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PEOPLE'S REPUBLIC OF BANGLADESH

Ministry of Irrigation, Water Development and Flood Control

Bangladesh Water Development Board

CYCLONE PROTECTION PROJECT II - FAP 7
FEASIBILITY AND DESIGN STUDIES

FINAL PROJECT PREPARATION REPORT

APPENDIX F - OPERATION & MAINTENANCE

May 1992

Joint Venture of
KAMPSAX INTERNATIONAL A/S,
BCEOM
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD

Financed by European Community - Project No. ALA/87/05

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ABBREVIATIONS AND GLOSSARY

BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere
CE	Chief Engineer
CEP	Coastal Embankment Project
CFE	Cash Foreign Exchange Budget
CIDA	Canadian International Development Agency
DB	Development Budget
EIP	Early Implementation Project(s)
FAP	Bangladesh Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FCD/I	FCD(see above) with or without Irrigation
FFW	Food For Work
GOB	Government of Bangladesh
IDP	Infrastructure Development Programmes(LGEB)
IOM	Improved Operation and Maintenance
IRWP	Intensive Rural Works Programme
LCS	Landless Contracting Society
LGEB	Local Government Engineering Bureau
LPC	Local Project Committee
NGO	Non-government Organisation
O&M	Operation & Maintenance
O&MCC	Operation & Maintenance Cost Cell (CIDA/BWDB)
Parishad	Elected council (e.g. of Upazila or Union)
RMP	Rural Maintenance Programme (CARE)
RRA	Rapid Rural Appraisal
SDE	Sub-Divisional Engineer (BWDB)
SE	Superintending Engineer (BWDB)
SO	Section Officer (BDWB)
SRP	System Rehabilitation Project
SSDFCP	Small Scale Drainage and Flood Control Project
SSSFCDIP	Second Small Flood Control Drainage and Irrigation Project
XEN	Executive Engineer (BWDB)

REPORT VOLUMES

The present Report Volume is part of the

CYCLONE PROTECTION PROJECT II - FAP 7
FEASIBILITY AND DESIGN STUDIES
BWDB COMPONENT
FINAL PROJECT PREPARATION REPORT

Consisting of the following Volumes :

Volume 1	-	Main Report
Volume 2	-	Annexes I - XI, XIII
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Appendix A	-	Hydraulic Studies
Appendix B	-	Field Surveys and Soil Investigations
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Appendix D	-	Agriculture
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Appendix F	-	Operation & Maintenance
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1. INTRODUCTION

This O&M Report is a component part of the Cyclone Protection Project II (Feasibility and Design Studies). This project under the Terms of Reference is limited to giving priority to seafacing polders and embankments vulnerable to monsoon waves and cyclone surges. The limitation consequently forms a constraint as the project, by nature of its work, precluded any involvement in polder operation and its O&M. The report therefore takes into account the prevailing BWDB O&M organisation and management, also relying considerably on the FAP project studies aimed at improving and strengthening O&M within the BWDB.

It is understood that, pending the results of the several FAP projects, it is the intention to adopt improved O&M procedures in all O&M divisions of BWDB on or about 1994.

2. O&M BACKGROUND

During a number of review missions and studies into the benefits achieved by FCD/1 projects a lack of O&M has been identified as a major constraint

2.1 O&M Problems

Problems identified as contributory to the lack of O&M for completed projects are :

- Over emphasis on construction works to the detriment of O&M
- Insufficient funding and resulting non - optimized use of prevailing O&M funds
- Overstaffing and lack of staff motivation
- Inadequate planning of work programmes and their implementation
- Inadequate budgeting and cost control
- Lack of training specifically aimed at O&M.
- Unsuitable, non standard production of O&M manuals
- Lack of beneficiary participation.

This problem has caused such concern that O&M components have been included in a number of sub-projects within some externally aided projects or programmes, involving SSSFCEIP, DDP and EIP. Further more, there are, projects, for example FCD/I rehabilitation systems which are specifically aimed at improving O&M and remedying the constraints on benefit achievement.

2.2 Projects Directed at Improving BWDB O&M

- Systems Rehabilitation Project (SRP)
- Second Small Scale Flood Control, Drainage and Irrigation Project (SSSFCDI)
- Land Reclamation Project (LRP)
- Delta Development Project (DDP)
- Early Implementation Project (EIP)
- Ganges - Kobadak Rehabilitation Project (GK)
- Operation and Maintenance Cost Cell (O&MCC)

2.3 BWDB Headquarters Organisation for Rehabilitation, Operation & Maintenance

In addition to the projects' recommendations to improve O&M procedures, and in accordance with the FAP to strengthen BWDB, an O&M Headquarter Technical Unit has been established to improve planning, budgeting and implementation of O&M activities. This technical unit consolidates the separation of construction and O&M activities. The O&M

Technical Unit (HQ) is headed by a Chief Engineer (O&M) and composed of an O&M Directorate and a Rehabilitation Directorate. The Chief Engineer (O&M) would be responsible to the Board Member for O&M.

The unit will carry out the following broad future functions:

a. Review and consolidate the annual budget requests prepared by the field divisions which cover operation, maintenance, and rehabilitation under different budget heads (Revenue, FFW, and ADP) and establish priorities under budget constraints;

b. Develop long-term (five year) rolling budget requirements for O&M covering all operational and soon-to-be completed BWDB projects;

c. Guide the field divisions in preparing and updating O&M manuals and prepare instructions for the operation of projects;

d. Participate in scheduled maintenance reviews and monitor the progress of maintenance and rehabilitation works;

e. Assist O&M field staff in solving new and difficult problems pertaining to operation, maintenance and rehabilitation; and

f. Assist the Training Directorate in preparing and executing O&M training programs;

2.4 O&M Training

BWDB O&M organisation and management changes should be accompanied and strengthened by relevant training throughout the hierarchy of the O&M. It is understood that BWDB's Training Directorate will be strengthened to cope with appropriate training of O&M staff in the tasks for each work category.

3. OPERATION AND MAINTENANCE DEFINITIONS AND OBJECTIVES

Terminology used in various studies, reports and discussions, with particular regard to maintenance, is not standardized;

For Example ;

- Routine or preventative maintenance
- Periodic or repair maintenance

For the purpose of this report the terms routine and periodic will be used.

3.1 Definitions

3.1.1 Operation

Relates to the operation of water control structures.

3.1.2 Maintenance (General)

The work required to maintain a structure in, as near as possible to, its original as constructed condition.

3.1.3 Routine Maintenance

The year round day to day work to repair defects caused by ordinary wear and tear.

3.1.4 Periodic Maintenance

The work required to repair defects which can be carried out only when climatic or physical conditions allow, or when routine maintenance alone is no longer sufficient to preserve the structures (embankments, protective works, water control structures, plantation, buildings and equipment).

3.1.5 Emergency Maintenance

Emergency repair of damages to embankments and structures.

3.2 Flood and Cyclone Damage

Major damage caused by floods and cyclones is not considered within the scope of normal maintenance resources (labour, materials, equipment and finance) and should be financed from special budget.

3.3 Maintenance Objectives

The objectives of maintenance are :

- To maintain the embankment and hydraulic structures in such a manner that polders can operate productively and safely.
- To protect the capital investment provided for the construction of the polders.

4. THE BWDB (O&M) ORGANISATION & MANAGEMENT

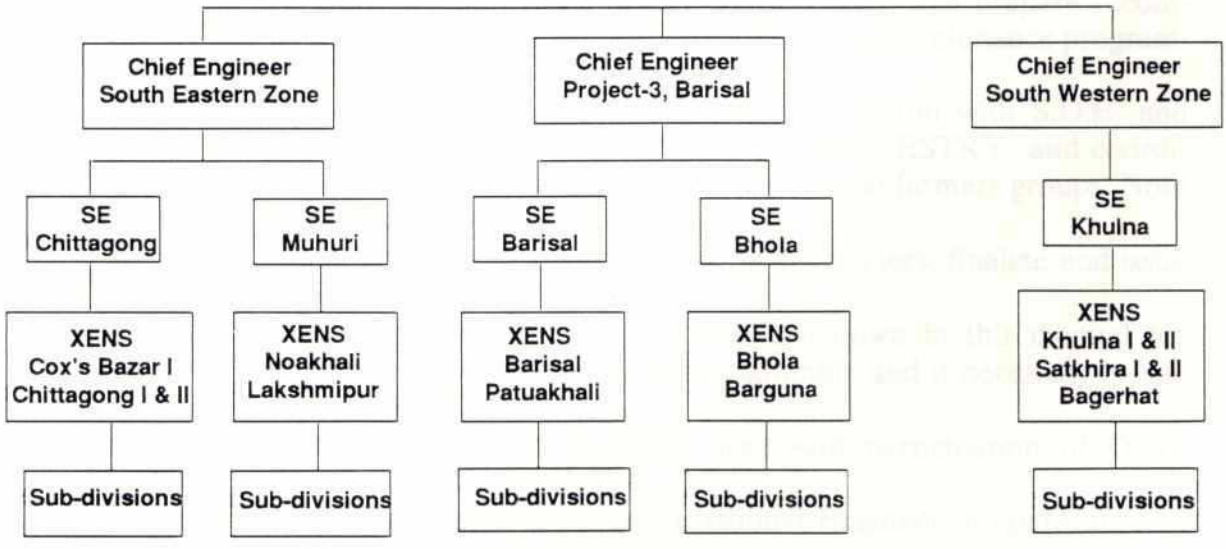
4.1 Bangladesh Water Development Board (BWDB)

The Bangladesh Water Development Board (BWDB) is a semi-autonomous public agency under the control of the Ministry of Irrigation, Water Development and Flood Control (MIWDFC) and was established in 1972. The BWDB is managed by an appointed Chairman and five Board Members, and is responsible for planning, execution and O&M of FCD/I projects along with river erosion control and town protection, and employs about 18,000 staff.

An O&M member was appointed to the board in 1983 and in 1985, the regional BWDB zones, supervised by Chief Engineers, were placed under the control of the member for O&M. The basic zonal organisation consists of:

-	Zone	Chief Engineer	(SZ)
-	Circle	Superintending Engineer	(SE)
-	Division	Executive Engineer	(XEN)
-	Sub-division	Sub-divisional Engineers	(SDE)
-		Section Officers	(SO)
-		Work Assistants	(WA)

The BWDB O&M organisation directly involved within the project area consists of :



There are, on average, 3 subdivisions within a division and each is supervised by an SDE, supported by 3 SO's and a variable number of WA's. As an average, an SDE supervises approximately 60 kms of embankment, an SO approximately 20 kms, and a WA's responsibility can vary from 5 to 10 kms of embankment.

4.2 Duties

Duties, in addition to O&M, include supervision and control of small schemes, and in some cases assessment and collection of water rates.

The duties of an Executive Engineer and his staff are as follows :

Executive Engineer (XEN)

The O&M Divisions will have to cope with all the functions envisaged in the project planning of Cyclone Protection Project II of the identified coastal embankment project. The Executive Engineers of these divisions are responsible to Superintending Engineers of respective O&M circles for efficient & timely execution of all works assigned to their divisions. The Executive Engineers besides other duties will have specific duties of CPP-II in regard to operation and maintenance. His duties include :

- Guide S.D.E. O&M Sub-divisions under their control
- Scrutinize and compile the O&M budgets prepared by sub-ordinate officers under their jurisdiction.
- Periodically (at least monthly) review the operation and maintenance programme with the S.D.E. to see that all matters of policy are properly carried out and to ensure that the programmes cover all aspects of operation and maintenance in an efficient, complete and satisfactory manner.
- Inspect the area of facilities on a regular schedule to ensure that the facilities function properly and to review and prepare recommendations for improving the operation and maintenance programme.
- Review agricultural programme in conjunction with S.D.E. and officers of D.A.E. BRDE FISHERIES, FORESTRY and coordinate the activities of SDE, local officials and farmers groups. Note any irrigation activities.
- Make necessary arrangements to invite tenders, finalize and issue work orders timely.
- Prepare a plan as per guide line laid down in this manual for materialization of the planned programme and if necessary it may be updated.
- Plan for maximum irrigation area with participation of DAE, BRDB, BADC and UCCA.
- Provide guidance to the Sub-divisional Engineer in operation and maintenance of the project.
- Maintain complaint box in XEN's office for farmers in regard to problems and suggested solutions.
- Submit Monthly Report of Operation and Maintenance to the S.E.O&M circles in the existing format used in BWDB.

Sub-Divisional Engineer (SDE)

Sub-divisional Engineers report to XEN O&M Division, on all functions pertaining to field operation, repairs and maintenance relating to coastal embankment polder. Their responsibility in regard to Operation and Maintenance will be as follows :

- Report to XEN of their O&M Division on all functions pertaining to all field operations, repairs and maintenance of the project in the existing format used in BWDB.
- Inspect periodically (at least fortnightly) the conditions of the systems, repairs, maintenance, and operation of drainage channels, embankments, drainage sluices, and other systems in the project.
- Maintain a list of repair works to be required for the year for all functions of the project. Identify points of leakage, ghogs, seepages, hollows & depressions where re-sectioning in the embankment is needed together with other major repairs and maintenance to be required for other structures and functions of the project.
- Prepare estimates on operation and maintenance works and submit to XEN in time for his approval.
- Prepare the cost estimates for the annual budgets and help XEN in the preparation of the O&M budget and submit fortnightly report on the achievement, failures or problems in regard to the O&M management in the field.
- During emergency inspect more frequently the condition of the systems and report to XEN.
- Help establish effective coordination with other agencies working in the project area.
- Provide instructions and assistance to Sectional Officers.
- Maintain complaint box in subdivision office for farmers to voice opinions on problems and suggested solutions.
- Exert all efforts to realize efficient and satisfactory completion of assigned duties of all field staff.

Sectional Officer (SO)

The Sectional Officers are to report to O&M Sub-divisional Engineer. He is responsible for supervision, repairs, maintenance and functional activities in the project area they are to :

- Report to S.D.E. in the existing format needed in BWDB.
- Supervise and direct the Work Assistants, Khalashis and work crews assigned to their area of responsibilities.
- Identify items of work for the annual maintenance and repair to be needed. Assist S.D.E. in preparation of budget estimate for the project.
- Execute all work plans drawn by XEN covering functional activities

of the project width the help of the supporting field staff.
- Maintain liaison with the other parties working within the project area, i.e. BADC, BRDB, DAE, FISHERIES and FORESTRY.
- Verify all reports recorded in work registers by Work Assistant and Khalashis. Assess the implementation of the programme assigned to the field staff. Report to S.D.E. weekly.

Work Assistant (WA)

The Work Assistants (W.A) will work under a Sectional Officer and inspect the whole of his jurisdiction thrice in a week. They are to :

- Report to S.O. thrice in a week.
- Supervise Khalashis on the basis of inspection of their work and collect reports from the Khalashis thrice in a week.
- Verify maintenance of principal features including khalashi sheds, and buildings.
- Examine khalashi work reports and verify contents.

Embankment Khalashi

The embankment Khalashis will patrol every day the whole of his jurisdiction of 8.0 km or so and report to the Work Assistant thrice in a week. Their responsibilities will be as follows:

- Report to Work Assistant and Sectional Officer any condition that is unusual or may cause serious problems requiring immediate attention.
- Identify and mark leaks, slips erosion, sand-boils, rain-cuts, overtopping, ghogs, hollows, depressions or any other unnatural condition. Report to Work Assistant on emergency minor repairs if any, after attending to it.
- Remove undesirable plant growth and re-establish a good grass turf. Eliminate cattle grazing. Submit daily report to Work Assistant of their performances.

Sluice Khalashi

The Sluice Khalashis will have the following responsibilities :

- Operate the sluice as per roster to be supplied to them by Sectional officer.
- Report to the Work Assistant any condition that is unusual, may cause serious problem, or require emergency repair.
- Report to their Work Assistant any corrosion in the steel parts of the hydraulic structures, leakage in rubber seals, structural defects, sign on failures in back-fills.
- Eradicate and/or control weeds, water hyacinth, trees or bush

which obstruct normal flow of water.

- Record daily low tide and high tide gauge reading.
- Tighten loose bolts. Lubricate moving parts of gates with water proof grease whenever required. Provide routine cleaning of wooden fall boards at instructed intervals. Paint gates with anchors every six months or as per schedule.

4.3 O&M Manuals

The Leedshill - De Leuw CEP Operation and Maintenance Manual "1967 is still used as the basic BWDB manual,, However, a number of other manuals have been produced for individual projects such as the Meghna Dhonagoda Irrigation Project, and Rehabilitation of Water Development Project (Coastal Embankment Polder 59/1A).

The Consultants have included in Chapter 11 of this report, the maintenance aspect in outline only of sections which could be considered for use in an O&M manual.

There is clearly a need for rationalizational of existing O&M manuals and the production of an updated BWDB O&M manual.

4.4 Inspections (Condition Survey)

The frequencies, responsibilities and mode of reporting on standard forms are laid down in standing orders as follows :

Office	Reporting item	Inspection Interval	Reporting interval	Mode of reporting	Sub-mitted to
P. D. (SE)	Operation and Maintenance	Annually	Annually	Written	CE(SZ)
XEN	"	Quarterly	Quarterly	Prescribed	PD, CE(SZ)
SDE	Operation	Twice monthly	Monthly	"	XEN, PD, CE
SDE	Maintenance	"	"	"	XEN, PD
S. O.	O & M	Weekly	Twice Monthly	"	SDE, XEN
Work Assistant	Maintenance	2 per week	Weekly	Written	SO
Sluice Khalashi	"	2 per week	2 per week	Verbal	WA

A considerable amount of time is involved, in travelling measurement of defects, and completion of forms particularly from SDE level down, and must lead to a considerable amount of duplication, and consideration must be taken also of the amount of time remaining for other duties the system should be reviewed to provide :

- A clear assessment of defects found
- Locations and quantities of defects
- A relationship to maintenance work activities/items for easy translation into work programmes and schedules
- Only information necessary for good management

Inspections are of prime importance to maintenance management and can be said to be the generating source of all work programmes.

Management should ensure that sufficient support and action must be given to inspection operations, failure to do so can result in delay or stoppage of work programmes.

Some problems which may be encountered are:

- Other duties causing insufficient time for the inspector to carry out inspections and reports at prescribed intervals.
- Lack of, or deprivation of transportation to carry out the inspections
- Delay in processing inspection reports and decision and directions on higher level on actions to be taken

4.5 Annual Budget O&M

The BWDB receives its O&M budget allocations from four main sources:

- Revenue budget
- Development budget
- Food for work programmes
- Cash foreign exchange budget

The four budgets are prepared separately and at present there is no system to extract and develop an overall O&M work programme.

The annual divisional O&M budget is based on the following main categories of work :

- Building repairs and construction
- Protective works
- Resectioning works
- Construction and repair of sluices
- Establishment
- Transport and equipment
- Supply of fall boards and gates

There is no facility for further breakdown of the categories into Routine and Periodic Maintenance or secondary categories to enable monitoring of financial progress and costs.

The four budget system precludes an overall estimated annual O&M budget based on need so this can be compared with the O&M budget allocated. This type of information is essential for good financial management as it would enable the O&M Technical Unit (HQ) to :

- Prove and justify the annual O&M budget requirements based on need.
- adjust work programmes in a logical manner to match funds actually allocated.
- Monitor and update O&M costs.

The forthcoming reviews, in particular the CIDA O&MCC study will no doubt aim at rationalising the present situation.

O&M revenue funds are at present consumed by establishment costs so that field engineers heavily depend on funding such as the development funds for a great part of their O&M works.

The Consultants understand that the O&M Cost Cell Project is currently examining this problem and will produce recommended solutions.

BWDB O&M engineers submit their annual budget estimates in April for the fiscal year commencing in July, Then, based on actual allocation, a revised estimate is prepared in July. Further reviews and estimate revisions generally take place in the following January.

Issue of O&M funds are on a monthly basis and field engineers consider these are received promptly and on time.

4.6 Planning of Maintenance Works

The present absence of clear definitions of O&M (in particular maintenance) and its objectives provides a severe restraint on the current annual and long term planning of O&M works.

Planning of annual maintenance work based on need requires :

- A clear definition of maintenance and its objectives
- The work activities involved
- An inventory of all BWDB facilities
- Inspecting to identify, locate, and quantify the repair work required
- Work importance in priority order
- Work standards and output
- An assessment of the resources (manpower, materials and equipment to carry out the repair work)
- Annual work programmes and schedules

The work programmes and schedules, when completed in a logical and systematic manner, provide the basis for the annual maintenance budget.

The CIDA O&MCC study has completed an inventory of all BWDB facilities, this inventory is an essential component of management, and will enable the O&M Technical Unit (HQ) to ensure that all facilities have been considered and allowed for, when preparing their annual maintenance work programmes, schedules & budget.

4.7 Work Implementation

O&M works are normally carried out by BWDB approved contractors, however, some works have been carried out satisfactorily by destitute women's groups based on payment for a predetermined quantity of work. The payment is made to the group leader who arranges distribution of payment within the group.

4.8 Polder and Sluice Committees

Polder and Sluice Committees have been formed within the project area, but the majority of them are non operational. The consultants, by nature of their work, have not been involved with any committees so are unable to comment on the reasons or causes for their present condition.

It is understood that the SSSFCDIP (IDA credit 1870-BD) has produced draft regulations 1991 which may go some way in solving committees' problem.

5. PROJECT CONDITION SURVEY

Condition surveys were carried out for the project by senior engineers and are described in Appendix B.

5.1 Location Reference System

The current BWDB location reference system was used throughout the condition survey, for the purpose of recording embankment and structure conditions and locations.

The BWDB location system consists of an embankment chainage system in kms from a specified zero chainage point, structures also have reference numbers allocated to them by the BWDB.

5.2 Inventory and Condition

The consultants produced a format for recording an embankment and hydraulic structures inventory, together with their condition. Separate forms were used, one for embankments and a second for structures.

5.3 Condition Survey Recording

The project Senior Engineers carried out the condition survey using the BWDB location reference system and the two types of recording forms.

It is suggested that possibly the format used for the condition survey could be used as part of an historical register for use in monitoring historical annual work programmes.

5.4 Review of Condition Survey

The consultants reviewed the condition survey giving optimum priority to assessing the most severely damaged embankments and structures, and then the overall implementation programme.

5.5 Operation and Maintenance

5.5.1 Operation

The condition survey did not involve polder operation.

5.5.2 Maintenance General

Throughout the duration of the condition survey at no time was there seen to be any routine or periodic maintenance being carried out, with the exception of some resectioning of embankments by the FWW orgnisation.

5.5.3 Maintenance of Embankments

The condition survey of embankments proved impossible to identify and separate, deterioration due specifically to lack of maintenance from post flood and cyclone damage. However, the consultants are of the opinion that lack of maintenance contributed to and accelerated the deterioration of embankments.

It was observed during site visits that :

- Embankments were in some cases being occupied by homesteads and side slopes becoming damaged as a consequence
- There were raincuts due to cohesionless soils or lack of vegetation.
- Numerous minor depressions
- Damaged protection works
- Scour on both the seaward and countryside slopes.
- Previous resectioning not to original design section.

5.5.4 Maintenance of Hydraulic Structures

The condition of hydraulic structures inspected during the survey gave indication that many of the defects found were as a result of lack of maintenance.

Examples of defects found were :

- Structural flaps, hinge joints and lift rods in poor condition or missing.
- Structural aprons, wing walls damaged due to erosion
- Fall boards warped, rotted or missing.

6. PARTICIPATION BY LOCAL BODIES AND BENEFICIARIES IN MAINTENANCE

6.1 Maintenance

Maintenance should have the objective of maintaining a structure (embankment or hydraulic structure) in, as near as possible to, its original as constructed condition. This involves routine maintenance and periodic maintenance as defined in section 3 of this report.

Objectives :

i. To maintain the embankment and hydraulic structures in such a manner that polders can operate productively and safely.
ii. To protect the capital cost invested in construction.

6.2 Work Activities

A series of work activities are necessary to repair defects found during inspections of both embankments and hydraulic structures. Typical work activities are shown as follows :

Embankments

Routine Maintenance

- Repair rat holes.
- Temporary sealing of minor leaks
- Ringing the minor leaks with dirt filled bags on countryside
- Draining and filling minor depressions
- Repairs to turf and rain cuts
- Maintain recently planted approved type of vegetation.

Periodic Maintenance

- Repair protection works
- Repair slips
- Repair erosion
- Planting approved type of vegetation
- Resectioning to original design section
- Permanent repair of leaks

Hydraulic Structures

Routine Maintenance

- Clean and grease moving parts of the gates with water proof grease

- Remove silt and debris that affect operation
- Remove weeds & water hyacinth in areas near intake
- Patch minor damage to the concrete structure
- Clean and maintain the khalashi shed
- Care and maintain area around the structure and khalashi shed
- Maintain and keep off all problems in the embankment and channel within 200 m of the sluice
- Check bolts.

Periodic Maintenance (low/nil water level)

- Replace water seals when necessary
- Check bolts and tighten where necessary
- Repair or replace damaged metal work
- Wire brush or chip loose paint and rust from all metal work.
- Paint all metal work and bolts with rust preventive paint
- Clean and grease moving parts of the gates with water proof grease
- Patch minor damage to the concrete structure
- Repair defective areas to blockwork aprons
- Repair and consolidate any erosion/scour in the immediate vicinity of the structure.
- Clean and repaint both upstream and downstream gauges.

It can be seen that routine maintenance work activities are labour intensive with minimum materials and equipment content, for example, hoes, baskets and hand rammers (durmuss) for embankments, and grease, grease gun and spanners for hydraulic structures. Periodic maintenance, however, is less labour oriented and requires a higher level of tradesmens-kills, materials and equipment for example, masons, cement, blocks/bricks for repair of protection works, metal work skills, blacksmith tools, spanners etc. for repair, replacement of seals for hydraulic structures.

6.3 Maintenance Alternatives

A number of recommendations have been made in the various studies and projects such as :

- Employment of destitute women on maintenance of embankments
- Long term leasing of embankment to destitute women, landless, or local farmers with the condition that they will carry out routine maintenance of their section.
- Use of landless contracting societies (LCS)
- Structure maintenance teams
- Long term leasing of immediate embankment section and hut to hydraulic structures to a khalashi
- Payment of an honorarium to a khalashi
- Forestry of embankments by NGO's

6.4 Routine Maintenance

The consultants consider that of the alternatives i) long term leasing of embankments to destitute women and landless ii) employment of destitute women on embankment and iii) either long term leasing or honorarium for khalashi should be further considered.

i. Long term leasing would enable participants to become "beneficiaries" with a vested interest in preserving the condition of the embankment. However, participants must be instructed on the work activities required and given on the job training, also methods of cultivation and planting allowed should be specified in the terms of the lease. This method of maintenance would be at no cost to the BWDB with a resulting saving of O & M funds

ii. Employment of destitute womens' groups on embankment routine maintenance would provide continuity of employment for the groups, with a vested interest in preserving the condition of the embankment. Allocation of 0.5 km of embankment per woman has been proposed with a five hour 6 day working week at Tk. 25 per day including equipment amounting to Tk. 9125 per woman for year round work or Tk. 18,250 per km of embankment.

iii. Leasing of embankment plus hut in the immediate vicinity of hydraulic structures to a khalashi would provide similar benefits as described in i) or alternatively paying an honorarium to the khalashi would reduce present costs.

Leasing can only be carried out providing all land acquisition and payment for has been finalised. This will be necessary to avoid disputes and as a consequence the groups becoming disillusioned and lacking in motivation.

6.5 Periodic Maintenance

Periodic maintenance, as its name implies, is not an all year round process but restricted to limited work conditions, such as low/nil water flow level (e.g maintenance of flap gates) or specified time intervals (maintenance of buildings). Periodic maintenance work activities can include work items both labour intensive and requiring specific labour skills (e.g. masons, welders), materials (e.g flap gates) and equipment (e.g welding gear) and therefore requires the use of both i) labour intensive groups and ii) specific skills groups.

i. Labour Intensive Groups

Labour intensive groups, as in routine maintenance, could consist of destitute women or landless paid either on a daily rate or a

negotiated lump sum basis. However groups already being used on routine maintenance should not be allocated to this work to the detriment of routine maintenance, rather that other groups should be used. Alternatively the use of Landless Contracting Societies (LCS) as developed by EIP could be considered for this type of work.

Payments to the groups involved should be paid regularly and promptly, delays will prove to be a disincentive causing lack of motivation, delays or stoppage of routine maintenance.

ii. Specific Skills Groups

These groups require specialist tools and equipment but will only be required for relatively short periods throughout the year. Retention of this type of group throughout the year would result in under utilisation of skilled labour consequently high cost.

This type of work could be developed by the use of LCS with NGO's acting as an interface between the groups and BWDB, being paid at least BWDB scheduled wage rates.

6.6 Supervision of Maintenance Works

Routine Maintenance

The work groups will be maintaining specific sections of embankments and individual khalashis the hydraulic structures throughout the year, supervision will consist of regularly monitoring quality and quantity of work, and making approved payments if required. Providing close co-ordination is maintained between the BWDB and the polder organisation, either of the two organisations could be responsible for supervision of routine maintenance.

Periodic Maintenance

Individual periodic maintenance works will have been identified, work programmed and scheduled by BWDB. Works are generally required quickly within a specified time, e.g. during low/nil water level, and require good preplanning and close supervision.

It is suggested that the BWDB supervise this work as they will have identified, quantified, budgeted, programmed and scheduled the work in their annual budget and work programmes and also have the technical expertise required.

However, the polder organisation should be advised early of the works proposed as the beneficiaries may be affected by the works.

7. A BASIC O&M MANAGEMENT SYSTEM

The consultants consider the basic elements of an O&M management system should consist of :

7.1 Location Reference System

Uses:

- Location basis for inventory of facilities.
- Location basis for inspection systems.
- Locations of maintenance defects.
- Locations for remedial work programmes.

7.2 Inventory of O&M Facilities

Uses:

- Preparation of annual work programmes.
- Preparation of annual budgets.

7.3 Typical Work Activities (for Both Routine & Periodic Maintenance)

Uses:

- Assessment of productivity (work, output).
- Assessment of unit rates.
- Preparation work programmes (short term or annual).
- Preparation of work budgets (short term or annual).

7.4 Inspections (Condition)

Uses:

- Identification, location and measurement of defects in embankments and structures for use in work programme and budgets.

7.5 Quantify Defects

Uses:

- Preparation of work programme (short term or annual)
- Preparation of work budgets (short term or annual).

7.6 Preparation of Annual Work Programme

Uses:

- Prioritising work activities particularly periodic maintenance.
- Preparation of annual work schedule.

- Preparation of annual work budget.
- Assessment or resources (labour, plant, materials); Required to complete the work Programme.

Note This programme will be based on need i.e. repair of all defects recorded during inspections, and not to anticipated financial allocation.

7.7 Work Activity Methods and Productivity

Uses:

- Method used and assessment of labour, plant and materials required to carry out activity.
- To assess productivity (work output), i.e. quantity of work produced per unit of time.

7.8 Assessment of Resources Required to Complete Annual Work Programme

Uses:

- Preparation of annual work budget.
- To review resources available with resources required using working activity methods and productivity.
- Allocation of resources for work implementation.

7.9 Preparation of Annual Work Schedule

Uses:

- To schedule work in priority order, particularly periodic maintenance.
- To assess requirement and allocation of resources for work implementation throughout the year with particular regard to seasonal or physical considerations.
- To assess likely variations in expenditure flow throughout the year.

7.10 Preparation of Annual Work Budget (According to Works Need)

Uses:

- To provide a cost of works needed to repair all defects found as the result of inspections.
- To provide a comparison between the annual work budget required according to need with anticipated budget allocation.

7.11 Review Annual Work Budget (Need) with Annual Budget (Allocated)

Uses:

- To assess shortfall, if any, of funding annual work budget (need).

- To reassess the annual work programme (need) as a result of any shortfall in annual fund allocation.

7.12 Review & Finalise Annual Work Programme and Annual Work Schedule

Uses:

- Reduction of works (by low work priorities) to match any shortfall in annual funds.
- Preparation of revised and final annual work programme and work schedule.

7.13 Reassess Resources Required for Final Annual Work Programme and Schedule

Uses:

- To finalise resources and work schedules, required to complete the new annual work programme & schedule.

7.14 Monitor Work Implementation

Uses:

- Monitor work quality
- Measure work quantities
- Monitor work activity methods
- Monitor work activity productivity
- Monitor progress of work programmes and schedules
- Prepare monthly payment certificates
- Monitor progress of work budget
- Monitor unit rates
- Maintain required records

7.15 Annual Review

Uses:

- Review annual work programmes and schedules
- Review activity work methods and productivity
- Review annual work budget
- Review and update unit rates
- Review problems which occurred during current year

Future annual or long term work programmes and budgets can now be prepared based on updated information obtained as a result of the annual review and the process repeated annually.

8. MAINTENANCE COSTS

Currently there are no maintenance costs available on the basis of maintenance as defined in this report i.e. routine and periodic maintenance. There are available, however, unit rates applicable to new or reconstruction work, a few of which could possibly be used for particular periodic maintenance work activities.

The CIDA O&M cost cell study is primarily concerned with improved management and prioritization, and with budgetary control over contractors' work. The budgetary control, however, mainly involves new construction and rehabilitation work costs rather than maintenance, no doubt maintenance costs will be established during the implementation stage in the future.

8.1 Yearly Maintenance Costs

Based on analyses on the effects of wave erosion and an information obtained from BWDB regarding repair requirements of hydraulic structures the following assessments of yearly maintenance costs per km or unit have been made. For further details on maintenance of embankment reference is made to Appendix C

Maintenance of Embankment		Yearly cost/km - Tk.
Routine maintenance based on destitute women's groups, refer chapter 6.4(ii)		20,000
Periodic maintenance based on 800 m_3 earth work/km performed by labour intensive groups		40,000
		60,000
Establishment cost 25%		15,000
Total, routine and periodic maintenance	Tk.	75,000
Repair of cyclone damages, based on yearly average of 1700 m^3 earth works/km by contractors and labour intensive groups		120,000
Establishment cost 25%		30,000
Total cost repair of cyclone damage	Tk.	150,000

Maintenance of Revetments and Protective works

Periodic maintenance		
based on 65 m^3/km by Contractor		96,000
Establishment costs 25%		24,000
Total periodic maintenance	Tk.	120,000
Repair of cyclone damages		
Based on 310 m^3/km by Contractor		465,000
Establishment costs 25%		115,000
Total repair cyclone damages	Tk.	580,000

Maintenance of Hydraulic Structures

		Average Yearly cost per Unit - Tk.
Routine maintenance		
based on one Kalachi per structure		26,500
Period maintenance		
Repair or exchange of sluice gates		22,200
Desilting		20,000
		68,700
Establishment cost 25%		17,200
Total routine and periodic maintenance	Tk.	85,900
Repair of cyclone damages		20,000
Establishment cost 25%		5,000
Total repair of cyclone damages	Tk.	25,000

8.2 Maintenance Budgets

The Mid Term Programme covers 403.3 km embankment 10.2 km revetment and a total of 79 hydraulic structures. The yearly budget requirements for maintenance can thus be estimated as follows :

Yearly Budget for Routine and Periodic Maintenance in 1000 Tk.

Embankment 403.3 x 60,000	24,198
Revetment 10.2 x 96,000	979
Structures 79 x 68,700	5,427
	30,604
Establishment cost 25%	7,651
Total Routine and Period Maintenance	38,255

Yearly Allocation for Repair of Cyclone Damages

Embankment 380.5 x 120,000	45,660
Revetment 10.2 x 465,000	4,743
Structures 79 x 20,000	1,580
	51,983
Establishment cost 25%	12,996
Total for Repair of Cyclone Damages	64,979

The above amount for repair of cyclone damages is not intended to be spent each year but should be accumulated in a cyclone repair fund to be drawn from when a cyclone causes damages on the embankments.

For a total of 22.8 km embankment cyclone damages were not considered relevant and these sections were therefore excluded from the above calculations.

9. AFFORESTATION

The Appendix Report 1 - Afforestation concludes that afforestation in the coastal area, newly accreted land, the foreland of the embankment and embankment slopes will not only protect the coastal area and improve the environment, but will also provide a source of timber, fuel wood, oil, fruits and fodder.

Three categories of plantation are recommended, i) quick maturing trees, such as Ipil Ipil, Babla, Arhar, for fuel and fodder ii) fruit bearing trees, such as Coconut, Date palm, Tal trees, Mango and Kulboroi and iii) long maturing trees such as Mahogany, Shil Koroi and Rain trees for timber.

Embankments, soil and climatic conditions vary, so these conditions would have to be evaluated before planting at specified locations.

Afforestation can be said to be an "aid to maintenance" by its contribution to the protection to the protection and preservation of embankments,however afforestation would require considerable supervision and control.

Control & supervision of afforestation could be achieved in some cases by:

- Including afforestation at the polder construction stage and seedlings established during the maintenance period
- Inclusion in any long term embankment leasing issued to destitute women, landless or farmers. The leases could stipulate the approved type of afforestation allowed.

10. TRAINING

The establishment of an O & M Technical Unit (HQ) should create a new career structure, divided from new construction work, specifically for personnel who will be involved solely in O & M. This career structure will enable BWDB to build up an O&M organisation staffed by personnel experienced in O&M and motivated to attain the required objectives.

Careful selection of personnel is essential, too often in other countries it has been seen that poor quality or "about to retire" staff have been allocated to O&M, consequently the system fails or falls into disrepute.

The formation of a new O&M organisation should be accompanied by a planned training programme for the tasks required of each category of personnel, from management through to fieldwork implementation.

The planning of training should involve close co-operation between the O&M Technical Unit (HQ) and the BWDB's Training Directorate, furthermore members of the O&M Technical Unit (HQ) must show their interest and support of training by visits to both classroom training and on-the job training.

11. BWDB O&M MANUAL

11.1 Introduction

The BWDB O&M organisation and management system is currently under review, with a number of projects and studies aimed at improving BWDB O&M and the objective of installing new organisation and management systems on or about 1994.

The Cyclone Protection Project II by virtue of the limited scope of its work (Feasibility & Design) has not been directly involved in polder organisation, or maintenance in its entirety, consequently, the Consultants consider that polder organisation is outside the scope of this project but that they can make some contribution to the maintenance aspect.

The Leedshill De Leuw O&M Manual, though some 23 years old, is still considered the official O&M manual, however a number of O&M Manuals have been produced by various projects over the years and will no doubt be considered for rationalisation in the coming O&M reviews.

It is suggested that this O&M manual should deal with maintenance in outline only and be a contribution to be considered together with detailed reviews of the BWDB O&M organisation and management.

Rehabilitation, flood & cyclone damage are not considered as being within the scope of normal maintenance. Use of maintenance resources (labour, materials, equipment & finance) can only result in lack of funds, delay or stoppage of maintenance work causing deterioration of embankments and structures and subsequently, high costs for rehabilitation or reconstruction.

11.2 Maintenance

Maintenance can be defined as the work required to preserve embankments and hydraulic structures in, or as near as possible, to their original as constructed condition. Maintenance is required from the day the embankments and structures are handed over to the O&M organisation, for example rat holes, raincuts etc. can occur in embankments and require repair, and moving parts of hydraulic structures will require greasing.

Routine and Periodic Maintenance

Maintenance can be divided into two categories :

i. Routine Maintenance

Routine maintenance is the year round day to day, work to repair defects caused by ordinary wear and tear. Some examples of routine maintenance are, repair of minor depressions in embankments

caused by wear or settlement, repair of rat holes and rain cuts, and in the case of structures, removal of weeds and debris from channel and greasing moving parts.

ii. Periodic Maintenance

Periodic maintenance is the work required to repair defects which can only be carried out when climatic or physical conditions allow, or when routine maintenance is no longer sufficient to maintain the structures (embankments, protective works, hydraulic structures, plantation, buildings and equipment).

Some examples of periodic maintenance are, repair of embankment erosion possible only at low/nil water conditions, repair of metal or concrete sections of hydraulic structures available only at low/nil water conditions. Resectioning of embankments due to settlement when routine maintenance can no longer maintain the design section of the embankment.

BWDB personnel should familiarise themselves with the terms and definitions of routine and periodic maintenance. Repair of major flood and cyclone damage are not within the scope of normal maintenance resources (labour, materials, equipment and finance).

Objectives of Maintenance

The objectives of maintenance are :

- To maintain the embankments and hydraulic structures in such a manner that polders can operate productivity and safely.
- To protect the capital investment provided for the construction of the polders.

11.3 Defects

Embankments and hydraulic structures can deteriorate because of neglect, or the affect of climatic and physical conditions. Good maintenance, by the repair of defects, will arrest the deterioration of the embankments and hydraulic structures.

Defects which occur are :

- Leaks in embankments and hydraulic structures
- Rat holes in embankments
- Depressions and settlement in embankments
- Erosion/scour of embankments and hydraulic structures
- Slip in the embankment
- Rain cuts

- Removal of vegetation
- Damage or rusting of the metal work of hydraulic structures
- Damage, settlement of concrete structures
- Lack of maintenance of moving parts of hydraulic structures
- Loose bolts in hydraulic structures
- Leaking seals in hydraulic structures

11.4 Work Activities

The defects found in embankments and structures will require repairs, by means of both routine and periodic maintenance, to ensure embankments and hydraulic structures are maintained in good condition.

The work activities required to carry out these repairs are :

Embankments

Routine Maintenance :

- Repair rat holes
- Temporary sealing of minor leaks
- Ringing the minor leaks with dirt filled bags on countryside
- Draining and filling minor depressions
- Repairs to turf and rain cuts
- Maintain recently planted approved type of vegetation.

Periodic Maintenance :

- Repair protection works
- Repair slips
- Repair erosion
- Planting approved type of vegetation
- Resectioning to original design section
- Permanent repair of leaks

Hydraulic Structures

Routine Maintenance

- Clean and grease moving parts of the gates with water proof grease
- Remove silt and debris that affect operation
- Remove weeds & water hyacinth in areas near intake
- Patch minor damage to the concrete structure
- Clean and maintain the khalashi shed
- Care and maintain area around the structure and khalashi shed
- Maintain and keep off all problems in the embankment and channel within 200 m of the sluice
- Check bolts.

Periodic Maintenance (Low/Nil Water Level)

- Replace water seals when necessary
- Check bolts and tighten where necessary
- Repair or replace damaged metal work
- Wire brush or chip loose paint and rust from all metal work.
- Paint all metal work and bolts with rust preventive paint
- Clean and grease moving parts of the gates with water proof grease
- Patch minor damage to the concrete structure
- Repair defective areas to block work aprons
- Repair and consolidate any erosion/scour in the immediate vicinity of the structure.
- Clean and repaint both upstream and downstream gauges.

11.5 Inspections

Before defects can be repaired they must be first identified by :

- Inventory of BWDB facilities
- Type, eg erosion
- Location by chainage
- Quantity by measurement

This information is required by the BWDB Engineer to enable him to draw up a work programme and schedule, together with a cost estimates for the implementation of the repair works.

11.6 Inventory of BWDB O&M Facilities

A detailed inventory of BWDB facilities (hydraulic structures, embankments, protection works, pump stations, buildings and canals) provides the BWDB with full details of facilities under their control. The facilities are generally listed by:

- Type
- Location
- Quantity
- Technical Description

This information can also be used to plan inspections as and when required.

11.7 Location Reference System

There is an existing BWDB location reference system, which should be used when recording defect locations during inspections.

This system should be used also when reporting emergencies.

11.8 Quantities

The defects must be measured using units of measurement specified by BWDB for individual work items.

Inspections are a key element in the BWDB O&M system and can be said to be the information source for work programmes, work budgets and work implementation.

11.9 Recording Defects

Standard proforma will be produced for recording information obtained during the inspections.

Care will be taken to present the proforma in a manner to provide only such information necessary for good management; superfluous and unnecessary information will only impede or clog the management system, conversely, too little information will be inadequate for management purposes.

Complete inspection reports should be submitted without delay, to supervising officers at the specified time and frequency, out of date information is little or no use to management.

11.10 Inspection Frequencies

A rational approach must be made to the frequencies and reporting periods of inspections, too short a frequency will produce too little change in information for any use or action by management, too long a frequency will allow unnecessary deterioration and consequently higher repair costs.

Care should be taken to avoid duplication of inspections over the same ground by BWDB personnel, this will only result in a waste of time and superfluous information.

11.11 Use of Inspection Information

An explanation of how the information collected by inspections is used, should be given to all BWDB personnel involved in inspections, this will give them an appreciation of the importance of inspections.

The explanation could include such subjects as :

- Use of the information for production of O&M work programmes and schedules
- Use for the production of O&M work budget estimates
- Use in the implementation of work programmes

11.12 Work Activities - Methods

BWDB personnel should not only be conversant with the work activities involved in routine and periodic maintenance but should also understand the methods to be used and resources (labour, materials & equipment) for implementation of each work activity. Standard work methods should be produced giving:

- A description of the methods to be used for the activity
- Labour, materials and equipment to be used.

The production of standard work activities will provide BWDB personnel with a universal understanding of the work activities and the methods used in maintenance repairs.

11.13 Emergency Procedures

Emergency procedures are actions required when normal inspections and maintenance have failed and rapid deterioration of embankments or hydraulic structures is imminent or has occurred.

Staff carrying out inspections must always be on the alert for signs indicating potential trouble spots before they require emergency treatment, any signs found should be reported verbally immediately and followed up with written information.

Reports should give details such as :

- Date and time of occurrence.
- Location by BWDB location reference system.
- Description of problem
- Action being taken
- Assistance required (technical advice, manpower, materials and equipment).

The O&M Technical Unit (HQ) will have the duty of drawing up and implementing an BWDB emergency action plan as a component art of an overall rational flood action plan.