PEOPLE'S REPUBLIC OF BANGLADESH

MINISTRY OF IRRIGATION, WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANIZATION

DHAKA INTEGRATED FLOOD PROTECTION

FAP-8B

A.D.B. T.A. NO. 1318-BAN

INTERIM REPORT NO. 1

MAY 1991

Submitted by:

LOUIS BERGER INTERNATIONAL, INC.

In Association With:

Associated Consulting Engineers (Bangladesh) Ltd.
Desh Upodesh Ltd.
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Dhaka Integrated Flood Protection Project
ADB TA No. 1318-BAN
Ministry of Irrigation, Water Development and Flood Control

Louis Berger International, Inc.
In association with
Associated Consulting Engineers Ltd.
Desh Upodesh Limited.
Technoconsult International Ltd.

Memo No.: BY399\DIFP\ADB\220591-160 May 22, 1991

Asian Development Bank
P.O. Box 789
Manila, Philippines

Attn. : Mr. P.K. Thomas
Manager, IFSI

Subject : T.A. No. 1318-BAN, Dhaka Integrated Flood Protection Project
Interim Report No. 1 (Integrated Environmental Management Plan)

Dear Mr. Thomas,

In accordance with Section 4.01 of the *Contract for Consultants Services* we are pleased to herewith submit five copies of our Interim Report No. 1, the *Integrated Environmental Management Plan for Dhaka.*

On behalf of myself and our team, I wish to extend my thanks to the many people in BWDB, DCC, DWASA, DOE, RAJUK, CUS and DOF who provided so much of the information which made this report possible, to the FPCO for their excellent coordination work between the FAP consulting teams, and to the other FAP consultants with whom we have been exchanging ideas and information. Special thanks are due to the JICA team who have shared their data so freely with us, and to the engineers at DWASA who have slogged through the drains and worked long into the night to assist us in accurately defining the problems and costs for the drainage component.

We hope that the benefits of this report will extend beyond the immediate future by assisting the Government in the formulation of long term strategies for improved urban environmental management, and by assisting the Government and other donors in identifying and selecting worthy projects for support to complement this Project and create a better environment for the people of Dhaka.

With best regards,

Yours truly,

22/05/91

R.D. Berlin, P.Eng.
Project Manager

enc. : As listed
c.c. : Mr. A.M.M. Nurul Huq, Chief Engineer, FPCO (with 50 copies)
Dr. Asad Ali Shah, Sr. Urban Development Specialist, ADB
Mr. K.H. Talukdar, Project Officer, ADB-BRO

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ABBREVIATIONS

ADB	-	Asian Development Bank
AEC	-	Atomic Energy Commission
BWDB	-	Bangladesh Water Development Board
CUS	-	Center for Urban Studies
DCC	-	Dhaka City Corporation
DEPC	-	Department of Environment and Pollution Control
DMA	-	Dhaka Metropolitan Area
DOE	-	Department of Environment
DOF	-	Department of Fisheries
DPHE	-	Department of Public Health Engineering
DWASA	-	Dhaka Water Supply and Sewerage Authority
EQS	-	Environment Quality Standards
FAP	-	Flood Action Plan
FPCO	-	Flood Plan Co-ordination Organization
HBFC	-	House-Building Finance Corporation
IDA	-	International Development Association (of the World Bank)
IPH	-	Institute of Public Health
JICA	-	Japan International Corporation Agency
LGD	-	Local Government Division
LGEB	-	Local Government Engineering Bureau
MEF	-	Ministry of Environment and Forest
MIWDFC	-	Ministry of Irrigation, Water Development & Flood Control
MLGRDC	-	Ministry of Local Government, Rural Development and Cooperatives
MOI	-	Ministry of Information
MOW	-	Ministry of Works
NGO	-	Non-Government Organization
PC	-	Planning Commission
PHED	-	Public Health Engineering Department
PIU	-	Project Implementation Unit
PMU	-	Project Management Unit
PWD	-	Public Works Department
RAJUK	-	Rajdhani Unnayan Kattripaka (Capital Development Authority)
SOB	-	Survey of Bangladesh
SPARRSO	-	Bangladesh Space Research and Remote Sensing Organization
UDD	-	Urban Development Directorate
UNCHS	-	United Nations Centre for Human Settlements
UNDP	-	United Nations Development Programme
UNICEF	-	United Nations International Childrens Education Fund
WHO	-	World Health Organization

Physical Units

Cusec	-	Cubic meters per second	m	-	meter
ha	-	hectares	mld	-	million liters per day
kl	-	kilo-liters(thousand liters)	mm	-	millimeter
km	-	kilometer	sq m	-	square meter
l	-	liter	sq km	-	square kilometer

1.0 INTRODUCTION

1.1 Background

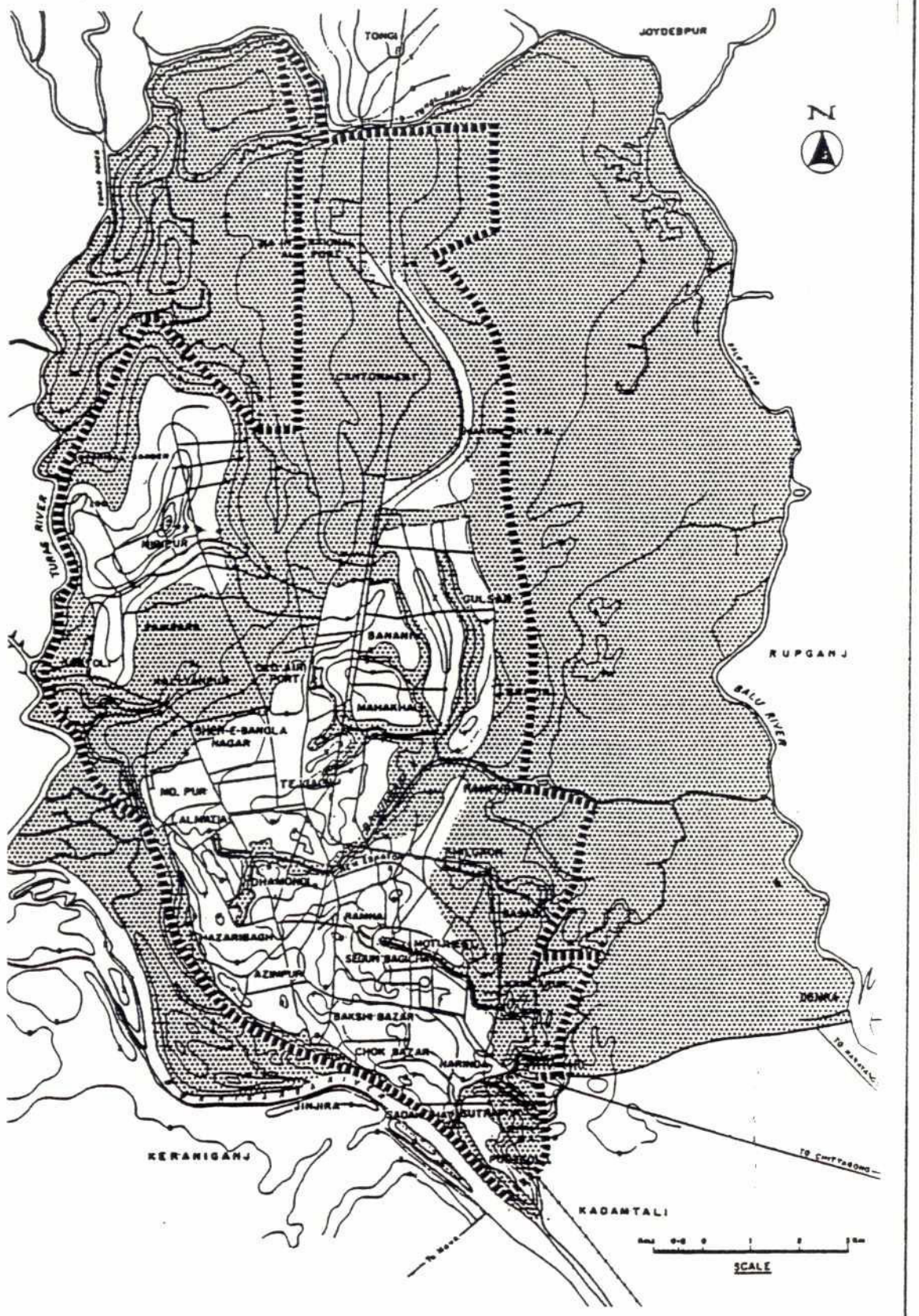
During the monsoons of 1987 and 1988, Bangladesh suffered two of the most serious floods on record. Vast areas of the country, including the capital city of Dhaka with a population of about 4.8 million people, were flooded to an unprecedented degree with flood levels 1.5 meters higher than normal for periods of up to four weeks. In Dhaka city alone it is estimated that about 200 sq. km., or 77% of the total area of 260 sq km, were submerged to depths ranging between 0.3 to over 4.5 meters (see Figure 1.1), and that about 2.5 million people, or 60% of the city population, were directly affected by these floods. City life was totally disrupted during this period, and it is estimated that flood damages, which average about Tk. 250 million in normal years, exceeded Tk. 700 million in 1988.

In the wake of these floods, in October 1988 the Government of Bangladesh (GOB) established a Committee for Flood Control and Drainage of Greater Dhaka, with the primary objective of preparing a flood control plan for the Greater Dhaka Metropolitan area, based primarily on the 1987 JICA study on storm drainage system improvements for Dhaka City, and the 1988 "Jansen Report" on causes of the 1988 flood and recommended solutions. In January 1989 the Committee submitted a detailed scheme for phased investments in flood protection and drainage for Dhaka, Tongi, Narayangonj and Savar, which was approved by the Government in March 1989.

Figure 1.2 shows the recommended program for Dhaka. In view of the high priority assigned to the Dhaka protection scheme, the Government immediately initiated Phase I of the recommended works on a crash program basis using their own resources. These works, which were designed to provide protection to about 136.5 sq km in the highly urbanized westerly part of the city, included construction of about 30 km of embankment and 7 km of flood protection wall along the westerly perimeter of the city, complemented by about 2 km of new roads, 8.5 km of road raising to the east, pipe sluices, cleaning and repair of internal drainage khals and sewerage systems. Additional works taken up at the same time included construction of a flood protection bund around Zia International Airport and 30 km of flood protection wall around the Dhaka-Narayanganj-Demra zone to the south of the city. Implementation of the program was a coordinated effort involving the BWDB, DCC, DWASA, RAJUK, CAAB and the Army.

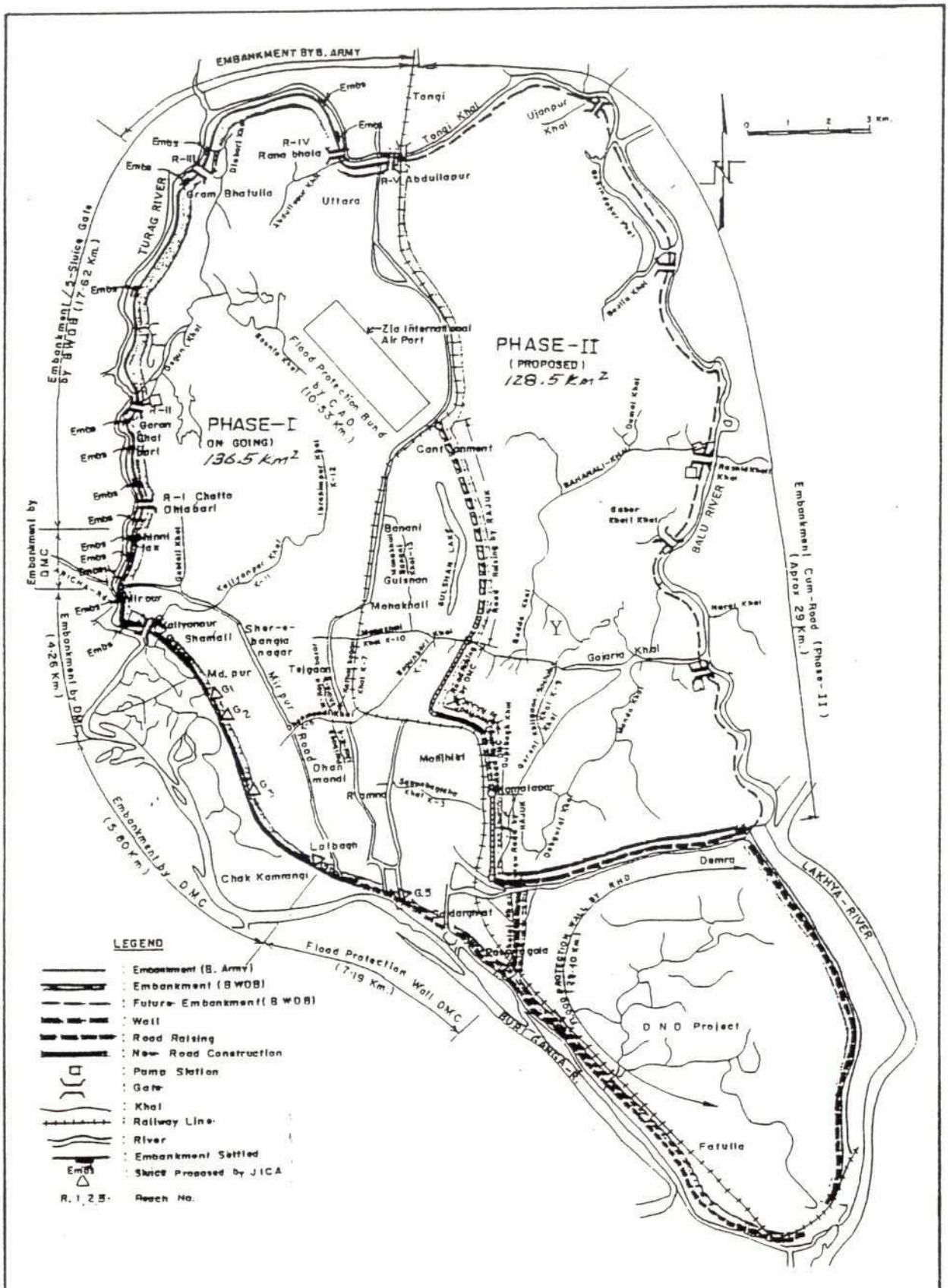
1.2 Flood Action Plan

Several additional studies were carried out in 1988 and 1989 to develop a comprehensive flood policy and program for Bangladesh, including Dhaka city. Based on the results of these studies (all of which agreed on the priority to be given for protective works for the urban areas) a Flood Action Plan (FAP) was formulated under the coordination of the World Bank in November 1989. The FAP identified a total of 11 components and 15 supporting activities to be taken up over a five year period as part of



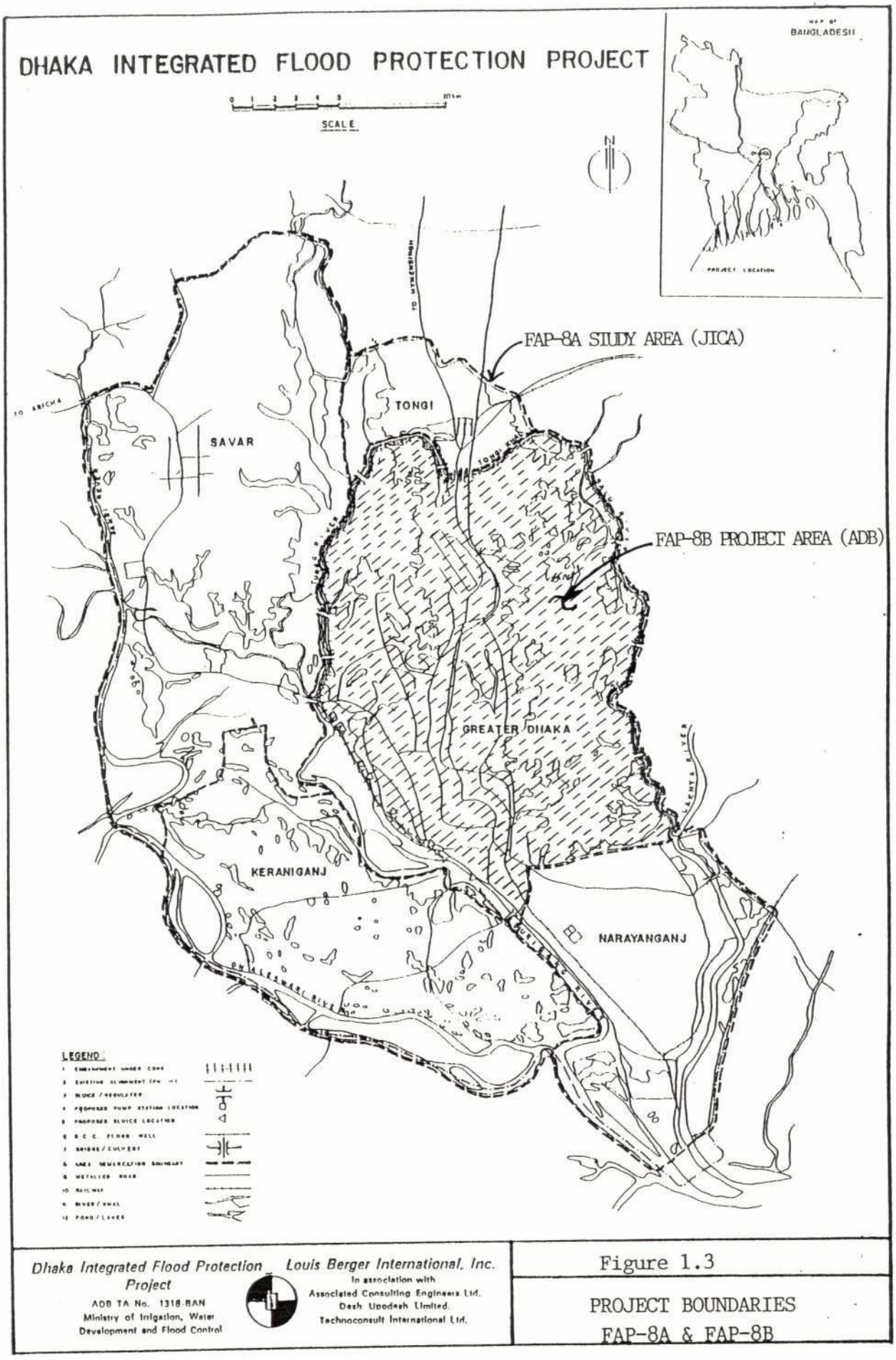
Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	Figure 1.1 1988 FLOODED AREA

Source : JICA Storm Water Updating Study, February 1990



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	Figure 1.2 GREATER DHAKA FLOOD PROTECTION PROJECT.

Source : BWDB Synopsis of Flood Protection and Drainage Project, June 1990



Dhaka Integrated Flood Protection Project

ADB TA No. 1318-BAN

Ministry of Irrigation, Water Development and Flood Control

Louis Berger International, Inc.

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Technoconsult International Ltd.

Figure 1.3

PROJECT BOUNDARIES

FAP-8A & FAP-8B

a long term plan of physical works and improved preparedness and management of floods. This was confirmed at the London conference of donors in December 1989 for the purpose of formalizing commitments from various donors for FAP components.

In support of the Government's flood action program, both the Government of Japan and the Asian Development Bank agreed to provide assistance for the Dhaka Town Protection component, FAP-8. This is a two part coordinated action plan specifically focused on the Dhaka Metropolitan Area, and includes:

i) FAP-8A, JICA Master Plan Study for Greater Dhaka, Tongi, Savar, Keraniganj and Narayangang, which has the objective of developing Master Drainage and Flood Control Plans for the Dhaka Metropolitan Area of 850 sq. km., identifying priority projects within this area, and preparing feasibility studies for selected components, and

ii) FAP-8B, ADB Dhaka Integrated Flood Protection Project (DIFPP), which has the objective of identifying drainage, flood protection and complementary environmental improvement projects, and preparing feasibility studies for the immediate investment needs in the Greater Dhaka Area of 260 sq. km. (included in the above larger study area).

Figure 1.3 shows the boundaries of the respective study areas. As a part of their work programs, the JICA and ADB consultants are maintaining close liaison and sharing information and findings to ensure that their actions are complementary and that unnecessary duplication of work is avoided.

1.3 Technical Assistance Objectives

As defined in the Terms of Reference and agreed at the Inception Report stage, the technical assistance for this Project has two primary objectives:

(i) to prepare an integrated urban environmental plan for the Dhaka Metropolitan Area (260 sq km) and surrounding urbanized areas to a pre-feasibility level of detail with emphasis on flood protection and drainage. Other aspects to be considered include management of land use, water quality, sewerage/excreta, solid waste, hazardous and toxic wastes, and slum and squatter areas. Also included will be review and comments on the institutional arrangements and legislation related to environmental policy and controls.

(ii) to prepare a feasibility study (together with selective assistance in detailed design and contract preparation for flood control and drainage elements) for Dhaka City, not covered under ongoing flood protection programs. Infrastructure works expected to be included include flood protection embankments, roads, internal drainage improvements, sluices and pump stations for the flood protection and drainage components, plus complementary activities in slum area improvement, solid waste management,

and sanitation. Recommendations are to be made on the planning and design standards adopted in the works taken up in the Phase I program, on appropriate institutional arrangements for implementation, operation and maintenance of the facilities, and on appropriate cost recovery mechanisms.

In summary, the main objective of the technical assistance is to assist the Government in the implementation of environmental improvements in the DMA, with emphasis on solving the most serious existing problems.

1.4 Interim Report No. 1

This Interim Report No. 1 presents an outline Integrated Environmental Management Plan for Dhaka City, developed to the pre-feasibility level of detail in accordance with the Terms of Reference. It includes, (i) the Consultants analysis of the current situation in Dhaka in regards to land use management, flood control and drainage activities, water quality and sanitation/excreta management, water supply, solid waste management, slum and squatter area improvement, hazardous and toxic waste management, environmental legislation, and institutional and policy aspects, (ii) the Consultants recommendations for appropriate short and long term actions to be taken to improve the Dhaka environment, and (iii) recommendations for taking up of selected high priority components for implementation under ADB assistance in connection with the proposed Dhaka Integrated Flood Protection Project. In addition, it includes an analysis of the major environmental impacts of the proposed flood protection and drainage schemes, and the specific activities which must be taken into consideration in order to mitigate potential adverse impacts of such a program.

It is expected that this report will form the basis for discussions and agreement between the Government of Bangladesh and the ADB in selecting priority items to be taken up for detailed feasibility analysis and selected design assistance during subsequent stages of this study, in order that implementation can commence during the following 1991-1992 financial year.

It is also hoped that this report will act as a guideline for various agencies in Dhaka city to formulate their respective long term strategies for improved integrated urban environmental management, and will assist other donor agencies in identifying and selecting worthy projects for future support.

2.0 LAND USE MANAGEMENT

2.1 Introduction

As set forth in the Terms of Reference, the purpose of this section is to;

i) assess the existing land use planning in DMA and policies being implemented/enforced, including policies relating to conversion of agricultural lands to industrial and urban uses and management of squatters,

ii) recommend for alternative land use design/strategies for optimal land utilization in DMA, and

iii) evaluate the adequacy and usefulness of any existing land use standards to regulate land use activities.

2.2 Existing Land Use and Planning

The most up-to-date review of the status of land use and urban planning in Dhaka and the surrounding areas is the comprehensive analysis contained in the JICA FAP-8A Interim Report of March 1991. This report provides an in-depth review of the historical growth of Dhaka city, the results of a land use survey conducted by the JICA study team, and a forecast of the probable patterns and rates of growth for Dhaka up to the year 2000.

The major relevant observations extracted from the JICA Interim Report can be summarized as follow:

i) during the period from 1981 to 1990, the Greater Dhaka population grew at an average annual rate of 5.5%, from about 2.8 million people to 4.6 million. During the same period, the built-up area increased from 104 sq. km. (39% of the city area) to 114 sq. km. (43%).

ii) currently (1991), it is estimated that the population of Greater Dhaka City is about 4.8 million. The surrounding areas of Savar, Tongi, Narayanganj, Keraniganj and the fringes contain a further 2.2 million people, for a total Dhaka conurbation population of about 7.0 million.

iii) major land uses in Dhaka city (total area of 265 sq. km.) in 1990 included: residential (5,320 ha. or 19% of the total area); commercial, industrial and institutional (2,380 ha for 8%); roads and other (2,930 ha. for 11%); village settlements (1,110 ha. for 4%); agriculture (12,370 ha. for 45%); and water bodies (3,430 ha. for 12%). 39% of the total land was in urban use, while 61% was rural or semi-rural.

The JICA consultants observed that the notable features of this land use were:

- o the low proportion of parks, roads, commercial and industrial areas compared to the major residential use and the population served,
- o the wide scatter of very poor slum and squatter settlements which house a third of the cities population, but in very small areas,
- o the disproportionately large areas used for housing the upper income groups, and
- o the high densities prevailing, particularly in the slum and squatter settlements,

all of which reflect an intensity of land use brought about by increasing population pressure, limited alternative development areas, and the lack of a transportation system which would allow a more extensive development pattern.

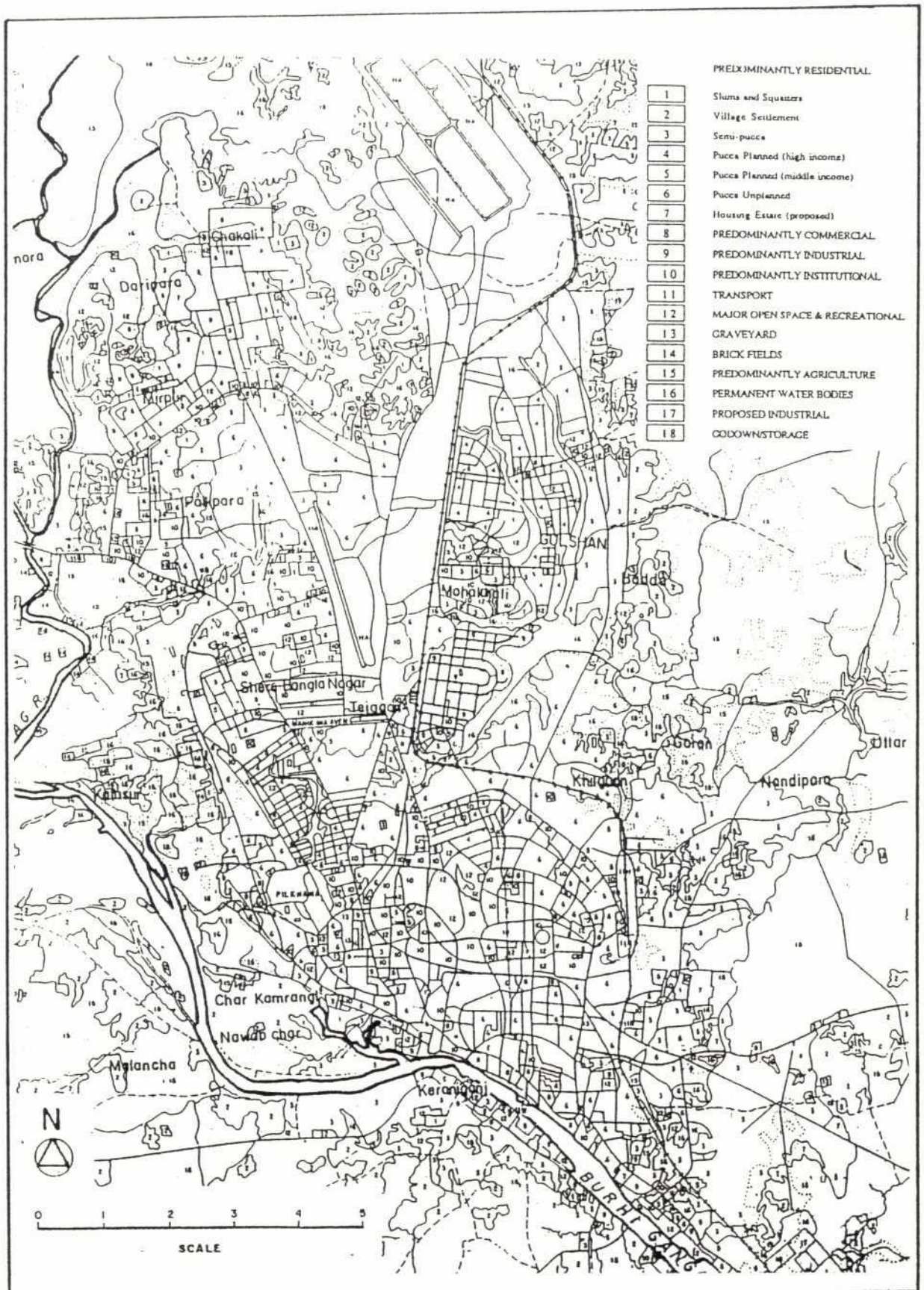
iv) it is estimated that the growth rate for Dhaka city will diminish in the coming years, to an average of 4.6% from 1990-2000, and 2.0% between 2000-2010, resulting in populations of 7.1 million in 2000, and 8.7 million in 2010.

v) much of this growth will be absorbed by increased densification in existing developed areas, and the demand for new land for development will grow at a lower rate averaging about 2.2% for the period up to 2010. In spite of this, however, it is estimated that the built-up area will increase from it's 1990 level of 114 sq. km. (43% of the city area) to 177 sq. km. (67% of the area) over the 20 year period.

vi) the major growth pressures will occur along the perimeter of existing built-up areas, in what are now marginal lands. The main demands for new development areas are expected to take place in the West Embankment, Eastern Dhaka, Mirpur and the Eastern Embankment areas, on what are presently agricultural lands.

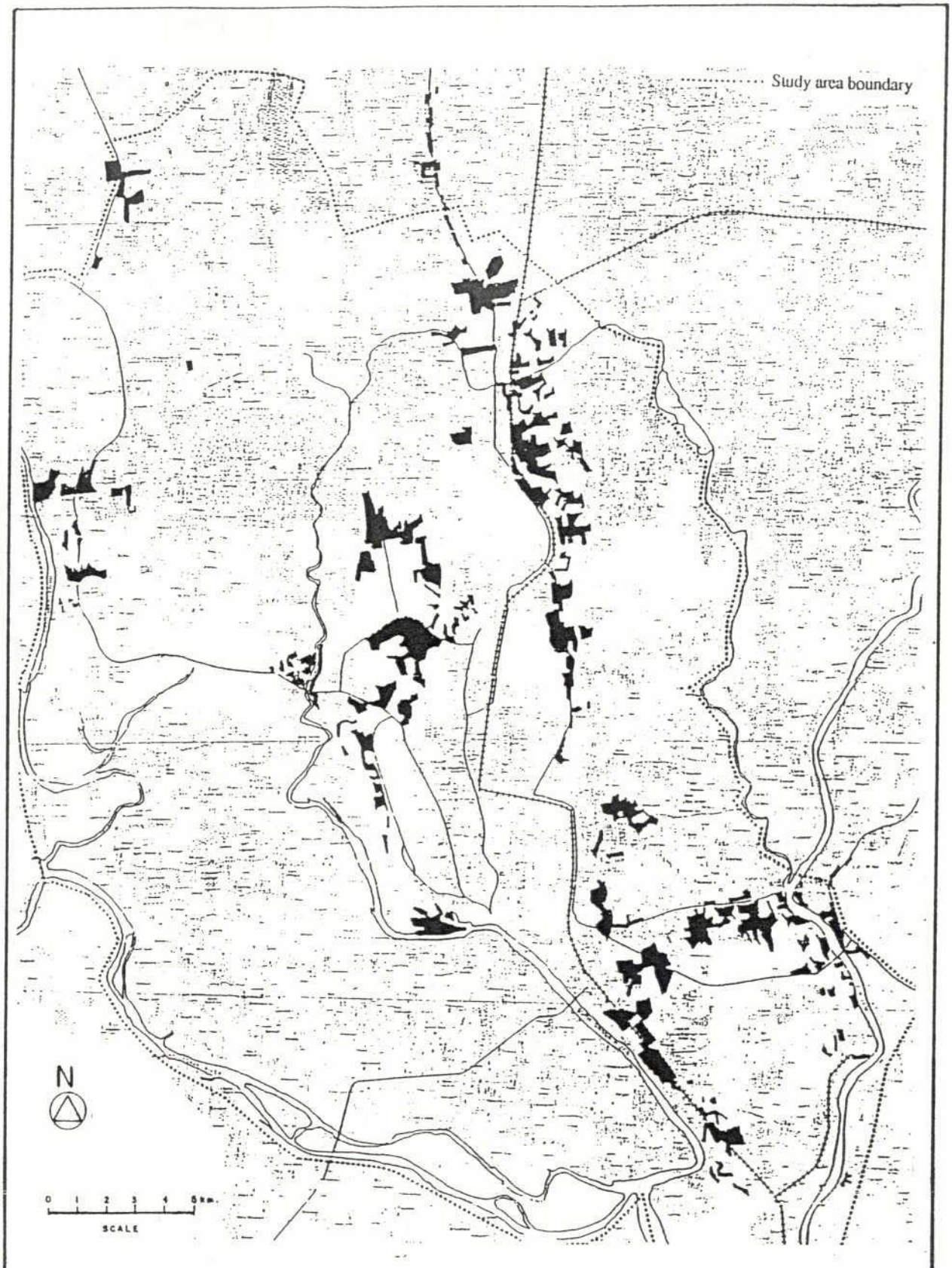
vii) the proportion of low income slum and squatter dwellers will probably increase in proportion to their present ratio of about 30% of the total population.

Figures 2.1 to 2.4, derived from the JICA report, show the existing land use in Greater Dhaka, the main growth areas from 1983 to 1990, and the projected growth areas for 1990 to 2000 , and 2000 to 2010. Table 2.1 summarizes the population and land use estimates for the years 1990, 2000 and 2010.



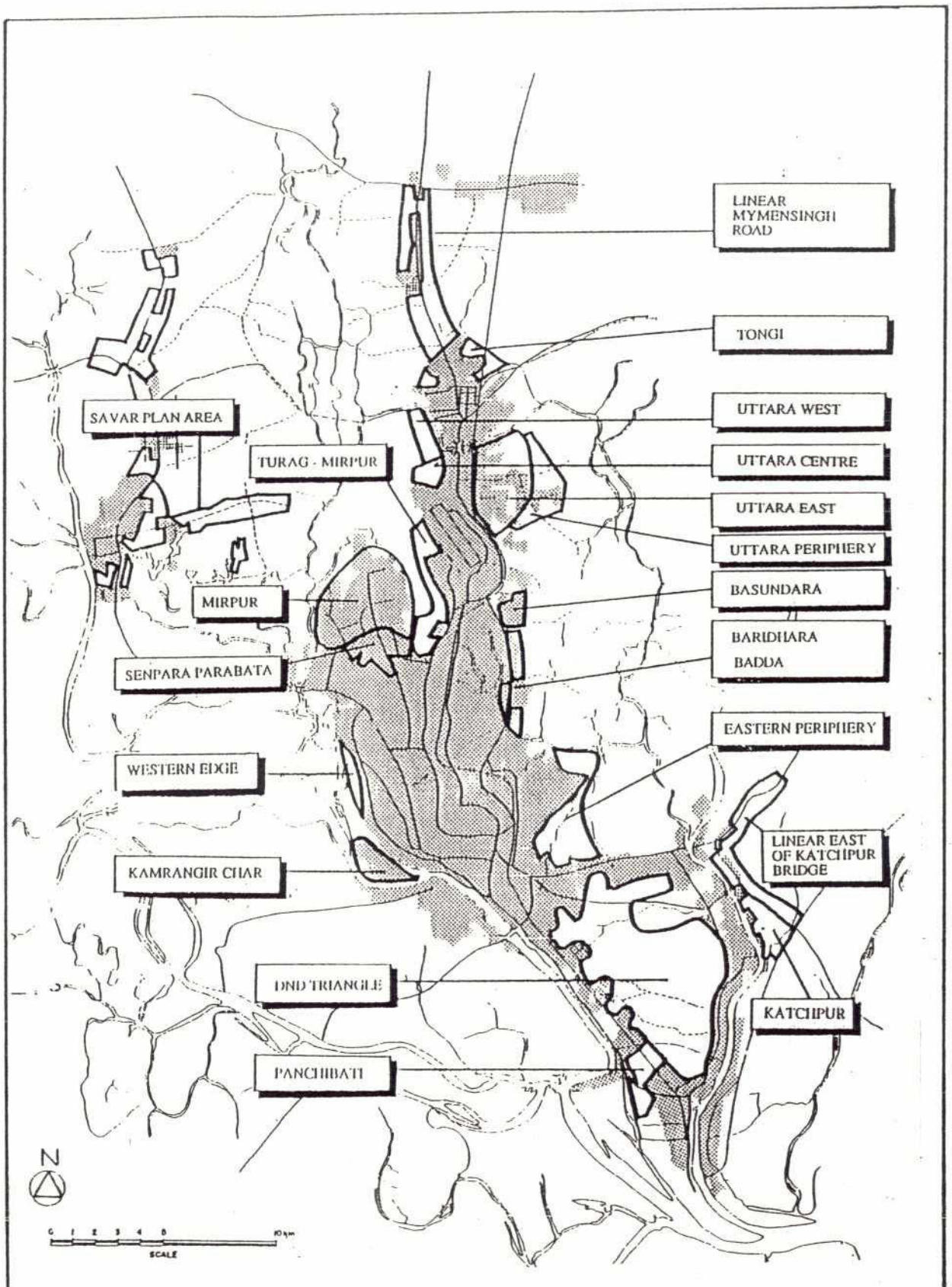
Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 2.1 EXISTING LAND USE: GREATER DHAKA

Source: JICA INTERIM REPORT, GDPP, MARCH 1991



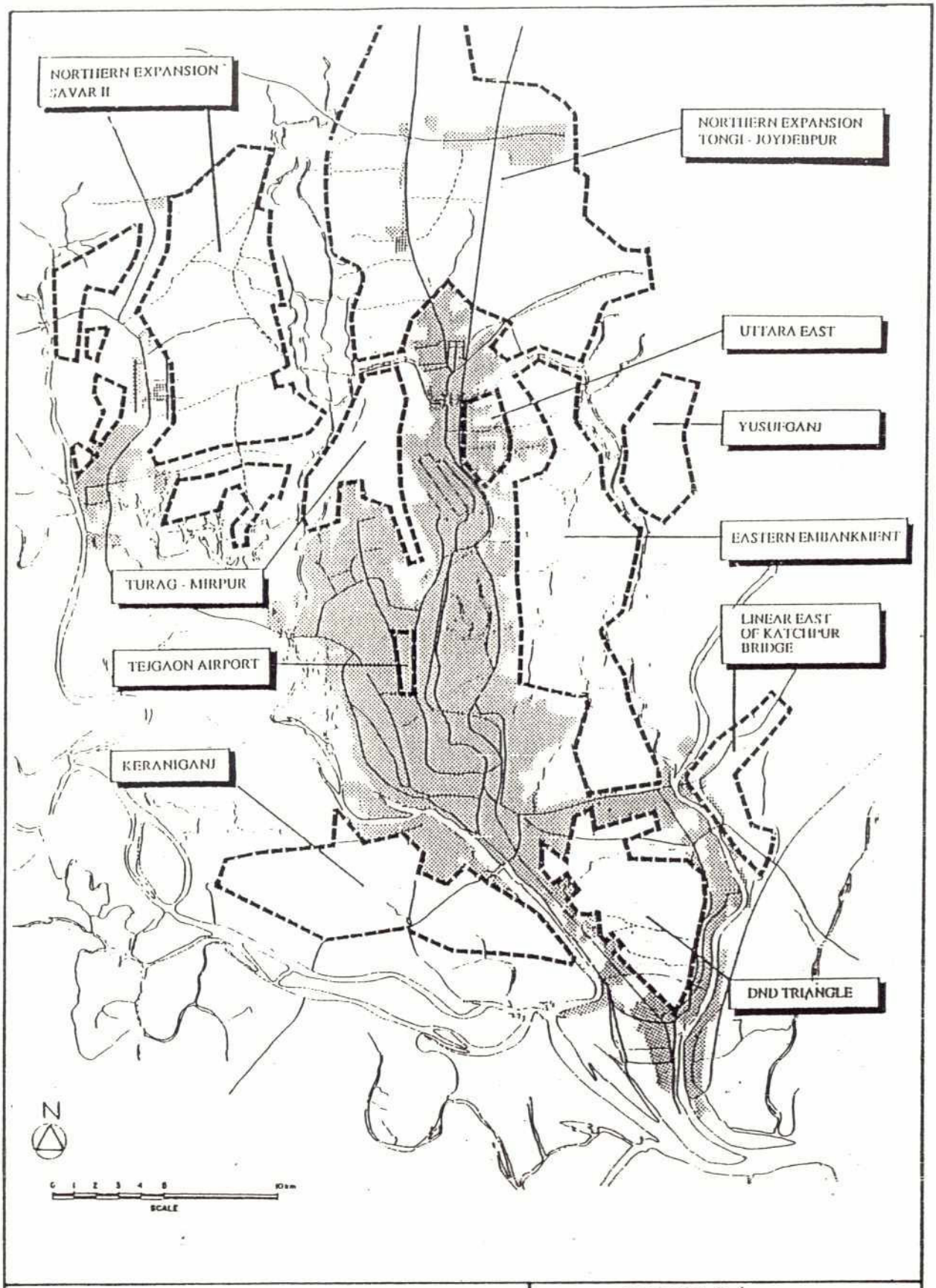
Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 2.2 MAIN URBAN GROWTH AREAS 1983 TO 1990

Source: JICA INTERIM REPORT, GDPP, MARCH 1991



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited Technoconsult International Ltd.	FIGURE 2.3 POTENTIAL DEVELOPMENT AREAS 1990 TO 2000

Source: JICA INTERIM REPORT, GDPP, MARCH 1991



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upadesh Limited Technoconsult International Ltd.	FIGURE 2.4 POTENTIAL DEVELOPMENT AREAS POST 2000

Source: JICA INTERIM REPORT, GDPP, MARCH 1991

TABLE 2.1

POPULATION AND LAND USE PROJECTIONS FOR GREATER DHAKA
(1990 TO 2010)

AREA	POPULATION ('000)			LAND USE (HA.)			
					BUILT-UP AREA		
	1990	2000	2010	TOTAL	1990	2000	2010
High Established Area	188	252	285	1,072	1,072	1,072	1,072
West Embankment	312	524	587	1,043	330	627	627
Old Dhaka	1,266	1,778	1,778	1,166	1,142	1,156	1,156
Commercial/Indust/Instit'l	514	775	861	1,893	1,759	1,807	1,807
Eastern Dhaka	968	1,447	1,617	2,044	1,715	2,044	2,044
Mirpur Area	669	1,283	1,608	5,653	1,732	2,595	3,300
Other Central Areas	294	305	345	370	312	357	357
Cantonment	162	238	322	3,175	1,717	1,943	2,023
Eastern Embankment	292	530	1,300	10,100	1,642	2,422	5,325
GREATER DHAKA TOTAL	4,565	7,132	8,703	26,516 (100%)	11,421 (43%)	14,023 (53%)	17,711 (67%)
AVERAGE GROWTH RATES	4.6%	2.0%			2.1%	2.4%	

Current land use planning in Dhaka is still primarily guided by the Master Plan developed in 1959/60 under the Technical Cooperation Scheme of the Colombo Plan. Although this plan was developed for only a 20 year planning horizon up to 1978, based upon a planning area with a population of 1.0 million and projected growth rates of only 1.75%, it has proven to provide a remarkably accurate forecast of the overall development pattern which has since taken place. Part of the reason for this is that it forecast a logical growth pattern along the higher lands at the periphery of existing developments based on reasonably foreseeable conditions; a second reason is that the major development agencies have continued, to a large degree, to model their expansion programs along the lines originally indicated in this Master Plan.

There have been no major revisions to the Master Plan since it was prepared, and minor modifications have been made on an ad-hoc basis. Most of the land use planning in Dhaka is an informal exercise, responsive to the existence/provision of the major public infrastructure expansions which have been guided by the 1959/60 Master Plan, and to the market forces.

There is an acute shortage of adequately serviced land for development in Dhaka, and it is estimated[1] that 70% of the population (predominantly low income and poor) have access to only 20% of the land, while the more affluent 30% have access to the remaining 80%. RAJUK, as the primary public sector land development agency, has undertaken extensive planned developments throughout Dhaka in the past, and will continue to play the lead role in the future. In addition, cooperatives are becoming more active in a developing private sector role for providing housing stock in larger urban centers. Both RAJUK and the cooperatives, however, target their developments exclusively for the middle and upper income groups. HSD, which has the authority/responsibility to provide housing for the lower income groups has not had an effective role in the past. With the notable exception of as few externally financed low income housing projects (e.g., the Mirpur resettlement project, the ongoing ADB Mirpur area development project, and the ongoing World Bank Integrated Urban Development Project) most housing for the poor has been developed in a totally unplanned way along the urban fringes, in high density pockets in the urban core, in low lying vacant lands subject to regular flooding, and on vacant public lands. Nearly all these areas have inadequate basic services for water, sanitation, drainage, access, or public services such as solid waste collection, health and education facilities.

2.3 Institutional Responsibilities

Radjahani Unnayan Kattripaka (RAJUK - the Capital Development Authority) has the primary responsibility for land use planning and control in Dhaka and the surrounding areas. RAJUK is a semi-autonomous Government body which is responsible for most of the public development activities within Greater Dhaka and the surrounding urban areas, and for regulation and control of the development activities of others within the same area. Primary activities of Rajuk include: (i) capital development works in Dhaka and its' suburbs, (ii) planning and development of residential and commercial areas, including planning and construction of feeder roads, (iii) allotment of land to public for housing and commercial centers, and (iv) registration and control of development plans of private agencies and other public bodies. RAJUK is responsible for maintaining and updating City Master Plans, and has the legal authority for controlling development within the context of any approved Master Plan zoning regulations.

Other agencies which have an important, though not necessarily a lead, role in land use management in Dhaka include: (i) the Urban Development Directorate (UDD) of the Ministry of Works for developing overall urban development policies, planning strategies and control legislation; (ii) DWASA for planning and supply of essential water supply, drainage and sanitation services; (iii) DCC for planning and provision of Municipal

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[1] Report of the Task Force on the Social Implications of Urbanization, Planning Commission, February 1991.

services; (iv) HSD for providing sites and service projects focused specifically on the urban poor; (v) the Roads and Highways Department (RHD) of the Ministry of Communications for planning and implementation of major communication networks and bypass roads; and (vi) all other public organizations and private utility companies for providing essential urban services and infrastructure.

2.4 Policies and Regulation

As mentioned in the Section 2.2, the 1959/60 Master Plan has continued to serve as a guideline for development in Dhaka. Even though it has not been officially updated since preparation, the major development agencies have used it as a guidance in the planning of urban infrastructure expansions, and market forces have followed.

At the present time there is no formal urban development policy in effect, there is no urban development strategy, there are no zoning regulations, there are no formal land conversion regulations, and there is no policy for addressing the problems of slum and squatter settlements. Although UDD/UNCHS prepared a draft Physical Planning (Land Use) and Development Control Ordinance in 1985 under the National Physical Planning Project, it has never been adopted. The only quasi-effective controls in effect are those exercised through RAJUK, which has the authority to regulate and control formal development applications for the construction and expansion of permanent structures under the provisions of the East Bengal Building Construction Act of 1952 (as updated in 1961 and 1986), and has a review and approval procedure for doing so. There are no effective control mechanisms in place to either guide, assist or regulate the proliferation of the numerous slum and squatter settlements in Dhaka.

In summary, the development controls which are exercised are largely done in an informal manner through the provision of extended infrastructure by the Government and utility agencies, e.g., "where roads go, people follow". Public, private and informal sector developments follow. RAJUK exercises a degree of control on the permanent developments through approval of building applications. There are no controls over low income, non-permanent, constructions, and there are no controls (other than economic ones) over the conversion of agricultural land to urban uses.

2.5 Ongoing and Proposed Programs

There are a number of ongoing or proposed projects in Dhaka which have the potential for providing the foundation for improving the land management practices in Dhaka.

Under the ongoing FAP-8A, Greater Dhaka Protection Project, JICA is preparing a Master Plan for Dhaka and the surrounding areas which will provide a long term plan for development of flood control and drainage facilities to increase the security of the Dhaka residents.

Under the recently completed Report of the Task Force on the Social Implications of Urbanization (Planning Commission, February 1991), the existing conditions, problems and needs of urbanization have been evaluated, and appropriate recommendations tabled for Government consideration on: (i) national urban system development strategies, (ii) urban planning and management strategies, (iii) alleviation of urban poverty, and (iv) strategies for the development of the capital city, Dhaka.

Under the upcoming (1991) UNDP/UNCHS assisted project for Preparation of Structure Plan, Master Plan and Detailed Area Plan (Dhaka and Chittagong), technical assistance and support is to be provided to RAJUK for training and strengthening their staff capabilities, providing computerized data base and mapping facilities (GIS) and training, strengthening regulatory systems, preparing and adopting Structure Plans, Master Plans and Detailed Area Plans for the DMA, and conducting per-investment feasibility studies for priority projects in land development and housing.

Under the upcoming (1991) UNDP assisted Greater Dhaka Metropolitan Integrated Transportation Study, assistance is to be provided for developing improved traffic management planning and control systems for Dhaka.

2.6 Problems and Needs

Some of the key problems which have contributed to the lack of effective land use management in Dhaka City include:

i) the absence of a cohesive urban development policy to provide clear directions for the basic issues of urban development, including national urban development strategies, urban planning and management strategies, and alleviation of urban poverty. Policies on such basic issues as the right of universal access to clean water and sanitation, and of access to shelter for the poor must be addressed.

ii) the lack of an up-to-date Master Plan and Structure Plans for long term planning and guidance of the growth and development of the city.

iii) the lack of effective legislation to guide/control land use and establish appropriate development standards.

iv) a lack of coordination amongst sectoral development agencies in providing forward planning to meet the demands and needs of the growing population.

v) the absence of a clear Government policy regarding effective use of vacant and under utilized public lands.

vi) the absence of any mechanism for application or collection of development surcharges to assist in financing the essential public infrastructure and services which must be provided to sustain development.

Some of the more acute problems which presently affect the Dhaka residents which are, at least in part, attributable to the lack of effective land use management include:

i) an extreme shortage of serviced land for meeting the ongoing growth demands, particularly for the low income and poor groups,

ii) rapid and uncontrolled growth of slum and squatter communities,

iii) inadequate provision of access to the basic sanitation services, particularly for the poor, including clean water, sanitation, drainage, solid waste, health and education,

iv) sustained environmental degradation due to uncontrolled discharges of wastes (both human and industrial),

v) deteriorating public health conditions, particularly for the poor,

vi) inadequate protection of drainage facilities, resulting in obstructions, clogging and indiscriminate in-filling of drains, khals, and ponds, and leading to increased frequency and severity of local flooding,

vii) indiscriminate and uncontrolled infilling of low lands, which would potentially form an essential part of a planned flood control scheme for the city,

viii) excessive demands on inadequate public infrastructure, utilities and services (e.g., water supply, sewerage, drainage, electricity, telephone and gas services) due to increasing densification in older serviced areas,

ix) increasing traffic congestion due to inadequate provision of roads and appropriate traffic controls,

x) failure to provide appropriate park lands and open spaces, particularly for private developments,

xi) inadequate financial resources for public bodies to provide essential services.

2.7 Recommended Strategies

In order to improve land use management, it is essential that the Government recognize the nature of the problems and take effective actions to develop and adopt appropriate legislation to correct the problems.

This is not a new observation. It has been made by many others in the past, but little or no action has been taken to date. Weak legislation is the primary cause of todays problems, and although it may benefit a few influential landowners and developers in the short term, in the long term it harms all the residents in Dhaka.

Fortunately, the means to address some of the key issues are now available, or will be in the relatively near future. The Task Force recommendations provide clear recommendations on appropriate policies and strategies, and should be reviewed and adopted without delay. The draft UDD/UNCHS planning and control ordinance, which provides the necessary means for effective control of land use and development, is available for review and should be adopted without further delay. The upcoming UNDP assisted studies will provide the necessary Master Plan, Structure Plans and Traffic Control Plan for Dhaka City which, when adopted, will provide the essential tools for the long term planned development of Dhaka City.

The following are recommended actions to be taken up to address the problems described in this section. Some of the recommended actions related to policy and legislation are solely a Government responsibility, and should be initiated immediately to provide a strong foundation for future strategies and actions. Those actions which are considered to be high priority and appropriate for inclusion in this proposed Dhaka Integrated Flood Protection Project are identified with an asterisk (*), and are included in the priority projects recommended in Chapter 11. Still other components, which may be no less important but which are not included in this project, may be considered for inclusion in other ongoing projects, or for inclusion in future projects with financing by others.

i) Prepare and adopt a national policy for providing clear direction on urban development policies and strategies, and alleviation of urban poverty. It is recommended that the Report of the Task Force on Social Implications of Urban Poverty, February 1991, be used as a basis for this. (National Government)

ii) Review, approve and adopt physical planning and land use control legislation for effective control of land use and development. It is recommended that the previously prepared draft Physical Planning (Land Use) and Development Control Ordinance (UDD/UNCHS, 1985) be reviewed and adopted. (National Government)

iii) Prepare up-to-date Master Plan and Structure Plans for long tern guidance and strategic planning for the growth and development of the City (upcoming UNDP/UNCHS assisted project). Upon completion, adopt the plans through legislation. (National Government)

iv) In connection with Items ii and iii above, develop land use standards, development standards, and control mechanisms, including standards for maximum development densities, minimum park and open space provisions, and provision of land for low income housing areas. Identify long term needs for drainage, flood plain, transportation, solid waste disposal, park land and open space

areas, and include appropriate controls in the legislation to restrict/control development within these zones.

Consideration should be given to the introduction of development charges for all new developments or changes in land use to assist in financing the essential public infrastructure, services and amenities (e.g. parks) which must be provided to sustain new developments. Based on this, recommendations should be made to establish an appropriate and equitable system of charges, and the charges should be approved through legislation. (RAJUK, in connection with the Master Plan project)

v) * Review Government land ownership and needs. Prepare a detailed inventory of all Government owned lands in Dhaka City, along with a detailed description of present use, future projected uses, and a statement of need for vacant or under utilized land. Based on the inventory, recommend appropriate Government policies and strategy for rationalization of the use of vacant and under utilized lands.

Consideration should be given in this evaluation to the potentials for disinvesting the lands, converting the lands for public use, converting the lands for use for low income residential use, or transferring/leasing/selling to squatters/settlers to provide long term security of tenure. (Planning Commission)

vi) Establish a formal development review committee with representatives from RAJUK, DWASA, DCC, DOE and all utility agencies to ensure effective coordination for approval of all new developments and for long term planning of service development and expansions. (RAJUK)

vii) Develop a strategic long term plan for land acquisition for provision of land for public use and for low income housing needs. Develop a phased schedule for advance provision of essential infrastructure to enable development to proceed in a planned manner. (RAJUK)

viii) * In connection with the preparation of long term flood control and drainage plans for Dhaka City, appropriate provisions should be made in the Master Plan preparation, the detailed engineering designs, in the operation and maintenance plans, and in the land use controls and regulations to:

- o prepare/adopt drainage and flood control master plan for provision of facilities,
- o develop a surface water management system and enact legislation to protect the drainage, detention pond and flood plain reserves based on the management system and related master plan provisions,

- o establish non-structural measures for flood management and mitigation, including standards on minimum road crest elevations, lot development elevations, plinth levels. Enact legislation which prohibits construction of permanent structures with grade elevations below the designated levels.

- o develop integrated drainage/on-site storage standards for new developments,

- o integrate the development of drainage networks and detention pond reserves with provisions for park lands and public open spaces. Integrate the system with provisions for providing supplemental irrigation facilities for agricultural lands.

- o adopt and implement an operations and maintenance program which is complementary to the land uses in the affected area and assists in maintaining an appropriate ecological balance,

(Various Agencies)

3.0 FLOOD CONTROL AND DRAINAGE

3.1 Introduction

In accordance with the terms of reference, the purpose of this section of the report is to:

i) review the JICA sponsored study for an updated flood control/drainage plan, together with the parallel master planning study being carried out under FAP-8A;

ii) review work done by Government agencies in preparation of priority flood control and drainage components of a critical nature;

iii) make recommendations in the context of the overall urban environmental management plan; and

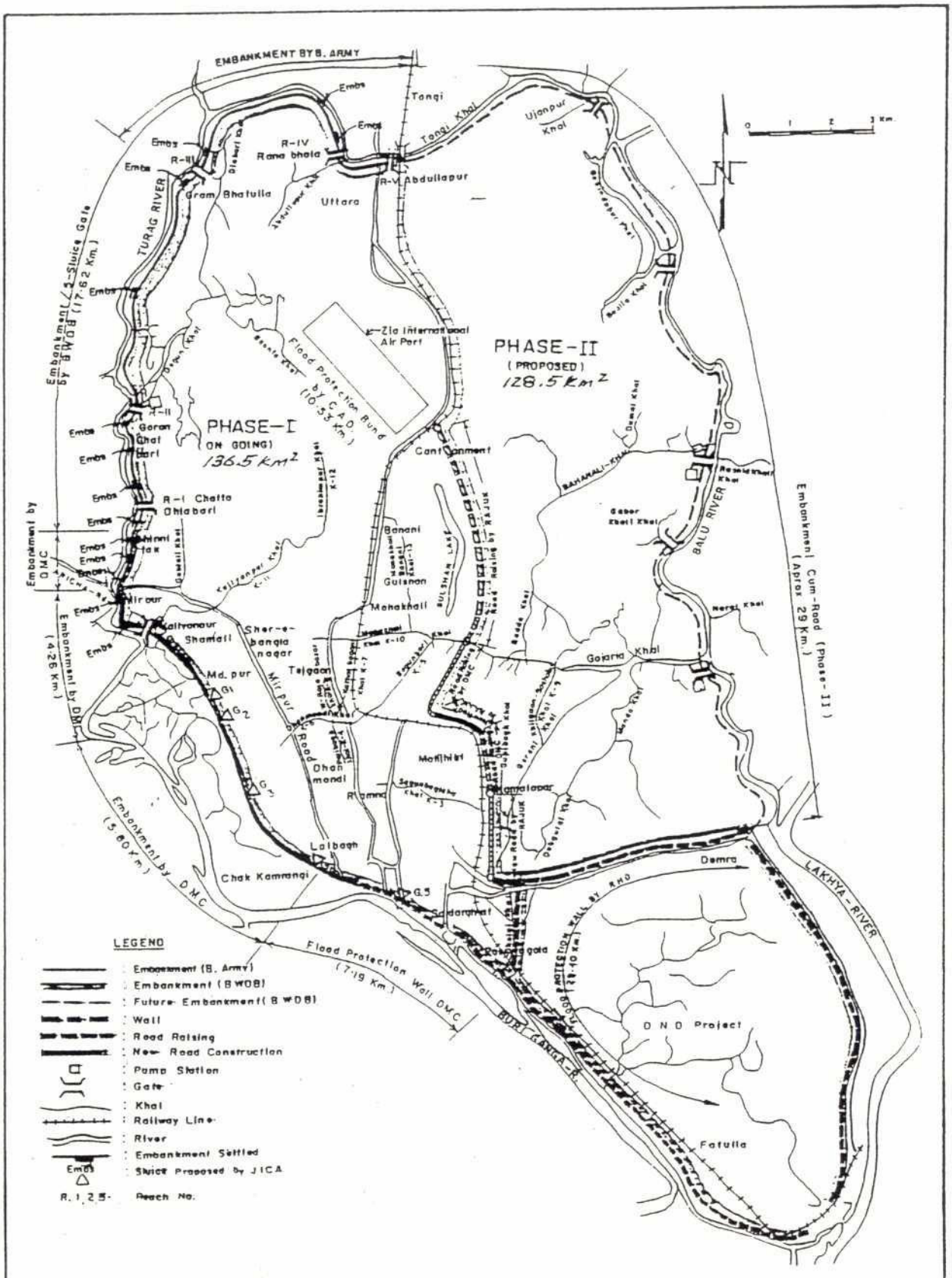
iv) formulate a comprehensive program, together with an immediate action plan, to establish/upgrade/improve technologies and approaches for flood control, erosion protection and drainage.

3.2 Existing Conditions and Evaluation.

3.2.1 Background.

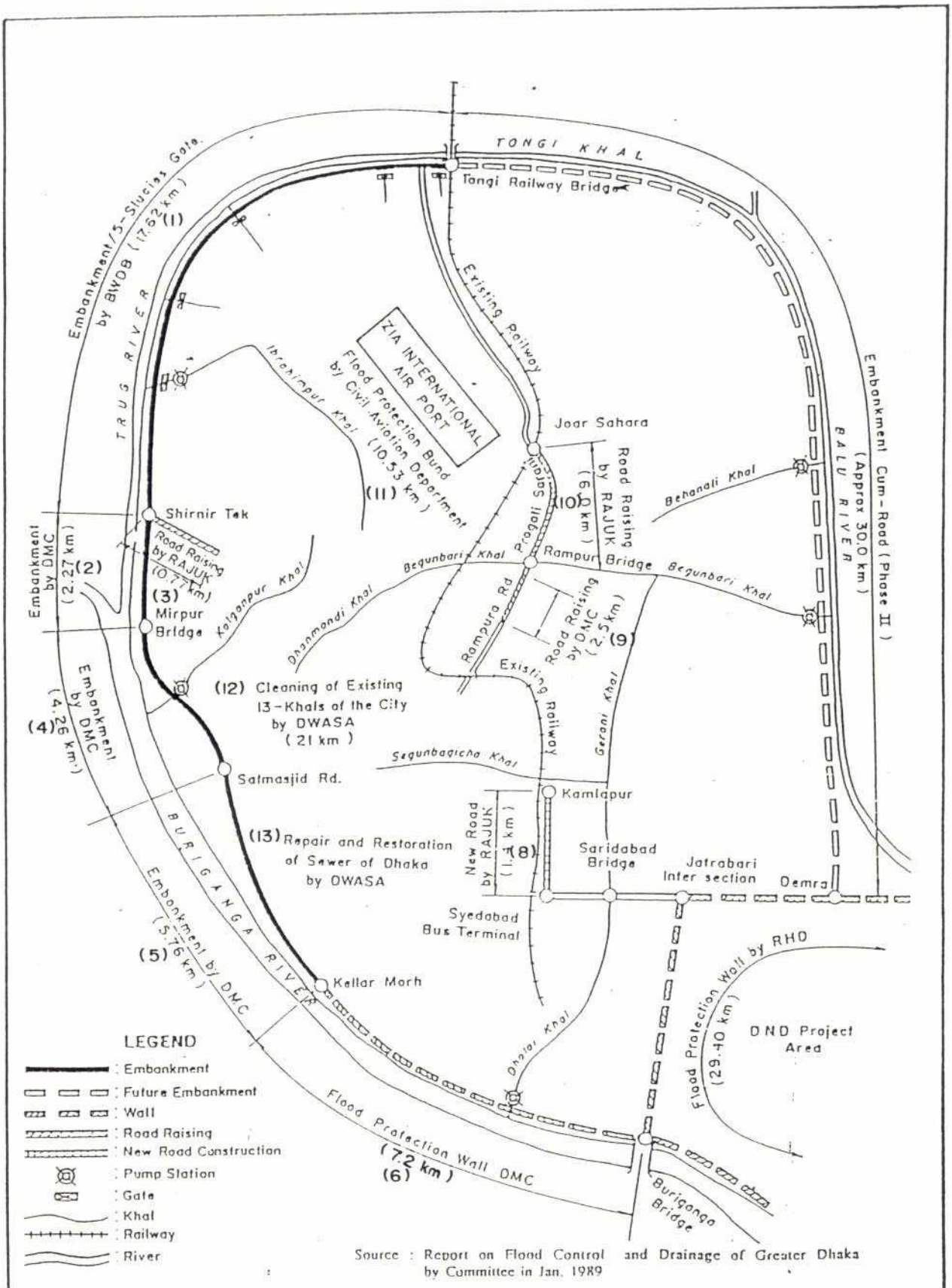
Plans for flood protection for the Greater Dhaka area have been under study and consideration for many years, but the extreme flooding which occurred in 1987 and 1988 brought into focus the urgent need to proceed with immediate action. Subsequently the Government of Bangladesh prepared an urgent flood protection and drainage plan which included enclosing the Greater Dhaka area (about 260 Square Kilometers), as shown in **Fig. 3.1**, with flood embankments, reinforced concrete walls, and drainage/flood regulation structures (sluices and pumping stations).

Construction activities commenced on a "crash program" beginning in 1989 and most of what was defined as Phase I works, as shown in **Fig. 3.2**, has been completed. The status of these activities has been reviewed by the Consultants for this Dhaka Integrated Flood Protection Project (DIFPP) and more detailed review comments are provided later in this report. As a result of this review, which included discussions with key Government officials and others, it became apparent that there was general agreement that flood protection and drainage improvement work was essential. However it was also observed that serious concerns have arisen since the construction activities began. As discussed in the **Consultants' *Inception Report***, the main concerns relate to inadequate project preparation and control, social and physical problems which were created as a result of the lack of funding to complete the works, and a lack of direction regarding ultimate responsibility for operation and maintenance of the completed works. Further action is required because of the high risk of



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	Figure 3.1 GREATER DHAKA FLOOD PROTECTION PROJECT.

Source : BWDB Synopsis of Flood Protection and Drainage Project, June 1990



Source : Report on Flood Control and Drainage of Greater Dhaka by Committee in Jan. 1989

Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control Louis Berger International, Inc. In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 3.2 PROPOSED PROJECTS IN GDFCD PROJECT

failure of the existing embankment. As discussed subsequently, remediation of some of the failed embankment sections has occurred, but additional failures are anticipated, including failures of the repaired areas.

It therefore became necessary to re-evaluate all of the work completed to date on Phase I activities and place highest priority on completion of remaining segments of the Phase-I plan, prior to proceeding with other work which was described in the Governments' Plan as Phase II work. As agreed during the ***Inception Report*** review, (i) the definition of work by Phases will no longer be used; (ii) the remaining work to be accomplished will be arranged by priority, including the incomplete segments and problem areas of Phase I works; and (iii) the emphasis placed upon the development of roadways in connection with the embankments has been reduced pending receipt of results of proposed road network and transportation studies which are under execution but not completed.

Future activities will proceed on the basis of highest priority work being initiated first, in accordance with funding availability, without further reference to the prior Phased divisions.

3.2.2 Coordination of FAP-8A and 8B Studies.

The Flood Action Plan for Bangladesh, which was formally adopted in December 1989 to provide flood protection throughout Bangladesh, comprises eleven plan components and fifteen supporting activities. Component 8 of the plan has been divided into two sections. FAP-8A provides for a Master Plan Study of an area, including Dhaka City, of about 850 sq. km. This segement of the FAP is currently under execution by Pacific Consultants International on behalf JICA. They will complete their study in April 1992.

This project, FAP-8B, provide for the identification and feasibility analysis of urgent needs and works within the Greater Dhaka City area only (about 260 sq. km), and lies within the FAP-8A area. The general approach will follow the overall strategy recommended under the FAP-8A Master Plan Study.

It is noted that close coordination and sharing of information has been developed between the Consultants for FAP-8A and 8B in order to avoid unnecessary duplication of effort. Supplementary investigation programs have been developed to be complimentary to each other, and continuing efforts are being made to obtain maximum usage of available information. This interim report covers the activities of FAP-8B.

3.2.3 Review of Previous Studies.

Several reports prepared previously by JICA have been reviewed and used extensively in the preparation of this report. These include, (i) Study of Storm Water Drainage System Improvement Project in Dhaka City, October 1987, with the February 1990 update on that same project, and (ii) The

Interim Report for FAP-8A, March 1991, which covers the Master Plan preparation for a project area of 850 sq. including the Greater Dhaka area. These reports have contained a comprehensive review of all pertinent previous studies (**see Table 3.1**, reproduced from the JICA Interim Report) and have been extremely useful in review of past, present and future proposed flood protection, erosion and drainage works.

The Consultants find that the approach and methodology used by the JICA Consultants is rational, logical and clearly presented, and founded upon data gathered from comprehensive surveys of the existing situation. The Consultants agree with the assumptions made by the JICA Consultants, and with their conclusions and recommendations for appropriate flood control, erosion protection and drainage measures for Dhaka.

Much of the information presented in the JICA reports has been included in this report with their permission, to ensure uniformity of approach and to avoid duplication of effort on these closely related Projects.

3.2.4 Institutional Responsibilities.

There are three agencies or institutions which are expected to be most directly involved in implementation of the flood control, erosion protection and drainage aspects of the DIFPP. These include the Bangladesh Water Development Board (BWDB), Dhaka Water and Sewerage Authority (DWASA), and Dhaka City Corporation (DCC). The cooperation, and effective inter-working relationships between these organizations will be critical to the development and execution of the DIFPP.

In brief, the BWDB is primarily responsible for coordination of the works programs and for implementation of most of that portion of the work directly related to flood protection for Dhaka city. The BWDB has a long history and wide experience in poldering works throughout Bangladesh, and has adequate engineering staff and capabilities to perform the work. Their responsibility is expected to include the planning, design and construction of most of the embankments and outlet structures, and operation and maintenance of the completed facilities.

The BWDB is a centrally funded Government body, and has no significant revenue generating capability or authority. It relies on central Government allocations in the annual development plan for financing of its' work programs. The greatest strength of the BWDB is its' strong engineering organization and implementation capabilities; the greatest weakness is its' operation and maintenance capabilities which tend to be subordinate to the implementation works, and to traditionally suffer from inadequate attention and funding.

DWASA is a semi-autonomous Government agency which has historically been responsible for the provision of water supply and sewerage services for Dhaka city. In March, 1989, these responsibilities were increased with the transferral of responsibilities and staff from the Department of Public Health Engineering (DPHE) for the internal drainage facilities within the City, and over the past two years DWASA has taken up a cleaning

Review of Previous Studies

TABLE 3.1

No.	Title of Study	Year of Publication	Authority Concerned	Study Area	Content of Study	Scale of Flood Water level in Frequency	Major Flood Control Facilities/ Recommendation	Project Implimentation
1	Master Plan and Feasibility Report For Storm Drainage and Flood Control for the City of Dhaka	1968	DPHE	Dhaka City 75 km2	M/P & F.S: Flood Control and Storm Drainage	50 years (Rainfall Intensity:5 years)	Embankment, Concrete wall, Pump Sta., Open&Pipe Drains, Reservior	Not - due to Financial constraint
2	Sir William Halcrow &Partner's Study	1973	BWDB	Dhaka City & Surroundings 260 km2	F.S: Flood Control and Storm Drainage	500 years	-Ditto-	-Ditto-
3	Dhaka Metropolitan Area Integrated Urban Development Project	1981	ADB/ UNDP	Dhaka Metro-politan Area 256 km2	M/P:Integrated Development and Flood Control	----------	Northern part of high area is proposed for the development area-No embankment policy	Not duly approved by the Government
4	Study on Storm Water Drainage System Improvement Project In Dhaka City	1987	DPHE/ JICA	Dhaka City & Surroundings 137 km2	M/P &F.S: Storm Water Drainage and Flood Control	30 years (Rainfall Intensity:5 years)	Embnkment,Pump Sta.,Open &Pipe drains, Reserviors	Revised in 1990's study
5	Mr. Jansen's Recommendation	1988	----------	Greater Dhaka Area 260 km2	Recommendation on Flood Control Measures by consider-ing 1988 's Flood	500 year	Principal idea of Sir William Halcrow 's Study was recommended	Taken into considera-tion by the committee for phased inplementa-tion (on-going)
6	Greater Dhaka Flood Control and Drainage Project (GDFCD)	1988	COMMITTEE	Dhaka Metro-politan Area	Flood Control Project Plans by Phased Program	Scale of 1988 year's flood	Embankment,Flood wall,road-cum-embankment Regulators	Phase I: Complition/ under Construction
7	26 Action Plans (FAP)	1989	WORLD BANK	Whole Country	T/R of Flood Action Plans	----------	Plans composed of broad countermeasures for Flood control and Storm water problems	Study is in progress.
8	UNDP/UNCHS Proposal	1989	UNDP/ UNCHS	Dhaka and Chittagong	Drainage and Flood Control, Water Supply and Sewrages, Land Development Projects Implimentation	(Rainfall Intensity:10 years)	Dhaka:Pump sta., Reservoir, Khal improvement	Tendering Procedure is being taken
9	Updating Study on Storm Water Drainage System Improvement Project in Dhaka City	1990	DWASA/ JICA	Dhaka City & Surroundings 137 km2	M/P and F.S:Revision of Previous JICA Study	Not mentioned (Rainfall Intensity:5years)	Pump Sta.,Sluice,Road culvert, Khal Dredging	- Ditto -

Note:

DPHE : Department of Public Health Engineering
BWDB : Bangladesh Water Development Board
ADB : Asian Development Bank
UNDP : United Nations Development Programme
COMMITTEE : Committee for "Flood Control and Drainage of Greater Dhaka"
UNCHS : United Nations Centre for Human Settlement
DWASA : Dhaka Water Supply and Sewerage Authority
M/P : Master Plan Study
F.S : Feasibility Study
FPCO. : Flood Plan Co-ordination Organisation

TABLE 3.1

program for removal of major blockages in the City drainage khal system. It is expected that DWASA will be responsible for all internal drainage works to be taken up under the Project, including planning, design, construction, operation and maintenance of khals and piped storm drainage systems. There is also a possibility, though this is yet to be decided, that this responsibility will be extended to include the operation and maintenance of some of the proposed pumping stations for discharge of storm drainage and control of interior water levels.

As a semi-autonomous body, DWASA has the authority to charge for services rendered. They currently charge for water and sewerage where such services are available to the public. Though no policies are yet in place for charging for storm water drainage services, DWASA have indicated that they are willing to consider proposals for this (possibly through a surcharge on the existing water supply and sewerage rates), and that they have the legal authority to do so. At present, however, DWASA has no funds available for taking up extensive programs for drainage improvement works other than those covered under special project funding through Government allocations.

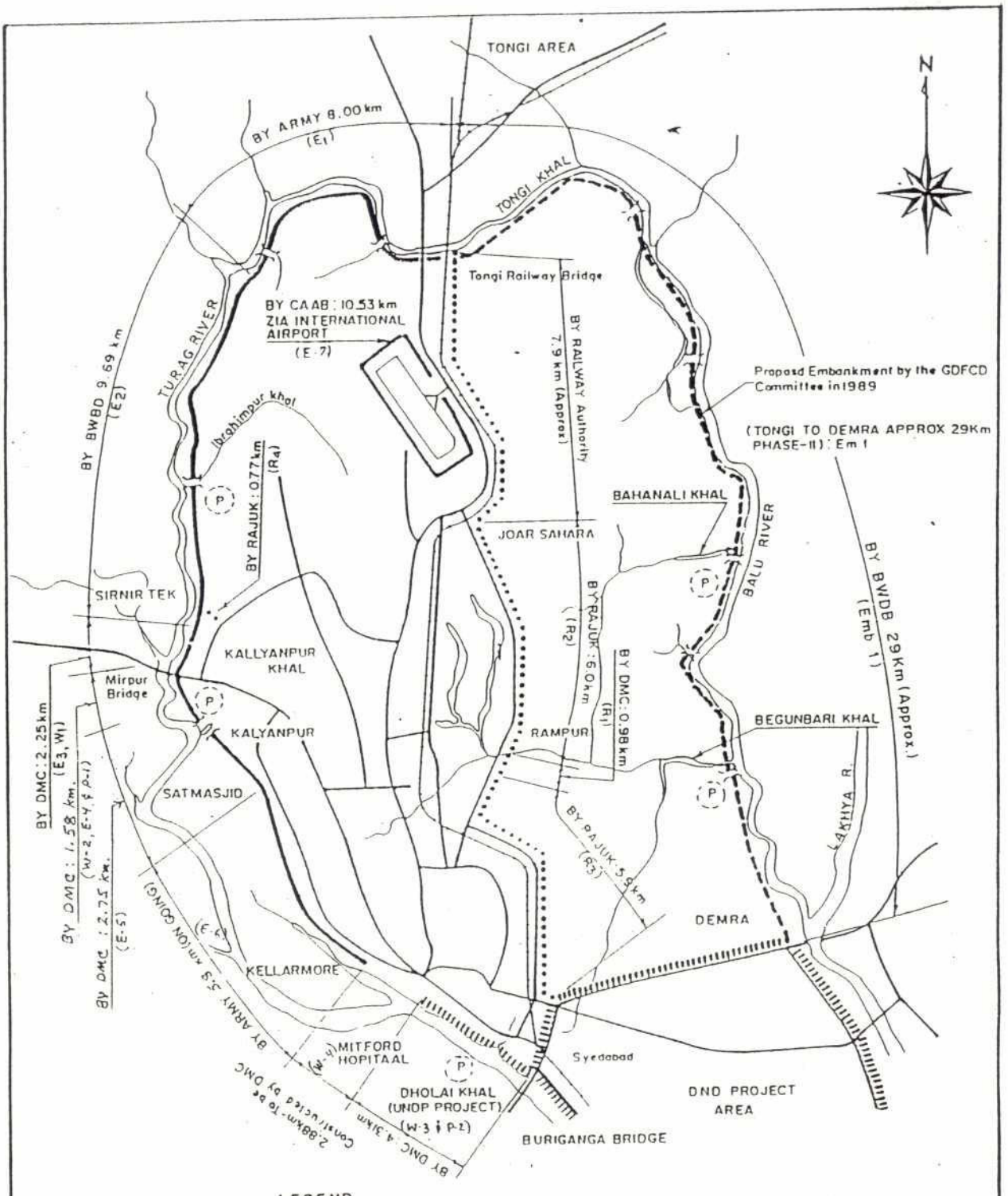
DCC has overall responsibility for provision of all other city services not covered by DWASA, including general sanitation and community health services, roads and surface drains, solid waste collection and disposal, street lighting, slum improvement projects, etc., and for the implementation of special projects which may fall under its' jurisdiction such as construction of embankments and flood protection walls under the Phase I flood protection program, and the Dholai Khal drainage and pump station improvements.

As a City Corporation, DCC is empowered to raise revenue through taxes, rates and fees. Much of DCC's annual works program is concerned solely with the operation and maintenance of existing facilities, and is heavily constrained by limitations on the self generated revenues. New construction is generally taken up only through special project funding as allocated by the Government.

3.2.5 Existing Flood Control Facilities and Evaluation.

Under the "crash program" previously mentioned in Section 3.2.1. the Government undertook a priority program of works to provide flood protection facilities to the westerly half of Dhaka city, which includes the most highly urbanized areas and covers about 87 percent of the city population.

As shown **Figure 3.3**, major components taken up for implementation included approximately 29.2 km of embankment and 5.2 km of reinforced concrete (R/C) flood walls along the westerly perimeter of the city adjacent to the Turag and Buriganga Rivers, plus approximately 13.65 km of road-cum-embankment raising/construction on a north-south spine running from Tongi in the north to Syedabad to the south. The construction of gated sluices for venting of internal drainage was a part of this priority program. Implementation responsibilities for the work were divided between the



Source: JICA Preliminary review Report- FAP 8-A, Dec. 1990.

BWDB, DCC and the Army to expedite the program, with BWDB taking the lead role in planning and coordination.

Planning standards adopted for this initial program included construction of all embankments to a crest level of elevation 10.0 PWD (adequate for a 100 year return period flood with 1.2 m free board), construction of all R/C walls to the 1988 highest flood level plus 0.60 m, and raising of the road-cum-embankment up to the level of the 1988 flood. It was considered that this would provide temporary protection against floods of about a 50 year recurrence interval, except for a segement of road near the Jatrabari road crossing where apparent low elevations must be checked and determination must be made if road raising in that area is needed as part of proposed future work. It was planned that the road raising would form the first stage of a complete flood protection program for all of Dhaka City capable of providing protection against a 100 year flood.

Work taken up under this program is now nearly, but not all, complete. All embankments have been constructed and are being maintained. Six sluices are being, or have been, constructed. 5.2 km out of 8.1 km of flood protection walls have been constructed, and all road-cum-embankment raising has been done. Works which have not yet been started include about 2.8 km of flood protection wall at the Mitford Hospital area, where local residents and businesses have strenuously objected against the proposed wall construction, and 4 sluices in the Kellar Morh area. These components are essential in order to provide a complete flood protection system for Western Dhaka.

3.3 Status of Flood Protection and Drainage Works.

3.3.1 Introduction.

Notwithstanding the intent of the "crash program" to provide flood control and drainage, serious problems have developed in large portions of the works which have already been completed. These problems are summarized in **Table 3.2** Based upon the Consultants' field investigation programs and discussions with officials of the implementation agencies, it has been found that:

i) the existing earthen embankment is unstable in large sections of the Phase I area;

ii) the existing R/C wall is severely cracked in some areas, has been breached by erosion beneath the wall, and may not be adequately designed and/or constructed to withstand the design high water level; and

iii) construction of the embankment through low-lying areas, without providing adequate drainage, has caused internal flooding, adversely affecting the residents in these localities.

TABLE 3.2

STATUS OF WORK RECOMMENDED BY THE FLOOD PROTECTION COMMITTEE FOR GREATER DHAKA.

ITEM NO.	DESCRIPTION	INVOLVED AGENCIES	ASSESSMENT AND/OR COMMENTS
E-1	8 Km Embankment, from Tongi to Diabati with 3 sluices	ARMY & BWDB	Embankment is complete but embankment consolidation and slope instability has occurred at some locations. Extensive redesign and repair work is needed. Sluices are complete and in good condition.
E-2	9.69 Km. Embankment from Diabati to Shirnir Tek, with 2 sluices.	BWDB	Embankment is complete but serious embankment consolidation and slope instability has occurred at some locations. Extensive redesign and repair work is needed. Sluices are near completion with no visible problems. Some degree of maintenance is needed to protect against wave action.
E-3 & W-1	1.5 Km Embankment and 0.75 Km of R/C Wall from Shirnir Tek to Mirpur Bridge	D.C.C.	Construction completed on embankment, but some degree of maintenance is needed to protect against wave action.
W-2 E-4 & P-1	0.16 Km R/C Wall and 1.42 Km of Embankment from Mirpur Bridge to Kallyanpur Khal. Temporary sluice by BWDB. Future Sluice and Pump Station by Japan financing.	D.C.C. & BWDB	Construction completed on embankment, but some degree of maintenance is needed to protect against wave action on embankments.
E-5	2.75 Km Embankment from Kallyanpur to Satmashjid.	D.C.C.	Construction on embankment is completed and extensive slope protection is needed to protect against wave action.

E-6	5.8 Km Embankment from Satmashjid to Kellar Morh with location, Number and size of permanent sluices (± 5 locations).	D.C.C. ARMY BWDB	Construction on Embankment is nearly complete except for several locations for drainage where temporary works are underway. Moderate maintenance is needed to protect against wave action. Location, number and size of permanent sluices must be determined.
W-4	2.88 Km R/C Wall from Kellar Morh to Mitford Hospital.	D.C.C.	This section of R/C Wall has not been constructed due to space limitations, land acquisition problems and community resistance. Completion is required to provide full flood protection.
W-3 & P-2	4.31 Km R/C Wall from Mitford Hospital to Buriganga Bridge, with future Sluice, Pump Station and Dholai Khal Improvement by World Bank financing.	D.C.C.	Construction work has been completed on the R/C wall. Construction by World Bank financing is expected to begin in near future.
E-7	10.53 Km Embankment Surrounding Zia Airport.	CAAB	Construction completed.
R-1	0.98 Km Road raising - Rampura.	D.C.C.	Construction completed.
R-2	6.0 Km Road raising - Joor Sahara to Rampura.	RAJUK	Construction completed.
R-3	5.9 Km Road raising Rampura to Syedabad.	RAJUK	Construction completed.
R-4	0.77 Km road raising from Shirnir Tek to Mirpur Mazar.	RAJUK	Construction completed.
K-1 to K-13	Cleaning of 13 Khals/Canal of City.	WASA	Minimal amount of cleaning work completed. Extensive amounts of additional work are needed.

These problems are further discussed below:

3.3.2 Embankment Stability.

Instability of the existing embankment poses a major threat to human life in the event of a major flood. Many sections of the existing embankment have failed, are failing, or will fail. If failure occurs during a high water period, a sudden breach of the levee could occur, causing a sudden rise in water levels within the embankment.

Based on the studies performed by the Consultant, the following types of damage have occurred along the embankments:

(1) Deep - Seated Failure: This type of failure occurs in areas where the subgrade soils have low shear strengths. These failures typically occur in areas where the embankment intersects or runs along major drainage features where the soft, highly plastic clay and silt soils may extend to great depths. The failures may occur rapidly, but are typically preceded by cracks along the crest and running parallel to the embankment. Deep-seated failures are catastrophic failures which could occur suddenly without forewarning, and could cause the embankment to be breached.

(2) Shallow Slope Failure: Based on the data obtained from the field investigations, observations of remedial work, and discussions with government personnel, it appears that much of the embankment was constructed without adequate compaction. In areas where the subgrade shear strength is greater than the embankment shear strength, shallow slope failures have occurred in the embankment. These shallow slope failures are a nuisance, but are not typically catastrophic, and likely would not cause the embankment to be breached.

(3) Differential Settlement: Differential settlement has occurred in areas where the embankment is underlain by materials such as peat, which have decidedly lower moduli then surrounding soils. Rapid settlement in these areas has resulted in vertical block displacements. These block displacements typically occur during or shortly after construction, and are manifest by cracks perpendicular to the embankment alignment. These types of failures are typically not catastrophic because they occur during or shortly after construction. The areas where large differential settlements have occurred have already been repaired.

(4) Borrow Pit Induced Failures: In some areas, the borrow pits were located too close to the toe of either the river or city side of the embankment. Deep seated failures of the embankment, exiting through the base of the borrow pit, have occurred and will occur in the future. These failures may occur rapidly, but are typically preceded by cracks along the crest and running parallel to the embankment. Borrow pit induced failures could be catastrophic and could cause the embankment to be breached.

(5) Variable Shear Strengths: Two types of failures have occurred due to variable shear strengths in the subgrade soils, (i) block and displacement failures near locations where drainage features cross perpendicular to the embankment alignment; and (ii) deep-seated failures in areas where the embankment runs parallel to and above drainage features. These drainage features are typically underlain by very soft, highly plastic silts and clays. In areas where the embankment runs perpendicular to the drainage features and where the drainage features are relatively small, block, or combination block and displacement failures have occurred. These failures may or may not be catastrophic, depending on the size and magnitude of the failure.

In areas where the embankment runs parallel to and above a drainage feature or the river, deep-seated failures have occurred. These failures are manifest by cracking at and along the crest of the embankment. The failure surface typically extends near vertical through the embankment, intersecting the subgrade near the point where the subgrade transitions from stronger desiccated soil to weaker soils which were below the water level on the river. These failures could be catastrophic and would likely cause the embankment to be breached.

(6) Erosion: In areas where the main channel of the river is adjacent to the embankment, significant erosion of the embankment toe has occurred. This erosion at the toe of the embankment has undermined the slope, causing shallow slope failures to occur.

(7) Vector Damage: In many areas the embankment has been damaged by rodents and reptiles. These animals have burrowed into the embankment, creating a network of holes. These holes are problematic for two reasons: (i) they create preferential flow paths through the embankment, which could lead to piping and embankment failure; and (ii) they create points of weakness on the slope, which may lead to further slope instability.

(8) Cracking: Cracking has been a problem in both the embankment and the R/C wall. Desiccation cracks have occurred in the embankment which could create pathways of preferential flow through the embankment. Desiccation cracks also become points of weakness in the embankment, which causes instability.

3.3.3 Stability of R/C Walls.

The stability of the R/C walls must be analyzed and assessed. Cracking, erosion under the wall, and breaches in the existing R/C walls could jeopardize the integrity of the flood protection systems during periods of high water levels. These types of wall damage are discussed below:

(1) Shrinkage cracks and settlement cracks have occurred in the R/C wall. During periods of high water flow, these cracks could jeopardize the integrity of the wall.

(2) Breaching: The wall has been breached at many locations to facilitate crossing. A careful check must be taken at those locations to find suitable methods of providing access to the river.

(3) Erosion Under the R/C Wall: There is at least one location where erosion has occurred under the R/C wall. Obviously, this is serious because it could lead to failure of the entire wall during periods of high flow. In addition, the erosion uncovered a potentially more serious problem. That is, the R/C wall may not be adequately designed to support the lateral loads which could develop during periods of high water. The wall design must be critically reviewed and modifications made as needed.

The conditions of the R/C walls and appropriateness of the design of the walls has not yet been addressed. It is anticipated that a summary of this review will be included in a subsequent report.

3.3.4 Summary of Embankment Conditions.

The Consultants made a critical review of the existing 29.2 km embankment. The review identified areas where failures have occurred or are occurring. The findings of this review are summarized in **Table 3.3.** The recommended actions described in the table are described below:

I - Immediate action is needed to prevent catastrophic failure of the embankment. This action should be consistent with the remedial action plan developed subsequently so that remedial actions do not further jeopardize the embankment.

S - Short-term action required because the embankment has sustained significant damage, which could cause it to fail during a period of very high water. These areas do not require immediate action, but should be remediated as soon possible after the remedial action plan is developed and funds become available for the work.

M - These areas are designated as medium to long-term action areas and have sustained moderate damage, and could become serious maintenance problems if not remediated. These areas should be addressed by the remedial action plan.

The types of damage described below are consistent with those described previously. For convenience, the types of damage are listed below:

(1) Deep - Seated Failure;
(2) Shallow Slope Failure;
(3) Differential Settlement;
(4) Borrow Pit Induced Failure;
(5) Displacements Induced by Varying Shear Strengths;
(6) Erosion;
(7) Vector Damage;
(8) Cracking;

TABLE 3.3

SUMMARY OF EMBANKMENT DAMAGE (MARCH 1991)

Chainage From	Chainage To	Length m	Action	Type of Damage	Comments
0.900	1.600	700	S	2, 4, 5, 7	Embankment consolidation and bearing capacity failures. Some deep borrow pits could induce deep-seated failures.
4.100	4.600	500	S	2, 5, 7	Embankment consolidation and bearing capacity failures. Shallow slope failures.
4.600	4.700	100	S	2, 5, 7	Shallow slope failure and bearing capacity failure. Slope repaired, but failure of repair is likely.
6.200	6.350	150	S	2, 5, 7	Embankment consolidation and bearing capacity failure.
6.350	6.550	200	I	2, 4, 5, 7	Embankment consolidation and bearing capacity failure. Shallow failure repaired, but failure of repaired area is likely.
6.550	6.950	400	I	1, 2, 3, 4, 5, 7	Refilling operations probably will induce a new failure next monsoon. Sliding is evident on land side as well as river side. Embankment breach is possible.
6.950	7.450	500	I	2, 4, 5, 7	Embankment consolidation and bearing capacity failures have rendered the embankment unstable.
7.450	7.750	300	I	2, 5, 7	Many shallow slides have occurred in this area.
7.900	8.000	100	S	2, 5, 7	Embankment consolidation and bearing capacity failures have caused cracking in the embankment.
9.100	10.600	1500	S	2, 5, 7	See 7.900 to 8.000
10.600	11.100	500	I	1, 2, 5, 6, 7	Rebuilding operations added weight to crown and inside berm, but erosion cut the toe away. Reoccurrence next monsoon almost certain. Could breach dike down to elev 6±.
11.100	12.850	1750	M	2, 5, 7	Probably a maintenance problem resulting primarily from embankment consolidation.
13.700	14.350	650	I	1, 2, 5, 7	Rebuilding operations adding land side berm and river side berm. Likely to reoccur next monsoon, of earlier.
14.550	15.250	700	I	1, 2, 5, 7	Deep-seated failure was repaired. Failure of repair is likely.
15.625	15.675	50	I	1, 2, 5, 7	Deep-seated failure was repaired. Failure of repair is likely.
15.800	17.200	1400	I	1, 2, 5, 7	Deep-seated failure is just beginning to occur due to variations in subgrade shear strength.
22.600	24.000	1400	M	2, 6, 7	Embankment consolidation and erosion has caused cracking.

NOTES: (1) Chainage begins at the Tongi Railway Crossing of Tongi Khal and proceeds west and southerly to Dhaka Metropolitan area, at Kellar Morh.

(9) Breaching; and
(10) Erosion Under R/C Wall.

The result of the survey are summarized in Table 3.3. The required actions are summarized below.

Action Level	Embankment Length (m)	Total of Existing Embankment Length (%)
I	4700	16.1 %
S	3050	10.4 %
M	3150	10.8 %
	10900	37.3 %

The status of the embankments as described above is considered to be extremely critical, and remedial measures will receive highest priority in proposed future work.

3.3.5 Flood Protection Drainage Problems.

The problems of local drainage in the area from Satmasjid to Kellar Morh, have been exacerbated by construction of the flood embankment in that area. The embankment was constructed without proper design for drainage waters to be discharged into the Buriganga River after the flood level in the river subsided. Consequently, flood waters and waste water could not be discharged. As part of the high priority work required under the flood Greater Dhaka Integrated Flood Protection Plan, these drainage problems must be resolved by installing drainage/flood regulating structures (sluices and pumping stations) to control flood waters during the flood season, and drainage waters during other times of the year, as needed.

3.3.6 Internal Drainage Facilities and Evaluation.

According to the JICA ***Interim Report*** major existing drainage facilities in Dhaka city consist of about 110 km of drainage pipe, ranging in size from 0.3 m to 3.0 m in diameter, approximately 437 km of Khals, and a Pumping Station located in Old Dhaka (Narinda).

A minor amount of cleaning was accomplished on 13 of the khals identified as priority drainage khals in the JICA storm drainage report, and as recommended by the Committee for Greater Dhaka Flood Control and Drainage Project; however, no major improvements were made at that time. The khals are continually being clogged with debris and by construction of other obstructions in the drainage ways, and are a primary cause of regular internal flooding in Dhaka.

For purposes of this report and the proposed work program for flood protection and drainage, the extent of drainage works considered will be limited to improvement of priority main khals and construction of pumping stations to remove some of the storm water from within the embanked areas. The existing khals will be evaluated on a priority basis as identified in the JICA report, and as confirmed by DWASA officials and other concerned agencies and individuals, and proposed improvements will be made on the basis of priority and funding availability.

3.3.7 Ongoing Activities and Completion Needs.

As described in Section 3.2.5, most of the works originally scheduled for the Phase I "crash program" have been completed. The implementing agencies are now in the process of finishing off all works which were previously started, and maintaining/repairing problem sections which have developed.

However, several portions of the western embankment and related drainage/flood regulation structures have not been completed, and there are presently no plans to take up any additional works this year. In addition, many sections of the embankment are unstable and will require remediation. In order to complete the western embankment, the following tasks must be performed:

i) construct the embankment and Flood wall from Kellar Morh to the Mitford Hospital;

ii) construct drainage/flood regulation structures along the west embankment (Satmasjid and Kellar Morh);

iii) provide erosion protection;

iv) perform further site investigations to fully characterize the extent of damage on the west embankment;

v) prepare a remedial action plan for the west embankment;

vi) reconstruct the unstable sections of the west embankment; and

vii) khal improvements as required.

3.4 Alternative Flood Control and Drainage Strategies.

3.4.1 General.

The alternative proposals which have been developed in the following are based upon efforts to stage the work according to:

i) benefit;

ii) size of the protected area;

iii) population at risk; and

iv) cost.

A number of different plans have been prepared to present various options which might be used to develop a strategic development plan. It was concluded, after study of the JICA March 1991 ***Interim Report*** on the Master Plan for FAP-8A, that protection of the largest area possible is most economical and most desirable in view of the great increase in benefits derived by protecting the larger area.

Seven strategies are considered in the following strategic development plan, and are identified as Plans A, B, C, D, E, F & G. The Plans vary according to the priorities assigned to development, the cost and availability of funding with time, and the embankment alignment, and the extent of interference with existing businesses and residences along the river.

The plans and cost estimates which have been prepared are based upon information received from various involved Government agencies, and with considerable reliance upon information presented in the JICA March 1991, Interim report on the Master Plan for FAP-8A, and the JICA February 1990, Updating Study on Storm Water Drainage System Improvement Project in Dhaka City. Estimated costs for the proposed activities are base costs, and include construction costs, contingencies and engineering (design, quality control and monitoring). Estimates for the contingencies vary from 10 to 30 percent depending upon the type of work and amount of information available for preparation of the estimate. Estimates for engineering vary from 5 to 10 percent depending upon the amount of participation expected by the various involved Governmental agencies. No additional costs have been added for price escalation during the implementation period.

Right-of-way costs have been estimated using information obtained from DWASA, JICA reports, RAJUK and other information collected by the FAP-8B Consultant staff. Estimated right-of-way costs for lowland areas range from about 115 Tk. per square meter in the east area to more than 300 Tk. per square meter in the western more populated lowland areas. Higher lands at or above annual flood levels prices range from about 300 Tk. per square meter in the East to over 3000 Tk. per square meter in developed metropolitan areas. Right-of-way costs have been listed separately and would be considered a local cost.

Detailed activities for each plan, with implementation schedule, priority of implementation and cost estimates are provided in Appendix B in Tables 3.4A through 3.10A, and the locations of activity for each of the plans are shown in the accompanying Figures 3.5A through 3.9A. The plans are described below:

3.4.2 Alternative Strategies Considered.

Consideration of construction staging to optimize the benefits and use of

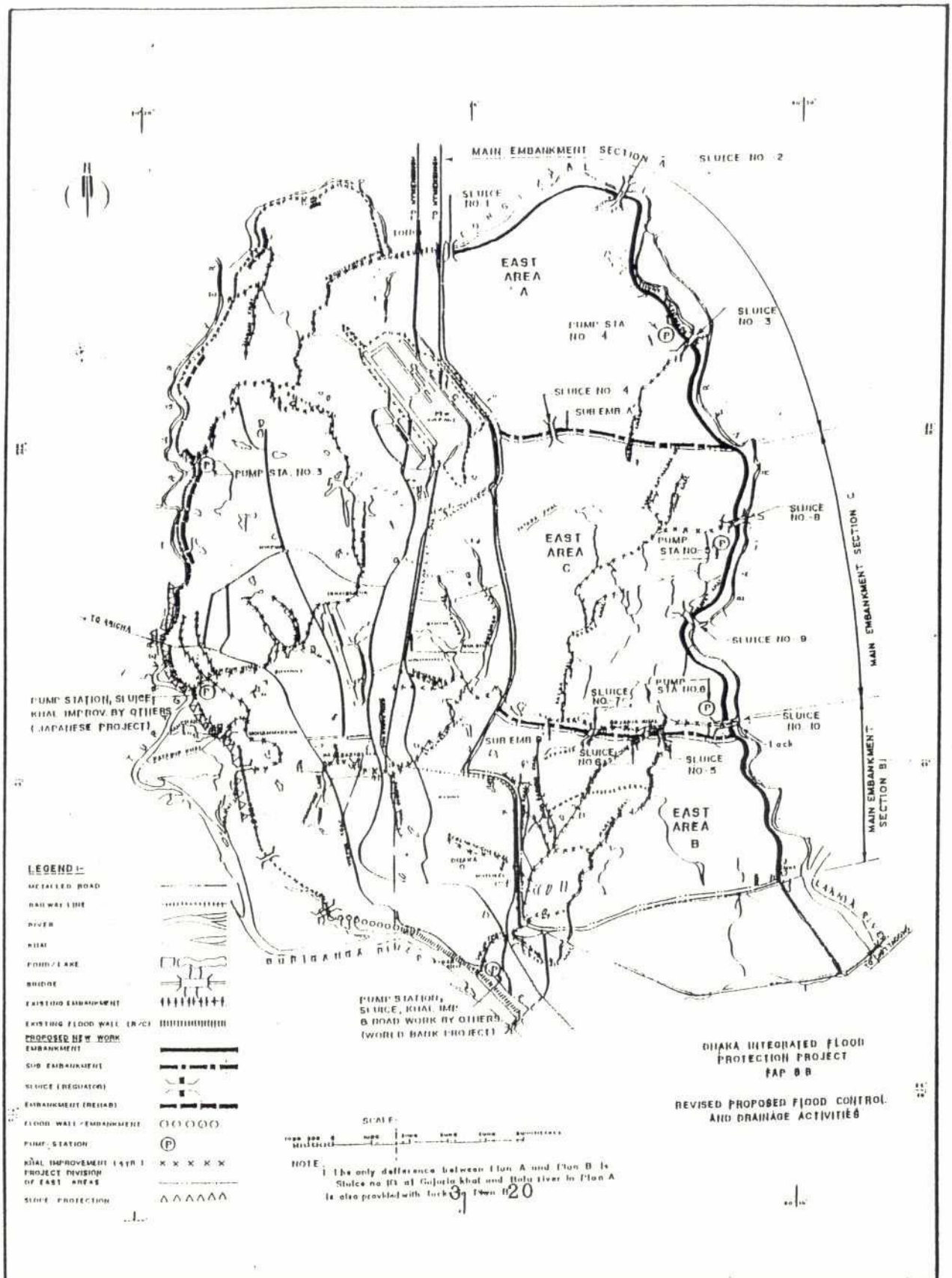
available funding have been an important consideration in developing the alternative strategies described in the following sections. Preliminary cost estimates indicate that the cost of the full flood protection and drainage works needed to provide protection against the 100 year recurrence floods for Dhaka City greatly exceeds the amount of financing which was previously indicated as being available for this project. Accordingly, the Consultant has prepared alternative schemes for consideration which provides varying levels of protection to different areas of the city, and which are capable of being extended and enhanced to provide a greater level of protection over time.

The following proposed plans describe the alternative strategies considered for development of the flood protection and drainage schemes. **Figure 3.4** following shows the general location of the facilities and areas described in the following sections. Additional details are provided in the Tables and Figures in the Attached Appendix B.

i) PLAN A - Improvements Required for Entire Area with Sluice No. 10.

Plan A has been prepared to include all work required to provide flood protection and drainage improvements in the Greater Dhaka area (approximately 260 square kilometers) for the full 100 year recurrance floods, assuming that waterway transportation on the Gojaria Khal will be interrupted by installation of a sluice (No. 10) at the junction of the Gojaria Khal and Balu River. The proposed activities described in Plan A (shown in Figure 3.4A and listed in Table 3.4A) are summarized as follow:

- construct and equip a soils testing laboratory;
- perform site investigations and rehabilitation of west embankment;
- construct drainage/flood regulation structures on west embankment (Satmasjid and Kellar Morh);
- construct embankment/Flood Wall to complete flood protection in West Dhaka, from Kellar Morh to Mitford Hospital;
- perform site investigations and construction of east embankment sections A, B, and C and sub-embankments A' & B';
- construct Sluices 1 through 10 along main east embankments A, B, & C and along sub-embankments A' and B';
- construct Khal (Drainage) Improvements - first 3 years;
- construct Drainage Pipe Improvements - 4th year; and
- perform site investigations and construction of Pump Stations 3, 4, 5, & 6.



Dhaka Integrated Flood Protection Project ADB TA No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upadesh Limited. Technoconsult International Ltd.	FIGURE 3.4 LOCATION OF PROPOSED ACTIVITIES

The estimated cost for Plan A, without right-of-way, is 9609.09 million Tk. and planned activities for Plan A works would extend over an implementation period of about 4 years.

ii) PLAN B - Improvements Required for Entire Area with Sluice No. 10 and Locks.

Plan B is identical to Plan A except for the following : Sluice No. 10 at the junction of Gojaria Khal and Balu River under Plan A would be provided with locks at that same location, which would permit waterway transport along Gojaria Khal through the Lock system. Plan B is also shown on Figure 3.4A and proposed activities, with cost estimates, are shown in Table 3.5A.

The estimated cost for Plan B, without right-of-way, is 9669.74 million Tk. and planned activities would extend over about a 4 year implementation period.

iii) PLAN C - Improvements Required for Entire Area with Sluice No. 10 Relocated, Sub-Embankment C' and Bridge.

Plan C is identical to Plan A except for the following : (a) Sluice No. 10 has been moved from its location at the junction of Gojaria Khal and Balu River in Plan A to a new location about 6 kilometers west on the Begunbari Khal near Rampura Bridge, (b) site investigations and construction of sub-embankment C' have been added; (c) construction of Sluices No. 11 and 12 on sub-embankment C' have been added; and (d) soils investigation and construction of a Bridge at the Junction of Gojaria Khal and Balu River are required. These changes are shown in Figure 3.5A and are listed with cost estimates in Table 3.6A.

The estimated cost for Plan C, without right-of-way, is 9982.04 million Tk. and planned activities would extend over about a 4 year implementation period.

iv) PLAN D - Improvements Required for Phase I Area plus East Area A.

Plan D has been prepared with emphasis on completion of unfinished Phase I works (Section 3.3.7) including completion of East Area A, covering the westerly half of Dhaka and the urbanized southerly area near Demra, for a total protected area of about 181 sq. km. It includes the main embankment A, sub-embankment A' with Sluices 1 through 4, as shown in Figure 3.6A, along with urgent Khal improvements, site investigations and construction of Pump Station No. 3 (west). The proposed implementation schedule and cost estimate for Plan D are shown in Table 3.7A. Plan D activities would be implemented over a period of about 3 years and would provide flood protection for East Area A against a storm flood frequency of about 5 years with about 0.35 m freeboard (or 15 years at overtopping levels) after the 1st stage construction (Second year). This plan provides for full 100 year design height for the main embankment and sub-embankments but internal areas would be protected to about 15 year overtopping levels until all of the east embankment is completed to the final design height.

The estimated cost for Plan D, without right-of-way, is 3877.71 million Tk.

v) PLAN E - Improvements Required for Phase I Area, plus East Area B.

Plan E has been prepared with emphasis on completion of unfinished Phase I works (Section 3.3.7) including completion of East Area B, covering the westerly half of Dhaka and the urbanized southerly area near Demra, for a total protected area of about 178 sq. km. It includes the main embankment B and sub-embankment B', with Sluices 5, 6 and 7 as shown in Figure 3.7A, along with urgent Khal Improvements, site investigations and construction of Pump Station No. 3 (west). The proposed implementation schedule and cost estimate for Plan E are shown in Table 3.8A. Plan E activities would be implemented over a period of about 3 years and would provide Flood Protection for East Area B against a storm flood frequency of about 5 years with about 0.35 m freeboard (or 15 years at overtopping levels) after the first stage construction (Second year). This plan provides for full 100 year design height for the main embankment and sub-embankments but internal areas would be protected to about 15 year overtopping levels until all of the east embankment is completed to the final design height.

The estimated cost for Plan E, without right-of-way, is 3265.76 million Tk.

vi) PLAN F - Improvements Required for Phase I Area, Plus East Areas A and B.

Plan F has been prepared with emphasis on completion of unfinished Phase I works (Section 3.3.7) including completion of East Areas A and B, covering the westerly half of Dhaka and the urbanized southerly area near Demra, for a total protected area of about 212 sq. km. It includes the main embankments A and B, and sub-embankments A' and B' with sluices 1, 2, 3, 4, 5, 6, and 7, as shown in Figure 3.8A, along with urgent khal improvements, site investigations and construction of Pump Station No. 3 (west). The proposed implementation schedule and cost estimate for Plan F are shown in Table 3.9A. Plan F activities would be implemented over a period of about 3 years and would provide flood protection for East Areas A and B against a storm flood frequency of about 5 years with about 0.35 m freeboard (or 15 years at overtopping levels) after the first stage construction (Second year).

The estimated cost for Plan F, without right-of-way, is 4575.75 million Tk.

vii) PLAN G - Improvements Required for Phase I Area.

Plan G has been prepared with emphasis on completion of unfinished Phase I work only (Section 3.3.7), covering the urbanized westerly half of the Dhaka area with a total protected area of about 146 sq. km., and containing about 87% of Dhaka city residents. It includes urgent Khal improvements, site investigations and construction of Pump Station No. 3 (West), as shown in Figure 3.9A. The implementation schedule and cost

estimate for Plan G are shown in Table 3.10A. Plan G would be implemented over a period of about 3 years and would provide flood protection for the Phase I Area against a storm flood frequency of about 5 years with a freeboard of about 0.35 m (or 15 years at overtopping levels) after the first stage (first year), and 100 year protection with 1.2 m freeboard upon completion of all proposed works. However, prior to completion of East Area works, the flood protection level along the eastern side of the West Area (West area is defined as the area westerly from the main Dhaka - Rampura - Tongi Road/embankment and shown as Phase I in Figure 1.1), would be protected against a storm flood frequency of about 50 years, at overtopping levels. This estimated level of protection is based upon scattered and limited information along the raised roadway, and further elevation verification is needed. This additional information will be collected and results will be presented in subsequent DIFPP report.

The estimated cost for Plan G, without right-of-way, is 2567.72 million Tk.

3.4.3 Summary of Proposed Plans

The alternative strategies have been prepared dividing the flood control, erosion protection, and drainage work into segments to allow completion of each segment in order of highest priority, depending upon benefit, area of protection, population at risk, and cost. Priority of work has been assigned as shown in Tables 3.4A through 3.10A (Appendix B), but is subject to modification to best satisfy all involved participants in the decision- making process.

A summary of the proposed plans, estimated implementation costs, estimated right-of-way costs, and total estimated cost is presented in **Table 3.4.**

The total cost for all work needed to complete the flood protection work for the full 100 year recurrance interval flood is listed under Plans A, B and C. Plans B and C are variations of Plan A and provide the same degree of protection. Plan A is least expensive and would be recommended, if provision for uninterrupted boat traffic on Gojaria Khal through the embankment is not required. Plan B, which provides for locks to allow boat traffic along Gojaria Khal through the embankment, would cost approximately 60.65 million Tk. more than Plan A. Plan C, which provides for an inland waterway, from Balu River to the Metropolitan Dhaka City area, by moving sluice No. 10 and constructing additional sub-embankment C' with additional sluices and a bridge for crossing the Gojaria Khal near the Balu River, would cost about 377.95 million Tk. more than Plan A.

A further variation to Plan A has been studied (designated A * in Table 3.4), which would include construction of all the high priority work in the west (Phase I area) plus all main embankments and sluices for the easterly zones A, B and C, to first stage 2 meters below final design elevation. This would provide approximately 5 year flood protection for East areas A, B and C with about 0.35 m freeboard, (or 15 year protection at overtopping levels). The remaining stages of work for each area could

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Table 3.4
Summary of Proposed Plans

Plan	Description	Primary Elements	Development Cost (Million Tk.)	Right-of-Way Cost (Million Tk.)	Total Estimated Cost (Million Tk.)
A	Improvement for entire area with sluice no. 10	1. Soils laboratory 2. Site investigations and remediation of phase I area 3. Sluices on west embankment 4. Embankment/Flood wall from Kellar Morh-Mitford Hospital 5. Site investigations and construction of east embankments A,B,C, A' and B' 6. Construction sluices 1 three 10 on east embankment 7. Construct khal (drainage) improvements 8. Construct drainage pipe improvements 9. Site investigations and construciton of pump stations 3,4,5 & 6	9,609.07	5,228.36	14,837.45
B	Improvements for entire area with sluice no. 10 and locks	1-9 from Plan A 10.Locks at sluice 10	9,669.74	5,228.36	14,898.10
C	Improvements for entire area with sluices no. 10 relocated, sub-embankment C', and a bridge	1-9 Plan A 10.Site investigation, design and construction of sub-embankment C' 11.Site investigation, design and construction of bridge	9,987.04	5,307.61	15,294.65
D	Improvements for phase I area plus east area A	1-4. from Plan A 5. Site investigations and construction of east embankments A and A' 6. Construct sluices 1 through 4 7. Construct khal improvements 8. Site investigations and construction of pump station 3 (west)	3,877.71	2,087.03	5,964.74

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Plan	Description	Primary Elements	Development Cost (Million Tk.)	Right-of-Way Cost (Million Tk.)	Total Estimated Cost (Million Tk.)
E	Improvements for phase I area plus east area B	1-4 from Plan A 5. Site investigations and constructions of east embankments B and B' 6. Construct sluices 5,6 and 7 7. Construct khal improvements 8. Site investigations and construction of pump station 3 (west)	3,265.76	1,834.13	5,099.89
F	Improvements for phase I area plus east areas A and B	1-4. from Plan A 5. Site Investigations and construction of east embankments A,B,A' and B' 6. Construct sluices 1 through 7 7. Construct khal improvements 8. Site investigations and construction of pump station 3 (west)	4,575.75	2,325.49	6,901.24
G	Improvement for phase I area	1-4. from Plan A 5. Construct khal improvements 6. Site investigations and construction of pump station 3 (west)	2,567.72	1,595.67	4,163.39
A*	Improvements for phase I area and east embankments A,B and C to stage I (5 year flood)	1-9. from Plan A, except * East Embankments Constructed for stage 1 level only * Sluices 1-6 constructed on east side * Embankments A' and B' not constructed	4,371.67	2,390.68	6,762.35

then be finished as determined most desirable, based fund availability. The estimated cost, without right-of-way costs, to complete all work under Plan G for the westerly side of Dhaka and this first stage work on the east side is 4371.67 million Tk.

The highest priority work is the remediation of the existing embankment and R/C wall. This work is included as Plan G and must receive the highest priority for the following reasons:

i) the existing embankment is unstable along more than 37 percent of the 27.2 km alignment;

ii) portions of the wall have not been completed, which could concentrate flow in highly populated areas of the city;

iii) drainage behind the embankment has not been completed in some areas, causing flooding for even minor precipitation events; and

iv) catastrophic failure of the Phase I embankment could occur at high water level, endangering tens of thousands of lives.

The next level of priority would be to complete a section of work as described by either Plan D or Plan E. Plan D would develop East Area A first, first while Plan E would develop East Area B first, also including the highest priority works under Plan G. Plan E is less expensive than Plan D and may be most desirable to proceed with if funding is limited.

Plan F includes development of East Areas A & B, prior to commencing with work in East Area C. Development of East Area C is considered to be lower priority due to the predominance of lowlands in that area (approximately 75% of the land is lower than elevation 4.0 m PWD).

Consideration in final planning will be given to utilizing the drainage pump stations at Pumps Stations 5 and 6 to also provide irrigation water for the lowland areas, to continue with agricultural production during the next few years while the Greater Dhaka population is expanding in other areas.

3.5 Problems and Needs

3.5.1 General

The problems and needs for the flood control, erosion protection and drainage systems in the Greater Dhaka area have been discussed to some extent in the previous sections of this report. However in order to develop a strategy to deal with the deficiencies, it is beneficial to identify and define these problems and needs.

3.5.2 Problem Definition

Based on the Consultants' review of previous studies and reports, available site data, and discussions with appropriate government agencies, the Consultants have identified the following problems and needs:

(1) Remediation of Phase I Embankments: Approximately 37 percent of the existing 27.2 km Phase I embankment is unstable and presents a serious threat to all of the people living in the lowland areas encompassed by the Phase I embankment. More than 16 percent of the embankment (4.7 km) is subject to catastrophic failure, which could imperil tens of thousands of lives if the embankment were to fail during a period of high water.

Additional studies and investigations are needed to fully characterize the problem and identify areas which could potentially fail in the future. A preliminary conceptual design has been prepared for remediation of the Phase I embankment, but additional work is needed to develop a cost effective and safe design.

An assessment must also be performed to evaluate the suitability of the R/C wall design. Cracking, piping, erosion, and overturning must be addressed in the wall design.

(2) Project Office for Control of Proposed Work: Due to the number, diversity, and varying goals of the parties involved (BWDB, DWASA, and DCC), project coordination, control, and management could be a problem.

In order to provide a smooth operating system for control of activities during: (a) planning; (b) design; (c) contracting; (d) construction inspection and quality control; (e) monitoring of work during and after construction; and (f) operation and maintenance of the system after construction, a project office is needed. This office should be staffed with key people from BWDB, DWASA, and DCC to provide the necessary engineering and administrative support. A determination must be made as to the responsible agencies during planning, design, construction, monitoring, and continuing with operation and maintenance of the flood protection system, for all of the flood protection facilities. A lead agency should be designated for the project to facilitate management on project oversight.

As part of the Project Office, a testing laboratory is needed to provide construction quality assurance/quality control (QA/QC), which will be included as the Contractors responsibility under terms of the contract. The testing laboratory is also needed to perform required soils investigations both prior to and during design, and during construction.

(3) Design of New Embankments: Design of the new embankments will be important if the instability problems of the Phase I embankment are to be avoided. In order to avoid the problems encountered with the Phase I embankment, the following is needed: (i) detailed site investigations including soil borings and laboratory testing; (ii) instrumentation of the embankments; (iii) design using appropriate technologies (wick drains and

high strength base reinforcement) to cost effectively address stability problems induced by soft subgrade conditions; and (iv) utilization of multiple cross-sections to reduce cost and appropriately address site conditions.

(4) Contractor Qualifications and Experience: The embankment contractor must have extensive experience in embankment construction, including the use of geosynthetics. Construction of embankments on very soft subgrades, where subgrade shear strength varies with time is difficult, and will require highly experienced and educated designers and construction contractors.

A strict set of rules is needed to prequalify the Contractors and Subcontractors, including staff experience and capabilities, amount and condition of equipment, past performance records, bonding capabilities, and general administrative capabilities. Once established, the rules must be adhered to, with no exceptions.

(5) Construction QA/QC: Construction QA/QC of the Phase I embankment was inadequate, as witnessed by the lack of compaction of embankment soils, excessively high and variable water contents of embankment soils, cracking and deterioration of R/C walls, and unstable embankment slopes. These problems must be rectified through implementation of QA and QC plans.

In order to obtain good quality work results, an efficient, reliable QA/QC program is needed. Unless the QA/QC program can be established and properly enforced, the safety and integrity of the constructed work cannot be assured. Development of the QA/QC plan for subsequent work is essential to the successful accomplishment of project goals.

(6) Right-of-Way Acquisition: Right-of-way acquisition could create some very difficult financial problems, especially in acquiring right-of-way for drainage improvements. In much of the area builders and others have encroached upon the Khals, limiting the capacity and in some instances blocking them completely.

Land values have been rising rapidly since work began on the Flood Protection Plan, and will continue to increase with the potential of full flood protection. These increased prices are, in many areas, making the cost of right-of-way acquisition more expensive than the construction costs involved. If these conditions prevail it would be likely that the Central Government would not be able to provide the funds needed for right-of-way acquisition, hence the foreign funds for the construction activities would not be forthcoming.

This would appear to be a problem that must be settled at a higher government level, which may involve new legislation to fit the conditions in the area.

(7) Operation and Maintenance: The sections of the Phase I embankment which have been completed are in need of continuing maintenance. An

effective and workable operation and maintenance plan is needed to begin as soon as work is completed by each Contractor and turned over to the contract administrators. However, a suitable contractors maintenance period should be allowed in the contracts to ensure completion of all work to the required standards.

(8) Budget Constraints: The total cost of embankment remediation, construction administration, design, and right-of-way acquisition is much higher than previous estimates. This increased cost will present a strain on the amount of construction work which can be completed depending upon the availability of foreign funding.

The high cost of right-of-way acquisition may also create a severe strain on the Central Governments' ability to finance the local costs required.

The increased construction costs may be addressed by staging the construction, as described in Section 3.4. High priority construction can be completed first, providing some degree of protection. Future expansions can be added as funds become available.

A strategy and plan to address right-of-way acquisition costs must be developed and implemented. Legislation may be required to establish the legal basis to deal with the problem of escalating costs.

3.6 Recommended Strategies

3.6.1 General

The development of a unified strategy to deal with the immediate, short-term, and medium to long-term flood control, erosion protection, and drainage problems is an essential component of the DIFPP. The immediate and short-term activities are required to minimize the risk of catastrophic failure of the Phase I embankment and to reduce the risk for failure of the embankment in the future. Priorities were assigned based on : (i) benefit; (ii) size of protected areas; (iii) population at risk; and (iv) cost and availability of funds. The recommendations are based on the Consultants' understanding of existing conditions, availability of funding, and the desires of the Central Government, BWDB, DWASA, and DCC.

3.6.2 Immediate

The immediate needs of the project have been discussed previously, but are summarized here for convenience:

i) Perform an initial assessment to determine the extent of damage to the Phase I embankment and identify sections of the embankment which could fail.

ii) Prepare a Conceptual Design for remediation of the Phase I embankment. The Conceptual Design should include multiple cross-sections to cost-effectively address variable site conditions. The immediate work

should focus on those actions required to remediate the sections of the embankment which could potentially fail catastrophically.

iii) Initiate a Remedial Action Plan for the Phase I embankment. This initial part of the Remedial Action Plan should focus on sections of the embankment which could fail catastrophically.

iv) Prepare final designs for remediation of embankment sections which could potentially fail catastrophically. These designs should utilize construction materials and techniques which enhance the performance of the in-situ materials and can withstand significant deformations. Wick drains and high strength geosynthetics are highly recommended.

v) Perform additional site investigations, including soil borings and laboratory testing, in order to complete the designs.

vi) Assess the structural integrity of the existing R/C wall. Prepare design drawings as needed to address deficiencies in the original design.

vii) Prepare QA and QC plans.

viii) Prequalify bidders, tender the critical remediation work, and reconstruct critical sections of the failed Phase I embankment to Stage I elevations (8.0 m PWD).

3.6.3 Short-Term

The following tasks are highly recommended for implementation in the short-term, as funding becomes available.

i) Establish a project office as described in Section 3.5.2. The project office would provide administration of the proposed plan and would cover site investigations, design, construction inspection, QA/QC, and monitoring of embankments as required, before, during and after construction.

ii) Develop a Strategic Development Plan for the flood control, erosion protection, and drainage works in the Greater Dhaka area. The Strategic Development Plan would should be based on the plans and strategies discussed in Section 3.4.2.

iii) Complete site investigations, including soil borings and laboratory testing, along the Phase I embankment.

iv) Complete the Remedial Action Plan for the Phase I embankment.

v) Complete design of the embankment reconstruction, including cross-sections of damaged or unstable sections of the embankment not addressed in Section 3.6.2, and the recurring works required to complete the westerly flood protection scheme.

vi) Tender the remaining remediation and completion work, and reconstruct remaining damaged or unstable sections of the Phase I embankment to the Stage I elevation (8.0 m PWD).

vii) Perform site investigations for the east embankments and drainage/flood regulation structures.

viii) Perform design of the east embankments and structures.

ix) Tender work on the eastern embankments, and construct the east embankments to the Stage I elevation (2.0 m below final design top of embankment, varying from elevation 7.6 m PWD at the Tongi Railway Crossing to elevation 6.6 m PWD at Demra).

x) Develop a strategy to deal with right-of-way acquisitions. This is a Central Government issue because it may involve enactment of legislation to provide the authority to deal with right-of-way acquisition in a cost-effective way.

xi) An Operation and Maintenance Plan must be developed. An effective well organized, well trained inspection, operation, and maintenance staff must be trained, under the direction of the Project Office, to assume the required duties of inspection, operation, and maintenance as each section of the Flood Protection Plan is completed and turned over to the Government.

3.6.4 Medium to Long-Term

The medium to long-term components of the project were identified using the criteria described previously. These components are described below.

i) Prepare design of embankment extensions from elevation 8.0 m to the design level for the 100 year recurrance with 1.2 m freeboard.

ii) Implement the operation and maintenance program.

iii) Tender the embankment extensions, and construct the embankments to the design level for the 100 year recurrance with 1.2 m freeboard.

iv) Improve design of breaches in the R/C wall.

v) Construct R/C wall redesign at the breach points.

3.6.5 Summary

The design and construction of the flood control, erosion protection, and drainage works in the Greater Dhaka area require planning, coordination between the responsible parties, and experienced design and construction. Use of traditional design and construction techniques for the Phase I embankment have resulted in numerous failures, embankment instability, and have placed a significant number of people in the Greater Dhaka area at risk.

Innovative, cost-effective, and stable construction methods and materials are needed to reconstruct the Phase I embankments, and to design and construct the east embankments. The soft subgrade conditions in many areas along the embankment alignment can be addressed cost-effectively and appropriately by utilizing materials which allow the subgrade materials to increase in strength over time. By improving the subgrade materials, embankment stability increases with time, thus reducing the risk of failure. This is accomplished by providing drainage and increasing the overburden stress on the soil.

Due to the nature of the subgrade materials, the drainage medium must remain functional, notwithstanding large anticipated deformations. Sand drains would not remain functional for an adequate period of time. Therefore, wick drains are recommended as the drainage medium.

Staging of the embankment construction will be used in combination with the wick drains in critical areas to allow the subgrade soils to support the required loads. In areas where minimum staging elevations cannot be achieved with wick drains alone, high strength geotextiles will be used to reinforce the base of the embankment. Preliminary design calculations have demonstrated that the design methodology is appropriate for the most critical site conditions. Other areas may be addressed by wick drains alone, flattening of slopes, toe berms, or a combination of earthen embankments and R/C walls. The preliminary conceptual design of the embankments will be discussed further in a subsequent report.

Due to the potential for catastrophic failure of the Phase I embankment, and the number of people at risk in low-lying areas, remediation of the Phase I embankment must proceed immediately. Immediate actions are recommended for those areas of the embankment which the Consultants have identified as having a potential for catastrophic failure. Subsequent remedial actions may be deferred until additional funding is appropriated.

4.0 WATER QUALITY, SEWERAGE AND EXCRETA MANAGEMENT AND LEGISLATION

4.1 Introduction

In accordance with the terms of reference, the purpose of this section is, based on an inventory compiled from existing information and reports, to:

i) assess the adverse effects/impacts of existing point and non-point sources of water pollution,

ii) assess the adequacy of existing environmental control systems (drainage, sewerage and excreta management facilities),

iii) evaluate the adequacy and usefulness of existing water quality standards to regulate water pollution sources,

iv) recommend improvements needed for bringing water quality up to acceptable levels, not covered under ongoing programs, and

v) review the status of existing environmental legislation (and draft new legislation now being processed), and identify gaps which need to be corrected to enable implementation of improvements for DMA proposed under this study.

4.2 Existing Situation

Release of pollutants into the environment constitutes an extremely serious health hazard to the Dhaka residents, particularly for the urban poor who rely extensively on open water bodies for daily use and who are most directly affected during flooding periods. According to the report of the Task Force[1] on urbanization, the health conditions of urban slum settlements are extremely bad, and at any given time 30% to 46% of the population suffer from disease. Most of the diseases are related to environmental conditions - particularly from pollution of water and air. The crude death rate for urban slums is 43.62 per thousand (highest), which is four times the national average and six times the urban non-slum average. The infant mortality rate is 152 to 180 per thousand, over 50% higher than the national norm and almost double the urban non-slum rates.

Within the urbanized portion of the Greater Dhaka Area, which covers approximately 10,630 ha. or 39% of the total city area[2], the problems of poverty, heavily concentrated populations, low levels of public awareness, and inadequate environmental control systems have inevitably led to

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1 Report of the Task Force on Social Implications of Urbanization, Planning Commission of the GOB, February 1991.

2 Greater Dhaka Protection Project, FAP-8A, Interim Report, JICA, March 1991

escalating pollution levels of both the immediate urban environment and the water bodies in and around Dhaka. Inadequate sanitation and excreta management services, uncontrolled discharges of household and industrial wastes to the open drain and khal systems, and inadequate solid waste management services have all contributed towards creating the problem. A lack of clearly focused Government policies on urban development issues, inadequate control mechanisms and resources, and low communal awareness are contributing towards perpetuating the situation.

4.2.1 Sanitation Systems

Accurate information on the existing sanitation situation in Dhaka is not available, but based on a comparison of estimates quoted in the Task Force recommendations, the JICA Interim report, and the 1988 CUS[3] study on the urban poor, it is estimated that only approximately 15% to 20% of the city population of 4.8 million is currently serviced by the DWASA sewer and sewage treatment system. Of the remainder, about 25% are serviced by on-site septic tanks, 15% by sanitary pit latrines, and 5% by bucket latrines. The remaining 35% to 40%, representing some 1.8 million people, are serviced by unsanitary systems, consisting mainly of kutcha latrines and open defecation which deposit human wastes directly into the local living environment.

Municipal Sewage System: Dhaka City contains a municipal sewerage collection and treatment system which dates back to the early 1920's and has seen periodic expansions in conjunction with the growth of the community. Currently the system extends over approximately 50 sq. km., or about 20% of Dhaka City, as shown on Figure 4.1, and consists of a network of 440 km. of sewer mains, trunk lines and interceptors ranging in size from 200 to 1360 mm, plus 15 sewage lift stations. The sewers are constructed of a range of materials, including mild steel, asbestos concrete, uPVC, ductile iron, and brick, many of which are seriously deteriorated. Infiltration rates are high, many of the manholes are damaged and sewers are blocked. Pump station failure, system surcharging and sewage overflows are common during the monsoon season.

Per capita sewage flows vary depending upon the DWASA Service Zone. Based upon the 1990 JICA Design Study Report, the range is from 56 to 102 lcd. As of March 1991 there were 37,900 sewer connections representing coverage of 28% of the 136,000 registered holdings, or about 15% to 20% of the Greater Dhaka population. According to DWASA[4] the existing sewerage collection network is currently operating near its maximum capacity. Dry season flows total about 75 mld, and wet season flows equal the system capacity of about 120 mld. Further opportunities for expanding the

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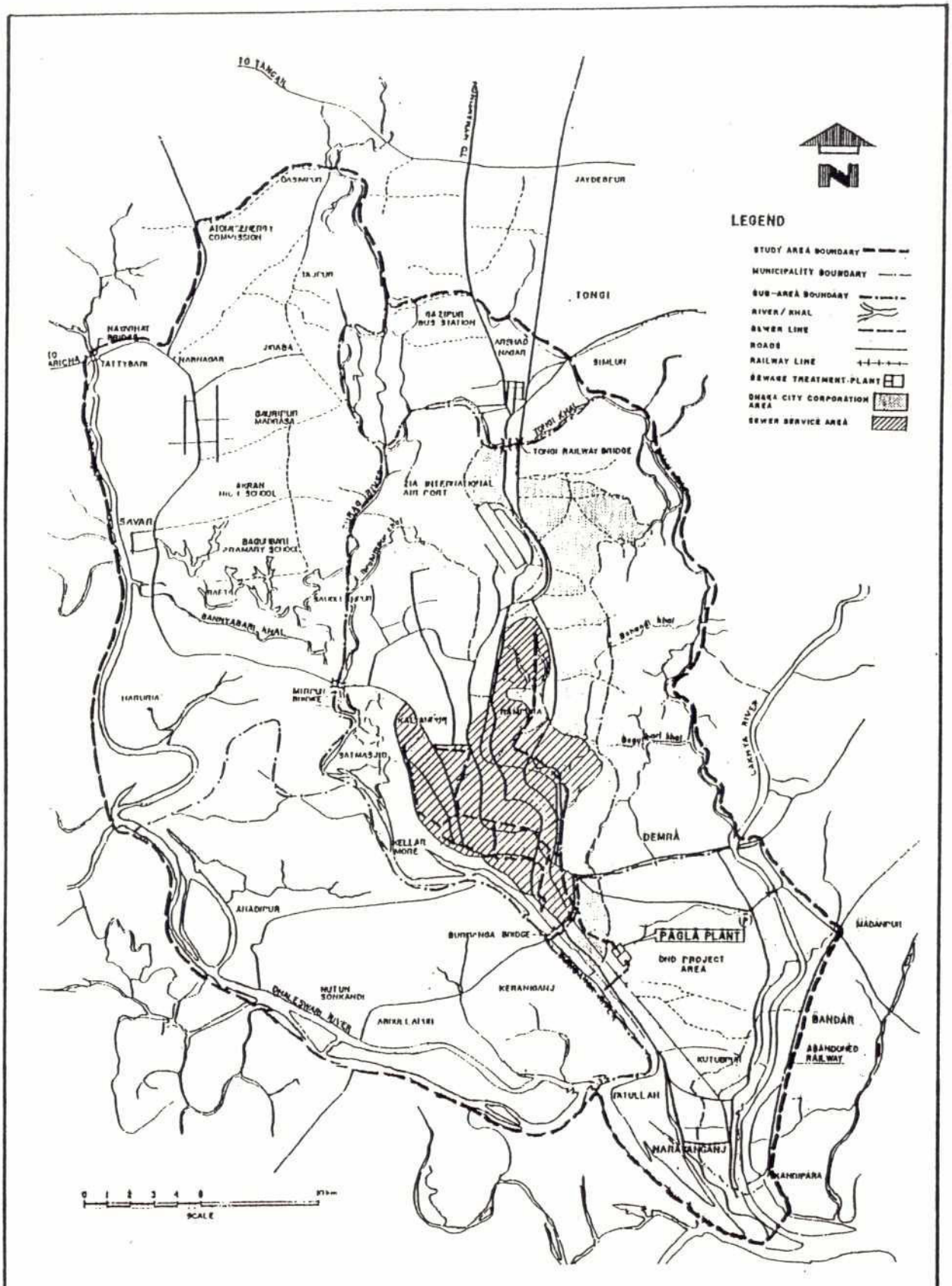
3 **Slums and Squatters in Dhaka City, A Survey Conducted for DMC, The Center for Urban Studies (CUS), June 1988.**

4 **Water Treatment Plant at Demra and Other Works - Interim Report on Sewerage, DWASA, February 1990.**



Dhaka Integrated Flood Protection Project ADB TA No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control	*Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.
FIGURE 4.1	
EXISTING SEWERED AREA	

SOURCE: GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA)OF BANGLADSH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

service within the existing network are very limited. Unless the system is expanded, infiltration rates are reduced, or further connections are limited, the system will become overloaded within the next few years, resulting in flooding of sewerage throughout the City.

Effluent is transported to a single treatment plant at Pagla, which is currently off-line during rehabilitation and expansion of the treatment system. Raw effluent by-passes the treatment plant through an outfall on the Dholai Khal, and passes through portions of Old Dhaka before discharging into the Buriganga River.

Other Sanitation Systems: Households not connected to the municipal sewerage collection system depend upon one of two general categories of disposal systems located on the property site. The first category consists of in-ground sanitary disposal systems, including septic tanks which service about 25% of the population, or more basic pit latrines which service about 15%. The second category consists of unsanitary systems which deposit human waste to the ground surface or adjacent water body, including kutcha latrines and open defecation. This latter system covers about 35% to 40% of the total population, and is used extensively by residents of slums and squatter settlements. Bucket latrines, where wastes are collected and disposed offsite, cover about 5% of the population (mainly in congested older areas) and in accordance with Government policy are slowly being phased out.

Many of the systems nominally regarded as being "sanitary" systems are, however, also active sources of pollution due to improper installation, or poor operation and maintenance. Septic tank effluents frequently discharge into the local storm drainage systems; pit latrines overflow during wet periods; wastes collected from bucket latrines and sludge collected by private septic tank cleaning services are deposited into local low-lands, drains and khals.

Communal Facilities: Public sanitary facilities are constructed, operated and maintained by DCC and there are currently about 20 public toilets located within Dhaka City, the majority of which are in densely populated areas with Old Dhaka. The public toilets provide the general population with access to toilets, wash basins and bathing rooms, and are connected to the municipal water and sewerage systems. A nominal fee of 50 poisa to one Taka is charged, depending on the service provided.

4.2.2 Drainage and Pond Systems

Within Dhaka city approximately 3,430 ha.[5], or 12% of the total area, are covered by open water bodies - lakes, ponds, khals and permanently submerged low lands. These are used extensively by the city residents for recreation, washing, bathing and - in many cases, particularly for the

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[5] Greater Dhaka Protection Project, FAP-8A, Interim Report, JICA, March 1991.

lowest income groups - as a primary source of household water supplies, and as a recipient body for defecation. The city drainage system, which covers about 40 sq. km. or 15% of the City area as shown on Figure 4.2, discharges into this network of open water bodies, and the quality of these water bodies is frequently directly dependant on the quality of the storm drain discharges.

Both the storm drains and many of the open water bodies are extremely polluted. They serve year round as the recipient body for household "grey" water discharge, for septic tank effluents, for unauthorized dumping of septic tank sludge and bucket latrine wastes, for uncollected and decomposed garbage, for commercial and industrial wastes where connections to the sewer system are not available, and for urine and feces where sanitary facilities are not available. In the dry season many of the smaller ponds are stagnant, and serve as a breeding ground for mosquitos and other pests. In the wet season, they receive additional pollutants from street runoffs and from flushing of human wastes from the kutcha latrines and open defecation areas.

DWASA advised that they have conducted random water quality samples at various locations, and test results indicated the presences of coliforms in concentrations equivalent to the levels found in raw sewage. The Department of Fisheries advised that pollution levels in Dhanmomdi Lake had, in the recent past, reached such extreme levels that most of the fish had died off. JICA, in their Interim Report, provided a list of 21 dry season test results on various water bodies in and around Dhaka (see Appendix C) which clearly indicated pollution levels well beyond accepted limits for human safety. In three locations (Dholai Khal, Begunbari Khal and Segunbagicha Khal) the dissolved oxygen levels were zero, and the waters uninhabitable for any type of aquatic life.

These extreme levels of pollution found throughout Dhaka appear to be known to the general public, but the seriousness of the situation does not seem to be appreciated. Storm drain overflows and overspills of highly polluted waters into the living environment are common during rainy periods, leading to a high incidence of waterborne diseases. Children playing and people bathing in polluted waters are a common sight in Dhaka, and unquestionably contribute significantly to the high incidence of disease and child mortality rates described earlier.

4.2.3 Industrial Pollution

Dhaka is a major industrial center containing predominantly cottage and light industries. Although both DOE and DWASA stated that industrial waste discharges are a serious problem in the City, precise information is again limited. DOE[6] have identified ten of the larger industries as specific sources of hazardous and toxic industrial pollutants within and around Dhaka, and the areas listed where industrial discharges are

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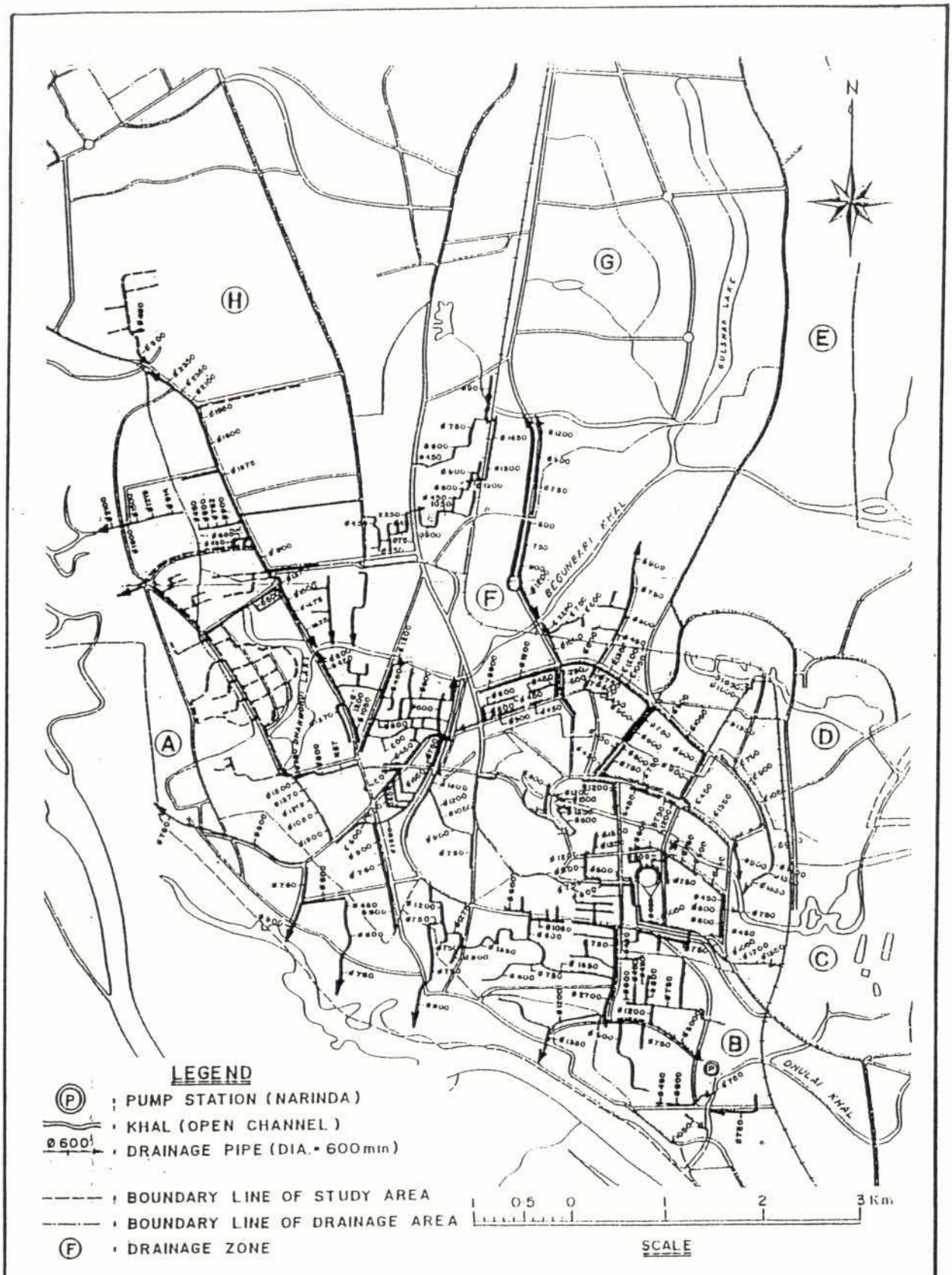
6 DOE letter to LBII, dated 14 April 1991.



Dhaka Integrated Flood Protection Project ADB TA No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited Technoconsult International Ltd.	FIGURE4.2 LOCATION OF TRUNK DRAINAGE PIPES IN DHAKA CITY

SOURCE: GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

considered to be of greatest concern include Hazaribagh, Tejgaon and Motijheel. Less prominent smaller industries which may also be significant polluters were not specifically identified.

Hazaribagh contains about 144 tanneries, most of which are small operations. Chromate and various volatile hydrocarbon compounds used in the curing of animal hides are routinely discharged into the roadside drains which connect with the Dhaka khal system. Prior to the construction of an earthen embankment by the Government in 1989 as part of the a Flood Action Plan for Dhaka City, the khals discharged freely to the Buriganga River. The outlets have been blocked since that time, resulting in the retention of the sewerage and accumulation of pollutants. According to the Flood Action Plan a pump station, retention pond, and sluice gate are to be constructed at the mouth of the drainage canal.

Various attempts have been made to remedy the problems in Hazaribagh. In one such case, DWASA reported that meetings with the Tannery Association were held in 1986 to discuss the construction of a pre-treatment facility for removing heavy metals and chemicals harmful to the efficient operation of the Pagla Treatment Plant. The Association opposed this plan based upon projected costs for construction, stating that most of the tanneries are small operations and do not generate sufficient revenue to finance pollution control measures. No further discussions were reported. In another case, DCC reported that a proposal had been developed calling for the relocation of all tanneries in Hazaribagh to a site outside of the City on the east side of the Lakhya River south of the confluence with the Balu River. A copy of this report could not be obtained for review in conjunction with this environmental assessment, and it is understood that no actions have been taken on this proposal up to date.

Tejgaon Industrial Area and Motijheel contain several large industries, including pesticide, insecticide, pharmaceutical and other chemical factories. DOE reported that the content of the waste stream contains various toxic and hazardous chemicals. According to DWASA some, though not all, of the factories are connected to the municipal sewerage collection system, and they are concerned about the impact of these wastes on the future operation of the Pagla Treatment Plant. Most industries are not connected to the municipal sewerage collection system, and almost none have any type of waste treatment system. These routinely discharge their raw wastes into the local drainage systems, which ultimately discharge into the khal systems flowing through Dhaka and discharging into the Balu River.

In addition to the larger factbries which have been specifically identified as sources of pollutants, there are innumerable small and medium sized industries and commercial establishments which have no access to sewer systems and which routinely discharge wastes to the local drains and khals. Although no information is available as to the number of establishments, or as to the magnitude of the problems, it is the consultant's opinion that the cumulative impact of pollution by these small establishments is at least equivalent to, if not greater than, that of the identified larger industries.

From discussions with private sector industrialists it is apparent that they are aware of some (though not necessarily all) of the problems associated with the current practice of dumping wastes into the municipal drainage systems, but that continue to do so because this is the current "norm" for Bangladesh, because there are no cheap alternative options available, and because there is no effective legislation or standards to direct them to do otherwise. It was indicated that they would be receptive to change, provided that the cost of any such changes would not adversely impact their competitive position in both the local and international markets in their industry. It was stressed that any future controls should be devised in such a way that the impacts would be spread equitably amongst all competing industries of a similar nature. It was felt that the best way to ensure this would be for the Government to provide the waste collection and treatment services and to charge a usage fee for the service, as DWASA currently does for the water and sewerage supply.

4.2.4 Landfill Sites

In Dhaka landfill sites have typically been located in lowlying areas both within and immediately next to the urbanized areas, and collected garbage has traditionally been used as a cheap source of fill for bringing these lands up to grade. There are two major active landfill sites currently in use in Dhaka (see Chapter 6), and numerous other abandoned sites where past landfill operations have been completed. Some have been covered by earth fill following completion of operations, while others have been left exposed.

Regardless, however, of the treatment upon completion, these sites all share the common characteristic of remaining as localized sources of pollution for the adjacent open water bodies, and potentially for the shallow ground water tables in the area. Although the Dhaka soils are relatively impermeable and suitable for forming a good barrier to isolate the landfill sites from the surrounding areas, this has not been done in the past. All old sites are open to the surrounding areas, and leachates discharge onto the surrounding ground or into the adjacent water bodies. Although it is apparent that this is a problem, no testing has been done with specific attention to the disposal sites, and the nature and extent of the problems have not been clearly identified.

4.2.5 Water Quality and Monitoring

Various government agencies conduct routine and/or periodic water quality testing in and around Dhaka. These include periodic testing of various surface waters and effluent discharges by the Department of Environment (DOE), routine testing of municipal water supplies by Dhaka Water and Sewerage Authority (DWASA), selected testing of water supplies on request by the Institute of Public Health (IPH), special testing for heavy metals and other exotic contaminants on request by the Atomic Energy Commission (AEC), and testing of selected lakes and ponds by the Department of

Fisheries (DOF) in conjunction with their fish hatcheries operations. In addition, supplementary sampling was conducted by JICA in conjunction with the Interim Report for the Greater Dhaka Protection Project, FAP - 8A (see Appendix C).

In spite of the number of agencies involved in testing of the water quality, however, there is no formalized monitoring program which is focused on developing a reliable data base for identifying specific sources of pollution, or the varying effects over time. Testing of the shallow groundwater tables, upon which many of the low income residents rely for domestic water supplies, have not been adequately covered under any of the testing programs seen to date. Although, as described in preceding sections, it is clear that pollution is a serious problem in Dhaka, at present there is insufficient information available upon which to formulate a definitive action plan to address all the pollution problems.

4.2.6 Community Awareness and Participation

Environmental awareness is growing in recent times in Bangladesh, but is still generally limited to a relatively select group of informed individuals. Though several government agencies (including DOE), NGOs and the public media have ongoing public information programs, there are no intensive programs being implemented in Dhaka that we are aware of which are specifically targeted on raising the general awareness of the public and involving the community as a whole in improvement programs.

4.3 Institutional Responsibilities

Within Dhaka there are several agencies which are directly involved, or have the potential to be involved, in monitoring and controlling the Dhaka environment. Chief amongst these are the Dhaka City Corporation (DCC), the Department of the Environment (DOE), Dhaka Water and Sewerage Authority (DWASA) and Rajadhani Unnayan Kattripaka (RAJUK). Agencies which do not have a direct controlling function, but which can provide a supporting role, include the Institute of Public Health (IPH), the Atomic Energy Commission (AEC), and the Department of Fisheries (DOF).

DCC: DCC is empowered to undertake a wide range of urban functions, including road construction and maintenance, surface water drainage, the construction and management of parks and markets, solid waste collection and disposal, public health and sanitation, streetlighting and traffic management, and slum improvement projects.

In practice, however, much of DCC's work is involved in operating and maintaining existing infrastructure and services. Capital improvement projects are undertaken primarily by RAJUK for new developments, and by DWASA for water supply, sewage and drainage sector works. The slum improvement cell within DCC has never been staffed to it's approved levels, and it has been unable to provide any significant improvements to

the slum and squatter areas up until now. Similarly, DCC's involvement in regulatory activities is limited. RAJUK is responsible for approval of all new developments within the Greater Dhaka Area, and DCC is not required to issue permits for the construction of new on-site sewage disposal systems or new connections to the municipal sewage collection system. Although it's mandate permits DCC to control sewage and other health related activities which may be detrimental to the city environment, in practice DCC has limited staff and little involvement in control activities. In the rural portions of Greater Dhaka, and in squatter settlements within the City, temporary and fixed Kutcha toilets are constructed without prior review and approval by DCC, and polluters are rarely identified or required to take corrective actions.

DOE: The main objective of the DOE[1] is to ensure, on a national level, the overall environmental protection and better management of the environment, and in connection with this DOE is responsible for environmental planning, management and monitoring. Its major responsibilities with respect to water quality/human excreta management include environmental assessments and monitoring of development, controlling and monitoring of industrial pollution, promoting environmental awareness through public information programs, and assisting the Ministry of Environment and Forests on technical issues.

DOE programs include monitoring of the pollution levels of rivers and groundwater used for human consumption, monitoring and analysis of surface water for pesticide residue and heavy metals (in collaboration with Bangladesh Atomic Energy Commission and Bangladesh Center for Advanced Studies), and analysis on request of water and waste water samples which are brought to DOE laboratories by others.

DOE has testing laboratories attached to each of its four divisional offices, one of which is located in Dhaka. According to DOE, they have a sanctioned staff of 388 people, but currently only 70 are recruited, of which approximately 25 have scientific or technical training/ education. The staff at the laboratory at Dhaka consists of a senior chemist, an assistant bio-chemist, a junior chemist, two sample collectors, and a junior technician. DOE has undertaken some surface water monitoring in and around Dhaka, but with the constraints on staff and budget this has been limited to only occasional periodic testing up until now.

DWASA: DWASA is responsible for the operation and maintenance of the municipal water supply system, the municipal sewerage collection network and Pagla Treatment Plant, and the major storm drainage and khal system within Dhaka. DWASA established a laboratory in 1963 for control and monitoring of their own operations, in conjunction with the formation of DWASA as the water and wastewater utility of the City. The laboratory is staffed with an administrative head, a micro-biologist, a chemist, and a laboratory assistant, and the staffing has not been changed since it's inception. DWASA has a routine program for testing water samples on a

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[1] Department of Environment - A Brief, DOE, February 1991.

weekly basis from each of the 148 deep tube wells before and after chlorination, from the intake and outlets of the Chandighat Water Treatment Plant, and from three or four in-line locations around each tube well. In addition, periodic samples are taken from the Buriganga River downstream from the discharge of the Pagla Sewage Treatment Plant.

RAJUK: RAJUK, the Capital Development Authority, is primarily responsible for planning and approving all development activities in and around Dhaka. Specific functions include master planning, preparation of zonal or project plans, development of new areas and disposal of serviced plots and market facilities under it's own self-financing development schemes, approval of other public and private development plans, construction of major roads, control of all non-DCC areas and provision of water in non-DWASA areas. RAJUK serves as a control agency for all formal developments within Dhaka, but in practice has little coordination with either DCC, DWASA or DOE during the approval process, and has little involvement in development activities focussed on the urban poor sector.

The Institute of Public Health (IPH) is responsible for the testing of food products, and provides a supplementary service to the public by providing water quality testing upon request. The Atomic Energy Commission (AEC) has more sophisticated laboratory equipment than either DOE or DWASA and has the capability to periodically test for heavy metals and other contaminants upon request. The Department of Fisheries (DOF) has it's own laboratory facilities and programs for testing the water quality in the larger water bodies in Dhaka, and is in a position to provide expert advise on topics directly related to impacts of pollution on the fisheries. All these agencies can provide a supporting service in programs for water quality monitoring for Dhaka.

4.4 Standards and Regulations

Over the years various laws have been enacted to provide some form of guidance or control for protection of environmental health and pollution control. Local Government laws spanning the period from the Bengal Local Self Government Act of 1885 up to the recent Local Government (Union Parishad) Ordinance of 1983 have assigned Municipalities with elaborate responsibilities to deal with water supply, sanitation, solid waste management, public health and other conservancy issues. The Town Improvement Act of 1953 made provisions for the improvement and development of Dhaka City through the establishment of a development authority (now RAJUK), and covered all public health amenities of water supply, sanitation, drainage and sewerage schemes, retention of parks and other open recreation spaces, and formulation of land use master plans. The Factories Act of 1965, Shops and Establishments Act of 1965, and Factories Rules of 1979 made provisions for health and sanitation requirements for protection of workers, and stipulated requirements for obtaining permission of the Directorate of Health Services for disposal of wastes and effluents. Other related laws include the Bengal Motor Vehicle Act of 1939-1983 covering vehicle emissions and noise, the Agricultural Pesticides Ordinance of 1971-1983 covering import, manufacture,

distribution, sales and use of pesticides, and the Bangladesh Pure Foods Ordinance of 1959 for prevention of food adulteration and distribution of food injurious to health. All these regulations shared the common feature of providing guidance on their relevant provisions, but in practice were difficult to enforce.

At the present time, the most comprehensive legislation for the protection of the environment is the Environment Pollution Control Ordinance of 1977. This law entrusted the Environmental Pollution Control Board to formulate policies for control, prevention and abatement of environmental pollution, and to recommend on necessary measures for such policy implementation. The execution itself was under the jurisdiction of the Department of Environmental Pollution Control (DEPC), which is today the DOE. The legislation provided power for the Director of the DEPC to enter onto premises for inspection, and to order any person, commercial or industrial undertaking to adopt all such measures as were deemed necessary to prevent, control, or abate existing or potential pollution of the environment. Though the legislation provided broad and sweeping powers to the Director, there were no qualitative standards established to complement the legislation, and it is - in practice - nearly impossible to enforce. As stated in the DOE Brief, February 1991, "Present enforcement of environmental protection and pollution control laws is almost non-existent due to .... inadequate legislation ...".

To make the law more comprehensive and the penalties more stringent, in 1989 the DOE proposed a revised ordinance named Bangladesh Environment Preservation Ordinance. Under this ordinance, the powers and authorities of the implementing agencies have been clarified and elaborated, regulations regarding the prevention control and abatement of pollution have been expanded, and penalties for infractions have been more clearly defined. Within this ordinance, reference is made to "prescribed standards" which will provide the standards for comparison in determining environmental pollution levels, and which are - by implication - an essential prerequisite for effective regulation. The draft ordinance has been reviewed by ADB consultants, and is currently under consideration by the Government.

In parallel with the development of these revised regulations, the DOE prepared draft Environmental Quality Standards (EQS) in August 1988. The EQS provides proposed qualitative standards for many, though not all, major environmental elements including water, air, noise, industrial effluent and emissions, and municipal sewage based on a comparison of standards prevailing in other countries and as judged to be economically viable for the present stage of development in Bangladesh. It is currently awaiting Government approval. As stated in this draft, the establishment of a reliable monitoring system is a prerequisite for ensuring compliance with the standards.

4.5 Ongoing and Proposed Programs

Within Dhaka there are a number of ongoing and proposed projects and Government actions which are targeted towards upgrading the urban infrastructure and improving the general living conditions for the Dhaka residents. Included amongst these are area-based integrated urban improvement projects, sanitation improvement projects, strengthening programs for DOE, revisions to environmental legislation and standards, and a comprehensive Task Force review of the social implications of urbanization. All are, in their own way, attempting to provide assistance and direction for improving the quality of the urban environment.

4.5.1 Urban Improvement Projects

Under the ADB financed Dhaka Urban Infrastructure Improvement Project an integrated urban improvement project is being taken up for about 520 ha. of existing development in the Mirpur area in Dhaka, benefitting about 350,000 people. Under the municipal services upgrading component of the project the existing roads, drains, water supply, sanitation and solid waste systems will be rehabilitated and extended, infill development of 40 ha. will be done for low and middle income residents, markets and community centers will be provided, and equipment for the operation and maintenance of the sanitation and solid waste collection systems will be supplied. For the sanitation component, the strategy applied will be to initially rehabilitate and expand the existing sanitary sewers to collect partially treated effluent from septic tank outlets, and to convey the effluents via force mains and gravity sewers for disposal into suitable drainage easements in the surrounding low land areas, outside the developed zone. Future provisions include the use of pour flush latrines for on-site disposal where possible, and the construction of communal septic tanks for in-fill plots to reduce capital and operation costs.

Under the World Bank/UNDP financed Environmental Improvement Project, Dhaka, DCC is taking up an area-based integrated urban improvement project for the high density, low income areas in the heart of Old Dhaka, covering Islambagh, Shaheed Nagar and Rasulpur. Components include testing of new arrangements for community development, improving solid waste disposal management, improving water supply, sanitation, health and education facilities, improving the living conditions in the low income areas, and upgrading the Dholai Khal drainage system through Old Dhaka.

4.5.2 Sewage System Rehabilitation and Expansion Programmes

Ongoing Improvement Programs: Under the IDA financed DWASA-III Urgent Expansion Project, DWASA is undertaking expansion and rehabilitation of portions of its sewer network. The work includes the installation of 75 km. of new sewer, 8,000 sewer connections and 15 sewage lift stations, covering parts of Moakhali, Gorn-Madertek, Zigatola and Ragamatganj. Completion of the work program is well advanced and is scheduled for the end of 1991. Upon completion, there will be approximately 39,800

connections to the sanitary sewer system, covering about 30% of the registered holdings and 15% to 20% of the city population.

Under the Urgent Sewerage Construction and Expansion Project, JICA is providing financial assistance and construction management for the rehabilitation and up-grading of the Pagla treatment plant, and existing sewers, pump stations and outfall, including installation of standby generators to protect against power failure. Work is currently about 75% complete. The treatment plant up-grade consists of the addition of primary sedimentation tanks and the extension of the existing facultative lagoons. The maximum design capacity of the plant will be 120 mld, based upon the peak flow capacity of the existing sewer interceptor. It is anticipated that the effluent quality will be approximately 37 mg BOD/l.

In connection with the above programs, DWASA reported that subsequent to the 1988 flood, a program was initiated to clean and floodproof the existing sanitary sewer system and pump stations to reduce clogging and infiltration, and to increase system reliability. A fleet of tank trucks and vacuum pumps have been purchased for sewer cleaning operations, manholes are being cleaned and floodproof covers installed. Electrical pump motors, circuitry and in some cases platforms are being raised to an elevation at or above the 1988 flood levels.

Future Facilities Up-grading: DWASA, under IDA financing, commissioned a feasibility study as part of a proposed Phase IV expansion programme to respond to recommendations of the 1981 Long Term Development Plan[8] for water supply and sewerage system within the Dhaka Metropolitan Area. According to the Interim Report[9], a modified proposal was developed for collecting and transferring sewage from Dhaka and its surrounding areas to an up-graded sewage treatment plant as Pagla. The major components of the project include construction of 34 km. of major sewer force main plus 23 km. of secondary force mains, 5 major plus 10 local pump stations, installation of 46,000 new sewer service connections, and further upgrading of the Pagla sewage treatment plant from 120 mld to 270 mld. In additional, construction of approximately 700 Community Sanitation Blocks are also included. If implemented, the project would more than double the number of connections to the sanitary system, and would provide service to about 35% of the city population upon completion.

According to estimates contained in the Interim Report, the cost of the recommended upgrading of the sewage treatment plant and collection system is approximately U.S.$233.10 million. According to DWASA, the Government of Bangladesh has requested financial assistance from World Bank for the implementation of the recommended plan. However, the World Bank has

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8 The Long Term Development Plan and Feasibility Study for the Dhaka Metropolitan Area Water Supply and Wastewater System, RMP/Montgomery, 1981.

9 Water Treatment Plant at Demra and Other Works - Interim Report on Sewerage, DWASA, February 1990.

reportedly expressed concern about the financial viability of the project in view of the revenue currently generated through user fees, and has requested DWASA to improve their financial performance before the project would be considered further. It appears likely that implementation of this project will not occur until this problem is resolved.

Consumer Surveys: DWASA stated that there are numerous unauthorized connections to the municipal collection system, resulting in lost revenue and an added burden to the collection and treatment systems. DWASA has therefore proposed to the Ministry that a survey be conducted of all holdings to identify legal and illegal connections, to determine whether appropriate billing is being done, to identify illegal connections to the system, to identify disposal methods where connections do not exist, and to identify illegal effluent connections to the curb-side drains or storm sewers.

4.5.3 Low Cost Sanitation Programs

Under the Water Supply and Sanitation Program in Urban Slums and Fringes, DPHE, with UNICEF assistance, is providing assistance for the supply and installation of hand tubewells and water sealed latrines in all Municipal areas, including Dhaka. Tubewell sinking and resinking are being done on a self-help basis with nominal contributions from the beneficiaries. Latrine production centers are being established by DPHE and handed over to the Municipalities, and latrine components are being sold to the beneficiaries at cost with repayment in ten installments. The Municipalities are directly involved in the program administration in site selection, motivation and money collection as well as latrine production.

4.5.4 Drainage Programs

DWASA is currently engaged in emergency cleaning of 13 of the critical major khal systems within Dhaka city to alleviate some of the constrictions and bottlenecks before onset of the coming monsoon season. Although this program will not meet the recognized needs for rehabilitating and upgrading the khals, it is expected that it will assist, to a degree, in reducing the occurrence and duration of the annual internal flooding, and will assist in mitigating some of the effects in the low lying areas of Dhaka.

JICA has started a program of khal improvements and pump station construction on the Kallyanpur khal system, which is recognized as being one of the priority khals requiring rehabilitation within the urban area.

The program is scheduled for completion in early 1992, and upon completion is expected to provide a substantially flood-free environment[10] for all areas tributary to this system, comprising approximately 17.6 sq. km.

Under the World Bank assisted Environmental Improvement Project, Dhaka (see Section 4.5.1), DCC is taking up the rehabilitation and upgrading of the Dholai Khal system in Old Dhaka, including construction of the Dholai Khal pump station. The project has started, but implementation is currently being delayed pending completion of resettlement of affected persons. It is expected that implementation will commence during the latter part of 1991, and will be completed over a three year period. Upon completion, approximately 7.24 sq. km. will be substantially[11] flood free.

4.5.5 Environmental Legislation and Control

Technical assistance and institutional support is being provided to the DOE to strengthen their capabilities for environmental planning, monitoring and control under two on-going ADB projects. Under the three year National Environmental Monitoring and Pollution Control Project, which started in 1989, technical assistance and institutional strengthening is being provided to improve DOE's capabilities in national environmental planning, assessment and monitoring. Under the environmental improvement component of the Dhaka Urban Infrastructure Improvement Project, DOE's capabilities are being strengthened in the fields of national environmental monitoring, pollution control and environmental management through provision of a new office cum laboratory building, procurement of additional laboratory and logistic support equipment, and enhancing the staff levels through recruitment of an additional 44 persons.

Three future projects are currently under consideration for additional strengthening of DOE capabilities. Under ADB financing, a three year TA project is proposed for developing technical capabilities and technology transfer on EIA, and a six month PPTA is proposed for industrial facilities (1st. phase). The Ford Foundation is proposing an eleven month program for training on environmental management in Bangladesh to start this year.

Draft Environmental Quality Standards (1988) and a revised Bangladesh Environmental Preservation Ordinance (1989) have been prepared by the DOE and submitted to the Government for consideration (see Section 4.4). DOE is hopeful that these will be approved in the near future to provide the necessary mechanisms for more effective environmental controls.

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10 **Storm drains are designed to freely discharge floods with a two year recurrence interval, and the pump station to discharge floods with a five year recurrence interval.**

11 **The Dholai Khal improvements and pump station are designed for a ten year recurrence interval.**

4.5.6 Task Force on Urbanization

In February 1991 the Planning Commission of the Government of Bangladesh prepared a Report of the Task Force on Social Implications of Urbanization. This report presented an in-depth and comprehensive review of the current status of urbanization in Bangladesh, the social implications of urbanization, and the state of the urban environment; it reviewed the current policies on urbanization and related issues; and it tabled a number of recommendations focused on development of strategies for urbanization and urban development in Bangladesh.

The conditions and needs of the urban poor were one of the highlighted features of this report. Notable amongst the recommendations was the recommendation that the first step towards an urban poverty alleviation program is the enhancement of the urban poor's access to basic services, notably water supply and sanitation.

4.6 Problems and Needs

From the preceding sections it is apparent that the problems of water quality, sewerage and excreta management within Dhaka are extremely serious, and all-encompassing. Issues which must be addressed include not only the technical issues of "what to do", but also the much larger issues of setting policies and priorities, institutional coordination and development, environmental monitoring and control, and education and motivation of the general public.

4.6.1 Policies, Planning and Coordination

Within the Greater Dhaka Area no overall strategy has yet been developed to address the urban problems in general, or the urgent water supply, sanitation and environmental problems in particular. Excellent work has been done by many parties to attempt to address this situation, but up to now the programs undertaken by the various agencies involved in development in Dhaka tend to follow there own priorities, without necessarily any clear linkages or common theme between them.

DWASA, which has the major role in providing water supply, sanitation and drainage services to the Dhaka residents, has no clear statement of policy which addresses the overall needs in these sectors. Although they have numerous on-going projects focused on the rehabilitation and expansion of the existing water supply, sanitary and storm drainage systems, they do not have any clear direction for addressing the overall city sanitation problems as a whole. The various projects are not visibly held together by an integrated management and development plan with long term objectives, which tends to result in internal confusion among the management staff and inefficiencies in the overall operation of the utility. In addition, long term development efforts are clearly hampered by financial constraints. Although a Master Plan for Water and Sewerage was developed in 1981, it was never fully implemented due to lack of

funding. Those portions of this plan which are being implemented (ie. DWASA-III and potentially DWASA-IV) are highly dependant upon external aid, and address only parts of the problem. There are no long term strategies for addressing the overall needs within the city.

Similarly, DCC, which has the responsibility for city "sanitation" also has no clear policy or long term plans for meeting the overall needs within Dhaka. Although over 80% of the sanitation needs must be met by individual property owners, DCC has few effective controls on private developments, and no controls on the informal developments which house most of the urban poor. Discharges of sewage effluents and commercial and industrial wastes to the open drainage system are considered to be the "norm" for Dhaka, and there are no effective control measures taken to either prevent or reduce the impacts of this practice.

Effective environmental control for new development within Greater Dhaka is further hampered by a lack of coordination between RAJUK, DCC, DWASA and DOE. Development permits are issued by RAJUK without a properly integrated review of the impact of the development upon the existing infrastructure. One example of this is exemplified by the recent construction of high-rise commercial buildings and apartments in areas which do not have sufficient water supply and sewage collection capacity to meet the enhanced demand. Coordination is also needed to assess the impact of proposed development on electrical power and natural gas supplies, communication and transportation systems, schools and other human and environmental concerns.

There is an obvious need for the Government to develop a clear national policy setting out the goals, objectives and priorities for future programs to address the urban development issues as a whole, and the water supply, sanitation and environmental issues in particular. Similarly, there is a need for the individual agencies to improve the coordination of their activities, and to develop clear local policies within a coordinated framework which support and complement the overall Government objectives.

4.6.2 Sanitation Systems

Although most of the current emphasis and investments for the long term development of the sanitation systems in Dhaka have been focused on upgrading and expanding the sewer and sewage treatment systems, these currently service less than 20% of the Dhaka population. Today, and for the near future, these "formal" sewage systems will continue to play only a relatively minor role in addressing the total sanitation needs of the city. There is a priority need to address the immediate requirements of the remaining 80% of the population who do not have access to sewer service, half of whom have clearly unsanitary systems or no system at all. The problems and needs of both the public and private systems are discussed in the following.

Maintenance of Existing Sewer Facilities: The ongoing program of cleaning, rehabilitating and floodproofing the existing sewer systems is commendable, but must not be regarded as a one-time activity. It is important that DWASA continue with these activities as part of a routine maintenance program, and expand upon them to optimize the investments made in existing infrastructure. Due to the limited capacity of the exiting system it is important that every effort be made to ensure that the system is working to it's maximum effectiveness. There is a need to ensure that infiltration is reduced to a practical minimum to provide the maximum capacity for effluent conveyance, sewers are routinely inspected and cleaned, and manholes and pump stations are kept in good repair.

DWASA lacks the data base necessary for efficient maintenance and operation of their sewage and stormwater systems. The records of the existing sewer systems are limited and although the general routes and sizes of the sewers are known, there is little data available relating to manhole locations, sewer elevations and gradients upon which estimates of capacity and potential can be made. In addition, data is needed to determine the location of all connections to the network for accurate invoicing and future planning. DWASA stated that a request for a consumer survey has been submitted to the Ministry, which is currently reviewing the proposal.

Development of Municipal Sewerage System: With completion of the ongoing DWASA-III program, the sewer system will be operating near it's maximum capacity. According to the Interim Report on Sewerage, implementation of the recommendations for the DWASA-IV sewerage project will result in a foundation upon which to further develop the sewerage system. However, unless DWASA improves the efficiencies of the existing system, limits future connections, and/or initiates an urgent and comprehensive programme of new development projects, sewer pipes will continue to periodically overflow into streets and untreated sewage will continue to be discharged into lakes and water courses. For the long term development, there is a need for the sewer and treatment capacity to be expanded, particularly for those areas with heavy concentration of developments, or in areas where industrial discharges are creating a serious pollution problem.

Effluent Treatment: Operational guidelines for the Pagla Sewage Treatment Plant, currently being up-graded under JICA, specify disinfection of the final effluent through chlorination at a recommended dosage rate of 3 mg/l. Contact time is to be provided during flow through the discharge pipe from the treatment plant to the out-fall at the Buriganga River. According to the Interim Report for the construction of a further treatment plant expansion under DWASA - IV[12], this dosage rate is considered too low to completely kill all remaining bacteria, viruses, cysts and ova, based upon the presence of organic material and ammonia in the effluent, which exert a high chlorine demand. The Report recommended

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12 **Water Treatment Plant at Demra and Other Works - Interim Report on Sewerage, DWASA, February 1990.**

that bacteria levels of the effluent be closely monitored and the dosage adjusted if necessary.

The present, albeit temporary, situation of direct discharge of untreated sewerage into the Dholai Khal during the treatment plant upgrading operations creates a serious health risk to the adjacent densely populated areas of Old Dhaka, and potentially the entire City. Sewerage contaminated with pathogens could result in the contact and spread of infectious, water-borne diseases. The treatment plant upgrading program should be phased so that the effluent can be routed through the plant bypass at the earliest possible time to minimize this hazard.

Communal Facilities: Public toilets have been strategically located in commercial areas of the City receiving high use, and have been reported by DCC to be highly successful. However, many public areas of the City, including parks and market areas, are not serviced by public facilities, and many slum and squatter areas have no sanitation services. According to the Center for Urban Studies, 87% of slum and squatter settlements rely upon the use of kutcha toilets. Sanitary systems, such as a pit latrine, are not common due to the transient nature of these settlements, the lack of coordination among residents, and lack of sufficient access to capital to construct them.

There is a need to construct additional public toilets or sanitation blocks in strategic locations around the city to provide service (i) in public areas where large numbers of people regularly gather and where no sanitary facilities currently exist, and (ii) adjacent to the most serious slum and squatter areas where no facilities exist and where lack of capital or of secure tenure prevent the dwellers from constructing facilities under their own initiatives.

Septic Tank Operation and Desludging: According to estimates by JICA[13], approximately 42,000 septic tanks are in operation within Dhaka City. DCC does not have any regulations regarding desludging operations, and periodic cleaning of the tanks is the responsibility of the owner. Private contractors commonly clean the tanks by depositing effluents into a pit on the premises, and by dumping the collected sludge into the closest low-lying vacant land or into the drainage system. This practice results in contamination of stormwater and the tributary water bodies. There is a need to either introduce effective regulations and controls to prevent this practice, or to provide an effective Municipal service for collection and disposal of septic tank wastes in a sanitary manner. In addition, discharge of septic tank effluent into the roadside drains is a common feature of septic tank operation in Bangladesh, and the hazards are similar to those caused by sludge dumping. There is a need to undertake a survey to identify the extent of this problem, and to develop remedial measures to eliminate or reduce the impacts of effluent discharge by installation of seepage pits or some similar system.

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13 Greater Dhaka Protection Project - FAP 8A, Interim Report, JICA, March 1991

Development of Alternative Sanitation Systems: One of the highest priorities in the sanitation sector is to provide viable sanitary alternatives for the approximately 2.0 million people who are presently estimated to be serviced by bucket latrines, kutcha latrines, or who have no facilities at all, and who are mainly amongst the low income groups. Bangladesh has well developed programs of low cost sanitation measures, of which the pour flush water sealed latrine has proven to be the most effective. There is a clear need to develop an intensive program of low cost sanitation facilities to eliminate or reduce the extreme pollution hazards caused by unsanitary human waste disposal in Dhaka.

4.6.3 Dhaka Urban Infrastructure Improvement Project - Mirpur

The upgrading and expansion of the sewer network in Mirpur will improve sanitary conditions within the community by removing effluent from the immediate urbanized areas. However, the proposed project does not provide for any treatment of the effluent before discharge into adjacent low lying areas. Effluent contains residual bacteria, cysts and ova which carry infectious diseases. Concentrating this into adjacent low lying areas is undesirable, because it has the potential for creating a serious health risk to people using these water bodies for irrigation, fishing, bathing, recreation, and other uses.

DWASA has stated that the long-term solution to this problem is to connect Mirpur to the DWASA system, as proposed in the DWASA-IV Programme. Due to the fact that the implementation of this program is uncertain at this time, short-term measures should be taken to remedy this problem. This could entail eliminating or minimizing the problem by either (i) adding seepage pits with overflows between the septic tanks and the sewer system to reduce the effluent discharges and provide an additional level of pretreatment before the effluent reaches the sewers, and/or (ii) disinfecting the effluent prior to discharge into the environment. Measures to mitigate the potential pollution problems should be reviewed and incorporated into the ongoing project before project completion.

The construction of the flood control project is not expected to exacerbate this problem. During non-flood conditions, the drainage of the lowlands adjacent to Mirpur will not be interrupted. During periods of external flooding, the flood control project will maintain the internal water elevation at a lower elevation.

4.6.4 Drainage and Pond Systems

The waste water collected by the storm drainage system and the local open water bodies is extremely polluted and creates a serious health hazard for the community at large, and the urban poor in particular. On-going and future proposed structural improvements to the drainage system are intended to improve the hydraulic efficiency of the storm drainage system. Though this will reduce the frequency of overspill and flooding into the living environment in the short term, it will not address the longer term

problems of water quality and the polluting effects on the recipient bodies.

Possible alternatives for remedying this problem consist of: (i) collection and diversion of the dry season base flows into the existing sanitary sewer system for treatment the Pagla Treatment Plant, (ii) identification and removal of the point sources of pollution, or (iii) construction of new collection and treatment (or pretreatment) systems for specific localities where the problems are identified to be particularly serious and to present an extreme hazard to the local residents.

The first alternative would require a detailed hydraulic study of the storm and sanitary sewer systems to determine the viability of the solution and its potential impact upon the capacity and efficiency of treatment of the Pagla treatment plant. The second and third alternatives would require a survey to be made of all the sewage disposal connections throughout Dhaka, and determination of the most appropriate actions to be taken. These could include, amongst others, (i) requiring on-site disposal facilities to be constructed, (ii) providing connections to sanitary sewers where available, (iii) providing local collection systems and treatment or pretreatment facilities prior to discharging the wastes into the drains, and/or (iv) constructing new sewer systems and treatment plant facilities for larger area coverage as a part of an integrated sewerage plan for Dhaka. Where deemed necessary, subsequent enforcement action against parties found illegally discharging pollutants into the storm system could be taken to ensure compliance.

As described previously, a request for a consumer survey has been submitted by DWASA to the Ministry. This survey could also provide essential data for proper operation and maintenance of the existing sewer, water and stormwater networks, and for planning purposes for evaluating viable short and long term alternatives.

4.6.7 Industrial Pollution

In many areas of Dhaka commercial and industrial discharges into the drainage systems are the primary cause of pollution, and the problems of industrial pollution are intimately linked with those of the drainage and pond systems described above. The alternatives described above apply equally well to the problems of industrial pollution.

However, in order to determine the most appropriate solutions there is a need to ensure that the cost implications of any selected alternative are equitably distributed amongst the competing industries. Any requirements for on-site systems should accordingly be made a uniform across-the-board requirement for all industries of a similar nature. Similarly, any service charges applied for municipal services provided, or to be provided, should be applied to all industries of a similar nature on the principle that pollution control measures are for the common good rather than for the benefit of a selected few.

4.6.8 Solid Waste Landfill Sites

There is a need to determine how much pollution is being contributed to the Dhaka waterways from the leachates from both abandoned and active landfill sites, whether there is a problem, and whether or not corrective actions should be taken to seal off the sites to minimize the problems. Similarly, there is a need to determine whether or not the water quality of the shallow water table has been, or is likely to be, affected by these sites, and whether it presents any hazards to the population in the immediate area.

Accordingly, DOE should undertake a special program of monitoring and testing the surface and groundwater qualities in and adjacent to the landfill sites to determine the extent and nature of the problems. Appropriate responses should be developed based on these results.

4.6.9 Flood Control and Drainage Projects

Potential adverse impacts upon drainage resulting from construction of the Dhaka flood control project are proposed to be mitigated by construction of a series of sluice gates and pump stations for venting the storm drainage to the surrounding rivers. The sluice gates will allow natural and artificial drainage systems to function normally during non-external flood conditions. During periods of external flooding, the sluice gates will be closed and the pump stations used to allow internal drainage to continue. Due to the high costs for purchase and operation of large capacity pumps, retention ponds will be constructed to provide temporary storage of stormwater.

The implementation of the flood control plan will likely result in an overall reduction in the health risk caused by contaminated water. During non-external flooding conditions, the quality of the water will likely remain unchanged. However, during periods of flooding, water elevations within the City will be maintained at controlled elevations, thereby reducing the number of people who will come in contact with contaminated wastewater.

4.6.10 Water Quality and Monitoring

DOE and DWASA have primary responsibility for water quality monitoring, with DOE largely responsible for monitoring the surface waters with a focus on environmental control, and DWASA for monitoring the municipal supply system for quality control. However, their existing technical staffing, testing facilities, and monitoring programs are inadequate to provide the level of analyses necessary to protect the public from contaminated water.

DOE is heavily constrained by a lack of technically trained staff, testing equipment, and limited budgets, and as a result has been unable to mount any comprehensive routine water quality testing program of the drains,

khals and open water bodies in Dhaka. Their laboratory testing capabilities are limited to the basic physical characteristics. For specialized testing needs, such as for the presence of heavy metals and hydrocarbon compounds, they have in the past consulted with the Atomic Energy Commission. Technical assistance and support facilities are being provided by the ADB and the Ford Foundation under ongoing and proposed programs to assist in meeting these needs.

For DWASA, technical staffing and testing facilities have not undergone any up-grading since the formation of the utility in 1963. This contrasts with the fact that the number of tube wells have increased from 30 to 148 and the water production has increased from 9.6 to 130 IMGD. DWASA stated that there are no proposals pending for expansion of their facilities, they have no formal training programs for laboratory staff, there is no periodic in-service training, and the laboratory staff lack access to trade journals to keep abreast of new analytical techniques. Access to sampling sites is constrained due to the availability of only one vehicle, which is on a half-time basis only. As is the case for DOE, their laboratory has facilities for the testing of only the basic water quality characteristics. There is a need for DWASA to provide additional staff, facilities and training in order to maintain effective testing and quality control for their water supply and sewage treatment facilities.

4.6.11 Water Quality Standards, Legislation and Control

DOE is currently unable to enforce environmental protection and pollution control laws. According to DOE[14], this is due to poorly equipped laboratories, insufficient manpower and logistics, poor annual budgets, inadequate legislation, lack of co-ordination among various agencies and an absence of a sustainable development strategy. DOE has in the past informed government agencies and private industries where environmental pollution is on-going. They have acted as a resource body, providing suggestions for remediation. However, in instances where environmental degradation continues unabated, the DOE has been unable to effect enforcement actions.

The Environment Pollution Control Ordinance of 1977, which is the only legislation for overall protection of the environment, does not have sufficient strength to act as an effective enforcement document. Although DOE, DWASA and IPH reported that they currently use water quality standards established by the World Health Organization for drinking water evaluation, no standards have yet been adopted by the Government which define the limits for pollutant discharge into the air, land and water, and which would serve as a tool for regulation of polluting activities.

There is a need both to improve the environmental legislation, and to simultaneously adopt a set of pollution control standards to make such legislation effective. The DOE have submitted both draft revised

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14 **Department of Environment - A Brief, DOE, February 1991.**

legislation and draft environmental control standards for Government approval. It is important that these be reviewed and approved as soon as possible so that the DOE has the necessary tools for beginning the process of environmental control. It is also important that mechanisms be built into the legislation so that periodic revisions and updating can be accomplished at the Ministerial level without undue delay in the future.

4.6.12 Environmental Awareness Programs

The DOE is engaged in a program to create awareness regarding urgency of preservation of environment among the general public using various media including posters, pamphlets, leaflets and public speeches. However, due to the high illiteracy rate in Bangladesh, this program needs additional resources to develop alternative strategies for reaching all levels of the public. A long term approach should be developed for utilizing, amongst others, the public media, NGOs, health service organizations, public servants, teachers and women's organizations to reach out to all levels of the community and involve the community as a whole in environmental improvement programs.

In addition, no programs presently exist which provide the public with access to water quality information related to their own living environment. Particular attention should be given to providing up-to-date information regarding situations which could have an adverse impact on the health and well-being of the public. For example, the public should be immediately informed where cross-contamination of the water supply system is occurring. Information regarding the quality of Dhaka's lakes and groundwater could regularly be made available to the media for publication on a weekly basis. Signs containing written and visual information could be posted adjacent to local lakes and ponds informing people of the water quality, and of any potential dangers from external or internal contact.

4.7 Recommended Strategies

4.7.1 Introduction

Future strategies for any sanitation improvements in Dhaka must be developed with full consideration of the overall picture. This includes considerations of the major issues related to the present sanitation situation, the capabilities and potentials of the existing systems, the likely impact of current and future development trends, the capabilities of the implementing agencies, and the costs and affordability of alternative improvement options.

The present state of sanitation in Dhaka can be summarized as follows:

i) there is no comprehensive sanitation policy currently in place at either the national or local levels. Very little coordination of activities exists between the various agencies.

ii) the Dhaka sewer and treatment facilities are currently operating at or near their full capacity. Upon completion of ongoing upgrading programs it will be capable of servicing not more than 20% of the total population. Continued proper maintenance of the facilities is essential in order to maintain this level of service.

iii) of the remaining 80% of the population, about half (40%) are serviced by private on-site "sanitary" systems. The remaining half (40%), primarily from the low income group, are serviced by unsanitary systems, or have no facilities available.

iv) there is insufficient information available to accurately determine the existing usage of the sanitary system, and it's potential for expansion of service to optimize the investments already made.

v) it appears unlikely that the proposed DWASA-IV expansion program under IDA financing will proceed in the near future.

vi) population growth is currently estimated to average about 5.5% per year[15], or equivalent to about an additional 260,000 persons per year. Based on current trends, roughly half of these (25,000 households) will establish residence without adequate sanitary facilities.

vii) storm drains and open drainage channels convey highly polluted waste water, equivalent in effect in some areas to that of raw sewage. The greatest impact of flooding from these systems is felt by the low income groups who most commonly live in lower lying areas.

viii) the surface waters in lowlying areas and khals in and around Dhaka are already severely polluted. It is probable that pollution levels are increasing almost on a daily basis.

ix) there is not sufficient information available to accurately quantify the various sanitation methods used in Dhaka, to identify the most serious point and non-point sources of pollution, or to identify areas with the greatest hazards for determining priority areas for focusing attention on.

x) there is not sufficient monitoring information available to precisely evaluate the impact of the various sources of pollution, the pollution trends, and the degree of hazard that these present to the affected population. (Note: In spite of this, however, it is known that very serious health hazards exist as a result of the inadequate sanitation practices. Starting of remedial actions should not wait for monitoring results.)

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15 Derived from population projection estimates contained in the JICA Interim Report, Greater Dhaka Flood Protection Project, FAP-8A, March 1991.

xi) there is insufficient information on the sources and composition of industrial discharges to evaluate it's impact on the Pagla treatment facilities should industries be connected to the existing sanitary system.

xii) there is no information available on the effects of the sanitary landfill sites on the adjacent surface waters and groundwater tables.

xiii) the proposed drainage improvement project under consideration in this Dhaka Integrated Flood Protection Project will benefit the urban dwellers in the short term by reducing the frequency and severity of flooding. It will not, however, have any effect on the longer term effects of pollution and water quality.

xiv) present environmental legislation is inadequate to control pollution. The adoption of improved legislation and accompanying pollution control standards is an essential prerequisite to effective environmental controls. Provision must be made in any such legislation to enable periodic reviews and updating to be done at the Ministerial level so that needed adjustments can be periodically made as DOE gains experience with the specific conditions and needs prevailing in Bangladesh.

xv) in order to resolve the sanitation problems, the entire resources of the community will be required. Government agencies alone will not, by themselves, be capable of solving all the problems. It is essential that the community as a whole become involved in the process for long term improvements to take place.

4.7.2 Recommended Strategies

In order to address this situation it is essential that the government fully recognize the growing seriousness of the problems and adopt a comprehensive sanitation policy to meet the needs. This policy should explicitly recognize that the provision of adequate sanitation services must, along with the supply of clean water, form one of the highest priorities of the decade. It should be reflected by the allocation of adequate resources to meet the challenge, and by providing clear goals and direction to the executing agencies. The policy statement should be clear enough so that the general public can understand and appreciate it, and provide the needed support.

For the Dhaka situation specifically, it is recommended that a coordinated action plan be developed by all agencies with the objectives of developing a priority program to:

i) protect the population (in the short term) by containing and diverting the wastes away from the immediate living environment,

ii) stop the accelerating degradation of the environment by exercising strict controls over all new developments, and

iii) reverse the degradation by a combination of actions including land use control legislation, eliminating or reducing all point and non-point sources of pollution, extending sewer collection systems and providing new pre-treatment or treatment facilities, and/or exercising pollution control options on offenders.

In developing this program it must be recognized that appropriate low-cost sanitation options must be utilized to the fullest extent, both now and in the future. Financing for a full scale system of sewers and treatment facilities is unlikely to be available in the near future, and should therefore be reserved for specific high priority areas including high density development areas and/or industrial and commercial areas with recognized pollution hazards. All future long-term planning for sanitation services in Dhaka must recognize the limitations on available resources, and include low cost sanitation alternatives as an integral part of any overall strategy.

A diverse, but integrated, series of appropriate measures will be required to address this situation. Although the final solutions for the sanitation and pollution problems in Dhaka will take years to achieve, an appropriate start can be made immediately. Following are recommended elements of an overall plan to address these problems.

Some of the recommended actions related to policy and legislation are solely a Government responsibility, and should be initiated immediately to provide a strong foundation for future strategies and actions. Those actions which are considered to be high priority and appropriate for inclusion in this proposed Dhaka Integrated Flood Protection Project are identified with an asterisk (*), and are included in the priority projects recommended in Chapter 11. Still other components, which may be no less important but which are not included in this project, may be considered for inclusion in other ongoing projects, or for inclusion in future projects with financing by others.

Short Term Measures:

i) Prepare and adopt a clear national policy for providing sanitation services, with time-bound goals to be achieved. In the absence of existing guidelines it is suggested that setting a goal for covering 80% of the urban residents, plus 100% of industrial and commercial enterprises by the year 2000 be adopted. (National Government)

ii) Review, approve and adopt revised pollution control legislation and standards to provide the essential legal foundation for future actions for guidance, control and regulation of environmental issues. The legislation finally adopted should be formulated in such a manner so that periodic revisions and updates can be made at the Ministerial level in order for modifications to be readily made

to respond to new or changed needs that become apparent as experience is gained. (National Government)

iii) * Rehabilitate and upgrade the storm drainage system within Dhaka to contain and vacate the wastes away from the immediate living environment. (DWASA for main drains; DCC for surface and roadside drains)

iv) Complete ongoing sewer and treatment plant rehabilitation and expansion works, and flood proofing of the sewer system. Ensure adequate resources for continued routine maintenance and repairs. (DWASA)

v) Establish a formal development review committee with representatives from RAJUK, DWASA, DCC, DOE and all utility agencies to ensure that all new developments have satisfactory provisions for utility services and waste disposal prior to approval. (RAJUK)

vi) * Initiate a comprehensive, and long term, low cost sanitation program for Dhaka city with the primary objective of reducing or eliminating the disposal of human wastes in the urban environment. Components to be included in the program would include, as appropriate, (i) intensive promotion of the use of twin pit water seal latrines for the conversion of kutcha latrines, elimination of bucket latrines and elimination of open defecation, (ii) construction of community sanitation facilities in public areas and near squatter settlements, and (iii) improvement of existing on-site disposal systems to reduce or eliminate the discharge/overspill of partially or inadequately treated human wastes. (DCC, with cooperation of DWASA, LGEB, DPHE and NGOs)

vii) * Initiate a long term municipal program for desludging of septic tanks throughout Dhaka city, and convey collected wastes to the Pagla treatment plant site for disposal. In parallel, introduce effective regulations to prevent the unauthorized dumping of septic wastes into the drains and low-lands, and exercise strict controls on offending private contractors. (DWASA and DCC)

viii) * Initiate a public information campaign for promotion of sanitation and environmental awareness amongst the general public, and for regularly disseminating up-to-date information regarding water quality and pollution issues to the Dhaka residents. (DOE, with cooperation of DWASA, DCC, MOI, NGOs and the media)

ix) * Seal off abandoned and active landfill sites by constructing impervious perimeter embankments to reduce exfiltration of leachates into the surrounding water bodies. (DCC)

x) Undertake a detailed sanitary and storm sewer condition survey. Work to be undertaken would include: (i) a field survey of all manholes and sewers to determine locations, manhole elevations, sewer sizes and gradients, and any overflow locations, (ii) flow

measurements (dry and wet season) for all trunk sewers, (iii) identification of problem areas, (iv) inspection of selected sewers using closed circuit television, (v) preparation of up-to-date "as-built" drawings, and (vi) theoretical flow analyses for all trunk sewers. The results would be used to determine existing conditions, urgent rehabilitation needs, sewer capacities, flows and potentials for optimizing the use of the existing infrastructure, and would establish a sound foundation for the long term planning of sewer and drain system expansion programs. (DWASA)

xi) * Undertake a door-to-door consumer survey of all households, industries and commercial establishments to determine: (i) source and conditions of water supply service, (ii) water usage and consumption rates, (iii) type and conditions of solid and liquid waste disposal system(s), (iv) characteristics of wastes disposed, and (v) water and sewer invoicing and payment records. The information would be used to: (i) establish base line data from which to develop programs for the operation, maintenance and expansion of the existing water supply, sanitary sewer, storm drain and solid waste collection systems, (ii) develop programs for alternative low cost sanitation systems, (iii) identify potentially serious point sources of pollution, (iv) identify illegal water and sewer connections for taking corrective measures, and (v) identify delinquent accounts, under billings, and under billing patterns for taking corrective measures. (DWASA, with cooperation of and information to DCC and DOE)

xii) * Undertake a short term pollution study to: (i) evaluate the characteristics of major storm drain discharges and sanitary sewer overflows, (ii) evaluate the characteristics of specific point sources of pollution, as identified under item xii above, and including landfill sites, and (iii) evaluate the impacts of the discharges upon the khals, open water bodies and ground water tables in and around Dhaka. The results of the study would be used to: (i) identify/ quantify the most serious sources and zones of pollution in and around Dhaka, (ii) develop alternative programs for correcting the problems and/or mitigating the impacts, (iii) identify situations where legal action may be appropriate to be taken against serious offenders, and (iv) establish base line data for evaluating the long term impacts of sanitation improvement and pollution control programs in Dhaka. (DOE, with the cooperation of DWASA, DCC and DOF)

xiii) * Initiate a long term water quality monitoring program in and around Dhaka to routinely monitor the surface and ground water qualities in order to (i) evaluate the impact of sanitation and pollution control programs, (ii) provide early identification of increases in pollution levels and potential problem areas, (iii) provide accurate information and/or warnings to the general public regarding pollution levels in Dhaka city. (DOE, with assistance of and information to DWASA, DCC, DOF, NGOs and the media)

xiv) * Provide assistance to DWASA to upgrade the laboratory facilities, staffing and training to enable DWASA to maintain a thorough monitoring and quality control program for the tubewells, surface water treatment plant, water supply system and sewage treatment plant. This program should be coordinated with the ongoing improvements at DOE so that DWASA and DOE can mount complementary testing and monitoring programs with sharing of information. Optional responsibilities for DWASA could include the testing and monitoring of stormwater discharges and sanitary sewer overflows as a part of an overall water quality monitoring program (see item xiii above) to be coordinated by DOE. (DWASA, in coordination with DOE)

Medium and Long Term Measures:

i) A new Master Plan for sewerage and drainage should be developed for Dhaka city which updates the Long Term Plan prepared in 1981, based upon the structure plans proposed to be developed under the upcoming UNDP program for Preparation of Structure Plan, Master Plan and Detailed Area Plan for Dhaka and Chittagong. Development of the Master Plan should be done in coordination with RAJUK, DCC and other government agencies involved with development. It should include specific provisions for the use of low cost sanitation alternatives and on-site systems to reduce the needs for community collection systems as a part of the overall strategy. Development/extension programs should be phased to meet priority problems identified under the programs proposed above, and should include consideration of local collection and pre-treatment facilities for pollution mitigation in hard-to-access priority areas. Input from the public should be obtained via public hearings, and the final plan should be formally adopted by the government. Future amendments to the Master Plan should be conducted according to a formal procedure designed to promote coordination among all government agencies. (DWASA)

ii) Local government, DWASA and DOE legislation should be reviewed in order to develop a system for requiring that discharge permits be issued for all industrial and commercial waste discharges into the municipal sanitary collection and storm drainage systems. Such permits would apply to all existing and proposed industrial and commercial establishments, and would specify discharge flow rates and the acceptable levels of pollutants. Where necessary, private pre-treatment facilities should be required, or payment surcharges be applied to offset additional treatment costs which are attributable to these discharges. (MLGRDC and MEF)

iii) Testing, monitoring and public information programs introduced under the recommended short term actions above should be continued, and adequate resources provided to ensure their operation.

5.0 WATER SUPPLY

5.1 Introduction

In accordance with the Terms of Reference, the purpose of this section is, based on an inventory compiled from existing information and reports, to:

i) review the existing situation on water supply planning and project implementation, considering both surface and ground water sources,

ii) delineate any gaps in previous studies for additional needed improvements; and

iii) prepare recommended investment projects for filling critical gaps, especially with respect to provision of water to the urban poor in the context of integrated flood protection.

5.2 Existing Situation

Access to potable water is essential for the health and well-being of human populations. Therefore, an adequate supply of potable water is an essential component in the planning and development of urban areas. Currently within the Greater Dhaka Area - estimated population of 4.8 million - approximately 60% of the residents are connected to the municipal water supply system, with another 15% served indirectly by households with connections. The remaining population relies on water from private wells and surface water.

Despite the fact that there is an abundance of surface and groundwater water within the immediate vicinity of the City, access to potable water is a problem for a majority of the City's residents. There are three major components to this problem:

1. Availability: The municipal water supply system is inadequate to service the present needs of the entire population; thus alternative sources of water are heavily relied upon. These include private deep tube wells, shallow wells, and surface water.

2. Quality: Contamination of water supplies commonly occurs from inadequate collection and treatment of sewerage and industrial effluent, inadequate maintenance of the municipal water supply system, inadequate or complete lack of treatment of private water supplies.

3. Poverty: Over the past decade, Dhaka has experienced in-migration of large numbers of poor people. Presently, approximately twenty-five (25) percent of the City's population reside in slum or squatter

settlements[1]. These people cannot contribute significantly to the City's tax base to expand municipal services, nor are they able to invest in private sources of potable water.

This has resulted in adverse impacts on the existing population and may reduce the potential for future growth of the City. This chapter will further examine the existing water supply systems presently used in Dhaka and the need for improvements. An explanation will be given of problems and recommended strategies for solving these problems.

5.2.1 Dhaka City Municipal Water Supply System

A semi-autonomous governmental organization, Dhaka Water and Sewerage Authority (DWASA), was created in 1963. It is responsible for operation, maintenance and planning of the municipal water supply and sewerage systems[2]. Its service area covers nearly all of the built-up urban area of 115 square kilometers, or 43% of the Greater Dhaka Area. Included within the service area are Old Dhaka, portions of newly developed adjacent areas in Dhaka City, Mirpur and Narayanganj, as shown in Figure 5.1. The estimated population within their service area is 3.6 million. Approximately 97% of the residents within the service area obtain their drinking water from the municipal system. Raw water supplies are obtained from a combination surface and subsurface water system. According to DWASA records for the month of March 1991, an average of 117.10 million imperial gallons per day (IMGD) were supplied to the distribution system, against a peak production capacity of 130.95 IMGD.

Estimated water demand is based upon a per capita daily requirement of 120 liters per day. The total demand from the service area is then estimated to be 95 IMGD. Although the demand is significantly less than the daily production rate, the service area suffers from a chronic shortage of water. Under the DWASA Phase III Programme, an ongoing study since September 1989 is identifying the specific causes for this problem. Preliminary reports are that approximately 56% of water production is unaccounted for. Of this total, 30% of the water is lost due to leakage in the pipe network, and the remaining 26% to withdrawals from illegal connections and under billing. Therefore, deliverable water is only 84 IMGD, or 70% of water production, and revenue generation is based upon only 67 IMGD.

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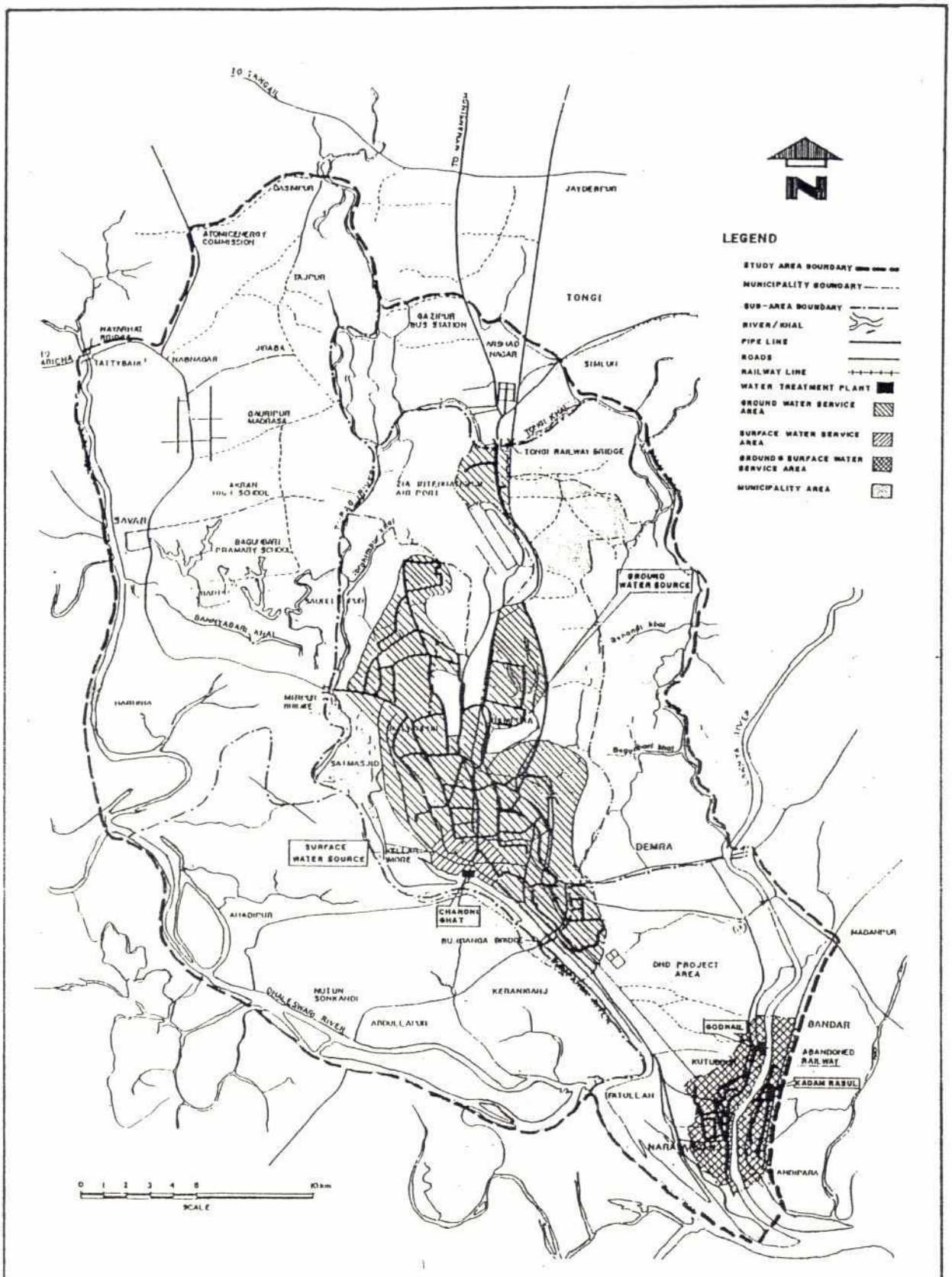
1 This statistic is based upon a 1988 study by the Centre for Urban Studies, entitled "Slum & Squatter Settlements in Dhaka City".

2 In March 1989, DWASA was also given jurisdictional control over the sub-surface storm drainage system.



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 5.1 EXISTING PIPED WATER SERVICE AREA

SOURCE: GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLOITAN AREA) OF BANGALDESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

5.2.2 Surface Water Supply and Treatment System

The municipal water supply system for the city of Dhaka commenced in 1874 with the construction of the Dhaka Water Works at Chandnighat for treatment of surface waters drawn from the Buriganga River. The distribution system is limited to portions of Old Dhaka lying along the Buriganga River. Surface water is drawn from the River at a location immediately downstream from the confluence with an old river channel.

The Water Works uses a conventual treatment process comprising rapid mixing, coagulation and flocculation, sedimentation, rapid sand filtration and chlorination. The capacity of the Water Works was 13.5 MLD (3.0 IMGD). A recently completed expansion program has increased production to 27 MLD (6.0 IMGD). Surface water represents a maximum of only 4.6% of the treated water supplied to the distribution system.

5.2.3 Groundwater Supply and Treatment

The subsurface system consists of a large and easily accessible aquifer located beneath the City. A network of 150 deep wells[3] have been constructed throughout the City in a grid pattern to minimize transmission facilities and the cost of pumping. The groundwater based supply system was developed by DWASA Phase I and II Programmes, and further expansion is on-going under Phase III Programme.

The wells have been drilled to depths ranging from 65-170 m., with the majority of wells over 107 m. Based upon Dhaka records for the month of March 1991, the average rate of water extraction for the entire well system was 114.47 IMGD. Due to the quality of the water obtained from the aquifer, the only treatment used is chlorination.

5.2.4 Transmission and Distribution

Treated surface and groundwater are transmitted throughout the service area via an interconnected network of 1,145 km. of in-ground water main. The water main is constructed from a variety of materials depending largely upon the age of the main. Materials include mild steel, asbestos, uPVC, and ductile iron. According to a study by JICA[4], the major transmission lines interconnecting tube wells and those leading to the elevated storage tanks are 300-400 mm. in diameter. Service connections are restricted to 300 mm. in diameter and below in order to minimize leakage and loss of pressure. All residential, commercial and industrial connections are provided by DWASA upon request from consumers.
Thirty-three (33) elevated storage tanks are located throughout the Dhaka service area. According to March 1991 records from DWASA, 30 tanks are

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3 Two wells are currently out of order.

4 "Greater Dhaka Protection Project - Interim Report", Japan International Cooperation Agency. March 1991.

operational. The distribution system suffers from low pressure due to a combination of insufficient water supply, cracks in old pipes and poor quality joints.

Data obtained from DWASA for March 1991 lists 111,945 service connections, of which 70,407 (63%) are metered and 41,538 (37%) are unmatured. This represents approximately 82% of the registered households within the city[5]. According to DWASA, the total population served via household connection is approximately 3.3 million. Therefore, each household connection serves an average of 27 people.

An additional 300,000 people access the municipal system via 1209 standpipes located predominately along the narrow roads within Old Dhaka. Standpipes provide access to water by poor people living in adjacent slums and squatter areas. Many of the standpipes, especially those located in Old Dhaka, are un-valved, resulting in excessive waste and reduced line pressure. Each standpipe services an average of 250 people.

The uncertain availability of water from the municipal system has resulted in private construction of facilities to extract water from the distribution system during periods of very low pressure, or when no pressure exists in the main. During such periods the water main may be full or partially full of water. According to DWASA, a technique widely used in Old Dhaka consists of a hand-pump well connected directly to the water main. In more affluent parts of the City, people have constructed catch basins below the elevation of the water main. The service connection is altered to draw water from the lower half of the pipe. The water is then pumped to the holding tank located on the roof of the dwelling. Alterations to the water supply system without the permission of DWASA are illegal. DWASA has not conducted an investigation of each service connection within its network; therefore, it is presently unable to take actions to correct this situation.

5.2.5 Private Sources of Water

Large industrial and commercial enterprises, and Zia International Airport, operate their own deep tube wells. They provide more reliable water supplies and are less expensive than water obtained from the municipal system. The construction of deep tube wells requires prior approval from DWASA.

Residential households not connected to the municipal water supply system or living outside the service area, obtain water predominately from shallow hand-tube wells or surface water (i.e., ponds, rivers, khals and lakes). Construction of shallow wells is an unregulated activity.

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[5] Based upon a total registered holding of 136,000.

5.2.6 Access to Potable Water by Slums and Squatter Settlements

According to the Centre for Urban Studies[6], about half of the city's slum dwellers use water from municipal taps or have their own municipal water connections. Fourteen percent of the slums get water from community tube-wells set up locally. The remaining 36% of the slums without any access to water facilities obtain water from neighboring residences or nearby ponds or rivers. DWASA does not supply water connections to unregistered households.

5.3 Policies and Regulation

DWASA does not have stated policies or performance objectives regarding expansion of its distribution system, reliability of water supplies, revenue generation, or efficiency in the management of its programmes and projects. Water is supplied to its service area to the limits of its financial capability, with expansion and maintenance programs based upon the availability of internal as well as external funding.

Projects included in the DWASA Phase IV Programme are based upon recommendations of the Long Term Plan prepared in 1981. However, according to DWASA, this plan was never formally adopted due to lack of financing. Therefore, it does not have the legal authority to guide future program development for the entire Authority.

DWASA does not have a formal policy regarding access to potable water by residents of slums and squatter settlements. Given the necessary funding, DWASA stated that the preferred source of water for most of these settlements would be from expansion of the municipal system. However, DWASA stated that they cannot address the financial and technical issues with respect to this problem until the problems regarding land ownership are resolved.

5.4 Ongoing and Proposed Programs

There are numerous ongoing and proposed projects under DWASA Phases III & IV Programmes, and supplemental programmes; all of which are intended to upgrade the urban infrastructure. These projects include the planning and construction of new water supply facilities, and expansion and rehabilitation of the water distribution system. Included in these programmes are studies of environmental impact, technical, and management issues which affect the performance of the existing facilities.

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[6] The Centre for Urban Studies, "Slums and Squatters in Dhaka City". Government of Bangladesh. June 1988.

5.4.1 On-going Programs

Urgent Expansion Project (DWASA Phase III Programme): This program was started in July 1985 under the Government of Bangladesh and IDA financing. Under this program, the water supply and distribution systems are to be expanded and the number of service connections increased. Areas where expansion are to occur include Mirpur, Dar-us-Salam, Dhanmondi, Tejgaon, Baridhara/Badda, Rampura, Magbazar, Jatrabari and Islambagh. Completion is scheduled sometime in 1991. Specific components of the project are included below:

i) 25 additional deep tube wells
ii) 269 km. of pipe network
iii) 25,000 service connections
iv) 55 standpipes replacing dysfunctional standpipes in Old Dhaka

According to DWASA records for March 1991, all the deep tube wells have been constructed, 185 km (69%) of pipe installed, and 21,283 (85%) new service connections have been made.

Crash Programme for Development of Dhaka City Water Supply: Under this programme, the Government of Bangladesh is financing further expansion of the water supply and distribution system. Areas affected are in Mirpur, Kafrul, DOHS, Mohakhali, Uttara, Dhania and Shaymoli. Specific components of this project are listed below:

i) 60 deep tube wells
ii) 100 km of pipe network
iii) six (6) overhead tanks containing 450 cubic meters.

According to DWASA records of March 1991, 56 (93%) deep tube wells have been constructed, 10 km. (10%) of the pipe installed, and approximately 45% of the work completed on the overhead tanks.

Dhaka Urban Infrastructure Improvement Project - Mirpur: The Government of Bangladesh, with assistance from the Asian Development Bank, recently completed financial arrangements for an expansion of the water supply and distribution system in Mirpur. The purpose of the project is to facilitate the development of new low income housing. Components of this project include:

i) two (2) deep tube wells
ii) one (1) elevated storage tank with pumps
iii) 550 meters of 300 mm diameter pipes and 260 meters of 200 mm pipes
iv) additional secondary reticulation lines servicing of the new plots and covering an areas of some 40 ha.

Construction was initially to commence in January 1989, with completion in December 1992. However, the project was delayed due to lack of funding. DWASA stated that construction has not yet begun on any of the facilities.

Groundwater Extraction and Ground Subsidence: In conjunction with funding from the World Bank/IDA for the DWASA Phase IV Programme, a study is ongoing to determine 1) the impact of groundwater abstraction on ground subsidence, 2) the likely impact of subsidence due to continued groundwater abstraction, and 3) the present and future impact of groundwater abstraction on the aquifer. An Interim Report was completed in November 1990[7]. The final report will be submitted to DWASA in May 1991. Based upon conversations with DWASA, the final report concluded that there has been insignificant land settlement within the main aquifer, and that land settlement should not be an impediment to future ground water development. The study also determined that the drawdown of the watertable has been insignificant based upon the size of the aquifer and the rate of recharge. Therefore, further exploitation of groundwater may be possible.

Leak Detection: In conjunction with the DWASA Phase III Programme, the Government of Bangladesh and IDA are providing funds for implementation of a leak detection programme. According to estimates by DWASA, approximately 30% of its production is lost due to leakage within the transmission and distribution system. Repair of identified leaks is part of their general maintenance program.

5.4.2 Proposed Projects

DWASA Phase IV Programme: In response to the rapidly growing demand for potable water, and the uncertainty of future supplies of subsurface water, DWASA commissioned a feasibility study for the development of a surface water treatment plant. The study was funded through assistance from the World Bank. The proposed location of the plant is in Demra, approximately 8 km east of central Dhaka, which was first identified in a 1959 Master Plan for water supply for Dhaka City. An Interim Report[8] was complete in November 1989 and later revised in February 1990. The report calls for the construction of a 450 MLD treatment plant to be located on the west bank of the Sitalakhya River, just upstream from its confluence with the Balu River, as shown on the map in Figure 5.1. The design of the plant will allow further expansion to 910 MLD at some future date. According to the Interim Report, the design parameters are generally consistent with the Long Term Plan (for water supply and wastewater treatment), developed in 1981.

The transmission system will consist of a network of 12.1 km. of primary and 47.9 km. of secondary water mains, which will allow water to be

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7 Water Supply & Sanitation Urgent Expansion Project, "Dhaka Regional Groundwater and Subsidence Study", November 1990.

8 Dhaka Water Supply and Sewerage Authority. "Water Treatment Plant at Demra and Other Works - Interim Report on Water Supply". February 1990.

conveyed to all areas of the city which are currently being served. In conjunction with this proposed expansion, 20,000 water service connections are to be installed.

The total cost of the project is U.S. $523.66 million, of which U.S. $290.56 million is for construction of the water treatment plant. The Government of Bangladesh has requested financial assistance from World Bank for the implementation of the recommended plan. According to DWASA, World Bank has determined that operation costs of the plant could be reduced if the plant were located closer to the City. In addition, the site is presently occupied by a large squatter settlement. Relocation of this community is an issue that is still unresolved.

An alternative site at Sayedabad, near Jatrabari, has been selected for investigation. Raw water would be brought from the Sitalakhya River to the treatment plant via an existing irrigation canal.

Flood Proofing: DWASA stated that the 1988 flood caused disruption in some electrical supply systems, resulting in a power outage to some of its tube well pumps. Since that time, DWASA has flood proofed wells located in affected areas. DWASA stated that it is now fully capable of supplying potable water to its customers during flood events.

5.5 Problems and Needs

Providing the residents of Dhaka City with access to a reliable source of potable water will necessitate attention to a series of interrelated issues. They include not only the obvious technical issues of increased water production and network expansion, but also the issues concerning the establishment of policies and priorities, institutional coordination and development, financial planning, and access to information about the existing system.

5.5.1 Policies, Planning, and Coordination

DWASA has numerous on-going projects which are not visibly held together by an overall management and development plan. This results in internal confusion among the various management staff and inefficiencies in the overall operation of the utility.

DWASA stated that a Master Plan for Water and Sewerage was developed in 1981; however, it was never implemented due to lack of funding. Portions of this plan are none-the-less being implemented in an informal manner. For instance, feasibility studies in conjunction with the construction of a surface water treatment plant and primary distribution system are based upon recommendations contained within this Master Plan.

New development within Dhaka City is hampered by the lack of coordination between RAJUK, DCC and DWASA. DWASA stated that permits are issued without proper review of the impact of the development upon the existing

infrastructure. This is exemplified by the recent construction of high-rise commercial buildings and apartment complexes in areas which do not have sufficient excess water supply capacity. Coordination is also needed to assess the impact of the development on sewerage capacity, electrical power and natural gas supplies, communication and transportation systems, schools and other human and environmental concerns.

In addition to the 30% loss through leakage, according to current estimates, a further 26% of water production is "unaccountable loss". Some of this may be the result of illegal connections. However, a very significant amount is due to the under-reporting of water consumption by DWASA meter readers. DWASA must institute measures which will require more accountability in the reporting of water consumption by holdings. This may include public participation in reporting illegal activities by DWASA meter readers.

5.5.2 Insufficient Water Pressure

The distribution network is plagued by frequent periods of low line pressure, sometimes reaching zero. DWASA states that the primary reason for this problem is lack of water supply. However, based on estimates of water demand (95 IMGD) and water production (117 IMGD) previously described in Section 5.2.1, it would appear that the water supply system as a whole has appreciable excess capacity. Additional production is necessary as a result of line losses estimated by DWASA to be 30% of production.

Line losses are significant despite the fact that the line pressure of the distribution system is very low. This indicates that the pipe network suffers from chronic leakage. According to DWASA, the major contributors to this problem are (1) the use of inferior construction materials, (2) poor workmanship at joints for secondary main and lateral connections, and valves, and (3) the age of the pipe. Water mains and lateral connections are made from mild steel, UPVC and asbestos cement pipe. Old sections of the secondary distribution system, containing locally constructed 150-300 mm. diameter asbestos cement and mild steel, are particularly problematic.

Increases in pressure through increased production may result in an increase in line losses. Therefore, increasing production alone may not increase deliverable water supplies appreciably. Identifying and repairing leaks will be necessary to improve the efficiency of delivery.

5.5.3 Contamination of Water Supply System

Cross-contamination of sewerage into the water supply system occurs as the result of low system pressure combined with leaking joints and cracks. DWASA stated that this is particularly a problem at two general locations within the supply system. The first location lies within the narrow lanes of Old Dhaka. The width of the road is so narrow that water supply mains must be placed inside sewer manholes. Constant exposure to corrosive sewer gases reduce the thickness of the pipe. During periods when the

water main is submerged in sewerage, and the pressure within the pipe is less than the external water pressure, sewerage may leak into the water main. DWASA stated that this problem is being mitigated by lining the pipes within manholes with a protective coating.

The second location where cross contamination often occurs is in the lateral connection, i.e., between the water main and the household. Joints often leak from poor workmanship. Portions of the lateral connection may lie in contaminated water originating from roadside ditches. During periods when there is no system pressure, contaminated water may enter the lateral pipe. DWASA has a leak detection program, but the details of this program have not been reviewed in conjunction with this study.

5.5.4 Access to Potable Water by the Poor

Local access to potable water is urgently needed to protect the health and well-being of the City's urban poor. Accelerated growth of the City due to in-migration of large numbers of poor people has resulted in creation of hundreds of slum and squatter communities, which now comprise over 25% of the population of the Greater Dhaka Area. These communities are by definition unplanned; therefore, basic amenities such as water supply are not available. Historically, standpipes where constructed in Old Dhaka to provide the poor with free access to water supplies. However, the demand for water has increased at a faster rate than production, and large numbers of people are located in make-shift settlements far from a municipal standpipe. As reported in Section 5.2.6, about 36% of the slum dwellers rely on surface waters and other sources for their primary water supply.

Currently, residents of slums have difficulty in obtaining water for their daily needs. Options which are presently available to them include: 1) obtaining water free from a standpipe, if one is available nearby; 2) purchasing it from a nearby resident, who may be connected to the municipal system or has a private shallow well; or, 3) obtaining it from adjacent surface waters. In all cases, the water obtained requires disinfection before consumption due to the high incidence of contamination. Poor people are least likely to take proper precautions because of lack of education or the financial resources to properly treat water before consumption. Poor people are also the most vulnerable to sicknesses resulting from contaminated water, because they do not have access to proper health care facilities, nor do they have surplus income to use while they are recuperating.

DWASA stated that the most economical long-term solution to this problem is peripheral expansion of the municipal water system according to a Master Plan.

5.5.5 Income and Expenditures

DWASA generates income revenue through user fees obtained from its customers. However, DWASA accounting department records indicate that

revenue was generated from only 44% of water production. To meet its current expenditures, water and sewerage rates were increased by 15% since July 1990. Another 1.5% is charged as excise duty.

Substantial improvement is needed in the efficiency of revenue collection. As reported previously in Section 5.2.1, 30% of water production is lost through leakage, and 26% from illegal connections or under-reporting of water consumption. Increasing revenue from reduction in losses due to leakage will require substantial investment in capital expenditures for repair or replacement of portions of the distribution pipe network. However, an immediate increase in revenue could be realized through greater accountability in the collection of user fees. DWASA stated that it is common for their meter readers to under- report consumption by holdings upon payment of "baksheesh" by the owner. DWASA has in the past attempted to stop this practice; however, their efforts were unsuccessful due largely to the power and influence of the union representing the meter readers.

5.5.6 Institutional Improvements

According to the DWASA Staff Productivity Study of 1990[9], there are significant inefficiencies in management. Some of the examples cited include:

i) Potential savings of as much as 75% in the time required to install network pipe.

ii) Ninety (90) percent of the senior management personnel needed training in the areas of team building and quality control of works. 80% of this group needed training in the areas of organization objectives, output and achievement monitoring.

iii) Water disconnection resulting from non-payment of bills ranges from 185 to 321 days, which could have been accomplished within 24 to 30 days.

Promotion of government employees should be based in part upon meeting minimum requirements for technical expertise and management skills necessary to perform duties efficiently and completely. In addition, measures are urgently needed which will require greater accountability by personnel in the management of programmes and projects.

5.5.7 Lack of Engineering Data

The water supply system consists of a intricate network of water mains and lateral connections, which over the years have undergone numerous

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[9] This study is part of the DWASA Water Supply and Sewerage Urgent Expansion Project.

expansions and modifications. Each change to the network should have been recorded and an up-to-date as-built map maintained on file for future reference. However, DWASA stated that accurate mapping of the location of all in-ground pipes and service connects does not exist, resulting in maintenance problems and loss of revenue.

5.5.8 Fire Protection Systems

The Dhaka water supply system does not serve as a source of water for fire protection. There is presently insufficient pressure to provide water supplies to extinguish fires. Therefore, the Fire Brigade must transport water to the site of the fire. Sufficient water may not always be available to extinguish fires quickly, resulting in an increased threat to human life, health and property.

The recent development of high-rise commercial and apartment complexes present an even greater danger, because of the large numbers of people that reside in them, and the difficulty in extinguishing a fire from ground level. Current building standards do not require that high-rise buildings contain an automatic fire extinguishing system.

5.6 Recommended Strategies

Future investment strategies should be developed with full consideration of the overall picture of water supply and demand within the Greater Dhaka Area. This includes major issues related to the present water production and distribution capabilities, planned expansions based upon implementation of existing feasibility studies, remaining deficiencies in the distribution network, the likely need for further expansion based upon a continued high rate of future growth.

The present state of the water supply and distribution system can be summarized as follows:

i) Despite the past and on-going improvement programs related to the municipal water supply system, the existing need for potable water still far exceeds the capability of the existing facilities.

ii) 3.6 million of the 4.8 million (75%) of the people within the Greater Dhaka Area have direct connections to, or access to, the water supply system. The majority of people who are not directly connected are poor, and must obtain water through a secondary connection or from an alternative source.

iii) An estimated 56% of water production is lost due to leakage (30%) and unaccounted losses (26%).

iv) Contamination of water in the transmission system occurs due to low pressure, cracked pipes, poor quality joints, and illegal

connections. An increase in system pressure would reduce the inflow of contaminates but may result in an increase in line losses.

v) Substantial exploitable groundwater reserves remain despite current high rates of groundwater abstraction.

The following conclusions may be drawn from analysis of the broad issues regarding water supply:

i) There is an urgent need for a comprehensive program to provide potable water to the approximately 36% of the residents of slums and squatter settlements who currently rely upon completely unsanitary sources for their daily needs.

ii) It is technically and economically feasible to provide potable water to slums and squatter settlements. However, this will require a coordinated effort on the part of the government, non-governmental organizations and donor agencies.

iii) Further expansion of the municipal water supply system is urgently needed to address existing shortages in production as well as anticipated future demand. The transmission system must be expanded to accommodate new development, with special emphasis upon the existing and future need for low income housing.

iv) Identification of leaks and improvement in pressure in the existing municipal system is urgently needed to eliminate the incidence of contamination during transmission and reduce line losses.

The following are recommended measures necessary to address these problems. They will be grouped according to whether they are necessary to address immediate problems, or whether they should be components of a long-term development plan. Some of the recommended actions related to policy and legislation are solely a Government responsibility, and should be initiated immediately to provide a strong foundation for future strategies and actions. Those actions which are considered to be high priority and appropriate for inclusion in this proposed Dhaka Integrated Flood Protection Project are identified with an asterisk (*), and are included in the priority projects recommended in Chapter 11. Still other components, which may be no less important but which are not included in this project, may be considered for inclusion in other ongoing projects, or for inclusion in future projects with financing by others.

Short-term Measures:

i) Develop Priorities for Water Supply: Prepare and adopt a clear national policy for providing potable water to the public, with specific identification of ensuring access to supplies for the urban poor as a priority. Goals should be established with a specific time frame for their achievement. Until such legislation is passed, it is suggested that DWASA, in cooperation with RAJUK and DCC, establish a formal goal of

providing 90% of all residents within the urbanized areas of Dhaka City with municipal water by the year 2000. (National Government)

ii) * Potable Water Supply for Slums and Squatter Settlements: Initiate a comprehensive water supply plan for Dhaka City, with the priority attention on providing potable water to residents of slum and squatter settlements. This program should be a joint effort by RAJUK, DCC and DWASA. Different schemes should be reviewed based on the characteristics associated with each slum and squatter settlement. The following are some of the alternative systems to be considered:

1. Where possible, extend municipal water supply pipes to allow construction of standpipes within or adjacent to slums. In instances where settlements are on private land, standpipes should be provided on nearby public property.

2. Construct shallow wells with hand pumps in areas that are not susceptible to recurrent flooding. However, as shallow wells are more likely to be contaminated due to pollutants originating from the ground surface, periodic monitoring of the water should be conducted.

3. Construct a network of water supply depots within each slum or squatter settlement. The depot would consist of a portable, raised water tank to prevent contamination. The number and size of the tanks would depend on the number of people within the slum. Water would be transported to the tanks on a round-the-clock basis to reduce the number of tank trucks required for maintaining adequate water supplies. The tanks would be place under the direction of a responsible person within the area to be serviced. (DWASA, RAJUK and DCC, with assistance from CUS and NGOs)

iii) Coordination Among Agencies in the Issuing of Building Permits: It is recommended that RAJUK require review and formal approval by DWASA, DCC, and any other government agency that may be impacted, before the issuing of building permits. New construction, especially high-rise commercial and apartment complexes, should not be permitted unless adequate excess capacity exists in the water main located in the frontage road, or unless DWASA authorizes the installation of a private deep tube well. (RAJUK, with cooperation from DWASA, DCC, Titas Gas, and Power Development Board)

iv) * Consumer Survey: Initiate a comprehensive survey of connections to the water supply system for use in development of a Master Plan for Water Supply (Wastewater and Stormwater Management). This base-line data will be extremely valuable for development of operation and maintenance programs, future expansion, and financial planning. The survey would consist of an examination of the water supply connection of each household within the service area. This survey would be conducted in conjunction with an examination of household connections to the sewerage disposal and stormwater drainage systems, as described in Chapter 4. (DWASA)

v) Enforcement: Legal proceedings should be taken against parties who illegally connect to the water supply system. Fines should be levied in proportion to the degree of the violation. Repairs should be made as necessary by DWASA, with the cost of repairs borne by the owner.

DWASA, with assistance from the National Government, should investigate incidences of under reporting of water consumption by DWASA meter readers. Measures should be implemented to assure accountability by all DWASA employees in the performance of their duties. (DWASA with assistance from National Government)

vi) Financial Planning: A study should be done to determine how increased revenue could be generated by DWASA to finance urgently needed maintenance and expansion programs. This study could be based in part upon data obtained from the consumer survey previously described and anticipated improvements in the collection of user fees. (DWASA)

vi) Flood Proofing of DWASA Facilities: Essential facilities operated by DWASA should be protected against the adverse impact of flood inundation. The minimum level of protection should be equal to or higher than the anticipate height of a 100-year recurrence interval flood, as specified in the Flood Action Plan. Facilities which should be flood proofed include the Chandnighat Water Works and water supply wells. In addition, the Water Works should be protected against surcharging by installing a one-way valve in the respective intake pipe. (DWASA)

viii) Fire Protection for High-Rise Buildings: Building Codes should be revised to require high-rise buildings to install automatic fire protection systems consisting of water sprinklers. In addition, each floor should contain manually operated fire extinguisher. Fire protection systems should be inspected by the Fire Brigade on an annual basis. (RAJUK)

ix) Treated water from the Chandnighat Water Works should be tested for an expanded range of contaminates, based upon WHO standards or those to be established by water quality legislation, to determine whether the existing treatment system is removing contaminates from industries located up-stream from the in-take pipe. If modifications of the Water Works is necessary to comply with new water quality standards, an economic analysis should be conducted to determine if replacing the Water Works with additional tube wells is more cost effective. (Refer to Chapter 4, "Water Quality, Sewerage and Excreta Management, and Legislation", for an explanation of the water quality concerns with respect the Chandnighat Water Works.) (DWASA)

Medium and Long Term Measures:

i) Development of a Master Plan: A new Master Plan for sewerage and drainage should be developed for Dhaka City, which updates the Long Term Plan prepared in 1981. The Master Plan should be based upon the structure plans proposed for development under the upcoming UNDP program for

Preparation of Structure Plan, Master Plan and Detailed Area Plan for Dhaka and Chittagong. Development of the Master Plan should be done in coordination with RAJUK, DCC and other government agencies involved with development. Input from the public should also be obtained via public hearings. The final plan should be formally adopted by the government. Periodic up-dating may be required to reflect the changing needs of the City. Amendments to the Master Plan should be conducted according to a formal procedure designed to promote coordination among all government agencies.

The Master Plan should consist of a series of objectives by which national goals for the supply of potable water to the public will be achieved. These objectives should consist of a series of programmes and projects to be implemented within a specified time frame with targeted levels of achievement. The following are recommended provisions of the Master Plan:

1. A program should be developed to eliminate cross-contamination by maintaining a minimum positive pressure in the water supply system at all times.

2. There should be phased increases in production and distribution, with adjustments based upon future population growth patterns and needs of the poor.

3. An extensive rehabilitation program of the secondary water supply system should be developed based upon targeted objectives for reduction of line losses.

4. Based upon the results of the recent study of groundwater subsidence and groundwater abstraction, and up-dated demographic data, a new study should be conducted to determine the most economically efficient use of surface and groundwater for the future water supply needs of the Greater Dhaka Area.

5. Groundwater should be monitored adjacent of active and inactive solid waste landfills and known areas of contaminated soils. Strategies should be developed for remediation, based upon pollution control legislation, where contamination is found. (DWASA)

ii) Expansion of the Water Supply and Distribution System: The water supply and distribution system should be expanded according to the provisions of the Master Plan. (DWASA)

iii) Improve Reliability of As-Built Drawings of Network: DWASA should develop a program intended to up-date the as-built drawings of the water supply system. Field inspectors should record any discrepancies between the network of water mains uncovered during construction, and the current as-built drawings. Changes should be reported to the engineering office and the map promptly amended. (DWASA)

iv) Monitoring Program: DWASA should develop a long-term monitoring program to further study the impact of groundwater abstraction on ground subsidence and the main aquifer. (DWASA)

6.0 SOLID WASTE MANAGEMENT

6.1.1 Introduction

In accordance with the Terms of Reference, a review and evaluation of existing reports on solid waste management of the Dhaka Metropolitan Area has been conducted, and the following tasks completed:

i) An evaluation of the contribution of solid wastes to the overall water pollution problem of the Dhaka Metropolitan Area waterways, especially with respect to objectionable floatables; and

ii) Identification of institutional arrangements required to coordinate and manage an effective solid waste collection and disposal system for the Dhaka Metropolitan Area.

6.2. Existing Situation

6.2.1 Generation of Solid Waste

Based upon DCC estimates of between 2000-3000 tons of solid waste generation per day[1], the average per capita generation is 0.5 kg. per day. According to the final report, entitled "Country Status on Solid Waste Management in Bangladesh"[2], the average per capita collection of waste is 0.25 kg. per day, or 50% of the total generated waste. The rate of collection is significantly less than the rate of generation, because a large amount of waste is not collected by DCC. Also, extensive unofficial pick-up by scavengers reduces the quantity of wastes for collection and disposal.

This conclusion is support by an ongoing World Bank funded study of solid waste collection[3]. Preliminary estimates are that approximately half of the waste generated is being collected. According to this study, the density of household waste is about 225 kg per cubic meter (m^3). The waste removed from the collection bins has a density of about 275 kg/m^3, and the density of the waste removed from the truck is about 575 kg/m^3. DCC is currently collecting an average of 565 cubic meters of waste during the day and 1615 cubic meters during the night, for a combined

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[1] DCC reported that average of 2000 to 2500 tons of garbage are generated daily during the winter season and 2500 to 3000 tons per day during the rainy season.

[2] "Country Status on Solid Waste Management in Bangladesh", Final Report. Bangladesh University of Engineering & Technology and the Department of Environmental Pollution Control. May 1989.

[3] "Dhaka Urban Infrastructure Improvement Project", World Bank, 1991 (ongoing).

total of 2180 cubic meters per day. This results in a daily collection of approximately 1250 tons per day, or 0.26 kg. per capita per day.

The problems of sanitary collection and disposal of waste is an ever present threat to the public health of the vast majority of the City's residents. The following are major contributors to this problem:

i) solid waste is commonly discarded into streets, drainage ditches, khals, and open spaces;

ii) municipal collection and disposal practices by Dhaka City Corporation (DCC) are unsanitary and inefficient;

iii) extreme economic hardship of the urban poor, resulting in many people undertaking unsanitary foraging for recyclable materials to supplement their income; and

iv) lack of education regarding the link between solid waste and the spread of infectious diseases.

According to DCC, the service area comprises 233 square kilometers or 90% of the Greater Dhaka Area, as shown in Figure 6.1. However, regular collection of solid waste does not occur in many parts of the City. Piles of partially decomposed garbage are common sights along city streets and neighborhoods. Although people have learned to adapt to this problem, lack of sanitary collection and disposal of solid waste remains a serious health problem.

DCC obtains revenue from a holding tax of 7% of annual evaluation, garbage clearance tax of 3%, and street light tax of 2.5%. Expenditures for solid waste collection are approximately Tk. 26 per person per year, which is substantially below similar sized cities in India[1]. However, conversely this represents a very significant portion (14%-17%) of the operating budget of DCC.

6.2.2 Collection of Solid Waste

Local collection of solid waste is based upon the community bin system. Bins are placed along the roadside at designated locations, though there is no firm criteria for their siting and spacing. The design of the bin consists of a stationary, uncovered, corrugated iron or masonry structure. Waste from residential, commercial and industrial establishments is deposited in community bins, which are emptied by manually shoveling the collected material into trucks.

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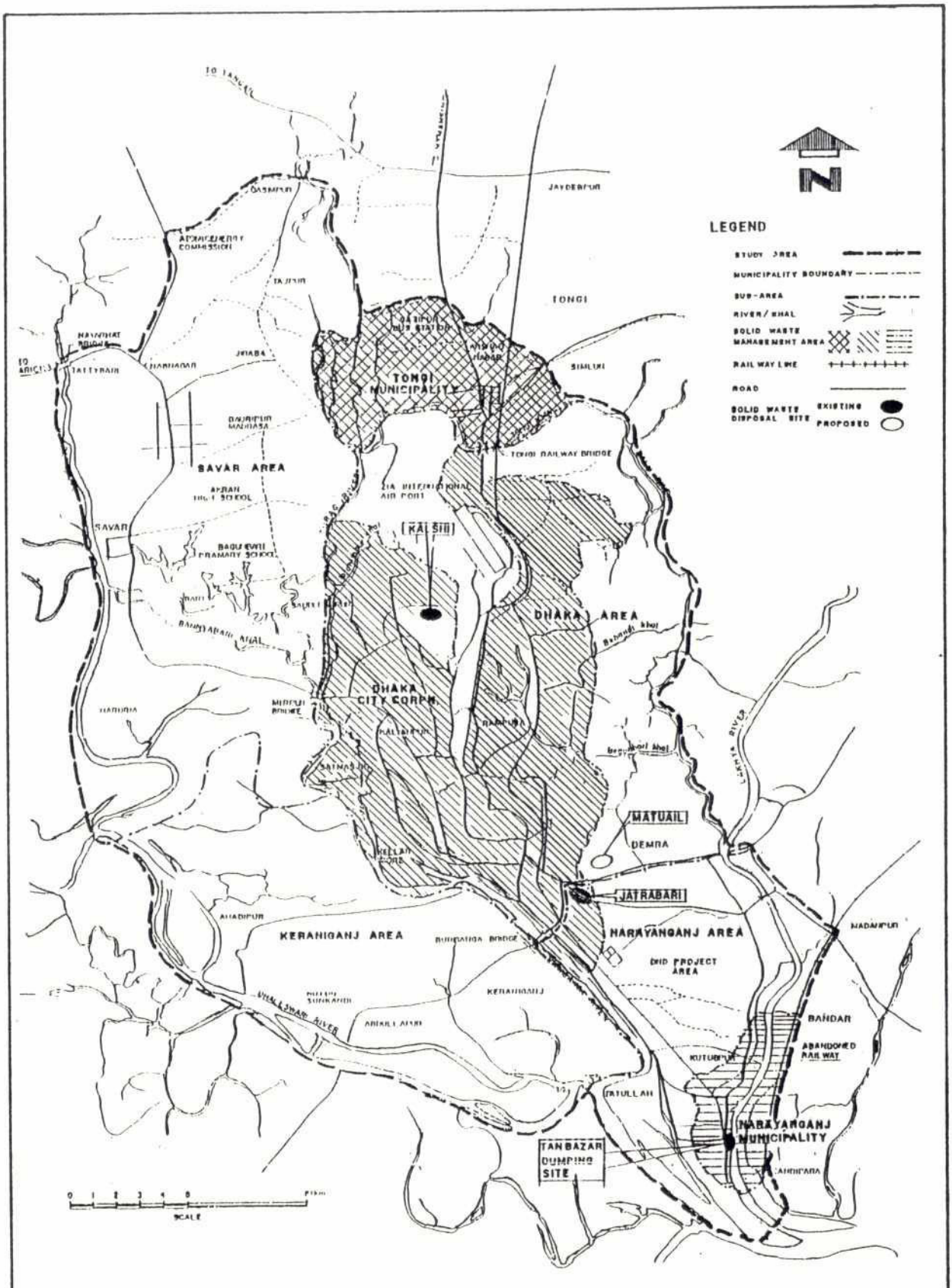
[1] "Solid Waste Management at Dhaka, Khulna and Natore, Bangladesh". World Health Organization. August 1990.

Comparable values in Bombay and Ahmedabad are 130 and 110 Tk./person/year.



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 6.1 EXISTING SOLID WASTE SERVICE AREA

SOURCE: GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DCC has a fleet of 190 trucks, ranging in capacity between 0.5 and 7.0 tons. A majority of the trucks have a closed body with open flaps on the back and 3-4 vertically sliding shutters on each sides. Ninety (90) trucks are used on the night shift and 60-70 in the day shift. Each truck has an assigned area, and makes 1-2 trips to the landfill per day.

The DCC employs sweepers to clean streets and storm drains. However, only main streets are cleaned. Each employee is provided with a broom, basket, brush and spade. Special protective clothing is not worn during cleaning operations. Each employee is assigned to clean a predetermined portion of street/road length, which is on average a 500 m. Hand carts are used to convey refuse and silt collected from the streets and storm drains for disposal in community bins.

6.2.3 Disposal of Solid Waste

The disposal method employed by DCC consists of land filling selected low lying areas for future development. Factors which contribute to this practice are listed as follows:

i) Solid waste is obtained free by DCC;

ii) there is a shortage of buildable land due to high in-migration and the susceptibility of most low lying areas to yearly flooding;

iii) land disposal of solid waste is cheaper than composting, incineration or other techniques;

iv) siting of landfills near the city reduces the cost of hauling and results in greater appreciation in value; and

v) land that has been filled with solid waste yields an economic return due to its increased value as residential or commercial property.

DCC presently operates one active landfill at Jatrabari[5], which is owned by the Government. A second small landfill site is located in Islambagh, where locally generated solid waste is deposited. According to JICA[6], additional filling occurs at numerous privately owned, low lying areas in Islambagh, Hazaribagh, Mukti, Larani, Dayaganj, Mugda, and Amiligola Balu Math. Siting for future landfills is currently being conducted by DCC. One site under consideration is a 59-acre tract of land in Matuail.

Landfill operations are conducted in an uncontrolled and unsanitary manner. Solid waste is unloaded by hand, with as many as ten trucks unloading at the same time. The partially decomposed waste is spread

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[5] A second landfill site at Kalshi was closed in late 1990.

[6] "Greater Dhaka Protection Project, FAP-8A", Interim Report. Japan International Cooperation Agency. March 1991

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over a wide area and partially compacted by a bulldozer. The waste is not covered with clean fill on a periodic basis. Exposed, decomposing organic waste attracts birds and vermin. Also, poor people can be seen scavenging for residual recyclable materials.

Solid waste is land filled until the surface elevation is at grade with the adjacent land. The landfill is then immediately developed to prevent unauthorized occupation by squatters. DCC stated that former landfills have been used for residential housing and the site of the Saidabad Bus Station.

6.2.4 Uncollected Solid Waste

Large quantities of solid waste within Dhaka City are never collected. Some of this waste is deposited in adjacent low lying areas, lakes, or rivers. However, a large percentage of uncollected waste generated within highly developed areas is deposited into local drainage ditches, storm sewers and khals. From field observations, it appears that approximately 10%-15% of the volume of storm sewer effluent contains solid waste. The major sources of waste are: i) household refuse, ii) scrapes of animal hides from tanneries, iii) human hair from barber shops and salons, iv) refuse from restaurants and hotels, v) residues from numerous cottage industries, vi) scrap pieces of cloth and dyes from textile shops, vii) sludge and refuse from industries, viii) animal wastes from over 100 uncontrolled, open slaughter areas, and ix) refuse collected during street sweeping by municipal employees.

Factors which contribute to this practice include: i) lack of convenient access to community bins, ii) lack of any municipal solid waste collection in some parts of the City, iii) inefficient and irregular municipal collection, iv) the ease of discarding waste rather than transporting it to a community bin, v) lack of awareness of the adverse environmental and health impacts, and vi) lack of social pressure to promote sanitary practices.

The resulting adverse impacts of this practice includes clogging of the drainage system, accumulation of noxious decaying material on the water surface, degradation of water quality, attraction of disease carry insects and rodents, and an overall degradation of the environment.

6.2.5 Waste Reduction in Dhaka City

The increase in market value of many solid waste materials has given rise to a very active private recycling business. When compared to cities in developed countries, Dhaka achieves a remarkable reduction in the amount and content of solid waste. Virtually anything that has economic value is removed from the waste stream. Recycled materials includes paper, wood, glass, metals, and many types of plastics. This is not the result of laws and regulations which require separation of recyclable materials. Rather, it is due simply to harsh economic conditions that exist for a large percentage of the City's residents.

Recyclable materials are removed from the waste stream at various stages. The first level is in the individual home or business. The second level is by urban poor who scavenge through community bins. The third level is by municipal sanitation workers. Lastly, people can be seen foraging through refuse deposited in landfills. The remaining refuse consists largely of organics and some non-recyclable plastics. Even these would likely be removed if some economic value could be found.

Various studies of solid waste reduction have recommended recycling of organic waste through composting. The most recent recommendation is found in 1985 feasibility study[7] for improved solid waste handling in Old Dhaka. The study calls for the initial construction of a manually operated pilot plant, with subsequent expansion and improvement in technology. However, funding was never obtained for its construction. Composting of organic waste remains a potential method of further reduction in solid waste; however, it has yet to be exploited by the public or private sector due to high processing costs and lack of commercial demand for compost.

6.2.6 Solid Waste Collection in Slum and Squatter Settlements

Generation of solid waste by the urban poor is small because of their inability to purchase consumable and durable goods. Due to the fact that the urban poor compose a significant portion of the city's population, the per capital generation for the City as a whole is low. However, they are the sector of the population most severely impacted by the City's sanitation problems.

According to a study conducted by the Centre for Urban Studies[8], more than 90% of the slums do not receive municipal solid waste collection. Solid waste is consequently deposited in khals, lakes, low lying areas, drainage ditches, or simply scattered in adjacent non-occupied areas. This results in adverse environmental impacts previously described in Section 6.2.4.

6.3 Institutional Responsibilities

The Dhaka City Corporation (DCC) is responsible for collection, transport and disposal of solid waste within an area encompassing 233 square

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[7] "Housing Development Project - Subcontract 'A'", Final Feasibility Report. United Nations Centre for Human Settlements. October 1985.

[8] "Slums and Squatters in Dhaka City, 1988 - A survey Conducted for the Dhaka Municipal Corporation". The Centre for Urban Studies. Dhaka University.

kilometers[9]. Solid waste management is under the jurisdiction of the Conservancy Division, one of the nine independent divisions of DCC.

The DCC service area is divided into 10 zones, each of which is managed by a separate zonal office. The Conservancy Division of the zonal office is responsible for solid waste collection. Each Conservancy Division contains a conservancy officer, conservancy supervisory inspectors and cleansing inspectors.

6.4 Policies and Regulation

Existing legislation related to solid waste, sanitation, and public health is almost non-existent. A few references are made in Chapter 1, Part IV, of the Dhaka Municipal Corporation Ordinance, dated 1983. However, they do not provide any standards for solid waste management programs or enforcement.

i) Clause 78, "Removal, Collection and Disposal of Refuse", entrusts the DCC with the responsibility for removal of refuse from all public streets, public latrines, urinals, drains, and all buildings and lands vested in the Municipality. However, administrative rules or performance standards have not been created which are consistent with the intent of this legislation. Standards for enforcement of this regulation also do not exist.

ii) Clause 81, "Infectious Diseases", states that DCC "... may, in the prescribed manner, frame and implement schemes for the prevention and control of infectious diseases." However, nothing is mentioned regarding the prevention of the spread of infectious diseases, e.g., through the sanitary disposal of solid waste.

iii) Clause 83, "Promotion of Public Health", states that "... the Corporation (DCC) may, and if the Government so directs shall, take such measures for promoting public health, including education in health, as it considers necessary or, as the case may be, the Government directs." There are no known government programs within the City whose goal is to improve the public's awareness of the connection between health problems and proper sanitation.

DCC stated that the procedures used for collection and disposal of solid waste are based upon guidelines specified in a document entitled, "Working Paper on Waste Disposal Control and Recycling"[10]. This document

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[9] This estimate was obtained from the study, entitled "Report of the Task Force on Social Implications of Urbanization", Planning Commission of Bangladesh, February 1991.

[10] This document was prepared by Mr. Anwar Hossan Khan, Chief Conservancy Officer, Dhaka Municipal (City) Corporation. The document is undated; however, DCC stated that the report was completed in 1985.

contains a general explanation of the system of collection and disposal of solid waste being employed in the City of Dhaka. It identifies the need for public education and awareness, and for legislation which establishes government policies, regulations and enforcement procedures.

6.5 Ongoing and Proposed Programmes

Ongoing and proposed projects are intended to improve the City's management of solid waste through improved efficiency of solid waste collection, siting of new landfills and upgrading the disposal techniques.

6.5.1 Solid Waste Collection and Disposal in Dhaka City

A UNDP financed feasibility study[11] was completed in October 1985 for upgrading solid waste management within Old Dhaka. Components of the report include:

i) review of currently used management practices in collection and disposal of solid waste;

ii) recommendations to DCC regarding improved techniques in planning and management;

iii) identification, design and implementation of new disposal sites;

iv) recommendations regarding the use of composting and other recycling and processing techniques to reduce the volume of the waste stream and the need for future land fill sites;

Funding for technical assistance and equipment for project implementation is being provided by World Bank under the "Environmental Improvement Project, Dhaka". In conjunction with this program, a study is being conducted of current practices in the collection, transport and disposal of solid waste. Recommendations will be submitted for increasing the efficiency in collection through improved management and allocation of resources. New landfill sites will be identified in conjunction with this project. DCC stated that an environmental assessment of recommended practices will be conducted in conjunction with this study.

Preliminary conclusions of the consultant are that significant improvements in the volume of solid waste collected can be realized through better management and the purchase of new collection vehicles. This may include changes in some of the collection methods used; or improvement in existing practices through increased efficiency in the use of labor, combined with trucks specially designed for the needs of Dhaka. This approach seems logical and should result in significantly increased

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[11] "Housing Development Project, Subcontract 'A'", Final Feasibility Report. United Nations Development Programme. October 1985.

efficiencies and lower unit costs for collection if successfully implemented.

DCC stated that three alternative disposal techniques have been under consideration. They include incineration, composting/bio-gas generation and sanitary land filling. Incineration was determined to be uneconomical due to high capital and operating costs. Composting, in combination with bio-gas generation, was also determined to be uneconomical. Lastly, operation of a sanitary landfill was not considered a viable option due to the high cost of land and site development. Therefore, it was concluded that continued unsanitary dumping of solid waste in low lying areas already ear-marked to DCC by the Government of Bangladesh is the most economical option at this time.

6.5.2 Support for Urban Management and Municipal Services[12]

This project calls for the development of a 72-acre parcel of land located in Matuail for resettlement of 418 families displaced by proposed improvements to the Dholai Khal. Thirteen (13) acres are to be filled from excavation of one meter of earth from the remaining 59 acres. DCC will then reclaim the excavated land through land filling with solid waste.

Nineteen (19) of the 72 acres have already been purchased. A decision is still pending in DCC regarding whether to purchase the entire 72 acres, due to escalation in land values. Detailed engineering plans have not yet been developed. Financial support for implementation will be provided by World Bank.

6.5.3 Construction of a Composting Plant

A Project Proforma[13], was submitted to the Ministry of Local Government, Rural Development and Co-operatives, calling for the construction of a refuse composting plant for Dhaka City. The proposed facility was to be located on 21 acres of municipally owned land near Jatrabari. The prime objective of the project is waste reduction. Construction and operation of the plant was to be financed in part from revenue generated from marketing the compost as a fertilizer substitute. Construction was to commence in December 1984 with completion in July 1987. The financing of the project was to come from the Ministry. The estimated cost of the project was Tk.2549 Lakh., based upon costs at the time of submittal to the Ministry. According to DCC, this project was never approved.

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[12] Financial support for the feasibility study is being provided by UNDP.

[13] The document is entitled, "A Refuse Composting Plant for Dhaka City, Dhaka Municipal Corporation". A date is not specified; however, DCC stated that it was written in 1984.

6.6 Problems and Needs

Extension of municipal solid waste collection to all residences within Dhaka City, improving the frequency of collection, development of sanitary disposal facilities, improving the efficiency of the stormwater drainage system, and protecting the health of the sanitation workers will require attention to a series of interrelated issues. The issues include establishment of policies and priorities; legislation and enforcement of environmental regulations; institutional coordination; training of DCC management personnel; financial planning; and development of educational programs regarding public health and solid waste.

6.6.1 Policies, Planning and Coordination

i) Lack of a Policy on Solid Waste Management with Dhaka City: A fundamental problem with the management of solid waste by DCC is the lack of a policy statement which defines achievable goals and establishes a timetable for their completion. Consequently, solid waste management is a program without direction, without a basis by which its performance can be assessed, and without the impetus to improve its efficiency.

ii) Lack of Technical Expertise in Management: According to a study by the World Health Organization[14], the supervisory staff of DCC are mostly promotees. With the exception of the chief conservancy officer and his deputy, no staff have received training in sanitation. The staff does not contain any engineers who are knowable in sanitary landfill construction and operation, maintenance of equipment, and planning for future disposal sites.

iii) Coordination of Activities: Vehicles, maintenance and cleaning staff are controlled by three different executive officers within DCC, resulting in fragmented responsibility and problems with coordinating daily operations.

iv) Solid Waste and Land Reclamation: Formal policies and associated implementation guidelines do not exist regarding the filling of both public and private lands, and development of closed landfills. DCC has an informal policy of land reclamation, stating that it is necessary for solid waste to be used as a landfill material because of the shortage of buildable land. However, when compared to the total amount of land reclamation ongoing within the Greater Dhaka Area, the amount of land reclaimed using solid waste is small.

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[14] "Solid Waste Management at Dhaka, Khulna and Natore, Bangladesh". World Health Organization. August 1990.

6.6.2 Legislative Needs

DCC stated that the procedures used for collection and disposal of solid waste are based upon guidelines specified in a document entitled, "Working Paper on Waste Disposal Control and Recycling"[15]. However, this document neither contains detailed guidelines for management of collection and disposal of solid waste, nor is it legally enforceable.

The collection and disposal of solid waste by DCC and other municipalities should be mandated by national environmental legislation, and implementation based upon legally enforceable administrative rules or guidelines. This will improve the solid waste management program by i) establishing minimum standards for performance by DCC, ii) provide a clear understanding to all employees of how work tasks are to be conducted, and iii) require greater accountability by management personnel.

6.6.3 Enforcement of Environmental Regulations

Enforcement of sanitation laws presently does not exist due primarily to a lack of regulations. Legislation is urgently needed which gives authority to the Department of Environment to monitor solid waste collection and disposal by DCC, and to take legal action if necessary where non-compliance with environmental laws occurs. Public officials should be held accountable in instances where violations of solid waste laws occur by municipalities.

6.6.4 Inadequacies of Current Collection and Disposal System

i) Design and Use of the Community Bin: Currently, people commonly deposit refuse outside of the bin. This is due in part to the unsanitary conditions of the area immediately adjacent to the bin. The current design should be changed in order to address the following areas of concern:

   1. Protect refuse in bins from contact with rain and stormwater overflowing from drainage ditches. This will prevent the formation of leachate and subsequent contamination of stormwater.

   2. Prevent foraging by disease carrying rodents.

   3. Promotion of sanitary disposal of solid waste through improvement in the aesthetic appearance of the bin, and placement of signs on or adjacent to each bin.

   4. Bins should be placed on a concrete pad for improved access and maintence, and to prevent refuse from entering the storm

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[15] This document was prepared by Mr. Anwar Hossan Khan, Chief Conservancy Officer, Dhaka Municipal (City) Corporation. The document is undated.

drainage system.

A redesigned community bin, and promotion of its proper use, is essential in promoting better control of sanitary waste.

ii) Inefficient Collection Practices: Current methods of collection and disposal of solid waste are very inefficient. Labor intensive handling of solid waste results in trucks standing idle for as much as 75% of collection time. The longer trucks remain idle, the less solid waste is collected. Through more efficient management practices, employing less handling of waste, substantially more solid waste could be collected with existing personnel and the same number of trucks.

Many narrow roads in Old Dhaka do not permit access by large sanitation trucks. Smaller vehicles and hand carts should be used to collect solid waste from community bins and transport the waste to regional collection centers. The smaller trucks should be equipped with detachable containers, which can then be transferred quickly to large trucks and transported to a landfill. Large trucks should be equipped with tipping mechanisms for dumping, thereby reducing substantially the time to complete a circuit.

iii) Lack of Access to Municipal Disposal Systems: A significant portion of the City's population does not have proper access to municipal collection of solid waste. This problem can be categorized as follows:

1) Areas Presently Not Serviced: Numerous areas are not included within the municipal collection service area, including about 90% of those people living in slums. Although an exact estimate of the affected population is not available, a conservative estimate is 25%.

2) Areas Under-Served: Many areas of the City do not receive regular collection of solid waste, resulting in piles of decaying waste accumulating along streets.

3) Service Provided to an Inadequate Number of Bins: The number of bins is inconsistent with the rate of generation of solid waste, resulting in waste spilling into adjacent areas.

4) Improper Siting of Bins: Bins are place in locations which are inconvenient for people to use. This is a common problem throughout the narrow lanes and bye-lanes of Old Dhaka, where land use is so intense that siting community bins is extremely difficult.

Public response to these problems has been to discard their wastes into streets, drainage gullies, adjacent low lands, etc., resulting in numerous adverse impacts previously described in Section 6.2.4.

iv) Solid Waste Landfills on Private Land: According to JICA, any private party may petition the DCC for solid waste material for land reclamation. Most of these sites are small when compared to government owned landfills. The scattering of solid waste in uncontrolled environments in and around the Greater Dhaka Area is inconsistent with the need for sanitary disposal.

A clear policy does not exist regarding government sponsored reclamation of private land. This raises questions of conflict of interests, because of the appreciation in the value of land after filling operations are completed, and lack of subsequent controls on building construction on old land fill sites.

v) Landfill Design: Current standards for disposal of solid waste consist of uncontrolled filling of low lying areas as a method of land reclamation. This short term practice limits the service life of the landfill, because solid waste is deposited to conform with the elevation of the adjacent grade. An alternative approach would be to obtain large tracts of land for long term development as sanitary landfills. From an environmental perspective, sanitary disposal in controlled sites is preferred to uncontrolled dumping throughout the Greater Dhaka Area.

Solid waste would be deposited to an elevation above the adjacent grade, thereby extending the life of the landfill far beyond the expected service life of present landfills. Use of the landfill for an extended period of time would allow time for appreciable decomposition and settlement to occur, creating additional storage capacity. The service life could be further extended through composting.

During and after use of the site, the perimeter of the fill area should be isolated from the adjacent areas by an impermeable berm, to prevent leachate from contaminating the adjacent areas. The landfill should be capped with a layer of clean fill before closure. Future development should be consistent with land use zoning regulations. Due to continued land settlement and the production of gases, the preferred type of development is an open space use, such as a park. Development of the land for residential or other uses should comply with building regulations designed to minimize anticipated adverse impacts.

vi) Activities of Street Sweepers: Debris collected by street sweepers is suppose to be collected and deposited in community bins. However, a common practice among many sweepers is to deposit the debris into drainage ditches or storm sewer drains.

6.6.5 Contamination of Surface and Ground Waters

Landfill sites are not designed to prevent contamination of surface and ground water. For example, a small, ongoing landfill operation was observed in a low lying area immediately adjacent to residential

development in Chandnighat. Solid waste was deposited directly into surface waters, and solid waste placed above the water surface was not covered. Leachate is produced from decaying organic vegetation, discarded toxic and hazardous chemicals, and rainwater percolating from the ground surface. Studies have not been conducted on the composition of the leachate produced, its movement in the subsoil, and the impact on water quality of adjacent water bodies and groundwater.

6.6.6 Development of Reclaimed Land

Land reclamation practices using solid waste are similar to filling operations using locally available soil. In each case the elevation of the land is raised to coincide with the adjacent grade. However, land filled with uncompacted solid waste will subside by approximately 35% due to compaction and decomposition[16]. Therefore, the eventual grade will be depressed, resulting in the accumulation of stormwater during rainfall events. An alternative approach would be to fill land to an elevation above the adjacent grade and allow for the anticipated settlement. This would provide the added benefit of extending the service life of the land fill.

It was observed that daily rainfall events make the surface of the Jatrabari landfill soft and spongy. The bulldozer in operation at the site sank about 15 cm. Previous reports have stated that newly closed landfills in Dhaka do not provide a stable foundation for construction of permanent buildings, unless piles are driven through the solid waste into natural soils. A period of 10-15 years is necessary for natural settlement to occur due to decomposition and compaction[17].

6.6.7 Public Health Impacts

The current management of solid waste posses a serious threat to the majority of people within Dhaka. The major health concerns arising from decaying solid waste include:

i) Sanitation workers do not have protective covering of their hands and feet while collecting partially decomposed wastes from bins and collection centres. During the course of their work, they may become infected by pathogens. Diseases, especially infectious diseases, not only reduce labor productivity, but poses a threat to the health of other employees and the larger community.

   Sanitation workers employed in maintenance of roads, open spaces and markets, are exposed to air-borne contaminates on a habitual

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[16] This assumes that the material has not undergone decomposition or extensive compaction.

[17] "Housing Development Project", Final Feasibility Report. United Nations Centre for Human Services. October 1985.

basis. As a result, most of them suffer from respiratory diseases.[18]

ii) The manual and unofficial resource recovery operation from the collecting centres and dump sites of solid waste poses a serious health risk to the urban poor. Due to lack of awareness of the need for proper hygiene, they become prey to numerous pathogens and diseases[18].

iii) Decaying refuse, whether placed in a community bin or discarded along a street or drain ditch, poses a health risk to all urban dwellers. Infectious diseases can be spread by insects, birds and rodents which feed on the organic waste.

iv) Leachate from decaying refuse within the City contaminates surface water. It may also contaminate shallow wells located near existing and closed solid waste landfills.

6.6.8 Need for Education Programs

Increased public awareness, especially among the urban poor, is urgently needed regarding the adverse health impacts from contact with decaying solid waste. However, according to Health Services of Bangladesh, of the Health Education Bureau, extensive education programs of this type are not being conducted by the Government within the Greater Dhaka Area[19].

6.7 Recommended Strategies

6.7.1 Introduction

Future investment strategies should be developed with full consideration of the overall picture of solid waste generation, collection and disposal within the Greater Dhaka Area. This includes major issues related to current legislation, efficiency in collection and disposal, solid versus hazardous waste collection and disposal, environmental impact of current disposal techniques, health impacts, future capabilities based upon implementation of existing feasibility studies, the anticipated need for further expansion based upon continued high population growth, and future growth trends resulting from implementation of the Flood Protection Plan.

The present state of the solid waste collection and disposal system can be summarized as follows:

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[18] "Country Status on Solid Waste management in Bangladesh", Final Report. Bangladesh University of Engineering & Technology and the Department of Environmental Pollution Control. May 1989.

[19] The only program identified was the placement of 120 neon signs placed throughout Bangladesh and advertisements on television.

i) Current management practices lack efficient use of labor and vehicles. Vehicles stand idle for long periods of time due to repetitive handling of waste.

ii) Inefficient use of resources results in refuse being left on city streets for long periods of time. Ninety (90) percent of all slums and squatter settlements do not have any municipal solid waste collection.

iii) Solid waste is land filled using techniques which may contaminate surface and subsurface water, and pose a serious health risk to adjacent populations.

In the absence of: i) changes and improvements in management practices; ii) the imposition and enforcement of regulations; and iii) education programs targeted at all sectors of the population, with special emphasis on the urban poor; solid waste may pose an even greater threat to personal health, the quality of life, and future development of the City.

The following are recommended measures necessary to address these problems. They are grouped according to whether they are necessary to address immediate problems, or whether they should be components of a long term development plan. Some of the recommended actions related to policy and legislation are solely a Government responsibility, and should be initiated immediately to provide a strong foundation for future strategies and actions.

Those actions which are considered to be high priority and appropriate for inclusion in this proposed Dhaka Integrated Flood Protection Project are identified with an asterisk (*), and are included in the priority projects recommended in Chapter 10. Still other components, which may be no less important but which are not included in this project, may be considered for inclusion in other ongoing projects, or for inclusion in future projects with financing by others.

6.7.2 Short Term Measures

i) Develop Priorities for Solid Waste Management: DCC should develop a formal policy for collection and disposal of solid waste. Priorities should be established with both short-range and long-range goals. Emphasis should be given to the development of management techniques which will increase the service area and frequency of collection, and safe-guard the lives of sanitation workers, the general public and the environment. (National Government and DCC)

ii) Legislation: The Government of Bangladesh should establish national policies, strategies and administrative guidelines for solid waste management. Model legislation should be developed for adoption by local governments, specifying: i) standards for 'sanitary' collection and disposal of solid waste, ii) the types of waste that may be placed in a solid waste landfill, iii)

disposal options for hazardous waste materials, iv) guidelines for construction and operation of solid waste and hazardous waste landfills, and v) the minimum staffing requirements and the qualifications for management personnel. (National Government)

iii) Enforcement: The Department of Environment should be mandated to enforce legislation regarding the collection, transport and disposal of solid and hazardous waste. If a municipality or private party is found in violation, appropriate steps should be taken to correct this problem. Public officials should be held accountable for violations of environmental laws. (National Government and DOE)

iv) Improve Efficiency of Collection: A study is being conducted under the World Bank "Housing Development Project" to determine where inefficiencies in the present use of labor and vehicles occurs, and to determine additional equipment to be supplied under this same project. The recommendations of the study should be implemented as soon as possible to improve the efficiency of collection, and to extend service into areas where municipal collection presently does not occur. Additional needs for future improvements should be determined once the World Bank project is finalized. (DCC)

v) * Improve Local Collection of Solid Waste: Municipal service should be extended to include all slum and squatter areas, and other portions of the city which are presently not served or under-served. DCC should develop a criteria for the siting of new bins, with the primary objective being to improve the use of bins by the public. The resulting impact will be the reduction of refuse that is discarded, contributing to degradation of the local environment. The design of the bin should prevent the solid waste from coming in contact with water due to rainfall and surcharging of local stormwater ditches. (DCC)

vi) * Community Bin Rehabilitation: The following modifications to existing community bins should be implemented as necessary: i) the area around bins should be cleaned, ii) a concrete pad should be placed around the bin to improve appearance and maintenance, and iii) signs should be placed on or adjacent to the bin promoting sanitary disposal of refuse. (DCC)

vii) * Develop Operation and Maintenance Manual for Sanitary Landfills: Manuals should be written for the operation and maintenance of solid waste landfills. The guidelines contained within the manual should comply with the minimum standards established by the Government of Bangladesh. (DCC with assistance from DOE)

viii) * Training Program: A training program should be developed for management and technical personnel. The program should consist of orientation for new personnel, and periodic attendance at seminars

and classes in management techniques and new technology. This program could be developed for the entire country and perhaps integrated with training programs already developed in the region. (DCC with assistance from DOE)

ix) * Health: Municipal sanitation workers should be provided with suitable attire (i.e. gloves, clothing, protective shoes, and nose masks) as necessary to protect themselves from contact with decayed refuse and/or excessive air borne dust. A program of preventative health care should be established whereby physical examinations are conducted on a periodic basis. Employees should have access to affordable medical facilities when necessary. (DCC)

x) * Education: Programs are urgently needed to educate the public regarding the health hazards related to solid waste. This should be part of a larger program with the dual objectives of promoting personal hygiene and protection of the environment. A long term investment is needed to target both children and adults. Schools should integrate courses in health care into their general curriculum. Advertisements and signs should inform people of activities that are harmful to themselves and which degrade the environment. Special programs are needed to reach inhabitants of slum and squatter settlement. Programs should be coordinated with non-governmental agencies currently undertaking development programs to assist the urban poor. (National Government with assistance from aid agencies and organizations)

6.7.3 Medium and Long Term Measures

i) Development of a Long Term Development Strategy: A development strategy for solid waste management is urgently needed. The results should be incorporated into the preparation of a Land Use and Facilities Plan for the Greater Dhaka Area. Development of the strategy should be coordinated with RAJUK, DCC and all other government agencies involved with development. Input from the public should also be obtained via public hearings. All criteria within the strategy should adhere to minimum standards for collection and disposal for solid waste, as established by the Government of Bangladesh.

Periodic up-dating may be required to reflect the changing needs of the City. Amendments to the strategy should be conducted according to a formal procedure designed to promote coordination among all government agencies.

The strategy should include the following:

1. Zoning of Solid Waste Landfills: Land occupied by landfills should be zoned to permit future uses which are compatible with its prior use as a land fill. Restrictions should be placed upon immediate use for commercial and residential

development due to the problems resulting from excessive settlement and the production of gases. Zoning laws should be strictly enforced to prevent settlement by squatters.

Zones should be established around landfills, and areas known to contain contamination, which prohibit the development of wells that are not of sufficient depth and quality of construction so as to assure that contamination will not occur.

2. Organic Waste Reduction: Long term strategies should be developed for the reduction of the organic waste stream through recycling. Research should be conducted to examine the suitability of various technologies for the production of bio-gas and compost, and for development of commercially viable uses of compost.

3. Siting of New Landfills: Selection of potential sites for construction of sanitary landfills should be based upon criteria which will minimize their adverse impact upon adjacent populations and the environment. Some of the characteristics that should be considered include: i) its proximity to existing development, ii) the underlying soils, and iii) the groundwater hydrology.

4. Financial Plan: Estimates of anticipated revenue should be made based upon planned replacement of equipment and vehicles, and additional labor and equipment resulting from expansion of the service area. (DCC)

ii) * Monitor Leachate Movement From Landfills: The movement of leachate from closed landfills should be monitored and an assessment made regarding its impact upon water quality and the health of adjacent populations. In instances where leachate is discovered in surface or ground water, appropriate measures should be taken to inform the public, and mitigation measures should be implemented. (DCC and DOE)

7.0 SLUM AND SQUATTER AREA IMPROVEMENT

7.1 Introduction

As described in the Terms of Reference, the purpose of this section is to:

i) assess the impact of squatter settlements on environmental quality, including projections of the expected magnitude of the problem,

ii) evaluate the slum/squatter programs/projects in DMA, with special reference to environmental aspects,

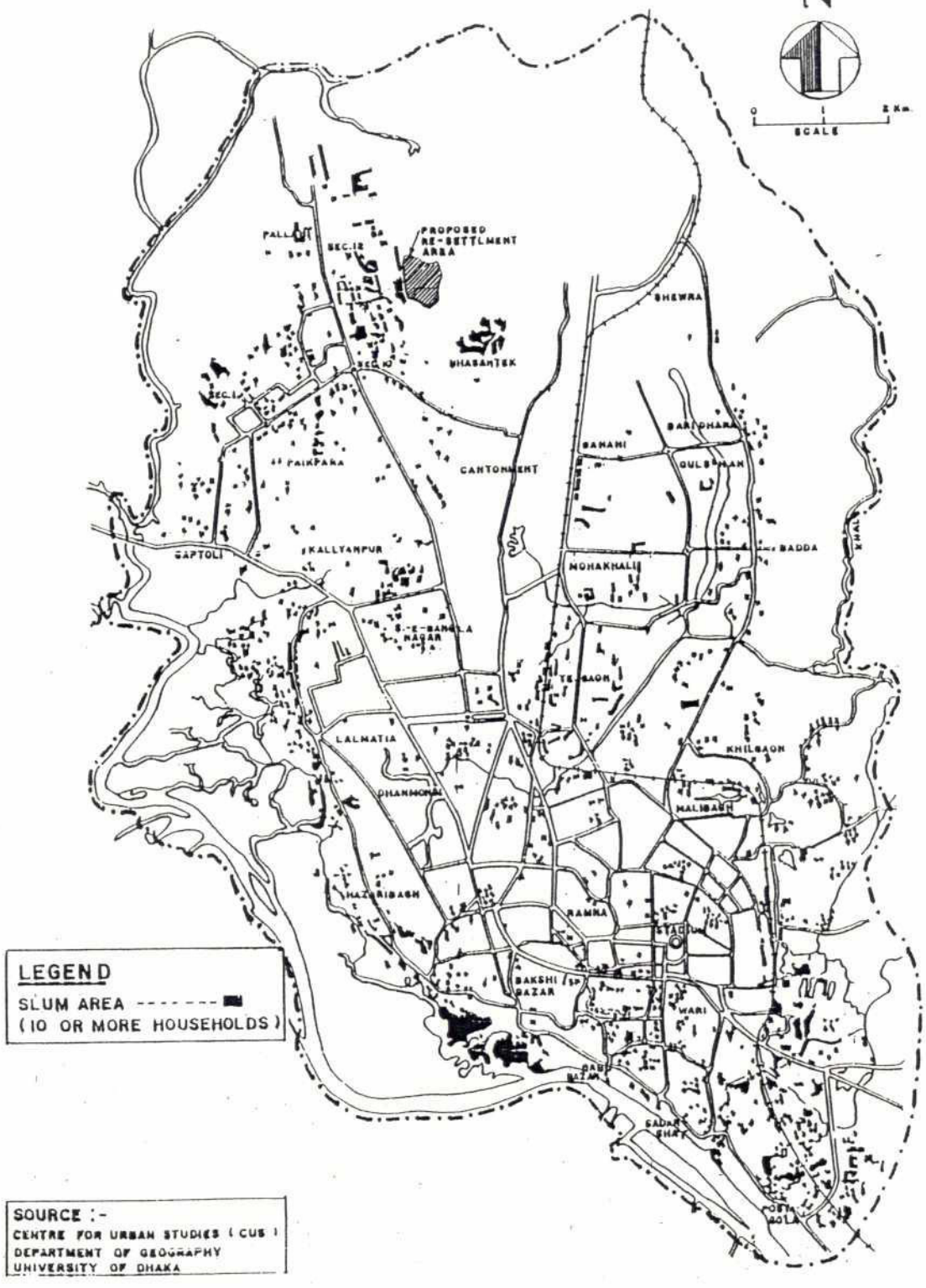
iii) recommend for slum/squatter area improvement measures for inclusion in the Integrated Plan, with emphasis on environmental health aspects.

7.2 Existing Situation

Within the last several years there has been a growing awareness that the problems of proliferating slum and squatter settlements in the urban areas are one of the more serious issues facing Bangladesh. It is estimated that about 25% of the total population of Dhaka live in slum and squatter areas. The extreme poverty, poor environmental conditions, and poor health conditions are not only a sociological problem, which must be addressed and resolved, but could also ultimately become an explosive political problem.

Several excellent studies have been undertaken over the last few years to identify the actual conditions of the urban poor and the extent of the problems. In 1986 the Bangladesh Bureau of Statistics undertook a "first of its kind" survey of the slums in Dhaka, Chittagong and Khulna to develop some bench mark statistics on housing, household facilities, population and economic aspects of the slum dwellers to provide a data base for planning remedial measures. In 1988 the Center for Urban Studies (CUS), on behalf of Dhaka Municipal Corporation (now DCC), undertook a comprehensive survey of a total of 1,125 slum and squatter settlements in Dhaka city comprising ten or more households, with a total surveyed population of 878,298 (see Figure 7.1).

In 1989 CUS, on behalf of UNICEF and the World Bank, undertook an expanded study to collate and analyze all available information on the urban poor, including their situation, the causes and prospects, forecasts of the magnitude of the problems, policies and programs to address the situation, and policy recommendations made by government, NGOs and others. Assistance for this study was provided by UNICEF, the World Bank, LGEB, Ford Foundation, UNDP, and BIDS, culminating in a comprehensive ten volume report, The Urban Poor in Bangladesh, in April 1990.



Dhaka Integrated Flood Protection Project ADB TA No. 1318-BAN Ministry of Irrigation, Water Development and Flood Control *Louis Berger International, Inc.* In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited. Technoconsult International Ltd.	FIGURE 7.1 EXISTING SLUM SETTLEMENTS IN DHAKA

Source: JICA INTERIM REPORT, GDPP, MARCH 1991

More recently, the Planning Commission established a Task Force on the Social Implications of Urbanization in Bangladesh which has reviewed the status and problems of urbanization in Bangladesh, based in part on the findings of the above referenced studies, and has recommended policies and actions for Government consideration. Their recommendations, which were tabled in February 1991, addressed the issues related to the conditions of the urban poor, and contained specific actions directed to poverty alleviation for the slum and squatter residents.

From these studies, it has been possible to derive an accurate picture of the current conditions of the slum and squatter settlements in Dhaka, and to determine the present and future needs. Based on the 1988 CUS survey, approximately 25% of the Dhaka population reside in slum and squatter settlements. This represents a current population of about 1.2 million people in 200,000 households. At the estimated present growth rate of about 5% per year for Dhaka, the slum and squatter population is increasing by at least 60,000 people, or 10,000 households, each year.

Slum settlements surveyed by CUS ranged in size from 10 households to over 500 households. It was found that the slum areas were scattered throughout all of Dhaka, generally in relatively small pockets. Although there are areas where over 5,000 people are clustered into larger slums, notably within the Mirpur area and in the Old City areas around Islambagh, Shaheed Nagar and Rasulpur, on average about 80% of the clusters were less than 1 acre in size, with average population densities of about 655 persons per acre (110 households). This conforms to the previous observation (Chapter 2) that 70% of the population has access to only 20% of the land. For housing, 29% (30,000 households) of the settlements were located on government or semi-government land (mainly squatters), while 67% was on private land and the remaining 3% on disputed land. 41% of the dwellers owned their own house, 49% were renters, and 10% were rent free. 90% of the housing was kutcha; 20% was in seriously deteriorated conditions.

The sanitation and environmental conditions within most of the slums are extremely poor. In summary, the conditions are as follow: (i) the best service is for water supply, where about 50% have access to municipal standpipes or their own connection, and 14% have access to community tubewells; the remaining 36% however rely on neighbors supplies, or on nearby ponds and streams, (ii) sanitation services are extremely poor; 87% of the population use community facilities, most of which are unsanitary kutcha latrines, and the remaining 13% either use others facilities or defecate in open spaces, (iii) 65% of the slums have poor drainage (affecting about 0.8 million people), of which 22% are regularly flooded during even minor rainfalls; 50% were totally inundated during the 1987 floods while 15% were partially flooded, and the situation was worse in the following year, (iv) 51% have no internal pathways, and 31% have very narrow paths, and (v) only 9% of the slum dwellers have any form of regular solid waste collection service; the remaining 91% (over 1.0 million people, generating about 100 tons of garbage per day) dispose of their garbage onto nearby low lands, vacant lots, roadside drains or khals.

As an inevitable result of these conditions, the living environment and general health of the slum and squatter residences in measurably worse than that of the urban population as a whole. The high rate of disposal of garbage and faeces into the immediate local environment of the slum areas, combined with the poor drainage conditions, lack of access to clean water supplies, and lack of access to proper health care services for a large portion of the population, renders the slum and squatter populations highly susceptible to disease. As noted in Chapter 4, the infant mortality rate is double that of the non-slum urban areas, the highest crude death rate is six times that of the non-slum areas, and at any given time 30% to 46% of the slum and squatter population is suffering from disease.

The effects of this are not restricted to the slum areas alone. The predominance of environmental pollution and of disease which affects 25% of the total city population poses a hazard to the entire city, not just the poor.

7.3 Ongoing and Proposed Programs

The Government is well aware of the problems, and in recent times has taken a number of positive steps towards developing effective solutions. In addition to establishing the Task Force noted above, they have undertaken a number of programs, both nation wide and in Dhaka, to attempt to resolve these issues.

Slum Improvement Project (SIP): One of the more notable programs which has been initiated on a national basis is the LGEB/UNDP Slum Improvement Project (SIP). Initially started in five Pourashavas in 1985, it was subsequently expanded in 1988 to a further 20 towns, including the four city corporations of Dhaka, Chittagong, Khulna and Rajshahi. Included in the LGEB/UNICEF model programs are modest infrastructural improvements to slum areas to provide basic services, including water supply (1 hand tube well/water connection per 10 families), sanitation (1 twin pit latrine per 3 families), footpath access and security lighting, improved drainage facilities and solid waste storage and collection services. It directly involves the Municipal authorities in the selection and development of the local programs, but one of the most significant aspects of the program is the high priority placed on motivation and community participation in the improvement works.

Selection of the slum areas for inclusion in the model program is restricted to those areas where security of tenure is guaranteed, and the slum dwellers are involved in the entire development process from the beginning of the project. Groups of ten households each are formed from within the beneficiaries, are trained in operation and maintenance of the infrastructure provided, and operate as a unit to receive further project benefits. Women are a specific target group, and funding is provided in the program for training, health care and support for income generating activities. Community health workers are selected from within the slum area to receive basic primary health and child care training, training in

income generating activities is provided for the female beneficiaries, and income generating loans are made available to the women within the groups. Operating on the Grameen Bank model, each group selects their own recipient for financial assistance, and when the initial loans are repaid select other recipients, in rotation, for further aid. NGO assistance is actively solicited for help in providing training for the slum dwellers and to assist in formulating education programs for the children.

In those towns where the SIP has been taken up, the model program has been very successful. The municipal authorities are the executing agencies, and are required to establish slum improvement cells staffed with qualified personnel to coordinate the program, assist in selection of appropriate areas for improvement, provide technical direction, and to motivate the beneficiaries. The start-up period for this program is slow, but it is designed to provide a lasting and sustainable development in the slum and squatter areas. Recently, the ADB has included components of the SIP in support of the LGEB/UNICEF project into its Secondary Towns Infrastructure Development Project, Bangladesh, which is scheduled to start in 10 Pourashavas this year.

In Dhaka, DCC is the designated implementing agency for the SIP. According to the Chief Slum Development Officer[1], a slum development unit with a staff of 87 employees was created to coordinate the LGEB/UNICEF slum improvement project, but has not yet been staffed due to administrative and financial problems within the City Corporation. Therefore, although Dhaka is included in the SIP, the project has not yet begun, and no time table has yet been set for starting this work.

Area Based Improvement Projects: In addition to the SIP, there are two area based improvement projects starting up in Dhaka which provide for integrated urban development with a strong focus on assistance for the low income and slum dweller groups.

Under the ADB financed Dhaka Urban Infrastructure Improvement Project, all urban services in about 520 ha. within the existing development area in Mirpur are being rehabilitated and upgraded, which will provide improved access to the basic services for all residents within the Project area (see Chapter 4).

Similarly, under the World Bank/UNDP financed Environmental Improvement Project, Dhaka, DCC is taking up an integrated urban development project within the Old City area, covering Islambagh, Shaheed Nagar and Rasulpur. Provision of basic services and facilities for the low income groups is one of the specific targets of the project (see Chapter 4).

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1 Paper presented at the Seminar on Urban Slum Development at NILG, April 23, 1991, organized by the District Urban Slum Development Committee of Rotary International.

NGOs and Service Organizations: There are a large number of NGO and service organizations in Dhaka who are providing support and assistance to selected slum and squatter areas. Typically, much of this support is modeled on providing education opportunities, community and health care services, income generating opportunities, and family planning services with an emphasis on promoting the welfare of the mother and child groups. Though the Consultant is not familiar with all the activities of the numerous NGOs and service organizations who are concerned with the welfare of the poor, there is a large opportunity to utilize the resources of this body of committed people in future development of slum improvement programs.

Other Government Agencies: Both DWASA and DPHE have a mandate to provide water and sanitation services to the Dhaka residents, with DWASA providing service to the developed urban core, and DPHE to the semi-rural fringe areas. Though they both have some involvement in providing services to the slum and squatter areas, this is very limited in scope. Both agencies are tied to developing approved projects within a defined annual budget, and neither has a specific focus on meeting the needs of the very poor.

7.4 Problems and Needs

As described in the preceding, the magnitude of the needs of the slum and squatter dwellers is almost overwhelming, and the actions taken up to now have not even begun to address these problems. It is widely accepted, as stated in the Task Force recommendations, that one of the first steps towards poverty alleviation is to provide access to the basic services of clean water, sanitation facilities and solid waste disposal to improve the environment and health conditions of the urban poor. This is not being done, and the very poor do not have the financial resources, the technical knowledge, the organizational skills nor the basic required education and understanding of the problems to be able to meet the needs themselves. Assistance from the Government bodies is essential and yet, with the exception of the ADB and World Bank financed integrated area development projects, there are no coordinated projects underway in Dhaka which begin to meet these needs. The SIP program, which the Consultant feels is one of the best models of its kind, has not even begun to start due to failure of the City Corporation to establish the slum development cell.

Despite the Government recognition of the need to provide assistance for the slum and squatter dwellers, none of the executing agencies in Dhaka have a priority on slum improvement programs address the problems. DWASA has clearly stated that they are aware of the need for a clean water supply for the low income residents, but advised that they do not have the financial resources to meet these needs. It has not been defined as a priority, and no program has been developed for extending services to this segment of the population. DCC has the mandate for taking up slum improvement projects, but has not yet set up its slum development cell to even start the SIP program. DCC also has the responsibility to provide

solid waste collection services to its residents, but for over 90% of the slum dwellers no service is available. Sanitation conditions in the slums are abysmal, and no agency is addressing these needs at all. Everyone recognizes the problems, nobody is acting, and the environmental and health conditions are continuing to degrade.

As stated at the closing session of the Rotary Club seminar on urban slum development: "We all know the problems and the urgency of the needs. It is time to stop talking about them, and to do something."

7.5 Recommended Strategies

It is clear that the Government has recognized the problems, the need for urgent actions to address them, and also the best ways to proceed to redress the situation, but for numerous reasons this recognition has not been translated into effective actions within Dhaka City. The individual agencies who are mandated to provide the needed services and are best qualified to initiate actions have not yet established slum and squatter area improvements as a major priority. Programs have not been developed and funding has not been arranged. This must be corrected, and action must start.

The following are recommended actions to be taken up to address the problems described in this section. Some of these have been previously stated in other sections, and are repeated here where applicable for slum improvement measures. Some of the recommended actions related to policy are solely a Government responsibility, and should be initiated immediately to provide a strong foundation for future strategies and actions. Those actions which are considered to be high priority and appropriate for inclusion in this proposed Dhaka Integrated Flood Protection Project are identified with an asterisk (*), and are included in the priority projects recommended in Chapter 11. Still other components, which may be no less important but which are not included in this project, may be considered for inclusion in other ongoing projects, or for inclusion in future projects with financing by others.

Short Term Measures:

i) Prepare and adopt a national policy for providing clear direction on urban development policies and strategies, and alleviation of urban poverty. It is recommended that the Report of the Task Force on Social Implications of Urban Poverty, February 1991, be used as a basis for this. (National Government)

ii) Issue clear directions to executing agencies identifying poverty alleviation programs as a high priority item, to be addressed by preparation of a long term strategy for identifying and meeting the needs. To be supported by providing adequate annual budgets for poverty alleviation measures. (Ministries)

iii) Set up and staff the DCC Slum Improvement Cell without delay; begin preparation work for implementing the LGEB/UNCHS SIP program. (DCC)

iv) * Provide additional support to complement and extend the LGEB/UNDP SIP program to a level sufficient to meet the needs of all slum and squatter areas within Dhaka where the dwellers meet the basic requirements for security of tenure and willingness to participate and to pay for a portion of the services provided. (DCC)

v) * Extend, on an urgent and priority basis, the basic water supply and sanitation services into those areas which do not meet the criteria for inclusion in the SIP program. Ensure access to clean water for all Dhaka residents, regardless of status or the right of tenure, through provision of communal standpipes or hand tubewells on nearby public property. Include these areas in the comprehensive low cost sanitation program recommended under Section 4.7.2 (DWASA for water; DCC for low cost sanitation)

vi) * Extend solid waste collection services into all areas covered under both the SIP program, and the urgent water and sanitation program area. Alternatively, provide community motivation and technical direction to assist slum dwellers and squatters in adopting local sanitary methods of solid waste disposal, such as composting or burying. (DCC)

vii) Ensure adequate allocation of adequate resources to meet the annual poverty alleviation program needs. (Executing Ministries, Ministry of Finance, Ministry of Planning)

Medium and Long Term Measures:

i) Review, approve and adopt physical planning and land use control legislation for effective control of land use and development. It is recommended that the previously prepared draft Physical Planning (Land Use) and Development Control Ordinance (UDD/UNCHS, 1985) be reviewed and adopted. (National Government)

ii) * Review Government land ownership and needs. Prepare a detailed inventory of all Government owned lands in Dhaka City, along with a detailed description of present use, future projected uses, and a statement of need for vacant or under utilized land. Based on the inventory, recommend appropriate Government policies and strategy for rationalization of the use of vacant and under utilized lands.

Consideration should be given in this evaluation to the potentials for disinvesting the lands, converting the lands for public use, converting the lands for use for low income residential use, or transferring/leasing/selling to squatters/settlers to provide long term security of tenure. (Planning Commission)

iii) Develop a strategic long term plan for land acquisition for provision of land for public use and for low income housing needs. Develop a phased schedule for advance provision of essential infrastructure to enable development to proceed in a planned manner. (RAJUK)

iv) Develop policies and strategies, including consideration of incentives, disincentives and regulatory methods, for promoting active private sector participation in providing serviced lands and/or affordable shelter for the low income segment of the population. (Planning Commission, UDD)

8.0 INDUSTRIAL, HAZARDOUS AND TOXIC MATERIALS AND WASTE MANAGEMENT

8.1 Introduction

As described in the Terms of Reference the purpose of this section, based on information provided by DOE, is to:

i) identify, classify and evaluate sources of toxic and hazardous chemical wastes in the study area;

ii) assess the adverse impacts of toxic and hazardous wastes;

iii) recommend alternative methods for waste treatment/recovery, and identify methods for collection, transport and handling;

iv) recommend policies and legislation for the control of importation, manufacture and distribution of toxic and hazardous chemical substances; and

v) prepare recommended programs for the control and management of hazardous and toxic wastes, including an appropriate monitoring system.

8.2 Background

The management of hazardous and toxic wastes and materials is a complex and difficult undertaking. Implementation of waste management guidelines and regulations is almost always controversial because of the divergent and contradictory environmental goals of developing nations. Simply stated, the primary environmental goals of the Government of Bangladesh are:

i) "to ensure long-term sustainable all around development of the country;"

ii) "to conserve the national heritage of Bangladesh in terms of both natural resources and quality of life;" and

iii) "to ensure a healthy and meaningful living environment for all citizens, including the poor and the prosperous."

Competition for resources continues to pit developers and industry against citizen's concerns to protect the environment and conserve resources for future generations. Industrialized nations are attracted to Bangladesh because of the availability of low cost labor and natural resources, but exploitation of both human resources and natural resources must be prevented. A developing nation can implement environmental policies, guidelines, and regulations which strike a balance between the conflicting goals of economic development, environmental protection, and competition for human and natural resources. However, these policies, guidelines and regulations must be carefully orchestrated to balance the concerns and

interests of the affected parties, to provide the desired minimum level of protection for human health and the environment, and to fairly and equitably distribute the cost of program implementation.

Economic development must not be discouraged in Bangladesh, but it must be tempered with sound environmental management. Continuing development must include effective management of human and natural resources, regulatory control of industrial, hazardous and toxic materials and wastes, and incentive programs to attract foreign industry.

Public health and the environment must be protected through effective regulatory control, land use planning, waste management, resource recovery/recycling, public awareness and education programs, and enforcement actions. A cooperative spirit should be fostered between development interests and environmental protection interests, but where conflicts arise, the environmental regulatory body must have the authority to enforce the regulations and mandate compliance.

Conservation of the Bangladesh national heritage may be accomplished through occupational health and safety controls, appropriate environmental regulatory control, and effective management of human and natural resources. The policies, guidelines and regulations which are developed and implemented must be developed with an eye towards providing an inheritance for future generations. Economic development comes at a price, and the price of development must be weighed against the benefits received. Regulatory control is the means which may be employed to provide the constraints on development which are needed to assure that the price of development does not outweigh the benefits.

The people of Bangladesh have always had a concern for the environment. This concern is deeply rooted in their historical, anthropological and socio-religious traditions, as evidenced by the Mauryan epigraphy, the Puthi calendars of Gengal, the sayings of Khana, the Quaran and the Hadith, and the value system of the Hindus. In recognition of the Government of Bangladesh's concern for the environment, 1990 was designated as "The Year of the Environment", and the 1990s as "The Decade of the Environment".

Notwithstanding a strong desire on the part of the Government of Bangladesh to provide the environmental management and leadership needed both for future development and rectification of existing environmental problems, it must be stated that environmental enforcement actions, remediation, and management are very expensive. Efforts have been undertaken to improve environmental management, including industrial, hazardous and toxic material and waste management. However, these efforts have been hampered by understaffing, inadequate funding, and lack of education and training. Numerous studies have been undertaken to assess and evaluate the problems, but the studies have yet to produce an adequate data base from which to assess the problem and begin to formulate a solution. Indeed, the entire process lacks the development of underlying policy or vision. Without said policy, it will be difficult, if not impossible, to develop a coherent set of regulations to deal with

industrial, hazardous and toxic waste and material management.

Environmental groups such as UBINIG (Policy Research for Development Alternative) and the Foreign Toxic Waste Resistance Committee have formed to address specific environmental problems which have come under public scrutiny. These groups may play an important role in promoting public awareness, but should not be placed in the role of developing policy or mandating enforcement actions.

Surveys of local industries have indicated a willingness to work with the Government of Bangladesh to resolve environmental issues. However, nearly all of the industries have expressed a common concern: equal enforcement and broad based implementation of new environmental laws. They understand that construction of wastewater treatment facilities, implementation of improved waste management practices, and redesign of processes to minimize waste and reduce toxicity levels will be expensive. Their concern is that the new environmental regulations will not be enforced equally between similar industries, thus creating an economic inequity. They state very simply that the implementation of the regulations must be equitable in order not to discourage fair competition between businesses both within the country and outside the country.

8.3 Standards and Regulations

8.3.1 Existing Policies, Guidelines and Regulations

The UBINIG paper on dumping of toxic wastes in Bangladesh summarizes the basis of environmental law in Bangladesh. The paper notes that "laws relating to environmental protection are not very strong." The paper points out that enforcement actions have only been undertaken against one party in the last decade, and that no punitive actions were undertaken in that case. In addition, the paper states that it is very difficult to obtain access to the environmental laws, which has led to a lack of understanding and awareness on the part of the public.

The basis for environmental law in Bangladesh was established during the period of British rule, with the enactment of the following laws:

i) Smoke Nuisance Act of 1905;

ii) Poisons Act of 1919;

iii) Mines Act of 1923; and the

iv) Forest Act of 1927.

Modern waste management activities were initiated through the Town Improvement Act of 1953. This act provided the basis for improvement and development of Dhaka City. The act provided development authority for water supply, sanitation, drainage and sewerage, parks and recreation, and the development of land use master plans.

The Directorate of Public Health Engineering was established in the middle 1950s. The Directorate oversaw the implementation of sanitation and sewerage projects in Dhaka City.

The Bangladesh Pure Foods Ordinance of 1959 provided regulatory control of food processing activities. The ordinance specifically prevented adulteration and preparation of foods which could be injurious to human health.

The Factories Act of 1965, Shops and Establishments Act of 1965, and Factories Rule of 1979 provided health and sanitation requirements for workers. These acts also provided an informal permitting requirement for new factories, requiring the permission of the Directorate of Health Services for disposal of wastes and effluents. Though these acts provided the basis for monitoring and control of industrial waste streams, in reality the acts have been largely ignored.

The Bengal Motor Vehicles Act of 1939 to 1983 provided legislation for noise abatement and control of vehicle emissions. Since enactment, road surveys have been conducted for more than 19,951 vehicles, and the DOE has taken punitive actions against more than 13,342 automobiles (as of December 1989).

The Agricultural Pesticides Ordinance of 1971 to 1983 provided control of manufacture, distribution and sales of pesticides. Impacts of the used of agricultural pesticides on receiving waters were not considered.

The Water Pollution Control Act of 1973 provided regulatory control over industrial discharges to drainage canals (Khals) and other surface water bodies. However, the act has not been effectively enforced, as witnessed by the large number of industries in Dhaka City discharging waste streams directly to open sewers, Khals, and surface-water bodies (lakes, streams and rivers).

The Pesticide Ordinance and Explosive Act were enacted in 1984. The Pesticide Ordinance provided control over formulation, manufacture, distribution, and sales of pesticides, augmenting the Agricultural Pesticides Ordinance of 1971 to 1983. The Explosive Act dealt with the manufacture, distribution, and sale of explosives.

As discussed in Section 4.4, the most comprehensive environmental legislation is The Environment Pollution Control Ordinance of 1977. This law led to the creation of the Department of Environment Pollution Control (DEPC) and the Environmental Pollution Control Board. The DEPC was subsequently renamed the Department of Environment (DOE). The ordinance provided the Director of the DOE with the power to enter premises for the purpose of inspection, order individuals, commerce or industry to adopt such measures as deemed necessary to prevent, control, or abate existing or potential pollution to the environment. Though the legislation provided broad powers to the Director, no statement of policy was

developed, qualitative and quantitative standards were not adopted, and the legislation was nearly impossible to enforce.

More stringent environmental legislation has been drafted in the form of the Draft Bangladesh Environment Preservation Ordinance of 1989. This draft ordinance greatly expands and increases the powers of the DOE. The draft ordinance addresses pollution of air, water, and soil, deals with noise pollution issues, and specifically addresses industrial, hazardous and toxic wastes. The draft ordinance not only provides the DOE with the powers to set standards for industrial waste effluents, it also clearly defines infractions and penalties, and provides the DOE with the authority to undertake remedial actions under a cost reimbursement program. This ordinance was recently reviewed by ADB consultants and is under consideration by the Government of Bangladesh.

Draft Environmental Quality Standards (DEQS) were developed by the DOE in August 1988. The DEQS provide quantitative standards for commercial and industrial discharges to water, air, soil, and municipal sewage treatment plant systems. These standards were developed based on a comprehensive review of similar standards in many other countries, and were judged to be economically viable for the present stage of development of Bangladesh. These standards are currently under consideration by the Government of Bangladesh.

In addition to the above legislation, the DOE has adopted guidelines for analysis of potential environmental impacts of new or proposed industrial or commercial development projects. These guidelines are modeled after ADB guidelines for infrastructure projects and include submittal of an Initial Environmental Examination (IEE) and an Environmental Impact Assessment (EIA). These assessments are intended to uncover potential adverse impacts on the environment so that the benefit of the project can be weighed relative to the environmental impact.

8.3.2 Discussion

The current status of environmental legislation in Bangladesh was summarized in a February 1991 DOE brief, which stated "Present enforcement of environmental protection and pollution control laws is almost non-existent due to ... inadequate legislation ... ." Efforts are underway to strengthen environmental legislation relating to industrial, hazardous and toxic wastes, but these efforts are painfully slow. In addition, and perhaps more importantly, the draft regulations lack a clear statement of policy, and are not nearly as comprehensive as are needed.

The proposed environmental quality standards are based on a review of standards in other countries, and not based on a clear understanding of potential impacts on environmental conditions in Bangladesh. A clear policy must be defined for establishment of environmental quality standards, which relates to public health and environmental issues in Bangladesh if effective standards are to be implemented now and in the future. However, the effort to establish policy and direction should not hamper implementation of the new environmental regulations and standards.

In the absence of policy, the proposed regulations and standards should be implemented as quickly as possible.

As discussed previously and addressed in Section 4, the draft regulations do not go far enough. These regulations should be expanded to deal with issues such as waste minimization, toxicity reduction, handling, collection and transport, storage (drums, tanks, containers, etc.), disposal of wastes, treatment and pretreatment of wastewater, remediation of existing contamination, permitting and registration of existing waste management units, discharge limitations of air, ground water, surface water, and sewage treatment systems, and monitoring of discharges, storage facilities, waste management facilities, and waste streams. In addition, issues such as occupational health and safety must be addressed.

A single government entity should be empowered to manage the environmental issues for the Government of Bangladesh. While these efforts must be coordinated, effective management of the program can only be realized if a lead department is designated. It is highly recommended that the DOE be designated as the lead environmental agency and that it be empowered to enforce all of the environmental regulations. These powers may be delegated to subordinate agencies, but the delegation should be controlled by the DOE. The DOE should also have the primary responsibility for training of the agencies and departments taking on the subordinated responsibility, and should provide oversight of those agencies and departments.

8.4 Studies and Programs

The following environmental studies have been undertaken in the recent past, or are currently in progress.

"Environmental Problems in Bangladesh: An NGO Perspective for Policies and Action," ADAB Environment Advisory Group, 1990.

"Socio-Economic Issues in Environment Management in Bangladesh," Dr. M Asaduzzaman, 1989.

"Major Environmental Problems of Bangladesh: An Overview," Mr. S. M. Al-Husainy, 1989.

"Strategic Plan for National Agricultural Research to the Year 2000," BARC, 1990.

"National Seminar on the Year of Environment: 1990," BARC and DOE, 1990.

"Environmental Aspects of Agricultural Development and Surface Water Systems of Bangladesh," Bangladesh Centre for Advanced Studies (BCAS), 1989.

"Study of Chakoria Sundarbans using Remote Sensing," A. M. Choudhury et. al., 1990.

"Environmental Profile: Bangladesh," Danida, 1989.

"Environmental Issues in Fisheries Development," Danida, 1989.

"National Conservation Strategy for Bangladesh," IUCN (BARC), 1989.

"Population Growth, Agricultural Production and Environmental Degradation," Dr. K. Khandakar, 1990.

"A Survey on Water Use, Sanitation and Personal Hygiene Awareness in Northern Bangladesh," Dr. A. H. M. Zehadul Karim, 1989.

"People and Environment in Bangladesh," A. Q. M. Mahbub, 1990.

"Environmental Sanitation in Bangladesh," NGO Forum, ADAB, 1990.

"Implications of Climatic Changes & the Impact of Rise in Sea Level in South Asian Seas," National Institute of Oceanography (Pakistan), 1990.

"Review of Studies on Shallow Tubewell Irrigation Management," S. Z. Sadeque & M. A. Hakim, 1989.

"The Environment & Development in Bangladesh (CIDA)," Wit Treygo and P. B. Dean, 1989.

"Bangladesh Environment and Natural Resource Assessment," World Resources Institute, 1990.

Ongoing programs for environmental management are discussed in Section 4.5. None of these ongoing programs specifically addresses the issue of industrial, hazardous, and toxic waste and material management.

8.5 Assessment of Existing Conditions

8.5.1 Summary of Existing Conditions

The Government of Bangladesh has undertaken a number of studies to identify potential sources of industrial waste pollution in air and water bodies. The DOE issued a notice on 5 June 1986 summarizing the "types of factories polluting the environment". The notice summarized a survey undertaken by the DOE to identify the types of industries in Bangladesh on a regional basis. The survey identified the following industries:

i) Tanneries (176 total, 87 in Greater Dhaka);

ii) Pulp and Paper Mills (5 total, 1 in Greater Dhaka);

iii) Sugar Mills (16 total, 4 in Greater Dhaka);

iv) Distilleries (3 total, none in Greater Dhaka);

v) Steel Mills (57 total, 30 in Greater Dhaka);

vi) Textile Mills (298 total, 166 in Greater Dhaka);

vii) Fertilizer Plant (5 total, 2 in Greater Dhaka);

viii) Pesticide/Insecticide Plants (25 total, 1 in Greater Dhaka);

ix) Chemical Industries (23 total, 18 in Greater Dhaka);

x) Jute Mills (92 total, 49 in Greater Dhaka);

xi) Cement Factories (3 total, none in Greater Dhaka);

xii) Rubber and Plastic Industries (34 total, 23 in Greater Dhaka); and

xiii) Pharmaceutical Industries (166 total, 106 in Greater Dhaka).

The February 1991 environmental brief by the DOE indicated that the DOE had surveyed a total of 6313 industrial units as of December 1989, and found that 2152 were polluting the environment to various degrees. In addition, the DOE has collected and analyzed a total of 9917 samples (as of December 1989) from 27 major rivers of the country and set up an informational data base. An additional 732 samples from 9 specific locations were collected and analyzed for GEMS.

8.5.2 Discussion

Notwithstanding the concerted effort by DOE to obtain data on the impact of industrial, hazardous, and toxic wastes on the environment, there are too few data to evaluate the impacts. A comprehensive, well-designed monitoring program is needed to establish the baseline environmental conditions so it is possible to evaluate the impact of the new regulations and waste management policies. In addition, data are needed to evaluate the impacts of existing conditions on the environment and human health, and to establish appropriate standards for effluent discharges and clean-up levels.

8.6 Assessment of Impacts

8.6.1 Summary of Impacts

The impacts of various industries on surface water have been monitored by the DOE, the Atomic Energy Centre (AEC), and other government agencies. Notwithstanding concerted efforts to obtain access to the DOE database, the Consultant was unable to do so.

The results of the AEC analyses are summarized by Khan. These analyses were performed between September 1988 and August 1989, and included 34 samples analyzed for heavy metals. Effluents from three industries were analyzed: (i) news print and white print paper mills; (ii) tanneries; and (iii) Urea fertilizer industries.

These data indicate the composition of the effluent, but without data on the corresponding rates of discharge, and the flow rates of the receiving streams it is not possible to determine the impacts of the effluent discharges on the environment. In addition, the data vary over more than two orders of magnitude for several constituents. This, combined with a lack of QA/QC analytical data makes it impossible to assess the validity of the data.

What is needed is a well designed monitoring and analysis program for industrial discharges to receiving waters. These analyses should be designed to monitor the characteristics of the effluent, and the impact of the effluent on the receiving waters. Effluent and surface water samples should be obtained at regular intervals from discrete sampling stations so the data are comparable over time. Field and Laboratory QA/QC and analytical requirements must be established. These data should be maintained in a statistical data base so that trends in the data can be identified and studied. Industries with solid waste management units and industries which handle or dispose of toxic wastes should also be required to monitor ground water impacts.

8.6.2 Remedial Action Programs

Based on available data, it is the Consultants' understanding that no remedial investigations have been conducted to date. An analysis was performed on the impact of the tanneries on surface-water quality. Based on this analysis the Government decided to shift the Hazaribagh tanneries out of Dhaka City.

There is a strong need for clear policy and clearly defined roles within the Government of Bangladesh to deal with environmental issues. The data collected to date have demonstrated that industries discharge potentially hazardous and toxic constituents to surface waters in Greater Dhaka. The impact of these discharges have not yet been sufficiently investigated to assess human health and environmental effects. This is unacceptable. The Government must develop a strategy for remedial investigations of industries which degrade surface-water and ground-water quality. Based on these studies, a time table and plan must be developed to remedy the problems.

8.6.3 Permitting

A quasi-permitting function currently exists in Bangladesh whereby a proposed industry must prepare an IEE and an EIA. Based on the DOE review of these documents, a Certificate of Acceptance or No Objection Certificate (NOC) is issued. However, there are no clearly defined requirements for acceptance or rejection of a proposed development on the basis of the IEE or EIA. A systematic permitting process must be developed with clearly defined requirements for acceptance or rejection, if the permitting process is to be fairly enforced.

The Government of Bangladesh received a request in 1988 to site an electrical plant adjacent to a caustic chlorine plant at Sitakundu,

Chittagong. The proposed plant was to generate electricity by incinerating industrial wastes from the USA. A four-member committee was appointed by the Ministry of Industries to study the proposal. The committee recommended against the siting of the facility in Bangladesh because the country was ill-equipped to handle the influx of hazardous industrial wastes.

The authority to assess the potential environmental impacts of the plant was usurped from the DOE and put in the hands of a panel appointed by the Ministry of Industries. If an effective environmental policy is to be established in Bangladesh, it must be managed by a single agency or department--the DOE. The DOE must have the authority to review siting and permit all industry which handles solid, hazardous, and toxic wastes and materials. This permitting process will provide the DOE with the opportunity to assess the potential impacts of the proposed industries and will assure that the industry installs the necessary treatment equipment to meet the discharge standards for air, water, soil, and sewage.

8.7 Institutional Responsibilities

At the present time, assessment of the impacts of industrial waste on surface water quality is being performed by DOE, DWASA, AEC, and the Department of Fisheries (DOF). Permitting is overseen by DOE, but in specific instances, responsibilities for permitting activities have been delegated to others by the Ministry of Industries. Other agencies that may be involved in monitoring or permitting activities include DCC, RAJUK, and the IPH.

DOE: The main objective of the DOE is to ensure, on a national level, the overall environmental protection and management of the environment. The primary responsibilities of the DOE with respect to industrial, hazardous, and toxic waste management include: (i) environmental assessments; (ii) monitoring of development; (iii) controlling and monitoring of industrial pollution; (iv) promoting environmental awareness through public information programs; and (v) assisting the Ministry of Environment and Forests on technical issues.

DOE programs include monitoring of the pollution levels of rivers and ground water used for human consumption, monitoring and analysis of surface water for pesticide residue and heavy metals (in collaboration with AEC and the Bangladesh Center for Advanced Studies), and analysis on request of water and wastewater samples which are brought to DOE laboratories by others.

DOE has analytical laboratories attached to each of its four divisional offices, one of which is located in Dhaka.

DWASA: DWASA is responsible for the operation and maintenance of the municipal water supply system, the municipal sewerage collection network and Pagla Treatment Plant, and the major storm drainage and Khal system within Dhaka. DWASA established an analytical laboratory in 1963 for

control and monitoring of their own operations, in conjunction with the formation of DWASA as the water and wastewater utility of Dhaka City.

DCC: DCC is empowered to undertake a wide range of urban functions, including road construction and maintenance, surface-water drainage, the construction and management of parks and markets, solid waste collection and disposal, public health and sanitation, street lighting and traffic management, and slum improvement projects.

In practice, much of DCC's work is involved in operating and maintaining existing infrastructure and services. DCC does not issue permits for the construction of new sewage disposal systems or new connections to the municipal sewage collection system. Although it is DCC's mandate to control sewage and other health related activities which may be detrimental to the city environment, in practice DCC has limited staff and little involvement in control activities.

RAJUK: RAJUK is responsible for approval of all new developments within the Greater Dhaka Area. Capital improvement projects are undertaken primarily by RAJUK, except for water supply, sewage and drainage sector works, which are managed by DWASA.

8.8 Problems and Needs

As discussed in the preceding sections, the problems and needs of industrial, hazardous, and toxic waste and material management are severe. Ongoing discharge of hazardous waste and toxic waste constituents to open sewers, the municipal sewage system, and surface waters constitutes a clear and present danger to the public health and the environment. A comprehensive program to deal with these problems must be established in the short-term.

8.8.1 Program Management

The management of industrial, hazardous, and toxic wastes and materials lacks direction and focus. A clear national policy for environmental management has not been developed. Program development and legislative controls lack continuity and direction because of the lack of national policy.

Management of a national environmental program requires well trained, highly educated individuals. Coordinated management is imperative if a fair and equitable program is to be established. It is imperative that a single department be given total management control over the environmental programs of the Government. This department should establish the basis for a coordinated national policy, upon which all legislative controls developed in the future will be based. It is highly recommended that DOE be given the mandate to develop the national environmental policy, and that they develop legislative controls consistent with that national policy. Implementation of the environmental programs may be delegated to other departments or agencies, but the overall responsibility for the program should rest with the DOE.

8.8.2 Legislation

The current environmental legislation is totally inadequate for the control of industrial, hazardous, and toxic wastes and materials. No distinction is made between municipal wastes and other special waste materials. There are no enforceable permitting requirements for new facilities, and there are no enforceable operating requirements for existing facilities.

Draft regulations are proposed for waste management, but these regulations do not go far enough for industrial, hazardous, and toxic waste management. These regulations should be expanded to deal with issues such as waste minimization, toxicity reduction, handling, collection and transport, storage (drums, tanks, containers, etc.), disposal of wastes, treatment and pretreatment of wastewater, special wastes (ash, medical waste, contaminated soils, sludge, etc.), remediation of existing contamination, permitting and registration of existing waste management units, discharge limitations for air, ground water, surface water, and sewage treatment systems, and monitoring of discharges, storage facilities, waste management facilities, and waste streams. In addition, issues such as occupational health and safety must be addressed.

While it is possible to model these programs after existing programs in other nations, it is highly recommended that the following actions be taken:

i) Adopt the draft environmental regulations and standards as presently constituted.

ii) Prepare a national environmental policy consistent with the environmental goals previously stated.

iii) Redraft the environmental regulations and standards to be consistent with the national policy.

iv) Incorporate regulations for waste minimization, toxicity reduction, handling, collection and transport, storage (drums, tanks, containers, etc.), disposal of wastes, treatment and pretreatment of wastewater, special wastes (ash, medical waste, contaminated soils, sludge, etc.), remediation of existing contamination, permitting and registration of existing waste management units, discharge limitations for air, ground water, surface water, and sewage treatment systems, and monitoring of discharges, storage facilities, waste management facilities, and waste streams. Address occupational health and safety issues.

8.8.3 Remediation

Numerous studies have been conducted to date to assess the impacts of industry on water quality, public health, and the environment. These studies have clearly shown that the industries in Dhaka and Bangladesh have adversely impacted water quality. While adverse health impacts and

environmental damage are suspected, none of the studies provides enough data to analyze the impacts.

In order to address the impacts of existing industry on public health and the environment, the following steps must by taken:

i) Develop permitting requirements for existing facilities.

ii) Require existing industries to submit permit applications for all discharges to air, water, soil, and sewer. These permit applications should include a requirement for an environmental impact assessment.

iii) Require existing industries to submit process drawings for storage and handling of all hazardous and toxic materials and wastes.

iv) Develop guidelines for review of permits, and assessment of remediation requirements.

v) Develop effluent standards consistent with a national environmental policy. Require existing industry to upgrade capabilities to meet those requirements within a specified period of time.

vi) Develop guidelines for remedial investigations and remedial designs.

vii) Develop a national plan for enforcement and cost recovery actions.

8.8.4 Siting/Permitting

Siting and permitting of industrial facilities are currently controlled by several government bodies, including RAJUK and the Ministry of Industries. Fragmented control of environmental assessment and analysis has led to uneven analysis and implementation. In addition, there are no formal permitting requirements or permitting fees required for waste management units.

As stated previously, the environmental aspects of siting and permitting functions must come under the purview of the DOE. This will assure that permit reviewers are adequately trained and educated to assess the environmental issues, and will ultimately lead to more effective enforcement. Formal permitting and permit review requirements must be legislated. Permitting fees should be assessed and should be adequate to cover the government's cost of the review process.

8.8.5 Monitoring and Inspection

The monitoring and inspection programs undertaken to date are totally inadequate. They do not allow analysis of impacts of existing industries on public health and the environment.

A comprehensive monitoring and inspection program must be initiated as quickly as possible. This program should included requirements for self

monitoring and reporting on the part of the individual industries, and inspection monitoring on the part of the DOE and its designates to determine compliance. Monitoring should encompass air, surface water, ground water, soil, waste materials, raw materials, and sewage discharges. All points of discharge from each industry should be permitted, monitored and inspected.

Guidelines for monitoring and inspection should be developed on a priority basis. Data should be stored in a statistical data base which can be used to evaluate compliance, and trends in the data. Monitoring should include key constituents identified in the permit application (flowrates, volumes, etc.).

8.9 Recommended Strategies

8.9.1 Introduction

Future strategies for the management of industrial, hazardous, and toxic wastes and materials must be developed in concert with other waste management considerations, as discussed in Section 4. This includes both the assessment and analysis of impacts of existing industries on public health and the environment, and the development of permitting requirements for future industrial development.

The present state of industrial, hazardous, and toxic waste and material management in Dhaka can be summarized as follows:

i) A clearly defined national policy for management of industrial, hazardous, and toxic wastes and materials does not exist.

ii) Enforcement actions against known polluters are non existent.

iii) Impacts of industrial discharges on public health and the environment are unknown.

iv) Industrial discharges to the existing sewage systems are unregulated, and could upset treatment processes.

v) Most industries discharge directly to surface water and open sewers.

vi) Environmental management and enforcement is spread between several agencies.

vii) Existing legislation is not extensive enough and must be expanded.

viii) Only draft environmental standards exist for discharges.

ix) There are no formal permitting requirements.

x) There are no guidelines for monitoring and inspection.

xi) There are no guidelines for sampling and analysis.

xii) Remediation of existing contamination has not yet been initiated at any level.

xiii) Cost reimbursement and enforcement guidelines and rules have not been developed.

xiv) There exists a concern on the part of existing industry that enforcement actions will be unequally applied, giving certain industries economic advantages over other industries, both within and outside the country.

8.9.2 Recommended Strategies

In order to address the situation, the government must recognize the seriousness of the situation and adopt a comprehensive national environmental policy. This policy must be consistent with the national environmental goals:

i) Promote economic development;

ii) Protect human health and the environment; and

iii) Preserve the cultural heritage through protection of human and natural resources.

In order to achieve these goals, the following recommendations are made.

Short-Term Measures:

i) Prepare and adopt a clear national policy to deal with environmental issues, including industrial, hazardous, and toxic waste management.

ii) Designate a single department as the manager of the environmental programs of the country. Establish formal requirements for delegation of responsibilities to other government departments and agencies.

iii) Adopt the draft environmental regulations and standards as constituted.

iv) Begin modification of existing and draft legislation to be consistent with the national environmental policy.

v) Establish a comprehensive monitoring and inspection program for existing industry.

vi) Develop guidelines for monitoring, inspection, testing, and analysis.

vii) Establish a national permitting program for both existing and proposed facilities.

viii) Address siting issues through the DOE.

ix) Establish permitting fees which cover the cost of government review of permit applications.

x) Require environmental impact assessments as a part of the permitting process.

xi) Require existing industry to submit permit applications for all points of discharge from their facilities.

xii) Evaluate the impacts of existing industry on public health and the environment.

Long-Term Measures:

i) Establish an effective public education and awareness program with regard to industrial, hazardous, and toxic wastes.

ii) Implement waste reduction and toxicity reduction methods on a national basis.

iii) Continue long-term monitoring and inspection programs and implement a statistical database.

iv) Implement regular monitoring and reporting requirements to be undertaken be industry.

v) Develop discharge standards for air, surface water, ground water, soil, and sewage which are consistent with the national environmental policy. These standards should be toxicity based or risk based, and should be designed from the monitoring database for the area.

vi) Establish national guidelines for laboratory analysis, sampling, remediation, and preparation of environmental impact assessments.

vii) Upgrade the qualifications and education of the staff through a comprehensive long range plan of hiring, short-courses, on-the-job training, and education release programs.

9.0 INSTITUTIONAL CONTROLS AND RESPONSIBILITIES

9.1 Introduction

As set forth in the Terms of Reference, the purpose of this section is to:

i) review environmental considerations in the planning and decision making activities of the various Government of Bangladesh agencies involved in DMA flood control, infrastructure and land use planning which significantly affect environment, including review of specific attention given to environmental aspects in existing/ongoing studies; and

ii) review and assess the present arrangements for institutionalizing integration of environmental factors in planning/decision making in the DMA area and measures for its strengthening.

9.2 Overview

The primary control of environmental issues in Greater Dhaka is undertaken by BWDB, DWASA, DOE, DCC, and the DOF. Permitting requirements are none existent for waste management units. Agencies which have been involved in monitoring of surface water, industrial effluent, and ground water include the aforementioned, AEC and the Bangladesh Center for Advanced Studies. Siting of new industries which include processes that could be potentially harmful to the environment has been evaluated by DOE, RAJUK, and the Ministry of Industries.

Institutional controls and requirements are addressed in the individual sections discussing the relevant environmental issues. A summary of the discussions of institutional controls follows:

i) Land Use Management - Section 2.3;

ii) Flood Control and Drainage - Section 3.2.4;

iii) Water Quality, Sewerage, and Excreta - Section 4.3;

iv) Water Supply, Section 5.3;

v) Solid Waste, Section 6.3;

vi) Slum and Squatter Area Improvement, Section 7.2; and

vii) Industrial, Hazardous, and Toxic Wastes and Materials - Section 8.7.

9.3 Problems and Needs

The problems and needs relating to institutional control of environmental issues is immense. These problems are discussed individually in the text, but several global problems and needs have been identified. These global problems and needs are discussed below.

i) Environmental management in Bangladesh lacks direction and focus. A clear national environmental policy has never been developed. Program development, legislative controls, and institutional controls lack continuity and direction because of the lack of national environmental policy.

ii) Legislative control of environmental issues is widely dispersed between several departments and agencies of the government. This has led to uneven enforcement, varying siting requirements, and a general lack of direction.

iii) The government agencies are underfunded, understaffed, inadequately educated, and inadequately trained.

iv) Existing monitoring programs have not adequately assessed the impact of development and existing facilities on public health and the environment.

v) Existing environmental regulations are weak, incomplete, and unenforceable.

vi) Proposed environmental regulations and standards have not been legislated.

vii) Notwithstanding the bulk of data demonstrating the deleterious effects of existing waste management practices on water quality, human health, and the environment, remedial actions have not been implemented.

9.4 Recommended Strategies

The recommended strategies for each of the environmental issues discussed in the report are included in each of the sections. However, several global institutional issues have been identified and are listed below.

i) The Government of Bangladesh must recognize the seriousness of the environmental situation and take appropriate actions.

ii) A national environmental policy must be developed to deal with the preponderance of environmental issues discussed herein. This policy will form the basis for development of future regulatory controls, guidelines, and institutional controls.

iii) The Central Government must delegate the responsibility and authority of environmental management to a single department or agency. Strict controls for delegation of responsibilities to other qualified departments and agencies must be closely managed and formally controlled.

iv) The technical capabilities of the individuals having the responsibility of permit review and environmental management must be upgraded through a process of training, education, and recruiting of qualified personnel.

v) National pollution control standards and guidelines must be developed and legislated for monitoring, inspection, testing, and analysis.

vi) A coordinated and well defined national environmental monitoring program must be initiated as quickly as possible.

vii) Remedial activities should be undertaken on facilities which impact the public health and the environment. Appropriate standards must be developed, and all private and public industries required to conform to these standards within a defined time frame. Where municipal facilities are provided for waste collection and treatment, charges appropriate to the costs should be equitably applied to the users.

viii) The draft environmental regulations and standards should be legislated as soon as possible.

10.0 PRIORITY INVESTMENT PROGRAM

10.1 Introduction

As is apparent from the discussions in the preceding Sections of this report, the overall needs in Dhaka City for flood protection, drainage, service improvements and environmental improvements are so large that it will take years to meet the needs, the full cooperation of all agencies, and virtually unlimited resources. In order to ensure that the long term needs of Dhaka city are met, and indeed those of all urban areas in Bangladesh, major policy decisions on land management and environmentally related issues will have to be taken by the Government to provide clear direction and strategies for the various executing agencies. Coordinated actions will be required at all levels to achieve lasting results.

The project components which are described in this report and which will be ultimately selected for detailed feasibility study and implementation will be constrained only by the financial resources available from both the donor and Government sides, and not by the needs.

Based on preliminary estimates, the base cost (not including price contingencies) for the minimum cost recommended flood control and drainage scheme (referred to as PLan G in Chapter 3) will be approximately Tk. 4,163 million ($115 million), of which Tk. 1,595 million ($44 million) will be for land acquisition. This will provide for rehabilitation and completion of the "Phase 1" embankments and walls, plus completion of internal drainage, sluices and pump stations. It will complete the flood control/drainage scheme for about 146 sq. km. of the most densely inhabited western half of the city, covering about 87% of the city population, and provide protection against flooding equivalent to about the 50 year recurrence interval.

The cost of providing a full flood control and protection scheme which would cover all of Dhaka city, as was originally contemplated in the preliminary stages of Project formulation, has now been estimated at Tk. 14,837 million ($412 million), of which about Tk. 5,228 million ($145 million) would be required for land acquisition (Plan A). This would provide protection to the full recommended 100 year flood stage recurrence interval, and would include all complementary main drain improvements, sluices and pump stations in accordance with the design criteria recommended in the JICA Master Plan study. Other alternatives range between these limits, as summarized in Chapter 3, Table 3.4.

For selection of components from the complementary environmental improvement programs described in Chapters 2, 4, 5, 6, 7 and 8 (water and water quality, sanitation, solid waste management, hazardous and toxic waste management, slum and squatter area upgrading, land use management, etc.) it is concluded that the needs and demands will, in all probability, far surpass the funding likely to be provided under this project alone. Accordingly, final selection during the feasibility stage will have to be made based on agreed priorities and consideration of benefits.

The actions recommended in this report are complementary to each other, and reinforce their effects. Other aid/donor agency assistance should therefore be actively solicited for taking up of those components which can not be included in this ADB project.

The actions which have been identified in this report as being necessary to be done by the Government for policy preparation and development/ approval of appropriate legislation must be done on an urgent basis. Attention needs to be focused on priority issues of urban development and environmental protection and control, clear directions provided for the executing agencies, and necessary powers delegated to them for effective actions.

10.2 Flood Control and Drainage

The rehabilitation and completion of the westerly embankment/flood wall scheme is recommended to have the highest priority over extending improvements to the easterly zone. At present, approximately 37% of the existing embankment is unstable and potentially subject to failure, and over 16% is potentially subject to catastrophic failure. This is potentially a life threatening situation for thousands of people in lowlying areas who may have a false sense of security, and for whom failure would mean sudden inundation rather than the past slow and predictable rise of flood waters. The flood protection scheme must not be made operative until remedial measures are completed.

Effective FC&D programs are one of the highest priority items for improving the security and health of Dhaka residents. This is especially true for the low income groups and slum dwellers who live in areas of highest risk, and of whom 66% are reported to be regularly affected by floods.

Similarly, in order for these programs to be effective, they must be integrated with each other. Flood control works alone without accompanying drainage improvements, sluices and pump stations are ineffective, and possibly detrimental.

Descriptions of the problems, needs and recommended strategies for completion of the entire flood control and drainage scheme for Dhaka are provided in detail in Chapter 3. For the current situation in Dhaka, the highest priority zone for a phased protection scheme is the westerly "Phase 1" area of 146 sq. km., with 87% of the population. For subsequent phase considerations, priorities should be sequentially assigned to East Area B, East Area A, and East Area C respectively (see Figures in Appendix B), considering the population and properties at risk and the benefits to be derived.

10.3 Complementary Environmental Improvement Programs

In Chapters 2, 4, 5, 6, 7, 8, of this report, the existing situation, problems, needs and recommended strategies for complementary activities are presented by sector for: (i) land use management, (ii) water quality, sewerage and excreta management, (iii) water supply, (iv) solid waste management, (v) slum and squatter area improvement, and (vi) industrial, hazardous and toxic materials and waste management, as set out in the Terms of Reference. The recommended programs are, however, complementary to each other, and overlapping.

Ideally, all recommended actions should be taken up. However, the scale of all the needs to solve todays problems is so great that the resources available under this Project will determine the amount of work actually taken up for study and implementation. Therefore, the size of the program, and the components selected, will be dependant on the amount of financing available, and on priorities agreed between the Bank and Government.

For final selection of the components for further feasibility analysis, it is recommended that priority be given to those elements which: (i) in the short term, will provide the greatest benefit to the low income and poor groups at the least cost, (ii) are complementary to each other, and serve to reinforce their impacts, (iii) are not reliant upon major institutional changes or Government actions for successful implementation, (iv) do not duplicate ongoing programs, and (v) provide a foundation for promoting lasting environmental improvements for Dhaka in the long term.

Based on this, it is recommended that priority for investment projects be given to: (i) extending access to clean water supplies to all residents in Dhaka, irrespective of their status or whether they have legal tenure, (ii) developing a comprehensive low cost sanitation program to reduce/eliminate disposal of human wastes in the environment, (iii) developing a comprehensive slum improvement program for all slum areas where there is security of tenure, modeled on the ongoing LGEB/UNICEF programs, (iv) promote improved handling and local storage of solid wastes to reduce the intrusion of wastes into the local environment, the drainage systems and the surface water bodies.

For complementary support programs, it is recommended that support be provided to: (i) DOE to assist in undertaking a short term pollution study to evaluate the most serious zones/point sources of pollution and develop strategies to address these, (ii) DOE to develop a routine water quality monitoring program for evaluating the impacts of the improvement program, early identification of potential new problems, and informing/warning the public about the Dhaka situation, and (iii) DWASA to undertake a comprehensive door-to-door consumer survey to assist in identifying serious point sources of pollution and to provide base line data for developing strategies for improvements in efficiencies, service and revenues.

11.0 MAJOR ENVIRONMENTAL IMPACTS OF FLOOD CONTROL AND DRAINAGE

11.1 Introduction

This section will be used as a preliminary Environmental Impact Assessment (EIA) in accordance with ADB guidelines[1]. A Progress Environmental Impact Assessment (PEIA) had been previously prepared by the Department of Environment (DOE) with outside consultant assistance[2] as part of the National Environmental Monitoring and Pollution Control Project (NEMPCP). This identified a number of significant environmental impacts (SEI) but clearly indicated that it could not resolve all the salient environmental issues in detail. As agreed with ADB, this report builds upon the PEIA for evaluating the major environmental impacts. While this does not resolve all the salient environmental issues, it does indicate the further studies necessary for their resolution in the form of recommendations for each concern which is discussed.

As indicated in the Inception Report, a number of additional SEIs have been identified and are discussed in this section.

This EIA format follows that of the PEIA which identified the following SEIs:

- Integrity of design and construction for dikes/walls
- Dike routing/location
- Severance problems
- Resettlement
- City drainage systems
- City sewerage system
- In-city flood level control/economic evaluation
- Interference with utilities/traffic
- The need for O & M

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1 Environmental Guidelines for Selected Infrastructure Projects, Office of the Environment, Asian Development Bank, 1990

2 Progress Environmental Impact Assessment (EIA) for Dhaka Flood Protection Project (DFPP), The Government of the People's Republic of Bangladesh, Department of Environment, July 1990

The Consultant's Inception Report indicated the following further potential impacts which should be addressed:

- o Impacts on agriculture
- o Migration of population to protected areas
- o Interference with commercial waterways
- o Impacts on public health

11.2 Assessment of Impacts

11.2.1 Integrity of Design and Construction for Dikes/Walls

Description: As indicated in the Inception Report, the Consultant agrees with the concerns expressed in the PEIA that the integrity of the design and construction of the existing Phase I dikes and walls is questionable, and these problems are addressed in other sections of this report. The Consultant is recommending improvements in the design and construction of future dikes and walls, as well as the repair or replacement of those which have been built as necessary to ensure their safety. This should assure a high standard of integrity for the system as a whole.

However, no design or construction method can be entirely free of risk of collapse of a dike or wall. While foundation investigations and analyses are not complete at the time of writing, there is an understanding that soil conditions are poor, both for the embankment foundation and for the supply of construction materials. The integrity of the design is also largely dependent on adequate inspection and maintenance during the operational life of the system. Maintenance of infrastructure is a major problem in Bangladesh, as in other developing countries, and therefore the potential for failure through lack of maintenance must be considered.

A dike breach followed by flooding is likely to have much greater impacts and cause a much higher level of property damage and loss of life than annual flooding. Annual flooding is, by its name, a yearly occurrence to which the people of Bangladesh have accommodated since this deltaic region was originally populated. The rise of floodwater is relatively slow and predictable giving people adequate time to move onto high ground. The extent of flooding is known and residences are placed on higher ground. Only in exceptional years, such as 1987 and 1988, is there significant loss or damage.

A dike breach will, on the other hand, be sudden and unexpected and people will not have time to move out of the way of the subsequent flood wave. The existence of the flood protection system will give a sense of security and is likely to induce people to build in low lands unless strict controls are implemented. This will particularly apply to slum dwellers and squatters who tend to locate at will. It is noted that 65.8 percent of

the slums where either totally or partially inundated in the 1987 floods[3].

Engineering studies currently under way will determine the requirements for the safe design and operation of dikes and walls. Given the highest standards of engineering design and maintenance, the safety of the dikes will be limited by local soil conditions, available construction materials, construction standards and controls, and cost considerations.

Further studies are being undertaken to limit the area of flooding in the event of a dike breach by compartmentalizing the protected area such that only a proportion of the total protected area will be flooded in the event of a breach. As these studies have not been completed there is no way of undertaking a risk assessment of either the probability of a dike or wall breach or the extent of impact it would have.

Bangladesh has a developed emergency management system to deal with flooding and cyclones. However, both these types of disaster can be predicted from weather data and therefore action taken to precede them. Excepting that it will be limited to a period of high water, a dike failure may be sudden and come without warning, requiring a different approach to emergency management.

Recommendations:

1. Risk Assessment: As part of the feasibility study/design of the total system a risk assessment of failure of a dike or wall should be undertaken taking into account the engineering design of the dikes and walls, soil conditions, construction standards and failure through inadequate inspection or maintenance.

2. Hydrological Study: A hydrological study should be undertaken of flooding in the event of a dike or wall failure indicating the extent of flooding from failures in different areas, the depth of water for the 100 and 10 year floods. Floodwater curves should be developed to show time to maximum flood level after a breach under alternative scenarios.

3. Assessment of Damage Potential: An assessment of the damage potential from dike or wall breaches should be made based on the hydrological study. This should take the potential loss of life as well as property damage into account. It should pay particular attention to facilities such as schools, hospitals, nursing homes and other institutions with a relatively immobile population within the flood plain. This assessment should take into account existing conditions, projected conditions without land use controls and projected conditions with land use controls. The risk of a dam breach multiplied by the estimated value of damage should be taken into consideration in the benefit/cost calculations.

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[3] Report of the Task Force on Social Implications of Urbanization, Planning Commission, People's Republic of Bangladesh, February 1991

4. Review of Engineering Design to Minimize Damage: After the assessment has been completed the engineering design should be reviewed to see whether it is feasible to reduce the exposure to property damage and loss of life by modifications to either the design of key sections of the walls and dikes or by further compartmentalizing the protected area to limit the extent of flooding from a breach.

5. Development of Land Use Controls: Land use controls should be developed including zoning regulations leading to progressive and controlled expansion of urban development, site development controls, including minimum road, lot and plinth elevations.

6. Preparation of an Emergency Management Plan: Prior to putting the flood protection system into operation an emergency management plan should be prepared under Plan Component FAP-11 (Flood Disaster Preparedness Program) including:

- Detailed maps of the flood plains and floodwater curves.

- Detailed descriptions of the responsible agencies to signal an actual or potential dike or wall breach, to give the signal for emergency action including the evacuation of threatened areas, to coordinate evacuation and to breach repairs.

- A detailed description of emergency conditions, e.g.:

  a) Actual dike or wall breach leading to immediate implementation of the emergency response plan including a signal to evacuate effected areas (in practice the potential for loss of life will be high at this point).

  b) Likely dike or wall failure, due to the identification of a condition leading to a probable failure which warrants the implementation of the full emergency response plan including evacuation of affected populations. (A review of the history of failures of earth dams indicates that in some cases failures occur without warning, in others there is warning but too great a confidence that the situation is under control until there is a sudden failure. For still others, a condition leading to failure was noted early enough to take appropriate action.)

  c) Possible dike or wall failure, due to the identification of a condition which could lead to a failure if it gets out of control leading to all emergency management services being put on full alert and the evacuation of immobile populations.

  d) Warning conditions where a problem has been identified but is currently under full control leading to putting the emergency services in a state of readiness and ensuring that all emergency communication systems are operating effectively. An impending flood of greater than a certain level, say a 10 year

flood, might be a signal for declaring a warning condition, making a special inspection of the walls and dikes, blocking all openings, checking and mobilizing equipment, materials and labor to deal with any impending or actual breach, testing of the emergency warning system and the emergency management system.

- The installation of a dike/wall breach warning system. This will have to be carefully designed. The most effective system is sirens. The area of coverage relative to the power and location of each siren, the type of siren (electronic or electro-mechanical), the control of the sirens, the effected response to their sounding and the authority to set them off will all have to be carefully designed. Modern siren systems are very complex and offer many options. In the US the sounding of a siren is normally not a signal to evacuate but rather to turn on the emergency radio service for instructions. In Dhaka, two complications will occur: in many areas few people will have radios (only 7 percent of slum households have radios[4]) and if the protected area is compartmentalized the population effected will be limited to an area whereas the sirens will be heard over a much wider area. A system will have to be developed to ensure that only the inhabitants of a particular compartment respond to an emergency signal. Electronic sirens, which are in effect powerful loudspeakers, allow the use of a wide range of signals and voice messages but are unreliable and expensive to maintain and the voice messages are difficult to understand due to the rapid attenuation of high frequencies distorting the spoken message. Electro-mechanical sirens are far more reliable but are limited in terms of the signal they can emit.

- The implementation of an ongoing emergency management system including training, testing and maintenance of all systems. A nuclear power station in the US, comparable in terms of risk, maintains a staff of about 20 people to maintain their emergency management system. This excludes all services such as repair teams, police, etc., which would take action in the event of an emergency.

11.2.2 Dike routing/location

Description: The PEIA indicates that the construction of the Phase I dikes and walls has taken land without regard to the social impacts and no adequate procedure was developed during the selection of their routing to ensure that these impacts are minimized. As a result the safety and effectiveness of the system is threatened by affected people cutting sections of the dikes and walls. It is recommended that, for Phase II, all routing be optimized on the basis of site-specific technical and economic details and local concerns before construction is allowed to begin.

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[4] Report on the Slum Area Census 1986, Bangladesh Bureau of Statistics, June 1988

The Consultant has noted that the dikes have been cut in some areas by local people to restore natural drainage channels. Openings in the walls have also been damaged such that the slots designed for stop logs have been destroyed and they will have to be blocked with sand bags. This appears to be due to carelessness in the driving of trucks through them and not due to deliberate sabotage.

The dike alignments being selected by the Consultant for Phase II are based on both engineering and social considerations. The main dike is being located as close to Balu River and Tongi Khal as possible to maximize the protected area, though it cannot be placed too close to the river to avoid erosion and assure its stability. In some areas, this may result either in river bank communities being excluded from the protected area or being split. These communities are generally located on higher ground and thus the height and width of the dikes going through them will be relatively small. The impacts on the communities needs to be assessed and mitigation measures designed. This could include resettlement, provision of alternate access or the relocation of the dikes.

It is important that this issue be fully addressed not only as an environmental concern but to ensure the integrity of the dike system. The possibility that local people may remove dike sections destroying the integrity of the system if their needs and concerns are not adequately addressed is a serious issue. The result could lead to complete failure of the whole system resulting in as great a property loss as if it did not exist. Thus, until it can be assured that dike sections will not be destroyed through a combination of satisfying local people's needs and policing, the benefit side of the benefit/cost calculation must be appropriately reduced.

The existence of poor soil conditions and the lack of good construction materials is likely to require wide dikes to ensure their safety. This will increase their impact on communities which they go through. However, housing is normally placed on higher ground and thus dikes will be lower, and thus narrower, where they pass through communities. Walls have been used in the place of dikes in many areas in Phase I where the flood protection passes through a community. These walls have numerous openings, many of which are at the end of narrow alleyways making access by truck difficult or impossible, and the major concern will be to mobilize the resources necessary to block these openings with stoplogs or sand bags in time when there are flood conditions.

The problem of the location of dikes and/or walls will be particularly difficult in the area adjacent to Old Dhaka from Lalbagh to Babu Bazaar. In this zone a low area has residences and businesses abutting the water's edge and in some cases built on stilts over the water. Much economic activity in the area is dependent on river transport. Building a dike would require the destruction of a wide swath of high density construction. A wall would cause significant damage and leave a large section of the old city unprotected. The plans for protecting this area will be finalized during the feasibility study stage of the report. An

option under consideration is to put sheet piling in the water and back fill to the land. Access to the river would have to be provided.

It was observed during a field survey and discussions with local people that there is high level of local awareness of alignment plans. The major source of knowledge is through the arrival of survey and soil boring teams and the alignment they are surveying or taking borings from. It was noticeable that English technical terms such as "soil borings" had entered the local language and people even seemed to informed about soil conditions. From their perspective, the arbitrary nature of the alignment selection process and the lack of consultation with them is reinforcing their concept that decisions intimately affecting their lives are being taken in remote offices, and that the only people able to influence them are the rich with political clout. To prevent damage and to protect and mobilize the resources necessary to block openings during flood periods requires local people to feel that they are involved in the flood protection system. For this to occur requires them to be informed and consulted on the alignment and construction decisions which intimately affect them. This points to the need for the early development of a public participation program which is currently lacking.

Recommendations:

1. Study the Impacts of the Existing Dikes and Walls: The impacts of the existing dikes and walls on affected communities and people should be studied and documented. This should include a precise description of all communities affected and the types of impact they have suffered. This could include division of communities, the separation of homes from place of occupation, access to residences or commercial properties and the division of individual properties. The perception of local residents needs to be studied. Do they perceive the flood protection system as a benefit to them? If not, what action could be taken to change their views? The results of this study will be useful in determining the impacts of the proposed alignment of the Phase II dikes and walls.

Furthermore, the instances of destruction of existing dikes and walls should investigated and related to the impacts on the local people.

2. Study the Impacts of the Phase II Dikes: All communities and properties along the proposed dike alignment should be delineated and mapped. The following impacts should be assessed:

- Communities excluded from flood protection zone:
  - Increased risk of flooding (if any)
  - Access to inland areas
  - Access to fields

- Communities cut off from a river:
  - Access for commerce
  - Access for river dependent occupations, e.g. fishing
  - Access to fields

- Communities divided by dikes:
  - Social impacts (community cohesion)
  - Loss of housing

- Properties divided by the dikes:
  - loss of amenity
  - Viability as an agricultural unit

3. Development of Mitigation Measures: Measures to mitigate negative impacts to the maximum extent feasible need to be developed. These could include:

- Re-routing of dikes or walls

- Replacement of dikes by walls in sensitive locations to reduce the area to be taken. This may be feasible in higher elevations where protection is limited to a height of 2 meters or less.

- The provision of access across walls through openings with which could be rapidly blocked by stoplogs or sand bags or, across dikes, by providing a road or pathway.

- Re-settlement

- Re-grouping of agricultural plots

4. Public Participation: The lack of an adequate public participation program leads to local people who are affected by dike/wall alignment decisions feeling that they are excluded from it. This can reinforce a negative attitude in those who feel threatened and a neutral attitude in those who are in fact protected. This increases the likelihood of sabotage and indifference at the time of flooding when their active cooperation is required to put the system into operation and to assure its effectiveness. It is strongly recommended that a full and properly designed public participation program be implemented as early as possible.

11.2.3 Severance Problems

Description: The PEIA reports that the construction of the Phase I dikes and walls have caused severe severance problems for local people. These structures have made it difficult to access riverside business with severe economic consequences. It has made access to riverside residences difficult especially for vehicles and has divided communities between those who are protected and those who are not causing mental (i.e. social) conflict. It reports claims by local people that in some cases, toilets and tubewells may be on one side of the dike while the house in on the other, making living conditions difficult. It was recommended that the completion of unfinished parts of the Phase I dikes and walls and the construction of Phase II be delayed until the problems of severance have been adequately addressed.

The Consultant's preliminary site reconnaissance would indicate that the walls are not much over a meter high and adequate openings have been provided to allow access to establishments outside the wall. These gaps can be blocked relatively easily with sandbags or stoplogs.

Though the reports of the severity of this problem may be exaggerated in some cases, it a major concern. This may be the reason for the cutting of gaps in dikes and walls reported in the PEIA which, if it continues, could threaten the integrity of the whole flood protection system. Therefore it is important that it be addressed not only from the perspective of environmental impacts but to avoid a disastrous failure of the system.

Recommendations: Though it was appropriate for the PEIA to address this separately from the question of location of the dikes, the Consultant recommends that both issues be integrated and covered under the studies recommended in Section 11.2.2 above. The issues are inter-related and mitigation measures should address both issues together.

11.2.4 Resettlement

Description: The PEIA indicates that people whose property has been taken have been given inadequate compensation and assistance with resettlement because:

a) Property has been undervalued.

b) Some payments for illiterate landowners have been made to middlemen who have kept the money.

c) Ten percent of the property value is sometimes necessary to expedite payment.

d) No contribution has been made towards the cost of resettlement.

It is difficult to develop a totally equitable method of compensation. It is reported that some individuals purposefully placed shacks in the way of the dikes to increase the compensation received. This is an issue which should be addressed and resolved in the EIA.

The review of the inception report for the Land Acquisition and Resettlements component of Flood Action Plan (FAP-15)[5] would indicate that some of the important issues related to the impacts of the projects on local people in the path of flood protection works have not been addressed there. In particular, it does not address problems of community cohesion, access to the river or agricultural lands or the division of individual properties into uneconomic units.

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[5] A Study on Land Acquisition and Resettlements, Inception Report; Multidisciplinary Action Research Center (MARC) in collaboration with HIFAB International, February 1991

Recommendations: The procedures for compensating landowners for property taking should be documented. The properties to be taken and the needs for resettlement will be established under the task recommended in Section 11.2.2 above. It is recommended that a formal resettlement plan be established before commencement of construction of the Phase II dikes. It is important that this plan not only be equitable but be seen to be equitable by local peoples if sabotage of the flood protection is to be discouraged. Therefore, it is recommended that there should be as much public participation by the affected local people in the formulation and administration of the plan as possible. Further, sociologists or other professionals with a good insight of the problems and perception of the people to be affected should take a leading role in the formulation of the plan, its presentation to the local people, its revision to overcome local objections, coordination with the design engineers to modify the design of the dikes and walls to accommodate serious objections and its administration. Its presentation to local people should be undertaken through the public participation program proposed in Section 11.2.2 above.

Appropriate procedures for compensation and resettlement are to be developed under FAP-15 (Land Acquisition and Resettlement Project). It is suggested that the above recommendations be incorporated into this plan component. Important recommendations arising from this study, which is due to be completed in January 1992, should be incorporated into the land acquisition proceedings for this project after they have been reviewed to ensure that they adequately address the specific needs of this project.

It is further recommended that the scope of this study be reviewed in light of the total need to address the problems of people affected by the flood protection works as described in the preceding section. Where issues identified are beyond its scope measures should be taken to ensure that they are addressed elsewhere.

11.2.5 City Drainage Systems

Description: The PEIA indicates that the DFPP could have a negative impact on the city's stormwater drainage system if the pumping system is not properly designed and operated.

The design of an adequate drainage and pumping system including sluice gates is part of the DFPP engineering task. The cost of these works is a significant proportion of the total cost of the flood protection system.

If electrical pumps are selected for pumping systems, it also adds indirect costs in terms of electrical generating and transmission capacity which will have to be reserved for the system. This capacity will only be required on an occasional basis and it may be possible to accommodate it by load shedding during critical periods. At the time of writing the overall plan for pumping and draining the protected area is still being developed. Once it is complete, its impacts on both the drainage system and the electrical distribution system need to be evaluated. It should be noted that consideration is being given to the use of diesel engine driven

pumps in the place of electrically driven pumps to avoid dependance on the electrical system.

Recommendations: It is recommended that after completion of the preliminary design of the drainage and pumping system an environmental impact assessment of system design and plans for its operation and maintenance should be carried out to cover:

- o Potential interference with existing drainage paths causing impoundments and the creation of stagnant ponds behind the dikes causing a health hazard (also see Section 11.2.13 below).

- o Impacts on existing and potential built up areas including slum areas and the need for land-use controls to prevent development in areas planned to be flooded.

- o Impacts on agricultural lands. As will be described in Section 11.2.10, the pumping system could potentially be used to improve agricultural output within the protected area.

- o If electrically driven pumps are proposed, impacts on the electrical power system. Methods of reducing the peak load requirements should be investigated including:

    - To the extent possible, restricting pumping to off-peak demand periods on the electrical system.

    - The use of high efficiency and synchronous motors to reduce the demand (load and power factor) on both the generating capacity and the transmission system.

    - Load shedding rather than installing added generating capacity during the relatively limited peak pumping capacity demand periods.

    - The dependability of the electrical system to be able to supply the power required during peak flood periods and rainfall periods.

- o If diesel pumps are proposed, the impacts on imported energy demands and the potential for using domestic natural gas as an alternative fuel.

11.2.6 City Sewerage System

Description: The PEIA indicates that the question of how the DFPP will affect the Dhaka sanitary sewage system is left unanswered.

The Consultant's preliminary review of the interaction between the sewage collection and treatment system and the flood protection system would indicate that the flood protection system is likely to have a positive

impact on the operation of the sewerage system. It should prevent the infiltration/inflow due to external flooding and if the drainage system is properly designed, from internal flooding as well. Sewered areas will be above the maximum internal flood level which will be allowed during operation of drainage pumps. The sewage treatment plant is currently being upgraded and it is expected that this will provide the capacity to pump out sewage and prevent any back flow of external floodwater during peak flood periods. The precise interface between the sewage system and the DFPP has not been checked at the time of writing and should be checked after finalization of the design of the pumping system.

Recommendations: An investigation should be undertaken after completion of the design of the pumping and drainage system to ensure:

- That the sewage treatment plant is adequately equipped to deal with a 100 year flood and to prevent back flow of floodwater into the plant.

- That sewered areas are above maximum flood levels during operation of the pumping system.

11.2.7 In-City Flood Level Control/Economic Evaluation

Description: The PEIA quotes the IEE as stating: "According to the DFPP plan ..., flooding of Dhaka inside the dikes will be allowed to occur without control by the dike system, up to some specified limit beyond which the gates would be closed, in order to achieve an optimal balance between damages which will occur within the protected area and extra damages to communities, agriculture, fisheries, and other values. The need is for an economic evaluation of the savings versus losses at various control heights so an appropriate plan can be prepared to compensate the losers who are disadvantaged by the project (especially the poor people who will be among the losers)."

The PEIA further indicates that the economic savings within the dike can be estimated with the following information:

i) the vertical distribution (in increments that are as small as possible) of land categories, numbers of people, and infrastructure.

ii) the frequency of flooding of each vertical increment, without the DFPP.

iii) the frequency of flooding of each vertical increment, without the DFPP

iv) economic evaluation of ii) and iii) above.

Further the PEIA comments on potential damage in densely populated areas outside the protected area as a result of the flood protection system raising the water level in them. It indicates that damage outside the dike

can be estimated from the following information that should be gathered sequentially;

i) the elevations of calculated backwater curves with and without the dike, for a range of flood conditions.

ii) the vertical distribution (in increments that are as small as possible) of land categories, numbers of people and infrastructure in areas where there are dike-induced increases of more than a few centimeters.

iii) the frequency of flooding of each vertical increment without the dike.

iv) the frequency of flooding of each vertical increment with the dike.

v) economic valuation of iii) and iv) above.

The Consultant suggests that it will be difficult to ensure equity between gainers and losers for the DFPP. The type of study suggested in the PEIA would require a major effort. Due to the difficulty of quantifying economic impacts in terms of unpriced items, it will be difficult to achieve valid results from the suggested studies. These studies should be given second priority over studies necessary to ensure integrity of the system and to minimize negative impacts.

The pumping regime has not been finalized at this time and options of controlling the early flood periods to enhance agricultural production are currently being investigated.

A field survey and discussions with local people would indicate that one of the major concerns of local people excluded from the protected zone is that the construction of the system will increase flood levels around them. This implies that they are at greater risk and therefore they may feel that their property and lives are at stake. Whether justified or not, this perspective is likely to cause them to have a negative attitude towards the project increasing the risk that they will sabotage it. It is therefore important that they see that there concerns are adequately addressed and appropriate measures taken to protect them.

Recommendations: The Consultant recommends that backwater curves for areas outside the protected area be checked to determine whether there will be significant impacts to residents, and measures developed to minimize negative impacts as far as possible. It is understood that backwater curves have been prepared under FAP-8A by JICA.

Local people who could be affected should be informed of the results of these studies under the public participation plan recommended in Section 11.2.2 above. It is important that measures be incorporated into the project to ensure that their lives are not placed at risk and potential property damage minimized. The emergency management plan should

incorporate plans for the evacuation and temporary re-housing of people who adjacent but outside the protected area who are threatened.

11.2.8 Interference with Utilities/Traffic

Description: This a detailed issue which was identified in the IEE and should be covered in the design of the system. There will be some interference with traffic when the flood protection system will be put into operation and gaps in the dikes and walls normally kept open for traffic are blocked. A number of residences and businesses will be cut off.

Recommendations: A review should be undertaken as part of the design to ensure that the impacts of construction on traffic and utilities are minimized. The residences and businesses which will be cut off when the flood protection system is put into operation should be established during the studies recommended in section 11.2.2 above. Efforts should be made to mitigate these impacts not only to minimize negative impacts but to discourage the sabotaging of the system by affected people.

11.2.9 The Need for O & M

Description: The PEIA identifies the need for the implementation of an adequate operations and maintenance (O & M) plan and recommends that construction of uncompleted sections be delayed until one has been prepared. The Consultant agrees that this is an important issue. As described in Section 11.2.1, if the system is not adequately maintained, and an emergency management plan operated in parallel, there is a high risk that a severe flood could cause far greater damage and loss of life with the protection system than without it.

Recommendations: The Consultant concurs with the recommendation of the PEIA that construction of Phase II should not commence until an adequate O & M plan has been prepared, approved and its implementation assured. This plan should be carefully coordinated with the emergency management plan recommended in Section 11.2.1 which should be developed under FAP-11.

11.2.10 Impacts on Agriculture

Description: As described in Appendix D, the DFPP will have a positive impact on agriculture within the protected area. 45 percent of the protected area is devoted to agriculture and much of this land is flooded for up to 15 weeks. Flooding from both the rivers and unexpected rains cause considerable damage to crops. Protection from early flooding and the ability to drain areas flooded by rains will both protect crops and allow additional crops to be grown. With the changed water regime there are likely to be considerable changes in crops grown.

The following benefits are foreseen:

- o More rice and other crops in the protected area.
- o Use of most agricultural land throughout the year.
- o Reduction of damage of crops/property due to high floods.
- o An increase in land values in certain areas.

As described in Section 11.2.7, alternative pumping regimes are currently being investigated to enhance agricultural production.

Recommendations: Detailed recommendations for taking advantage of the DFPP to improve crop production within the protected area are contained in Appendix D. It is recommended that agricultural extension services be improved to realize the benefits offered.

11.2.11 Migration of Population to Protected Areas

Description: The existence of an area protected from floods may increase the attraction of Dhaka as a metropolitan area which is a center of employment. Currently 61 percent of the area to be protected is classified as rural[6] indicating a great deal of vacant land. Unless development is strictly controlled, much of the development and particularly the creation of slums is likely to occur in low lying land, increasing the risk of loss of life and damage in the event of dike breach during the flood season. The fact that most of the higher land has already been developed is likely to encourage this trend.

Between 1961 and 1981 the urban population of the Dhaka region increased from 754,000 to 3,857,000[7] or at annual exponential rate of 8.5 percent. Net life time in-migration to Dhaka to 1981 was 1,142,369[8]. The population of the Dhaka "pull area" (the urbanized area of Metropolitan Dhaka which acts a magnet for in-migration; most of it is inside the protected area but some is outside) is projected at 6.32 million in the year 1990, 9.86 in 2000 and 13.48 million in 2010[9]. These figures do not indicate the

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6 Greater Dhaka Protection Project (Study in Dhaka Metropolitan Area) of Bangladesh Flood Action Plan No. 8A, Interim Report, Japanese International Cooperation Agency, March 1991

7 1990 Statistical Year Book of Bangladesh, Table 2.39, Bangladesh Bureau of Statistics

8 Ibid, Table 2.43

9 Greater Dhaka Protection Project (Study in Dhaka Metropolitan Area) of Bangladesh Flood Action Plan No. 8A, Interim Report, Japanese International Cooperation Agency, March 1991

proportion of this population which is currently outside the protected area nor do the projections take the added attraction of relocating into a flood protection zone into account.

The major attraction to moving to a metropolitan area is the perceived or real opportunities for employment. It is not clear to what extent protection from flooding would be an added inducement to move from rural areas to Dhaka. However, as described above, the pull area includes areas outside the protected zone. It would be clear that someone who is able to maintain his employment but can move his home and family to an area protected by flood would have a strong inducement to do so. The limitation is likely to be the cost and availability of housing. In the case of the "relatively rich", defined as the top 30 percent of the population, this may be a significant barrier to moving. The remaining poor, especially those living in slums, may be more mobile in that they are outside the traditional housing market. It is reported[10] that though most slum dwellers live on government owned land, 63 percent pay rent. It is not clear to whom they pay "rent", the government, the builders of the shacks, as protection money to criminal elements, or as bribes to police or civil officials to leave them in peace.

Many studies have been undertaken on the process of migration into the Dhaka area. None has been specifically related to added inducement caused by the existence of a zone protected from floods. One study[11] indicates that rural migrants usually move to closest urban areas and that the primary motivation is economic opportunity. River erosion causing the loss of land is another major cause of migration as it turns many people into homeless destitutes within a short period of time. Natural hazards such as cyclones, drought and floods which are responsible for famine also stimulate rural urban migration.

In common with most metropolitan areas in the developing world, Dhaka has difficulty in maintaining its existing urban infrastructure let alone improving and expanding it to meet the demands of increasing population and economic growth. Accelerated population growth and stimulated economic activity resulting from the existence of a flood free zone may increase this pressure and thus have a negative impact on the quality of life within the zone.

Recommendations: It is recommended that a study be undertaken to determine, as best as possible, the likely impact of the DFPP on migration to the protected area. This should include:

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10 Report on the Slum Area Census 1986, Bangladesh Bureau of Statistics, June 1988

11 The People of Dhaka, Center for Urban Studies, July 1982

- An assessment of the likely impact of the DFPP on migration patterns to be largely based on previous studies of migration patterns, of which there have been a large number[12].

- The settlement pattern of new migrants. Will they move to existing settled areas or are they likely to overflow into currently undeveloped areas? The real and theoretical constraints on their settlement should be established including their inability to settle on private land and land use controls on government land. It is noted that some squatters have settled on the existing dikes which are by definition government land above the flood line.

- The impact of increased migration on urban infrastructure including housing, transportation and utilities and government services including health, education, public order and other public services.

- An assessment of the number of people, both normal migrants and those induced by the existence of the DFPP, who are likely to settle into low lying areas and thus be vulnerable to a dike or wall breach. This could be used in the assessment of the potential for loss of life and damage to property recommended in Section 11.2.1.

This study should develop mitigation measures including;

- Infrastructure, regulatory and government service improvements necessary to meet the projected in-flow of population.

- Measures to discourage migration to the protected area at a rate higher than can be accommodated by improved infrastructure and services. This could include not completing the DFPP until corresponding flood protection and river control works have been built in the nearby rural and urban areas from which population might migrate.

11.2.12 Interference with Commercial Waterways

Description: The construction of the dikes and walls associated with the DFPP will block a number of waterways which serve commercial boat traffic and will cut a number of establishments off from their transportation routes. The most important of these waterways is the Gajaria Khal connecting to the Balu River. Alternatives are being considered for this waterway to mitigate this impact, including a lock or access road for substitute transportation.

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12 The People of Dhaka states that at present hundreds of books and articles are published each year on the subject of urbanization and migration in Bangladesh and the work published in 1982 has a bibliography of 34 works.

During a field survey a group of residents living on the Gajaria Khal were interviewed. They indicated that the DFPP will provide more benefits than costs to them and that if the waterway is cut they would find alternative transportation means. In particular, they would use a road if it is provided. Some concern was expressed for the impact on fishermen who did not appear to be represented in the group.

Recommendations: It is recommended that all the waterways to be cut and significant commercial establishments along them be identified and an assessment be made of the impacts of DFPP on them. In the case of the Gajaria Khal, a benefit/cost calculation should be undertaken for the lock and road to determine their feasibility.

The possibility of mitigation measures should be investigated including the possibility of relocating or providing alternative means of transport to affected enterprises for other waterways.

11.2.13 Impacts on Public Health

Description: The DFPP may impact public health both positively and negatively in a number of ways:

- The dikes may cut existing drainage channels leading to the formation of stagnant ponds behind them which could become the breeding ground for disease vectors. Further, stagnant ponds are often used by slum dwellers for bathing even though they may be highly polluted by both chemicals and pathogens, posing a severe health risk. The design of the system should eliminate this problem to a great extent. In view of the number of stagnant ponds already existing, some being used simultaneously for both defecating and bathing, it is doubtful whether the DFPP will have a significant impact on the health control problems of Dhaka but it may add to the eventual cost of eliminating stagnant ponds as a public health hazard.

- Immigration to the Dhaka metropolitan area induced by the existence of the flood protection zone will add to pressures on the water supply and sewage disposal system as well as public health services. This issue is covered in Section 11.2.11 above.

- The existence of a protected zone should reduce infiltration and inflow of floodwater into the sewage system which lead to possible overflows and consequent health hazards.

- The risk of a breach with consequent sudden flooding increases the risk epidemics which are commonly associated with such disasters.

Recommendations: The location of all lowlying areas areas should be identified during the design phase, and appropriate drainage facilities provided to ensure that no new empondment areas are created. After completion of the design, the location of any remaining impondments caused

by the blocking of drainage channels, both in the existing Phase I area and the proposed Phase II area, and their potential impact should be assessed. If they will have little impact in the short term, the cost of their eventual elimination should also be assessed. If this assessment indicates that they do cause a significant health hazard, they should be eliminated.

11.2.14 Water Quality

Description: Though Dhaka has a sewage system, a large but unknown proportion of human and industrial wastes are discharged to natural drainage channels and khals which eventually discharge to the major rivers. These waterways are known to be highly polluted but insufficient studies have been carried out to determine the actual level and degree of hazard of this pollution. The construction of the flood protection works will replace these natural drainage channels with a planned water regime using pumps to discharge waters to the rivers. The impact of this to water quality is not clear and, as noted in the section above, it may pose a health risk. It should be studied. It is possible that the pumping system could improve water quality in some khals.

Recommendations: The impacts of the proposed pumping system on water quality should be studied and where possible, the system should be operated in such a way as to improve water quality.

11.2.15 Fisheries

Description: Fish are an important component of the local diet and fishing is a major economic activity in the riverain villages which will be impacted by the system. The impacts of the DFPP on fish populations has not been studied but it is likely to be negative if for no other reason that the local fish populations are likely to be adapted to the current regime of periodic flooding.

Recommendations: It is strongly recommended that the impacts of flood protection works on fish populations and the productivity of the local fisheries be studied. As this issue applies to the overall development of the Flood Action Plan rather than the DFPP alone, this might be an appropriate issue to study and prepare detailed guidelines under FAP-16 (Environmental Study).

The study should address:

1. The impacts of the DFPP on the local freshwater ecology fish production.

2. The impacts of the DFPP on local fisherman.

3. Mitigation measures to minimize negative impacts, including the possibility of allowing floodwaters to enter the protected area in

a controlled manner during the monsoon season and it's likely impact.

The economic loss in terms of fish production and the cost of mitigation measures should be incorporated into the benefit/cost studies for the project.

11.2.16 Groundwater

Description: It has been reported that there is a general concern that the establishment of flood protection works throughout Bangladesh may have significant impacts on the groundwater table which is reported to be largely recharged during flood periods.

Mott, MacDonald, Consultants to DWASA on water supply have orally stated that their studies indicate that the groundwater supplies in Dhaka region are abundant, and that the potential use of the groundwater aquifers for domestic consumption has barely been tapped.

It is suspected that much of the recharge to the aquifers underlying Dhaka are from recharge areas to the north, and as such the DFPP by itself will have little impact on the groundwater recharge in Dhaka. However, this is only an informed judgement, and the issue has not been fully investigated.

Recommendations: There should be further investigation of the groundwater issue to determine that the DFPP will not have a significant impact on water supplies for the Dhaka metropolitan areas.

11.2.17 Soil Erosion

Description: If the dikes are not properly constructed with adequate measures to control soil erosion from construction areas and borrow pits, drainage channels, streams and agricultural fields will receive excessive sediment loads causing water quality problems and loss of agricultural production.

If the dikes are not adequately protected with suitable vegetation, soil erosion will continue during the operation of the system causing maintenance problems and continued sedimentation in waterways and fields.

Recommendations: Proper requirements for soil erosion control and planting of the dikes should be included in the contract specifications and bills of quantity and supervision of the implementation of these measures should be assured during construction.

TABLE 11.1

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE FLOOD CONTROL AND DRAINAGE WORKS

Potentially Disastrous Impacts in the Event of a Breach in the Walls or Dikes.

Type	Description	In PEIA?	Mitigation Measures
Integrity of design and construction for dikes/walls	While maximum integrity is planned, a dike/wall break during a flood could cause a catastrophic flood	Yes	1. Risk assessment 2. Redesign of critical wall sections to improve stability and decrease risk of failure. 3. Implementation of emergency management system (FAP11)
Impacts, Which if They Are Not Adequately Addressed, May Lead to the Sabotaging of the Flood Protection System			
Dike routing/location, severance problems, resettlement	Existing Phase I dikes and walls have been damaged or destroyed apparently in protest by local people over routing, severance and isolation of communities, commercial establishments and residents. If this is repeated during the operation of the system it could destroy its integrity.	Yes	1. Study problems for existing dams/walls 2. Determine impacts of Phase II 3. Modify design and take other measures to minimize impacts. 4. Improve administration of compensation system 5. Encourage participation of affected people in decision making
Positive Impacts			
Agriculture	Potential for improving agricultural production through controlled water regime.	No	
Sewerage system	DFPP will protect sewer system from flooding	yes	
Expansion	The DFPP creates room for expansion of the city to areas which are protected from major flooding.	yes	
Flood Control	The DFPP reduces the maximum design flood level to 5.0 m PWD. Future improvements could further reduce flood stage levels, reducing the number of people at risk during flooding.	yes	
Plastic Health	Reduction of flood stage levels reduces the number of areas within the city that would be flooded. This reduces cross-contamination from exposure to flooded open sewers, which in the past have been a primary source for the spread of disease.	no	
Negative Impacts			
Impacts of drainage system	1. Creation of stagnant pools (probably not significant) 2. Impacts on electrical power system	yes/no	1. Check health impacts, drain if necessary 2. Use diesel driven pumps, use energy efficient motors. pump in off-peak hours
Higher flood levels outside DFPP	The DFPP works will increase flooding in populated areas outside the protected zone.	yes	Check backwater curves (FAP-8A), determine impact and mitigate as required.
Induced in-migration	The existence of flood free zone will encourage in-migration further straining infrastructure and government services.	no	1. Study issue 2. Increase land use controls 3. Improve infrastructure and service to meet demand
Waterways will be cut	Dikes will cut waterways and isolate commercial businesses	no	1. Study potential Impacts 2. Investigate use of locks of improvement of river access outside dike on Gojaria Khal.
Access to River	Many business depend on access to the river for their livelihood	no	1. Study impacts 2. Improve will breach design 3. Improve river access
Public Health	The DFPP may increase the number of polluted stagnant pools which are breeding grounds for disease vectors and unsafe for bathing. Induced in-migration will add strain on water supply, sewer and public health services.	Yes/no	Determine extent of risk of formation of stagnant pools and design operation of pumping system to minimize health risks. Increase investment in water supply, sewage and public health services to meet demand.
Water Quality	Cutting of natural drainage channels may increase water pollution problems.	No	Study issue and design pumping system to minimize impacts or even improve water quality if possible.
Soil Erosion	Lack of soil erosion control could cause sedimentation of waterways and fields during and after construction	No	Include requirements for soil erosion control and re-vegetation in contract specifications.

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TABLE 11.2

MATRIX OF ENVIRONMENTAL IMPACTS

Action	Loss of Life	Impacts Within Protected Area					Impacts Outside Protected Area
		Socio economics	Agriculture	Commerce	Water Supply	Public Health	
Completion of System	Reduced risk	Protection of property. Development pressure in Dhaka. Disequities in benefits/ losses.	Stable water regime	Improvements in transport system Severance	Controlled water regime inside containment area	Reduced Risk	Increased risk of flooding. Fisheries
Taking of land		Loss of property. Severance	Loss of land Severance				
Drainage/ Pumping System		Local flooding	Potential for improved agricultural systems.	Electrical power Demand	Contamination mitigated by pumping	Risk of water borne disease transmission reduced by pumping	
Interference with drainage and waterways				Blocking of waterways Decreased access to river		Interference with sewage disposal Stagnant pools breeding mosquitoes mitigated by pumping	
Risk of collapse*	Increased risk	Property damage		Damage to infrastructure	Loss and contamination	Water borne diseases	
Construction		Disturbance to utilities and transportation systems	Loss of land and damage from soil erosion	Interference with transportation routes		Breeding grounds for mosquitoes (Temporary, mitigated by pumping during and after construction).	

* Risk of Collapse mitigated by redesign of wall and construction of critical sections using materials and techniques which increase stability over time.

APPENDIX A

24 May, 1991

LIST OF SELECTED REFERENCES

1. "Bangladesh Action Plan for Flood Control", Document of The World Bank, December 11, 1989.

2. "Flood Control in Bangladesh", A Plan for Action, Asia Region Technical Department, World Bank Technical Paper Number 119.

3. "Greater Dhaka City Flood Control : Recommendations to the Committee", T.G.H. Jensen, A.F.M. Abdul Hadi and F. R. Asgar, November 1988.

4. "Report on Flood Control and Drainage of Greater Dhaka", Report of the Committee for Flood Control and Drainage of Greater Dhaka, January 1989.

5. "Updating Study on Storm Water Drainage System Improvement Project in Dhaka City", Main Report, Japan International Cooperation Agency (JICA), February 1990.

6. "Updating Study on Storm Water Drainage System Improvement Project in Dhaka City", Supporting Report, Japan International Corporation Agency (JICA), February 1990.

7. "Study on Storm Water Drainage System Improvement Project in Dhaka City", Main Report, Japan International Corporation Agency (JICA), October 1987.

8. "Greater Dhaka Protection Project (Study in Dhaka Metropolitan Area) of Bangladesh Flood Action Plan No. 8A", Inception Report, Japan International Corporation Agency (JICA), October 1990.

9. "Preliminary Review Report for Greater Dhaka Protection Project - FAP 8A", Japan International Corporation Agency (JICA), December 1990.

10. "Interim Report for Greater Dhaka Protection Project - FAP 8A", Japan International Corporation Agency (JICA), March 1991.

11. "Detailed Design Report, Volume I - Main Report & Volume II - Design Notes and Calculations for the Project for the Improvement of the Storm Water Drainage System for Dhaka City", Pacific Consultants International, Tokyo, Japan, June 1990.

12. "Tender Documents, Volume I & Drawings, Volume II, for the Project for the Improvement of the Storm Water Drainage System in Dhaka City", Pacific Consultants International, Tokyo, Japan, June 1990.

13. "Environment Action Plan (Draft)", MOEF of GOB, 1990.

14. "Bangladesh Environment and Directorate of Environment", Department of Environment, 1990.

15. "Initial Environmental Examination for Dhaka Flood Protection Project", Department of Environment, October 1989.

16. "Progress Environmental Impact Assessment (EIA) for Dhaka Flood Protection Project (DFPP)", Department of Environment, July 1990.

17. "Year Book of the Department of Environment Pollution Control Vol-II", Environment Department, July 1975 to March 1980.

18. "Analysis of Water of the River Buriganga at Hazaribag", Environment Department, January 1991.

19. "Analysis Sheets of Water Samples", (various) Environment Department, 1989 to 1990.

20. "Bacteriological Test Report", Environment Department, November 1990.

21. "Analysis of Air Sample of Dhaka", Environment Department, July 1990.

22. "Report of Tanneries and Various Industries in Dhaka and Other Cities of Bangladesh", Environment Department, June 1986.

23. "The Environmental Pollution Control Ordinance", Environment Department, 1977.

24. "Bangladesh Environment Preservation Ordinance", Environment Department, 1989.

25. "Appraisal Report for Dhaka Urban Infrastructure Improvement Project (Loan 942-BAN), Asian Development Bank (ADB), November 1988.

26. "Guidelines for Social Analysis of Bank Projects", Main Report, Asian Development Bank (ADB), Office of the Environment, November 1990.

27. "Environmental Guidelines for Selected Infrastructure Projects", Asian Development Bank (ADB), Office of the Environment, 1990.

28. "Environmental Guidelines for Selected Industrial and Power Development Projects", Asian Development Bank (ADB), Office of the Environment, 1990.

29. "Guidelines for Integrated Regional Economic-cum-Environmental Development Planning", A Review of Regional Environmental Development Planning Studies in Asia, Asian Development Bank (ADB), October 1988.

30. "Project Preparatory Technical Assistance for Dhaka Integrated Flood Protection Project", Aide Memoire, Asian Development Bank (ADB), April 1990.

31. "Draft Design Report, Volume I Main Report and Volume III Drawings, of Final Engineering Design of the Dholai Khal Rehabilitation Dhaka", by BKH Consulting Engineers, February 1990.

32. "Final Report - Summary Volume, Dholai Khal Rehabilitation and Area Development Study", by BKH Consulting Engineers, October 1986.

33. "Schedule of Rates for Dhaka O & M Circle", Dhaka, by Bangladesh Water Development Board (BWDB), in force from September 1988.

34. "Study of Project Delivery Systems for the Bangladesh Water Development Board", (World Bank) Mid Term Report, April 1990.

35. "Staff Appraisal Report on BWDB System Rehabilitation Project", The World Bank, February 1990.

36. "Emergency Flood Flight Manual", US Army Corps of Engineers, Omaha Dist., March 1988.

37. "Flood Problem and Planned Urban Growth", Nazrul Islam, Geography Dept. University of Dhaka, 1989.

38. "Social Formation in Dhaka City", Siddiqui Kamal et-al-Dhaka University Press Ltd. 1990.

39. "Slums and Squatters in Dhaka city", CUS, University of Dhaka, 1988.

40. "Dhaka City Drainage and Flood Control Project", Sir William Halcrow and Partners Ltd., August 1973.

41. "Dhaka City Drainage and Flood Control Project : Project Brief", Sir William Halcrow and Partners Ltd; October 1988.

42. "Report of the Task Force on Social Implications of Urbanisation", Planning Commission, GOB, February 1991.

43. "Cleaner Environment at Lower Cost, A New Approach for Solid Waste Management", Prof. K. J. Nath, April 1991.

44. "Bangladesh Population Census 1981", Report on Urban Area, November 1987.

45. "Pourashava & Municipal Corporation Law Manual", Bangladesh Local Government Law Series, August 1989.

46. "Earthwork Manual", Ministry of Local Government, Rural Development and Co-operatives.

47. "Housing Development Project Subcontract "A", Dholai Khal Rehabilitation and Area Development Study, Final Report : Summary Volume, Dhaka City Corporation (DCC), October 1986.

48. "Housing Development Project Sub-Contact - 'A' Final Feasibility Report Annexes Vol - II", Dhaka City Corporation (DCC), October 1985.

49. "Estimated Annual Budget", Dhaka City Corporation (DCC), 1990-91.

50. "Proposed Organization and Staffing Arrangement", Dhaka City Corporation, March 1990.

51. "Support for Urban Management and Municipal Services; Final Engineering Design of the Dholai Khal Rehabilitation Dhaka.", Main Report, Wasa Drainage Division, February 1990.

52. "Support for Urban Management and Municipal Services; Final Engineering Design of Dholai Khal Rehabilitation Dhaka", Volume - I, Wasa Drainage Division, February 1990.

53. "Emergency Flood Fight Manual", A Manual of Construction and Field Practices During Flood Emergencies, U.S. Army Engineer District, OMAHA, March 1988.

54. "Report on Reconnaissance Soil Survey Dhaka District", Soil Resources Development Institute, Second Edition, 1981.

55. "Dhaka Urban Infrastructure Improvement Project (HSD-Component) and Institutional Strengthening of Housing and Settlement Directorate", Housing and Settlement Directorate, Segunbagicha, June 1989.

56. "Position of Dhaka City Canals" (MAP), Dhaka Wasa Drainage Division, 1990.

57. "Analysis of Water Samples of Dhaka Water Works" (Various), Wasa Laboratory, 1991.

58. "Report on Flood Control and Drainage System of Greater Dhaka", Wasa Sewerage Division, January 1989.

59. "Layout Plan of Dhaka Water Supply and Sewerage Authority Dhaka (WATER SYSTEM)", Wasa Main Office, 1990.

60. "Greater Dhaka Flood Control and Drainage Project (Phase - I) Report for Cleaning of 13 Khals/Canals in the Dhaka City", WASA (MOD CIRCLE), 1990.

61. "Greater Dhaka Flood Control and Drainage Project (Phase - I) Repairing and Restoration of the Sewerage of Dhaka City", Accounts Section, WASA BHABAN, 1990.

62. "Master Plan of Sewerage System (DMA) Present and Proposed", Wasa Main Office, 1990.

63. "Rule for Construction of Building", RAJUK, 1984.

64. "Govt. of East Pakistan Master Plan and Feasibility Report of Dhaka Storm Drainage and Flood Control", Mr. Feroz Ahmed, October 1968.

65. "Revised Scheme of Crash Program for Removing Surface Water Logging of Dhaka Metropolitan City", Mr. Feroz Ahmed, October 1977 to March 1978.

65. "Report of Dhaka Drainage Committee", Mr. Feroz Ahmed, February 1970.

66. "Mouza and Mahallahs of Dhaka District RICT", Bangladesh Bureau of Statistics (BBS), September 1985.

67. "Report of the Slum Area Census", Bangladesh Bureau of Statistics (BBS), June 1988.

68. "A Case Study on Floating Population in Dhaka City", Bangladesh Bureau of Statistics, June 1988.

70. "Bangladesh Population Census Dhaka Statistical Metropolitan Area (Dhaka SMA)", Bangladesh Bureau of Statistics, July 1985.

71. The following information and Maps received from Japan International Corporation Agency (JICA) for the Greater Dhaka Area (Master Plan Study)

72. - Administrative boundary Map, Scale 1:50,000

73. - Existing and Future land use Maps, Scale 1:50,000 and survey information.

74. - External flood data survey information and Maps.

75. - Topographic Maps Scale 1:50,000 and 1:20,000

76. - Survey information for associated Drains and Rivers

77. - Survey information for Phase I embankment with Bench mark data.

78. "Map of Dhaka Road Circle", Road and Highways Department.

79. "Project Map, Land Plan on Mouza Maps, Minutes of Various Meetings & Bore-Logs of Phase-2 Works", 1990.

80. Dhaka City Map and Various Thematic Maps viz Landuse, Forest Cover etc. (Based on Satellite Imageries, 1984).

81. Satellite Imageries (Land Sat) (4 Prints) Scale 1:100,000 1972, 81 & 88.

82. "Geological Survey Map of Bangladesh & A Report on Geology of Dhaka & Adjoining Areas", 1988.

83. "Topo Maps 1989 (Based on Aerial Photo 1983-84)", of Scale 1:10,000 with Contour for Area Covering Greater Dhaka.

84. "Pipe Line Diagram on Dhaka City (Duplicate)", Titas Gas T and D Co. Ltd., 09.09.1989.

85. "Water Treatment Plant at Demra and Other Works", Interim Report for Sewage, Camp Dresser & Mc Kee International, Inc. etc., February 1990.

86. "Water Treatment Plant at Demra and Other Works", Interim Report for Water Supply, Camp Dresser & Mc Kee International, Inc. etc., Revised February 1990.

87. "Slums and Squatters in Dhaka City" The Center for Urban Studies, Department of Geograph, Dhaka University, June 1988.

88. "Cleaner Environment at Lower Cost: A New Approach for Solid Waste Management", by Dr. K. J. Nath, Preserve Planet Earth.

89. "Project Proforma for a Refuse Composting Plant for Dhaka City Municipal Corporation", Dhaka City Municipal Corporation, 1984.

90. "Country Status on Solid Waste Management in Bangladesh" by Dr. M. Feroze Ahmed and Mr. Abu Taleb Khondaker, May 1989.

91. "Management Information Report for the Month of March 1991", Dhaka Water Supply and Sewerage Authority.

92. "Investment Strategy for Improvement of Sanitation in Municipal Area of Bangladesh", Local Government Engineering Bureau, Local Government Division; Low Cost Sanitation Project BGD/85/004 UNDP - DANIDA - World Bank, December 1989.

93. "Solid Waste Management at Dhaka, Khulna and Natore, Bangladesh" by Mr. A. D. Bhide; World Health Organization; Project CWS001, August 1990.

94. "Working Paper on Waste Disposal Control and Recycling", by Mr. Anwar Hossain Khan, Dhaka Municipal Corporation.

95. "Dhaka Regional Ground Water and Subsidence Study" Dhaka WASA Water Supply and Sanitation Urgent Expansion Project, Interim Report, Sir Moth MacDonald & Part. Ltd. etc., November 1990.

96. "Staff Study Report" under Dhaka WASA Water Supply and Sewerage Urgent Expansion Project, Bangladesh Project Management Institute and Checchi & Company Consultants, Inc., 1990.

97. "Greater Dhaka Protection Project, FAP 8A", Interim Report, Japan International Corporation Agency, March 1991.

98. "Report of the Task Force on Social Implications of Urbanization" Planning Commission of the Government of Bangladesh, February 1991.

99. "Department of Environment - A Brief" Government of Bangladesh, Department of Environment, February 1991.

100. "Environmental Quality Standards (EQS)", Draft, Government of Bangladesh, Department of Environment, August 1988.

101. "Environment Pollution Control Ordinance, Government of Bangladesh, 1977.

102. "Bangladesh Environment Preservation Ordinance", Draft, Government of Bangladesh, 1989.

103. "The Long Term Development Plan and Feasibility Study for the Dhaka Metropolitan Area Water Supply and Waste Water System", RMP/ Montgomery, 1981.

104. "Bangladesh Third Dhaka Water Supply and Sanitation Project Staff Appraisal Report", The World Bank Report no. 5364-BD, June 1986.

105. "Environment Action Plan", Government of Bangladesh, Ministry of Environment and Forest, 1990.

106. "4th 5-year Plan Bangladesh Bureau of Statistics", BBS

107. Estimated Annual Budget", DCC, 1990-91

108. "Proposed Organization and Staffing Arrangement", DCC

109. "Road-net work for Bangladesh", R&H

110. "Khals layout and long section", DWASA Consultant DPM & ACE (B) Ltd.

111. "Cross section of khals", DWASA Consultant DPM & ACE (B) Ltd.

112. "Right-of-ways Khals of Dhaka", DWASA Drainage Division.

113. "The Town Improvement Act 1953 (E.B Act. XIII of 1953)", GOB.

114. "The Building Construction Act 1952 (East Bengal Act 11 of 1953)", Ministry of Low & Justice.

115. "Fishiculture & Management", Soft Water Research Centre Chandpur, 1983.

116. "Comprehensive Fishiculture Instruction & Yearly Calendar", Fishery Directorate.

117. "Progress Report of the Organization Dhaka WASA", Dhaka WASA, February 1981.

118. "World Health Organization Preliminary Project (Paper for Aided Project)", WHO, 13.3.91.

119. "Annual Report Atomic Energy Centre Dhaka", Bangladesh Atomic Energy Commission, July 1988 - June 1989.

120. "Journal of Radio Analytical & Nuclear Chemistry, Artical, Vol 134 no. 2, 367-381", Bangladesh Atomic Energy Commission, 1989.

121. "Multielement Proton - Induced X-Ray Emission Analysis of Betel Leaves, Betel Nuts and Lime Vol.12, Bangladesh Atomic Energy Commission, 1987.

122. "Multielement Analysis of Water Residue: A Pipe Measurement", Bangladesh Atomic Energy Commission, 1985.

123. "Joint Research Proposal (International Scientific Cooperation), Directorate General Science Research & Development", Bangladesh Atomic Energy Commission, January 1992.

124. "Dhaka WASA Activities Progress Report", DWASA, 1991.

125. "Project Proforma of Institute of Public Health", Institute of Public Health, Mohakhali, Dhaka, 1989.

APPENDIX B

APPENDIX B

CONTENTS

actvitis

PROPOSED ACTIVITIES FOR VARIOUS PLANS
WITH COST ESTIMATES

ITEM NO.	DESCRIPTION OF ACTIVITIES	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	COST EST. MILLION - TK. W/O R/W	COST EST. MILLION - TK. WITH R/W
1.	Construct soil testing laboratory with equipment.	*	*	*	*	*	*	*	10.65	17.65
2.	Perform site investigations for rehabilitation of west embankment.	*	*	*	*	*	*	*	5.00	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*	*	*	*	*	*	*	216.34	278.34
4.	Construct 2nd stage on rehabilitation of west embankment.	*	*	*	*	*	*	*	173.10	173.10
5.	Finish and provide slope protection for west embankment.	*	*	*	*	*	*	*	46.52	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*	*	*	*	*	*	*	32.00	32.00
7.	Construct Embankment/Flood-wall (Kellar Morh-Mitford Hospital)	*	*	*	*	*	*	*	296.55	337.55
8.	Provide Slope Protection on West Embankment for More Severe Waves	*	*	*	*	*	*	*	40.80	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*	*	*	*	-	*	-	2.50	2.50
10.	Perform site investigations on Sec. A' (East) sub embankment.	*	*	*	*	-	*	-	0.65	0.65
11.	Perform site investigations on Sec. B (East) main embankment.	*	*	*	-	*	*	-	0.70	0.70
12.	Perform site investigations on Sec. B' (East) sub embankment.	*	*	*	-	*	*	-	1.03	1.03
13.	Perform site investigations on Sec. C (East) main embankment.	*	*	*	-	-	-	-	1.80	1.80
14.	Perform site investigations on Sec. C' (East) sub embankment.	-	-	*	-	-	-	-	1.02	1.02
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev	*	*	*	*	-	*	-	781.10	1205.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.	*	*	*	*	-	*	-	204.75	204.75
17.	Provide final finish with slope protection Sec. A.	*	*	*	*	-	*	-	116.80	116.80
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev	*	*	*	-	*	*	-	214.73	373.94
19.	Construct 2nd stage Sec. B main embankment to full design elev.	*	*	*	-	*	*	-	53.63	53.63

Contd...Page-2-

ITEM NO.	DESCRIPTION OF ACTIVITIES	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	COST EST. MILLION - TK. W/O R/W	COST EST. MILLION - TK. WITH R/W
20.	Provide final finish with slope protection Sec. B	*	*	*	-	*	*	-	27.17	27.17
21.	Construct 1st stage Sec. C main emb. to 2m below final design elev.	*	*	*	-	-	-	-	596.70	808.50
22.	Construct 2nd stage Sec. C main embankment to full design elev.	*	*	*	-	-	-	-	98.75	98.75
23.	Provide final finish with slope protection Sec. C.	*	*	*	-	-	-	-	56.05	56.05
24.	Construct 1st stage Sec. A' sub embankment to elev.	*	*	*	*	-	*	-	73.06	140.42
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.	*	*	*	*	-	*	-	55.57	55.57
26.	Provide final finish with slope protection Sec. A'.	*	*	*	*	-	*	-	12.06	12.06
27.	Construct 1st stage Sec. B' sub embankment to elev.	*	*	*	-	*	*	-	289.98	369.23
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.	*	*	*	-	*	*	-	40.79	40.79
29.	Provide final finish with slope protection Sec. B'.	*	*	*	-	*	*	-	30.51	30.51
30.	Construction of 1st stage Sec. C' sub embankment to elev.	-	-	*	-	-	-	-	289.98	369.23
31.	Construction 2nd stage Sec. C' sub embankment to full design elev.	-	-	*	-	-	-	-	40.79	40.79
32.	Provide final finish with slope protection Sec. C'.	-	-	*	-	-	-	-	30.51	30.51
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4	*	*	*	*	-	*	-	63.50	63.50
34.	Construction of sluices (East Emb.) No. 5, 6, 7	*	*	*	-	*	*	-	39.50	39.50
35.	Construction of sluices (East Emb.) No. 8, 9	*	*	*	-	-	-	-	57.00	57.00
36.	Construction of sluices (East Emb.) No. 10	*	*	*	-	-	-	-	* 100.00	* 100.00
37.	Perform Site investigations on Pump Station No. 3	*	*	*	*	*	*	*	0.65	0.65
38.	Perform site investigations on Pump Station No. 4, 5 & 6	*	*	*	-	-	-	-	2.20	2.20
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*	*	*	*	*	*	*	616.01	791.78
40.	Construction of Khal improvements 2nd Phase JICA	*	*	*	-	-	-	-	238.02	346.05

* use 40,000 for Plan C.

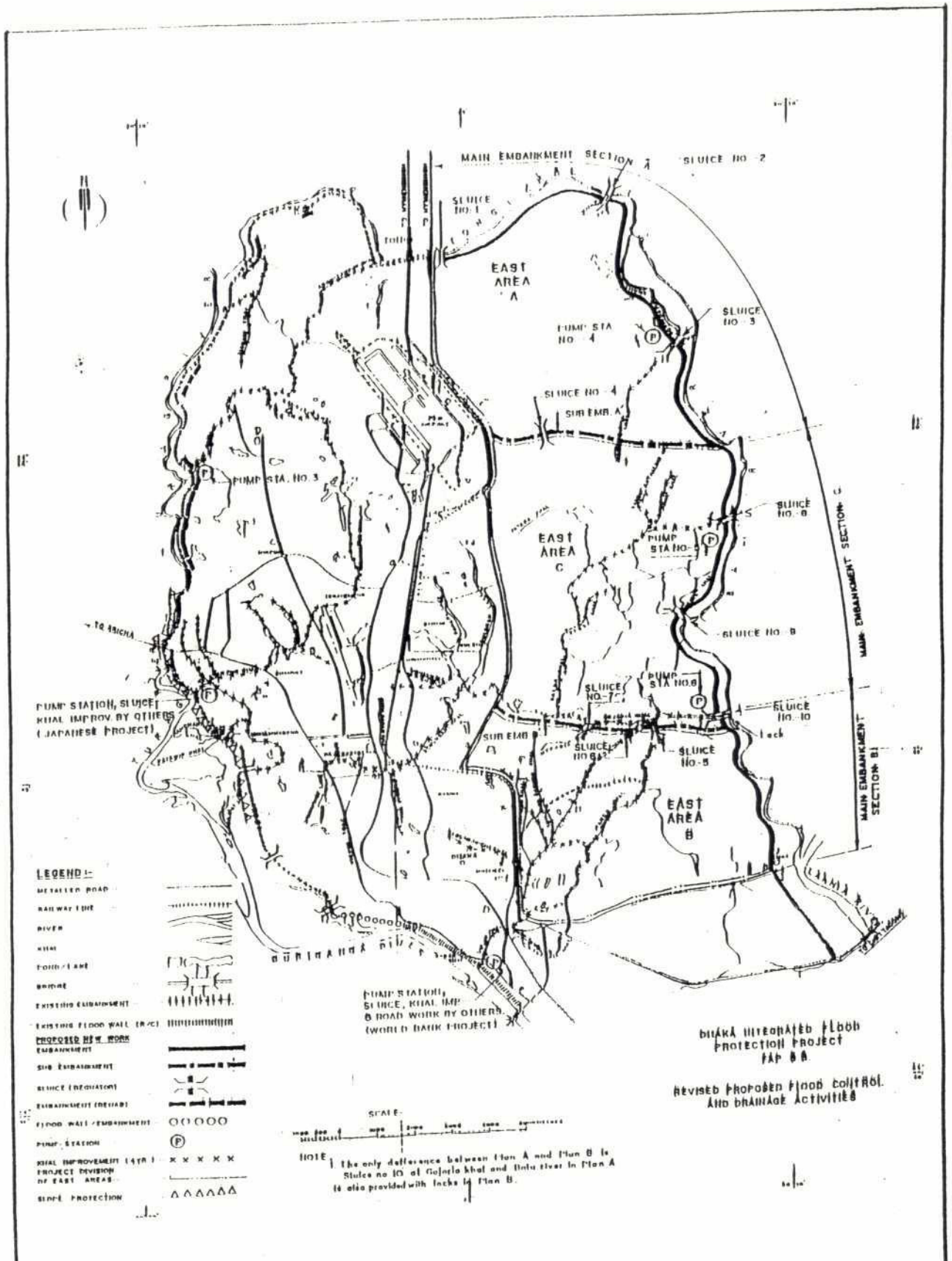
Contd...Page-3-

ITEM NO.	DESCRIPTION OF ACTIVITIES	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	COST EST. MILLION - TK. W/O R/W	COST EST. MILLION - TK. WITH R/W
41.	Construction of Khal improvements - Other	*	*	*	-	-	-	-	243.42	483.86
42.	Construction of Drainage improvements - pipe	*	*	*	-	-	-	-	344.40	411.00
43.	Construct Pump Station No. 3	*	*	*	*	*	*	*	1130.00	2440.00
44.	Construction Pump Station No. 4	*	*	*	-	-	-	-	760.00	1139.50
45.	Construction Pump Station Nos. 5 & 6	*	*	*	-	-	-	-	2535.00	4431.50
46.	Site investigations for locks	-	*	-	-	-	-	-	0.65	0.65
47.	Construction of locks at Gojaria Khal & Balu River	-	*	-	-	-	-	-	60.00	60.00
48.	Site investigations for bridge at Gojaria Khal & Balu River	-	-	*	-	-	-	-	0.65	0.65
49.	Construction of Bridge at Gojaria Khal & Balu River	-	-	*	-	-	-	-	20.00	20.00
50.	Construction of Sluices No. 11 & 12	-	-	*	-	-	-	-	55.00	55.00

ESTIMATED COST :	TOTAL COST W/OUT R/W MILLION TK.	R/W COST MILLION TK.	TOTAL COST INCL. R/W MILLION TK.	TOTAL COST INCL. R/W MILLION $US
PLAN A: Improvements required for entire area with sluice No.10	9609.09	5228.36	14837.45	412.15
PLAN B: Improvements required for entire area with sluice & locks	9669.74	5228.36	14898.10	413.84
PLAN C: Improvements required for entire area with sluice & bridge	9987.04	5307.61	15294.65	424.85
PLAN D: Improvements required for Phase - I Area plus East Area A	3877.71	2087.03	5964.74	165.69
PLAN E: Improvements required for Phase - I Area plus East Area B	3265.76	1834.13	5099.89	141.66
PLAN F: Improvements required for Phase-I Area plus East Areas A&B	4575.75	2325.49	6901.24	191.70
PLAN G: Improvements required for Phase - I Area.	2567.72	1595.67	4163.39	115.65

Notes: (1) Estimated cost for the proposed activities include construction costs contingencies and engineering (design, QA & QC and monitoring) contingencies vary from 10 to 30 percent depending upon the type of work and amount of information available for preparation of the estimate. Estimates for engineering vary from 5 to 10 percent depending upon the amount of participation expected by the various involved Governmental agencies. Right-of-way costs have been estimated seperately and would be considered to be a local cost. No costs have been included for price escalation during the implementation period.

(2) R/W = Right-of-Way.



Dhaka Integrated Flood Protection Project ঢাকা সমন্বিত বন্যা নিয়ন্ত্রণ প্রকল্প Ministry of Irrigation, Water Development and Flood Control	Louis Berger International, Inc. In Association with Associated Consulting Engineers Ltd. Desh Upadesh Limited Techno-Consult International Ltd.	FIGURE 3.4 PLAN A & B

table3-4

TABLE 3.4
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - A

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR				PRIORITY	COST ESTIMATE MILLIONS - TK.
		1	2	3	4		
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/Floodwall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*****				A	2.50
10.	Perform site investigations on Sec. A' (East) sub embankment.	*****				A	0.65
11.	Perform site investigations on Sec. B (East) main embankment.	*****				A	0.70
12.	Perform site investigations on Sec. B' (East) sub embankment.	*****				A	1.03
13.	Perform site investigations on Sec. C (East) main embankment.		*****			A	1.80
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev		*****			B	781.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.			*****		B	204.75
17.	Provide final finish with slope protection Sec. A.				*****	B	116.80
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev		*****			B	214.73
19.	Construct 2nd stage Sec. B main embankment to full design elev.			*****		B	53.63
20.	Provide final finish with slope protection Sec. B				*****	B	27.17
21.	Construct 1st stage Sec. C main emb. to 2m below final design elev.		*****			C	596.70
22.	Construct 2nd stage Sec. C main embankment to full design elev.			*****		C	98.75
23.	Provide final finish with slope protection Sec. C.				*****	C	56.05
24.	Construct 1st stage Sec. A' sub embankment to elev 7.0 m. PWD		*****			B	73.06
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.			*****		B	55.57
26.	Provide final finish with slope protection Sec. A'.				*****	B	12.06
27.	Construct 1st stage Sec. B' sub embankment to elev 6.6 m. PWD		*****			B	289.98
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.			*****		B	40.79
29.	Provide final finish with slope protection Sec. B'.				*****	B	30.51

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PLAN - A

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4		*****			B	63.50
34.	Construction of sluices (East Emb.) No. 5, 6, 7		*****			B	39.50
35.	Construction of sluices (East Emb.) No. 8, 9		*****			C	57.00
36.	Construction of sluices (East Emb.) No. 10		*****			C	100.00
37.	Perform site investigations on Pump Station No. 3	*****				A	0.65
38.	Perform site investigations on Pump Station No. 4, 5 & 6		*****			B	2.20
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****	*****			A	616.51
40.	Construction of Khal improvements JICA 2nd Phase		*****	*****		B	238.02
41.	Construction of Khal improvements - other			*****	*****	C	243.42
42.	Construction of Drainage improvements - other				*****	D	344.40
43.	Construct Pump Station No. 3		*****	*****		B	1130.00
44.	Construction Pump Station No. 4			*****	*****	C	760.00
45.	Construction Pump Station No. 5 & 6			*****	*****	C	2535.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.1
Embankments, including site Invest. :	3102.07	32.3
Sluices, including site Invest. :	292.00	3.0
Slope Protection :	40.80	0.4
Khal Improvements :	1442.02	15.0
Flood-Wall/Embankment :	296.55	3.1
Pump Station :	4425.00	46.1

TOTAL = 9609.09 Million Tk.
266.92 Million $US.
Exchange rate 36.0 Tk.=1 US$

table3-5

TABLE 3.5
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - B

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR				PRIORITY	COST ESTIMATE MILLIONS - TK.
		1	2	3	4		
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/Floodwall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*****				A	2.50
10.	Perform site investigations on Sec. A' (East) sub embankment.	*****				A	0.65
11.	Perform site investigations on Sec. B (East) main embankment.	*****				A	0.70
12.	Perform site investigations on Sec. B' (East) sub embankment.	*****				A	1.03
13.	Perform site investigations on Sec. C (East) main embankment.		*****			A	1.80
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev		*****			B	781.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.			*****		B	204.75
17.	Provide final finish with slope protection Sec. A.				*****	B	116.80
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev		*****			B	214.73
19.	Construct 2nd stage Sec. B main embankment to full design elev.			*****		B	53.63
20.	Provide final finish with slope protection Sec. B				*****	B	27.17
21.	Construct 1st stage Sec. C main emb. to 2m below final design elev.		*****			C	596.70
22.	Construct 2nd stage Sec. C main embankment to full design elev.			*****		C	98.75
23.	Provide final finish with slope protection Sec. C.				*****	C	56.05
24.	Construct 1st stage Sec. A' sub embankment to elev 7.0 m. PWD		*****			B	73.06
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.			*****		B	55.57
26.	Provide final finish with slope protection Sec. A'.				*****	B	12.06
27.	Construct 1st stage Sec. B' sub embankment to elev 6.6 m. PWD		*****			B	289.98
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.			*****		B	40.79
29.	Provide final finish with slope protection Sec. B'.				*****	B	30.51

Contd...Page-2-

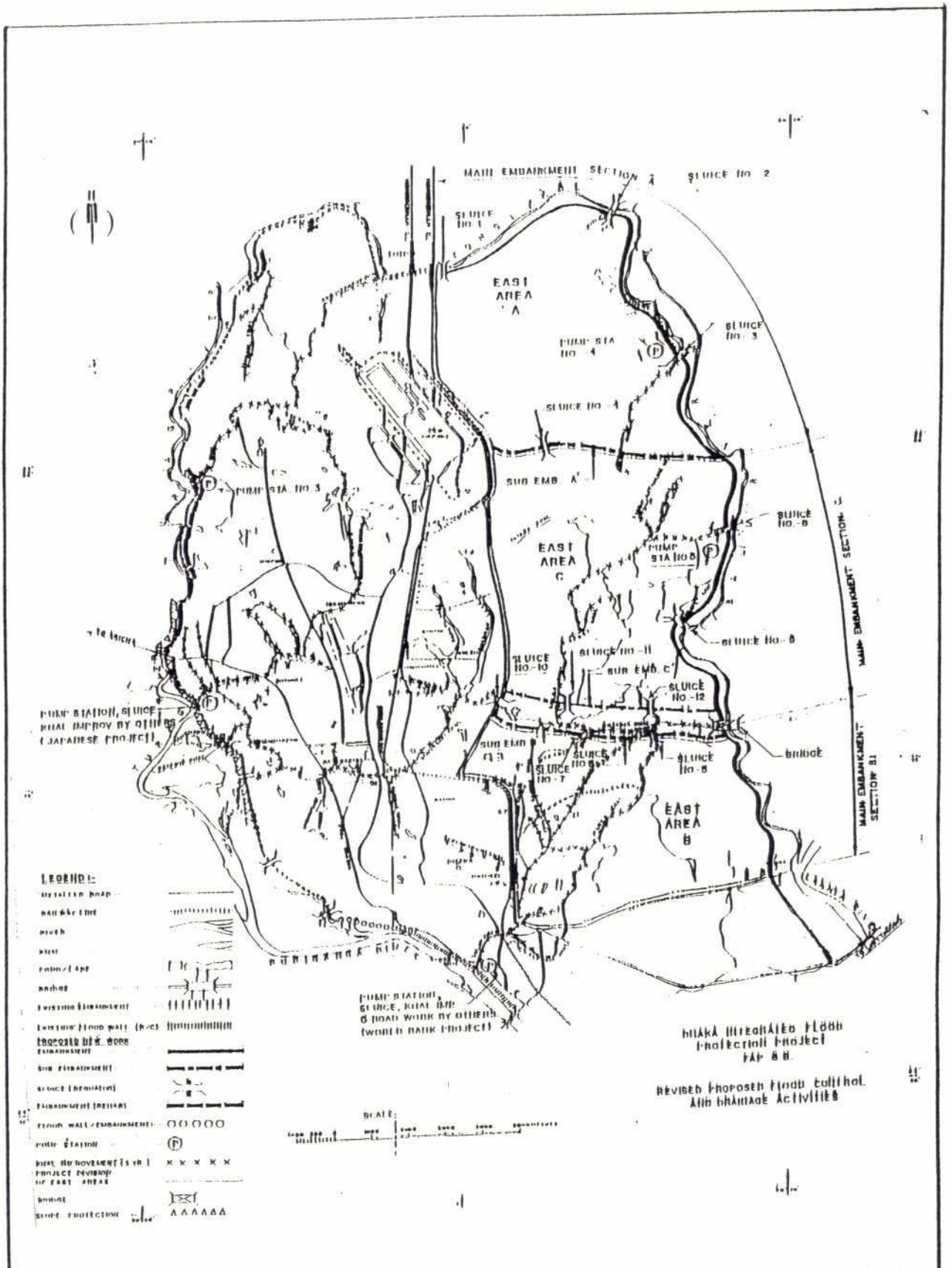
ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4		*****			B	63.50
34.	Construction of sluices (East Emb.) No. 5, 6, 7		*****			B	39.50
35.	Construction of sluices (East Emb.) No. 8, 9		*****			C	57.00
36.	Construction of sluices (East Emb.) No. 10		*****	*****		C	100.00
37.	Perform Soils investigations on Pump Station No. 3	*****				A	0.65
38.	Perform soils investigations on Pump Station No. 4, 5 & 6		*****			B	2.20
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase,JICA)	*****	*****			A	616.51
40.	Construction of Khal improvements JICA 2nd Phase		*****	*****		B	238.02
41.	Construction of Khal improvements - other			*****	*****	C	243.42
42.	Construction of Drainage improvements - pipe				*****	D	344.40
43.	Construct Pump Station No. 3		*****			B	1130.00
44.	Construction Pump Station No. 4			*****	*****	C	760.00
45.	Construction Pump Station No. 5 & 6			*****	*****	C	2535.00
46.	Soil investigations for locks/sluice		*****			B	0.65
47.	Construction of locks/sluice at Gojaria Khal & Balu River			*****	*****	C	60.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.1
Embankments, including site Invest. :	3102.72	32.1
Sluices, including site Invest. :	292.00	3.0
Slope Protection :	40.80	0.4
Khal Improvements :	1442.02	14.9
Flood-Wall/Embankment :	296.55	3.1
Pump Station :	4425.00	45.8
Locks :	60.00	0.6

TOTAL = 9669.74 Million Tk.

268.60 Million $US.

Exchange rate 36.0 Tk.=1 US$



Dhaka Integrated Flood Protection Project ADB TA No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control	Louis Berger International, Inc. In association with Associated Consulting Engineers Ltd. Dash Woodrush Limited. Technoconsult International Ltd.
FIGURE 3.5	
PLAN C.	

table3-6

TABLE 3.6
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - C

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR				PRIORITY	COST ESTIMATE MILLIONS - TK.
		1	2	3	4		
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/Floodwall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*****				A	2.50
10.	Perform site investigations on Sec. A' (East) sub-embankment.	*****				A	0.65
11.	Perform site investigations on Sec. B (East) main embankment.	*****				A	0.70
12.	Perform site investigations on Sec. B' (East) sub-embankment.	*****				A	1.03
13.	Perform site investigations on Sec. C (East) sub-embankment		*****			A	1.80
14.	Perform site investigations on Sec. C' (East) main embankment.		*****			A	1.02
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev		*****			B	781.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.			*****		B	204.75
17.	Provide final finish with slope protection Sec. A.				*****	B	116.80
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev		*****			B	214.73
19.	Construct 2nd stage Sec. B main embankment to full design elev.			*****		B	53.63
20.	Provide final finish with slope protection Sec. B				*****	B	27.17
21.	Construct 1st stage Sec. C main emb. to 2m below final design elev.		*****			C	596.70
22.	Construct 2nd stage Sec. C main embankment to full design elev.			*****		C	98.75
23.	Provide final finish with slope protection Sec. C.				*****	C	56.05
24.	Construct 1st stage Sec. A' sub embankment to elev 7.0 m. PWD		*****			B	73.06
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.			*****		B	55.57
26.	Provide final finish with slope protection Sec. A'.				*****	B	12.06
27.	Construct 1st stage Sec. B' sub embankment to elev 6.6 m. PWD		*****			B	289.98
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.			*****		B	40.79
29.	Provide final finish with slope protection Sec. B'.				*****	B	30.51

Contd...Page-2-

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PLAN - C

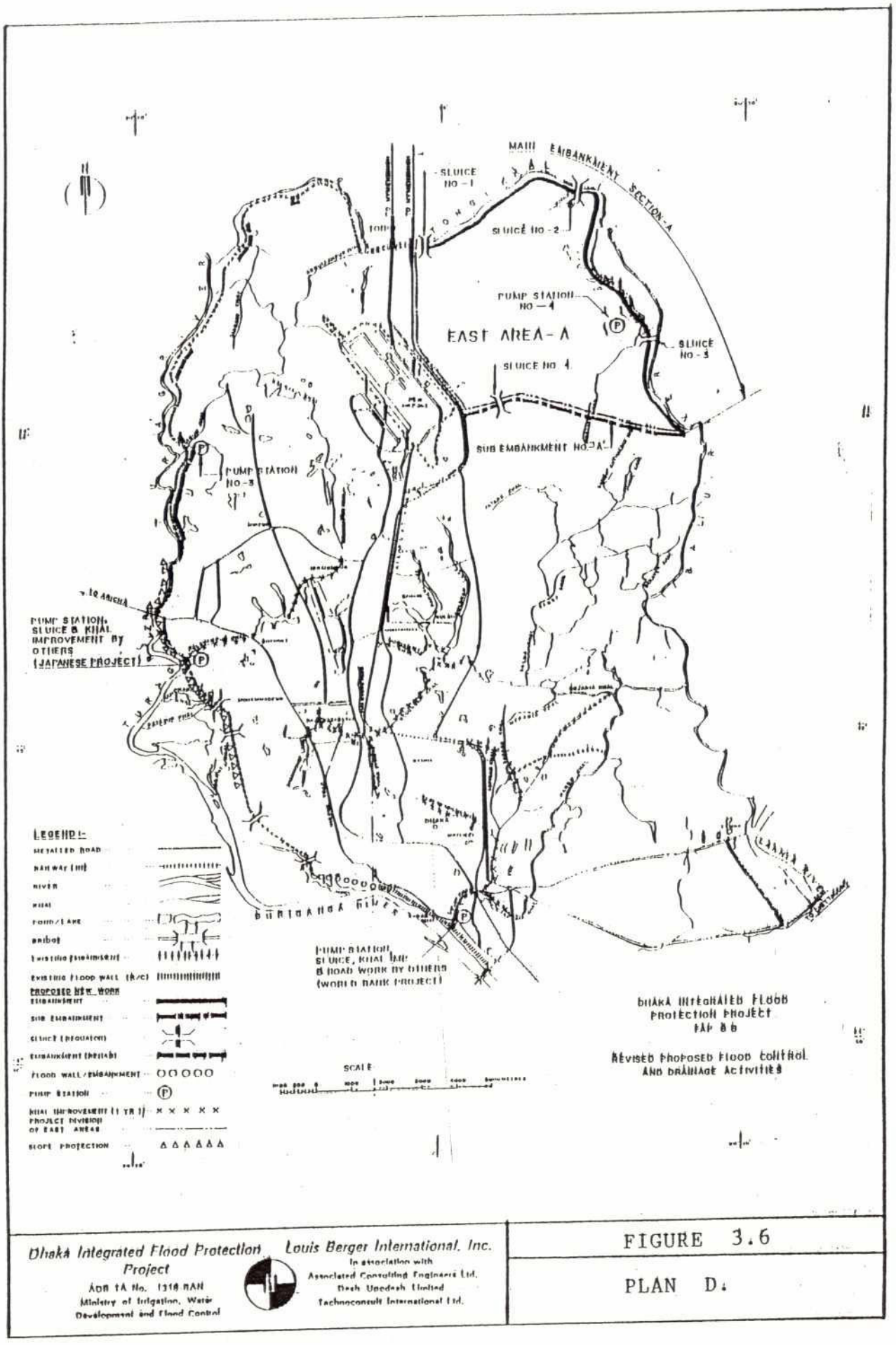
ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
30.	Construct 1st stage Sec. C' sub embankment to elev.		*****			C	289.98
31.	Construct 2nd stage Sec. C' sub embankment to full design elev.			*****		C	40.79
32.	Provide final finish with slope protection Sec. C'.				*****	C	30.51
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4		*****			B	63.50
34.	Construction of sluices (East Emb.) No. 5, 6, 7		*****			B	39.50
35.	Construction of sluices (East Emb.) No. 8, 9		*****			C	57.00
36.	Construction of sluices (East Emb.) No. 10		*****	*****		C	40.00
37.	Perform site investigations on Pump Station No. 3	*****				A	0.65
38.	Perform site investigations on Pump Station No. 4, 5 & 6		*****			B	2.20
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****	*****			A	616.11
40.	Construction of Khal improvements 2nd Phase JICA		*****	*****		B	238.02
41.	Construction of Khal improvements - other			*****	*****	C	243.42
42.	Construction of Drainage improvements - pipe				*****	D	344.40
43.	Construct Pump Station No. 3		*****			B	1130.00
44.	Construction Pump Station No. 4			*****	*****	C	760.00
47.	Construction Pump Station No. 5 & 6			*****	*****	C	2535.00
48.	Soil investigations for bridge at Gojaria Khal & Balu River		*****			C	0.65
49.	Construction of Bridge at Gojaria Khal & Balu River			*****		C	20.00
50.	Construction of Sluices No. 11 & 12			*****		C	55.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.1
Embankments, including site Invest. :	3465.02	34.7
Sluices, including site Invest. :	287.00	2.9
Slope Protection :	40.80	0.4
Khal & Drain Improvements :	1442.02	14.4
Flood-Wall/Embankment :	296.55	3.0
Pump Station :	4425.00	44.3
Bridge :	20.00	0.2

TOTAL = 9987.04 Million Tk.

277.42 Million $US.

Exchange rate 36.0 Tk.=1 US$



Dhaka Integrated Flood Protection Project ADB TA No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control	Louis Berger International, Inc. In association with Associated Consulting Engineers Ltd. Desh Upadesh Limited Technoconsult International Ltd.
FIGURE 3.6	
PLAN D.	

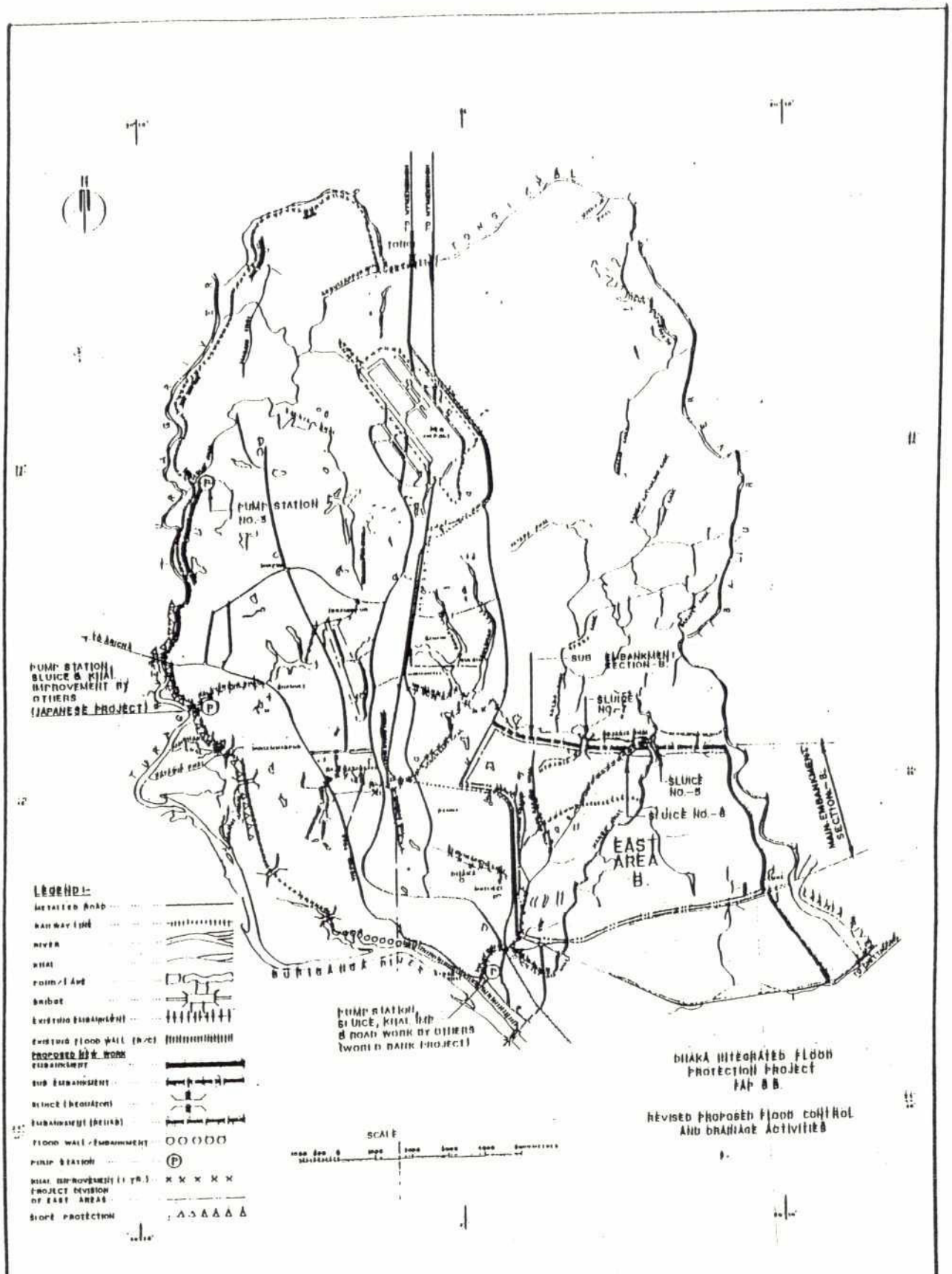
table3-7

TABLE 3.7
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - D

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/Flood-wall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*****				A	2.50
10.	Perform site investigations on Sec. A' (East) sub embankment.	*****				A	0.65
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev		*****			B	781.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.			*****		B	204.75
17.	Provide final finish with slope protection Sec. A.				*****	B	116.80
24.	Construct 1st stage Sec. A' sub embankment to elev 7.0 m. PWD		*****			B	73.06
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.			*****		B	55.57
26.	Provide final finish with slope protection Sec. A'.				*****	B	12.06
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4		*****			B	63.50
37.	Perform site investigations on Pump Station No. 3	*****				A	0.65
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****	*****			A	616.11
43.	Construct Pump Station No. 3		*****	*****		B	1130.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.3
Embankments, including site Invest. :	1687.70	43.5
Sluices, including site Invest. :	95.90	2.5
Slope Protection :	40.80	1.0
Khal Improvements :	616.11	15.9
Flood-Wall/Embankment :	296.55	7.7
Pump Station :	1130.00	29.1

TOTAL = 3877.71 Million Tk.
107.71 Million $US.
Exchange rate 36.0 Tk.=1 US$



Dhaka Integrated Flood Protection Project FAP 8A & 8B, 1418 MAN Ministry of Irrigation, Water Development and Flood Control	Louis Berger International, Inc. in association with Associated Consulting Engineers Ltd. Rush Hendrick Limited Techno-consult International Ltd.	FIGURE 3.7 PLAN E

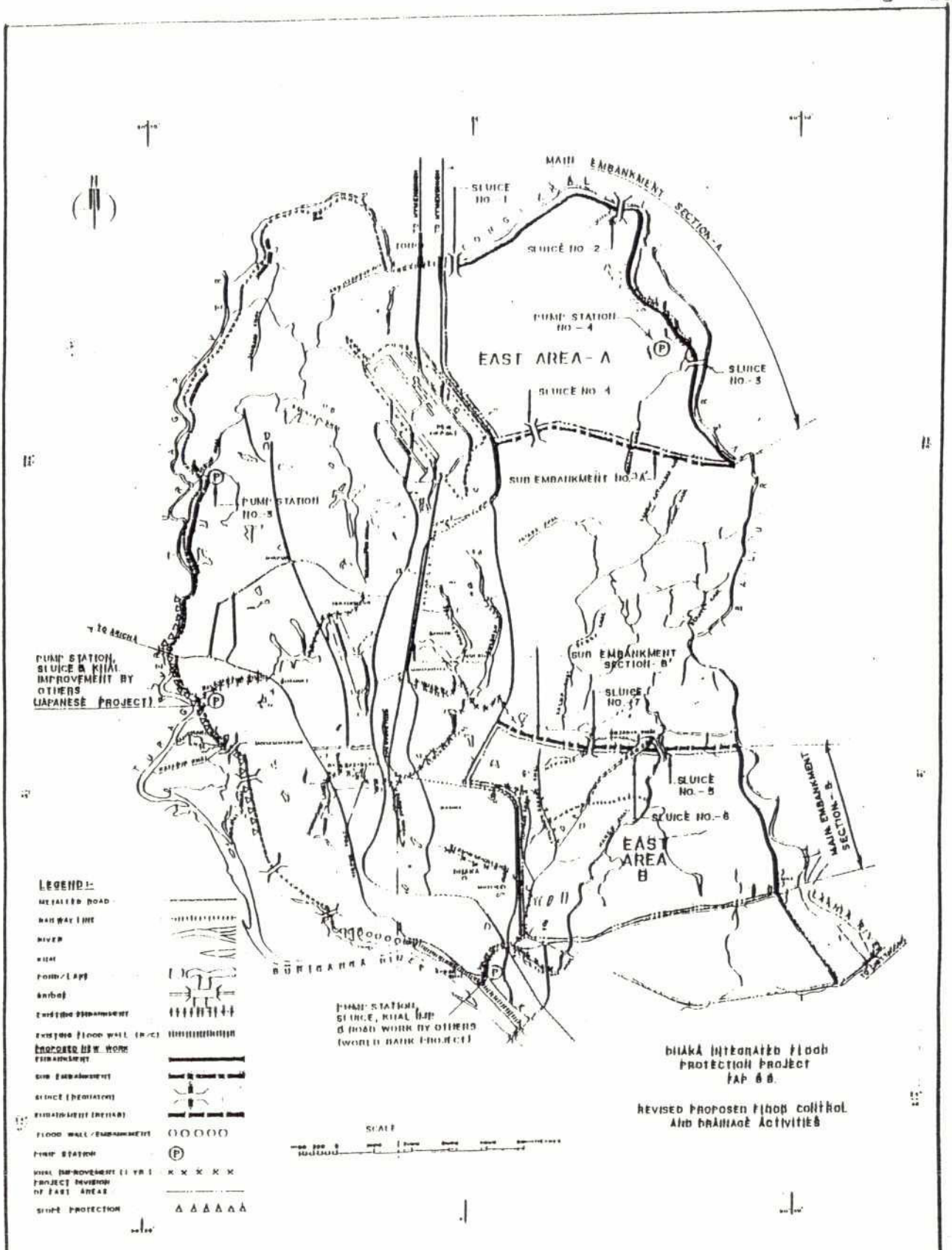
table3-8

TABLE 3.8
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - E

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/flood-wall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
11.	Perform site investigations on Sec. B (East) main embankment.	*****				A	0.70
12.	Perform site investigations on Sec. B' (East) sub embankment.	*****				A	1.03
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev		*****			B	214.73
19.	Construct 2nd stage Sec. B main embankment to full design elev.			*****		B	53.63
20.	Provide final finish with slope protection Sec. B				*****	B	27.17
27.	Construct 1st stage Sec. B' sub embankment to elev 6.6 m. PWD		*****			B	289.98
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.			*****		B	40.79
29.	Provide final finish with slope protection Sec. B'.				*****	B	30.51
34.	Construction of sluices (East Emb.) No. 5, 6, 7		*****			B	39.50
37.	Perform site investigations on Pump Station No. 3	*****				A	0.65
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****	*****			A	616.11
43.	Construct Pump Station No. 3		*****	*****		B	1130.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.3
Embankments, including site Invest. :	1100.15	33.7
Sluices, including site Invest. :	71.50	2.2
Slope Protection :	40.80	1.2
Khal Improvements :	616.11	18.9
Flood-Wall/Embankment :	296.55	9.1
Pump Station :	1130.00	34.6

TOTAL = 3265.76 Million Tk.
90.71 Million $US.
Exchange rate 36.0 Tk.=1 US$



Dhaka Integrated Flood Protection Project FAP 8A No. 1318 BAN Ministry of Irrigation, Water Development and Flood Control	Louis Berger International, Inc. In association with Associated Consulting Engineers Ltd. Desh Upodesh Limited Technoconsult International Ltd.
FIGURE 3.8	
PLAN F.	

table3-9

TABLE 3.9
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - F

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR				PRIORITY	COST ESTIMATE MILLIONS - TK.
		1	2	3	4		
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/flood-wall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
9.	Perform site investigations on Sec. A (East) main embankment.	*****				A	2.50
10.	Perform site investigations on Sec. A' (East) sub embankment.	*****				A	0.65
11.	Perform site investigations on Sec. B (East) main embankment.	*****				A	0.70
12.	Perform site investigations on Sec. B' (East) sub embankment.	*****				A	1.03
15.	Construct 1st stage Sec. A main emb. to 2 m below final design elev		*****			B	781.10
16.	Construct 2nd stage Sec. A main embankment to full design elev.			*****		B	204.75
17.	Provide final finish with slope protection Sec. A.				*****	B	116.80
18.	Construct 1st stage Sec. B main emb. to 2 m below final design elev		*****			B	214.73
19.	Construct 2nd stage Sec. B main embankment to full design elev.			*****		B	53.63
20.	Provide final finish with slope protection Sec. B				*****	B	27.17
24.	Construct 1st stage Sec. A' sub embankment to elev 7.0 m. PWD		*****			B	73.06
25.	Construct 2nd stage Sec. A' sub embankment to full design elev.			*****		B	55.57

Contd...Page-2-

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
26.	Provide final finish with slope protection Sec. A'.				*****	B	12.06
27.	Construct 1st stage Sec. B' sub embankment to elev. 6.6 m PWD		*****			B	289.98
28.	Construct 2nd stage Sec. B' sub embankment to full design elev.			*****		B	40.79
29.	Provide final finish with slope protection Sec. B'.				*****	B	30.51
33.	Construction of sluices (East Emb.) No. 1, 2, 3, 4		*****			B	63.50
34.	Construction of sluices (East Emb.) No. 5, 6, 7		*****			B	39.50
37.	Perform site investigations on Pump Station No. 3	*****	*****			A	0.65
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****				A	616.11
43.	Construct Pump Station No. 3		*****	*****		B	1130.00

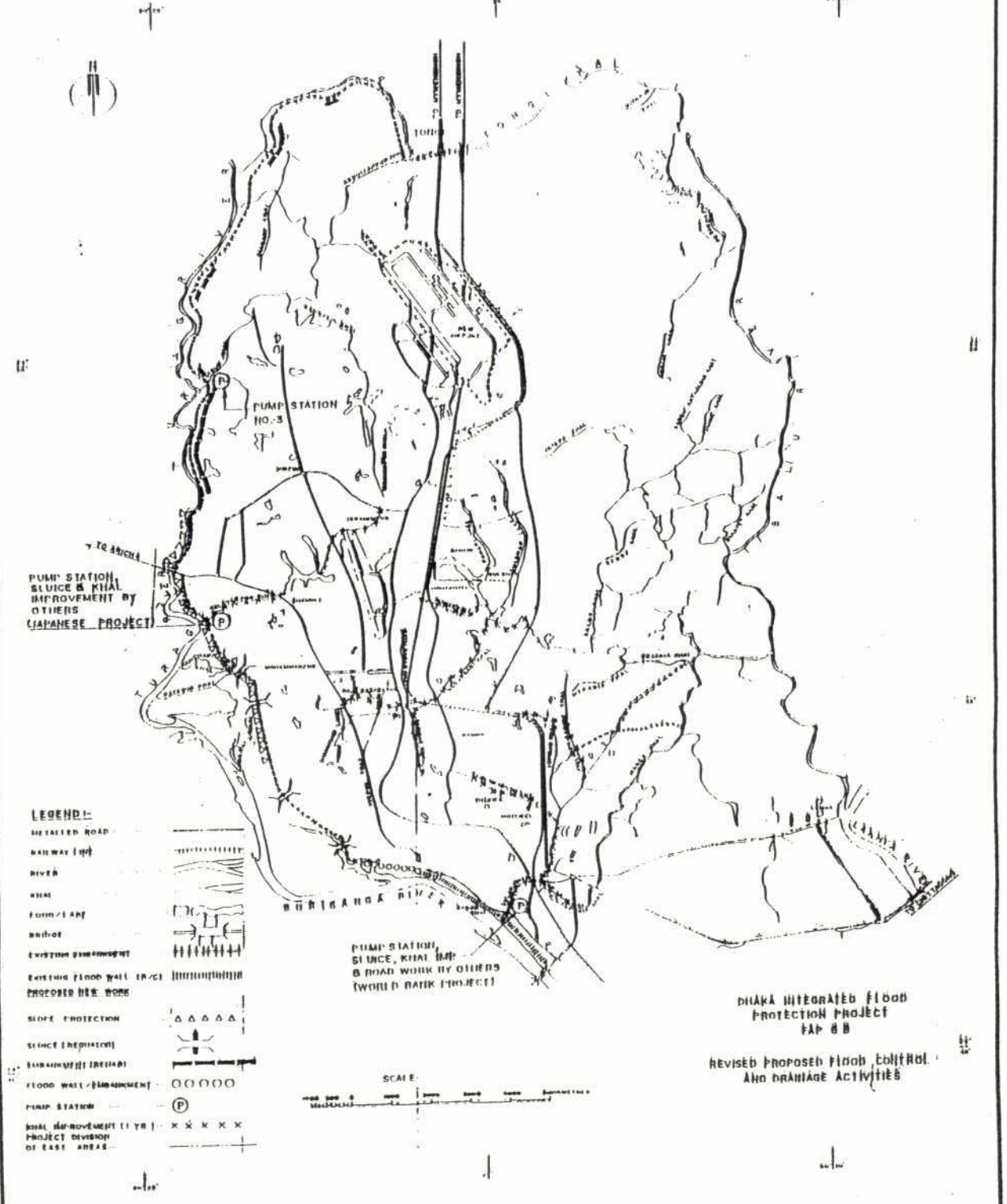
SUMMARY OF COST ESTIMATE :

		% of Total
Soil Test Laboratory & Equipment :	10.65	0.2
Embankments, including site Invest. :	2346.64	51.3
Sluices, including site Invest. :	135.00	3.0
Slope Protection :	40.80	0.9
Khal Improvements :	616.11	13.5
Flood-Wall/Embankment :	296.55	6.5
Pump Station :	1130.00	24.7

TOTAL = 4575.75 Million Tk.

127.10 Million $US.

Exchange rate 36.0 Tk.=1 US$



Dhaka Integrated Flood Protection Project
ADB TA No. 1318 BAN
Ministry of Irrigation, Water Development and Flood Control

Louis Berger International, Inc.
In association with
Associated Consulting Engineers Ltd.
Nath Haydock Limited
Environmental International Ltd.

FIGRE 3.9

PLAN G.

table3-10

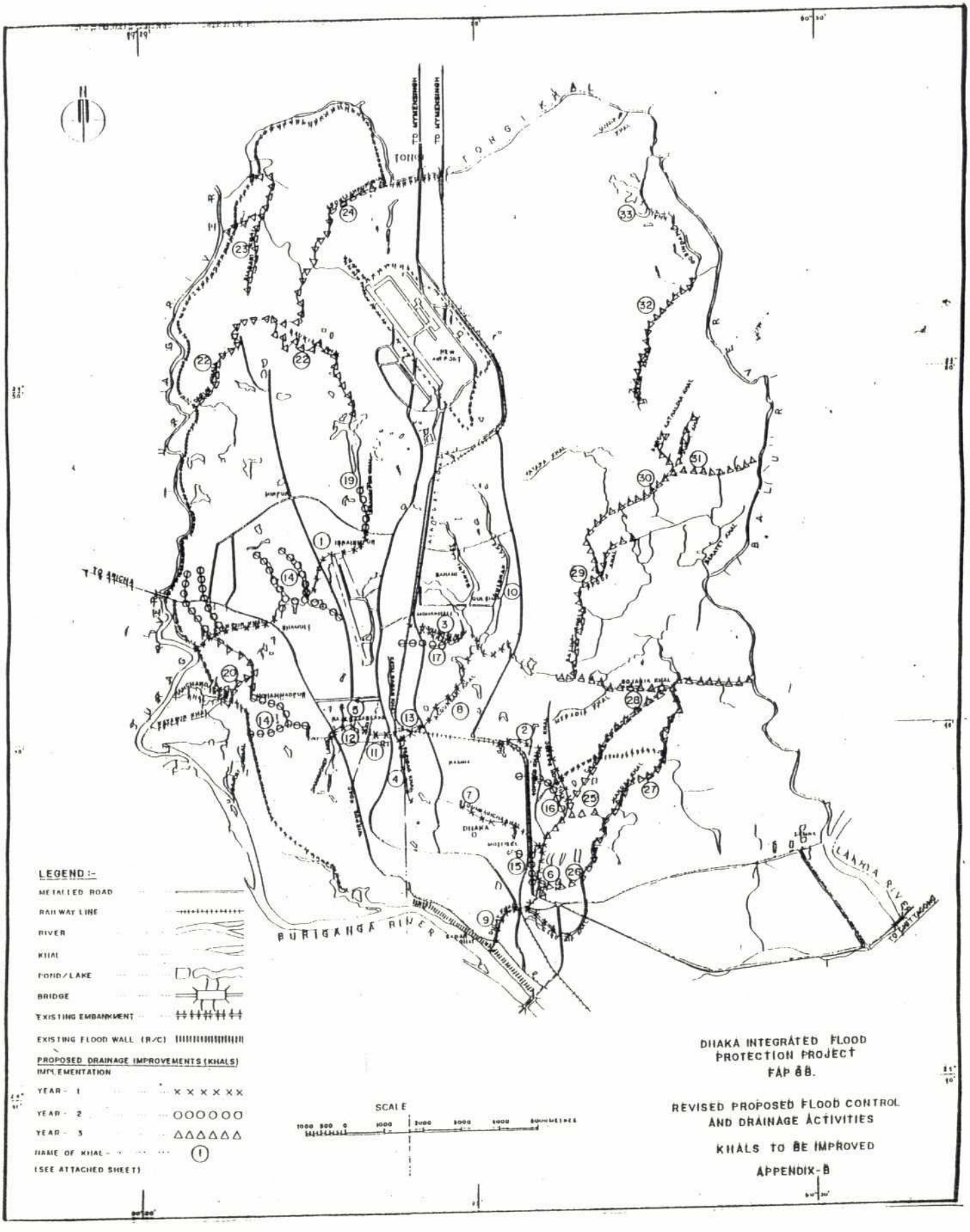
TABLE 3.10
PROPOSED IMPLEMENTATION SCHEDULE & COST ESTIMATE
FOR PLAN - G

ITEM NO.	DESCRIPTION OF ACTIVITIES	YEAR 1	2	3	4	PRIORITY	COST ESTIMATE MILLIONS - TK.
1.	Construct soil testing laboratory with equipment.	*****				A	10.65
2.	Perform site investigations for rehabilitation of west embankment.	*****				A	5.00
3.	Construct 1st stage on rehabilitation of west embankment.	*****				A	216.34
4.	Construct 2nd stage on rehabilitation of west embankment.		*****			A	173.10
5.	Finish and provide slope protection for west embankment.		*****	*****		A	46.52
6.	Construct sluices on west embankment (Satmasjid-Kellar Morh).	*****				A	32.00
7.	Construct Embankment/Floodwall (Kellar Morh-Mitford Hospital)	*****				A	296.55
8.	Provide Slope Protection on West Embankment for more severe waves	*****				A	40.80
37.	Perform site investigations on Pump Station No. 3	*****				A	0.65
39.	Construction of Khal improvements(10 Khals-urgent & 1st Phase JICA)	*****				A	616.11
43.	Construct Pump Station No. 3		*****	*****		B	1130.00

SUMMARY OF COST ESTIMATE :		% of Total
Soil Test Laboratory & Equipment :	10.65	0.4
Embankments, including site Invest. :	441.61	17.2
Sluices, including site Invest. :	32.00	1.2
Slope Protection :	40.80	1.6
Khal Improvements :	616.11	24.2
Flood-Wall/Embankment :	296.55	11.6
Pump Station :	1130.00	44.0

TOTAL = 2567.72 Million Tk.
71.32 Million $US.
Exchange rate 36.0 Tk.=1 US$

27


TONGI KHAL
BALU R.
BURIGANGA RIVER
LAKHYA RIVER
LEGEND :-
METALLED ROAD
RAILWAY LINE
RIVER
KHAL
POND / LAKE
BRIDGE
EXISTING EMBANKMENT
EXISTING FLOOD WALL (R/C)
PROPOSED DRAINAGE IMPROVEMENTS (KHALS)
IMPLEMENTATION
YEAR - 1
YEAR - 2
YEAR - 3
NAME OF KHAL
(SEE ATTACHED SHEET)
SCALE
DHAKA INTEGRATED FLOOD PROTECTION PROJECT
FAP 8B.
REVISED PROPOSED FLOOD CONTROL AND DRAINAGE ACTIVITIES
KHALS TO BE IMPROVED
APPENDIX-B

ESTIMATE FOR DRAINAGE WORKS-BOTH OPEN AND CLOSED DRAINS

APPENDIX B

						CONSTN COST		LAND COST					LAND AREA
1	2	3	4	5	6	7	8	9	10	11			12
SL. NO.	ZONE	NAME OF KHAL	SUM-BOL		CONSTN COST W/O R.WAY	6+20%	LAND COST AND AREA-X COST/AREA	50% OF 8	TOTAL COST SUM OF 7+9	LENGTH OF KHAL IN METRE			50% OF TOTAL LAND AREA (b)
										OPEN	CLOSED	TOTAL	
1	I.	IBRAHIMPUR	K-23		67.74	81.29	19.64	9.85	91.14	290	1,570	1,860	1.62 Acre
2	D.	KHILGAON-BASABO	K-8		32.91	39.49	68.85	34.43	73.92	1,946	384	2,330	4.25
3	G.	MOHAKHALI (PART-I)	K-13		58.27	69.92	60.75	30.38	100.30	437	1,783	2,220	3.75
4	F.	PARIBAG	K-11		44.48	53.38	-	-	53.38	0	767	767	-
5	F.	RAZABAZAR (WEST)			2.04	2.45	-	-	2.45	0	195	195	-
6	C.	GERANI	K-4		2.85	3.42	24.30	12.15	15.57	1,204	0	1,204	1.50
7	C.	SEGUNBAGICHA-ARAMBAG	K-5		9.72	11.66	100.99	50.49	62.15	978	2,964	3,942	3.21
8	F.	BEGUN BARI (TONGI DIVSN-MANDA KHAL)	K-9		33.77	40.52	48.00	24.00	64.52	4,500	320	4,820	8.00
9	B.	DHOLIKHAL (WORLD BANK PROJECT)	K2-3		-	-	-	-	-	-	-	-	-
10	G.	BANANI - GULSHAN (NOT NEEDED)			-	-	-	-	-	-	-	-	-
11	F.	KATHAL BAGAN	S-13		1.65	1.98	3.38	1.69	3.67	0	110	110	0.10
12	F.	BEGUN BARI (MIRPUR RD-GREEN RD)	K-10		120.00	144.00	-	-	144.00	0	1,000	1,000	-
13	F.	BEGUNBARI (AIRPORT RD-RLY CULVERT)	K-10		140.00	168.00	25.37	12.68	180.68	0	1,000	1,000	0.75
		SUB TOTAL :			513.43	616.11	351.28	175.67	791.78	9,355.00	10,093	19,448	23.18
14	A.	KATASUR	K-1		2.55	3.06	14.40	7.20	10.26	1,500	0	1,500	2.40
15	C.	GOPIBAG	K-6		40.60	48.72	17.01	8.51	57.23	0	700	700	1.05
16	D.	SHAJAHANPUR (MOKDAKHAL)	K-7		19.70	23.64	71.28	35.64	59.28	1,000	1,200	2,200	4.40
17	G.	MOHAKHALI (PART-2)	K-12		10.50	12.60	23.98	11.99	24.59	0	700	700	1.48
18	H.	KALLYANPUR	K15-20		112.50	135.00	52.78	26.39	161.39	0	8,700	8,700	3.83
19	I.	HOUSING COLONY-IBRAHIMPUR (PART-2)	K-12		12.50	15.00	36.60	18.30	33.30	3,500	2,500	6,000	3.00
		SUB TOTAL :			198.35	238.02	216.05	108.03	346.05	6,000.00	13,800.00	19,800.00	16.16
20	A.	RAMCHANRAPUR			15.00	18.00	54.00	27.00	45.00	8,000	0	8,000	9.00
21	K.	DIGUN			20.00	24.00	34.08	17.04	41.04	8,000	0	8,000	12.00
22	I.	BAUNIA			24.00	28.80	67.50	33.75	62.55	10,000	0	10,000	15.00
23	K.	DIABARI			18.75	22.50	31.95	15.98	38.48	7,500	0	7,500	11.25
24	I.	ABDULAPUR			9.60	11.52	17.04	8.52	20.04	4,000	0	4,000	6.00
25	D.	GERANI (PART-2)			8.00	9.60	28.80	14.40	24.00	3,200	0	3,200	4.80
26	L.	MANDA (PART-1)			16.25	19.50	58.50	29.25	48.75	6,500	0	6,500	9.75
27	L.	MANDA (PART-2)			26.25	31.50	94.50	47.25	78.75	10,500	0	10,500	15.75
28	L.	GOJARIA			15.00	18.00	21.00	10.50	28.50	5,000	0	5,000	7.50
29	L.	BADDA			15.00	18.00	31.50	15.75	33.75	6,000	0	6,000	9.00
30	L.	BHRA KATALDIA			12.50	15.00	15.00	7.50	22.50	5,000	0	5,000	7.50
31	L.	DUMNE			10.00	12.00	12.00	6.00	18.00	4,000	0	4,000	6.00
32	L.	BUPAR			12.50	15.00	15.00	7.50	22.50	5,000	0	5,000	7.50
		SUB TOTAL :			202.85	243.42	480.87	240.44	483.86	80,700	0	80,700	121.05
		TOTAL OF SL'S 1 TO 32			914.63	1,097.55	1,048.20	524.14	1,621.69	96,055	23,893	119,948	160.39
		PIPE DRAINAGE (450-3000 mm dia.)			287.06	344.47	-	66.60	411.07	-	39,745	39,745	20.00
		GRAND TOTAL :			1,201.69	1,442.02	-	590.74	2,032.76	96,055	63,638	159,693	180.39

Notes: (a) Refer to attached map (khals to be improved).
(b) Total land requirement per DWASA estimates has been reduced by 50% for this estimate.

APPENDIX C

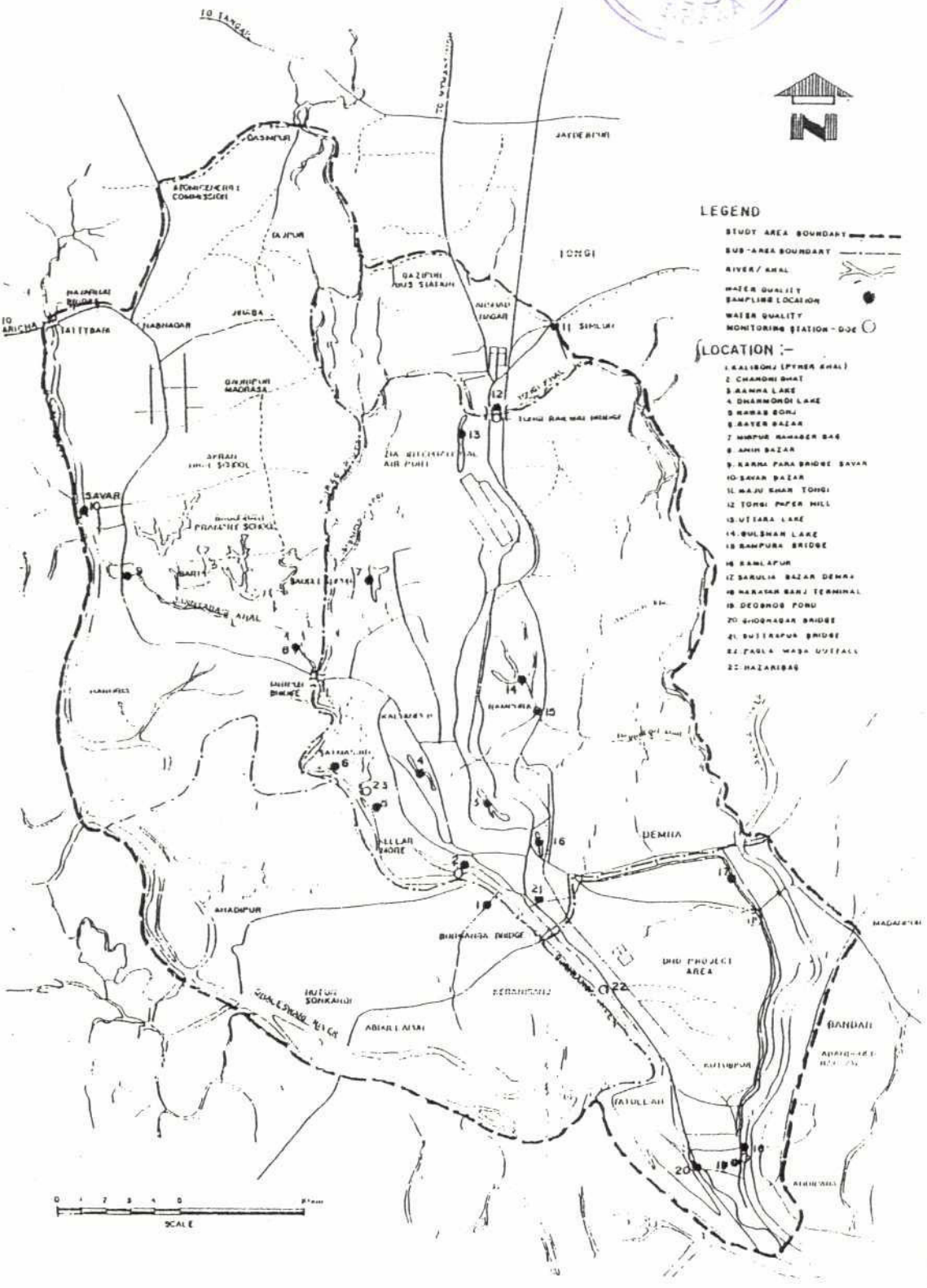


FIG. 7.5 SAMPLING AND MONITORING STATION OF WATER QUALITY

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Table 7.9 Recent Dry Season Water Quality Data of DOE Stations (Jan.~ Mar. 1988, 1989)

Monitoring Station		Sampling Period	PH	EC (µmho/cm)	TDS (mg/l)	SS (mg/l)	DO (mg/l)	BOD (mg/l)	Nc. of Sample
Index No.	Location								
DOE - 1 (2)	Chandnighat WASA Intake in Buriganga River	Jan. - Feb. 1988 Jan. - Mar. 1989	6.8 – 7.1 7.2 – 7.4	102 – 140 290 – 450	140 – 172 200 – 310	45 – 114 33 – 57	5.0 – 6.0 4.7 – 5.2	2.1 – 3.2 0.2 – 2.8	8 9
DOE - 2 (22)	Balu River near Tongi paper mill	April 1989 *	7.1 – 7.2	376 – 380	262 – 265	42 – 45	6.6 – 7.2	110 – 190	3
DOE - 11 (18)	Lakya River in Narayanganj	Jan. - Mar. 1989	7.2 – 7.4	205 – 230	145 – 162	30 – 61	5.0 – 7.4	0.9 – 2.4	9
DOE - 3 (22)	Pagla-WASA sewage effluent in Buriganga River	Jan. - Mar. 1989	7.1 – 7.4	290 – 460	4 – 320	9 – 92	5.0 – 6.7	2.0 – 3.2	9
DOE - 6 (23)	Hazaribag - Buriganga River	Feb. 1988 Jan - Feb. 1989	6.8 – 7.0 7.2 – 7.4	160 – 202 245 – 360	322 – 340 174 – 252	122 – 127 34 – 101	5.8 – 6.2 5.8 – 7.1	– 1.2 – 1.9	3 6

Note : Index No. as DOE is that of the Department of Environment as per national grid.
Index No. in parenthesis is as per that of station location shown in Fig. 7.5
* No available data for Jan. – Mar. 1988, 1989.

Table 7.10 Dry Season Water Quality Sampling Results of JICA (Jan.~Feb. 1991)

Location		PH	EC	TDS	SS	DO	BOD	COD	Org - N	NH - N	FC
No.	Description		(µmho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)
1	Painar Khal Keranigang	6.9	492	246	100	0.9	198	381	1.1	0.5	$1.8x10^6$
2*	Chandighat WASA Intake	7.1	431	215	69	3.6	9.8	64	0.7	1.3	$1.2x10^5$
3	Ramna Lake	6.8	264	130	56	3.2	3.7	83	0.8	1.1	$1.2x10^4$
4	Dhanmondi Lake	6.9	632	316	68	9.8	2.9	21	1.5	12.5	$3.2x10^5$
5	Nawabganj Khal	7.0	719	358	310	2.5	232	799	1.1	11.9	$3.6x10^6$
6	Rayer Bazar Khal	7.2	775	388	175	4.0	199	420	1.0	8.1	$4.4x10^5$
7	Nawaberbag Lake	7.1	121	61	14	6.3	1.9	5.0	0.9	1.8	$4.3x10^2$
8	Amin Bazar Bagunbari Khal	7.7	368	184	98	8.3	2.4	28	0.4	0.6	$9.0x10^3$
9	Savar Bank Town Karnatali River	7.3	473	237	22	7.8	2.8	42	1.4	0.9	$9.0x10^2$
10	Savar Bazar Banshi River	7.7	424	213	132	8.0	5.0	31	0.4	0.6	$5.0x10^3$
11	Majukhan Railway Bridge Hydrebad Khal	7.6	244	120	388	7.9	4.0	6.9	0.4	0.9	$1.3x10^4$

Location		PH	EC	TDS	SS	DO	BOD	COD	Org - N	NH - N	FC
No.	Description		(µmho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)
12*	Balu River near Tongi paper mill	7.0	338	169	108	3.4	0.4	353	0.7	1.1	$3.2x10^4$
13	Uttara Lake	6.9	159	79	228	7.6	7.0	69	0.5	0.6	$4.0x10^3$
14	Gulshan Lake	7.0	221	110	118	3.2	4.8	76	0.4	1.2	$5.1x10^3$
15	Rampura bridge Begunbari Khal	6.6	754	404	230	0	400	1334	0.8	21.8	$8.4x10^5$
16	Kamalapur Segunbagicha Khal	6.7	831	415	1560	0	348	982	1.4	23.5	$8.0x10^5$
17	Sarulia Bazar DND Khal	7.2	381	562	110.0	3.8	76	275	1.8	5.3	$3.2x10^4$
18*	Narayanganj terminal-Lakya river	7.4	303	147	12	10.6	1.5	6.9	0.3	2.6	$4.5x10^3$
19	Daobhog pond Narayanganj	7.2	1262	631	202	2.4	290	570	1.7	50.5	$1.2x10^5$
20	Ghognagar bridge Lakya khal	7.2	457	228	62	10.8	0.9	6.5	0.6	1.3	$5.0x10^2$
21	Sutrapur bridge Dholai khal	6.6	1117	562	372	0	220	812	1.6	41.0	$3.6x10^7$

Note : For locations Ref. Fig. 7.5

* Also monitoring stations of DOE

APPENDIX D

30 April, 1991

DHAKA INTEGRATED FLOOD PROTECTION PROJECT

FAP - 8B

Agriculture Sector Report

By

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1. INTRODUCTION AND PRESENT AGRICULTURAL SITUATION

The Dhaka Integrated Flood Protection Project (DIFPP) covers an area of 265.70 Sq. Km. This is divided in Phase I and II. Flood protection embankments for Phase I is on going and Phase II is proposed. The existing land use of the study area is classified as follows :

Residential	5,320	19%
Commercial	410	1%
Industrial	340	1%
Institutional	1,630	6%
Roads and others	2,930	11%
Village	1,110	4%
Agriculture	12,370	45%
Water bodies	3,430	12%
Urban total :	10,630	39%
Rural total :	16,910	61%
Grand total :	27,540	100%

The higher parts of alluvial terraced lands of Dhaka have been developed to form the urban areas. The new urbanization are taking place on the fringes of alluvial terrace. The study areas located on the alluvial plain of the three major International rivers i.e. the Ganges, the Brahmaputra and the Meghna, surrounded by the Turag River, the Balu River, the Buriganga River, Tongi Khal and their tributaries.

The low lying areas which are submerged during the monsoon season for several months by the water overflowing from the sorrounding rivers, cover more than half of the study area, used mainly for agriculture and sometimes limited area for brick yards after the monsoon season. The flood plain with a maximum depth over 3.5 m in flood season and in mostly paddy fields in dry season.

The land form is as low 2 m - 13 m above sea level, composed of alluvial terraces and low lying areas which submerged upto 2.0 - 4.0 meters during the monsoon season for several months every year. The climate of the area is classified as tropical monsoon type characterized by three seasons i.e. monsoon (rainy season), post - monsoon (dry season) and pre monsoon (transitional season). Average rainfall is about 2000 mm, 90% of which occurs during the monsoon season from May - October. Average temperatures varies from about 20°C in December and January to about 30°C in April to September. Maximum temperature sometimes exceeds 40°C in March and April. Monthly evaporation varies from 80 to 130 mm. It is the lowest in November and highest in August.

Agriculture plays a very important role in the study area. The cultivated area comprising approximately 12,370 ha which is 45% of the area of the DIFPP. Rice is predominant in the farming systems. The other crops grown are partly rice oriented cropping patterns. The rice crops are rainfed during the rainy season and irrigated during the dry season and dry periods. Farmers are using water supplied by low lift pumps or traditional methods to irrigate their rice fields or other cropped areas. Depending on land types, soil and irrigation availability rice cropping may be single or double. Limited double rice cropping in practiced in medium low lands. In some low lands cropping of T. Amon in the Kharif season and Boro in the Rabi season in practiced.

The major factors determining cropping patterns are land elevation, soils, available inputs, climate and duration and depth of flooding. Present cropping patterns in each land class have been shown in Table 1.

Table - 1 : PRESENT CROPPING PATTERN.

Land Form		Cropping Patterns
1. High land (F0) (Flood depth 0.30 cm)	:	Trees Limited T. Local Aus
2. Medium High Land (F1) (Flood depth 30-90 cm)	:	Summer and winter vegetables. Limited HYV and Local T. Aman
3. Medium Low Land (F2) (Flood depth 90-180 cm)	:	Limited HYV Boro
4. Low Land (F3) (Flood depth 180 cm and above)	:	HYV Boro/Local Boro
5. Very Low Land (F4) (Flood depth 180 cm and above)	:	Watershed, Limited Local Boro

In the high land class, most of it is occupied by homestead, trees and backyard garden crops. A very limited area is cultivated with transplanted Aus. In the medium land class, in a limited area only two cropping patterns have been identified. In the study area normal precipitation is satisfactory and with some irrigation it is possible to grow

transplanted Aman. As the major area is in the lower elevations and subject to severe inundations, only local and HYV Boro are cultivated. Most of the non-rice crops are dry land crops.

The Rabi season crops cultivated by the farmers may be early, middle or late depending on land types. Present intensity of cropping in the area is very low (estimated 110%) in comparison with that of Bangladesh as a whole. This is mainly because most of the project area lies in the low land classifications and single cropping only is possible over a large area.

In rainfed, dry land areas, growing of drought tolerant, short duration crops has been an important feature. Although high crop yields have been difficult to obtain, traditional cropping patterns do exhibit a high degree of stability. The most important dry land crops are Aus, vegetables, potatoes and mustard.

The main crops irrigated by the farmers in the area are HYV Boro and Local Boro by LLPs and traditional means. HYV T. Aus and HYV T. Aman are also grown over a limited area with irrigation.

Agriculture in the study area in still traditional and human labour and very limited bullock power are used. Farmers in addition to the use of their family labour, also hire labour. Animal power use is very limited in agricultural operations. In the low lying areas, land preparation is done by human labour and in high lands sometimes with animal power. Threshing is also done by human labour. In a very limited area, land preparation for growing crops is done by bullock driven wooden ploughs. One pair of bullocks can plough 0.15 ha of land in a day. To prepare land for seedling to transplanting 4 - 6 ploughings are necessary. Agricultural extension services in the area is very poor.

Agricultural marketing is predominently an individual business. Selling of fresh vegetables is done by the individual traders directly in the local markets. State procurement of paddy and rice are done in the harvesting season to maintain a maximum price at farm level. But sometimes in harvest season prices fall sharply. Relative output prices are the principal determinants of crop production, specially for commercial farmers. The existing situation show that these factors are also important for subsistence agriculture.

The present crop yield and level of use of inputs are very low. (Table 2) This is due to the extent and depth of monsoon flooding and the high risk of crop damage caused by floods in the premonsoon period which discourages farmers from investing in crop inputs.

Table - 2 : PRESENT CROP YIELD AND USE OF INPUTS (SELECTED CROPS)

Crops	Yield (ton/ha)	Seeds Kg/ha	Fertilizer & Manure			Insecticides kg/ha	Total Power	
			Urea kg/ha	TSP kg/ha	MP kg/ha		Labour number	Animal pair
HYV T. Aus	2.20	30	75	30	10	0.30	165	35
HYV T. Aman	1.30	30	75	30	10	0.50	165	35
Local Boro	1.25	30	-	-	-	-	155	35
HYV Boro	2.50	30	115	50	10	0.30	110	35
HYV Wheat	2.50	130	120	50	15	-	115	28
Oil Seeds(Mustard)	1.00	10	60	40	-	0.50	105	42
Potato	15.00	1000	80	50	40	-	180	45

2. POTENTIAL EFFECTS OF FLOOD CONTROL AND DRAINAGE SCHEMES ON AGRICULTURAL PRODUCTION.

2.1 Present Effects :

The normal flood period spread over 14 - 15 weeks, starting from June when a huge area of the country gets inundated. Sometimes floods may be both early and late. Early floods occur by the end of April to the 1st week of May and they submerge nearly ripened Boro paddy and young plants of Aus and deep water Aman rice. Summer vegetables are also badly affected. In case of floods which happen to occur in the end of August on first week of September, transplanted and deep water Aman paddy are destroyed. 1987-88 flood caused average crop damage estimated 110.1 million Taka.

Lack of drainage often causes heavy damages to standing crops mainly Boro and to some extent Aus and Aman. Heavy showers in early monsoon for consecutive 2-3 days often submerge nearly ripened Boro. Young transplanted Aman plants are sometimes rotten by stagnant water caused from incessant rains. Heavy damages to Boro paddy by flash floods are often reported when drainage channels from rivers have been silted up.

Flood damage crops, fruit plants, vegetables, animals, birds, fish production and dwelling houses. Among the major crops in the study areas, Boro and T. Aman are severely damaged. Among other crop, damages to T. Aman seedbeds, summer vegetables are of importance. In the hemesteads, fruit plants and trees like mango, jack fruit, papaya, banana etc. die from flood water. The damage estimates of the crops are not available except some guesses. It may be relevant to note that flood damage not only crops but also their by products and animals and poultry suffer owing to lack of fodder and veterinary care. Losses are also reported by fish farmers.

Fishery development will be effected by flood protection and drainage schemes and requires action to limit or prevent overall deterioration.

Under the present condition, the constraints imposed by monsoon flooding and the high risk of crop damage due to flash floods in the premonsoon period are such that no significant changes can be assumed in either future cropping patterns on in production levels unless flood control and drainage embankments are constructed and water regime is controlled.

Due to the construction of embankments there will be reduction of agricultural land and fertility inside embankments will be reduced due to stoppage of accumulation of fertile silt during rainy season.

2.2 Future potential effects :

The probable economic impact of flood control and drainage scheme will be :

a. More rice and other crops inside the dike.

b. Use of most agricultural land area throughout the year.

c. Reduction of damage of crops/property due to high floods.

d. Land value of certain area will increase.

2.2.1 Future Cropping pattern :

The Project area is at present mostly cropped with rice. A considerable area in however, available for cultivation in the Rabi season, and in keeping with the national policy of crop diversification, wheat (HYV), oil seeds, potatoes and vegetables have been proposed after the efficient scheme of flood control and drainage.

Further, with the improved hydrological condition, transplanting of deep water Aman has been proposed in the low land, a new technology in the area. The area enjoys sufficient rainfall during the month of April and it is suitable for transplanting of deep water T. Aman rice. By transplanting, weed competition is practically eliminated, efficiency of fertilizers in highly increased, optimum population density is assured and better primary tillering in achieved; these are all positive factors for increased yields. The only precaution that has to be taken is to ensure that transplanting is done atleast two-three weeks prior to the inlet of flood water in the field. With proper irrigation facilities, expansion of cultivation of HYV T. Aman is also proposed.

Tables 3 show the anticipated future cropping patterns for each land class.

Table 3 : FUTURE CROPPING PATTERN.

Land Form	Cropping Patterns
1. High land (F0)	Wheat - B. Aus - T. Aman. Wheat/Potato - T. Aman. HYV Boro - T. Aman
2. Medium High Land (F1)	Potato - T. Aus Winter Vegetables - HYV Boro HYV Boro - T. Aman
3. Medium Low Land (F2)	Pulses/Oilseeds/Winter Vegetables - HYV Boro.
4. Low Land (F3)	Winter Vegetables - HYV Boro/T. Deep Water Aman.
5. Very Low Land (F4)	Limited Local Boro.

2.2.2Future input use:

As the crops are subject to flood damage, the farmers at present are hesitant to invest more money on inputs. Under controlled condition when the crops are assured from flood damage, farmers will have incentive to use more inputs, better seeds and take better care of the crops. In this condition, proper (recommended) doses of inputs have been proposed to obtain optimum yields of crops.

2.2.3Future crop area, yield and production :

The areas under each crop will be based on the anticipated cropping patterns in the area after efficient flood control and drainage scheme. Although DIFPP basically a flood control and drainage project, the proposed regulators make provision for holding water for irrigation in the winter season, so that the farmers can use the water with their own efforts either by LLP or using traditional methods for lifting into the fields. Under the controlled condition, the depth of maximum flooding will be reduced. HYV T. Aman and HYV T. Aus area will be significantly increased in

high and medium lands under the prevailing rainfall condition. Considering some improvement in water storage, a modest increase in the area under Boro has been proposed and local Boro will be replaced by HYV Boro. In the controlled condition some single cropped area will be converted into double cropped areas and thus the total area under crop will be increased. The expected yields, as shown in Table - 4 may be achieved with optimum doses of inputs and protection of crop damage due to flash flooding. In addition, there will be satisfactory production of oil seeds, potatoes and vegetables. Therefore, cropping intensity may also increase at least by 200%.

Table - 4 : FUTURE CROP YIELDS AND USE OF INPUTS
(SELECTED CROPS)

Crops	Yield (ton/ha)	Seeds Kg/ha	Fertilizer & Manure			Insecticides kg/ha	Total Power	
			Urea kg/ha	TSP kg/ha	MP kg/ha		Labour number	Animal pair
HYV T. Aus	3.0	40	160	60	30	0.30	170	35
HYV T. Aman	3.5	40	100	60	30	0.50	170	35
Local Boro	2.0	40	-	-	-	-	155	35
HYV Boro	4.0	40	200	100	60	0.30	180	35
Deep Water Aman (T)	1.5	40	-	-	-	-	130	35
HYV Wheat	3.5	130	130	100	30	-	115	28
Oil Seeds (Mustard)	1.5	10	60	40	-	0.50	105	42
Potato	20.0	1200	200	160	120	-	180	45

2.2.4Land/irrigation/drainage :

The soils of DIFPP are already used intensively in many areas. However, a considerable potential exists to increase agricultural production. Realization of this potential will require further expansion of irrigation, increased and more efficient use of fertilizers and organic manures, and reduction of the risk of crop damage by floods. Institutional measures to improve the supply of agricultural inputs, credit, research and extension support, and market opportunities will also be required.

The main development requirements for lands are :

- Supplementary irrigation to make transplanted Aman production more secure.

- Reduction of peak flood - levels where it is feasible, to enable HYV Aman to be grown more extensively and securely, such flood control would also benefit Aus cultivation in some area.

Development opportunities in the monsoon season are restricted by the depth of flooding and the risk of crop damage by untimely or high floods. The greatest opportunities for increased production exist in the dry season, especially with irrigation.

The main development requirement are :

- Expansion of irrigated lands not presently irrigated to grow HYV Boro on impermeable soils and dry land Rabi cash crops on some reliably higher, permeable soils;

- Improvement of drainage in basin centers, where it is feasible, to enable HYV Boro to grow more extensively and reliably.

- Controlled flooding, where it is feasible, to enable Aus and deep water Aman to be grown securely; controlled flooding would also enable deep water Aman to be transplanted more reliably after the harvesting of Boro.

- Protection of land close to river channels from burial by sandy alluvium during high flood, where it is feasible.

Eventually, provision of pump drainage, where it is technically and economically feasible, to convert lands with appropriate cropping opportunities.

There are lands generally have little potential for improvement because of its location in the basin centers which are difficult to drain and are subject to rapid flooding during heavy local rainfall. In these areas the main development requirements are :

- Improve external drainage to enable HYV or local Boro paddy to grow more extensively or reliably.

- Provision of pump drainage to reduce flood depth and to convert some areas with appropriate cropping opportunities.

3. RECOMMENDATIONS ON APPROPRIATE OPERATION PROCEDURES IN REGULATING THE INTERIOR WATER LEVELS FOR OPTIMISING AGRICULTURAL BENEFITS.

The DIFPP project relying on embankments for flood protection is essentially aimed at :

- reducing flooding of low lying areas during the pre-monsoon season, when standing crops suffer extensively from early flooding;

- alleviating the drainage congestion problems of pre and post monsoon season;

- storing water in the post monsoon and winter seasons for irrigation.

To meet these objectives, a typical scheme includes re-excavation of existing silted up khals and/or rivers to improve drainage conditions, and the construction of regulators to control flooding and store water at the end of monsoon season. The DIFPP project include the construction of several hydraulic structures and the operation of these will have to be carried out according to regional interest.

3.1 Ways to reach the full potential :

The main way to improve agricultural development, after flood protection and drainage have been provided, is through the development of irrigation and efficient use of available water resources accompanied by the diffusion of improved techniques (improved varieties, improved soil and crop management). Possibilities to extend the total irrigated are however limited. To a certain extend there is still some scope for extension of irrigation in the medium and low land areas (atleast 25%) provided there is flood protection and controlled flooding. Irrigation will take place mainly in the "Rabi season", but will also increase cropping intensity and yields of early and late "kharif" crops where the risk of flooding on the inundation period has decreased. Efficient use of water resources can maximize the out puts of the farmers fields. The measures that may be taken are presented below:

1. For borrow areas proper planning is needed to minimize loss of agricultural land.

2. Channel lining and field levelling should be done properly, for easy movement of irrigation water.

3. Improved design of irrigation, and drainage systems to prevent formation of pools of stagnant water. This calls for proper construction and maintenance systems of the channel.

4. Proper water level control and stable water regime are needed for boosting agricultural production.

5. Rotational irrigation and alternate water supply may help to reduce water loss and to boost production.

6. Pump operation with adequate pumping capacity is needed to drain out excess water and to irrigate crops properly whenever necessary.

7. System of double lifting of irrigation water into higher lands may be needed especially during Rabi season.

8. Additional LLPs in the present rainfed areas are needed whenever the ground water availability permits.

9. In highly permeable soils, growing of dry land "Rabi crops and/or direct seeded Aus/Jute instead of HYV Boro paddy may reduce irrigation cost.

10. Provision of transportation routes/modes is needed to carry agricultural produce.

Improved soil and crop management within the dike will raise the production capacity of the area like:

- Timely planting to make optimum use of the available growing season.

- Increased and more efficient fertilizer applications following the recommendations of the Research Institutes.

- Use of manure/mulch to increase the organic matter content and to improve the moisture holding capacity of the soil.

- Better land preparation

- Levelling of fields to prevent water logging after heavy rainfall

- Making field drains to speed up drying after floods and to protect dryland crops from water logging.

- Raise platforms, beds and ridges in flood prone areas for the cultivation of cash crops like banana, vegetables and spices.

- Efficient use of pesticides and plant protection.

- Promotion of dibble and line sowing and transplanting of Aus and deep water Aman paddy.

Limitations on available and suitable land :

There are limited possibilities to raise agricultural production through the extension of cultivated area in the DIFPP in order to feed the increasing population. The best way to increase the food production is to extend the productivity per acreage. This can be done by :

- extension and improvement of irrigation
- improved soil management
- the use of HYVs, fertilizer and pesticides.
- improved flood control and drainage.

3.2 Impact of proposed agricultural development :

As mentioned before, the recommendations given can considerably boost production of food crops. With an efficient Agricultural Extension Service it is possible to motivate the farmers to practice the recommended husbandry practice. A total rise of production with the current cropped and irrigated area of 50% can easily be obtained.

If protection against flash floods and high early and late floods is provided and drainage impediments can be eliminated a further increase of production can be attained.

The production capacity per hectare is increasing with the extension of growing periods. For example : An inundation lasting 5 months reduces the growing period to 7 months. If the inundation period can be shortened by an improved drainage system, the growing period will increase. This will make it possible for farmers to plant earlier and to harvest on time. Larger lasting crop varieties with a higher yield potential can be used or an additional crop can be grown. With higher crop security, farmers are inclined to invest more on inputs like fertilizers and irrigation. Each month of extension of growing period will result in atleast 10% increase of the total production per hectare. A further impact of the increase in cropping intensity will be the lack of a sufficient number of draught animals for timely land preparation.

3.3 Impact of irrigation/drainage :

Flood protection will delay early flooding; drainage improvement will reduce early monsoon drainage and enhance timely drainage during post monsoon time. This development will allow earlier planting of "Rabi" and Boro crops and offer more security to Aman cropping. Introduction of irrigation by pumped surface water becomes more feasible in this way and physical investments more secure. Furthermore, proper water management due to compartmentlization will reduce the need for supplementary irrigation during the Aman season and will be part of the required infrastructure for irrigation development of winter crops.

4. COMPLEMENTARY DEVELOPMENT :

Flood protection and drainage improvement actions are preconditioned to other development activities or do support those. Directly linked are :

- Infrastructural development : without flood protection, construction and maintenance of infrastructure is quite more expensive.

- Agricultural Extension : with more secure flood protection and increased irrigation development the Department of Agricultural Extension has to increase its activities and efficiency.

- Furthermore, fishery development will be affected by flood protection and drainage improvement and requires action to limit or prevent overall deterioration.

CROP CALENDAR OF DIFPP