No. 1

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR ESTABLISHMENT OF FISH LANDING, PRESERVATION AND DISTRIBUTION FACILITIES AT MONOHARKHALI

IN

PEOPLE'S REPUBLIC OF BANGLADESH

JULY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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国際協力事業団
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PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a basic design study on the Project for Establishment of Fish Landing, Preservation and Distribution Facilities at Monoharkhali and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team headed by Mr. Akiyoshi Nakayama, Deputy Director, Fishing Port Planning Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry & Fisheries from January 26 to February 24, 1991.

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

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

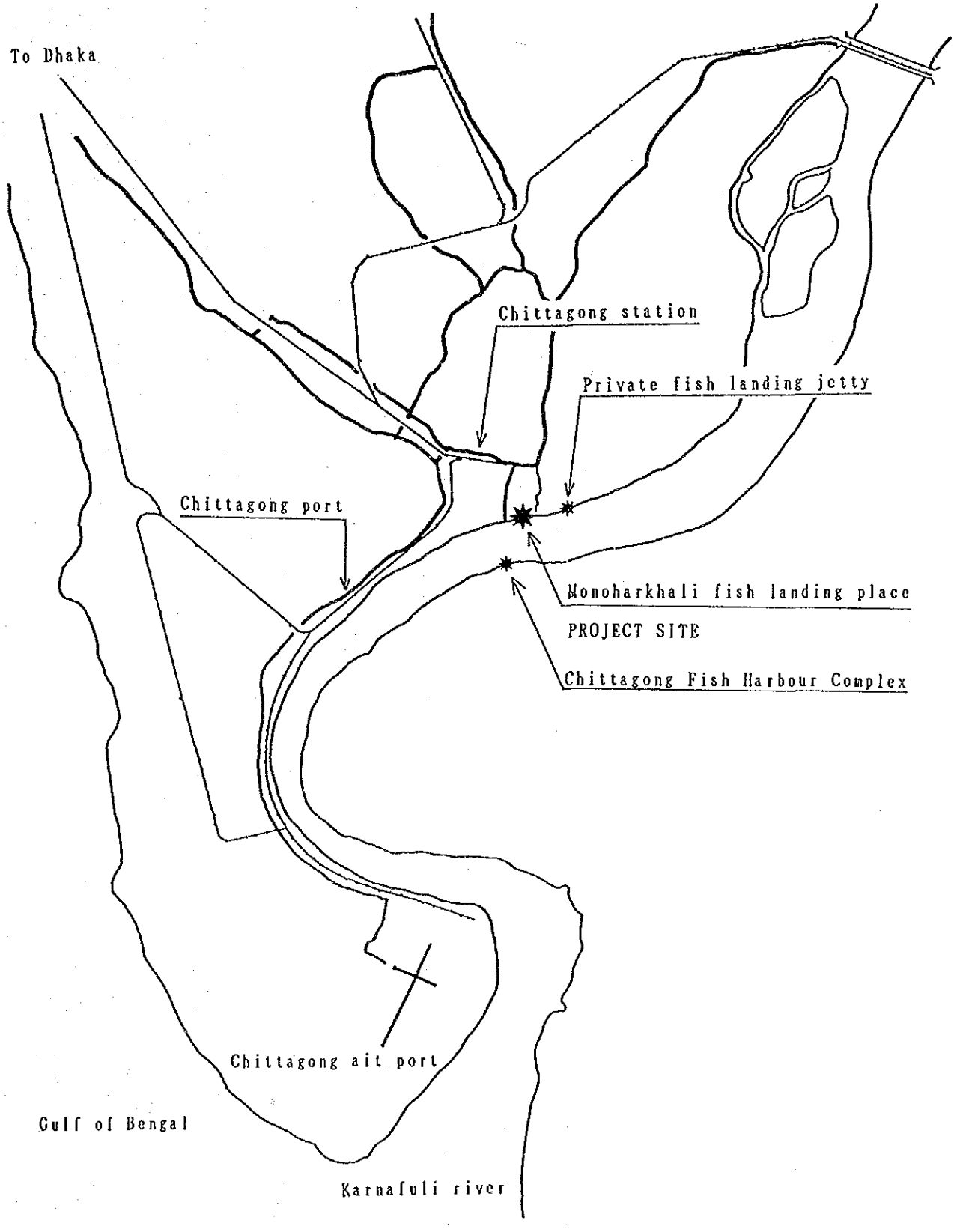
I wish to express my sincere appreciation to the officials concerned of the Government of People's Republic of Bangladesh for their close cooperation extended to the teams.

July 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

MAP OF CHITTAGONG



SUMMARY

SUMMARY

In the People's Republic of Bangladesh much hope is being placed on the promotion of fisheries within the context of securing the supply of animal protein to and improving the nutritional conditions of the people. The Government of Bangladesh is attaching top priority to the promotion of fisheries in the Fourth Quinquennial Development Plan (1990-95) with the object of increasing the supply of fishery products to the people. However, proper fishery infrastructure and fish distribution facilities in Bangladesh are lagging behind and can not appropriately support fish landing, distribution and marketing. These circumstances result in low efficiency of the fish landing and deterioration of the quality of the catch, consequently, interfere with the increase of fish supply to the people and the development of fisheries.

In view of this background, the Government of Bangladesh has decided to take measures to improve the existing fish landing and distribution facilities at Monoharkhali in Chittagong, which is the most important fish landing area of the marine fishery of the country. In this regard, a request was presented to the Government of Japan to allocate Grant Aid under the Grant Aid Program for the establishment of fish landing, preservation and distribution facilities, with the object of increasing the fish landings, realizing efficient utilization of the catch, etc., through streamlining fish landing and distribution.

In response to this request, Japan International Cooperation Agency (JICA) has sent a Preliminary Study Team, to Bangladesh from June 23 to July 4, 1990. As a result of the Preliminary Study, the propriety of the project implementation under Japan's Grant Aid Program was confirmed.

Based on the results of the Preliminary Study, the government of Japan has decided to execute the Basic Design Study of the project, and JICA sent the Basic Design Study Team to Bangladesh from January 26 to February 24, 1991. The Basic Design Study Team has carried out such works as the confirmation of the contents of the request and the project, geological survey at the project site, etc. After the team returned to Japan, further studies were made. Then, a mission was sent to Bangladesh from July 1 to July 10, 1991 in order to discuss a draft report and the present report was prepared.

The project is aimed at constructing fish landing, distribution and preservation facilities capable of coping with the current demands as well as suggesting the most effective use of the facilities to cope with the demands in near future by improving fish landing and distribution methods. As a result of field survey and analysis, construction of the following facilities and supply of the following equipment are judged most appropriate for realizing the project objectives.

(1) Fish landing facilities

1) Floating pontoon	Steel structure, 20 mL x 10 mW x 3 units
2) Gangway	Steel structure, 25 mL x 5 mW x 2 units
3) Fish landing apron	Steel pile structure, extension 70 m, depth -2.0m apron area 490 m^2 (70 mL x 7 mW)
4) Collision protector	Mooring buoy system, 12 sets

(2) Fish distribution facilities

1) Wholesale market building	RC concrete structure, single floor with mezzanine
a) first floor	auction space 1,316 m^2
b) mezzanine	auctioneers' rooms 609 m^2 (42 rooms)
2) Fish loading space and parking	concrete block pavement 2,700 m^2
3) Canal bridge	floor panel & RC pile structure, 16 mL x 12 mW
4) Equipment	
a) fish container	50 l volume, 1,830 sets
b) fish cart	150 kg load, 40 sets

(3) Fish preservation & Administration facilities

1) Ice plant & Administration building structure	RC concrete structure, double floors
a) first floor	Ice making room 446 m^2 (daily production of 32 tons of 135 kg block ice) Ice storage 139 m^2 (temporary storage of 20 tons and ice storage of 96 tons) Ice handling & passage 63 m^2
b) second floor	Administration office 168 m^2 (general manager room, conference room, office, etc.)
2) Guard post	brick flat structure, 10 m^2
3) Facilities for power receiving and water receiving & supply	

The Bangladesh Fisheries Development Corporation (BFDC) will take charge of the execution of this project. The contents of the facilities and the equipment of the project are designed to cope with BFDC's manning and budgetary planning.

This project will be implemented in two phases. In the first phase, it will take about 2.5 months for detail design and 11.5 months for construction. In the second phase, it will take 2.5 months for detail design and 11.5 months for construction.

Details of each phase construction are as follows.

- Phase I
  Civil engineering works (floating pontoon/gangway, canal bridge, etc.) : Realization of the fish landing functions.

- Phase II
  Construction works (wholesale market, ice-making plant, etc.) : Realization of the fish distribution and preservation functions.

This project is aimed at improving fish landing and distribution through the construction of fish landing and distribution facilities for artisanal fishery in Chittagong, the center of marine fishery in Bangladesh. The following impacts are expected as a result of the implementation of this project.

1) In the fish landing and distribution facilities existing in the project area, the fish, precious source of animal protein in Bangladesh, suffer a remarkable loss of quality and value during the waiting for landing, the landing itself and the distribution process. Deterioration of the quality and decline of the value of the fish are expected to be prevented as a result of the improvements through the implementation of this project, thereby making substantial contributions to the economy of Bangladesh.

2) One of the disadvantages of fishery products comparing with other sources of animal protein is the high degree of vulnerability of their quality due to the surrounding environment. However, since the facilities of this project have an appropriate level of environment sanitation, it will be possible to supply further hygienic animal protein sources to the consumers.

3) The mechanized artisanal fishing boats, the major objects of this project, are currently forced to reserve 3 days for landing their catch and to make preparations for sailing, while the actual fishing period of each trip is just an average of 7 days. Improper equipment of the landing and preparation facilities is the major cause of this situation. When the improvements planned in this project are implemented, it would be possible to shorten the period required for the fishing boats to land their catch and to make preparations for the next sailing down to a maximum of one day. In that case, it would be possible to increase the fishery production through the improvement of the operation efficiency of the fishing boats even when the existing fishing boat fleet is not increased.

4) It is presumed that within the context of the operation of this project, to be taken charge by the BFDC, improvement will be possible not only in the fish landing and distribution process, but also in some aspects related to the form of distribution (e.g. control over the fishermen by the distribution business, unreasonably low fish prices, etc.) that have ample room for improvement. The establishment of fair distribution practice through the market will make ample contributions to the benefit of the people in general.

5) Improvements in the fish landing and distribution activities that are expected to be realized within the context of this project will play the role of a model case for Bangladesh, and the achievements of this project will bring about strong impact to stimulate the development of the fishery and the distribution of fishery products in Bangladesh.

Consequently, implementation of this project under Japan's Grant Aid Program is judged very significant. This report also presents recommendations to improve current ways of fish landing and distribution in order to utilize the project facilities and equipment and to assure the impacts expected by the project.

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CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

In the People's Republic of Bangladesh much hope is being placed on the promotion of fisheries within the context of securing the supply of animal protein to and improving the nutritional conditions of the people. The Government of Bangladesh is attaching top priority to the promotion of fisheries in the Fourth Quinquennial Development Plan (1990-95) with the object of increasing the supply of fishery products to the people. However, proper fishery infrastructure and fish distribution facilities in Bangladesh are lagging behind and can not appropriately support fish landing, distribution and marketing. These circumstances result in low efficiency of the fish landing and deterioration of the quality of the catch, consequently, interfere with increase of fish supply to the people and progress of fisheries development.

In view of this background, the Government of Bangladesh has decided to take measures to improve the existing fish landing and distribution facilities at Monoharkhali in Chittagong, which in spite of being the most important fish landing area of the marine fishery of the country, is unable to give full play to their functions under the current conditions. In this regard, a request was presented to the Government of Japan to allocate Grant Aid under the Grant Aid Program for the establishment of fish landing, preservation and distribution facilities, with the object of increasing the fish landings, realizing efficient utilization of the catch, etc., through streamlining fish landing and distribution.

In response to this request, Japan International Cooperation Agency has sent a Preliminary study Team, headed by Mr. Noboru Oshima, Deputy Director, Fishing Port Construction division, Fishing Port Department, Fisheries Agency, the Ministry of Agriculture, Forestry and Fisheries, to Bangladesh from June 23 to July 4, 1990. As a result of the Preliminary study, the following points were examined and the

propriety of the project implementation under Japan's Grant Aid Program was confirmed.

1) Monoharkhali is an important fish landing and distribution place for artisanal fisheries which supports fish supply to the people of Bangladesh.
2) The existing fish landing and distribution facilities at Monoharkhali can not fulfill present fish landing and distribution demands there and landed fish are deteriorated due to poor hygienic conditions.
3) Improvement in the relevant facilities at Monoharkhali results in benefits to fishermen and local residence not only in Chittagong but Dhaka and other areas as well. Furthermore, it plays a key role in the improvement of nutritional conditions of people of Bangladesh.
4) As Chittagong Fish Harbour Complex, located on the opposite side of Karnaphuli river against Monoharkhali, is for marine industrial fisheries, the Harbour will not compete with this Project.

Based on the results of the preliminary survey the Government of Japan has decided to execute the Basic Design Study of the project, and Japan International Cooperation Agency has sent the Basic Design Study Team, headed by Mr. Akiyoshi Nakayama, Deputy Director, Fishing Port Planning Division, Fishing Port Department, Fisheries Agency of the Ministry of Agriculture, Forestry and Fisheries, to Bangladesh from January 26 to February 24, 1991. The Basic Design Study Team has carried out such works as the confirmation of the contents of the request and the project, geological survey at the project site, etc.

After the team returned to Japan, further studies were made. Then, a mission headed by Mr. Akiyoshi Nakayama, Senior Researcher, Aquaculture and Fishing Port Engineering Division, National Research Institute of Fisheries Engineering, Fisheries

Agency, Ministry of Agriculture, Forestry and Fisheries, was sent to Bangladesh from July 1 to July 10, 1991 in order to discuss a draft report.

This report analyzes and examines information collected during the field survey, examines the appropriateness of the project, formulates the basic design, and presents conclusions regarding the project evaluation.

Such information as the list of members of the study team, the field survey schedule, the minutes of discussions and other data are attached to the end of this report.

CHAPTER 2
BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 General Conditions in the People's Republic of Bangladesh

The People's Republic of Bangladesh (hereinafter called Bangladesh) is located at the eastern end of the Indian subcontinent, facing the Bay of Bengal to the south and borders India's West Bengal state to the west, the Assam and Meghalaya states to the north and the Tripura and Mizoram states to the east. The mountainous districts around Chittagong borders Myanmar (Burma). The lower reaches and the estuaries of three large rivers, Padma (Ganges), Jamuna and Meghna, account for most of the territory of Bangladesh, which has the typical characteristics of a delta with tributaries and branches criss-crossing in a complicated way.

Since most of the national territory of Bangladesh is formed as a result of the sedimentation effect of large rivers consisting mainly of three rivers mentioned above, most of the topography consists of plains with practically no undulations, and the difference in altitude over the 600 kilometers in the north-south direction is barely 40 meters. The water level of these rivers rises over a wide area of its land conspicuously during the rain season, and 84% of the national territory was flooded in 1988.

The climate divides the year in three seasons such as summer season (intermediate period from March to May), the monsoon season (rain season from June to October) and the winter season (dry season from November to February). The summer season accounts for 18% of the annual rainfall, the monsoon season for 78% and the dry season for 4%, respectively. As can be seen, the monsoon season accounts for most of the annual rainfall of the country, with particularly heavy concentration of rainfall during the season from June to August, followed by a dramatic reduction in October. South-eastern winds from the Bay of Bengal to the land

direction are predominant during the monsoon season, and they carry the humidity that brings about the heavy rainfall. Moreover, a number of cyclones break out every year in the Indian Ocean during the monsoon season, and damage is caused by flood tides and the wind that accompanies them, particularly in the southern part of Bangladesh. Strong thunderstorms occur all over the country in during the summer season, with particularly high frequency in the northwestern part of the country. Generally speaking, the rainfall is large in the eastern part and small in the western part of the country, and the annual average in overall Bangladesh is of the order of 2,100 mm.

The land area of Bangladesh is 143,998 km^2 (equivalent to 40% of Japan) and the estimated population of 1988 is about 109 million. This gives a population density of 947 inhabitants per square kilometer of the dwell areas (around 115,000 km^2) excluding rivers and woods. Bangladesh's population density is one of highest countries in the world. According to the survey carried out in 1981 a net demographic growth rate of 2.2% was estimated and the population is expected to be approximately 130 million before 2000. The population ratio in urban areas has increased from 5.2% in 1961 to 15.2% in 1981.

According to World Bank, the gross national product (GNP) per capita was US$170 in 1988. Agriculture (including fishery of 3.1%) accounts for 38.7% of the GDP whereas transportation and communication accounts for 10.5%, industry for 8.5%, housing and services for 7.4% and commerce for 8.2%. In view of these figures, it may safely be said that Bangladesh has a typically monoculture economic structure relying heavily on agriculture. As for the state of employment in the various sectors as of 1986, agriculture accounts for 57.2%, industry for 9.9%, public servants for 0.1%, construction for 2.1% and commerce for 30.7%.

With regard to international trade balance in 1989, it is estimated that exports of traditional commodities (jute, tea, leather, etc.) amounted to US$65 million and that exports of non-traditional commodities (fishery products, garments, etc.) amounted to US$819 million, with frozen fishes and shrimps accounting for US$152 million (10.3% of the total sum of exports). The imports amounted to US$3,652 million in total, with food totaling US$586 million (16.0% of the total sum of imports).

"Structural Deficit of the International Balance of Payments", "Permanent Budgetary Deficit", "Unemployment" and "Absolute Poverty" are regarded as the major problems of the economy of Bangladesh.

2-2 National Development Plan

The main targets of the Third Quinquennial Plan (1985-90), whose priority theme is improvement of poverty, are listed in the following.

1) Reduction of the population growth
2) Increase of productive employment
3) Increase in of elementary education
4) Equipment of the infrastructure for technical innovation
5) Establishment of the system for self-sufficiency in food and improvement of welfare
6) Satisfaction of the basic human needs
7) Acceleration of the economic growth
8) Development of self-sustained economy

The main goal of the Fourth Quinquennial Plan (1990-95) is the development of human resources with priority attached to the increase of the income of the people, independence of the economy and creation of chances of employment. There is no basic difference from the previous Quinquennial Plans, but further importance is attached to strengthening the private sector comparing with the Third Quinquennial Plan. While the financial scale of the plan is estimated as 672.3 billion Taka, 52% of the financial resources depends on foreign aid.

2-3 Outline of the Fisheries Sector

2-3-1 General Conditions of the Fisheries

According to Bangladesh Statistical Year Book of 1990, in 1987/88, fisheries accounted for 3% of the GDP and for 8% of the added value of primary products. The number of professional fishermen is estimated to be approximately 1.28 million as of 1988/89, with 60% engaged in inland-water fisheries and 40% engaged in marine fisheries.

In Bangladesh, fish is an important source of animal protein. During the 1985/86 period the daily consumption of fish protein mounted to 8 grams/day per capita. That accounts for barely 12% of the daily consumption of protein per capita (63.5 grams/day), but it must be remembered that it accounts for 71% of the consumption per capita of animal protein (11.03 grams/day).

The fisheries sector is growing rapidly as a source of foreign currency. From 1975/76 to 1988/89 the exports of Bangladesh increased by approximately 7 times from 5.5 billion Taka to 41 billion Taka. During the same period the exports of

fishery products increased by more than 20 times from 200 million Taka to 4.7 billion Taka mainly by increase of export of frozen shrimp and frog leg, and accounted for 12% of the export value. Frozen shrimps account for more than 80% of the exported value of fishery products.

Broadly speaking, the fisheries of Bangladesh consists of four categories, inland-water capture, inland-water culture, industrial marine fishery and artisanal marine fishery. It is estimated that the catches during the 1987/88 period reached approximately 827,000 tonnes, with inland-water capture accounting for 424,000 tonnes, inland-water culture for 176,000 tonnes, industrial marine fishery for 10 thousand tonnes and artisanal marine fishery for 217 thousand tonnes. The annual growth rate of the fishery production averaged to 2.4% during the 1983/84 to 1987/88 period. (See Table 2-1).

From the fishery production data and demographic statistics it is presumed that the annual consumption per capita of fishery products mounts to approximately 7.5 kg of gross fish weight. The goal for 1994/95, which is the last year of the Fourth Quinquennial Plan, is to increase that consumption to 9.5 kg.

In Bangladesh, the private sector is playing a predominant role both in fishing and in the distribution of fishery products. The Department of Fisheries and Bangladesh Fisheries Development Corporation (BFDC) of the Ministry of Fisheries and Livestock are taking the initiative to improve the infrastructure of the fishery sector. The Chittagong Fish Harbor Complex being operated by the BFDC is the only fishing port available in Bangladesh. Besides the this complex the BFDC is operating a number of public facilities such as 9 fish landing centers and 7 fish wholesale markets. These facilities have basic installations such as wharves, floating pontoons, auction halls, ice-making facilities, etc. On the other hand, the fish landing facilities and fish marketing facilities that

are being operated by the private sector engaged in the fish distribution consist mostly of wooden jetties and open markets, which are not appropriate for supporting sound fishing and fish marketing activities.

As for the ice-making facilities in Bangladesh, the number of plants in 1986 is 285 with a daily production capacity of 3,500 tonnes, but the actual operation rate is about 60%. As for freezing plants in Bangladesh, there are 63 units in total consisting mainly of plants for freezing shrimps and bottom fishes, and their daily freezing capacity is around 360 tonnes. The construction of a new freezing plant is under way in the Khulna district.

2-3-2 Administrative System

The administrative system of Bangladesh related to fisheries is under the control of the Ministry of Fisheries and Livestock. The fisheries section of this Ministry belongs to the Department of Fisheries and to the Bangladesh Fisheries Development Corporation (BFDC). The Department of Fisheries is in charge of the control and development of the inland-water and marine fishery and aquaculture, control and survey of natural resources, education and training. On the other hand, the BFDC is the executive organization in charge of fishery projects implementation. It has production and distribution facilities in the main districts of the country, and it carries out the construction and repair of fishing boats, the manufacture of fishing nets, and the operation of facilities of various kinds for fishery training. Figure 2-1 shows the organization chart of the Department of Fisheries and Figure 2-2 shows the organization chart of the BFDC.

The predecessor of the BFDC was established in 1964 by Law No. 6 of Pakistan, but in 1973 it was reorganized by the Clause

No.22 of Bangladesh into a state-owned corporation under the control of the Ministry of Fisheries and Livestock.

The BFDC has the following functions ;

a) To take all measures for development of the fisheries and fishing industry of Bangladesh.
b) To establish fishing industry.
c) To establish units for capture and promote a better organization for exploitation of fish wealth.
d) To acquire, hold or dispose of boats, fish carriers, road and river transports and all equipment and accessories necessary in connection with the development of fishing industry.
e) To establish units for preservation, processing, distribution and marketing of fish and fish products.
f) Advance loans to fishing industries and to the fishermen cooperative societies.
g) To encourage establishment of fishermen cooperative societies. Undertake survey and investigation of fishery resources.
h) To establish institute or make arrangements for the training and research in the methods of catching, processing, transportation, preservation and marketing of fish.
i) To acquire, hold and dispose of such other properties as are required for carrying out all or any of the above mentioned purposes.
j) To formulate schemes for carrying out all or any of the functions specified above.

2-3-3 Outline of the Fishery Development Plan

The goals of the fisheries sector of the Third Quinquennial Plan (1985-1990) of Bangladesh as announced on are listed in the following.

1) To increase the production of the fisheries sector, thereby securing the sources for supplying animal protein with the object of improving the state of nutrition intake of the people.

2) To expand the chances of employment in the fishery and related trades, as well as to improve the welfare in fishery communities.

3) To increase the exports through the development of new fishery products for export.

4) To improve the living environment and the welfare of the people.

The concrete goals to be attained are mentioned in the following.

1) To increase the fishery production from 774,000 tonnes in 1985 to 1 million tonnes in 1990. The breakdown of that production will consist of 772,000 tonnes of inland-water fishery production and 228,000 tonnes of marine fishery production.

2) To increase the exports of fishery products up to the level in 1990, consisting of 30,000 tonnes of shrimps, 2,000 tonnes of frog legs and 6,000 tonnes of fishes.

3) To increase the number of persons employed in the fisheries sector up to 100,000 in 1990.

Programs covering such matters as control of natural resources of inland-water fishery, training and propagating aquaculture techniques in fresh water and brackish water as well as installation of the required facilities, equipment and

modernization of distribution facilities, strengthening and expansion of the fishery resource facilities, expansion of marine fishery, etc., in order to attain these goals. As things now stand, the Third Quinquennial Plan is in its final phase of execution, but only the goals for the marine fishery production and frog legs have been attained so far.

As for the Fourth Quinquennial Plan (1990-1995), the works for its formulation are in their final phase, and basically it will follow the goals of the Third Quinquennial Plan. The listing of the individual projects to be included in the Fourth Quinquennial Plan is practically finished. Of these projects, 36 are under the control of the Department of Fisheries and 7 are under the control of the BFDC.

The Department of Fisheries is in charge of many projects related to aquaculture and inland-water fishery development that are included mainly within the scope of the Third Fisheries Development Plan. On the other hand, the BFDC is in charge of many projects related to the promotion of marine fishery and improvement of distribution facilities, and the Project for Establishment of Fish Landing, Preservation and Distribution Facilities at Monoharkhali, which is the object of this study, belongs to this category.

2-4 Outline Of The Subsector In Question

2-4-1 Marine Fishery

The Bay of Bengal, which is the main fishing ground of Bangladesh, has a total area of approximately 5.2 million km^2 with depth under 200 meters. Of that total, approximately 69,900 km^2 belong to the Exclusive Economic Zone of Bangladesh, and 36,200 km^2 corresponding to approximately half of that

area have depth under 50 meters. Large volume of fresh water containing nutrients flows into this sea area from many rivers including the large rivers as Padma, Jamuna, Meghna, etc. At the center of the Bay of Bengal there is a sea trench called "Swatch of No Ground" and it generates a upwelling flow in the offings of Khulna which raises sea water containing deep sea nutrients to the surface.

From October to March in the dry season the predominant winds in the Bay of Bengal are from the north and north-east with mild wind force and mild sea conditions. From April to September in the rain season, there is predominance of winds from south and west, the wind force increases to 3-6 (Beaufort wind force class), the sea becomes stormy and the operation of small fishing boats becomes difficult.

The fishing methods that are being practiced consist of net trawling, gill-netting and traditional set bag netting. Such kinds of fish as shrimp, jewfish, catfish, etc., are caught by trawling. Hilsa, jewfish, catfish, pomfret, spanish mackerel, horse mackerel, indian salmon, etc., are caught with gill-netting, and hilsa, pomfret, bombay duck, swordfish, jewfish, shrimp, etc., are caught with set bag netting.

The number of people engaged in marine fishery is increasing yearly and the total number has increased from 334,000 in 1980 to 497,000 in 1988. The number of trawlers has doubled from 26 in 1980 to 54 in 1980. The number of mechanized fishing boats has increased by approximately 2.4 times from 1,400 in 1980 to 3,317 in 1988. About 14,000 non-mechanized fishing boats are operated in the marine fishery. The major marine fishing bases of Bangladesh are Chittagong for trawlers and Chittagong, Cox's Bazar, Barisal, Khulna, etc., for artisanal fishery. The production of marine fishery during the 1987/1988 period came to 227,582 tonnes, with industrial marine fishery consisting mainly of trawling, accounting for 10,395 tonnes and artisanal marine fishery accounting for 217,187 tonnes.

Examining in detail the composition of artisanal marine fishery one sees that in terms of fishery production, gill-net fishery accounts for approximately 61% (132,890 tonnes/year) of the total, set bag net fisheries for approximately 29% (63,464 tonnes/year), long line fishery for approximately 3% (6,118 tonnes/year) and other methods for the rest. Mechanized fishing boats play a very important role in artisanal marine fishery. Indeed, mechanized fishing boats account for 90% of the gill-net catch and 80% of the long-line catch, and moreover they account for 70% of the transportation of set bag net catch (seasonal set bag net catch). Such being the case, it must be pointed out that the landing of 168,093 tonnes, that correspond to 77% of the production of artisanal marine fishery, were landed by mechanized fishing boats during the 1987/88 period. Of the 3,317 mechanized fishing boats existing at the present time 85% (2,797 boats) are engaged in gill-net fishing, 9% (310 boats) are engaged in long-line fishing, and the remaining 6% (210 boats) are being used in the transportation of seasonal type bag net catch. (See Table 2-2).

The existence of 3,317 mechanized fishing boats was confirmed as a result of the survey carried out by the Department of Fisheries in 1984/85, but it must be remembered that no follow-up surveys have been carried out after then. Moreover, since the fishing boat registration system of the Department of Fisheries is not working, the authorities do not have control over the existing number of mechanized fishing boats, and as a matter of fact, from the statistical point of view, the matter is being handled as if there were no increase in the number of mechanized fishing boats. On the other hand, the construction of mechanized fishing boats is very active in recent years, and the Department of Fisheries believes that more than 300 new boats are being built every year. Since the service life of mechanized fishing boats exceeds 10 years, it is least likely that there are less mechanized fishing boats than 1984/85. These mechanized fishing boats are of the order of 5-10/T, 12 to 15 meters in overall length (18 meters at the

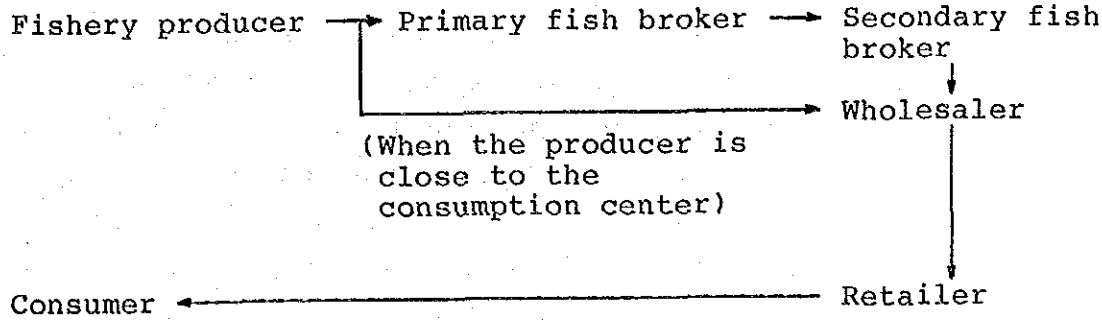
most), 3 to 4 meters in width, 2.5 to 3.5 meters in height and 1 to 2 meters in draft. The crew is of the order of 10 to 14 persons, the engine power is of the range of 22 to 45 HP, the speed is of the 4 to 6 knots, the fish hold has capacity of 2 to 4 tonnes, and they sail for fishing with 2 to 8 tonnes of ice blocks. As for the distribution by area of these mechanized fishing boats, they are concentrated in 2 major areas, 1,822 units in Cox's Bazar and 1,128 units in Chittagong. (See Table 2-3).

Gill-net fishing plays a leading role in the artisanal fishery by means of mechanized fishing boats, and it brings about more than 50% of the production of the artisanal fishery. The standard fishing trip of gill-net fishing boats has a duration of about 7 days. The gill-net mechanized fishing boats sail out at cycles of 10 days, with 3 days for landing, preparations and maintenance in addition to the said 7 day period on the sea. It must be kept in mind, however, that the average catch per trip falls under 0.5 tonnes during the off-season period from July to August, and may exceed 2.5 tonnes during the fishing season from September to November. During the 1988/89 period the annual catch of each gill-net fishing boat averaged 63.5 tonnes. The number of fishing boats in operation averaged 1,668 and since there are 2,797 mechanized gill-net fishing boats in total their operation rate was approximately 60%. (See Table 2-4).'

2-4-2 Fish Marketing

Approximately 95% of the fishery production of Bangladesh is being sold through commercial distribution channels. As for the form of distribution, approximately 85% is being distributed in the form of fresh fish and approximately 15% in the form of processed products. Anyway, since the demand of fresh fish is increasing in view of the recent demographic growth and other relevant factors, the percentage of fish distributed in fresh is increasing.

As a general rule a fresh fish is distributed through the routes shown in the figure below ;



Besides the distribution mechanism mentioned above, the BFDC and the BJMSS (Fishing Cooperative) have their own distribution channels, but their sales are just 2% of the total. These fish brokers, particularly most of the primary fish brokers, provide fishery producers with financial aid and buy the catch on exclusive basis. Moreover, the price is often determined by the broker.

The road, railways and ships in coastal areas and in rivers are the most important means of transportation. Bangladesh is crisscrossed by rivers of various sizes and most of the roads are flooded and becoming useless during the rain season. Moreover, automotive vehicles must rely on ferry boats at places where roads cross rivers, and to worsen the situation railway network is not sufficiently developed yet. And these are reasons of the transportation via navigation routes. It must be kept in mind, however, that in the arterial routes such as Dhaka-Chittagong and other areas the road situation is improving and land transportation by means of large trucks is getting in general use. As for the form of transportation, fish are packed with crushed ice in bamboo baskets, half-cut drums or other appropriate containers and covered with jute bags. In general, ice is used in fish distribution at about same quantity as fish.

There are wholesale markets including fish in the major towns of the various areas, but most of these markets are operated by the private sector in which the fish brokers play a leading role. Many wholesale markets have good location conditions and play an important role in the distribution system. However, only a few of them are being utilized in function because there are not enough fish landing facilities such as jetties, floating pontoons, transportation facilities such as access road and parking lots for markets, ice-making plants, cold storage, sanitary facilities such as drainage ditches, or waste-water treating installations, etc. Moreover, in most of the cases, the auction halls have bad sanitary conditions because they are not paved with concrete and these are not enough water drainage facilities. Wholesale commissions of the order of 3% to 6% are being charged in these private wholesale markets. At retail markets serving the consumers, fishery products are being sold together with other kinds of food and consumer goods, but the buildings are old and the sanitary conditions are not good.

Besides the traditional distribution system mentioned above, the BFDC is carrying out activities of various kinds to streamline and modernize the fish marketing. The BFDC is engaged in duties of various kinds covering a vast field ranging from fishery development to marketing development, with top priority attributed to marine fishery. In the fish marketing field, BFDC operates the Chittagong Fish Harbor Complex, 9 fish landing centers (Cox's Bazar, Khulna, Rangamati, Kaptai, Dhaka, Mongla, Khepupara, Patharghata, Barisal) and 7 wholesale markets (Cox's Bazar, Khulna, Rajshahi, Barisal, Khepupara, Patharghata, Rangamati). It also operates the system for distribution fishery product via land routes as well as the Kawaran Bazar fish retail market in Dhaka and the distribution center in Pagla. Out of these BFDC facilities, two fish wholesale market are briefed as follows as similar facilities of this Project.

1) Cox's Bazar Fish Wholesale Market

This wholesale market is located in the riverside area of Cox's Bazar, and has a wholesale hall (auction hall, passage) of approximately 1,000 square meters, block ice plant with daily production capacity of 15 tonnes, ice storage with capacity of 30 tonnes, cold storage with capacity of 15 tonnes. It does not have exclusive fish landing facilities such as floating pontoons, etc. and the like, and the catch is landed either by running the mechanized fishing boat directly on the river shore during the full tide period or by transferring the cargo to dugout canoes on the river. As a general rule, the market is open from 6 AM to noon, but in many cases the market opens in the evening for the convenience of landing the catch depending on the tide. The market is open 359 days a year, and closed for 6 religious holidays. The amount of fish landed during the 1989/90 period was 6,581 tonnes. The annual landing during the 1985/86 period was just 2,115 tonnes, and it has been increasing rapidly in the recent years. When there is a large landing, the capacity of the existing facilities is insufficient to give the catch proper handling, and there are plans to expand the wholesale hall by remodeling the fishing boat repair wing which is not used very frequently. There is large fluctuation in the monthly fish landings which ranges from less than 100 tonnes during the off-season period to more than 1,100 tonnes during the peak fishing season. Assuming that the effective wholesale area accounts for approximately 70% (about 700 square meters) of the overall area of the hall, the quantity of fish handled by square meter during the peak period of the fishing season is about 50 kg. Since the quantity of fishes that are handled per square meter in the current fish handling method (piling-up method) generally in use in Bangladesh is about 30 kg to 40 kg, it is presumed that the market is reaching the saturation point during the peak period of the fishing season. In the wholesale market there are 12 auctioneers authorized by the BFDC, and in general, the

auctioneers charge the sellers 5% of the selling price as auctioning commission. The BFDC charges the auctioneers 2% of the selling price for use of the market. The BFDC charges 425 Taka per truck for fish that are landed here and carried out instead of being auctioned because of the congestion of the market during the peak period of the fishing season and adoption of other forms of transaction. (See Table 2-5 and Table 2-6).

2) Khulna Fish Wholesale Market

This is the oldest wholesale market under the control of BFDC, and was opened in 1972. It is a two-story wholesale market located by the river close to Khulna town center, with the first floor consisting of the auction hall sized approximately 1,000 square meters and the second floor consisting of the auctioneers' rooms (18 rooms). The fish landing facilities at the river bank side consists of a concrete wharf equipped with a floating pontoon of 20 meters in length which is used for landing during low tide. The amount of fish handled in this wholesale market reached 4,300 tonnes per year during the 1983/84 and 1983/84 periods, but it has fallen to under 3,000 tonnes in recent years. This decline is occurring because this market is located at an inconvenient place deep inland, far from the Bay of Bengal, and the landing is being switched to the Barisal region which is located at a more convenient place. There are 18 auctioneers authorized by the BFDC operation in this wholesale market, and 5% of the selling price is charged as a commission to the sellers. The BFDC charges the auctioneers 2% of the selling price for use of the market. Moreover, the auctioneers are charged 890 Taka a month for using the auctioneers' rooms located on the second floor of the wholesale market. Each auctioneer's room is approximately 30 square meters, and the auctioneers use these rooms as offices and temporary dormitories. (See Table 2-7, Table 2-8).

2-5 Outline of the Request

2-5-1 Background of the Request

Chittagong is the most important marine fishery base of Bangladesh. Approximately 1,200 fishing boats in total, including small-sized wooden mechanized fishing boats, industrial trawlers engaged in large-scale industrial fishing, etc., are using this area as a base, and its fish landing accounts for approximately 30% of the production of marine fishery of Bangladesh. The Chittagong Fish Harbor Complex for industrial trawlers was constructed at the end of 1969. In the beginning, the complex was aimed at being used as a fishing harbor but in reality, this function is not being given full play due to the siltation which is occurring in the anchorage of the harbor. Anyway, it is being used to support the fishery activities through such functions as supplying ice, supplying water, processing fish, repairing, manufacturing of fishing nets, etc.

The mechanization (motorization) of wooden fishing boats has progressed steadily during the last 10 years thanks to the incentive measures taken within the context of the "Bay of Bengal Project" of the FAO and thanks to the support provided by foreign aid organizations. These mechanized wooden fishing boats are carrying out such activities as landing of the catch, loading of fuel and food, etc., by making use of a handful of wooden jetties projecting off the right bank of the Karnaphuli river. However, as these jetties are small-sized, during low tide the wooden fishing boats are forced to sit on the river bottom and to wait for the tide to raise. There are privately operated fish markets but they are carried out in open air, under the scorching sun during the dry season and under the rain during the rainy season. Under these improper sanitary conditions the fish spoil rapidly.

The Monoharkhali fish landing place is one of these

landing facilities. It has a fish market at the background area, and it functions as a facility for landing, collecting and distributing marine and fresh water fish. In 1981 the BFDC (Bangladesh Fisheries Development Corporation) formulated a plan for installing a fish wholesale market in Monoharkhali and submitted it to the Government of Bangladesh. The Evaluation Mission of DANIDA (Danish International Development Agency) visited the site in January 1982, and the project report was submitted in March of the same year. Based on that report the project was named "Chittagong Fish Wholesale Market Project", and in 1983 it was combined by the ADP (Annual Development Program) with the "Barisal Fish Landing and Preservation Facilities Project". The project was discussed at the PEC (Project Evaluation Committee) held in November 1983, and then it was sent to the ECNEC (Executive Committee of National Economic Council). At the ECNEC, it was decided to execute only the Barisal Project.

In connection with the Monoharkhali Project, the ECNEC asked the BFDC to execute it with its own financial resources. In October 1985 the BFDC informed the Ministry of Fisheries and Livestock that it was impossible to execute the project with its own financial resources, and pointed out that it was recommendable to execute it with financial resources of DANIDA. In the meantime the BFDC obtained from the CDA (Chittagong Development Authority) a 0.18 acre lot in 1984 and a 1.5 acre lot from CPA (Chittagong Port Authority) in May 1986. The ERD (Economic Relations Division) then requested the Government of Japan for assistance to implement the project.

In response to that request, the Government of Japan decided to conduct a preliminary survey and the JICA sent a preliminary survey team to Bangladesh from June 26 to July 4, 1990. It was found, as a result of this preliminary survey, that it was appropriate to carry out further studies on this project for grant-in-aid of Japan. Based on the results of this study, it was decided to send the Basic Design Survey Team to Bangladesh.

2-5-2 Objective of the Request

In Bangladesh, the daily intake of animal protein per capita is barely 11 grams, and since 70% of that total is fish protein, increasing the supply of animal protein to the people to improve nutrition is an issue of top priority for the nation. The promotion of fisheries is regarded as an issue of top importance within this context.

Chittagong is the largest marine fishery base of Bangladesh. The wooden artisanal fishing boats, that are responsible for securing the supply of fishery products to the people, land their catch and load their necessities in the landing sites located in the vicinity of Monoharkhali all along the right bank of the Karnaphuli river at the central city area of Chittagong. It must be remembered, however, that the fish landing facilities located in the vicinity of Monoharkhali are not properly established, and they are not satisfactory from the standpoints of size, functions and hygiene. The difference between high and low tide in this area, which is used by the small-sized fishing boats of artisanal fishermen, is 4 meters and the efficiency of the landing and loading activities at the existing wooden jetties is very low. Moreover, the outdoor market used for auctioning, handling and delivering the fish after the landing and the access roads have bad drainage conditions and are not sanitary.

This project is aimed at installing a floating pontoon for fish landing as well as constructing other public facilities such as a fish wholesale market, ice-making and fish preservation facilities at Monoharkhali in order to improve this situation. The execution of this project is expected to bring about such effects as increase of fish landings and effective utilization of the catch through the streamlining of landing and loading.

2-5-3 Contents of the Request

As a result of the preliminary survey it was confirmed that the Government of Bangladesh requested the following.

1) Construction of a jetty and floating pontoon that can be utilized by fishing boats engaged in coastal and offshore fishing that compose the artisanal fishery practiced in the project area. (Fish landing facilities)

2) Construction of an ice-making plant and cold storage. (fish preservation facilities)

3) Construction of a fish market. (fish distribution facilities)

4) Construction of an administrative building.

5) Supply of equipment required for fish landing and distribution.

CHAPTER 3
OUTLINE OF THE PROJECT AREA

CHAPTER 3 OUTLINE OF THE PROJECT AREA

3-1 Outline of the Chittagong District

Chittagong, where the project site is located in, is a city on the Bay of Bengal approximately 260 km to the south-east of Dhaka, the capital city of Bangladesh. The commercial harbor of Chittagong, located at the vicinity of the estuary of the Karnafuli river, plays an important role in connection with both domestic and international trade of Bangladesh.

According to the 1981 census the population of the Chittagong district, including both city areas and rural areas, was 4,465,000. Of that total, 1,392,000 was concentrated in the city of Chittagong. According to a population estimate after this census, the population of the Chittagong district as a whole is presumed to be approximately 5,805,000 in 1990 and 7,144,000 in 2000. The population of Chittagong city is presumed to be 1,810,000 in 1990 and will be 2,227,000 in 2000.

As for the contribution of the Chittagong district to the economy of Bangladesh, it accounted for 6.2% of the added value of agricultural, fishery and livestock products of the country in 1987/88. According to the manufacturing industry census of 1984/85 the Chittagong district accounts for 844 operations that correspond to 21% of the total of the nation. Thus, the Chittagong district contributed approximately 10% (approximately 60.8 billion Taka) of the GDP (current value of approximately 592.3 billion Taka) of Bangladesh as of 1987/88, which is comparable to the 12% contribution (70.9 billion Taka) of the Dhaka district.

3-2 Natural Conditions

3-2-1 Natural Conditions in General

(1) Climate

The project site (Monoharkhali district, Bridge Ghat area, Chittagong city) is located at latitude 22 degrees 19 minutes 30 seconds north and longitude 91 degrees 50 minutes 20 seconds east, belongs to the sub-tropical north and is subject to monsoons.

Broadly speaking, the year is divided in three seasons, the monsoon season (rainy season from June to October), the winter season (dry season from November to February) and the summer season (intermediate period from March to May). The wind direction changes from the south and south-east during the monsoon season to the east, then the north and then the west, and returns once again to the wind direction during the monsoon season. The heaviest rainfall occurs during the monsoon season, decreasing in the summer season and in the winter season, successively.

The most outstanding characteristic from the meteorological standpoint is the occurrence of cyclones. Chittagong is located in the route which the cyclones passes through, and 41 major cyclones have passed through the city during the last 42 years.

1) Temperature

Since the project site belongs to the sub-tropical region and is located in the coastal area, both the annual variations and daily variations of the temperature are not so large. Data referring to the temperatures recorded in 1988 are shown in the followings. (Refer to Figure 3-1 and Figure 3-2).

- Maximum annual temperature : 34.9°C
- Minimum annual temperature : 14.7°C
- Annual average temperature (estimated) : 25.7°C

2) Humidity

Generally speaking, the humidity is high with little variation. The monthly average humidity 1988 is shown below. (Refer to Figure 3-3).

- Maximum humidity : 89% (October)
- Minimum humidity : 69% (January)
- Annual average humidity : 77%

3) Rainfall

The rainfall recorded in Chittagong during the 1978-1988 period reached a maximum value of 3,728 mm in 1983 and averaged 2,924 mm. For the sake of comparison the rainfall in Tokyo is of the order of 1,460 mm. As can be seen, the rainfall at the project site is approximately twice as much as in Tokyo. (Refer to Figure 3-4).

The monthly distribution of the rainfall, it is concentrated during the monsoon season, with particularly heavy rainfall in June and July. In 1987, rainfall was recorded for 29 days of July, and the cumulative rainfall was 1,206 mm. The heaviest rainfall of 305 mm was recorded 8th of July 1988. No data is available about the continuous rainfall record but as can be seen from the example of July 1987, when there was no rainfall for only two days of the month, it is presumed that there is rainfall with practically no interruption in the monsoon season. (Refer to Figure 3-5).

4) Wind

Broadly speaking, the annual tendency of the winds in Chittagong consists of the predominance of southern and south-eastern winds from April to September during the monsoon season and the predominance of northern winds during the dry season and other directions during the transition season.

There are many days with high wind velocity during the monsoon season, but in the dry season there are many calm days with a mild breeze. These trends are summarized in the annual wind chart containing the wind directions and the wind velocities, attached to the end of this report. (Refer to Appendix VII-1). The wind velocity exceeds 10.3 m/s during 6% of the time over the year. The wind velocity exceeds 15 m/s during the cyclones that occur in the monsoon season, and these high velocities account for 0.1% of the year.

(2) Topography

Flood plains account for a vast amount (79.1%) of the land mass of Bangladesh. Approximately 30% of Bangladesh has an altitude below 4.5 meters. In the Chittagong district, the altitude is greater than 4.5 meters with exception of the Karnaphuli river banks, and there have been no cases of submergence during floods recorded so far.

The Chittagong district accounts for barely 6.1% of the national territory, but the wood areas of this district area 53.6% of the forests of the country. Forests account for 13.5% of the national territory of Bangladesh.

The artificially built Kaptai lake located at the upper reaches of the Karnaphuli river accounts for 46% (as of May) to 39% (as of October) of the lakes and marshes of the country. The Karnaphuli river is the 4th largest river of the country after the Padma, Jamuna and Meghna rivers. The project site is located on bank of the Karnaphuli river from the river mouth.

(3) Geological Characteristics

Since the land mass of Bangladesh is characterized by the extension of river estuary plains, most of the geology is Quaternary. In spite of the fact of being located in the estuary area, however, Chittagong is characterized by the existence of Tertiary layers.

In general, the geology of Chittagong consists of the Tertiary layer forming the hilly areas that stretch from NNW to SSE through the center of the city, the alluvial coastal plain stretching in the form of a belt parallel to the hilly areas at its western side and the alluvial plain of the Halda river, which is a tributary of the Karnaphuli river, located on the eastern side of the hilly area. The southern extremity of the Tertiary hilly area is located at the vicinity of Kafco (Fertilizer plant) plant on the left bank of the Karnaphuli river, and it stretches approximately 70 kilometers to the north up to the vicinity of Mirsarai. This stratum consists of the Miocene and the Pliocene, and is made of rocks such as fine sandstone, shale, etc. The stratum has an anticlinal structure, with its axis located to the western side of the hills, and the strike in the NNW direction. Moreover, the western edge of the hills form a fault.

The project site is located at the southern-most end of the Tertiary stratum and is covered with a few meters of alluvial sediment, but there is distribution of underground shale strata. This stratum has a strike line in an almost north-south direction, with a tilting of 5° to 10° to the east.

(4) Hydrological Characteristics

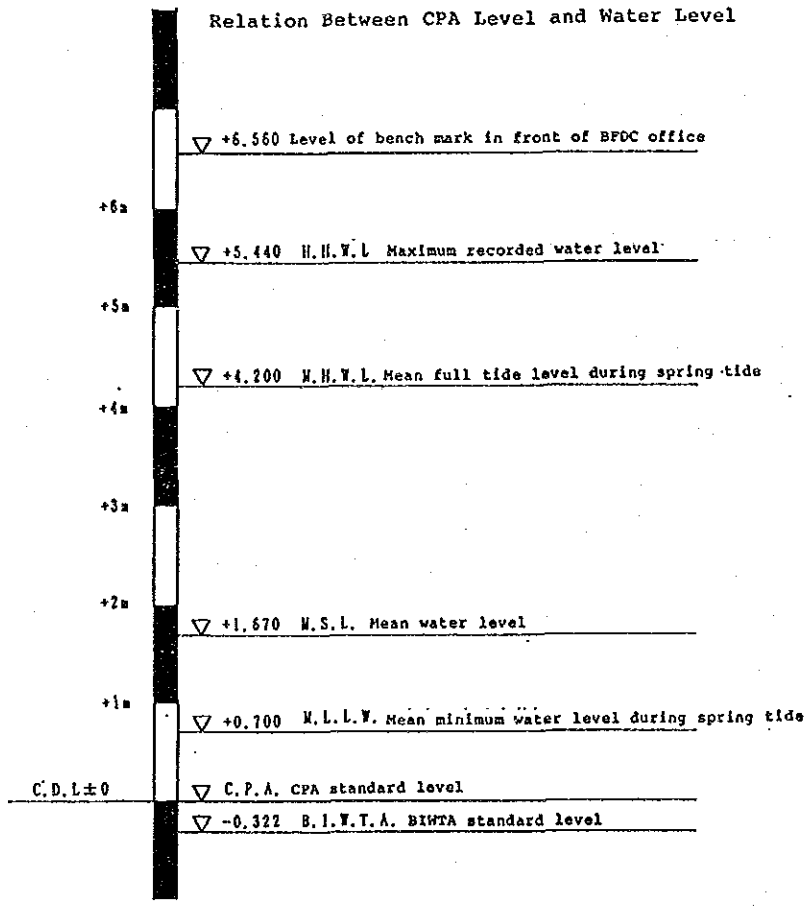
The Karnaphuli river has its sources in India, and at Chittagong discharges its waters in the Bay of Bengal after flowing down approximately 190 kilometers from the border. In the plain area it has an extremely gentle gradient, and the tide exerts on influence up to the mountainous areas located approximately 20 kilometers inland. The Kaptai dam is located in the middle reaches of the river and regulates the rate of flow.

1) Water Level

One point, which must be taken a notice in connection with the water level of the Chittagong district, is the existence of an original reference level called the CPA Level which is used as a reference level for navigational charts and heights as well. The Sadarghat Tide Station is located on the right bank of the river approximately 200 meters downstream from the project site. Tide level data recorded at station are based on the CPA reference level, and the observation results mentioned in the followings have been obtained from 1961 to 1990. These data are summarized in the figure below.

- Maximum recorded water level : +5.44 m
- Minimum recorded water level : ±0.0 m
- Mean full tide water level during spring tide : +4.20 m
- Mean minimum water level during spring tide : +0.70 m

(REMARKS) : All water levels refer to the CPA datum level (CDL). The BITWA standard level (CPA standard level - 0.322 m) is used more in general on the national level.



B.I.W.T.A. : Bangladesh Inland Water Transport Authority

C.P.A. : Chittagong Port Authority

The monthly average values of the maximum water levels recorded during each month of the 1985-1989 period indicate that the high water levels tend to occur during the monsoon season. (Refer to Figure 3-6).

The occurrence of the following water levels in unusual situations was confirmed as a result of the survey carried out with the parties concerned.

Date	Water level from the CPA standard Level	Observation site	Remarks
October 1 ,1966	+5.98 m	Jetty 1	
November 13 ,1970	+5.40 m	Jetty 1	Due to cyclone
November 28, 1974	+5.40 m	Sadarghat	
May 1975	+5.64 m	Sadarghat	Due to cyclone

The highest water levels recorded by CPA during the attack of the cyclone in April 30, 1991 are 10.13 m at Patenga near the river mouth, 7.25 m at KHAL-10 near Jetty 1 and 6.30 m at Sadarghat near the project site respectively. These are new records.

Fluctuations in the water level were observed by installing an Anderar tide gauge during the field survey carried this time, and the obtained results are shown in Appendix VII-2.

2) Flow Velocity

The flow velocity at the project site was measured during the field survey carried out this time. It was found, as a result, that both flow direction and flow velocity are determined by tide fluctuation, and the maximum flow velocity

was 0.5 m/s. It is known empirically, however, that there are noticeable differences in the flow velocity between spring tide period and neap tide period and during the monsoon season and the dry season. It must be remembered that this time the field survey was carried out during the neap tide period of the dry season. (Refer to Appendix VII-2).

The following data, measured at the opposite bank of the KHAL-10 tide station located downstream of the project site, are useful for the sake of analyzing the flow velocity at the vicinity of the project site.

(period)	: (flow velocity)
-Spring tide period of the monsoon season	: 2.3 to 2.8 m/s
-Neap tide period of the monsoon season	: 1.3 to 1.9 m/s
-Spring tide period during the winter season	: 1.54 m/s
-Neap tide period of the winter season	: 1.0 m/s
-When floods coincide with freshet	: 4.1 m/s

The situation described as "flow velocity of 4.1 m/s when flood coincides with freshet" means the case in which there is massive inflow of rain water after a rainfall exceeding 200 mm during 24 hours coinciding with freshet, and that results into a flow velocity of 4.1 m/s.

It must be remembered that the flow velocity is not even throughout the cross section of the river, and is heavily influenced by curves and other factors. Thus, data recorded at the KHAL-10 tide station can not be regarded as the flow velocity at the project site. The project site is located at the inner side of a bend of the river, and it was confirmed that the flow velocity occurring there is slower than the velocity at the opposite bank, by a simplified flow velocity observation carried out with echo sounding.

3) Water Quality

According to results of the observations on the temperature and salinity of river water, there is very low salinity at the project site in spite of the fact of being located at the estuary of the river. Whereas the salinity is of the order of 33 to 38 p.p.m. the salinity measured at the project site is barely 6 p.p.m. Moreover, that value occurs only during the high tide period. It must be remembered, however, that the salinity becomes somewhat high when the inflow of sea water presents a slat wedge pattern due to its differential density. The observation results of the salinity is shown below. (Refer to Figure 3-7).

	At SADARGHAT	At PATENGA
During the low water level period of the monsoon season	0.1 g/L	0.15 g/L
During the high water level period of the monsoon season	0.2 g/L	3.3 g/L
During the low water level period of the dry season	0.25 g/L	10.0 g/L
During the high water level period of the dry season	16.5 g/L	27.0 g/L

4) Waves

Generally speaking, waves are low. According to the CPA YEAR BOOK 1989 the wave height exceeded 2 meters only a few days during the 1972-1977 period, and those large wave heights were observed only during a short period during the day.

Since the project site is located on 16 km upstreams from the estuary mouth and in view of the water depth and river breadth characteristics, it is presumed that the possibility of occurrence of this wave height is very small.

5) River Bed Material and Siltation

River bed sedimentation samples were collected at places located 100 m upstream and downstream the project site respectively, and they were analyzed for the grading distribution and other characteristics. The analysis indicated that the bottom materials are silty to clayish with high cohesion. Thus, it is concluded that there is not much probability of drift sand. (Refer to Figure 3-8).

At the Chittagong Fish Harbor Complex located at the opposite bank, the water depth within the harbor is becoming shallow due to siltation. These facts and the results of analysis of the river water indicate the existence of large concentrations of solids (silty clay).

The probability of occurrence of siltation is reduced because the precipitation speed of fine particles such as silty clay and the like becomes slow in view of the flow velocity of the order of 0.5 to 2.0 m/s, which prevails when there are no structures to retain the river water and to accelerate the sedimentation. Instead of sedimentation, river bed corrosion was observed by echo sounding at the rear bank opposite to the project site.

(5) Earthquakes

Earthquakes are rare in Bangladesh, and only three cases accompanied with damages (1885, 1897, 1918) have been recorded in the last 100 years. This is because there are no active faults that bring about earthquakes in Bangladesh, but there is a possibility of earthquakes in the vicinity of the border with India and Myanmar in the northern and eastern parts of the country.

The country is divided in three zones for the sake of taking measures to cope with earthquakes. Zone I is the north-eastern region by the border with India and Myanmar, and Zone II is located to the western side parallel to the first one. Zone II is the coastal area. Chittagong belongs to Zone II. The values of the horizontal earthquake intensities prescribed for the various zones and cities are summarized in the following table.

Horizontal Earthquake Intensities by Area

Barisal	: 0.04	Faridpur	: 0.04	Patuakhali	: 0.04
Bogra	: 0.05	Jessore	: 0.04	Rajshahi	: 0.04
Chittagong	: 0.05	Khulna	: 0.04	Rangpur	: 0.08
Comilla	: 0.05	Kushtia	: 0.04	Rangamati	: 0.05
Cox's Bazar	: 0.05	Mymensingh	: 0.08	Sylhet	: 0.08
Dhaka	: 0.05	Noakhali	: 0.04	Tangail	: 0.05
Dinajpur	: 0.05	Pabna	: 0.04		

(6) Meteorological Abnormalities

Examining the monthly frequency of damages caused by cyclones in the Chittagong district (Refer to Figure 3-9) during the last 146 years (from 1797 to 1942) and during the last 42 years (from 1948 to 1989), one can see that cyclones are concentrated in May, October and November. The average frequency of cycle during the last 42 years is once a year. Cyclones which are accompanied with strong winds with velocity exceeding 20 m/s, with wave heights exceeding 2 meters occurs occasionally at the Karnaphuli river when it coincides the time of low tide changes to high tide in sprint tide.

The scale of the cyclone, which attacked coastal zone of Bangladesh in April 30, 1991, is recorded as a central atmospheric pressure of 970 mb and the maximum instantaneous wind speed of 260 km/hr (equivalent to 72.2 m/second). Ten minutes average wind speed is estimated approximately 60

m/second. Considering this new record, frequency of cyclone attack with maximum average wind speed of more than 60 m/second is counted up 5 times between 1948 and 1991 in Chittagong. Average frequency is estimated as once per 9 years.

As the attack of this cyclone coincided with high tide, water levels of the Karnaphuli river come up over the banks and the jetties along the river during the surge. Consequently, many vessels, boats and floating pontoons landed and stayed in land after water level down.

3-2-2 Survey of the Natural Conditions

(1) Topographical Survey

Topographic survey, covering the project site as a whole and the river area within 100 meters in the upstream and downstream was carried out in the field. The CPA datum level was used as a reference for the elevation, and the benchmark in front of the former CPA office was utilized for this purpose.

(2) Depth Sounding

Depth sounding using a echo sounder was carried out during the field survey to examine the shapes of the transversal and longitudinal sections of the river around the vicinity of the project site. A peculiar fact observed in connection with the transversal section of the river at the vicinity of the project site is the large water depth near the left bank. Since this is the attack side (flow axis) of the river flow it is presumed that corrosion is occurring due to the rapid flow velocity. (Refer to Appendix VII-3)

(3) Soil survey

A boring test was carried out during the field survey to identify the geological structure and obtain the soil proportion required for the design.

1) Methods of Soil Survey

a) Boring
- Number of boring sites : 5
- Boring depth : 2 sites with 30-meter depth from the existing ground surface and 3 sites with 10-meter depth
- Boring position : The boring sites were selected at places that are presumed to bring about general feature of the project site as a whole. (Appendix VII-4)

b) Standard Penetration Test
Carried out at the each boring site. (Test interval : 1 meter)

c) Sampling
Collection of disturbed sample : Every one meter
Collection of undisturbed sample : 13 samples

d) Indoor Tests
- Density
- Specific gravity
- Water content
- Unconfined compression test
- Consolidation test
- Grading analysis

2) Soil Survey Results

The result of the boring test shows that the geological structure of the project site consists of three types of strata. Approximately 2 meters at layers of the surface consists of a soft clay and/or silt stratum, the next 5 meters consists of a rather hard alluvial stratum of clay and silt. The stratum under more than 7 meters of depth consists of compact shale of the Tertiary which might be the bearing stratum. It must be kept in mind, however, that at the offshore side there is no sedimentation of the alluvial stratum

and the Tertiary shale is exposed. The Tertiary shale stratum contains many cracks and is presumed to be crushed. The following N-values were measured as a result of the standard penetration test.

- First stratum : 3
- Second stratum : 5 to 10
- Third stratum : Approximately 50 times/ 10 cm

The surface of the third stratum is tilted by 5 to 6 degrees to the south. The boring soil profile is shown in Appendix VII-4. The third stratum was too hard to carry out the prescribed 30 cm penetration test.

The results of the soil survey are summarized in the following table.

(4) Water Quality Survey

Samples of city water were collected from taps of the office of the BFDC located in the project site and analysis was carried out. All items of the analysis satisfy the WHO standards. (Refer to Table 3-1).

Soil Survey Results

	Particle size analysis				Water content in percentage of weight	Density (T/m)		Specific gravity	Consolidation test		Uni-axis compression		N-value
	Sand %	Silt %	Clay %	D60 mm	%	Wet	Dry		Void ratio (e o)	Coefficient of compressibility (C c)	Breaking strain (%)	Breaking unit stress ( ) Unconfined compressive strength kg/cm	
First stratum	8 - 19	67 - 68	25 - 13	0.01 - 0.029									3
Second stratum	10 - 38	69 - 48	21 - 14	0.017 - 0.005	30 - 36	1.94 - 1.86	1.46 - 1.36	2.65 - 2.67	0.6978 - 0.7350	0.067 - 0.151	2 - 17	0.43 - 0.53	5 - 10
Third stratum	4 - 11	65 - 65	31 - 24	0.0085 - 0.014	23 - 24	2.03 - 2.02	1.66 - 1.03	2.67 - 2.67	0.6430 - 0.674	0.1231 - 1.2840	8.5 - 5.5	2.14 - 6.5	30-time /10 cm 100times /10cm

3-3 Outline of the Fishery Sector

3-3-1 Fisheries in Chittagong

Chittagong is the largest and the most important marine fishery base in Bangladesh. All of the trawlers engaged in Bangladesh marine industrial fishery have their bases in Chittagong and operate bottom trawling in the Bay of Bengal. In the artisanal fisheries by small- and medium sized fishing boats, approximately 2,000 boats consisting mostly of mechanized fishing boats use the Chittagong area as a landing and supply base. It is said that approximately 30% of the marine fishes caught in Bangladesh are being landed in Chittagong. No statistical data for the landing by area is available, but it is presumed that approximately 78,000 tonnes, accounting for approximately 35% of the marine fishery production is being landed every year in the vicinity of Chittagong.

The consumption of fishery products in Chittagong consists of 80% marine fish and 20% inland water fish. On the other hand, the consumption of fishery products in Bangladesh as a whole consists of 26% marine fish and 74% inland water fish. As can be seen, Chittagong has a important position as a consumer's center of marine fish.

(Year : 1987)

Fishing method	(A) Annual fish landing in Chittagong (tonnes)	(B) Annual fish landing in Bangladesh (tonnes)	A/B ratio (%)
1. Industry fisheries (trawlers)	8,000 1)	10,395	80
2. Gill net (mechanized boat)	36,530 2)	118,276	31
3. Gill net (non-mechanized boat)	5,550 3)	14,616	38
4. Set bag net (seasonal type)	13,950 4)	45,000	31
5. Set bag net (all season type)	7,000 3)	18,464	38
6. Long line (mechanized boat)	1,500 4)	4,817	31
7. Long line (non-mechanized boat)	500 3)	1,301	38
8. Others	5,600 3)	14,715	38
Total	78,630	227,582	35

(REMARKS)

1) Estimation by the Department of Fisheries.

2) (Number of mechanized fishing boats of Chittagong) X (Percentage of gill-net fishing boats out of the mechanized fishing boats) X (Operation rate) X (Annual average catch per boat) = 1,128 boats x 85% x 60% x 63.5 tons/year/boat = 36,530 tons

3) (Landing quantity of the country as a whole) X (Percentage of non-mechanized fishing boats with base in Chittagong : 0.38) (Refer to Table 2-3)

4) (Landing quantity of the country as a whole) X (Percentage of landing of mechanized gill-net fishing boats obtained in 2) above : 0.31)

3-3-2 Fish Landing Facilities in Chittagong

The quantity of fish landed annually at Chittagong is approximately 78,000 tonnes, and it is presumed that there are three forms of landing.

1) Approximately 8,000 tonnes/year are presumed to be landed on the Chittagong Fish Harbor Complex or on private landing jetties either directly from trawlers or after being transferred to dugout canoes.

2) Catches of gill net (mechanized fishing boats), long lines (mechanized fishing boats) and the catches transported from seasonal set bag nets, totaling 51,980 tonnes are presumed to be landed on the Monoharkhali landing place and on relatively large private jetties located at the vicinity of Monoharkhali.

3) The remaining 18,650 tonnes, caught by non-mechanized fishing boats, are presumed to be landed on the front beaches at the vicinities of fishing villages, on small-sized private jetties, etc.

The major facilities currently available for supporting the landing are located at three places, the Chittagong Fish Harbor Complex, the Monoharkhali landing place and the Fisheries Ghat landing place. In addition there are also many small-sized wooden landing jetties, but they are privately-owned facilities with capacity for handling the landing of just 1 or 2 mechanized fishing boats.

(1) Chittagong Fish Harbor Complex

The Chittagong Fish Harbor Complex was built with financial resources provided by loans by the Government of Japan based on preliminary survey and design carried out by

consultants from the United States of America. It was being planned to use the floating bridge associated with the BIWTA jetty adjacent to the project site to transport the catch to Chittagong city located at the other bank of the river, but the floating bridge was lost during the cyclone of November 1970.

After the fish harbor facilities was handed over to the BFDC, BFDC started to operate them as the Chittagong Fish Harbor Complex in 1978. Since this fish harbor was constructed by digging down the bank of the Karnaphuli river, there is considerable siltation, and the depth of the harbor is decreasing yearly because no dredging has been carried out so far. As things now stand, it is becoming very difficult to bring ships alongside the jetty because mangrove is growing thick on the sand dune located in the center of the harbor. The facilities of this fish harbor complex consist of the elevated fresh water tank, ice-making plant, ice storage, cold storage, quick freezer, fish meal plant, slipway, repair shop, fishing net manufacturing plant, etc., and most of them are working satisfactorily. The balance of the 1986/87 period showed profits mounting to 302,379 Taka. The complex employs 152 persons, with 32 persons out of that total being technical personnel.

(2) Monoharkhali landing place

The facilities of this landing place consist of a floating pontoon sized approximately 20 meters in length and approximately 5 meters in width accessed from the land by a boarding bridge sized approximately 2 meters in width. At low tide this floating pontoon can not be used for landing fish from mechanized fishing boats because it sits on the bottom of the river. Landing is carried out during high tide, but fish are landed by manpower via bottom of the river by sitting the ship on the ground. The hinge of the boarding bridge is too old, and the boarding bridge may come off when the water level rises. A privately-owned outdoor wholesale market is located behind the landing place. There are 30 auctioneer's rooms at

the other side of a space of approximately 400 square meters. The market operates 360 days a year. Generally it opens from dawn to about 9 AM, and the auctioneers charge the sellers an auctioning commission of 5% of the selling price. Fish landed at Monoharkhali and catch from inland-water areas transported by land are distributed through this market. Approximately 10% of the inland-water fish caught in the Chittagong area are distributed at this place. The BFDC Monoharkhali office is located near the landing place. This office is equipped with chilled storage with a 30 ton capacity, and the BFDC used it exclusively for wholesale of inland-water fish transported from Kaptai Lake. Approximately one half of the fish caught at Kaptai Lake are sent to Chittagong.

(3) Fisheries Ghat Landing Place

A privately-owned landing jetty is located approximately 1 km from Monoharkhali upstream direction of the Karnaphuli river. There are many places with shallow waters near the area, and only the end of the jetty can be accessed during low tide. Thus, fish landing is carried out with the ship sitting on the river bed in most cases.

There is an outdoor wholesale market at behind the landing place. It is owned and operated by a private cooperative (Fish Merchant Association) whose members are brokers, fishermen and other related parties. The outdoor market lot, also used as parking lot, distribution yard and fish loading yard, is 2,000 square meters and has more than 40 auctioneer's rooms. Since large-sized trucks and carts jostle at the outdoor market space and fish are piled up and auctioned at any available spaces, the market is always in an uproar. The sanitary condition is extremely bad because there are no proper drainage facilities, etc. The market operates 360 days a year, and generally it is open from dawn to 9 AM, and the auctioneers charge the sellers a 5% commission. There are many ice-making plants around the wholesale market. Since

the road accessing Chittagong is narrow and there are 2 schools in between, it is extremely congested about 8 AM which is when fish are taken out of the market.

(4) Trends of Fish Landing Places

Two landing surveys for one week each were carried out in September 1990 and February 1991 at the Monoharkhali landing place and the Fisheries Ghat landing place, to identify the feature of the fish landing activities of the artisanal fishery in Chittagong.

1) The first survey was carried out in September, which corresponds to the peak of the fishing season in the Chittagong area (the peak season is from September to November). The quantities of fish landed at the two landing places is of the order of 80 to 100 tonnes a day, and the average quantity landed at the two landing places totals approximately 170 tonnes per day. The second survey was carried out in February, which is the time when the catch is declining to lean season. Just a few tonnes a day are landed at Monoharkhali, and 10 to 15 tonnes are landed at the Fisheries Ghat Landing place. The average landed at the two landing places is approximately 14 tonnes a day.

2) The fishing boats operating in these two landing places are mechanized gill-net fishing boats of 14 to 16 meters in length, and each fishing trips are for 4 to 7 days.

3) As for the composition of the catch, in the survey carried out in September it was found that more than 90% consists of hilsa, with the rest consisting of jewfish, bombay duck and catfish. In February, the catch was a mixture of hilsa, bombay duck, indian salmon and catfish.

FISH LANDING SURVEY RESULTS (1)

Date 1990	Monoharkhali landing place			Fisheries Ghat landing place		
	Fish landing (tonnes)	No of Boat (vessels)	Ice carrying (ton/boat)	Fish landing (tonnes)	No of Boat (vessels)	Ice carrying (ton/boat)
Sep.17	26.5	8	8.9	101.3	32	8.1
Sep.18	62.5	20	7.9	117.5	40	7.3
Sep.19	49.5	14	7.3	106.5	30	6.9
Sep.20	90.5	20	6.9	88.5	20	6.5
Sep.21	92.0	20	6.6	92.5	20	5.9
Sep.22	86.5	20	6.4	84.5	20	6.4

FISH LANDING SURVEY RESULTS (2)

Date 1990	Monoharkhali landing place			Fisheries Ghat landing place		
	Fish landing (tonnes)	No of Boat (vessels)	Ice carrying (ton/boat)	Fish landing (tonnes)	No of Boat (vessels)	Ice carrying (ton/boat)
Feb. 9	--	--	--	14.0	12	4.9
Feb.10	--	--	--	7.0	12	4.6
Feb.11	0.4	1	7.5	10.4	15	3.9
Feb.12	1.9	1	8.0	12.8	11	4.5
Feb.13	1.7	1	7.5	10.0	11	4.3
Feb.14	--	--	--	12.1	9	4.2
Feb.15	--	--	--	15.2	12	4.2

Comparison between fish landing in the Chittagong area and results of fish landing survey at the Project site is shown below.

	(A) Chittagong area	(B) Landing at two places	(B)/(A) ratio (%)
Annual landing quantity of mechanized fishing boat	51,980 tonnes/year	---	---
Monthly average landing quantity	4,332 tonnes/month	---	---
Estimated value of September	9,694 tonnes/month	5,100 tonnes/month	53
Estimated value of February	2.662 tonnes/month	420 tonnes/month	16

(Remarks)

a) Estimations of fish landing in Chittagong area in September and February are calculated by using the monthly ratio against the annual fish landing for gill-net mechanized fishing boats in all of Bangladesh (Table 2-4).

b) Estimations of fish landing at the two landing places are calculated by multiplying the daily average fish landing by 30.

As these two landing places, the Monoharkhali Landing place and the Fisheries Ghat Landing place, equipped for carrying out direct landing of mechanized fishing boats in the Chittagong area, it may safely be judged that they are landing 50% of the marine fishery production of mechanized fishing boats operating in the Chittagong area. Since these landing yards are influenced considerably by the ebb and flow, it is presumed that the quantity of fish landed is also influenced by the tide conditions. Since catches that are not handled at these landing places are being indirectly landed by means of non-mechanized boats at small-sized wooden jetties located at the vicinity of the Karnaphuli river, it is presumed that there is conspicuous loss of quality and value when large quantities of catches are handled at these places.

Approximately 50% of the fish taken at Chittagong are consumed locally, and 10% is exported. The remaining 40% is delivered to other areas of the country, and the main destination is Dhaka. The transportation is carried out 90% by truck and 10% by railway.

3-3-3 Fish Preservation Facilities in Chittagong

(1) Ice-making Facilities

In the Chittagong area, including Cox's Bazar, there are 111 block ice making plants (daily production capacity of 1,500 tonnes) and 15 crushed ice making plants (daily production capacity of 151 tonnes) operating as of 1986. These ice-making plants are obviously obsolete, and the actual capacity is said to be of the order of 60% of the nominal one. As things now stand, there are 6 plants (actual daily production capacity of 40 tonnes) in the vicinity of the Monoharkhali landing place, and they are supporting the operation of the Monoharkhali landing place through the supply of ice for fishery. Moreover, there are 10 plants (actual daily production capacity of 100

tonnes) in the vicinity of the Fisheries Ghat landing place and 7 plants (actual daily production capacity of 50 tonnes) within 2 km of Monoharkhali, and these plants support the Monoharkhali landing place through the supply of ice for fish distribution. There is a block ice making plant with a daily production capacity of 25 tonnes in Chittagong Fish Harbor Complex and it supplies ice mainly for trawlers. (Refer to Table 4-2).

(2) Freezing and Cold Storage Facilities

In Chittagong there are 34 freezing plants with a daily freezing capacity of 200 tonnes in addition to 5,600 tonnes of cold storage capacities, but they are being used mainly for freezing and storage of shrimps, frog legs and bottom fishes for export.

CHAPTER 4
OUTLINE OF THE PROJECT

CHAPTER 4 OUTLINE OF THE PROJECT

4-1 Project Objective

Facilities for fish landing, fish distribution and fish preservation that are required for artisanal marine fishery development is not well developed Chittagong, which is the most important center of marine fishery for Bangladesh. The existing facilities for fish landing and distribution are insufficient to cope with the demand, and as things now stand, it is paramount to support fish landing and fish distribution efficiently and sanitarily. In order to improve this situation, this project is aimed at constructing fish landing, distribution and preservation facilities capable of coping with the current demands as well as making recommendations to most effectively use the facilities to cope with the demand in near future by improving fish landing and distribution methods. The goals of the project are as follows :

1) To set the Project target year as 1994 when completion of construction of the project facilities is presumed.

2) To plan fish landing, distribution and preservation facilities capable of coping with the landing quantity at Chittagong by wooden mechanized fishing boats engaged in artisanal marine fishery in the Project target year.

3) To improve the current fish landing and distribution methods, thereby effectively using the facilities and to improve the quality and the value of the catch through streamlining the work.

4) To provide facilities and equipment capable of maintaining sanitary conditions at and around the new facilities.

5) To secure and to promote, through the operation of the new facilities, the supply of fish that are important animal protein sources for the people of Bangladesh.

4-2 Study and Examination on the Request

The request made by the Government of Bangladesh is summarized in Chapter 2-5 of this report. Followings are study and examination on this request.

(1) Appropriateness and Necessity of the Project

In Bangladesh, fish are an important animal protein supply source, and account for approximately 70% of the animal protein intake. Marine fishery products account for approximately 80% of the fish consumed in the Chittagong area, and are also shipped to Dhaka and other consumption centers to cope with their demands. In spite of this, there are virtually no facilities for artisanal marine fishery fish landing and distribution even in Chittagong, an important marine fishery base. Artisanal marine fishery is responsible for supplying fish to the people of Bangladesh. Under these circumstances, fish landing and distribution is being carried out inefficiently and under unsanitary conditions. This results in a loss of quality and value of the important fish, which means a waste of a valuable resource.

This project is regarded as very appropriate and urgently needed not only from the standpoint of the preservation and promotion of the artisanal marine fishery and the related distribution, but also from the standpoint of securing and promoting the supply of animal protein to the people.

(2) Plan for Implementation and Operation of the Project

The BFDC (Bangladesh Fisheries Development Corporation) will take charge of the operation of the fish landing,

distribution and preservation facilities of this project.

The BFDC is already operating similar facilities in the major fish landing places of the country and it presumably has vast experience doing so. Moreover, this is one of the development projects of the fisheries sector within the context of the Fourth Quinquennial Plan (1990-1995), and the operation system for project implementation is being prepared.

(3) Relation with Similar Projects

As things now stand, there is no other projects similar to this one.

Two projects of the fisheries sector in the Fourth Quinquennial are related to this project.

1) Project for Improvement of the Dhaka Fish Retail Facilities (Implementation Budget : 40 Million Taka)

The first Project is aimed at improving the existing fish retail facilities which the BFDC is operating in the Kaoran Bazar in Dhaka, which should further enhance the distribution effect of this project.

2) Project for Establishment of Fish Landing and Distribution Facilities for Artisanal Fisheries (Implementation Budget : 100 Million Taka)

The second project is aimed at improving the fish landing and distribution facilities for non-mechanized fishing boats engaged in artisanal marine fishery at fishery villages and should not compete with this project.

(4) Examination of the Project and its Component Elements

The functions of the facilities and equipment of this project are classified in three elements, (1) fish landing,

(2) distribution of landed and collected fish, (3) preservation of fish. These three elements are most effective when performed simultaneously within the flow of the fish catching to fish marketing. In this context the composed elements of this project are properly planned with no excess and no shortage.

(5) Examination of of the Facilities and Equipment

1) Fish Landing Facilities

At present there are not satisfactory facilities for carrying out proper fish landing for the wooden mechanized fishing boats engaged in artisanal marine fishery. The existing fish landing facilities are too small and the fishing boats are forced into low efficiency landing activities by having to wait for the high tide, dawn and other favorable conditions for landing operation. Such being the case, there is not only noticeable deterioration of the quality and value of the catch during the waiting period and the landing activities, but the fishing boats are forced to operate with low efficiency due to the long waiting time for fish landing and for preparation to sail. The construction of properly arranged fish landing facilities should play a decisive role in supporting the landing activities and remove the influence of the tide and dawn.

2) Fish Distribution Facilities

All of the existing facilities located around the major mechanized fishing boat fish landing places, that are used for wholesaling, packing, collection, delivery, etc. of both landed fish and inland-water fishes carried to these facilities, are outdoor facilities without proper arrangements for such basic aspects as drainage and lighting. Such being the case, these activities are being carried out with very low efficiency and under unsanitary conditions. There are also serious traffic congestions caused by fish transport and it is affecting to activities of the ordinary residents in the areas.

Facilities to allow good sanitary, efficient fish distribution not being affected by the time of day are an important part of this project.

3) Fish Preservation Facilities

Ice is the most popular means for maintaining the quality of the fish in Bangladesh, and the method is widely used among local fishermen and other parties concerned. There is a strong demand of the supply of ice for fishery and for distribution in order to cope with the catch to be landed within the scope of this project.

4) Fish Landing and Distribution Equipment

In Bangladesh, fish landing and distribution is carried out mostly by man power, and it is presumed that no radical change will occur in the situation in the near future. It must be kept in mind, however, that as things now stand, the catch is being landed using bamboo baskets, and that the fish are sorted by piling them up on the floor. The work is not efficient, and the facilities are not being utilized in an effective way. Securing a minimum level of efficiency by using fish boxes and hand carts should contribute not only to effectively utilize the facilities but also to improve the distribution system.

(6) Necessity of Technical Cooperation

In view of the record of management of similar facilities by the BFDC, which will take charge of the facilities of this project, technical cooperation will not be needed for operating the facilities, but technical cooperation is recommended for the operation techniques of the ice-making plants and the like through acceptance of technical trainees into Japan.

4-3 Project Description

4-3-1 Executive Agency and Operation Structure

The BFDC (Bangladesh Fisheries Development Corporation) is the executive agency in charge of this project. The BFDC has various facilities such as a fish harbor, fish landing centers, wholesale markets, freezing and cold storage facilities, fish processing plants, trawlers, fishing net factories, fishing boat repair facilities, etc., that are located at marine fishery production centers. (Refer to Table 4-1). Independent project bodies, operating commercially, are in charge of the operation of these facilities, and generally the self-supporting system is used. Currently there are 16 commercial base projects in operation. (Refer to Table 4-2).

The total income of the BFDC during the 1988/89 period was 180.87 million Taka and the total expenditure was 195.24 million Taka, resulting in an operating loss of 14.36 million Taka. During the 1989/90 period the income was 163.17 million Taka and the expenditures were 157.54 Taka, resulting in a profit of 5.62 million Taka. These figures indicate a gradual improvement in the business.

In order to operate new facilities which are implemented by this project, a new project body will be created.

4-3-2 Plan of Operation

(1) Project Activities

The activities implemented by the BFDC in the project, are as follows.

1) Control and Operation of the Fish Landing Facilities

a) Control of and guidance for fishing boats using the fish landing facilities.

b) Advice and lending of hand carts aimed at improving the landing work.

c) Collection of berthing fees.

d) Maintenance and repair of the facilities.

2) Control and Operation of the Fish Distribution Facilities

a) Registration of auctioneers
b) Control of and guidance for the activities of the auctioneers in the fish markets
c) Advice to improve the fish distribution activities, and lending of fish boxes.
d) Collection of the market use charge and auctioneer's room charge
e) Cleaning, maintenance and repair of the facilities.

3) Control and Operation of the Fish Preservation Facilities

a) Selling of block ice
b) Maintenance, repair and control of the facilities

4) Operation Plan

The basic policy of the operation of the facilities related to the present project is as follows.

	Project target year (1994)
Annual operating days of the landing facilities	360 days
Fish landing hours	From 3:30 AM to 7:30 AM
Loading hours of ice	9:00 AM to 5:00 PM
Annual opening days of the market	360 days
Market opening hours	From 5:00 AM to 9:00 PM
Ice production	Round the clock (3-shifts)
Ice sales hours	From 8:00 AM to 5:00 PM

(Remarks)

(1) The annual number of days open for the market is the same as at similar existing facilities.

(2) The hours available for using the fish landing and distribution facilities will be shifted in phases to the early morning.

Improving the fish landing and distribution procedures through the implementation of these duties is an important goal of this project. An operation plan shown below will be possible to be realized in near future by streamlining fish landing and distribution procedures. However, since these improvements can not be realized within a short period of time, they must be implemented in phases.

Annual operating days of the landing facilities	360 days
Fish landing hours	From 1:30 AM to 7:30 AM
Loading hours of ice	From 9:00 AM to 5:00 PM
Annual opening days of the market	360 days
Market opening hours	From 3:00 AM to 9:00 PM
Ice production	Round the clock (3-shifts)
Ice sales hours	From 8:00 AM to 5:00 PM

STEP IN IMPROVEMENT OF FISH LANDING AND DISTRIBUTION WORK BY THE PROJECT

	Current state	Project target year	Recommended conditions realized by improvement
Fish landing work			
(Landing hours)	After dawn	AM3:30 to AM7:30	AM1:30 to AM7:30
(Berthing)	By waiting for high tide or by sitting the fishing boat on river bed	Possible at any time	Possible at any time
(Loading fish landed)	Carrying on stevedores' heads by traditional baskets (30kg per basket)	Introduction of effective loading by fish boxes and hand carts (Two fish boxes totalling 60 kg will be loaded by each stevedore)	Regular execution of loading by fish boxes and hand carts (Three fish boxes totalling 90 kg will be loaded by each stevedore)
(Preparation for sailing)	Long time intermittent preparation with the ship sitting on the river bed	Possible at any time by using the preparation jetty	Sailing on the same day will be possible
Fish distribution			
(Market opening hours)	After dawn, when the berthing is possible	From AM5:00 to AM9:00	From AM3:00 to AM9:00
(Fish handling efficiency of the market)	35 kg/m^2 (Fish are piled up in bulk on the market floor	35 to 50 kg/m^2 (Partial introduction of fish box handling)	70 kg/m^2 (Regular use of fish box handling)
(Flow of fish handling)	Flow is not smooth as fish are piled up in bulk	Introduction of an integrated flow system using fish boxes	Regular use of the integratd flow system
(Fish handling environment)	Unsanitary	Sanitary	Sanitary
(Conditions in the market)	No clear distinction between parking area and fish handling area	Clear distinction between car parking and fish handling	Clear distinction between car parking and fish handling
(Packing & stacking)	Random packing and stacking wherever vehicles are parked	Smooth packing and stacking with vehicles parked with platforms	Smooth packing and stacking with vehicles parked with platforms
(Delivery form)	Delivery by 6-ton trucks with fish piled up in bulk. Stacking traditional baskets in rickshaws and hand carts	Delivery by 6-ton trucks with fishes piled up in bulk. Restriction of using ordinary rickshaws and encouragement of use of rickshaws with insulated boxes. Encouragement of use of auto-tricycles with insulated boxes.	Delivery by 6-ton trucks with fishes piled in bulk. Introduction of 6-ton insulated boxes. Encouragement of use of auto-tricycles with insulated boxes.
(Delivery traffic flow)	Traffic crosses with each other very often because vehicles are parked at random	Streamlined traffic through proper layout of traffic	Streamlined traffic trough proper layout of traffic

(2) Forecast of the Fishery Production in the Chittagong Area in the project target year

1) Forecasting method

The production by fishery in the Chittagong area in 1987/88 and the expected annual average growth rate up to the target year of the project are used to forecast the fishery production.

2) Forecast by the Department of Fisheries

a) The annual average growth rate by fishery category between 1983 and 1987 and the production expansion plan under the Fourth Quinquennial Plan are shown in the followings.

	Annual average growth rate (%) recorded during 1983/84 to 1987/88	Annual average growth rate (%) planned for 1987/88 to 1994/95
(Artisanal marine fishery)	9.6	2.3
(Industrial marine fishery)	-8.0	6.0
(Inland-water capture)	-2.7	4.0
(Inland-water culture)	10.7	10.8

(Source : Department of Fisheries)

3) Forecast by the Study Team

a) It is presumed that a production growth rate of 2.3% for the artisanal marine fishery will prevail up to the target year of the project in view of such facts as the fishery production growth recorded in recent years and the growth trend of the construction of mechanize fishing boats.

b) It is presumed that there will be no growth in the production in the industrial marine fishery in view of such

facts as the state of the fishery infrastructure and the environment for new investments.

c) It is presumed that there will be no growth in the production in inland-water capture in view of such factors as the pollution by pesticides, living pollution, expansion of inhabited areas, etc. in the water body.

d) The production is expected to also grow in the future in inland-water culture, in view of such factors as the latent possibility of new investments mainly in shrimp culture and improvement in culture techniques. It is presumed that the annual growth rates will fall behind the planned ones, with an annual rate of 5.0% for 1987/88 to 1994/95 and 2.5% after 1994/95.

4) Forecasts

	1987/88	1994/95 (project target year)	1999/2000
Artisanal marine fishery			
Gill-net (Mechanized fishing boat)	36,530	42,833	47,990
Gill-net (Non-mechanized fishing boat)	5,550	6,508	7,291
Set bag net (Seasonal type)	13,950	16,357	18,327
Set bag net (All season)	7,000	8,208	9,196
Long-line (Mechanized fishing boat)	1,500	1,759	1,971
Long-line (Others)	500	586	657
Others	5,600	6,566	7,526
(Sub-total)	(70,630)	(82,817)	(92,958)
Industrial marine fishery	8,000	8,000	8,000
Inland-water capture (Fishery at Kaptai Lake)	43,794 (4,068)	43,794 (4,068)	43,794 (4,068)
Inland-water culture	22,797	32,078	36,293
(Total)	145,221	166,689	181,045

(3) Forecast of the Fish Landing Volume at the Project Site in the Project Target Year of the Project

In the project target year, 60,949 tonnes of fish caught and/or transported by mechanized fishing boats, out of the catch of the various kinds of boats engaged in the artisanal marine fishery, will be landed in the Chittagong area as follows. As 50% of fish landing by the mechanized fishing boats in Chittagong is currently landed at the project site, 30,475 tonnes of fish is landed at the project site in the project target year.

Gill net (Mechanized boat)	42,833 tonnes/year
Set bag net (Seasonal type)	16,375 tonnes/year
Long-line (Mechanized boat)	1,759 tonnes/year
Total	60,949 tonnes/year

(4) Forecast of the Fish Distribution Volume at the Project Site in the Project Target Year

Besides the fish to be landed, part of the fish produced by inland-water fisheries is expected to be brought into the fish distribution facilities of the project site during the target year of the project. Currently, about one half of the production of the Kaptai Lake and about 10% of the inland-water fishery production of the Chittagong area is handled in the project site. Assuming that these proportions will remain unchanged also in the project target year, the quantity to be handled during the project target year is forecast to be 39,690 tonnes in total as follows.

(Unit : tonnes/year)

Quantity landed at the project site	30,465
Quantity brought into the project site from Kaptai Lake	2,034
Other inland-water capture brought into the project site	3,397
Other inland-water culture brought into the project site	3,208
Total	39,690

(5) Delivery for the Project Site in the Project Target Year

1) Quantities to be delivered to the various destinations

It is assumed that the distribution patterns by destination of the 39,690 tonnes of fish to be handled at the project site during the project target year will remain unchanged, consisting of 50% (19,845 tonnes/year) to be delivered to the Chittagong area by retailers and 50% (19,845 tonnes/year) to be delivered by middlemen to areas outside Chittagong.

2) Forms of delivery

a) Deliveries to areas other than Chittagong

Deliveries by middlemen will be done by mass transportation to centers of large consumption such as Dhaka and other urban areas. Currently, large, open-platform, 6-ton trucks are being used for this purpose. For the time being, this method is expected to remain as the main means of transportation.

b) Deliveries to the Chittagong area

Most of the deliveries by retailers at present are done by manpower of rickshaws. In view of their negative contribution to the traffic congestion, however, it is presumed that considerable restriction in the vicinity of the project area will be enforced about the project target year. Such being the case, it is very likely that transportation of fish in small quantities being carried out by retailers will switch to the use of auto-tricycles (motorized). Even rickshaws are still used, it is recommended to switch to rickshaws with insulated boxes encouraged by the BFDC. By the project target year it is predicted that 30% of the fish delivered to retailers will be transported by auto-tricycles and that 70% will be transported by rickshaws with/without insulated boxes.

4-3-3 Location and Conditions of the Project Site

The Monoharkhali landing place, the project site, is located on the bank of the Karnaphuli River, approximately 1.5 km from the center of Chittagong. It is accessed by going from Chittagong's loop road to the Bridge Ghat Street and by turning to the right before the river bank. The distance from the landing place to the Dhaka truck road terminal, the arterial route for land transportation between Chittagong and Dhaka, is approximately 3.5 km.

The landing place is located about 16 km upstream from the estuary of the Karnaphuli River, at the right bank just above the point where the river makes a large bend, and the river width at that place is about 800 meters. Since the center of the river is rarely exposed to waves, there are many large- and medium trawlers moored there.

The access road from Bridge Ghat Street to the river bank area is unpaved. Facilities such as the offices of the BFDC and the BIWTA (Bangladesh Inland Water Transport Authority), shops and warehouses are located in the area, and the floating pontoon for ferry boat traffic operated by the BIWTA is accessed from the edge of the river bank via a gangway. This floating pontoon is a strategic element of the system for water transportation to the inland cities along the river, and small passenger and cargo ships are operated from this floating pontoon. There is no space exclusively for parking in the vicinity of Bridge Ghat Street, and the transportation vehicles, rickshaws, etc., that are being parked nearby are obstructing the traffic.

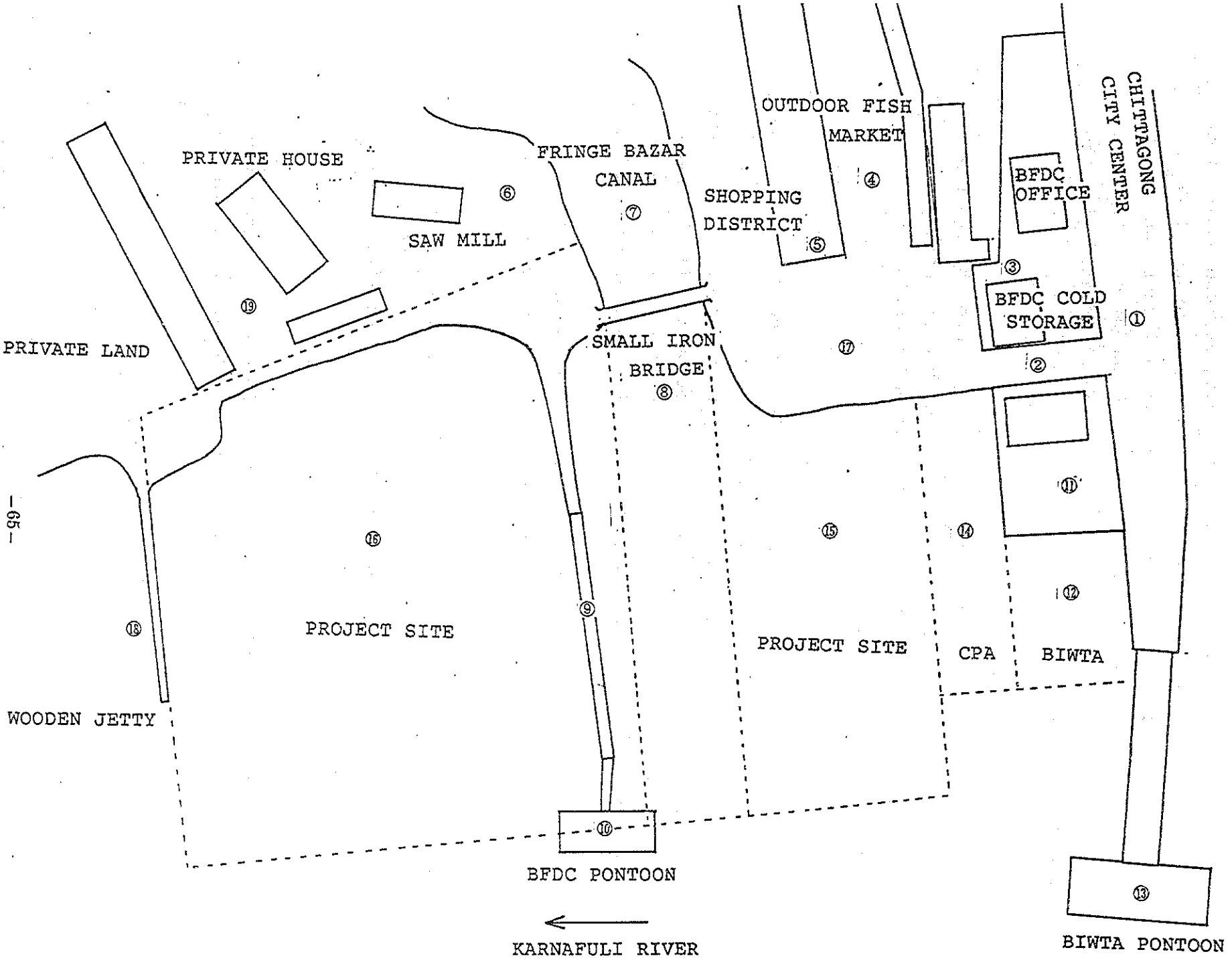
The project site <15>, <16> is located in the so called the Bridge Ghat district, which is adjacent to the BIWTA Office <11>, BIWTA's empty lot <12>, BIWTA's floating pontoon <13> and the CPA lot <14> to the eastern side, to the BFDC cold storage <3>, the open-air fish market <4>, the shopping district <5>, a privately-owned lot <17>, a small iron bridge <8>, a saw mill <6>, and a residential area <19> to the northern and eastern sides, and the wooden jetty <18> to the western side. A water canal known as Fringe Bazar <7> crosses the center of the project site. (Refer to the map of the project site).

{Access Road <1>}

Though the access road <1> connecting the project site with the city area is 3 lanes (approximately 15 m wide), many trucks usually park in this road. It will then be difficult to transport construction material (sand, etc.) and heavy equipment (bulldozers, crane trucks, etc.) by land. Thus, it will be necessary to transport the construction material and equipment by the river.

{Access Road <2>}

Currently, this access road is 6 m wide. Since it is too narrow to be used as an access road to the market to be built, it will be necessary to dismantle the existing BFDC cold storage <3> and to move it to another place to increase its width.



CURRENT CONDITION OF PROJECT SITE

{Alternative Roads During the Construction}

During the construction for this project, the access road <2> will be closed for safety, but since the outdoor fish market <4> and the shopping district <5> will continue to operate during the construction, part of the site of the BFDC cold storage will be opened for use as an alternative for the access road <2>.

{Suspension of use of the Canal}

The canal is being used to carry logs into the saw mill <6> and for transporting bamboo, but the use of the canal accessing the project site will be suspended during the construction.

{Relocation of the BFDC Pontoon <10>}

The BFDC pontoon is being used for landing work of wooden mechanized fishing boats that are loading fish to the fish market and as a terminal for the ferry boat connecting with the Fish Harbor Complex, but during construction it will be located beside the BIWTA jetty. The wooden jetty <9> will be dismantled concurrently, but the small iron bridge <8> will be left as it is because it is located out of the project site, and it will be used by the saw mill <6> and the houses located behind the project site.

{Suspension of the general uses of the project site <16>}

The project site is currently used for anchoring of fishing boats, piling up bamboo etc., but these kinds of uses will be suspended during construction.

{Border with the adjacent lots}

On the drawings, the border with adjacent lots are based on various dimensions in conformity with the authorization BFDC obtained from CPA.

{Site conditions for construction of the facilities}

The road approaching the Monoharkhali landing place is 500 to 600 meters from commercial center, and is a bustling commercial street with shops of various kinds related to fisheries. The width is approximately 13 m, which is sufficient for truck traffic, but such things as rickshaws waiting for passengers, a way of using of the road including pedestrians, etc., that obstruct the flow of the traffic.

4-3-4 Outline of the Facilities and Equipment

The facilities and equipment required for this project are listed below.

(1) Fish Landing Facilities
   1) Floating pontoon
   2) Gangway
   3) Fish landing apron
   4) Collision protector

(2) Fish Distribution Facilities
   1) Wholesale market
   2) Auctioneer's rooms
   3) Fish loading lot
   4) Parking lot
   5) Canal bridge
   6) Fish handling equipment (fish boxes, hand carts)

(3) Fish Preservation Facilities
   1) Ice-making plant
   2) Ice storage
   3) Machine room

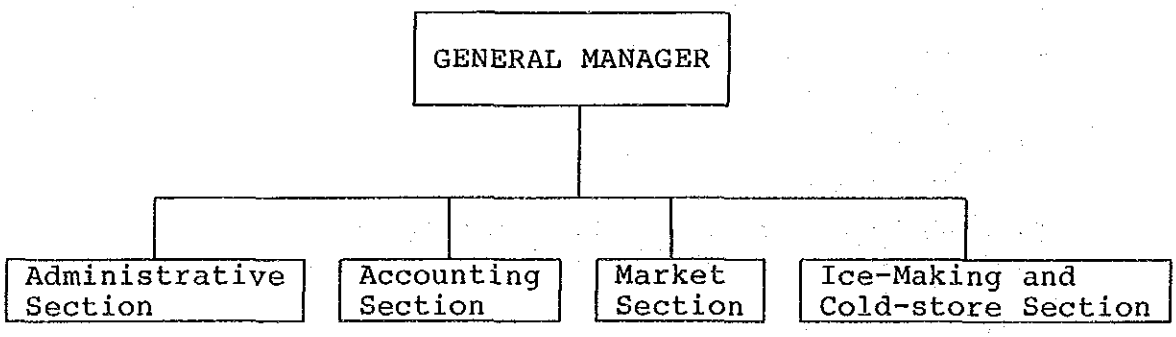
(4) Administrative Facilities

1) General Manager's office
2) Office
3) Conference room
4) Worker's room
5) Guard post
6) Power input facilities
7) Water intake facilities

4-3-5 *Maintenance and Operation Plan*

(1) Administration Organization

The BFDC will take charge of the execution of this project. The BFDC will create a new executive organization (independent project body) to take charge of the control and operation of the project. This executive organization will be similar to the other 16 project bodies that are already in operation by BFDC, and it will generally operate in conformity with the self-sustained accounting system. The executive organization will be organized as shown below.



(2) Operation Organization

The minimum personnel required for operation of the facilities and equipment will be allotted. In connection with the repair and the maintenance of the facilities and equipment, the operation of the project will be planned in such a way to secure the operating profit required for procurement of the

replacement parts and materials, and an appropriate percentage of the profit will be reserved for this purpose. Because the planned facilities are publicly utilized, however, the operating profits of the project will be restricted to a minimum indispensable level to alleviate the burden of the beneficiaries, in general consisting of the artisanal fishermen, the consumers, etc.

The personnel required to operate this project is planned as shown below. Experienced personnel will be recruited from the 16 other projects by the BFDC that are likely to reduce their scale.

Part-time personnel, 12 sweepers and 12 ice-making workers (4 persons x 3 shifts), will be hired on a temporary basis besides the regular personnel given above.

{PERSONNEL REQUIRED TO OPERATE THIS PROJECT}

OCCUPATION	NUMBER OF PERSONS	REMARKS	ANNUAL WAGE (TAKA/YEAR)
1. General Manager's Office			
General Manager	1 person		104,000
Secretary	1 person		45,500
2. Administrative Section			
Manager	1 person		78,000
Assistant Manager	1 person		52,000
Senior officer	1 person		52,000
Junior officer	1 person		45,500
Messenger	1 person		32,500
Guard	9 persons	3 shifts	32,500
Jetty assistant	4 persons	2 shifts	32,500
Cleaner	3 persons		32,500
3. Accounting Section			
Deputy chief accountant	1 person		58,500
Assist chief accountant	1 person		52,000
Accountant	1 person		45,500
Bill assistant	1 person		45,500
Typist	1 person		45,500
4. Market Section			
Senior market officer	1 person		58,500
Junior market officer	1 person		52,000
Assist market officer	2 persons		45,500
Market assistant	2 persons		32,500
5. Ice-making & Cold-store Section			
Refrigeration engineer	1 person		58,500
Foreman	3 persons	3 shifts	45,500
Assistant	3 persons	3 shifts	32,500
Electrician	1 person		45,500
	42 persons		

(3) Operating Plan

1) Fish Landing Facilities

The mechanized fishing boats utilizing the landing facilities will be charged a berthing fee of 100 Taka/day-boat equivalent to the current charge. Hand carts for unloading fishes will be lent free of charge to contribute to the improvement of the fish landing activities.

2) Fish Distribution Facilities

The auctioneers will be charge 2% of the selling price for use of the market as same as in the other BFDC wholesale markets. The auctioneer's rooms will be rented to the auctioneers registered at the BFDC at a rent of 900 Taka/month-room as same as in the Khulna Wholesale market. The fish boxes will be lent free of charge to contribute to the improvement of the fish distribution activities.

3) Fish Preservation Facilities

The selling price of 135 kg block ice varies from 400 Taka to 2,400 Taka per ton seasonally and the annual average is of the order of 550 Taka per block. Variable prices determined by taking into consideration the prices prevailing at the private markets will be used also in this project. The selling system will be organized in such a way to attain an annual average selling price of 550 Taka equivalent to the current price level.

(4) Financial Evaluation

1) Course of the financial Study

a) The operational profitability of the facilities and equipment of this project will be comprehensively examined to estimate the possibility of smooth operation of the project as a whole.

b) The basic financial study is carried out by assuming the operation of the facilities in the project target year. The major risks that are presumed to occur in connection with their operation are taken into consideration, and the basic study is complemented through the sensitivity analysis referring to the risks.

c) The income considered in the financial analysis of the project is generated by the berthing charges, the wholesale market utilization charges, the auctioneer's rooms' rent and the ice sales. The expenses are the salaries, the operating costs of the facilities (electricity, running water and fuel oil), maintenance costs, office expenses and depreciation costs.

2) Operating Income and Expenditure in the Project Target Year (Appendix VI-1)

An annual profit of 6,681,800 Taka (assuming current values) is expected for the project target year when the whole project is operated as planned.

- Annual income : 25,981,200 Taka
- Annual expenditure : 19,299,400 Taka
- Annual profit : 6,681,800 Taka

3) Sensitivity Analysis

If the fish landing and distribution volume during the project target year are reduced to about 80% of the planned values, and the production of ice is limited to about 80% of the planned quantity due to the lack of expertise occurring right after the introduction of the facilities, the annual operating profit during the target year of the project will be 1,960,970 Taka.

- Annual income : 20,784,960 Taka
  (Reduction of 20% in all income items)

- Annual expenditure : 18,823,990 Taka
  (Reduction of 15% in the electricity charge due to the smaller ice-making volume)
- Annual profit : 1,960,970 Taka

4) Evaluation

a) The project will secure sufficient operating profit during the target year of the project.

b) As for utilization charge of the market is expected to provide a high percentage of the operating income of the project, thus the operating profit of the project is expected to increase gradually from the project target year concurrently with the chronological increase of the distribution handling volume.

c) The operating income expected to be obtained during the project target year as indicated in the sensitivity analysis is not sufficient, but it is predicted that there will be no operating losses.

d) The income resulting from the utilization charge of the market is expected to be the mainstay of the operating profit of this project. It is planned to collect from the auctioneers a market utilization charge of 2% of the wholesale transaction. The 2% charge will be discounted from the auction commission (approximately 5% of the selling price) to be collected from the sellers, and it will exert direct influence on the fish price. Since this project is for the benefit of the public, it is thought that reducing the rate of the market utilization charge applicable to the transaction sum (2%) when the project has good profitability, and deducting the difference from the auctioneer's commission, thereby stabilizing fish prices would bring about social benefits.

For example, it is recommended to examine the possibility of a stepped reduction of the 2% charged in the project target year down to about 1% in the future.

4-4 Technical Cooperation

It is presumed that the human resources of the BFDC, which will be the executive entity in charge of this project, is sufficient from both qualitatively and quantitatively for operating of this project. The technical level of Bangladesh is regarded as sufficient for operating and maintaining the facilities and equipment of this project. However, this project is planned to play the role of a model for the development of fish landing and distribution system of Bangladesh, especially the part engaged in the handling of fresh fish. From the viewpoint of technical cooperation from overseas related to such process aspects as post-harvest techniques, improvement of fish landing and distribution procedure, etc., is presumed to make a particularly important contribution for further smooth and effective operation of this project. In this connection, the Government of Bangladesh is requesting the Government of Japan for technical cooperation referring to the following fields.

1) Training program

Trainees will be dispatched in the fields of post-harvest techniques, improvement of fish landing work, improvement of fish distribution work, fish marketing and refrigeration engineering.

CHAPTER 5
BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5-1 Design Policy

5-1-1 Basic Policy

In executing the basic design, the conditions prevailing in Bangladesh will be taken into account, and the following matters will be taken into account in order to make the most appropriate scale of facilities within the scope of the Grant Aid Program of the Government of Japan.

(1) Appropriate Scale of Project

1) Determination of the scale of the facilities through appropriate forecast of the demand.

2) The facilities should be practicable within the scope of the Japanese Grant Aid Program.

3) Proper design to minimize the operation and maintenance costs.

(2) Design to Take into Consideration the Natural Conditions

1) The natural conditions at the project site such as the meteorological conditions, the topographical conditions and the hydrological conditions should be taken into consideration and they should be properly reflected in the design.

2) Special attention should be paid to prevent dangers to the environment and other problems during the construction and after its completion.

(3) Appropriate Structures and the Construction Methods for the Conditions at the Project Site

1) The structures and the construction methods should be simple to facilitate operation and maintenance.

2) Materials available in Bangladesh should be given priority.

3) Attention should be paid to preserve the landscape.

5-1-2 Natural Conditions

Table 1 summarizes the design conditions related to the natural conditions at the project site to be taken into consideration when carrying out the basic design.

(1) Meteorological Conditions

1) An annual temperature fluctuation of 10°C to 35°C, a monthly temperature fluctuation of 20°C to 35°C and a relative humidity fluctuation of 70% to 90% is taken into consideration for the sake of the basic design by using as a reference the monthly maximum temperature, minimum temperature and average relative humidity data of Chittagong for 1980-89.

2) The maximum monthly rainfall is assumed to be 770 mm by using as a reference the monthly rainfall for 1980-89.

3) The wind velocity of cyclones observed during the 1941-89 period shows the value of 50-60 m/s once every 10 years and the value of 60-70 m/s once every 15 years. Thus, the maximum wind velocity of 60 m/s is taken into consideration in this project.

Table 1 Design Conditions

			Project site		Remarks
NATURAL CONDITIONS	Maximum wind velocity		60 m/s, S, SW		Design wind pressure = 120 kg/m^2
	Wave height		2 m		Surge of 5m or more occurring once every 15 years
	Water level	Tide level fluctuation	1.2 m - 4.2 m		Daily fluctuation (Astronomical tide level)
		Maximum water level	CDL +5.4 m CDL +5.0 m		Flooding occurring once every 10 years Flooding occurring once every year
	Maximum flow velocity		2.6 m/second		Flow velocity of 4.1 m/s occurring once every 30 years
	Seismical intensity		0.05		Local Standard for Chittagong
	Water quality of the river		pH=7.0 - 7.8, Salt concentration : 0.5 - 7.5 permil Silt in suspension : 100 - 1800 ppm		
	Rainfall		770 mm/month		Maximum monthly rainfall during 1980-89
	Temperature		Annual fluctuation	35°C/10°C	Average fluctuation value during 1981-89
			Monthly fluctuation	35°C/20°C	Average fluctuation value during 1980-89
	Relative humidity		70 - 90%		
SOIL QUALITY			Surface stratum		Base rock
	Wet unit weight		1.86 - 1.97 T/m^3		1.90 - 2.09 T/m^3
	Water content		36 - 28%		20 - 32%
	Grading		Clay content (12-21%) Sandy silt		Clay content (14-33%) Soft shale
	N-value		Under 10		50 or more
	Unconfined compression strength		2.1 - 8.1 T/m^3		21 - 65 T/m^3
	Stratum thickness		Maximum 7 meters		Under CDL-4m

(2) Water Level

The CPA standard level is used as control datum line (CDL) of the project.

Since the project site is located at near the river estuary, the water level fluctuation at the project site is subject to the influence of the astronomical tide and the meteorological floods. The fluctuation range of the astronomical tide at the estuary of the Karnaphuli river is of the order of 1.5 to 5.5 m, but at the vicinity of the Sadarghat Tide Station located close to the project site is of the order 1.2 to 4.2 m.

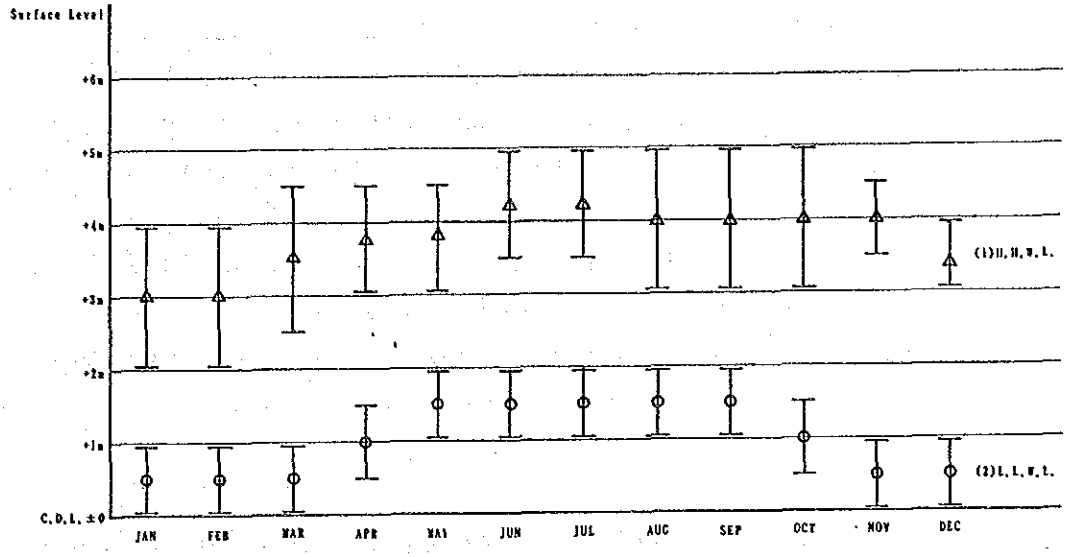
The following conclusions are drawn from the forecast value of the astronomical tides at the Sadarghat Tide Gauge Station during the year of 1990. (Refer to Figure 1).

1) During the neap tide, the low water level rises and the high water level lowers, and the fluctuation range of the water level due to the high and low tide is small (0.8 to 2 m). In the spring tide, the fluctuation range of the water level due to the high and low tide is large (2.5 to 4.2 m).

2) The low water level falls under {CDL + 1 m} during five months of the year, November, December, January, February and March. During October and April the average value of the low water level becomes close to {CDL + 1 m} and during May, June, July, August and September the low water level fluctuates within {CDL + 1 to 2 m}.

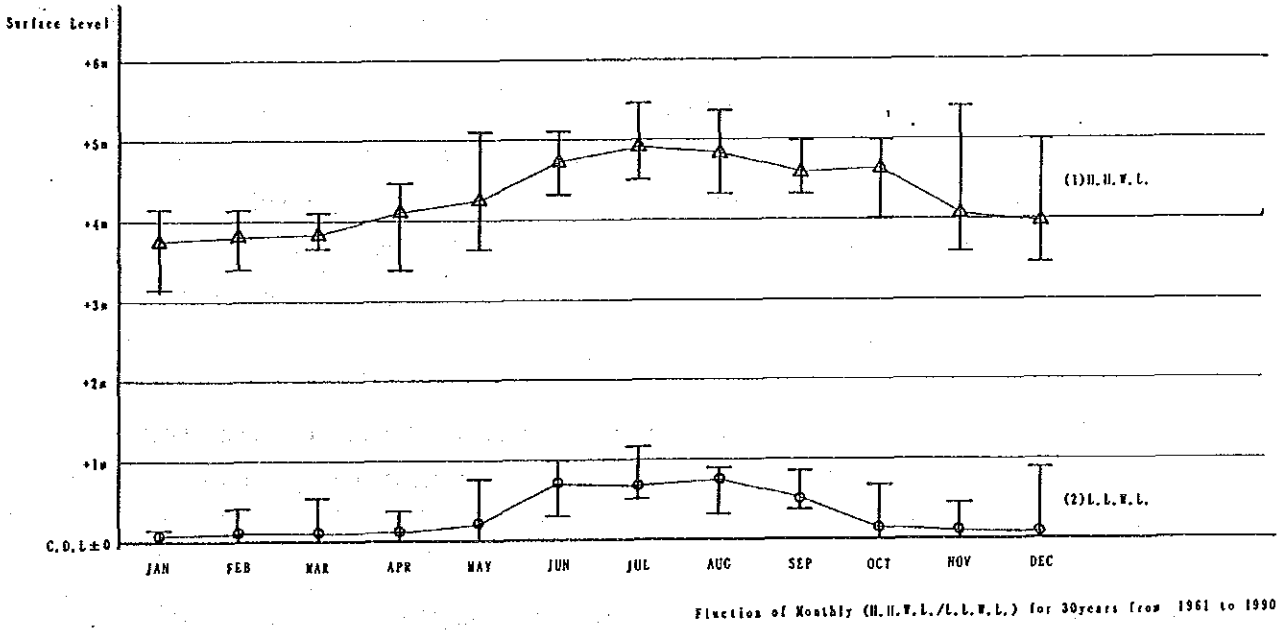
3) The monthly fluctuation range of the high water level is large except November and December, and is approximately twice as large as the fluctuation level of the low water level (1 m). The daily fluctuation level of the high water level is approximately 1 m during the neap/spring tides.

FIGURE 1 ASTRONOMICAL TIDE FLUCTUATION AT THE PROJECT SITE



On the other hand, Figure 2 shows the fluctuation of the tide, obtained from the frequency analysis of the monthly maximum and minimum water levels observed during 30 years at the Sadarghat Tide Gauge Station. The observed water levels shown in the figure comprise the influence of the swelling of the river in addition to the astronomical tide level.

FIGURE 2 FLUCTUATION OF THE WATER LEVEL AT THE PROJECT SITE



The following conclusions are drawn from Figure 1 and Figure 2.

1) Since the period from January to April is mostly in the dry season (rainfall of the order of 200 mm/month during April) and there are few cyclones (only one cyclone has occurred in April during the last 20 years), the monthly maximum water level is practically equivalent to the astronomical tide level.

2) May is the beginning of the rain season (rainfall of 250 mm/month), and it coincides with the occurrence of cyclones (1 cyclone/3.5 years). The maximum high water level has risen 50 cm above the astronomical tide level at most.

3) There are few cyclones during the period from June to September (only one cyclone has occurred in this period during the last 40 years), but on the other hand it corresponds to the peak of the rainy season. The maximum high water level rises 0.50 m to 1.0 m above the astronomical tide level.

4) October corresponds to the end of the rain season (rainfall of 400 mm/day) and to also the occurrence of cyclones (1 cyclone/3 years). The maximum high water level rises 50 cm above the astronomical tide level.

5) November and December correspond to the beginning of the dry season, with few rainfall, but on the other hand there is frequent occurrence of cyclones (1 cyclone/3.5 years for November/December). The maximum high water level may rise 1.0 m at most above the astronomical tide level.

The control datum lines (CDL) established at similar facilities existing at the vicinities of the project site are shown as follows ;

1) The jetty crest elevation of the Chittagong Fish Harbor Complex located at the opposite bank of the project site is CDL + 5.0 m.

2) The crest elevation of the CPA jetty located 8 km to the downstream of the project site is CDL + 6.4 m at the container yard and CDL + 5.5 m at the most part of yard.

In view of this, it is presumed that the water level at the project site will rise above CDL + 5.0 m once a year and that it will rise above CDL + 5.4 m once every 10 years. The crest of fish landing apron is therefore set at CDL + 5.0 m, the ground level of the yard (G.L.) at CDL + 5.5 m, and the floor level of the buildings at CDL + 6.0 m.

(3) Waves

Practically no sea waves, that occur at the Bay of Bengal, reaches the project site located at the bank of the Karnaphuli river which bends 16 km inland from the estuary. Even at the CPA jetty located 8 km to the downstream of the project site, waves larger than 2 meters (6-second cycle) occur only a few days of the year.

Surges (maximum wave heights of 5 to 6 m : occurring once every 15 years) during cyclones do not coincide rarely with high tide, and occur at low tide (close to CDL ± 0 m). No emergency evacuation of the existing floating jetty is required even during the surge, and no damage has been recorded so far.

It is not necessary to take abnormal surges into consideration for the design, and maximum wave heights of the order of 1 to 2 m are regarded as sufficient for the designing constructions located at the river bank.

(4) Soil Quality

Although the surface of the site consists of the stratum of sandy silt containing clay, having thickness of 5 to 7 m and of N-value under 10, it will be possible to secure the stability of the revetment and the retaining wall when the land is reclaimed on it. On the other hand problems due to soil

settlement by consolidation are expected to occur. It must be remembered, however, that since the results of the soil quality tests (refer to Appendix VII-4) suggest that the percentage of clay (particle diameter sized less than 2 microns) is relatively low (maximum 21%), it is presumed that the settlement, if there is any, will not take long time (probable 3 months at most).

Since the water content in percentage of total weight (28% to 36%) and the void ratio are both small, the extent of settlement is presumed to be small, and consequently the following measures will not be required.

1) Accelleration of settlement due to consolidation by the preloading.

2) Additional embankment to compensate the settlement after the completion of the work.

(5) Water Quality

1) Ground Water

The analysis of the ground water, carried out at a place located approximately 1.5 km to inland from the project site, shows that the pH varies from 5.2 (acid) to 9.4 (alkaline), and that the salinity varies 1.5 ppm (August) to 36.5 permillage (July). It is thus recommended to use WASA feed water from the standpoints of water quality (WHO standards) and stability of the supply.

2) Water of the Karnaphuli River

As a result of the water quality analysis (Refer to Table 5-1) carried out at the vicinity of the project site (Bambooghat), that the pH is alkaline (pH of the order of 7.0 to 7.8) with exception of December (pH of 6.1 to 6.2). The

salinity level is of the order of 0.5 to 7.5 permillage with exception of the abnormally high concentration of 25.5 permillage observed in October. These concentrations are lower than the values observed in ground water samples collected in land areas and remarkably lower compared with sea water. The level of suspended solid (S.S.) is of the order of 100 to 1,800 ppm, and the density is higher during the rainy season than in the dry season. Water of the Karnaphuli river has apparently a high degree of turbidity, but the BOD is small and in spite of the inflow of sewage water the pollution is not so advanced because of the abundant flow water and because it is a tidal river. No corrosion is observed in steel structures such as the floating pontoons that have been used for 10 or more years.

5-1-3 Examination of the Structure Design Standards

Regulations and technical standards of Bangladesh, if any, will be taken into consideration, and technical standards that are regarded as internationally acceptable will be adopted if the national ones are not available.

Generally speaking, the BS and ASTM standards are used for steel and concrete. The following standards, that are equivalent to or better than those are adopted in this project.

1) Standard Design Method of Structures of Fishing Harbors : National Fishing Harbor Association of Japan
2) Technical Standards for Port and Harbor Facilities in Japan (1980) : The Overseas Coastal Area Development Institute of Japan
3) Road Paving Standards : Japan Road Association
4) Soil Test Methods : Soil Engineering Institute of Japan
5) Standard Specifications of Concrete : Civil Engineering Institute of Japan
6) Japanese Industrial Standards (JIS) : Japanese Standards Association

7) Rules for Pontoon Barges : Nippon Kaiji Kyokai
8) Road and Bridge Specifications : Japan Road Association (1975)
9) Road and Bridge Bearing Device Manual : Japan Road Association
10) Design Manual of Floating Pontoon (Draft) : Society for Research and Development of New Technologies for Fishing Harbors (1989)

5-1-4 Design Conditions of Facilities and Equipment

(1) Facilities in General

In Bangladesh, the RAJUK is the government office with jurisdiction over matters related to the construction policy in the urban area of Dhaka, and the CDA (Chittagong Development Authority) is the government office with jurisdiction over all other areas of the country. Strictly speaking, this project would be under the jurisdiction of the CDA of Chittagong, but generally all matters related to the constructions of this project will be authorized by the CDA if they are submitted to the approval of engineers of the BFDC in charge of the matter. Technical standards referring to constructions in general are based on American standards and Japanese standards.

(2) Protection Against Disasters

The CDA is the government office with jurisdiction over the matter, but the design documents are examined also by the Fire Station of Chittagong. The design will be done in conformity with the UBC, and fire extinguishers will be installed in the administrative building, in the ice-making plant and other required area.

(3) Water Supply and Drainage

The WASA (Water and Sewage Authority) is the government office with jurisdiction over the matter. The water quality and other relevant aspects are in conformity with WHO standards. The water supply capacity in the city of Chittagong is of the order of 30 to 40 million gallons a day, and 4-inch PVC pipe is laid in the area of the project site. Service pipe, including the meters, is laid by WASA up to the underground storage tank to be installed by the user, and the piping after that is the responsibility of the user. The water storage tank must have watertight construction and must be durable.

Sewage is discharged directly to nature because there is no sewage system at all. A night soil purification tank and infiltration pipe system will be used in this project to prevent sewage from being discharged directly in the river.

Even when the user pumps water from wells, the WASA collects charges in conformity with the diameter of the piping of the well.

(4) Power

The PDB (Power Development Board) is in charge of the supply of power, and the power is 415/240 V 50 Hz. 11 KV power is available at the project site. The IEC standards will be applied to this project. Since power storage of 10 to 20 minutes occurs once every 7 or 10 days, emergency power supply will be required at the ice-making plant. The service line will be available up to the transformer, and the user must take charge of the wiring and other facilities after the secondary side.

(5) Telephone

The T & T Board has jurisdiction over telephones. The telephone charge is classified according to the system,