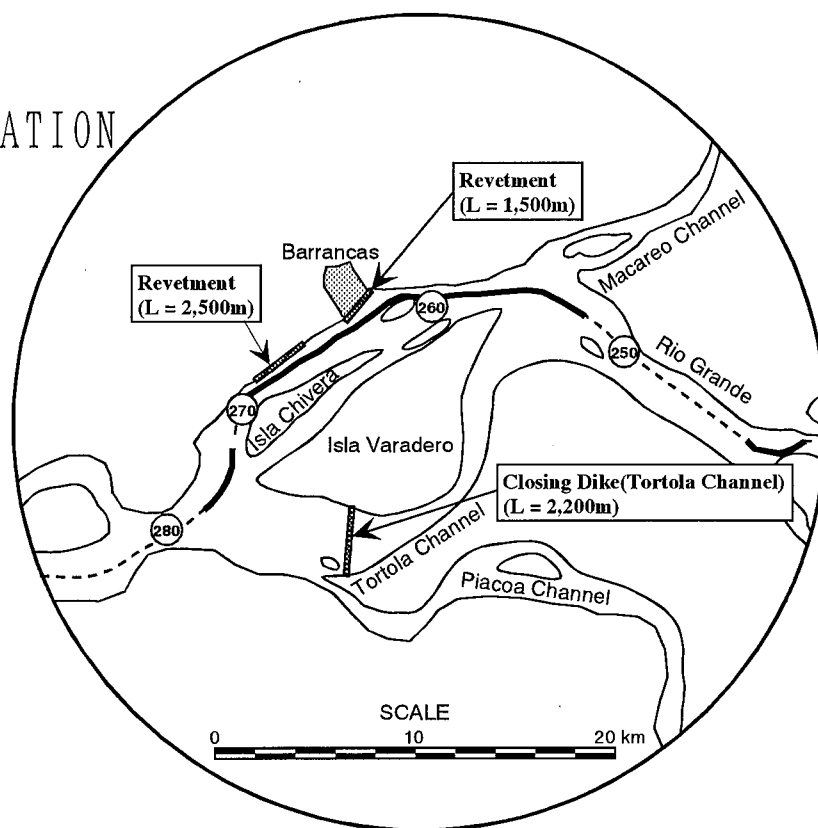
7.3 Non-Structural Measures

Seasonally deep-water path in the Rio Grande channel is subject to changes in elevation of riverbed according to flow variation, although it is recognized no remarkable changes in riverbank alignment and reaches required for dredging. By conducting regular bathymetric survey, the deeper area in the channel has to be defined and revised as the navigation route from the viewpoint of reduction of dredging activities and safe navigation, after careful evaluation of vessel maneuvering.

In the section of Barrancas from 260 km to 270 km, navigation route is located in the left sub-branch of flow divided by the long sandbar lying in the main stream of the Rio Orinoco. In the comparison of the navigation charts in 40 years between 1959 and 1998, the sandbar has been divided into two by a new diversion channel formed at 262 km, and the water path tends to flow from left to right sub-branch through the diversion break. Since it can be seen also from the results of the 2-dimensional analysis, there is a possibility that the present deep-water path would shift, in the near future, to the right flow side depending on the flow variation. Through the regular bathymetric survey, therefore, it is important to analyze the trend of the riverbed changes and review the navigation route for the reduction of dredging activities.

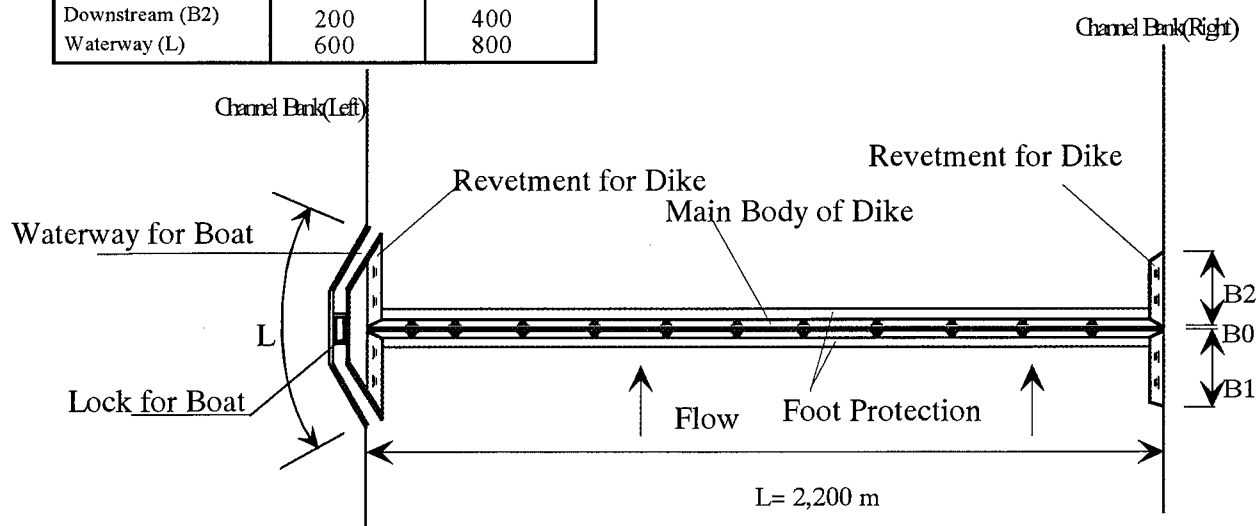
At present, the patrol survey, which is the longitudinal sounding survey for three lines: the right, center and left side of navigation canal, has been conducted each month by INC to detect the shallower channel bed. The extensive sounding survey from bank to bank in the dredging sections has been conducted once in several years at certain sections of the channel. However, it could be said that the bathymetrical information close to both banks in navigation chart has not been updated for a long time. In order to minimize dredging activities by specifying the best route for navigation through the deepest area of channel, the conduct of periodical bathymetric surveys in the navigation channel would be required.

LOCATION



Dimensions of Closing Dikes

	Complete Closing Dike (m)	Submerged Closing Dike (m)
Crown width (B0)	10	12
Revetment upstream (B1)	200	350
Downstream (B2)	200	400
Waterway (L)	600	800



PLAN VIEW OF CLOSING DIKE

Fig.S-7-2

LOCATION AND PLAN VIEW OF THE CHANNEL IMPROVEMENT STRUCTURES

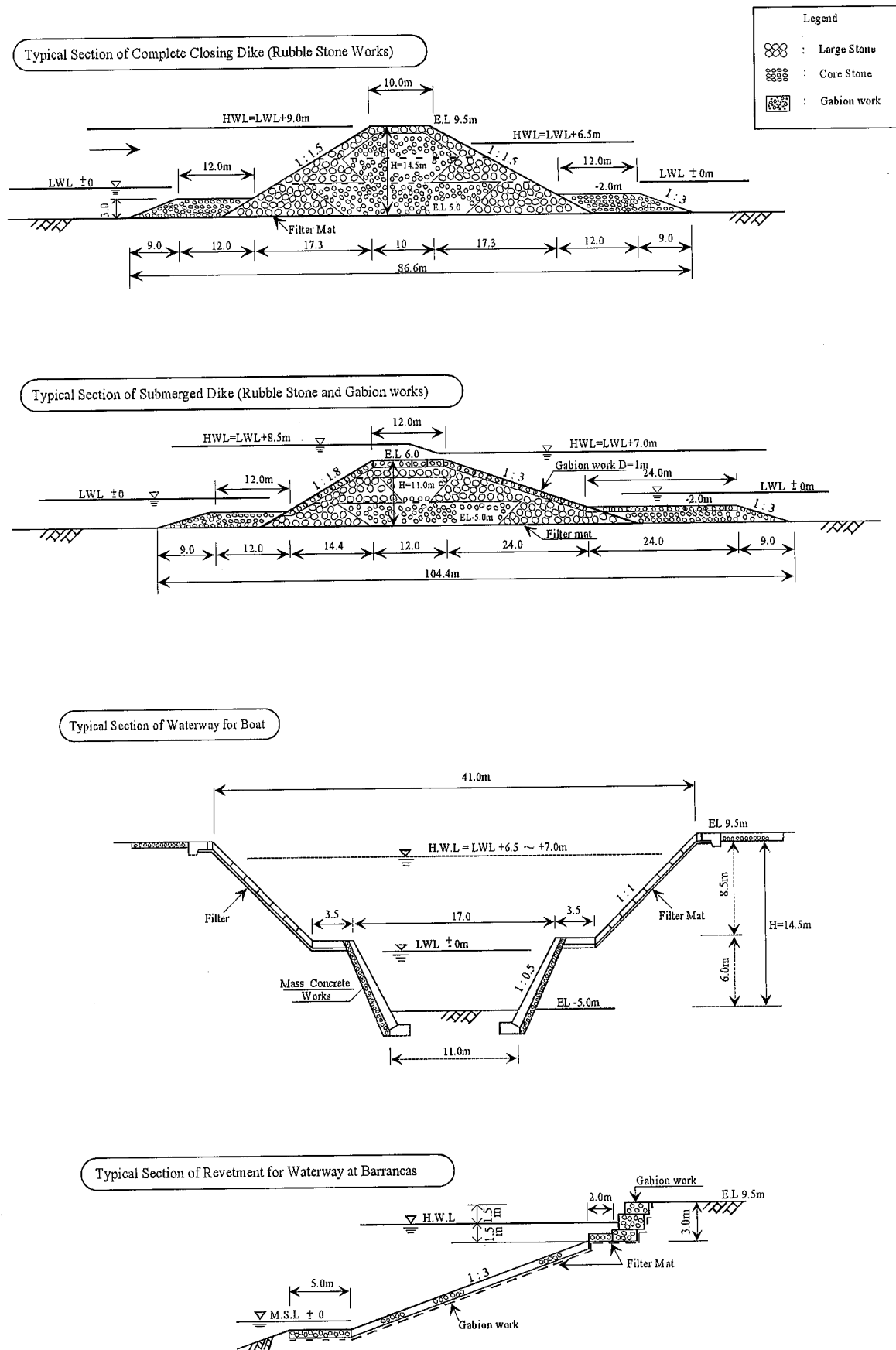


Fig.S-7-3

Typical Sections of Channel Improvement Structure