

**Implementation Monitoring and Evaluation Division
Ministry of Planning
Sher-e-Bangla Nagar, Dhaka-1207**

Monitoring & Evaluation (M&E) Guideline for

**FORESTRY, IRRIGATION, WATER RESOURCES AND SHIPPING
RELATED PROJECTS**



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Table of Contents

ABBREVIATION	I
LIST OF TABLE	IV
LIST OF FIGURE	IV
EXECUTIVE SUMMARY	V
CHAPTER ONE	
INTRODUCTION.....	1
1.1 BACKGROUND OF THE STUDY	1
1.2 WHAT IS MONITORING & EVALUATION?	1
1.3 GOAL AND OBJECTIVES OF THE MONITORING & EVALUATION STRATEGY	3
1.4 MONITORING AND EVALUATION PRACTICE IN BANGLADESH	4
1.5 PROJECT MONITORING FUNCTIONS AT DIFFERENT STAGE OF PROJECTS BY IMED	5
1.6 STRENGTHS AND WEAKNESSES OF MONITORING AND EVALUATION SYSTEM.....	7
1.7 IMPORTANCE OF MONITORING & EVALUATION.....	8
1.8 IMED AND MONITORING & EVALUATION.....	9
1.9 M&E AND THE PROJECT CYCLE MANAGEMENT.....	9
1.10 WHAT IS ACTUALLY MONITORED AND EVALUATED IN THE M&E SYSTEM.....	10
1.10.1. EVALUATION STANDARDS AND KEY FEATURE	14
1.10.2. TOOLS FOR MONITORING.....	15
1.10.3. TOOLS FOR EVALUATION	16
1.10.4. BASIS AND DEMARCATION LINE/AREAS OF PROJECT MONITORING & EVALUATION.....	17
1.10.5. KEY AREAS OF PROJECT DEVELOPMENT AND MANAGEMENT ACTIVITIES UNDER M&E	18
1.10.6. MONITORING & EVALUATION, RESULT BASED MANAGEMENT AND RESULTS.....	20
1.10.7. OBJECTIVE OF THE ASSIGNMENT AS PER TERMS OF REFERENCE (TOR).....	21
1.11 SCOPE OF THE SERVICES (AS PER TOR)	21
1.12 CAUSES OF INCREASING PROJECT COST, TIME AND SCOPE IN DEVELOPMENT PROJECT.....	22
CHAPTER TWO	
METHODOLOGY OF THE STUDY	24
2.1 STUDY IMPLEMENTATION STRATEGIES	26
2.2 STUDY METHODS.....	27
2.3 SELECTION OF THE PROJECTS.....	27
2.4 DATA PROCESSING, CONSOLIDATION AND COMPILATION	31
2.5 REPORT SUBMISSION.....	32
2.6 LIMITATION OF THE STUDY	32
CHAPTER THREE	
M&E GUIDELINES FOR FORESTRY SECTOR.....	33
3.1 GLOSSARY	33
3.2 OVERVIEW ON FORESTRY SECTOR OF BANGLADESH	37
3.2.1 INTRODUCTION	37
3.2.2 IMPORTANCE OF FORESTRY SECTOR	38
3.2.3 FOREST AND CLIMATE CHANGE	39
3.2.4 SUSTAINABLE DEVELOPMENT GOALS (SDGs) AND FORESTRY	40
3.2.5 SUSTAINABLE FOREST MANAGEMENT	41
3.2.6 STATUS OF FOREST RESOURCES IN BANGLADESH	43
3.2.7 FOREST MANAGEMENT PRACTICES	46
3.2.8 PRESENT FOREST MANAGEMENT.....	48
3.2.9 SOCIAL FORESTRY	49
3.2.10 CO-MANAGEMENT OF PROTECTED AREAS	50
3.2.11 ENFORCEMENT OF ACTS, RULES AND PLANS.....	50
3.3 GUIDELINES FOR FOREST PLANTATION AND MANAGEMENT.....	53
3.3.1 INTRODUCTION	53
3.3.2 REASONS OF PLANTING FOREST TREES	53
3.3.3 AREAS TO PLANT FOREST TREES	56
A. PLANTATION SUCCESS/FAILURE.....	59

3.3.4	GUIDELINES FOR THE SELECTION OF TREE SPECIES TO PLANT	59
3.3.5	GUIDELINES TO ESTABLISH FOREST PLANTATION	62
3.3.5.1	LAY-OUT.....	62
3.3.5.2	SITE PREPARATION.....	64
3.3.5.3	PLANTING TECHNIQUE.....	66
3.3.6	GUIDELINES TO MANAGE FOREST PLANTATIONS	67
3.3.6.1	MAINTENANCE.....	68
3.3.6.2	PRUNING	68
3.3.6.3	THINNING	69
3.3.7	HARVESTING AND STARTING THE NEXT FOREST PLANTATION.....	71
3.3.7.1	FELLING SYSTEM.....	71
3.3.7.2	REGENERATION SYSTEM.....	72
CHAPTER FOUR		
M&E GUIDELINES FOR IRRIGATION SECTOR		74
4.1	GLOSSARY	74
4.2	INTRODUCTION.....	76
4.3	LITERATURE REVIEW.....	76
4.5	IMED AND IRRIGATION MANAGEMENT	80
4.6	IRRIGATION CANAL/POND/DHIGI RE-EXCAVATION	82
4.6.1	NEED OF KHAL RE-EXCAVATION	83
4.6.2	KHAL RE-EXCAVATION STEPS	84
4.6.2.1	KHAL CONSTRUCTION EQUIPMENT	84
4.6.3	STEPS OF KHAL-EXCAVATION	85
4.7	RUBBER DAM.....	91
4.7.1	ADVANTAGES OF RUBBER DAM.....	92
4.7.2	MAIN COMPONENT	93
4.7.3	RUBBER DAM CONSTRUCTION STEPS	93
4.7.3.1	STEPS OF BURIED PIPE CONSTRUCTION.....	93
4.7.3.2	CONSTRUCTION PHASE.....	94
4.8	BURIED PIPE IRRIGATION SYSTEM	98
4.8.1	COMPONENTS OF BURIED PIPE IRRIGATION SYSTEM	98
4.8.1.1	HEADER TANK.....	98
4.8.1.2	FLOW CONTROL/MEASUREMENT STRUCTURE	99
4.8.1.3	OUTLET RISERS.....	100
4.8.1.4	AIR VENT AND ESCAPE STANDPIPES.....	100
4.8.1.5	WASHOUTS	101
4.8.1.6	PUMPS	101
4.8.1.7	POWER UNIT	102
4.8.2	BURIED PIPE IRRIGATION SYSTEM CONSTRUCTION STEPS.....	102
4.8.2.1	PRE-CONSTRUCTION PHASE	102
4.8.2.2	CONSTRUCTION PHASE.....	103
4.9	CONCLUSION	109
CHAPTER FIVE		
M&E GUIDELINES FOR WATER RESOURCES SECTOR.....		110
5.1.	INTRODUCTION.....	110
5.2.	LITERATURE REVIEW.....	110
5.3.	THE IMPORTANCE OF WATER MANAGEMENT	112
5.4.	SELECTION OF PROJECTS FOR STUDY.....	113
5.5.	LITERATURE REVIEW ON FLOOD CONTROL/ RIVER BANK PROTECTION/DRAINAGE/RE-EXCAVATION OF RIVER/BAMBOO BUNDLING STRUCTURES TO REDUCE RIVER BANK EROSION ETC.....	114
5.5.1	FLOOD CONTROL.....	114
5.5.2	River Bank Protection	118
5.5.3	Drainage in DND Area.....	120
5.5.4	Bamboo Bundle Structure	121

5.6	PLANNING, DESIGN AND CONSTRUCTION	122
5.6.1	Flood Control/River Bank Protection / Re-excavation of River/ Drainage	122
CHAPTER SIX		
M&E GUIDELINES FOR SHIPPING SECTOR..... 137		
6.1	GLOSSARY	137
6.2	INTRODUCTION.....	141
6.3	LITERATURE REVIEW.....	141
6.4	STAGES OF PORT DEVELOPMENT	144
6.4.1	PRE-CONSTRUCTION PHASE OF THE PROJECT.....	144
6.4.2	PORT CONSTRUCTION.....	146
6.5	JETTY.....	167
6.5.1	Architectural Design & Engineering of Jetty.....	167
6.5.2	Civil Construction.....	168
6.5.3	Maintenance Plan and Logistics	169
6.5.4	Jetty/Ferry Ghat Construction Methodologies.....	170
6.5.5	Equipment for Jetty Construction	171
6.5.6	Dredging and Reclamation	172
6.6	SHIP BUILDING AND REPAIR (DRY-DOCK).....	172
6.6.1	Introduction	172
6.6.2	Basic Design Review.....	173
6.6.3	Material BoQ Preparing and Supply Planning	173
6.6.4	Production Drawing Preparing	173
6.6.5	Inspection and Test Plan.....	173
6.6.6	Ship Building (Production) Process.....	173
6.6.7	Dry-Dock	176
CHAPTER SEVEN		
CONCLUSION AND RECOMMENDATIONS..... 181		
LIST OF GENERAL ANNEXURE..... 184		
	ANNEX-1: TERMS OF REFERENCE (TOR) OF THE STUDY	184
	ANNEX-2: CHECKLIST OF DPP FOR THE PROPOSED STUDY.....	189
	ANNEXURE -3: CHECKLIST FOR TPP	191
	ANNEX-4: CHECKLIST FOR KEY INFORMANT INTERVIEW (KII)	192
	ANNEX-5: PROJECT LIST OF RELEVANT SECTORS OF BANGLADESH (AS PER ADP).....	194
	ANNEXURE -6: CHECKLIST FOR PROCUREMENT OF EQUIPMENTS/INSTALLATIONS WORKS	220
	ANNEX-7: MONITORING & EVALUATION (M&E) TEMPLATE	223
	ANNEX-8: SECTOR WISE SMART INDICATORS FOR MONITORING & EVALUATION	246
	ANNEX-9: CHECKLIST FOR FOREST SECTORS PROJECT	249
	ANNEX-10: TEMPLATE FOR FOREST SECTOR PROJECT.....	250
	ANNEX-11: SMART INDICATORS FOR FOREST SECTOR PROJECT	251
	ANNEX-12: CHECKLIST FOR IRRIGATION SECTORS PROJECT	252
	ANNEX-13: TEMPLATE FOR IRRIGATION SECTOR PROJECT	253
	ANNEX-14: SMART INDICATORS FOR IRRIGATION SECTOR PROJECT	255
	ANNEX-15: CHECKLIST FOR WATER RESOURCE MANAGEMENT SECTOR PROJECT	256
	ANNEX-16: M&E TEMPLATE FOR WATER RESOURCE MANAGEMENT SECTOR PROJECT	271
	ANNEX-17: SMART INDICATORS FOR WATER RESOURCE MANAGEMENT SECTOR PROJECT.....	272
	ANNEX-18: CHECKLIST FOR SHIPPING SECTOR PROJECT	273
	ANNEX-19: M&E TEMPLATE FOR SHIPPING SECTOR PROJECT.....	276
	ANNEX-20: SMART INDICATORS FOR SHIPPING SECTOR PROJECT.....	280
REFERENCES 281		

Abbreviation

ACV	Accumulated Crushing Value
AC	Alternative Current
ADB	Asian Development Bank
ADP	Annual Development Program
AGV	Automatically Governed Vehicle
AMIS	Agency Managed Irrigation System
ASTM	American Standard Testing Method
ATON	An Aid to Navigation
AU	Australia
AWM	Agricultural Water Management
B.M	Bench Mark
B.M	Bench Mark
BADC	Bangladesh Agricultural Development Corporation
BHD	Back Hoe Dredger
BIWTC	Bangladesh Inland Water Transport Corporation
BMDA	Barind Multipurpose Development Authority
BOQ	Bill of Quantity
BOT	Built Operate Transfer
BS	Bangladesh Shipping
BWB	Bangladesh Water Board
BWDB	Bangladesh water Development Board
CAE	Civil, Architectural and Environmental Engineering
CBR	Cost-Benefit Ratio
Cc	Cubic centimeter
CD	Chart Datum
CDDL	Chittagong Dry-Dock Limited
CEC	Catayon Exchange Capacity
CG	Centre of Gravity
CHS	Circular Hollow Section
CIFOR	Center for International Forestry Research
Cm	Centimeter
CMP	Construction Management Program/ Catchment Management Plan
COSHH	Control Substances Hazardous to Health
CPM	Critical Path Method
CPTU	Central Procurement & Technical Unit
CSD	Cutter Suction Dredger
DAE	Department of Agriculture Extension
DB	Design Build
DBH	Diameter at Breast Height
DBO	Design Build Operate
DC	Direct Current
DCC	Dhaka City Corporation
DEWL	Dockyard and Engineering Work Ltd
DPP	Development Project Proposal/ Proforma
ECH	Empty Container Handler
EMOP	Environmental Monitoring Plan
FAO	Food and Agriculture Organization
FAO	Food and Agricultural Organization
FAP	Flood Action Plan

FCD	Flood Control Drainage
FCDI	Flood Control Drainage and Irrigation
FCS-RAI	Committee on Food Security- Principle for Responsible Investment in Agriculture and Food System
FD	Forest Department
FDD	Field Dry Density
FSL	Full Supply Level
GI	Galvanized Iron
GIS	Geographic Information System
GPS	Global Positioning System
GPT	General preferential Tariff
GWL	Ground water Level
GWP	Ground Water Point
H:V	Side Sloop Guide Bound
HFL	High Flood Level
HIT	Hongkong International Terminal
HP	Horse Power
ICB	International Competitive Bidding
IFRC	International Federation of Red Cross and Red Crescent Societies
IMED	Implementation Monitoring & Evaluation Division
INBO	International Network of Basin Organization
IRR	Internal Rate of Returns
IS- 2720	Dry Soil Sample Indian Standard codes
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IWMM	Integrated water Management Modeling
K	Potassium
K.M	Kilometer
KSY L	Khulna Ship Yard Limited
Kw	Kilo Watt
lbs	Symbol of Pound
LEDS GP	Low Emission Development Strategies Global Partnership
LFMA	Local Forest Management Administration
LL	Liquid Limit
M&E	Monitoring & Evaluation
M ²	Miter Cube
MDD	Maximum Dry Density/ Mercantile Marine Department (MMD)
MDD	Maximum Dry Density
MHWS	Mean High Water Spring
MIKE 11	A GIS module is an ArcView. GIS-based interface featuring tools for digitizing and editing river networks, generating and displaying 3D water surfaces, flood mapping etc.
MIKE	is a state-of-the-art system for integrated dynamic modeling of groundwater and surface water systems
SHE	Surface Hydrology Evaluation
MIS	Management Information System
MLLW	Mean Lower Low Water
MM	Millimeter
MMD	Multi-Model Data Set
MPR	Multi- purpose River
MS	Mild Soft (Bar)
N	Nitrogen

NCB	National Competitive Bidding
NFL	Natural surface level
NGO	Non-Government Organization
O&M	Operation & Maintenance
OIOS	Office of Internal Oversight Services
OMC	Optimum Moisture Content
P	Phosphorus
PD	Project Director
pH	Potential of Hydrogen
PI	Project Implementation/ Principle Investigator
PKSF	Palli Karma-Sahayak Foundation
PMIS	Project Management Information System
PPE	Personal Protective Equipments
PPR	Public Procurement Rules
RBM	Result Based Management
RCC	Reinforced Cement Concrete
RDPP	Revised Development Project Proposal/ Proforma
RPCL	Rural Power Company Ltd
RPM	Rotation Per Minutes
SMART	Specific, Measurable, Achievable, Relevant and Realistic, Time-bound
SMECI	Strengthening Monitoring & Evaluation Capabilities of IMED
STP	Standard Penetration Test
SWL	Standing Water Level
TFV	Ten Percent Fine Value
ToR	Terms of Reference
TPP	Technical Project Proposal
TSHD	Trailing Suction Hopper Dredger
UK	United Kingdom
UN	United Nations
u-PVC	Un-plasticized Polyvinyl Chloride
u-PVC	Un-plasticized Polyvinyl Chloride
WFP	World Food Program
WMO	World Maritime Organization
WMS	Warehouse Management System
WUA	Water Users Association
VTS	Vessel Traffic Service

List of Table

TABLE 1: TYPES AND COMPONENTS OF MONITORING	12
TABLE 2: TYPES AND COMPONENTS OF EVALUATION	13
TABLE 3: COMPARING KEY FEATURES OF MONITORING & EVALUATION	15
TABLE 4: TOOLS FOR MONITORING	15
TABLE 5: TOOLS FOR EVALUATION.....	16
TABLE 6: PROJECT EVALUATION CRITERIA	18
TABLE 7: PROJECT DEVELOPMENT ACTIVITIES AND MANAGEMENT STAGES.....	19
TABLE 8: THE RESULTS CHAIN COMPONENTS AND THEIR COVERING AREAS	21
TABLE 9: SAMPLE PROJECTS FOR THE PREPARATION OF M&E GUIDELINES	28
TABLE 10: ADDRESSED AREAS	31
TABLE 11: SDGs RELATED TO FORESTRY SECTOR IN BANGLADESH	40
TABLE 12: SEVEN WORLDWIDE ACCEPTED CRITERIA AND SOME INDICATORS APPLICABLE TO BANGLADESH	42
TABLE 13: DISTRIBUTION OF MAJOR FOREST TYPES IN BANGLADESH	46
TABLE 14: COMPARATIVE PER HECTARE ESTIMATE FOR NUMBER OF STEMS OF LARGE POLES & TREES 10-CM DBH AND ABOVE IN THE SUNDARBANS	46
TABLE 15: SEQUENCE OF FOREST PLANTATION DECISIONS AND OPERATIONS	53
TABLE 16: END-PRODUCTS AND FOREST PLANTATION SYSTEMS AND METHODS.....	53
TABLE 17: ECOLOGIC EFFECTS OF FOREST PLANTATION ACTIVITIES.....	55
TABLE 18: GENERAL GUIDELINES FOR FOREST LAND USE ALLOCATION.....	57
TABLE 19: ASSESSMENT PROCEDURE FOR SOIL TEXTURE	57
TABLE 20: ASSESSMENT GUIDELINES FOR SOIL DRAINAGE.....	58
TABLE 21: DEFINITION OF SOIL ACIDITY (PH) CLASSES.....	59
TABLE 22: CRITERIA FOR SPECIES SELECTION BY FOREST PLANTATION SYSTEMS	59
TABLE 23: RECOMMENDED SPECIES FOR DIFFERENT PLANTATIONS OF BANGLADESH	60
TABLE 24: GUIDELINES FOR FOREST PLANTATION LAY-OUT.....	62
TABLE 25: CALCULATION OF NUMBER OF SEEDLINGS ACCORDING TO SPACING TYPE	63
TABLE 26: SILVICULTURE OF DIFFERENT TYPES OF PLANTATIONS.....	63
TABLE 27: GUIDELINES FOR PREPARATION OF PLANTING SITE	65
TABLE 28: GUIDELINES FOR PLANTING TECHNIQUE	66
TABLE 29: DEVELOPMENT STAGES AND SILVICULTURAL OPERATIONS IN EVEN-AGED FOREST PLANTATION	67
TABLE 30: GUIDELINES FOR MAINTENANCE OF FOREST PLANTATION	68
TABLE 31: GUIDELINES FOR PRUNING OF FOREST PLANTATION.....	69
TABLE 32: NUMBER OF TREES TO LEAVE IN THINNING OPERATIONS	70
TABLE 33: SELECTION OF TREES TO REMOVE IN THINNING OPERATIONS	71
TABLE 34: SUITABILITY OF FELLING SYSTEMS UNDER DIFFERENT CONSTRAINTS ON PLANTATION MANAGEMENT.....	71
TABLE 35: GENERAL RULES FOR A SUSTAINABLE HARVESTING OF FOREST PLANTATIONS	72
TABLE 36: GUIDELINES FOR THE SELECTION OF FOREST REGENERATION METHOD.....	72
TABLE 37: EQUIPMENT GENERALLY USED FOR KHAL CONSTRUCTION	84
TABLE 38: PRE-CONSTRUCTION ACTIVITIES OF KHAL RE-EXCAVATION	87
TABLE 39: CONSTRUCTION ACTIVITIES OF KHAL RE-EXCAVATION.....	88
TABLE 40: STEPS OF BURIED PIPE CONSTRUCTION.....	93
TABLE 41: STEPS OF THE CONSTRUCTION OF RUBBER DAM SYSTEM	94
TABLE 42: PRE-CONSTRUCTION PHASE OF BURIED PIPE IRRIGATION SYSTEM	102
TABLE 43: CONSTRUCTION PHASE OF BURIED PIPE IRRIGATION SYSTEM.....	104
TABLE 44: SELECTED PROJECT LIST FOR WATER RESOURCES	113
TABLE 45: PRE-CONSTRUCTION ACTIVITIES OF RIVER BANK PROTECTION AND FLOOD CONTROL	128
TABLE 46: CONSTRUCTION ACTIVITIES OF RIVER BANK PROTECTION AND FLOOD CONTROL	129

List of Figure

FIGURE 1: MONITORING QUESTIONS	1
FIGURE 2: EVALUATION QUESTIONS	2
FIGURE 3: PART OF THE M&E PLAN	3
FIGURE 4: KEY M&E ACTIVITIES IN THE PROJECT CYCLE	10
FIGURE 5: ASPECTS OF MONITORING AND EVALUATION IN THE M&E SYSTEM.....	11
FIGURE 6: BASIS AND DEMARCATION LINE/ AREAS OF PROJECT MONITORING & EVALUATION	17
FIGURE 7: PROJECT DEVELOPMENT ACTIVITIES AND MANAGEMENT STAGES	19
FIGURE 8: THE RESULTS CHAIN	20
FIGURE 9: SUMMARY OF STUDY IMPLEMENTATION PLAN	32
FIGURE 10: SILVICULTURE AND MANAGEMENT OF PLANTED FORESTS CONTRIBUTES TO SDGs	37
FIGURE 11: FOREST AREA OF BANGLADESH BY FOREST TYPES	43
FIGURE 12: FOREST COVER AND TYPES IN BANGLADESH	44
FIGURE 13: ORGANOGRAM OF THE BANGLADESH FOREST DEPARTMENT.....	52
FIGURE 14: FREQUENTLY USED TYPES OF TREE SPACING.....	63
FIGURE 15: METHOD TO PLANT A TREE SEEDLING.....	67
FIGURE 16: CORRECT POSITION OF THE SEEDLING AND SEEDLING ROOTS IN PLANTING HOLE.....	67
FIGURE 17: METHOD TO PRUNE A TREE	69
FIGURE 18: TYPICAL CROSS-SECTION OF AN IRRIGATION CANAL.....	83
FIGURE 19: KHAL RE-EXCAVATION.....	84
FIGURE 20: PLAN FORM OF A TYPICAL KHAL TO BE RE-EXCAVATED	86
FIGURE 21: USE OF RUBBER DAM	92
FIGURE 22: 3D VIEW OF RUBBER DAM	93
FIGURE 23: HEADER TANK.....	99
FIGURE 24: FLOW CONTROL/MEASUREMENT STRUCTURE.....	99
FIGURE 25: OUTLET RISERS	100
FIGURE 26: AIR VENT AND ESCAPE STANDPIPES.....	101
FIGURE 27: WASHOUTS PIPELINES CROSS-SECTION	101
FIGURE 28: CENTRAL AND MIXED FLOW PUMPS.....	102
FIGURE 29: WATER RESOURCE MANAGEMENT AND EFFECTIVE USE	112
FIGURE 30: TYPICAL LAYOUT OF RIVER TRAINING WORK.....	115
FIGURE 31: TYPICAL LAYOUT AND SECTION SPUR.....	116
FIGURE 32: TYPICAL INSTANCE OF A CUT OFF	117
FIGURE 33: MARGINAL EMBANKMENT PICTURE	117
FIGURE 34: TYPICAL LAYOUT OF BAMBOO BUNDLE STRUCTURE	121
FIGURE 35: RECOVERY OF AGRICULTURAL LAND THROUGH RIVER BANK EROSION PROTECTION	122
FIGURE 36: CROP PLANTATION WITHIN THE RECOVERED AGRICULTURAL LAND	122
FIGURE 31: UNDER CONSTRUCTION RIVER BANK PROTECTION WITH SLAB AND CC CUBES	126
FIGURE 38: AN IDEAL LOCATION FOR PORT CONSTRUCTION	145
FIGURE 33: 3D VIEW OF DREDGING AND RECLAMATION	154
FIGURE 40: 3D IMAGE TO SHOW SEQUENCE, METHOD & PLANT.....	160
FIGURE 41: VIBRO COMPACTION - FILL BEHIND QUAY	160
FIGURE 36: CONCEPTUAL DESIGN OF A JETTY.....	167
FIGURE 43: A NEWLY CONSTRUCTED JETTY IN EUROPE.....	167
FIGURE 44: SOIL TEST FOR JETTY CONSTRUCTION	168
FIGURE 45: LOAD TEST FOR JETTY PILLING	168
FIGURE 46: OFFSHORE PILLING WORK IN THE SEA	169
FIGURE 47: ISOMETRIC VIEW OF JETTY LOOKING TOWARDS MAINLAND.....	170
FIGURE 48: INTEGRATED SHIP FABRICATION	174

EXECUTIVE SUMMARY

Introduction

Implementation Monitoring and Evaluation Division (IMED) as the apex body of the Government of Bangladesh responsible for monitoring and evaluation of development project is implementing a project called '**Strengthening Monitoring & Evaluation (M&E) Capabilities of IMED (SMECI)**'. One main purpose of the Monitoring & Evaluation (M&E) is to carry out regular field review of development projects to keep the IMED well informed with the latest progress of projects in the field level together with desk review of progress based on the periodic monitoring reports received from the ministries and agencies. By this process, the IMED informs the relevant ministries and agencies with the problems affecting the progress of projects for taking remedial actions at their end, so that project's physical and financial progress can be accelerated.

Under the SMECI project, the IMED is developing a number of sector specific guidelines. Shahidul Consultant is engaged to develop such guidelines for the forestry, irrigation, water resources and shipping sectors.

Monitoring is routine collection and analysis of information to track progress against set plans and check compliance to established standards. It helps identify trends and patterns, adapt strategies and take informed decisions for project/programme management.

Evaluation is an assessment, as systematic and objective as possible, of an ongoing or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, developmental efficiency, effectiveness, impact and sustainability.

IMED is involved in all stages of project planning, monitoring implementation and terminal as well as impact evaluation of projects. At the pre-project stage the IMED assesses rationale of the project, the proposed cost estimates, possibility of overlap or duplication with other project, checks learning from similar past projects, and checks proposed manpower, institutional framework and likely sustainability.

During implementation IMED is involved in preparing periodic monitoring reports based on the information received in the monitoring formats from the sponsoring ministries, preparing reports based on field inspection, intra and inter ministry coordination and review of the projects/programmes. These are done from project inception to project closing and comprise monitoring at the initial stage, at the middle of project period that includes in-depth monitoring, monitoring at the final stage of project implementation and result monitoring at project closing with information from the project completion report. IMED is also involved in impact monitoring of the project after the project period.

A well-functioning M&E system is a critical part of good project/programme management and accountability. Timely conducted and credible M&E provides information to support project/programme implementation with accurate, evidence based reporting that informs management and decision-making authorities to guide and improve project/programme performance. It contribute to organizational learning and knowledge sharing by reflecting upon and sharing experiences and lessons so that we can gain the full benefit from what we do and how we do it. A strong M&E system upholds accountability and compliance by demonstrating whether or not the work has been carried out as per DPP and in compliance with established standards and with any other donor requirements. It provides opportunities for stakeholder feedback, especially beneficiaries, contributes to organizational learning and knowledge sharing.

Methodology

This guideline has been developed by using qualitative method of collecting information from the key informants & stakeholders using KII checklist. There are two types of checklist are used for data collection and different group of peoples/ stakeholders are interviewed for the guideline development including the IMED officials, relevant project directors, M&E officials, of various department/ authorities/ agencies, field officers etc. The checklists were given to the informants for the purpose of strengthening inquisitiveness related to the technical subject and also develop confidence in oneself to respond. The questionnaires helped to learn the technicalities involved in checking the quality and workmanship in the project implementation in the four sectors.

The guideline comprises an introductory chapter and methodology followed by four chapters detailing Monitoring & Evaluation (M&E) guideline for the Forestry, Irrigation, Water Resources and Shipping sectors in chapters 3 to 6. Chapter 7 draws some conclusion followed by general recommendations applicable to all sectors and a matrix providing specific recommendations that apply to the four sectors.

Templates

An important part of the guideline comprises templates developed for general purpose (all projects) and specific templates for the four sectors. The templates include G1 for Kick-off stage and G2 & G3 for procurement. Templates 1 to 4 applies to all sectors for process monitoring on approval status & fund allocation, deployment of manpower, procurement planned and achieved, and project oversight format for reporting to higher authorities. Templates 5 to 7 are progress monitoring formats for initial, mid-term and terminal stages of project implementation. Templates 8 & 9 are formats for terminal and Impact evaluation respectively.

The guideline contains some SMART indicators (in section after templates) for the four sectors as example to be used in result based monitoring and Cost Effectiveness Analysis Tool (after shipping sector templates).

Conclusion

It should be noted that each project may have unique requirements, so IMED should attempt to develop general as well as sector specific monitoring and evaluation tools. It is recommended here that in the M&E officials be adequately trained to use the M&E tools for periodic monitoring and field visits. This guideline will help the IMED personnel with project implementation team to review and monitor process and progress at all stages of the project implementation and conduct terminal evaluation at project closing and impact evaluation after the project period.

Recommendations

General Recommendations

1. A technical unit may be established in the IMED that will be supportive to assess needs and provide direction for the Technical Services Program while detailed technical monitoring is the responsibility of the concerned agencies/ ministries;
2. Timely monitoring should be emphasized and be strengthened specially for managing procurement including tendering process;
3. Online monitoring system should be developed and made functional;
4. SMART indicators be defined clearly in the DPP and effective M&E template format should be developed and used;
5. Enthusiasm should be created for field visit/ field inspection among the M&E staff;
6. Risks allowance may be provided for M&E staffs during field inspection;

7. Strengthen the knowledge and capacity building of IMED M&E officials for information gathering and report preparation;
8. Result based monitoring system should be strengthen and practice in the field by using SMART indicators and template.

Sector specific Recommendations

Forestry sector	Irrigation sector
<ol style="list-style-type: none"> 1. Effective utilization of fallow land/ unused land into forest coverage 2. Plantation of local indigenous species like fruits and medicinal plants should be prioritized 3. Non-eco-friendly/ foreign species should be avoided 4. Decentralized the management system and encourage the local body& community management 	<ol style="list-style-type: none"> 1. Use of local knowledge and practices should be enhanced through community consultation and participation 2. Digging new ponds/ khal and re excavated pond/ khal and other water bodies be prioritized rather than too much depending on ground water 3. New sustainable irrigation project should be encouraged
WRM sector	Shipping sector
<ol style="list-style-type: none"> 1. Enhance surface water resource management system 2. Reduce dependency on ground water irrigation 3. Local indigenous practices should be appreciated 4. Cost effective interventions like groyen, bamboo bundle, Geo-tex, Vinna grass plantation be emphasized rather than CC blocks unless very essential 5. Interventions like large embankment must take in to consideration of social (affecting farmers, fishers, aquaculture, resettlement) and environmental issues (aquatic biodiversity) 	<ol style="list-style-type: none"> 1. Digital dredgers should be introduced (auto counting and measuring system) 2. Modern technology should include Cutter Suction Dredgers (CSDs) 3. Frequent field inspection should be conducted by M&E officer and senior management team members of IMED and observed field project/ program activities regularly/ frequently 4. Port development should be subject to serious technical feasibility taking in to account of likely silt deposit per year, cost of capital dredging and need for yearly maintenance dredging, likely closure of channel by silt deposit and cost benefit analysis.

CHAPTER ONE INTRODUCTION

1.1 Background of the Study

Implementation Monitoring and Evaluation Division (IMED) as the apex body of the Government of Bangladesh responsible for monitoring and evaluation of development project is implementing a project called ‘**Strengthening M&E Capabilities of IMED (SMECI)**’. The project is funded by the Government of Bangladesh (GOB) to assist the concerned Ministries and Agencies to ensuring timely and proper implementation of the projects included in the ADP under their jurisdiction. One main purpose of the Monitoring & Evaluation (M&E) is to carry out regular field review of development projects to keep the IMED well informed with the latest progress of projects in the field level together with desk review of progress based on the periodic monitoring reports received from the ministries and agencies. By this process, the IMED informs the relevant ministries and agencies with the problems affecting the progress of projects for taking remedial actions at their end, so that project's physical and financial progress can be accelerated.

Under the SMEC I project, the IMED is developing a number of sector specific guidelines. Shahidul Consultant is engaged to develop such guidelines for the forestry, irrigation, water resources and shipping sectors.

1.2 What is Monitoring & Evaluation?

Before presenting M&E guidelines, it is required to have clear and common understanding of the concepts of monitoring and evaluation so that the concerned stakeholders have an understanding of the operational definition of monitoring and evaluation.

Monitoring is routine collection and analysis of information to track progress against set plans and check compliance to established standards. It helps identify trends and patterns, adapt strategies and take informed decisions for project/programme management.

According to IFRC (2002), Monitoring is a continuing function that uses the systematic collection of data on specified indicators to inform management and the main stakeholders of an ongoing International Federation or national society operation of the extent of progress and achievement of results in the use of allocated funds. It is based on the logframe provided in the DPP/RDPP of the project and compares changes by various indicators against the DPP/RDPP targets.

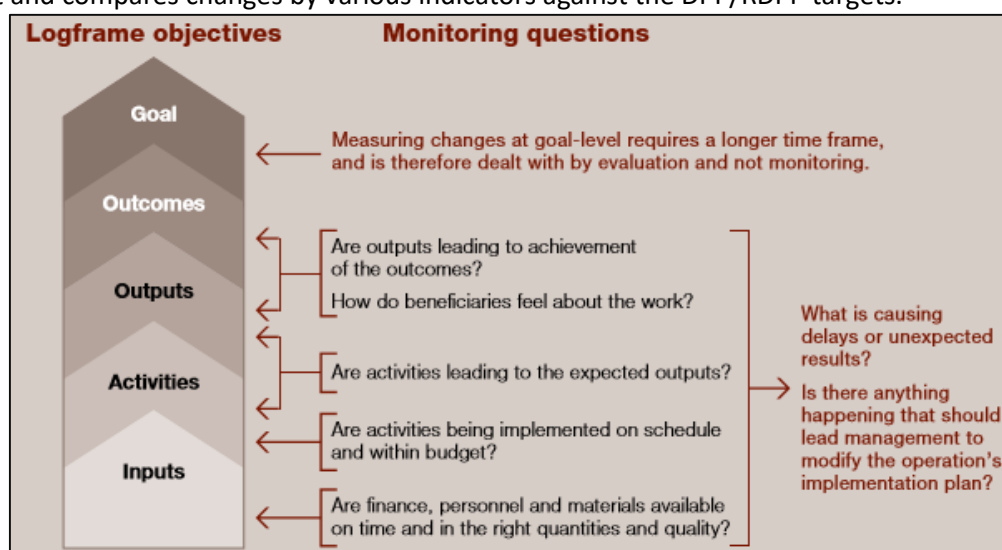


Figure 1: Monitoring Questions

Source: IFRC, Project/Programme M&E Guide

Objectives of Monitoring:

The primary objectives of monitoring are to:

- Assess the progress of the project with respect to the proposed timeline;
- Reveal if there is any impending problem to avoid disaster/delay;
- Make necessary adjustments in resources, if necessary;
- Ensure quality of the ongoing work;
- Learn weakness and strength of the project management;
- Redesign or readjust project implementation strategies or components during implementation (if required) to achieve desired objective.

Evaluation: Evaluation is an assessment, as systematic and objective as possible, of an ongoing or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, developmental efficiency, effectiveness, impact and sustainability.

According to IFRC (2002), Evaluation is the systematic and objective assessment of an on-going or completed operation, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, as well as efficiency, effectiveness, Impact (overall Goal) and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons into management decision-making for future project/program.

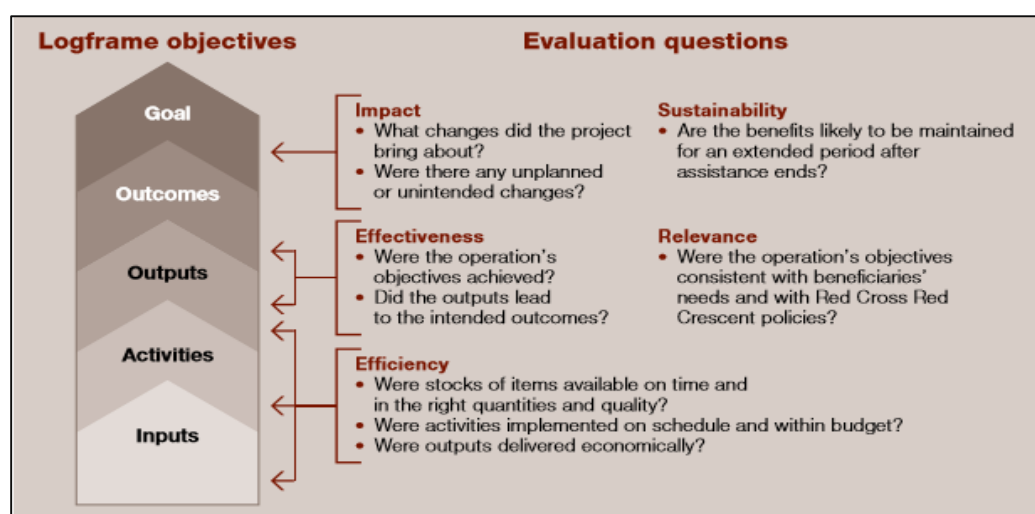


Figure 2: Evaluation Questions

Source: IFRC, Project/Programme M&E Guide

Objectives of Evaluation:

Evaluation is carried out mostly at the end of a project work. Evaluation is not just about demonstrating success, it is also about learning why things went wrong. Identifying the lessons learned from successes/ failures and mistakes is one of the key aspects of evaluation to be replicated/ followed or avoided in future project/ program.

The primary objectives of evaluation are to:

- Understand how the project has achieved its intended purpose, or why it may not have done so;
- Identify how efficient the project was in converting resources into activities, objectives and goals;
- Assess how sustainable and meaningful the project was;

- Inform decision-makers on how to build on or improve future projects.

Monitoring & Evaluation Guideline

FAO suggests that a Monitoring & Evaluation guideline is a document for assigning M&E Roles and Responsibilities to the organizations, departments, authorities, and responsible officers that needed to monitor and evaluate an operation's implementation and successful M&E of various projects/ programs.

1.3 Goal and objectives of the Monitoring & Evaluation Strategy

Monitoring and Evaluation strategy is an official document designed to ensure the provision of strategic information to measure whether the Fund is cost-effectively delivering against its goals and principles and how improvements can be made. The M&E strategy has formulated considering the needs for strategic information of different stakeholders, including target groups, grant recipients, donors and other partners, as well as for the management purposes of an organization.

The **goal** is to establish a sustainable M&E system for tracking progress and demonstrating results of the program and to ensure evidence-based decision making.

The **specific objectives** of the **M&E Strategy** are to:

- ✓ Improve the quality and capacity of the routine data collection systems, e.g., development of registries, routine data collection forms, type and frequency of reports, etc.;
- ✓ Outline specific activities required for strengthening the organizational capacity to conduct effective M&E;
- ✓ Ensure greater utilization of routine data sources; and
- ✓ Strengthen the monitoring culture within managers, planners, implementers, policy makers and funding agencies to acquire the information and generate informed decisions about project implementation.

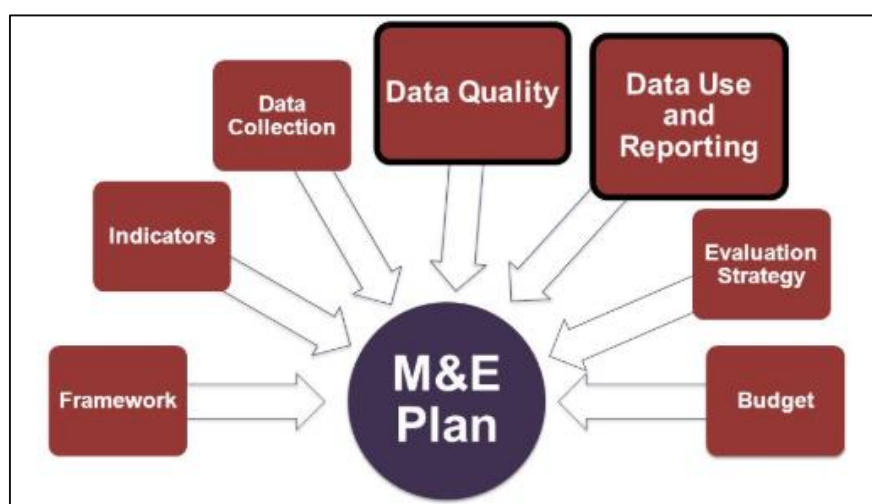


Figure 3: Monitoring & Evaluation (M&E) Plan

The expected **key outputs** of the M&E Strategy are:

- ✓ Prepare an M&E Action Plan for short- and medium-term;
- ✓ A functional robust, comprehensive, and well-coordinated M&E system on Forestry, Irrigation, Water Resources and Shipping related sectors in place;
- ✓ Regular updates on performance indicators available;

- ✓ Implementation progress reports are produced on time;
- ✓ Data sources outside the routine are aligned to facilitate the end-line review and assess Program's impact.

The M&E Strategy is expected the **outcome** are in:

- ✓ Promoting the practice of evidence-based decision making, policy development and advocacy;
- ✓ Reporting in time to concerned ministries/agencies and other relevant partners;
- ✓ Objective decision making for performance improvement; planning and resource allocation; and
- ✓ Promoting accountability to the relevant ministries/agencies.

Source: HPNSDP, December, 2014

1.4 Monitoring and Evaluation Practice in Bangladesh

The predecessor of IMED, the Project Implementation Bureau (PIB) was created in 1975 through an executive order of the government as a central project monitoring organization of the Government of Bangladesh. The PIB was latter upgraded and renamed IMED in 1982 in a modest way. Initially, its project monitoring activities were mostly limited to financial and physical progress monitoring based on periodic (monthly financial and quarterly physical) reports received from the ministries and agencies. Although, physical progress reporting formats were also in place, it was rather complex and information provided were not suitable for good analysis, hence were limited mostly to observations. Presently, monthly reports contain both physical and financial progress.

General Functions of IMED: The major functions of IMED related to the monitoring & evaluation are discussed below:

- Implementation monitoring of all on-going development projects including in Annual Development program (ADP);
- Terminal evaluation of all completed project;
- Impact evaluation of selected projects;
- Preparation of monitoring and field inspection reports of on-going projects;
- ADP Implementation Progress Reporting and Review;
- Collection of information/data through IMED Formats, 2003 (Revised) on a regular basis and submission of reports to the National Economic Council (NEC) where major implementation problems are presented for necessary decision;
- Field Inspections/Spot Verifications of high priority projects, projects targeted for completion and completed projects, aided and sick projects and report to appropriate authorities for necessary decisions;
- Participate in monthly ADP Review Meetings and other Meetings (e.g. Steering Committee, TEC, Wrap-up, etc.) organized by concerned project authorities;
- Managing database to process and preserve collected project information;
- Providing recommendations on future course of actions to be taken by the Government towards streamlining development activities;
- IMED has been conducting in-depth monitoring and impact evaluation of some important/large/technically complex/country-wide spread on-going projects by engaging individual consultants/consulting firms;
- Disseminate findings to the stakeholders, prepare recommendations, and provide feedback to concerned agencies/authorities

Source: IMED presentation, Ministry of Planning, 2010,

According to The Rules of Business of the government, allocated functions or activities to the IMED are as follows:

- Monitoring and Evaluation of the implementation of development projects included in the Annual Development Program;
- Collection and compilation of project-wise data for preparing quarterly, annual and periodical progress reports for information of the President, National Economic Council (NEC), Executive Committee for National Economic Council (ECNEC), Ministries and other concerned;
- Rendering such advisory or consultancy services to Ministries/Agencies concerned on implementation of projects as and when necessary;
- Field inspection of projects for on the spot verification of implementation status and such other Co-ordination works as may be necessary for the removal of implementation problems, if any, with the assistance of related ministries/agencies;
- Submission of project inspection reports to the President and Ministers concerned when attentions at such levels are considered necessary;
- Matters relating to Central Procurement Technical Unit (CPTU);
- Matters relating to the Public Procurement Rules (PPR), 2008;
- Such other functions as may be assigned to the Division by the Prime Minister from time to time.

1.5 Project Monitoring Functions at Different Stage of Projects by IMED

IMED is involved in the entire life cycle of a project – pre-project appraisal, monitoring during implementation and reporting on completion of projects as well as ex-post evaluation. The functions are given below:

Pre-project stage:

Identification, formulation and appraisal of projects are undertaken at this stage. During pre-project stage IMED contributes as under:

1. Undertakes cost rationalization prior to submission of the PCP for approval;
2. (This has been discontinued from February 1997);
3. Involves in the preparatory stage of ADP;
4. Represents in the NEC/ECNEC/SPEC/DPEC/DSPEC;
5. Checks rationale of estimate of costs;
6. Checks reliability of implementation schedules;
7. Checks duplication, overlaps, if any, with other projects;
8. Compares with experience of similar project(s) implemented before; and
9. Checks manpower size, reliability and also the suitability of institutional framework planned for implementation of the project.

Monitoring during implementation:

IMED monitors progress during implementation of projects through:

1. Periodic Reports>Returns;
2. Field inspection; and
3. Co-ordination/Review meetings.

Reporting on completed projects:

A project management is required to submit certain information through the administrative ministry to IMED as soon as a project is completed. Generally this takes place at the end of a financial year. IMED completes reporting on the projects completed in the preceding year in about ¾ months of

the following year. The findings form a part of the annual report presented to the NEC about overall implementation of development projects in the country.

Ex-Post Evaluation:

IMED also carries out ex-post evaluation of a few selected projects on a limited scale. The Population Development and Evaluation Unit (PDEU) of the Planning Commission were transferred to IMED. The personnel of this Unit are being used to gear up ex-post activities of IMED.

Monitoring of post-implementation operation (sustainability monitoring):

Sustainability monitoring is a recent concept. In Bangladesh, an institutional arrangement for sustainability monitoring has not yet developed in most of the agencies. IMED undertakes sustainability monitoring function on an ad hoc basis on assignments from the ECNEC, the Planning Commission and upon request from the ministries/agencies. Sustainability monitoring, though a very necessary tool in the development process, has not yet taken its desired shape in Bangladesh. The government is aware of this fact and this is emphasized in the Fifth Five Year Plan.

Project Evaluation

Formative or on-going evaluation:

Formative or on-going evaluation or diagnostic study is undertaken both by the executing agencies as well as IMED. This type of evaluation is done during the implementation of large projects which are of programme nature and implemented over many years on a continuous basis.

Summative or terminal evaluation:

Since 1983/84 IMED started evaluation of completed projects on a limited basis immediately after its implementation is declared complete by the executing agency.

Ex-Post or impact evaluation

The IMED could not take the function of ex-post/impact evaluation on a systematic and regular basis owing to lack of well-trained manpower in the techniques of ex-post evaluation and other logistic support. However, since 1983/84, IMED started ex-post evaluation of selected projects and incorporated them in the annual reports.

Identification of implementation problems:

Identification of implementation problems and recommendation of measures for their solutions are very important aspects of monitoring of projects during implementation. It has helped reduce the number of implementation problems as well as the number of projects affected by those problems. As against 33 different implementation problems in FY'82, the IMED's 1995/96 annual report identified only 10 major problems as follows:

1. Delay in approval of project/revised project;
2. Delay in release of fund;
3. Delay in land acquisition and handover;
4. Delay in lining up of project assistance;
5. Delay in calling tender and observing formalities;
6. Delay in appointment of consultant;
7. Delay in executing agreement with donor country/agency;
8. Delay in completion of civil works on deposit fund;
9. Delay in appointment of project personnel; and
10. Delay in fulfillment of conditions precedent for loan effectiveness and disbursement.

Ex-post evaluation:

IMED undertakes evaluation of all completed projects immediately after those are declared complete. But impact evaluation function is still insignificant both in volume and in quality. This is attributed to the fact that there are very few officials in the IMED with necessary skill and experience to undertake impact evaluation. This area needs immediate attention in the interest of sustainability of development projects. IMED has recently taken up an expansion program for its organization and hopes to undertake this function more systematically and effectively in future.

1.6 Strengths and Weaknesses of Monitoring and Evaluation System

Strengths

- Institutionalized and integrated for project monitoring, information gathering and dissemination, problem solving, etc;
- Linkage with the planning processes of the country provides it with the necessary planning-implementation feedback;
- The system of field inspection and holding of review meetings at the minister/secretary level has established;
- In sum, the benefits of the central monitoring system have been manifold such as establishment of some management accountability, improvement in implementation and identifying institutional linkages between planning and implementation.

Weaknesses:

In spite of the aforementioned contributions of the present monitoring system, the following weaknesses may be recognized which affect its operational efficiency:

- The need and importance of efficient monitoring and evaluation(M&E) activities is yet to be fully understood by the officials;
- The lack of proper and prompt response from top managers on monitoring reports
- Implementing officers often apprehend the problems reported may be considered as personal failures, and thus instead of seeking help in solving these, try to hide them.
- Quality control of progress reports is absent or neglected at the project, agency and ministry/division levels;
- There is inadequacy of manpower in the central monitoring organization to manage the monitoring of large number of projects efficiently;
- There is a lack of updated knowledge and techniques for efficient monitoring and evaluation both at the center as well as in the ministry/agency levels;
- IMED's own lack of authority and at times inability to initiate problem-solving actions seriously demoralize the project managers who in turn lose interest in reporting problems. This also contributes to low quality and lack of accuracy of the reports.
- Monthly project review meetings in some ministries are not held regularly.
- Submission of project completion reports after a project is declared complete by the ministries/divisions has not yet been developed as a regular practice.
- Physical units of measurement are sometimes not mentioned in the project documents as also in the progress reports from projects, thus rendering any meaningful interpretation of progress monitoring a difficult task.
- Even large projects do not always have full-time PDs.
- Sustainability monitoring lacks proper attention at all levels making investment ineffective.
- Monitoring and evaluation of private sector development activities have not been developed.

Source: Following 5th Five Year Plan

Weakness of current M&E format of IMED

1. Existing IMED Formats (Form 1 and 2 Monthly Implementation Progress Report, Form 3 progress of procurement report, Form 4 a-b quarterly financial and physical progress report, Form 4 c-d Implementation Problems and Suggested Measures and Contract Implementation Reports are formulated in generic form. It is required to be sector specific and addition to general M&E report;
2. The formats focus more on inputs and activities than on outputs and outcomes. Also the indicators are not defined as SMART (Specific, Measurable, Achievable and Time-bound);
3. The nature and demand of various sectors are different, so components should be detailed to the needs of the relevant sector;
4. Previously the development project were focused on physical infrastructure, production and growth but present-day projects cover more on health, education, poverty reduction, climate change, conservation of environment and social compliance following SDGs. These deserve due consideration in the new M&E formats;
5. Indigenous people and cultural heritage need to be incorporated in the new M&E formats;
6. It is generally observed that projects are not implemented timely and one reason behind it is that monitoring has not improved to the desired level. It causes delays and as a result cost increases;
7. Like time over run caused mainly the organizational weakness, structure and human resources. Lack of committed and capable human resources often contains time over run and cost overrun;
8. People who received training on the specific development issues/ areas are frequently transferred to the other sector/department where he is not able to utilize the gathered knowledge and skills;
9. Incentives/ dis-incentives structure is poor that does not prevail effectively;
10. Reward and recognition system is poor.

1.7 Importance of Monitoring & Evaluation

Monitoring and evaluation (M&E) of sport-for-development interventions is of high priority. It is a tool in development requires thorough assessment of the value of sport in development contexts. It helps for identifying and documenting successful programmes and approaches and tracking progress and strategic changes need to achieve target toward common indicators across related projects. At the programme level, the purpose of monitoring and evaluation is to track implementation and outputs systematically, and measure the effectiveness of programmes. It helps determine exactly when a programme is on track and when changes may be needed. M&E forms the basis for modification of interventions and assessing the quality of activities being conducted.

Monitoring and evaluation can be used to demonstrate the programme efforts has measurable impact on expected outcomes and have been implemented effectively. It is essential in helping managers, planners, implementers, policy makers and donors acquire the information and understanding they need to make informed decisions about programme operations. Monitoring and evaluation helps with identifying the most valuable and efficient use of resources, judged success etc. M&E can be used to demonstrate whether project has achieved the expected outcomes or not. It provides the necessary data to guide strategic planning, to design and implement programmes and projects, and to allocate, and re-allocate resources in better ways.

The specific importance of Monitoring and evaluation are as follows:

- It provides the only consolidated source of information showcasing project progress;
- Support project/program implementation with accurate, evidence based reporting
- Contribute to organizational learning and knowledge sharing

- Uphold accountability and compliance
- Provide opportunities for stakeholder feedback, especially beneficiaries, to provide input into and perceptions of our work,
- Promote and celebrate our work by highlighting our accomplishments and achievements.

Source: 5th five year plan 2011, and IMED, SMECI Project, November, 2015

1.8 IMED and Monitoring & Evaluation

Implementation Monitoring and Evaluation Division (IMED) is the apex body of the Government of Bangladesh. IMED excels in the practice and management of monitoring and evaluation with core organizational competences in programme monitoring and evaluation, mass communications, and project information systems it advises other government organizations on programme design and measurement. The IMED monitors and evaluates the performance of revenue and development investment by collecting and analyzing information on project and programme results originating from implementing organizations. IMED also analyses of the performance of ministries and sectors against agreed targets is provided to Executive Committee of the National Economic Council, line ministries and other concerned parties whenever necessary. Wherever possible IMED seeks to explain why sector or ministry performance targets have not been met by careful analysis of programme outcomes. This analysis is provided to the relevant bodies so that they can improve their performance if necessary.

Source: IMED strategic plan

1.9 M&E and the Project Cycle Management

Project cycle management (PCM) is the process of planning, organizing, coordinating, and controlling of a project effectively and efficiently throughout its phases, from planning through execution then completion and review to achieve pre-defined objectives or satisfying the project stakeholder by producing the right deliverable at the right time, cost and quality.

M&E should be addressed as part of project planning and integrated alongside project implementation and management systems. A well-functioning M&E system is a critical part of good project/program management and accountability. While an organization implementing activities as indicated in work plan, it is important to have regular monitoring and evaluation in order to provide timely and reliable M&E information.

The project cycle is a concept for understanding the tasks and functions that must be performed in the lifespan of a project. Commonly, a project cycle contains stages of design, implementation, monitoring and evaluation. The following figure presents the key stages in project/programme planning; monitoring, evaluation.

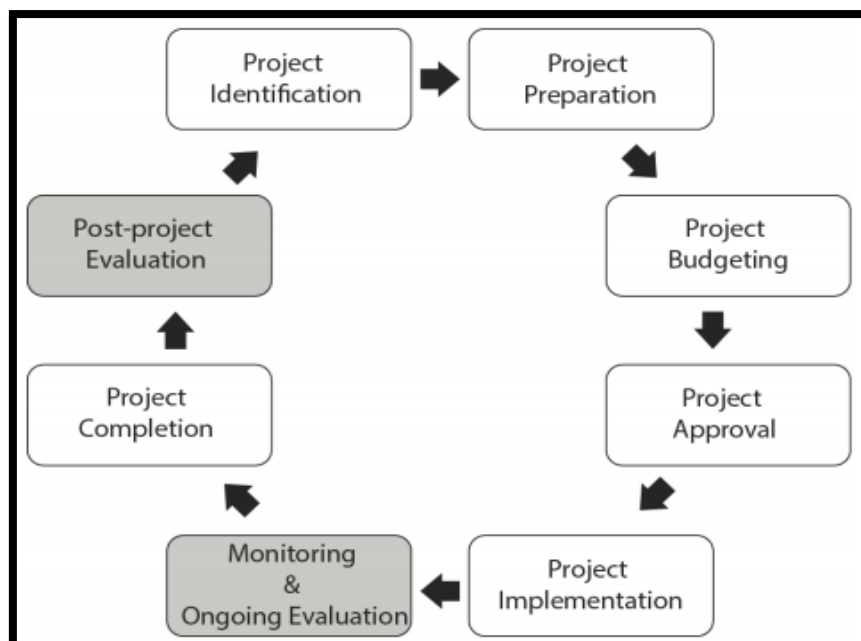


Figure 4: Key M&E Activities in the Project Cycle

Source: SMEC project report 2012

Steps for project/programme M&E

There are six steps are included with the effective project/programme M&E. Taken together, these steps are to guide planning for and implementing an M&E system for the systematic, timely and effective collection, analysis and use of project/programme information.

1. Identify the purpose and scope of the M&E system;
2. Plan for data collection and management;
3. Plan for data analysis;
4. Plan for information reporting and utilization;
5. Plan for M&E human resources and capacity building;
6. Prepare the M&E budget.

1.10 What is Actually Monitored and Evaluated in the M&E System

Monitoring is the continuous assessment of a programme or project in relation to the agreed implementation schedule. It is also a good management tool which should, if used properly, provide continuous feedback on the project implementation as well assist in the identification of potential successes and constraints to facilitate timely decisions. Unfortunately, in many projects, the role of this is barely understood and therefore negatively impacts on the projects.

Monitoring occurs throughout the operation. A baseline study is usually conducted before the operations begin. Evaluations can occur-for different purposes-at different points on an evaluation.

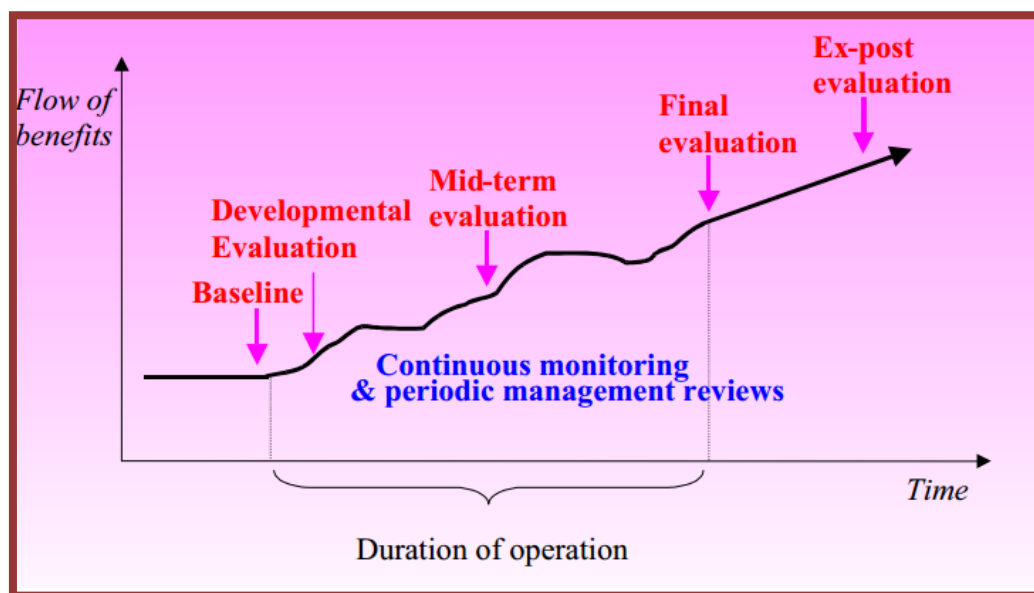


Figure 5: Aspects of Monitoring and Evaluation in the M&E system

Source: IFRC, 2002

The main focus of the monitoring and evaluation system are create a greater accountability in the use of resources; greater focus on the achievement of results; a clearer basis for decision-making, and the promotion of institutional learning and knowledge sharing.

A well-functioning M&E system is a critical part of good project/programme management and accountability. Timely and reliable M&E provides information to:

- Support project/programme implementation with accurate, evidence based reporting that informs management and decision-making to guide and improve project/programme performance;
- Contribute to organizational learning and knowledge sharing by reflecting upon and sharing experiences and lessons so that we can gain the full benefit from what we do and how we do it;
- Uphold accountability and compliance by demonstrating whether or not our work has been carried out as agreed and in compliance with established standards and with any other donor requirements;
- Provide opportunities for stakeholder feedback, especially beneficiaries, to provide input into and perceptions of our work, modeling openness to criticism, and willingness to learn from experiences and to adapt to changing needs;
- Promote and celebrate our work by highlighting our accomplishments and achievements, building morale and contributing to resource mobilization.

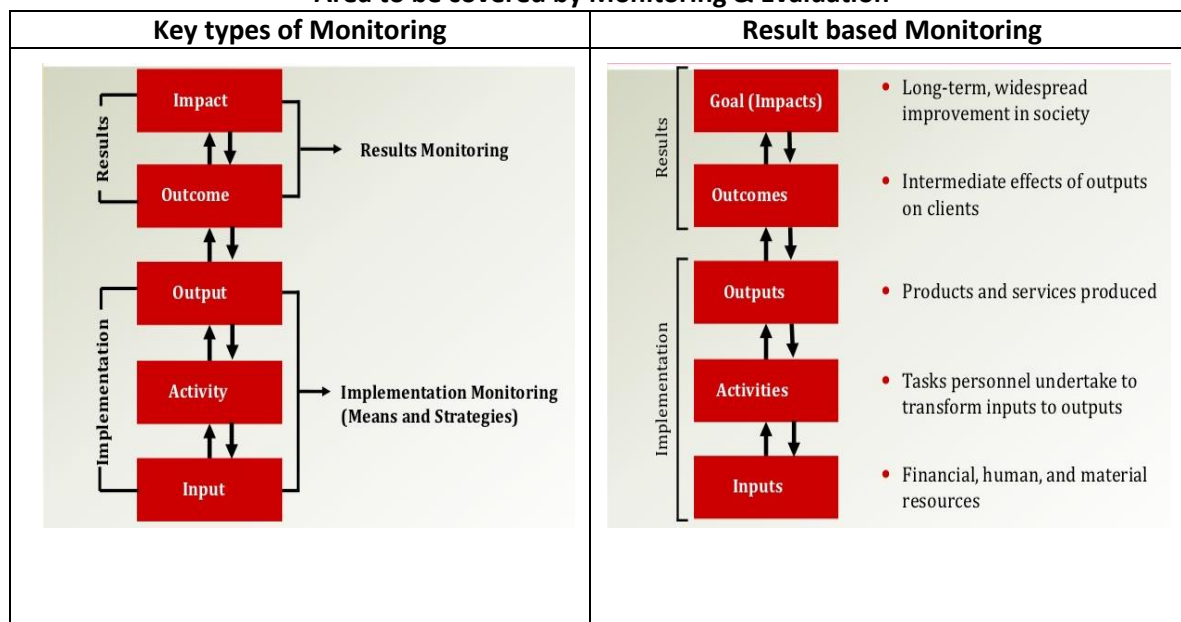
Areas covered by Monitoring and Evaluation

A project/programme usually monitors a variety of things according to its specific informational needs. The table provides a summary of the different types of monitoring commonly found in a project/programme monitoring system.

Areas covered by Monitoring and Evaluation		
SN	Monitoring	Evaluation
1	Process	Impacts
2	Progress	Outcome
3	Outputs	

SN	Monitoring	Evaluation
4	Activity	
5	Inputs	

Area to be covered by Monitoring & Evaluation



Source: IFRC 2002

Table 1: Types and Components of Monitoring

Types and Components of Monitoring	Covering Areas
Physical monitoring	Measuring progress of project or programme activities against established schedules and indicators of success.
Process (activity) monitoring	Identifying factors accounting for progress of activities or success of output production. Process (activity) monitoring tracks the use of inputs and resources, the progress of activities and the delivery of outputs. It examines how activities are delivered – the efficiency in time and resources. It is often conducted in conjunction with compliance monitoring and feeds into the evaluation of impact.
Result Monitoring	Results monitoring tracks effects and impacts. This is where monitoring merges with evaluation to determine if the project/programme is on target towards its intended results (outputs, outcomes, impact) and whether there may be any unintended impact (positive or negative).
Impact monitoring	Measuring the initial responses and reactions to project activities and their immediate short-term effects. Projects are monitored so as to: <ul style="list-style-type: none"> • assess the stakeholders’ understanding of the project; • minimize the risk of project failure; • promote systematic and professional management; and • assess progress in implementation.
Compliance monitoring	Compliance monitoring ensures compliance with donor regulations and expected results, grant and contract requirements, local governmental regulations and laws, and ethical standards.
Context (situation) monitoring	Context (situation) monitoring tracks the setting in which the project/programme operates, especially as it affects identified risks and assumptions, but also any unexpected considerations that may arise. It includes

Types and Components of Monitoring	Covering Areas
	the field as well as the larger political, institutional, funding, and policy context that affect the project/programme.
Beneficiary monitoring	Beneficiary monitoring tracks beneficiary perceptions of a project/programme. It includes beneficiary satisfaction or complaints with the project/programme, including their participation, treatment, access to resources and their overall experience of change. Sometimes referred to as beneficiary contact monitoring (BCM), it often includes a stakeholder complaints and feedback mechanism. It should take account of different population groups, as well as the perceptions of indirect beneficiaries (e.g. community members not directly receiving a good or service).
Financial monitoring	Financial monitoring accounts for costs by input and activity within predefined categories of expenditure. It is often conducted in conjunction with compliance and process monitoring.
Organizational monitoring	Organizational monitoring tracks the sustainability, institutional development and capacity building in the project/programme and with its partners. It is often done in conjunction with the monitoring processes of the larger, implementing organization.

Source: Revised from Food and Agricultural Organization (FAO), 2005

Evaluation is a process which determines as systematically and as objectively as possible the relevance, effectiveness, efficiency, sustainability and impact of activities in the light of a project/programme performance, focusing on the analysis of the progress made towards the achievement of the stated objectives.

Evaluation has several purposes and focuses, which include the following:

- It assists to determine the degree of achievement of the objectives.
- It determines and identifies the problems associated with programme planning and implementation.
- It generates data that allows for cumulative learning which, in turn, contributes to better designed programmes, improved management and a better assessment of their impact. The key words in this scenario are “lessons learned”.
- It assists in the reformulation of objectives, policies, and strategies in projects/ programmes.

Evaluations involve with identifying and reflecting upon the effects of what has been done, and judging their worth. The evaluation findings allow project/programme managers, beneficiaries, partners, donors and other project/programme stakeholders to learn from the experience and improve future interventions. There is a range of evaluation types and components, which can be categorized in a variety of ways. Ultimately, the approach and method used in an evaluation is determined by the audience and purpose of the evaluation. It is important to remember that the categories and types of evaluation are not mutually exclusive and are often used in combination.

Table 2: Types and Components of Evaluation

Types and Components of Evaluation	Focused Areas
Formative evaluations	Formative evaluations occur during project/programme implementation to improve performance and assess compliance.
Summative evaluations	Summative evaluations occur at the end of project/programme implementation to assess effectiveness and impact.
Interim evaluation	This normally takes place at some point during the life of a programme, usually mid-term.

Types and Components of Evaluation	Focused Areas
Terminal evaluation	This assesses the progress made towards the achievement of the pre-determined objectives at the end of the programme and provides a basis for decisions on future action. Its findings and recommendations are often used to decide whether or not to stop the project or when a new phase is under consideration.
Midterm evaluations	Midterm evaluations are formative in purpose and occur midway through implementation. For secretariat-funded projects/ programmes that run for longer than 24 months, some type of midterm assessment, evaluation or review is required. Typically, this does not need to be independent or external, but may be according to specific assessment needs.
Final evaluations/ Terminal Evaluation	Final evaluations are summative in purpose and are conducted (often externally) at the completion of project/ programme implementation to assess how well the project/ programme achieved its intended objectives. All secretariat funded projects/programmes should have some form of final assessment, whether it is internal or external.
Ex-post evaluations/ Impact Evaluation	Ex-post evaluations are conducted sometime after implementation to assess long term impact and sustainability. This is conducted after a sufficient number of years (depending on the project) have elapsed since project completion so as to measure the impact.
Organizational standards and policies	The extent that the organization's work upholds the policies and guidelines of the organizational movement.
Relevance and appropriateness.	The extent that the organization's work is suited to the needs and priorities of the target group and complements work from other actors.
Efficiency	The extent that the organization's work is cost-effective and timely.
Effectiveness	The extent that the organization's work has or is likely to achieve its intended, immediate results.
Coverage	The extent that the organization's work includes (or excludes) population groups and the differential impact on these groups.
Impact	The extent that the organization's work affects positive and negative changes on stakeholders, directly or indirectly, intended or unintended.
Coherence	The extent that the organization's work is consistent with relevant policies (e.g. humanitarian, security, trade, military and development), and takes adequate account of humanitarian and human-rights considerations.
Sustainability and connectedness	The extent the benefits of the organization's work are likely to continue once the organization's role is completed.

Source: Revised from Food and Agricultural Organization (FAO), 2005

It should also be noted that in some cases, evaluation has been used to resolve non-programme issues affecting different donors. Evaluation can be seen as a process that determines the viability of programmes / projects and facilitates decisions on further resource commitment.

1.10.1. Evaluation Standards and Key Feature

There are some other components for Evaluation standards that is includes with the flowing:

- Utility;
- Feasibility;
- Ethics and legality;
- Impartiality and independence;
- Transparency;
- Accuracy;
- Participation, and
- Collaboration status of the organization.

Table 3: Comparing Key Features of Monitoring & Evaluation

Basis	Monitoring	Evaluation
Why	Check progress, inform decisionmaking and remedial actions, update project plans, support accountability, transparency, participation.	Assess progress in achieving outcome/ goal and worth, identify lessons and recommendations for longer term planning and organizational learning, provide accountability.
When	Ongoing during project/ programs.	On completion/ after project program completion.
Who	Internal, involving project/program implementers & External IMED, Plann Comm, Independent In-depth Monitoring by outsourcing	Can be internal and external to organization but mainly external.
Link to logical hierarchy	Focus on inputs, activities, outputs and short term outcomes.	Focus on outcomes and overall goal.

Source: IFRC, 2011

1.10.2. Tools for Monitoring

Monitoring and Evaluation (M&E) is an area of growing importance for the development community. It allows those involved in development activities to learn from experience, to achieve better results and to be more accountable. One of the greatest weaknesses of management information is the lack of effective and timely communication of information to the users. In Some monitoring system organizations and staff often invests too much time and resources in gathering data which they frequently fail to interpret and present in a form that will convey the meaning of the progress made. This should be avoided if possible. Appropriate monitoring tools should be put in place and used accordingly. Some of the most widely used tools for project monitoring, and their limitations include the following:

Table 4: Tools for Monitoring

Monitoring Tools	Covering areas
1. Verbal communication	This is probably the most effective mode of communication. Among its advantages is that it is quick, and its presentation can be adapted to concerns and questions of the audience. However, this type of tool to communicate monitoring information can lead to misunderstandings and sometimes denial of information.
2. Conduct Meetings	The very nature of project/programme management makes it inevitable that certain meetings are convened to communicate and share project information. Other programmes may even require standing committees where outsiders may be invited to review programme performance. One needs to be cautioned that, while it is important to have meetings, they should be used as effective tools. Meetings can be used for sharing and interchanging information, clarifying, stimulating, and seeking the best solutions regarding project performance.
3. Reports	The importance of monitoring reports should not be overlooked. It should be noted that these are an essential part of project / programme monitoring. Activities undertaken, inputs supplied, money disbursed, etc. have to be recorded and accounted for. However, reports are only effective if they are submitted to the right people at the right time to facilitate corrective decision making.
4. Diary notes	While most people do not use this mode of recording information, it remains an important option. It is essential to record key decisions, which may have been made at formal or informal meetings. Its format should be simple – giving the date, time, place and the names of the people present when the decision was taken.
5. Preparation of monitoring reports	The purpose of a project monitoring report is to provide information to assist stakeholders in comparing performance against plans so that current or potential problems can be identified and analyzed. The uses of project monitoring reports are to: <ul style="list-style-type: none"> • Document completion of project activities;

Monitoring Tools	Covering areas
	<ul style="list-style-type: none"> • Identify significant deviations from plans; • Reveal problems to appropriate stakeholders; • Assist in corrective decision-making; • Monitor implementation of corrective actions; • Identify shortcomings of existing management and monitoring systems; • Provide information for coordination of national development programmes; • Provide reference material for planning of subsequent projects; and • Provide information for future evaluators.

Source: Revised from Food and Agricultural Organization (FAO), 2005

1.10.3. Tools for Evaluation

Project evaluation is a systematic and objective assessment of an ongoing or completed project. It aims to determine the relevance and level of achievement of project objectives, development effectiveness, efficiency, impact and sustainability. Evaluations also feed lessons learned into the decision-making process of the project stakeholders, including donors and national partners. Evaluation is also an important part of the organization's accountability to its donors and to the Governing Body. It is emphasized that the list is not comprehensive. Some of the tools and approaches are complementary or substitutes; some are broad in scope, others narrower. There are some important methods for project/ program evaluation is given below:

Table 5: Tools for Evaluation

Components	Covering areas
Performance indicators analysis	These measure inputs, processes, outputs, outcomes and impacts of development interventions. They are used for setting targets and measuring progress towards them.
The logical framework (LogFrame) approach	This identifies objectives and expected causal links and risks along the results chain. It is a vehicle for engaging partners and can help improve programme design.
Theory-based evaluation/ desk review	Similar to the LogFrame approach, this provides a deeper understanding of the workings of a complex intervention. It helps planning and management by identifying critical success factors.
Conduct formal surveys	These are used to collect standardised information from a sample of people or households. They are useful for understanding actual conditions and changes over time.
Rapid appraisal methods	These are quick, cheap ways of providing decision-makers with views and feedback from beneficiaries and stakeholders. They include interviewing, focus groups and field observation.
Participatory methods	These allow stakeholders to be actively involved in decision-making. They generate a sense of ownership of M&E results and recommendations, and build local capacity.
Public expenditure tracking surveys	These trace the flow of public funds and assess whether resources reach the intended recipients. They can help diagnose service-delivery problems and improve accountability.
Cost-benefit and cost-effectiveness analysis	These tools assess whether the cost of an activity is justified by its impact. Cost-benefit measures inputs and outputs in monetary terms, whereas cost-effectiveness looks at outputs in non-monetary terms.
Impact evaluation	This is the systematic identification of the effects of an intervention on households, institutions and the environment, using some of the above methods. It can be used to gauge the effectiveness of activities in reaching the poor.
Basis or Points of Evaluation	At various points during the project you want to M&E on the basis of following points: <ul style="list-style-type: none"> • Input • Schedule/ work schedule/ activity plan; • Activities; • Output; • Outcome; • Impacts;

Components	Covering areas
	<ul style="list-style-type: none"> • Quality; • Process; • Track/ path; • cost, Time; • Baseline; • Target and achievements; • Human resources; • stakeholder satisfaction; • Project performance; • Objectively verified SMARTS indicators; • Means of verification; • Risks/ Challenges identified
Cost effectiveness	Cost-effectiveness analysis (CEA) is a form of economic analysis that compares the relative costs and outcomes (effects) of different courses of action. Cost-effectiveness analysis is distinct from cost-benefit analysis, which assigns a monetary value to the measure of effect.
Cost-benefit analysis (CBA)	Cost-benefit analysis (CBA), sometimes called benefit costs analysis (BCA), is a systematic approach to estimating the strengths and weaknesses of alternatives used to determine options which provide the best approach to achieving benefits while preserving savings (for example, in transactions, activities, and functions). A CBA may be used to compare completed or potential courses of actions, or to estimate (or evaluate) the value against the cost of a decision, project, or policy.
Methods for evaluation	Survey; Observation; Case studies; Focus group discussion; Key Informants interview; Mapping.

Source: World Bank Operations Evaluation Department, 2002

1.10.4. Basis and Demarcation Line/Areas of Project Monitoring & Evaluation

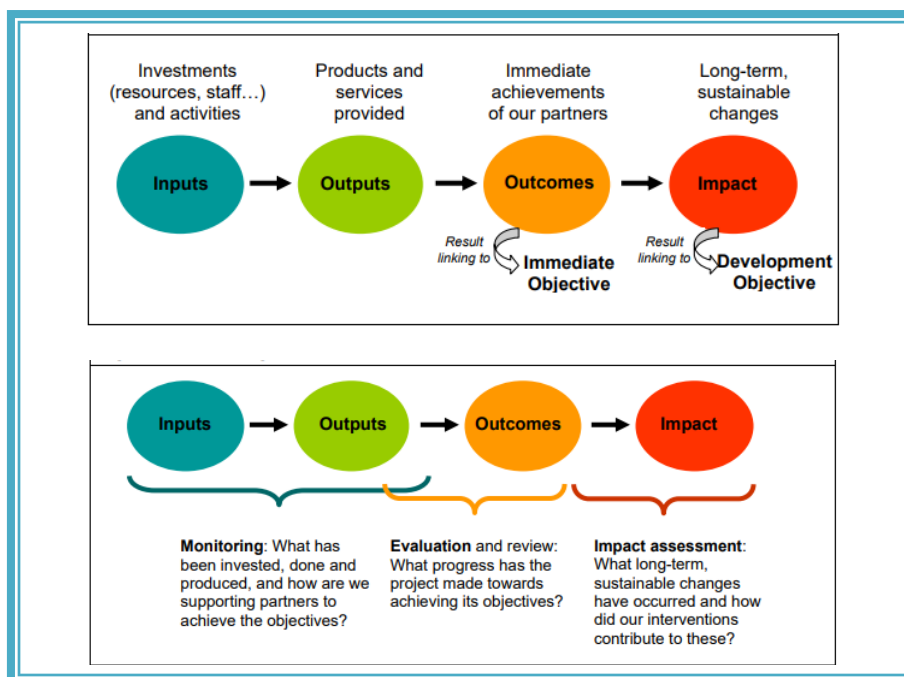


Figure 6: Basis and demarcation line/ areas of Project Monitoring & Evaluation

Source: ILO Technical Cooperation Manual for M&E

Table 6: Project Evaluation Criteria

Evaluation criteria	Description
Relevance and strategic fit of the project	The extent to which the objectives of a development intervention are consistent with beneficiary's requirements, country needs and global priorities, partners and donor policies. The context to which the approach is strategic and its comparative advantage.
Validity of project design	The extent to which the project design is logical and coherent.
Project progress and effectiveness	The extent to which the project's immediate objectives were achieved, or are expected to be achieved, taking into account their relative importance.
Efficiency of resource use	A measure of how economically resources/inputs (funds, expertise, time etc.) are converted into results.
Effectiveness of management arrangement	The extent to which management capacities and arrangements put in place support the achievement of result.
Impacts orientation and sustainability of the project	The strategic orientation of the project towards making a significant contribution to broader long term sustainable development change. The likelihood that the result of the project are durable and can be maintained or even scaled up and replicated by project partners after major assistance has been compiled.

Source: ILO Technical Cooperation Manual for M&E

1.10.5. Key areas of project Development and Management activities under M&E

Project management is one of the critical processes of any project. This is due to the fact that project management is the core process that connects all other project activities and processes together. When it comes to the activities of project management, there are plenty. However, these plenty of project management activities can be categorized into five main processes.

Project management is a responsible process. The project management process connects all other project activities together and creates the harmony in the project. Therefore, the project management team should have a detailed understanding on all the project management processes and the tools that they can make use for each project management process.

The project development and management of an ideal project management system consists of different steps are below:

- Conception and defining;
- Planning and budgeting;
- Executing;
- Monitoring & evaluation with Performance and Control;
- Project Terminating and Closing.

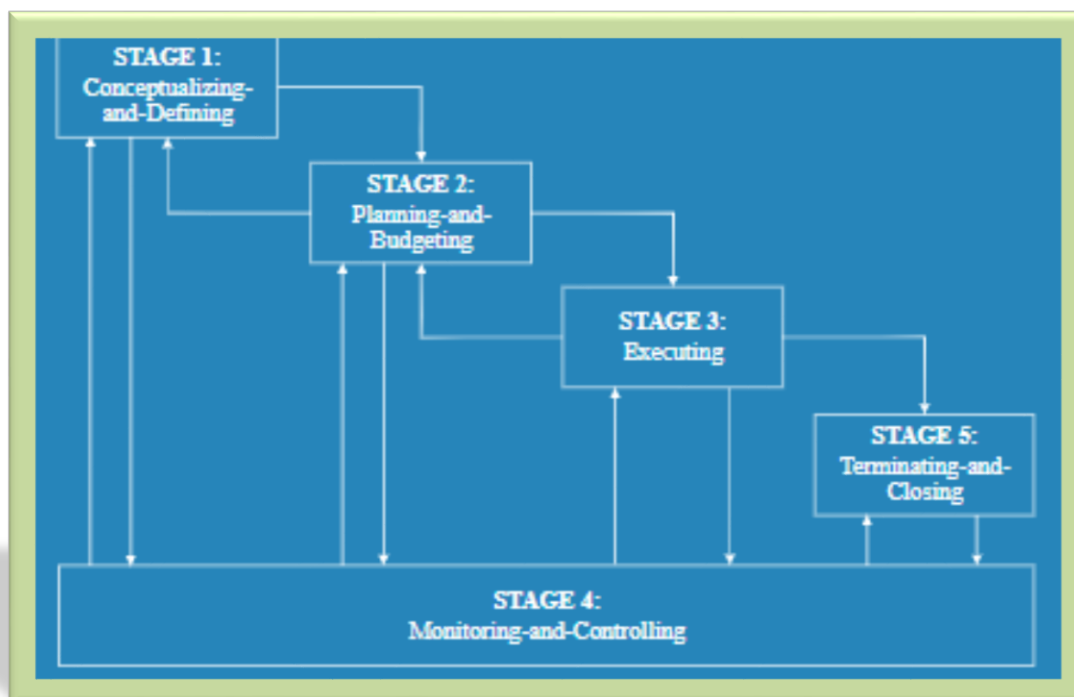


Figure 7: Project Development Activities and Management Stages

Source: www.smartsheet.com

Table 7: Project Development Activities and Management Stages

Stages	Areas Covered
1. Project Initiation and conceptualization	Project initiation and conceptualization is the starting point of any project. In this process, all the activities related to winning a project takes place. Usually, the main activity of this phase is the pre-sale. The conceptualization phase of a project occurs in the initial design activity when the scope of the project is drafted and a list of the desired design features and requirements is created. During the pre-sale period, the service provider proves the eligibility and ability of completing the project to the client and eventually wins the business. Then, it is the detailed requirements gathering which comes next.
2. Project Planning	Project planning is one of the main project management processes. If the project management team gets this step wrong, there could be heavy negative consequences during the next phases of the project. Therefore, the project management team will have to pay detailed attention to this process of the project. In this process, the project plan is derived in order to address the project requirements such as, requirements scope, budget and timelines. Once the project plan is derived, then the project schedule is developed.
3. Project Launch and Execution	After all paperwork is done, in this phase, the project management executes the project in order to achieve project objectives. When it comes to launch and execution, each member of the team carries out their own assignments within the given deadline for each activity. The detailed project schedule will be used for tracking the project progress. During the project execution, there are many reporting activities to be done. The senior management of the company will require daily or weekly status updates on the project progress.
4. Project Performance/ quality control and Validation	During the project life cycle, the project activities should be thoroughly performance / quality controlled and validated. The controlling can be mainly done by adhering to the initial protocols such as project plan, quality assurance test plan and communication plan for the project.

Stages	Areas Covered
	Validation is a supporting activity that runs from first day to the last day of a project. Each and every activity and delivery should have its own validation criteria in order to verify the successful outcome or the successful completion.
5. Project terminating, Closeout and Evaluation	<p>Once all the project requirements are achieved, it is time to hand over the implemented system and closeout the project. If the project deliveries are in par with the acceptance criteria defined by the client, the project will be duly accepted and paid by the customer.</p> <p>Once the project closeout takes place, it is time to evaluate the entire project. In this evaluation, the mistakes made by the project team will be identified and will take necessary steps to avoid them in the future projects.</p> <p>During the project evaluation process, the service provider may notice that they haven't gained the expected margins for the project and may have exceeded the timelines planned at the beginning.</p>

1.10.6. **Monitoring & Evaluation, Result Based Management and results**

Results-based management (RBM) is a broad management approach whose core focus is achieving results. The Office of Internal Oversight Services (OIOS) defines RBM as a “management strategy by which processes, outputs and services contribute to the achievement of clearly stated expected accomplishments and objectives. It is focused on achieving results, improving performance, integrating lessons learned into management decisions and monitoring and reporting on performance.”

A result is describe-able or measureable change that is derived from a cause and effect relationship. This means that a result is a change that can be observed, described and measured in some way. The terms goals, purposes, outpute and outcomes are different levels of results. The result can be identified by the word “**SMARTS**” means of

- S- Specific
- M- Measurable
- A- Achievable and Attributable
- R- Relevant and Realistic
- T- Time-Bound.

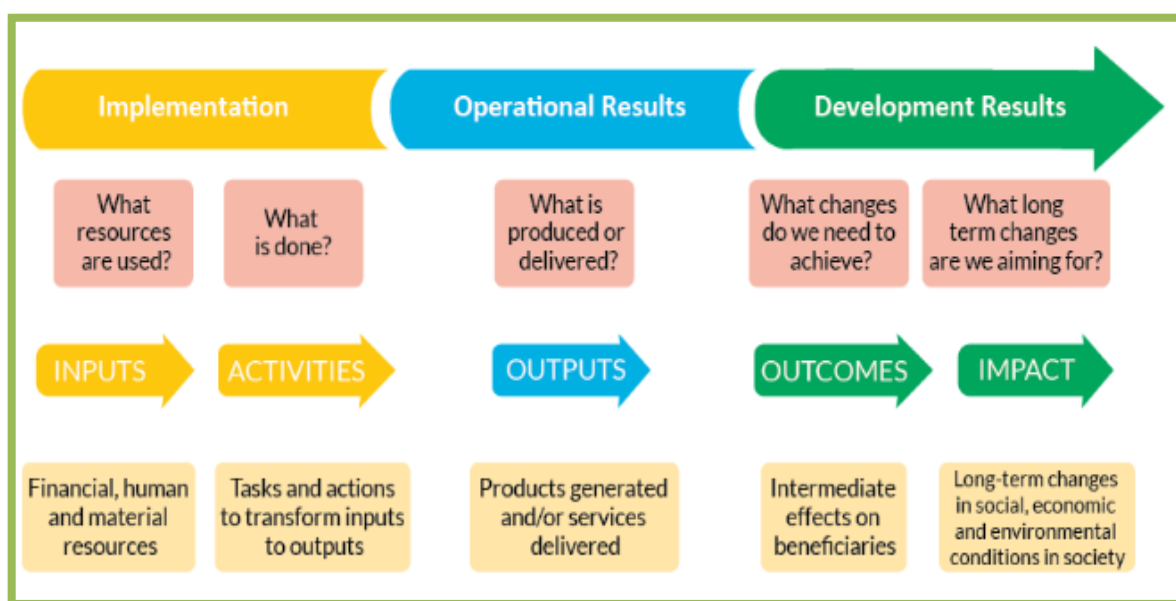


Figure 8: The Results Chain

Source: UN Habitat, 2018

Table 8: The Results Chain Components and Their Covering Areas

Result Chain Components	Description of Results
Impacts	Refers to long term improvement in society. The causal relationship between the development interventions and the changes that have taken place in society is often difficult to prove and it is a function of multiple factors, both negative and positive.
Outcomes	Are the intended intermediate effects on the target groups – they represent the most important result - level in RBM
Inputs	Financial, human and material resources used for the development intervention
Outputs	Products or services that are relevant for the achievement of outcomes -they are the short term products of complete activities
Activities	Are options taken or work performed using resources to produce specific output

1.10.7. Objective of the Assignment as Per Terms of Reference (TOR)

The main objective of the assignment was to prepare an M & E Guideline covering all important areas of Forestry, Irrigation, and Water Resources and shipping related projects, which would help as tool of monitor for IMED officials during ongoing project monitoring and evaluation of project after termination.

The specific objectives of the assignment were the following:

1. Review the existing available relevant documents/guidelines on project;
2. Review the existing available relevant documents/guidelines of other similar countries and development partner agencies;
3. Analyze objectives of the assignments thoroughly;
4. Develop a guideline that can be effectively used by the IMED officers during project monitoring and evaluation;
5. Develop on identical M&E template for relevant sector;
6. Guide the officers of the IMED in building systematic approach to field visit through use of the guideline;
7. Ensure the project management knowledge areas (such as scope, time, cost, procurement, quality, integration, human resource, stakeholders, communication and risk) and
8. Help accelerate progress of the development projects.

1.11 Scope of the Services (As Per TOR)

The scopes of the services were as follows:

1. Prepare a study design to carry out interviews of the stakeholders to know the actual requirement of Forestry, Irrigation, Water Resources and Shipping related projects for preparation of the guideline;
2. Identify weaknesses and limitations in the monitoring and evaluation process of the related projects;
3. Identify key areas of project development activities, and also identify/select smart indicators for effectively monitoring and evaluating related projects;
4. Identify the components of different development projects, and describe the parts of each component for effective monitoring and evaluation;
5. Study monitoring and evaluation reports, in-depth study reports and other related reports of the projects of the concerned sector and identify monitoring and evaluation weaknesses etc.;
6. Study other relevant documents and M&E procedure of Forestry, Irrigation, Water Resources and Shipping projects/program of in country and other countries that can be helpful in preparing M&E Guidelines;
7. Consultant/s will interact with the relevant ministries, agencies, projects and identify areas of interest that can be helpful in carrying out the assignment;

8. Consultant will deliver comprehensive M&E guideline and M&E templates for Forestry, Irrigation, Water Resources and Shipping in English and Bangla;
9. Any other related works assigned by the client.

The ToR of the study is attached in **Annex-1**.

1.12 Causes of Increasing Project Cost, Time and Scope in Development Project

Delay, cost overrun and changes of scope are inherent part of most projects despite the much acquired knowledge in project management. Although some may argue that this is negligible It is important to note that physical and economic scale of projects today is such that it is driven under the platform of profit to the parent organization, and of national interest (for government projects) by the degree of success defined within the Iron triangle of cost, time, and scope. It is therefore much appreciated to look at some reasons of delays and cost overrun in project and their mitigation process, so as to increase the perception of project success (QS Quote Limited 2015 and Project Management Institute, 2009).

Causes of increasing the project time-period	Causes of increasing the project cost of the project	Project scope & external factors
<ul style="list-style-type: none"> ➤ Improper Project design ➤ Inadequate assessment of available technology , resources, manpower, methods, planning for implementation ➤ Lack of skilled, resourceful contractors , Deficient contract management ➤ Change project scope/ design midway ➤ The complexity of project HRM and capacity building ➤ Lack of project management during execution ➤ Shortage of reliable data base on similar previous projects ➤ Inadequate monitoring particularly in the field level ➤ Delayed decision making 	<ul style="list-style-type: none"> ➤ Time over run leads to cost increase ➤ Delays lead to cost increase for inflation - need revision – time to approve revised DPP – vicious cycle ➤ Sources of raw materials and transportation cost of the project site ➤ Faulty transportation system and poor transport network ➤ Lack of skilled labor and availability of labors- during the Eid - vacation, Ramadan, Paddy harvesting season, labors are less interest to work in the project site ➤ Sudden increase of prices of goods and services ➤ Market price of goods and services increased due to government policy, increase facilities for government service holders, international policy and strategies, natural disaster, sometimes political interruption and syndicates etc. ➤ Increase of VAT and Tax ➤ Labor rate and unavailability of expert labors/ lack of skilled labors ➤ Deficient institutional structure ➤ Higher level management like PSC, PMC are too busy due to 	<ul style="list-style-type: none"> ➤ External factors, such as new vendors, technologies, or methodologies ➤ Changes organizational structure or restructuring ➤ Change of priority of project ➤ Condition imposed on source of goods/ service ➤ Lack of stakeholder engagement and Change in stakeholder requirements ➤ Gold-Plating (scope inflation, scope creep) ➤ Lack of clarity of the specification ➤ Political and funding agency interventions ➤ Project resourcing pattern changes (supply and demand) ➤ Practices of not delegating authority by Government, development partner’s etc. ➤ Technology advances, this can be considered in procurement contracts ➤ Nature of demands/ requirement shifted ➤ Requirements are not aligned with project scope

Causes of increasing the project time-period	Causes of increasing the project cost of the project	Project scope & external factors
<ul style="list-style-type: none"> ➤ Natural and anthropogenic disaster 	<ul style="list-style-type: none"> more involvement in administrative work. ➤ Unrealistic Cost Estimates initially ➤ Lack of Coordination ➤ Lack of a Contingency Plan 	

Source: Field investigation 2019

To achieving a project goal with little or no delay and cost overrun is in the definition of project success factors and criteria. The integration of these factors will lead to a better understanding of the issues in which the project manager needs to address and design a control system that will monitor these issues. The project owner and the project manager should be able to clear define the management success and product success so that the project team has clear knowledge of its objectives (QS Quote Limited 2015 and Project Management Institute, 2009).

CHAPTER TWO METHODOLOGY OF THE STUDY

Literature Review

IFRC (2011) aims to promote a common understanding and reliable practice of monitoring and evaluation (M&E) for IFRC project/programmes. This guide describes the monitoring and evaluation concept and considerations, six key steps of project/programme monitoring and evaluation including the identification of purpose and scope of M&E system, plan for data collection and management, plan for data analysis, plan for information reporting and utilization, plan for M&E human resources and capacity building, prepare the M&E budget.

FAO (2014) covered the key principles relating to M&E as set out in World Food Program (WFP) policies and the linkages between operation design, and M&E concepts and tools. The module provided clarification of responsibilities within WFP for evaluation, and an approach for the preparation of an M&E strategy. The module briefly introduced key concepts, such as Results Based Management (RBM) and the Logical Framework Approach, and demonstrated how they are linked together. It describes the characteristics and importance of M&E for planning and implementing of activities within operations, principles, clarifies responsibilities within WFP for evaluation, and approach for the preparation of an M&E strategy.

Nisar Ahmad Khan (2015) focused on the project cycle management with different steps including the project implementation, on-going monitoring, post project evaluation, objectives and importance of monitoring and evaluation etc. It shows the monitoring and evaluation practices in Bangladesh and functions of IMED with emphasis on the field inspections, site inspections of civil works related project and attitude and approaches of inspections. This report presents the M&E manual for civil works with different purpose, preparation for project inspection by using M&E Manual, Inspection of Roads, Bridges and Culverts. The Steps in construction of road, Steps in construction of road segments, Stages of Bridge Construction, Stages of Culvert's Construction and Removal of temporary structures and backfilling are also discussed in this report.

IFRC (2002) contains useful M&E tools and is supported by some theoretical background. Clarifying and demystifying the M&E function as a performance instrument to strengthen Better Programming Initiative (BPI) and Project Planning Process (PPP) has been demanded by all stakeholders. This M&E handbook codifies a more rigorous search for improved methods of assessing whether organizations are both "doing things right" and "doing the right things". This handbook is designed in modules to facilitate easy reading and a logical pathway through M&E. It provides the reader with opportunity to reflect and refresh by addressing a number of key questions following each module.

Scott G. Chap Lowe & J. Bradley Cousins (2016) describe that monitoring and evaluation represent two elements of the enterprise of assessing the merits and the worth of an organization or program encompassing assessment of both performance and impacts of broad ranges of different audience and purpose. It discussed the various types of monitoring & evaluation including the performance monitoring, implementation monitoring, process monitoring, planning, design monitoring & evaluation, program monitoring & evaluation and referred to as M&E must be mutually dependent parts of a whole. It recognized the importance of high quality monitoring system designed with evaluation in mind offers a tremendous opportunity to increase the relevance and utilization of evaluation.

EVALOC (2014) is designed to help groups working on community led approaches to climate change and energy conduct their own Monitoring and Evaluation (M&E). It aims to provide an accessible background to the principles of M&E, together with selected links to resources and

approaches that may be useful for your group. The different sections of the guide describe an overview of the approach to M&E in use, which is based on a logic model approach and provide a template for M&E resources. Another section of this guide gives an overview of information collecting methods, provides links to a host of resources to support your M&E and finally it contains some example questions and materials.

European Commission (2017) presents a systematic process of introduction to monitoring and evaluation (“M&E”) utilizing the logical framework approaches to project design. It is recommended that you access these (excellent) documents to continue your further reading in M&E. Ideally this manual provides summarized information to complement a training session facilitated by an experienced M&E practitioner. It can be used as a guide on its own without the formal training, but this is not advised without significant extra reading and mentoring. You are therefore encouraged to seek further information and support.

Policy of PKSF for Monitoring & Evaluation (2012) describes the goal, functions related to monitoring and evaluation, and reporting with output, outcome and impact etc. It aims to carefully plan, monitor, and report and eventually evaluate on output, outcome and impact to bring long lasting results or changes in project intervened area. It will help to reduce poverty through creating productive employment opportunities for the moderate and ultra-poor, small and marginal farmers and micro-entrepreneurs and sustainable poverty reduction through employment generation.

World Bank (2004) focused on monitoring & evaluation of development activities that provides government officials, monitoring and evaluation (M&E) of project managers, and civil society with better means for learning from past experience, improving service delivery, planning and allocating resources, and demonstrating results as part of accountability to key stakeholders. Strengthen awareness and interest in M&E, and to clarify what it entails. An overview of a sample of M&E tools, methods, and approaches outlined here, including their purpose and use; advantages and disadvantages; costs, skills, and time required; and key references also discussed. It illustrated here include several data collection methods, analytical frameworks, and types of evaluation and review are the key functions of this guide. It discusses the performance indicators, the logical framework approach, theory-based evaluation; formal surveys, rapid appraisal methods, participatory methods, public expenditure tracking surveys, cost-benefit and cost-effectiveness analysis and impact evaluation etc.

IMED (2008) Strategic Plan 2008 to 2013, Implementation Monitoring and Evaluation Division, Ministry of Planning, Government of the People’s Republic of Bangladesh. This Strategic Plan focused on the Vision, Mission, Strategic Goals and Objectives, Organizational Change Management and Implementation of Strategic Plan etc. IMED excels in the practice and management of monitoring and evaluation with competences in programme monitoring and evaluation, mass communications, and project information systems it advises other government organizations on programme design and measurement. IMED works for monitors and evaluates the performance of revenue and development investment by collecting and analyzing information on project and programme results originating from implementing organizations. It analyses of the performance of ministries and sectors against agreed targets and reports provided to Executive Committee of the National Economic Council, line ministries and other concerned parties whenever necessary.

Fifth Five Year Plan (1997-2002) Planning Commission, Ministry of Planning, Government of the People’s Republic of Bangladesh. The chapter eleven of this five year plan focused on the Implementation and Monitoring Like any other Plan, the success of the Fifth Five Year Plan will depend on the proper implementation of its programmes and projects, implementation monitoring and post-implementation evaluation. This is particularly important in view of the fact that it is

aflexible plan and plan projections will be revised based on evaluation of actual performance. Monitoring arrangements, Project approval process, Assigning responsibility of implementation to an agency, Allocation/Release of fund, Procurement of goods and services etc. also covered in this section.

IMED (2003) IMED Quarterly Report, Implementation Monitoring and Evaluation Division, Ministry of Planning, Government of the People's Republic of Bangladesh covered the Monthly Implementation Progress Review of ADP included Project, procurement progress, project monitoring format/ template, Quarterly Component-wise Progress, Implementation Problems and Suggested Measures, Contract Implementation Reporting procedure etc. This will be supportive for development new SMARTS indicators based and effective M&E template for IMED.

World Bank and IDA (2017) Project Appraisal Document for a Digitizing Implementation Monitoring and Public Procurement Project focused on the project development objective is to improve public procurement performance and enhance capacity for implementation monitoring of development programs/projects. It aims to Restructuring CPTU and Institutionalizing e-GP; Enhancing Digitization of Public Procurement; Professionalizing Procurement and Citizen Engagement; and Digitizing Project Implementation Monitoring

2.1 Study Implementation Strategies

The study was carried out for the preparation of M&E guidelines for forestry, irrigation, water resources and shipping sector related projects of Bangladesh which is currently in implementation stage, so as to IMED officials can follow the guidelines during the monitoring of such projects. The methodology of preparing guidelines has been divided into three phases:

Elementary Phase: The Consultants of this assignment were participated an orientation meeting with IMED officials aimed to know their requirements, understanding the objectives of the study, their involvement and support during the assignment, way to collect the data, selection of the project on which M&E guidelines have to be prepared, and structure of the report, etc. Elementary phase included the collection and review of sectoral Development Project Proforma (DPP) of sampled project for M&E guidelines, preparation of data collection tools and techniques, details of project components, and accomplishment of field plan in consultation with IMED.

*The checklist of DPP for the proposed study is attached in Annex-2.
The checklist of TPP for the proposed study is attached in Annex-3.*

However, the team reviewed the published reports and literatures to produce a draft of the strategy and action plan. Lessons learned from best practices in M&E in other countries, and project progress and technical reports from multiple government, non-government organizations and development partners working in the forestry, irrigation, water resources and shipping sectors in Bangladesh were also reviewed to produce the report.

Data Collection Phase: The study carried out through interpersonal face-to-face interview for the collection of primary data with concerned Ministry/Department, Organization/Agency, Planning Commission and relevant sector officials of IMED like forestry, irrigation, water resources and shipping related projects of Bangladesh. Checklist was used to conduct the study. The respective consultant for each sector taken the image/snap of activities under all components of the project mentioned in DPP. High resolution camera was used for taking the image. In fact, consultants were developed necessary checklists for the monitoring and evaluation of each activity that help the IMED officials during monitoring of the project activity. For sharing and the validation of findings, IMED

arranged a workshop with relevant various officials of line ministries and stakeholders in the field of M&E in proposed sectors.

Data Consolidation and Report Writing Phase: The team leader checked all information and/or data against all sampled projects, completed editing within due time, translated and consolidated qualitative findings, analyzed data and developed the report according to the guidance of the ToR.

2.2 Study Methods

The preparation of M&E guidelines involved a qualitative investigation and observation method using checklist over a period of 15 (fifteen) days from 20th January to 5th February, 2019. The appraisal was accomplished through inter-personal key informant interview (KII) with project directors, M&E officers, field officers, and IMED M&E officials, etc. of the sample projects of proposed sectors. The Consultants maintained a close interaction and cooperation with officials of various relevant line ministries before, during and after data collection in order to make guidelines fruitful.

A checklist of KII is attached in Annex-4.

2.3 Selection of the Projects

The public-sector development projects along with budgets in Bangladesh are included in the government's Annual Development Plan (ADP). The consultant team after orientation meeting with IMED carried out a rigorous desk review of last three year's projects undertaken in ADP of the fiscal year (FY) of 2018-2019, 2017-2018 & 2016-2017 of relevant ministries and department of Bangladesh¹e.g. on Ministry of Environment, Forests and Climate Change (MoEFCC), Department of Forests (DoF), Department of Environment (DoE), Ministry of Agriculture, Department of Agriculture Extension (DAE), Barindra Multipurpose Development Agency (BMDA), Bangladesh Agriculture Development Corporation (BADC), Ministry of Water Resources, Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Bangladesh Haor & Wetlands Development Board, Ministry of Shipping, Bangladesh Inland Water Transport Authority (BIWTA), Bangladesh Land Port Authority (BLPA), Bangladesh Inland Water Transport Corporation (BIWTC), Mongla Port Authority (MPA), Chattogram Port Authority (CPA), Bangladesh Shipping Corporation (BSC), Payra Port Authority (PPA), National Maritime Institute (NMI), etc.

A list of proposed last three years sectoral projects of different wings has been attached in **Annex-5** of the final report. **Table-9** presents the list of sample projects on which M&E guidelines were prepared by Consultants. These projects were selected, first, avoiding the same nature and type of components, geographical mix, and time of the assignment and also considering the perspective plan of relevant ministries etc.

¹<https://imed.gov.bd/site/page/eb9709ff-7344-42cb-8f4c-9df7e5b08ba2/%E0%A6%AA%E0%A7%8D%E0%A6%B0%E0%A6%95%E0%A6%B2%E0%A7%8D%E0%A6%AA-%E0%A6%A4%E0%A6%BE%E0%A6%B2%E0%A6%BF%E0%A6%95%E0%A6%BE-%E0%A6%93-%E0%A6%8F-%E0%A6%B8%E0%A6%82%E0%A6%B6%E0%A7%8D%E0%A6%B2%E0%A6%BF%E0%A6%B7%E0%A7%8D%E0%A6%9F-%E0%A6%A4%E0%A6%A5%E0%A7%8D%E0%A6%AF>

Table 9: Sample Projects for the Preparation of M&E Guidelines

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (BDT. In Lakh)	Information of Contact Person
A. FORESTRY SECTOR					
1	Sustainable Social Forest Development Project in the greater Rangpur District (2018-'19)	DoF	4531-5011	500.00	Md. Rafiquzzaman Shah Project Director & Divisional Forest Officer Social Forest Division, Rangpur, Mobile: 01999006673, Phone: 0521-62097 Email: dforangpur@gmail.com
2	Afforestation in coastal region including the newly accreted chars of Bay of Bengal (2018-'19)		4531-5018	1,500.00	Gobinda Roy Conservator of Forest & Project Director Tel:0431-62190, Email: cfcc.bsl@gmail.com
3	Eco restoration of the Northern region of Bangladesh (2017-2018)		4531-5000	1,694.00	Abdul Mabud Project Director Ban Bhaban, Mohakhali, Dhaka Phone: 9886282, 9893551, 01558816664, Email: amabud1958@yahoo.com
4	Establishment of plant gardens in the area of Lalmai hills (2016-2017)		4531-5024	1.00	Md. Mahbubur Rahmman Project Director & DFO, Cumilla Social Forest Division Mobile: 01711903975 Email: dfocom.fd@gmail.com; mahbub216@yahoo.co.uk
5	Climate Resilient Participatory Afforestation and Reforestation (2016-2017)		4531-5016	7,809.00	Uttam Kumar Saha Deputy Forest Conservator, Phone: 01715549120
6	Sheikh Rasel Aviary and Eco Park Rangunia, Chattogram (2016-2017)		4531-5330	126.00	Bipul Krishna Das, Divisional Forest Officer Chattogram South Forest Division, Forest Hill, Nandakana, Chattogram Phone: 031-2869138, 031-637328, 01711186725, Email: dfoetgs@gmail.com
B. IRRIGATION SECTOR					
1	Enhancement of Irrigation Efficiency through Construction of Sub-Surface Irrigation Channel (2018-2019)	BMDA	4305-5051	2248.00	Md. Shahidur Rahman, Executive Engineer BMDA, Cantonment Road, Bahrapur, Rajshahi-6000 Phone: 01558321323, 0721-761318, msrahman@bmda.gov.bd
2	Barind Rain Water Conservation & Irrigation Project (second phase) (2017-2018)		4305-8081	1,952.00	Shibir Ahmed, Executive Engineer BMD, Residential Quarter, Cantonment Road, Bahrapur, Rajshahi-6000.

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (BDT. In Lakh)	Information of Contact Person
					Phone: +88-0721-761897, 01712803627 Email: sahmed@bmda.gov.bd; ahmedbmda@yahoo.com
3	Sylhet Division Minor Irrigation Development Project (2016-2017)		4305-5035	3,000.00	Dhirendra Chandra Debnath, Superintend Engineer (current) Sheikhghat, Sylhet Phone: 0821-716708, 01715-815593 Email: pdsdmidp@gmail.com
4	Digitalization of Survey and Monitoring for Development of Minor Irrigation (Phase-IV) (2018-2019)	BADC	4305-5009	1,950.00	Engr. Mohammad Zafor Ullah, Project Director, Phone:02-9116143, Email:projectdirector.sm@gmail.com
5	Noakhali, Feni and Laksmipur districts Minor Irrigation Development Project (2018-2019)		4305-5061	4,720.00	Mohammad Noornabi Project Director, Phone: 0321-71430
C. SHIPPING SECTOR					
1	Re-construction of RCC Jetty at Guptachhara, Sandwip (2018-2019)	BIWTA	5205-5012	2,692.00	Mr. Md. Asraful Islam Executive Engineer & Project Director Mobile: 01712639766, Email: azaman1980@yahoo.com
2	Capital Dredging of 53 Route of Inland Water Ways (in 1st phase, 24 Route) (2017-2018)		5205-5026	22,800.00	Md. Rakibul Islam, Superintending Engineer 141-143, BIWTA Bhaban,. Mitijhil, Dhaka-1000. Phone: 9552127, 01551229977, 9571453, Email: rislamrokon@gmail.com
3	Infrastructure Development and Establishment of Dock-3 Marine Workshop for BIWTC (2018-2019)	BIWTC	5205-0526	435.00	Mr. Monjus Kanti Debnath Additional Chief Engineer & Project Director Mobile: 01742747985, Email: adl.ce.dy1@biwtc.gov.bd
4	Rehabilitation of 2 Ferry Jashore and Cumilla (2016-2017)		5205-0522	310.00	Shwadesh Prasad Mandal Executive Engineer Bangladesh Land Port Authority, TCB Bhaban (5th Floor), Kawran Bazaar, Dhaka-1215, Phone: 02-9132488, 01912235738, 956365, Email: spmandal@gmail.com
5	Construction of Potenga Container	CPA	5205-0529	30,000.00	-

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (BDT. In Lakh)	Information of Contact Person
	Terminal (2018-2019)				
6	Payra Deep Sea Port Operations Infrastructure/Facilities Development (2017-2018)	BSC	5205-5066	20,000.00	Capt. M. Muniruzzaman, Member (Engineering & Development) Al-Amin Millenium Tower, Level-7, 75-73 Kakrail, Dhaka, D-36/102, Nou Sadar Doptor R/A, Banani, Dhaka-1213 Phone: 01923603041, 02 9350125, 9349175 Email: member-ed@ppa.gov.bd
D. WATER RESOURCES					
1	Preservation of the left bank of the river Padma from Doairbazar, Doharupazila in Dhaka district to Braha bajaraghata (2018-2019)	BWDB	4705-5002	1.00	A.H.M Fakrul Hasan, Superindng Engineer, Central Zone, BWDB Elite House, 54 Motijheel C/A, Dhaka, 35/12, Shymoli (C-4), Road-4, Shymoli, Dhaka02-95560402, Phone: 01670757384, Email: ce.dhakabwdb@gmail.com,
2	Development of drainage system in Dhaka-Narayanganj Demra DND area (2017-2018)		4705-5019	15,000.00	Md. Abdul Awal Miah, Executive Engineer Dhaka O & m Division-1, BWDB Elite House (5th Floor), 54 Motijheel C/A, Dhaka. Phone: 02-9551371, 02-9551371, 01955522121, Email: xen.dhaka1.bwdb@gmail.com
3	The Pilot Project in different Areas of Bangladesh using Bamboo Bundling Structures to Reduce River Bank Erosion, Land Reclamation and Increase Navigation (2018-2019)		4705-5098	1,100.00	-
4	Re-excavation of Arialkha River, Haridoya River, Brahmaputra River, Paharia River, Meghna Branch River and Old Brahmaputra Branch River Project under Narsingdi District (2018-2019)		4705-5076	10,000.00	-

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (BDT. In Lakh)	Information of Contact Person
5	Tista Barage Project (Phase-2) (2016-2017)		4705-9160	2,000.00	Jyoti Prasad Ghosh, B.Sc.Engg. (Civil) Superintending Engineer Rangpur O&M Circle-2, BWDB, Alamnagar, Rangpur. Teesta Project Colony, Alamnagar, Rangpur. Phone: 01715949959, 0521-62720, 0521-54737. Email: circle2bwbd@gmail.com
6	Shibpur Flood Control, Drainage and Irrigation Project under Shibpur Upazila in Narsingdi District 2016-2017)		4705-5145	1,500.00	Md. Abdul Matin Sarkar, Superintending Engineer Dhaka O & M Circle, BWDB, 23/1, Hasan Court (6th floor), Motijheel C/A, Dhaka-1000, Olympia -C9, 32 Laka Circus, Kalabagan, Dhaka-1205. Email: 01710251869, 02-5716432 Email: se.dhakacircle@gmail.com
7	Construction of rubber dams to increase the use of water for agricultural production on Earth Surface (2016-2017)	BADC	4305-5003	4,700.00	Dr. Direndro Chandro Debnath Superintendent Engg. Sech Bhaban, Manikmia Avenew, Sher-e-Bangla Nagar, Dhaka. Phone: 01711-815593 Email: pdrdcp@gmail.com,

Addressed areas under different projects:

Table 10: Addressed Areas

SN	Name of the Sectors	Covered Areas
1.	Forestry	Social forestry, coastal afforestation, Hill plantation
2.	Irrigation	Sub-surface Irrigation Channel, Digitalization of minor irrigation
3.	Water resources	Bamboo Bundling Structures to Reduce River Bank Erosion, Land Reclamation and Increase Navigation; Protection of dam or embankment, Drainage system
4.	Shipping	Jetty, Marine Workshop, Container Terminal, port development

Noted that, sector-wise indicators and/or component based activities with technical specifications provided for sectoral monitoring and evaluation (M&E) guidelines; templates have provided to monitor and evaluate those activities/indicators accordingly. Even, the methods of measuring quality in the case of financial and physical progress of various works/services were included in final guideline. However, the consultant developed a checklist for procurement of sectoral works for the final M&E manual/guideline.

Checklist for procurement of equipments/ installation works Annex-6

2.4 Data Processing, Consolidation and Compilation

The activity based component wise data for each sector mainly qualitative information and images has transcribed and stored respectively into computer for putting into report using MS-Office Software. Even the collected data taken on individual field notebooks, field sheets has transferred to analysis proforma which calls 'converting data into information'. This means that the user of the

monitored output must find it usable. Figure 9 of following page presents the flow chart to carry out the study.

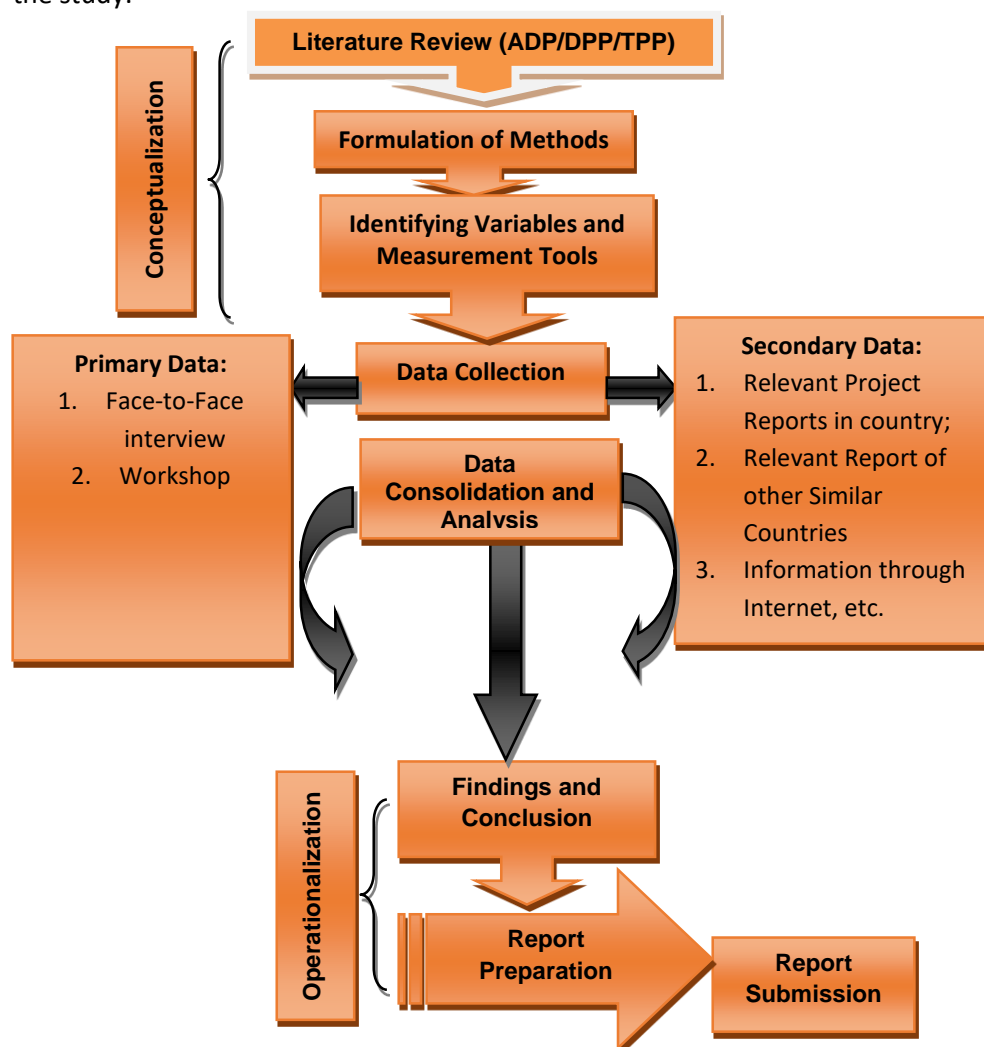


Figure 9: Summary of Study Implementation Plan

2.5 Report Submission

The report submitted with quite brief summarizing the observations and impressions of respective project officials of relevant sectors following a field trip. The draft report presented at workshop involving all the concerned officials' & stakeholders of relevant sector. The comments and suggestions of the workshop incorporated in the final report.

However, the draft/final M&E guideline has presented with simple, lucid, and easy to understandable for all IMED officials. Besides, the connection/link between the intersection and intermediate paragraphs has maintained properly and the syntax and the spelling of words would be written correctly. Moreover, sector-wise glossary has included in draft/final M&E guidelines.

2.6 Limitation of the Study

The study has some limitations that are given below:

- The study duration was so short (only 4 months) ; it is very difficult to conduct this type of study in this short duration with quality work
- The fund allocated for conducting the study was inadequate enlight of the existing market price
- Inadequate support from Project Directors and other relevant officials for the purpose of information related to the project activities and implementation information.

CHAPTER THREE M&E GUIDELINES FOR FORESTRY SECTOR

3.1 Glossary

Forest: Land spanning more than 0.5 hectares with trees higher than 5 meters (exception for the *Cerriops decandra* with height of 2 meters) and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under rural settlement, agricultural or urban land use therefore trees grow outside forest land are considered as non-forest trees.

Forest Plantation: A forest plantation is defined as “a forest crop or stand raised artificially, either by sowing or planting” (Ford-Robertson 1971 and Evans 1992). In the literature, “afforestation”, “reforestation” or “forestation” is used to distinguish new planted forests. The term “afforestation” is used in describing forests established artificially on land that previously did not carry forest for at least 50 years (Evans, 1992; Pancel, 1993a). For example, when man establishes a new forest on grassland or sand dunes, such afforestation is clearly artificial and can be termed a plantation (Evans, 1992). “Reforestation” is used when forests are established artificially on land which has carried forest within the previous 50 years, involving the replacement of the previous crop by an essentially different one (Evans, 1992; Pancel, 1993a). Sometimes, the term “forestation” is used for both “afforestation” and “reforestation” (Pancel 1993a, Wadsworth 1997).

Other terms used to characterize tree planting within existing forests are “inter-planting” or “under-planting”. Trees are planted in existing forests either for “enrichment” (inter-planting), which is the filling in of natural gaps in forest regeneration, or as “under-planting”, the planting of young trees or the sowing of tree seeds, usually spaced systematically under most or all of an existing forest (Ford-Robertson, 1971 and Wadsworth 1997). Based on the form of enrichment or the distribution of trees within the forest, the inter/under-planting methods are called “gap planting”, “line planting” and “group planting”.

Mulching: A protective covering, as of bark chips, straw, or plastic sheeting, placed on the ground around plants to suppress weed growth, retain soil moisture, or prevent freezing of roots.

Weeding: It is the process to remove out the weeds. Weeds are unwanted plants which grown along the useful crops. Weeding is required because weeds are competitive plants as they reduce the useful crop yield by acquiring space, fertilizers and nutrients from the soil.



Mulching

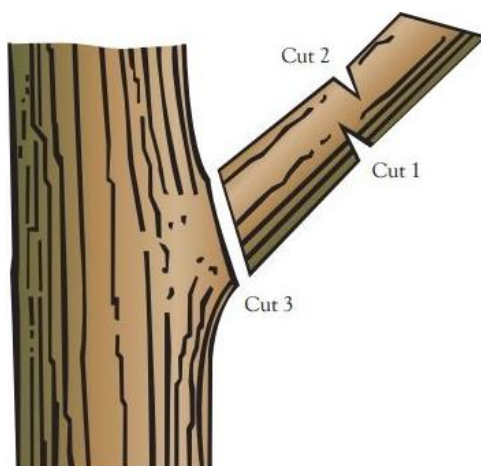


Weeding

Pruning: It is a horticultural and silvicultural practice involving the selective removal of certain parts of a plant, such as branches, buds, or roots. Reasons to prune plants include deadwood removal,

shaping (by controlling or redirecting growth), improving or sustaining health, reducing risk from falling branches, preparing nursery specimens for transplanting, and both harvesting and increasing the yield or quality of flowers and fruits.

Thinning: It is an essential maintenance procedure for forests and it will enhance the future growth and production of your plantation towards clear-fell. Thinning is the removal of a proportion of the trees in a crop. By removing smaller weaker trees the remaining trees are left with more light and room to grow to their full potential.



Pruning



Thinning

Silviculture: It is the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society such as wildlife habitat, timber, water resources, restoration, and recreation on a sustainable basis.

Wildlife Sanctuary: means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wildlife inclusive of all natural resources such as vegetation soil and water (paragraph) (p) of Article 2).

Special Biodiversity Area: means specialized forest areas to consider for the conservation and development of biodiversity. For example, Ratargul Swamp forest of Sylhet.

Vulture Safe Zone: means areas considered for conservation and reproduction of critically endangered white-rumped Vulture (*Gyps bengalensis*).

National Park: means comparatively large areas of outstanding scenic and natural beauty with the primary object of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed (paragraph) (p) of Article 2).

Eco-park: means an area of natural ecological habitat of flora and fauna with outstanding scenic beauties which is managed for providing recreational facilities for visitors and which is declared as such through official gazette notification under section 19 of the Act.

Botanical garden: means an area where different native and exotic plant species are conserved or managed for education, research and conservation and improvement of source of gene pool

introducing from another habitat and which is declared as such through official gazette notification under section 19 of this Act.

Safari park: means an area where indigenous and exotic wild animal species are protected in an approximation of a natural environment for increasing the population and grazing openly and which is declared as such through official gazette notification under section 19.

Literature Review

Ministry of Lands and Natural Resources(2016) works for developing a web-based integrated M&E Information Management System (IMS) to improve their organizational capabilities, responsiveness and efficiency of its M&E functions at corporate, divisional and grantees levels._The system is intended to facilitate the collection, collation and reporting of progress of implementation and achievement of results in a real time manner to support evidence based decision making and management. The system is expected to support evidence based decision making and knowledge sharing at all levels of the forestry sector by integrating the organizational, functional and operational information. This guideline will helps to project/operational performance management with support to tracking of project/program implementation and systematic collection, collation, analysis and reporting of project level performance information based on agreed indicators in the Results Measurement Frameworks (RMFs) and M&E Plans; organizational performance; documentation and communication of results to partners/stakeholder accountability; data analysis, modeling and reporting etc.

U.S. Environmental Protection Agency (1999) described the Monitoring, evaluating, reporting, verifying, and these projects in order to accurately determine Implementation of standardized guidelines is also for estimating GHG benefits. It is intended to increase the reliability of data so that programs and plans can be revised mid-course; introduce consistency and transparency across project types and reporters; enhance the credibility of the projects with stakeholders; reduce costs by providing an international, industry consensus approach and methodologies; and reduce financing costs, allowing project bundling and poked project financing. It cover the description of three methods (modeling, remote sensing, and field/site measurement) for evaluating changes in the carbon stock; an explanation of key issues influencing the establishment of a credible baseline (free riders) and the calculation of changes to the carbon stock (project leakage, positive project spillover, and market transformation); a process for verifying and certifying project impacts, based on an interpretation of the Kyoto Protocol.

Bangladesh Forest Department (2016) focused on Problems of existing BFD institutions and possible remedies, land management and ownership, forest and other related sectors assessment, monitoring and assessment including remote sensing, socio-economic survey and MIS/GIS database management, reporting and mapping related issues and roadmap to overcome this, wildlife management, review of the existing FMP, forest policies, acts regulation, programs, institutions, environmental and socio-economic challenges, and international commitments, economic / financial valuation of forests & ecosystem services, alignment with Five Year Plans. This plan covered the strategies, programs and resources for implementation of new Forest Management Plan (FMP), identified Climate change impacts, strategies for enhancing resilience of forest ecosystems and forest dependent communities to enable adaptation to climate impacts.

FAO, Forestry Department (2011) intended for forest owners and managers involve in monitoring forest management to concepts and common methods of monitoring and provide links to tools and case studies. It focused on the strategies for Effective monitoring that is essential for sustainable forest management (SFM). It shows an important distinction exists between monitoring and auditing, which are complementary components of a monitoring system. It concerns on the activities

in forest management units (FMUs), defined as clearly demarcated areas of land covered predominantly by forests, managed to a set of explicit objectives and according to a long-term forest management plan. It focused on the operational monitoring that is used to determine whether prescribed practices are being followed and if they are having the desired effects. It also provides a basis for modifications to improve practices and identifies areas in which corrective or remedial action, post-harvest forest assessment, and strategic monitoring system with management regimes, growth and yield, and environmental and social impacts. It highlighted on the environmental monitoring, monitoring forest for climate change, steps of adaptive forest management system, the purpose of monitoring and evaluation of thinning etc.

Ministry of Environment & Forests, Govt. of India (2000) green belts is recommended for containment of air pollution in the human environment, especially on Industrial and urban environment. Plant-Pollutant Interactions, theoretical Models for Development of Green Belts, agro-climatic Zones of India, choice of Plants for Green Belts, stabilization of Fly-ash with Plants etc. It discussed on a standard horticultural practice involves planting of saplings in pits of substantial dimensions i.e. 1m x 1m x 1m for big trees and almost half of these dimensions for smaller trees and shrubs. The pits filling process are also discussed in the guideline earth, sand silt and manure are filled on pre-determined proportions sampling planted in such pits are watered liberally.

Rocklin California 2016 discuss about the technical information about tree planting and maintenance. It focused on the location of trees in the landscape, distances away of trees from structures, routing space, strategies for tree placement for energy conservation, spacing between trees etc. It covers the Species selection process, intended functions of the tree at the site, space (above and below ground) is available for the tree, soil type and soil conditions at the site, water required for the tree require or tolerate etc. It shows the maintenance require for trees, climate and microclimate conditions at the site, conditions for long-term performance of the tree, developing a list of tree species potentially suitable for Landscape, Information in the list of tree species potentially suitable for landscape etc.

Georgia Forestry Commission (2017) intended to aid homeowners and local government staff in planting and directing the establishment and maintenance of community trees. The landscape design provided in this document has been endorsed by the American Society of Landscape Architects. The planting details were written and tested by certified arborists, foresters and landscape architects and were determined to be minimum requirements to facilitate the establishment and growth of community forests. It focused on the tree growth requirements, site selection, tree selection process, tree planting methods, basic installation methods, species of street trees, medians, parking lots, near utilities etc. It also describes the basic tree maintenance, and tree conservation methods.

3.2 Overview on Forestry Sector of Bangladesh

3.2.1 Introduction

The total forest area of Bangladesh is 2.6 million hectares, which is nearly 17.4% of the total land area of the country. The forestry sector accounts for about 3% of the country's gross domestic product (GDP) and 2% of the labour force. However, these figures do not reflect the real importance of the sector in terms of monetary value. The GDP figure does not count the large quantities of fuel wood, fodder, small timber and poles, thatching grass, medicinal herbs, and other forest products extracted illegally. The low contribution of the forestry sector to the GDP is also explained by several other factors e.g. value added from wood processing is counted under the industry sector, rather than the forestry sector. The benefits provided by forest ecosystems include: goods such as timber, food, fuel and bio-products; ecological functions such as carbon storage, nutrient cycling, water and air purification, and maintenance of wildlife habitat; and social and cultural benefits such as recreation, traditional resource uses and spirituality. Services provided by forests cover a wide range of ecological, political, economic, social and cultural considerations and processes. (FAO, Forestry Department, 2011). The contribution of forest resources in protecting watershed and irrigation structures, reclaiming land from the sea, protecting coastal areas from storm damage, and in maintaining and upgrading the environmental quality, has not been quantified. However, economic, social and environmental importance of ecosystem services provided by forests is increasingly recognized globally. The primary challenge for sustainable forest management is finding ways to continue to benefit from ecological services without compromising the forest's ability to provide those services. Owing to such factors as over exploitation, conversion of forestland into agriculture, fire and grazing, forest resources in Bangladesh have been continuously depleting in terms of both area and quality. Between 1990 and 2015, Bangladesh annually lost 2600 hectares of primary forest (FAO 2015). Primary forest land gradually decreased from 1.494 million hectares in 1990 to 1.429 million hectares in 2015. Thus, annual rate of deforestation in Bangladesh was 0.2% during 1990-2015 (FAO, 2015).



Figure 10: Silviculture and Management of Planted Forests Contributes to SDGs

Forests currently absorb billions of tons of CO₂ globally every year, an economic subsidy worth hundreds of billions of dollars if an equivalent sink had to be created in other ways. Concerns about the permanency of forest carbon stocks, difficulties in quantifying stock changes, and the threat of environmental and socioeconomic impacts of large-scale reforestation programs have limited the uptake of forestry activities in climate policies. With political will and the involvement of tropical regions, forests can contribute to climate change protection through carbon sequestration as well as offering economic, environmental, and sociocultural benefits. A key opportunity in tropical regions is the reduction of carbon emissions from deforestation and degradation (Canadell & Raupach, 2008).

Forests are essential for achieving all 17 Sustainable Development Goals (SDGs) and understanding this requires a broader approach and a long-term perspective, along with a redefinition of 'forestry' to include all of the ways that forests and trees contribute to sustainable development (CIFOR, 2016).

3.2.2 Importance of Forestry Sector

Forests provide essential ecosystem services beyond carbon storage and emissions offsetting – such as health (through disease regulation), livelihoods (providing jobs and local employment), water (watershed protection, water flow regulation, and rainfall generation), food, and nutrient cycling and climate security. Protecting tropical forests therefore not only has a double-cooling effect, by reducing carbon emissions and maintaining high levels of evaporation from the canopy (IPCC, 2013), but also is vital for the continued provision of essential life-sustaining services. These services are essential for the well-being of people and the planet, however they remain undervalued and therefore cannot compete with the more immediate gains delivered from converting forests into commodities (Mitchel et al., 2008, p. 17). Ecosystem services operate from local to global scales and are not confined within national borders; all people are therefore reliant on them and it is a collective interest to ensure their sustained provisioning into the future.

Forest is very important renewable resources which plays a crucial role for the livelihoods of local communities. In addition, forests provide valuable ecosystem service: they maintain local climate and strongly influence global fluxes of oxygen and carbon dioxide; protect top soil, prevent soil erosion and maintain food wave. From late 1960, the Bangladesh Forest Department (FD) started coastal afforestation programmes on the newly accreted coastal chars and offshore islands. In coastal areas, foreshore afforestation is a proven cost-effective method to dissipate wave energy and reduce floods on embankments during surges. Effectively acting as a barrier against gusts and storm surges, forests can save lives and protect communities vulnerable to climate change.

Intensive forestry programmes can create employment opportunities and help alleviate poverty. In 1990 employment in forestry sector was 1.65 million FTE and gradually decreased to 1.5 in 2015. Contrarily the female employment increased from 0.15 million FTE to 0.60 million FTE in 2015 (FAO, 2015). It indicates that although employment in forestry sector gradually decreased but the percentage of female employment has steadily increased from 10 percent in 1990 to 40 percent in 2010. Despite considerable thrust on poverty alleviation in all plan documents since the independence of Bangladesh, still 31.5% of the population lives below the national poverty line (ADB 2016). Role of forests in poverty alleviation is immense. There are at least 19 million of people who are absolutely dependent on forests for their livelihoods in Bangladesh. There could be another 19 million who are dependent on forests in one way or another (Rahman & Ahmed, 2016). Rahman (2011b) reported that contribution of village forest income to total household income varied from 8.9% to 18.6%. Forest degradation will hinder prospect of sustainable development. Forests and trees are rooted in life and livelihoods. They can be grown, improved, and looked after - they are measureable and renewable. It would be hard to find a simpler and more universal way of changing the world for the better than by planting and managing trees.

Forests provide essential ecosystem services beyond carbon storage and emissions offsetting – such as health (through disease regulation), livelihoods (providing jobs and local employment), water (watershed protection, water flow regulation, and rainfall generation), food, and nutrient cycling and climate security. Protecting tropical forests therefore not only has a double-cooling effect, by reducing carbon emissions and maintaining high levels of evaporation from the canopy (IPCC, 2013), but also is vital for the continued provision of essential life-sustaining services.

The specific Importance of forest resources are:

- Taking in CO₂ and releasing O₂;
- Preventing soil erosion and water conservation;
- Protect from different natural hazard such as flood, cyclone, river bank erosion, drought etc.;
- Harboring a diversity of wildlife;
- Reservoir of watershed;
- Acting as wind break;
- Provide us with shade;
- Helps happening adequate rainfall;
- Climate stabilization;
- Control environmental pollution;
- Sources of food;
- Provides fuel;
- Sources of industrial raw materials;
- Provide employment opportunities for people;
- Sources of recreational activities for human.

3.2.3 Forest and Climate Change

Forest and climate change have a two-way relationship. Tropical deforestation releases 1.5 billion tons of carbon each year into the atmosphere (CSIRO, 2007). Avoiding deforestation can play a key role in reducing greenhouse-gas-induced climate change. Contrarily climate change will likely alter the frequency and intensity of forest disturbances, including wildfires, storms, insect outbreaks, and the occurrence of invasive species. The productivity of forests could be affected by changes in temperature, precipitation and the amount of carbon dioxide in the air (EPA, 2016a). Sea Level Rise (SLR) could erode and inundate coastal ecosystems and eliminate wetlands (EPA, 2016b).

Bangladesh is a low CO₂ emitting country, but forest of Bangladesh is a rich repository of carbon. Bangladesh forests stocked a total 127.28 million tons carbon in above and below ground biomass including dead wood; litter and forest soil (FAO 2015).

Despite uncertainties exists with respect to projections of climate change and its impact on forest ecosystems, evidence is growing to demonstrate that climate change, coupled with socioeconomic and land use pressure, is likely to adversely impact forest biodiversity, carbon sink, biomass productivity, and the livelihoods of forest dependent communities. The Eastern hilly areas of Bangladesh will undergo change and the changes are likely to be triggered by changing moisture, CO₂ fertilization and temperature regimes (Chaturvedi, 2016).

Due to 32 cm Sea Level Rise (SLR), 84% of the Sundarban will be deeply inundated in 2050 and in 2100, for 88 cm SLR the whole of the Sundarban will be lost. Increased salinity intrusion due to sea level rise poses great threat to the Sundarban. The Sundarban has already been affected due to reduced freshwater flows through Ganges river system over the last few decades particularly during the dry season. This has led to a definite inward intrusion of the salinity front causing the different species of plants and animals to be adversely affected. Increased salt water intrusion is considered as one of the causes of top dying of Sundari trees. The impact of sea level rise will further intrude the saline water to landward. SLR of 32 cm will intrude 10 to 20 ppt salinity level more in the Sundarban. The rate of salt water intrusion will also affect the ability of the ecosystem to adapt (Mohal et al., 2006).

Shifting of vegetation boundaries due to climate change in combination with the lack of biodiversity richness, disturbed and fragmented habitats pose a serious threat. The fragmented and isolated

forests with low biodiversity could hamper the dispersal and migration of forest species to suitable niches and such forests are potentially vulnerable to climate-driven ‘dieback’ (Chaturvedi, 2016). Thus, climate change could adversely affect forest ecosystems, biodiversity and even mitigation potential of forests. The natural disasters associated with climate change impact and biotic pressure on natural resources in Bangladesh is very high. If forest cover decline in same pace, the potential for forests’ carbon sequestration will be reduced substantially. In this context, the country has to face the challenge of climate change vulnerability and depleting forest resources. There is a need to reduce forest fragmentation, degradation and disturbances in order to facilitate the dispersal and migration of forest species from one place to another in response to climate change.

Climate change, as a critical issue, has been focused with a firm commitment to pursue an environmentally sustainable development process. Sustainable development initiative for environment and climate change will complement and benefit from adaptation and mitigation activities.

3.2.4 Sustainable Development Goals (SDGs) and Forestry

The SDGs, a UN initiative, officially known as transforming our world: the 2030 Agenda for Sustainable Development are an intergovernmental set of aspiration with 17 goals and 169 specific targets to be achieved over the next 15 years. Forests are essential for achieving all 17 SDGs and understanding this requires a broader approach and a long-term perspective, along with a redefinition of ‘forestry’ to include all of the ways that forests and trees contribute to sustainable development (CIFOR, 2016). However, a review shows that 9 SDGs with 20 targets are related to forestry activities in Bangladesh (Table 11).

Table 11: SDGs related to forestry sector in Bangladesh

Goal 1. End poverty in all its forms everywhere
1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including micro finance.
Goal 5. Achieve gender equality and empower all women and girls
5.a Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws
Goal 6. Ensure availability and sustainable management of water and sanitation for all
6.6 By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
8.4 Improve progressively through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead
8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
Goal 12. Ensure sustainable consumption and production patterns
12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products
Goal 13. Take urgent action to combat climate change and its impacts*
13.2 Integrate climate change measures into national policies, strategies and planning
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland fresh water ecosystems and their services, in particular forests, wetlands, mountains and dry lands, in line with obligations under international agreements
15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world
15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products
15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species
15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts
15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems
15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation
15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

3.2.5 Sustainable Forest Management

Sustainable Forest Management (SFM) is the management of forests according to the principles of sustainable development. Sustainable forest management has to keep the balance between three main pillars: ecological, economic and socio-cultural. Successfully achieving sustainable forest management will provide integrated benefits to all, ranging from safeguarding local livelihoods to protecting the biodiversity and ecosystems provided by forests, reducing rural poverty and mitigating some of the effects of climate change (LEDSGP, 2015).

Criteria and indicators (C&I) have emerged as a powerful tool to promote sustainable forest management (SFM). ITTO pioneered the development of C&I for the sustainable management of natural tropical forests in the early 1990s and has continued to provide leadership in their review and improvement. The C&I are tools used to define, assess and monitor progress towards sustainable forest management.

ITTO (2005) specifies seven criteria as essential elements of sustainable forest management. In absence of any C&I for SFM in Bangladesh (Plouvier, 2016) seven worldwide accepted criteria and some indicators applicable to Bangladesh context are presented in Table 12.

Table 12: Seven worldwide accepted Criteria and some Indicators applicable to Bangladesh

Criterion	Indicators
Criterion 1: Enabling conditions for sustainable forest management	<ul style="list-style-type: none"> • Existence and implementation of forest policies, laws and regulations • Amount of funding in forestry sector • Structure and staffing of institutions responsible for sustainable forest management • Number of professional and technical personnel for forest management • Capacity and mechanisms for planning sustainable forest management and for periodic monitoring, evaluation and feedback on progress • Public participation in forest management planning, decision-making, data collection, monitoring and assessment • Existence of forest management plans
Criterion 2: Extent and condition of forests	<ul style="list-style-type: none"> • Extent (area) and percentage of total land area under comprehensive land-use plans • Extent (area) of forests committed to production and protection • Extent (area) and percentage of total land area under each forest type • Percentage of state forests with boundaries physically demarcated • Changes in forested area
Criterion 3: Forest ecosystem health	<ul style="list-style-type: none"> • Extent and nature of forest encroachment, degradation and disturbance caused by humans and the control procedures applied • Extent and nature of forest degradation and disturbance due to natural causes and the control procedures applied
Criterion 4: Forest production	<ul style="list-style-type: none"> • Extent and percentage of forest for which inventory and survey procedures have been used to define the quantity of the main forest products • Actual and sustainable harvest of wood and non-wood forest products • Composition of harvest • Total amount of carbon stored in forest stands • Availability and implementation of silvicultural guidelines for timber and non-wood forest products
Criterion 5: Biological diversity	<ul style="list-style-type: none"> • Protected areas containing forests • Existence and implementation of procedures to identify and protect endangered, rare and threatened species of forest-dependent flora and fauna • Measures for in situ and/or ex situ conservation of genetic variation within commercial, endangered, rare and threatened species of forest flora and fauna • Existence and implementation of procedures for the protection and monitoring of biodiversity in production forests • Extent and percentage of production forest that has been set aside for biodiversity conservation
Criterion 6: Soil and water protection	<ul style="list-style-type: none"> • Extent and percentage of total forest area managed exclusively for the protection of soil and water • Procedures to ensure the protection of downstream catchment values • Procedures to protect soil productivity and water retention capacity within production forests • Procedures for forest engineering • Extent and percentage of areas in production that have been defined as environmentally sensitive and protected
Criterion 7: Economic, social and cultural aspects	<ul style="list-style-type: none"> • Value and percentage contribution of the forestry sector to gross domestic product (GDP)

Criterion	Indicators
	<ul style="list-style-type: none"> Value of domestically produced wood, non-wood forest products and environmental services Existence and implementation of conflict-resolution mechanisms for resolving disputes between forest stakeholders Number of people depending on forests for their livelihoods Training, capacity-building and manpower development programs for forest workers Area of forests upon which people are dependent for subsistence uses and traditional and customary lifestyles Number and extent of forest sites available primarily for (a) research and education; and (b) recreation Number of important archaeological, cultural and spiritual sites identified and protected Extent to which tenure and user rights of communities and indigenous peoples over publicly owned forests are recognized and practiced Extent to which indigenous knowledge is used in forest management planning and implementation Extent of involvement of indigenous peoples, local communities and other forest dwellers in forest management capacity-building, consultation processes, decision-making and implementation

Like other sector, use of Information and Communication Technologies (ICT) is also imperative in achieving sustainable development in the forestry sector as it could change strategies for acquiring information for preparing forest management plans, forest cover, forest soil type, topography, wildlife, growth and yield, and marketing of forest products. It also includes a clear framework for investments in capacity building and in promoting multi-layered cooperation, knowledge sharing locally as well as globally to enhance nationwide economic growth and social progress (Jacob et al., 2013). However, in Bangladesh, these benefits are not available to those who are unable to use or learn ICT. Increased penetration of ICT in the forestry sector would make a greater impact and change the status of forest management. Remote sensing and GIS technologies are being used by FD. But, there is no established national forest Geospatial Database. Besides, inadequate experienced ICT personnel, unavailability of data, lack of centralized spatial database are major constraints to reap the benefits of ICT in sustainable forest management in the country.

3.2.6 Status of Forest Resources in Bangladesh

The total area of forest land in Bangladesh is about 2.6 million hectares (FD, 2016). Out of which 1.6 million hectares is under the control of the Forest Department (FD). Un-classed State Forests (USF) extending over an area of 0.73 million hectares were until recently under the control of the Deputy Commissioner and now have been placed under the control of District Councils. But there is a controversy and the NFA (2007) showed that the total area of forest land was 1.44 million hectares which is about 9.8% of the total land (NFA, 2007). However, tree cover in forest land amounts to only 6.7% (FAO, 2009) - much less than 17.62% of the land that has been designated as forest lands (FD, 2016). Contrarily, Global Forest Resources Assessment indicates that total forest area of Bangladesh is 1.429 million hectares i.e. 11% of the

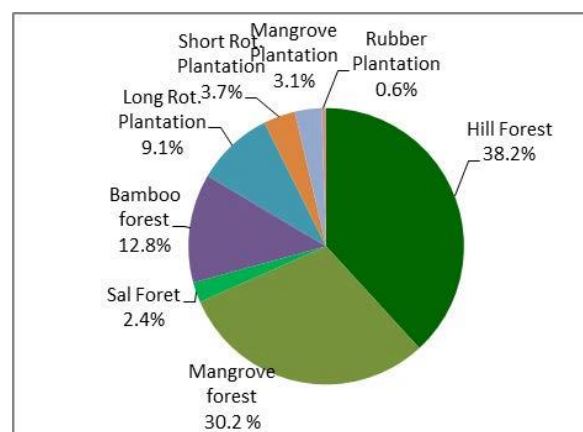


Figure 11: Forest Area of Bangladesh by Forest Types

land area of the country (FAO, 2015). The per capita forest area in Bangladesh is less than 0.015 hectare (Islam 2013) against the world average of 0.60 hectare (FAO, 2010).

Bangladesh have 2.52 million hector of forest land where as forest department manages 1.52 million hectors which includes reserved, protected and acquired forest and mangrove forest on the newly accreted land in estuaries of major rivers. The remaining 073 million hectors of land designated as un-classed state forest are under control of Ministry of Land. Village forests (homestead land) from the most productive tree resources base in the country and account for 0.27 million hector.

Total Forest Land of Bangladesh

Category of Forest	Area (million hector)
Forest Department Managed Forest	1.52
Un-classed State Forest	0.73
Village Forest	0.27
Total	2.52

Source: www.bforest.gov.bd

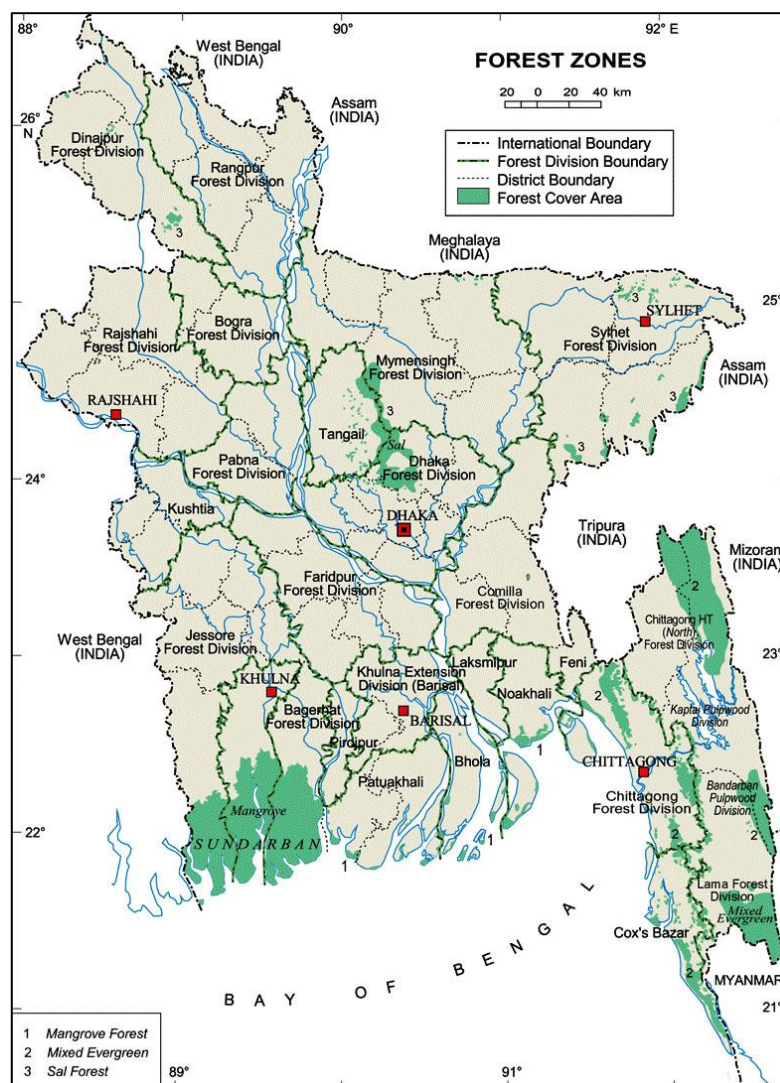


Figure 12: Forest cover and types in Bangladesh

Source: www.bforest.gov.bd

The state-owned forests are eccentrically distributed in the country (Figure 12). Over 90 percent of the state-owned forestland is concentrated mostly in 12 districts in the eastern and south-western regions of the country and out of 64 districts, 32 districts have no state-owned forest at all (BBS 2016). Of the total forest area, 84% has been classified as natural forest and nearly 16% as plantation forest. The two most common types of forest, namely Hill forest and Mangrove forest cover more than 68% of total forest area (NFA, 2007) (Figure 11).

Privately owned village forests, also known as homestead forests totaling an area of 0.27 million hectares (Hammermaster, 1981) are scattered throughout the country. Almost all the village area (2.86 million hectares) is covered by trees of varying density and only a very small area has no tree cover at all (NFA, 2007). Although meager in size, an estimated 70% of timber, 90% of firewood, 48% of sawn and veneer logs, and almost 90% of bamboo requirements are met from homestead forests (Douglas, 1982). Almost 50% of the area of Bangladesh has some kind of tree cover (NFA, 2007). More than 30% of the cultivated land has low percentage of tree cover (NFA, 2007). Location, area, major types and main economic resources provided by major forest types in Bangladesh shown in Table 13.

Degradation of forests and their resources have been occurring due to manifold reasons. Among others, major causes of forest destruction include unscrupulous felling, encroachment of forest lands and new settlements for growing population, land grabs by powerful elites illegal wood cutting, leaf-litter collection, dependency on forests for fuel wood and grazing, intentional forest burning, 'jhum' or shifting cultivation, conversion of forest lands into agricultural land, infrastructure development, urbanization, industrialization, overexploitation of particular economically important species such as medicinal, fodder and dye, indiscriminate use of forest wood in brick fields and in other small industries, and total clearing of undergrowth and excess consumption of forest materials for domestic purposes. In addition, natural calamities such as torrential rainfall, occasional landslide, soil erosion, flood and cyclones, increase of salinity, pest and diseases (e.g. top dying of Sundari disease in the Sundarban) are also major causes of depletion and degradation of forest lands and forest resources.

An indication of this decline is reflected in the tree density of the Sundarban, which constitutes about 51% of the total reserve forest estates, and contributes about 45% of the country's timber and fuel wood production. About 95% of the Sundarban's land area is covered with natural stands of only two timber species: Sundari (*Heritiera fomes*) and Gewa (*Excoecaria agallocha*). Tree density of Sundari and Gewa from three different inventory results is shown in Table.14. Between 1959 and 1983 the Sundari stems per hectare steadily declined by 42.1% and Gewa stems per hectare declined by 35.1%. Between 1983 and 1996 the Sundari stems per hectare has decreased by 2.1% and Gewa stems per hectare has increased by 1.9%. Latif et al. (1992) also reported from 13 years study that Sundari is in the decreasing trend and Gewa is in increasing trend.

Causes of poor stoking need to be identified and addressed for restoration of the forests. Less flow of fresh water through the Sundarban and resultant intrusion of salinity constrain the growth, survival and regeneration of mangrove plants (Mirza, 2004). Increasing population and growing demand for forest products, partial implementation and lack of monitoring of various forest management plans, non-compliance of forest policy, Acts, Rules and Regulations, and institutional constraints faced by FD due to shortage of manpower and inadequate logistic supports contribute to continual decline of forest cover over the years.

Table 13: Distribution of major forest types in Bangladesh

Forest Type	Location	Area (million hectares)	remarks
Hill Forest	Eastern part extending over Sylhet, Habiganj, CHT, Chattogram and Cox'sbazar	0.67	Under the control of FD. Major produce: large saw log, poles, firewood, thatching material and bamboo.
Natural Mangrove (Sundarban)	South-West in Khulan, Bagerhat and Satkhira	0.60	Includes 0.17 million ha water area; Major produce: timber, poles, firewood, pulpwood, thatching material
Mangrove Afforestation	Along the Coastal zone	0.19	Major produce: firewood, pulpwood.
Sal Forest	Chiefly in the Central region in Gazipur, Tangail, Cumilla, Sherpur and Mymensingh. Small patches also found to occur in Dinajpur, Rangpur, Thakurgaon, Naogaon and Panchagarh in the north-western region	0.12	Indigenous Sal and plantation of short rotation exotics for poles, posts and firewood.
Un-classed State Forests (USF)	Hill Tract districts	0.73	Under the control of district councils subject to shifting cultivation. Major produce: bamboo, thatching material and firewood.
Swamp Forest	Mainly in Sylhet and Sunamganj district in the north-eastern part	0.02	Hijal (<i>Barringtonia acutangula</i>) and Koroch (<i>Pongamiapinnata</i>) are the main species of the forest. The swamp forests support freshwater fisheries and are vital spawning grounds.
Village Forests	Scattered throughout the country mostly on the homestead land	0.27	Almost all the village area (2.86 million ha) is covered by trees of varying density. Major produce: timber, bamboo, poles, posts and firewood.

Table 14: Comparative per Hectare Estimate for Number of Stems of Large Poles & Trees 10-cm DBH and Above in the Sundarbans

Year	Species					
	Sundari		Gewa		Others	
	N/ha	Change (%)	N/ha	Change (%)	N/ha	Change (%)
1996	290	-2.1	228	1.9	42	14.7
1983	296	-42.1	224	-35.1	37	-61.85
1959	511		345		97	

Source: FD, (2010)

3.2.7 Forest Management Practices

The FD under the Ministry of Environment, Forests and Climate Change (MOEFCC) is the custodian of forests and wildlife for the entire country. The forest lands of Bangladesh have been primarily managed by FD. In recent years the government is strengthening its commitment to conservation forestry including biodiversity. Further management of forests for adaptation and mitigation of climate change is another major objective of forest management. The FD's prime function focuses

on the expansion of tree/forest resources throughout the country with the active participation of people for sustainable development of forestry, biodiversity conservation and socioeconomic development of the people. Principally, FD is responsible for the management, planning, protection and development of country's forest resources in accordance with the National Forest Policy, Forest Act and regulations. The FD acts as technical arm of the MOEFCC with regard to formulation of forest policies, Acts, rules, regulations as well as forest planning, management and development. The FD provides technical advices and assistance in respect of forestry operations, training and human resource development to the field forest offices. The field forest offices perform the functions of local forest administration, regulation of forest harvesting, forest revenue collection, forest law enforcement, implementation of forest management plans and silvicultural treatments within their respective jurisdiction.

Forest Department is playing a crucial role for country's natural and socioeconomic development, maintaining environmental equilibrium, and stabilization of land based production systems. The mandate of the FD as spelled out in the institutional reforms of the FD in June 2001 is as follows:

- a) Multi-dimensional resource management viz., forest resource development and management, conservation and management of biodiversity and watersheds;
- b) Protection and management of forests and wildlife wealth of the country couples with enforcement of various Acts, Ordinances, Rules and Regulations pertaining to forest management;
- c) Sustainable management of forests to facilitate meeting basic needs of present and future generations;
- d) Poverty alleviation through creation of forest-based employment and ecological role of the country;
- e) Maintenance of natural habitat for biodiversity conservation; enrichment and rehabilitation of degraded forest land;
- f) Participatory forest management, horizontal expansion of tree cover with fast growing and high yielding variety of species through people-oriented forestry programme in state-owned fringe, marginal, sub-marginal and newly accreted land and khas land including Un-Classed State Forest (USF) land;
- g) Realization of Revenue, preparation of budget, auditing, accounting, etc.;
- h) Encouragement and assistance in afforestation activities in public and private sector;
- i) Provide technical advice and support to plant trees and practice agroforestry;
- j) Fulfillment of national obligations towards the international efforts to control global warming, desertification, wildlife, biodiversity and other forestry related international treaties, protocols and conventions endorsed by the government;
- k) Rehabilitation of degraded forest land watershed through people's participation issuance.

Initially, the forests were managed based on "sustained yield" basis. Mainly two silvicultural systems are followed in FD managed forests: the clear-felling system followed by artificial regeneration; and the selection felling system followed by natural regeneration. Hill forests are worked on the clear-felling system followed by artificial regeneration with species of high market value. This is because natural forests are poorly stocked with species of low commercial value and are therefore not conducive to natural regeneration of economically important species. The Sundarban forest is worked on the selection-cum-improvement felling system.

The plain land Sal (*Shorea robusta*) forests were being worked on coppice system in the past. All exploitations in these forests were suspended since 1972 for conservation. But since then about 70% of the plain land Sal forests are encroached 70 percent of the forest area has been cleared by encroachment and better trees have been removed by theft (Khan & Millat-e-Mustafa, 2001).

Extraction of timber from the annual coupes of Cox's Bazar, Chattogram, Sylhet and Sundarban Forest Divisions is done by private loggers under the supervision of the Forest Department. The extraction of timber from the coupes of the Chattogram Hill Tracts forests is done by the Bangladesh Forest Industries Development Corporation (BFIDC) based on long-term lease agreement. BFIDC uses heavy equipment for dragging the round timber from otherwise inaccessible areas to the nearest riverside depot from where it is rafted to Kaptai. However, to conserve the natural forests, a moratorium on logging has been imposed since October 1989 in all forests of the country.

Recently, there has been some changes in the forest management approach: the “sustained yield” is being replaced by “sustainable and integrated management” approach, where the forests are not only seen as sources of raw materials for industries and households but also as the site of ecological resources. As yet, not much is known about the complex forest ecosystems of Bangladesh and most studies have focused on the Sundarban-the largest single tract of mangroves in the world. Presently (as of 2016), there four integrated management plans have been prepared for Sundarban, Cox’s Bazar, Sylhet, and Noakhali. These plans are being implemented either as “advanced prescriptions” or as part of project oriented “annual development programmes”.

3.2.8 Present Forest Management

The present forest management is different from the past one in respect of its objectives. Present forest management objectives are not only to produce timber only but also to provide clean air, clean water, healthy habitat for wildlife and to act as a major source of biodiversity and nature-based tourism. The present idea of forest management is to involve people in the management and create an environment so that people can feel that they have also some stakes on trees growing on the forestland and to improve living standard of the people residing in the vicinity of the forests. The objectives of the forest management are-

- enhancing environment preservation and conservation
- increasing public participation and benefit from the forest
- institutional strengthening
- improving management practices
- addressing climate change issues

Detailed inventories of all major forest types in the country except the forests in Chattogram Hill Tracts were carried out. This has provided the necessary database for using quantitative information for writing more comprehensive management plans for different forests. Small units of uniform crop have been identified and information on these units was recorded with the help of computer based Resources Information Management System (RIMS) unit in FD.

The inventory and associated activities have made long desired information on the status, growth and yield of forests in the country available. It has been possible to develop volume and yield functions for all major plantation species and volume functions for major species in natural forests. This has made possible to regulate yield for long period of time. A new working plan format has been devised to make it possible for the use of the available information in future management plans.

An annual plan of operation is included as part of the management plan. This is basically a detailed plan of operation within the forest division and is prepared by the Divisional Forest Officer.

In recent years there has been a substantial shift in emphasis in Forestry and Forest Management from maximizing yield towards maximizing sustainability through increased participation of local population, conserving biodiversity and maintaining forestry services.

The present management systems are evolved from the past ones through various modifications in order to incorporate present objectives of forest management. Some new forest management systems are also added to address new concept in forest management such as agroforestry, homestead plantation, strip plantation, participatory forestry on encroached forest, and mangrove afforestation on newly accreted land in the coastal area, reduce deforestation and forest degradation to mitigate the climate change, conservation area management to preserve wildlife habitat and biodiversity.

3.2.9 Social Forestry

In Bangladesh, the first attempt in community forestry can be traced back to the Betagi and Pomora community forestry projects in 1979 and 1980 respectively in Rangunia upazila of Chattogram. The experience of the projects was extended later. Since 1982 some community forestry programmes have successfully been completed by the FD. This was followed by the Community Forestry Project (1982-1987). The principal purpose of the project was to develop a participatory approach to resource generation and management based on a 'benefit-sharing' mechanism between the government and the local communities. The components of the project included strip plantation, fuel wood plantation, pilot agroforestry demonstration plot, village afforestation and community forestry growth centre.

Upazila Afforestation and Nursery Development Project (1987-95) and Extended Social Forestry Project (1995-97) were implemented to raise agroforestry and woodlot plantations in the degraded and encroached sal (*Shorea robusta*) forest land. The other components of the projects were: strip plantation; institutional planting and seedling distribution; training of local community leaders, NGO workers, teachers and students; establishment of Upazila Nursery and Forestry Extension Training Centre; and support to private nurseries.

Forest Resources Management Project (1992-2000) was implemented to develop forest and human resources for forestry development in the country. The project also envisaged developing participatory (experimental) agroforestry models in the degraded hill forest lands, especially in the southern districts, Chattogram and Cox's Bazar. Concurrently, the Coastal Green Belt Project (1995-2000) was implemented to create a live shelterbelt of trees along the coastlines of the country. The principal components included embankment plantation; foreshore and barrow pit plantation; homestead and institutional plantation; establishment of nurseries and training centres. The project has adopted a participatory approach to plantation establishment and management through benefit sharing mechanisms.

With the primary objectives of the project to augment and strengthen the overall tree resource base in the country and to reduce the rate of depletion of forest, to enhance public awareness about conservation and sustainable management of forest resources through local community participation, the Forestry Sector Project (1997-2004) was implemented. The project also emphasized on the participatory plantation and management of different forests including public protected forest areas and buffer zones. The project activities had been extended to the newly accreted lands (locally called char), drained tracts (undulated tracts), ponds and tank boundaries. Up to 2014-2015 51,389 hectares of woodlot plantation, 10,626 hectares of agroforest, 64,834 km of strip plantation and 9,007 hectares of other plantations have been raised and about 6,05,566 participants are involved in social forestry programmes. An amount of Taka 2,362 million has been distributed to 1,20,413 participants as benefit of social forestry (FD, 2016).

3.2.10 Co-Management of Protected Areas

Protected areas (PAs) in Bangladesh cover 267,330.75 hectares or nearly two percent of the country's total area. These include 17 declared national parks, 17 wildlife sanctuaries and one special biodiversity conservation area. In addition, there are dolphin sanctuaries Swatch of No Man Land Marine Protected Area and Vulture Save Zones.

In the case of protection of forest resources in protected areas it is likely that some sections of the community dependent on the forest for their livelihoods, and some having deep interest in extracting resources to further enrich themselves will oppose any move towards collective protection and conservation efforts. To reduce high dependency of people in the adjoining localities on the protected areas, a co-management system involving the local community and stakeholders and provision of alternative income generation activities of the forest dependent people have been introduced since 2003.

In the Co-management system, sharing of responsibilities is established through the formation of Co-management Committee (CMC). According to the guidelines framed by the Government in 2006 CMC is responsible for management of PAs on the basis of local stakeholders' participation. They perform activities in PAs under the guidance of the Co-management Council as approved by the Forest Department. Between 30 and 100 residents of villages organize to form Village Conservation Forum (VCF) having one-third female members. The VCF elects the Peoples Forum (PF) for each village (one male and one female) of VCF members through elections. Community Patrol Groups (CPG) and Eco-Tour guides are selected from the villagers and represented in CMCs (Rahman, 2016). As incentives CMC receives a portion of the income from the PAs for community development.

Although PAs have been established for all forest types of Bangladesh, in reality these areas are not really protected, mainly due to poor focus on public involvement in PA management and conservation process. Moreover, distribution, area and number of PAs are not adequate for the conservation of the rich biodiversity exceptionally possessed by the country. Effective co-management that ensures clearly defined rights and responsibilities of various stakeholders on PAs and in active participation in decision-making process is necessary to secure the future of the PAs in Bangladesh (Mukul et al., 2008).

3.2.11 Enforcement of Acts, Rules and Plans

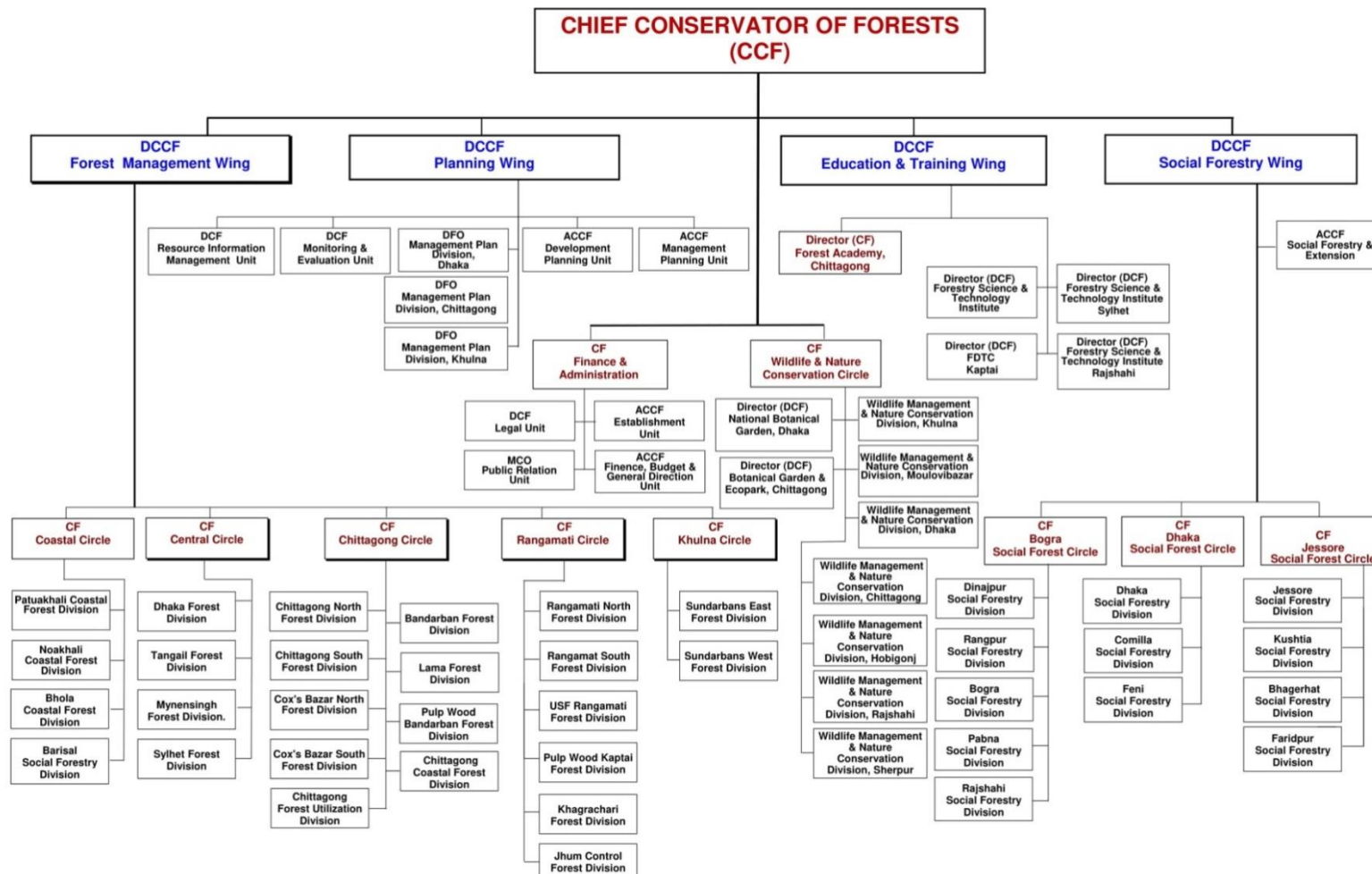
Section 12 of the Constitution (Fifteenth Amendment) Act, 2011 (Act XIV of 2011) provides a new Article 18A to safeguard the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens. The Forest Act of 1927 (Act XVI of 1927) and the Wildlife (Preservation) Order, 1973 (P.O. 23 of 1973) substituted by the Wildlife (Protection and Safety) Act, 2012 (Act No. 30 of 2012) provide legal protection of forests and wildlife respectively. The Forest Act of 1927 was amended in 1989 to provide deterrent penalties for certain forest offences and further modified in 2000 to provide for social forestry. To elaborate the social forestry procedure Social Forestry Rules were framed in 2004 under the Forest Act, 1927 and Forest Transit Rules were framed in 2011 under the provision of the Brick Burning (Control) Act came into force for the first time in July 1989 to ban firewood for brick burning that has been substituted by the Brick Manufacturing and Kiln Construction (Control) Act, 2013 (Act No. 59 of 2013) with effect from July 1, 2014 to meet the current context. Similarly, the earlier Saw-mill (Licence) Rules, 1998 were substituted in 2012.

Enforcement of these laws are weak primarily due to the lack of adequate and skill manpower and also inadequate financial support. Lack of coordination with law enforcement agencies and local administration further aggravates the situation. As many as 32,078 cases were pending in the courts assigned for trial of forest offences in June 2015. The number of cases in the courts is also increasing

day-by-day. Altogether 195 cases were disposed of in the month. The time taken on average case is more than four years. The reasons for such delay may include improper prosecution submissions, absence of plaintiffs and witnesses, non-submission of evidence and weak arguments. However, causes for inordinate delay in court proceedings need to be identified and properly addressed to derive advantages of law in any conservation efforts.

Forests of Bangladesh have run under various management plans but there were gaps in between the plans that caused discontinuities in important management activities. As with other sectors of the government, there has been little, if any, monitoring of the impact of the management plans. Thus, new plans are developed without having an account of the strengths and weaknesses of the old plan.

There have been several occasions when the donor funded development projects caused conflicts or incompatibilities with the existing management plan. For example, the ADB funded forest resource management project during the 1980-87 period called for “buffer zone” for which there was no land allocation in the management plan. Ad hoc projects lead to monoculture, where one or a few species are used for plantation even though these may not be suitable for a particular geographical/ecological region. Introduction of exotic species without proper impact assessment is another negative impact of these projects.



Abbreviations: DCCF - Deputy Chief Conservator of Forests, CF - Conservator of Forests, DCF - Deputy Conservator of Forest, DFO - Divisional Forest Officer, ACCF - Assistant Chief Conservator of Forest

Figure 13: Organogram of the Bangladesh Forest Department

3.3 Guidelines for Forest Plantation and Management

3.3.1 Introduction

In general, forestry plantation establishment is broadly divided into three management phases: seed collection and handling; nursery practices and plantation establishment; and management. This manual includes guidelines related to the entire range of planting activities from species selection for the site to tree felling. The initial plantation establishment phase is divided into the following activities: species selection, site preparation and planting operation. The plantation management phase includes silvicultural activities as follows: protection, tending (weeding and fertilizing), pruning, thinning, felling and regeneration/replanting. The sequence of these activities is shown Table 15.

Table 15: Sequence of forest plantation decisions and operations

Usual Silvicultural operation	Main decisions	Product
Obtain seeds	Species? Provenance?	Not applicable
Produce planting stock	Season? Containers? Size?	Seedlings Transplants
Site preparation	Intensity?	Not applicable
Planting	Spacing? Fertilizer?	Young trees
Tending	Frequency? Methods?	Saplings
Low pruning	Need? Partial?	Small poles
Thinning	Timing? Intensity?	Large poles
High pruning	Need? Height?	Large poles
Felling	When?	Mature trees
Regeneration/Replanting	Changes in species or culture?	Second crop

Source: Evans 1992, Wadsworth 1997

3.3.2 Reasons of Planting Forest Trees

The direct benefits of forest plantations on the value of the land are forest products such as timber, fuel wood, charcoal, poles, food products, fodder for livestock, medicinal products and shade for agricultural crops. The objectives and desired end products of the forest plantation will influence selection and application of establishment and management activities. Plantation activities and financial investment will vary depending on the objectives and the type of plantation to be established (Table 16):

- large-scale industrial forest plantation (industrial forestry)
- large-scale non-industrial forest plantation (environmental forestry)
- small-scale village/community forest plantation (social forestry) and agroforestry systems

Table 16: End-products and forest plantation systems and methods

End products	Plantation systems	Planting methods
Timber	Large-scale industrial plantation	Block planting
	Small-scale community plantation	Block planting, Enrichment planting
Fuel wood / charcoal	Large-scale industrial plantation	Block planting/Coppice
	Small-scale community plantation	Block planting/Coppice
Posts / boundary	Agroforestry system	Trees planted individually or in line

End products	Plantation systems	Planting methods
Food	Agroforestry system	Trees planted individually or in line
Fodder	Agroforestry system	Trees planted individually or in line
Medicinal products	Agroforestry system	Trees planted individually or in line
Shade	Agroforestry system	Trees planted individually or in line
Land reclamation	Large/small-scale non-industrial	Block planting/Nitrogen fixing
	plantation	species
Aesthetics/Biodiversity	Large/small-scale non-industrial plantation	Enrichment planting

The block planting method is a full planting used where there is no existing forest. Enrichment planting (line conversion planting, gap planting, under-planting) is a method to improve an existing secondary forest. The last planting method called “trees planted individually or in line” includes trees planted in pastures, boundary planting, live fences and line planting between agriculture crops (taungya or intercropping).

From an ecological point of view, the reconstruction of a vegetation cover through forest plantation restores the productivity of the land in terms of reduction of air pollution, regulation of water quality and regime, control of potential soil erosion, improvement of soil fertility and creation of habitat for wildlife (Table 17). The socio-economic effects are enhancement of the beauty of the landscape, creation of an environment beneficial to the health and increase in the value of the land.

Table 17: Ecologic Effects of Forest Plantation Activities

Ecological parameter	Large-scale industrial forest Plantation	Large-scale non-industrial forest plantation	Small-scale village/community forest plantation	Agroforestry systems
Climate	Positive effects comparable with those of natural forests Very positive effects compared with degraded sites		Improvement of the microclimate Only locally effective; in combination with terracing good chance to rehabilitate small catchments	Tree lines serve as windbreaks As trees are planted in steps and in strips along the contour line, sustainable reduction of runoff and erosion is achieved
Water balance and erosion control	Increased runoff and soil erosion during establishment/young plants phase Stabilisation (at complete area coverage) Use of heavy machinery promotes soil compaction, runoff, and erosion Forest roads built for forest plantation establishment often enhance erosion	Large-scale terracing as site preparation quickly controls runoff and erosion		
Soil fertility	Mechanical removal of the vegetation cover in combination with ploughing and partial removal of organic soil matter is more disadvantageous for plants than burning the vegetation Planting of fast-growing species with short rotations favours depletion of soil Nutrients	Reduction of runoff and erosion creates conditions for enrichment with organic matter and nutrients	Small-scale positive effects could be achieved provided that erosion is stopped and nutrients are released to the soils by the organic matter	Positive effects prevail because often nitrogen-fixing species are used, negative effects possible through root and light competition
	Pine monoculture could enhance soil acidity		Shade protects the humus layer; therefore the destruction of the soil structure is counter-balanced	
Species diversity	The establishment of monocultures is accompanied by a reduction of species diversity		Species diversity of agriculture areas is improved through tree groups, tree strips and small-scale village and community woodlots	
		Forest plantation establishment on degraded sites and the establishment of mixed forests increase species diversity		

Source: Zech et al. 1999 in Pancel 1993a.

3.3.3 Areas to Plant Forest Trees

First, the availability of land for forest planting on public or private lands must be known and second, the quality of the available land must be known to ascertain if it is appropriate to the objectives of the planned forest plantation. It is notorious that with all land capability classification systems, the classes of poor land, i.e., those with shallow soils and steep slopes, are earmarked for forestry production. This is because the main objective of most land capability classification systems is to map agricultural potential (of the land). However, the best soils for agricultural crops are also the best for industrial forest plantations.

Some foresters accept the fact that large-scale development of plantation forestry, especially on degraded lands, seems essential and inevitable in many tropical and subtropical countries (Brown et al. 1997), particularly those with high population densities where the available good land for agricultural crops is limited and the forest product needs are high.

A. Available Lands

In Bangladesh, land available for forest plantations is mainly publicly owned where the existing land use/cover types are abandoned. Protected Areas contains about 618253.49 hectares of forest land and represents 4.19% area of the country. The map of Bangladesh shows the location of protected areas. There are different IUCN categories of Protected Areas in Bangladesh. They are described as follows. However, in social forestry, about 79,298-hectare woodlot plantation; 10,626 hectares of agroforestry plantations; 6,647 kilometers of strip plantations have been raised under the social forestry program of Forest Department.

There remain huge fallow lands and wastelands along the sides of roads, highways, railways, embankments, homesteads, farm houses and farm boundaries, pond sides, lake and riversides, etc. These lands are needed to be brought under production systems (Hossain, 2006). Again, crop land 'ails' (bunds) as well as farm and homestead boundaries have to be used under specialized plantation systems to reduce friction and /or negative effects on others' land (Hossain, 1994, 1996). Bangladesh has about 4500 km of roads and highways, 16000 km of district council roads, 105000 km of thana and union parishad roads, 2900 km of railroads, 56000 km of river and coastal embankments, and about 2 million big and small ponds with riverside high banks. Specialized agro forests can be established there (Amin et al., 1996).

B. Appropriate Climate

Bangladesh is divided in 30-agro-ecological zones which are used as the basis to select the agricultural crops which will produce the maximum yield for any given zone. The area is under tropical monsoon climate where rainfall is heavy, humidity and temperature are also high during April to September and low rainfall associated with low temperature during October to March. The winter season is dry and cool, and receives only 2% of the total rainfall mostly as occasional drizzles between November to February. Bangladesh tries to reforest its barren land, but there are some areas where trees are still being cut down. The government inaugurates the tree plantation season in June every year, and it continues till September.

C. Appropriate Soils

The potential area for reforestation is discussed above for planning purposes at the national and watershed management unit levels (1:100 000 mapping scale). A detailed assessment of the soil quality of the site to be planted, if possible at 1:10 000 mapping scale, should be carried out before starting the planting lay-out. The selection of the appropriate forest land use allocation, such as

industrial forest plantation, forest plantation for soil protection, or agroforestry, is mainly governed by the slope and the effective soil depth (Table 18).

After climate, determination of slope and effective soil depth is second step in the process to select the species to be planted. Measurements of the slope with a clinometer and the soil depth using a soil auger are simple to carry out in the field.

Table 18: General Guidelines for Forest Land Use Allocation

Soil Depth	Gentle to Moderate Sloping		Slope Strongly Sloping to Moderate Steep		Steep to Very Steep	
	(1)		(2)		(3)	
Deep (D) [> 100 cm]	[< 15° [< 27%]		[15°- 30°] [27% - 58%]		[>30°] [> 58%]	
	FI(P), C		FI(P), C		FS, FP, AF	
Moderately Deep (M) [50 – 100 cm]	FI(P), C		FI(P), AF, C		FS, FP, AF	
Shallow (S) [20 – 50 cm]	FI, AF, C		FI, AF, PA		FP	
Very Shallow (V) [< 20 cm]	FS, AF, PA		FS, FP, AF		FP	
Potential Land Uses: FI(P): Forest for industrial production, including intensive site preparation and plantation establishment; possible mechanisation. FI: Forest for industrial production (e.g. selective cutting, enrichment planting, seeding and coppicing); possible mechanisation, but normally excluding intensive site preparation and plantation establishment. FS: Selection forest for environmental protection and limited wood extraction; selective logging only, no clear cutting, no road construction, no mechanised site preparation, no mechanised ground skidding. FP: Protection forest for watershed management, ecosystem protection, and/or recreation; no road construction, no timber extraction. AF: Agroforestry: trees or shrubs grown in association with herbaceous plants under an approved system involving soil conservation measures PA: Pastures <ul style="list-style-type: none"> • Cultivable land Note: In forest reserves, forest management areas, parks or protected areas: <ul style="list-style-type: none"> • Where the existing forest cover is Closed Broadleaf Forest, Mesic and Dry Limestone or Mangrove Forest, use will be restricted to FP. • Where the existing forest cover is Modified Forest (Closed Broadleaf, Mesic and Dry Limestone or Mangrove), land use will be retained as forest (ie, FP, FS, FI or FI(P)). • Where land is already under cultivation, pasture or agroforestry use, such uses may be permitted as specified in the table if warranted by local social, economic and environmental circumstances. 						

Soil texture, drainage and acidity (pH) can easily be estimated using a sample collected with a soil auger in the field before planting activities begin. The texture of soil, using particles <2 mm (about the size of a grain of rice), is estimated with the finger assessment method described in the Table 19.

Table 19: Assessment Procedure for Soil Texture

Texture Class	Definition
Sand	Loose and single-grained. Individual grains can be seen and felt. Squeezed in the hand when dry, it will fall apart when pressure is released. Squeezed when moist it will form a cast which will crumble when touched.
Sandy loam	Contains enough silt and clay to make it somewhat coherent. Sand grains are readily seen and felt. Squeezed when dry the cast will readily fall apart. Squeezed when moist the cast will bear careful handling without breaking.
loam	Mellow, with a somewhat gritty feel, yet fairly smooth and plastic when moist. Squeezed when dry, the cast will not break if handled carefully. When moist a cast can be handled freely without breaking.
Silt loam	When dry it may appear cloddy but the lumps are easily broken. When pulverized it feels soft and floury. When wet the soil puddles. Casts formed of either dry or moist soil can be readily handled without breaking. When moistened soil is squeezed between thumb and finger it will not "ribbon", but will form flat "pastry flakes".

Texture Class	Definition
Clay loam	When dry it forms hard lumps or clods. When moist it can be squeezed to form a thin ribbon, which will break readily, barely sustaining its own weight. When moist the soil is plastic and will form a cast that will take much handling.
Clay	Forms very hard aggregates when dry. When wet it is plastic and sticky. Moist clay can be pinched out between thumb and finger to form a long flexible ribbon. Note that some clay are friable and lack plasticity in all moisture conditions.

Source: Armson, K.A. 1977. Forest soils: properties and processes. University of Toronto Press, Toronto, 390 p.

The drainage class (or moisture class) is a global expression of the effective drainage and a summary of the drainage conditions for the soils in a given area (surface drainage soil permeability internal soil drainage). The procedure to assess soil drainage is shown in Table 20.

Soil acidity can be determined in the field with a simple pH Kit using the acidity classes presented in Table 21.

For the establishment of large-scale industrial plantations, it is recommended that soil samples be collected and sent to the Rural Physical Planning Division (Soil Laboratory) for the following soil analysis: texture, organic carbon, acidity (pH), cationic exchange capacity (CEC), nitrogen (N), phosphorus (P) and potassium (K).

Table 20: Assessment guidelines for soil drainage

Drainage Class	Definition
Excessively drained (E)	Coarse-textured soils (or some thin soils in steep slope), only saturated during and just after heavy rain. Surplus water is removed very rapidly, no mottling. Any water table is well below the surface.
Well drained (W)	Soil is rarely saturated in any horizon within 100 cm. Mottling is usually absented throughout the profile.
Moderately well drained (M)	Some part of the soil in the upper 100 cm is saturated for short periods in year or after heavy rain. Colours typical of well drained soils on similar materials are usually dominant but may be slightly lower in Chroma, especially on pedfaces and faint to distinct ochreous or grey mottling may occur below 50 cm.
Imperfectly drained (I)	Some part of the soil in the upper 50 cm is saturated for several months but not most of the year. Subsurface horizon colours are commonly lower in Chroma than those of well-drained soils on similar materials. Greyish or ochreous mottling is usually distinct by 50 cm and may be prominent below this depth. There is rarely any gleying in the upper 20 cm.
Poorly drained (P)	The soil is saturated for at least half the year in the upper 50 cm but the upper 20 cm is unsaturated during most of the year. The profiles normally show strong gleying. A horizon is usually darker and/or greyer than those of well drained soils on similar materials and contains rusty mottles. Grey colours are prominent on ped faces in fissured clayey soils or in the matrix of weakly structured soils.
Very poorly drained (V)	Some part of the soil is saturated at less than 20 cm for at least half The year. Some part of the soil within the upper 50 cm is permanently saturated. The profiles usually have peaty or humus surface horizons and the subsurface horizon colours have low (near neutral) chroma and bluish hues.

Adapted from: McRae, S.G. 1988. Practical pedology. Studying soils in the field. Elis Horwood Ltd., Chichester, 253 p

Table 21: Definition of soil acidity (pH) classes

pH	Reaction
< 4.0	Extremely Acid
4.5	Very Strongly Acid
5.0	Strongly Acid
5.5	Medium Acid
6.0	Slightly Acid
6.5	Very Slightly Acid
7.0	Neutral
7.5	Slightly Alkaline
8.0 +	Alkaline

A. Plantation success/failure

The failure of a forest plantation is mainly linked to two important causes: (1) early mortality due to the poor species selection for the site to be planted; and, (2) weed encroachment and discontinued maintenance (Francis 1998). Landowners can successfully establish trees and plantations virtually anywhere in Jamaica by using the best species, the proper site preparation and planting techniques and the good timing for maintenance and silvicultural activities for the site to be planted.

3.3.4 Guidelines for the Selection of Tree Species to Plant

In many cases, species selection directly determines the success of the plantation. Whether selecting species for a large -scale industrial plantation or a small-scale multipurpose tree plantation, a set of criteria is applied in various combinations. The criteria are determined by the purpose of the forest plantation, i.e., industrial or domestic uses, environmental protection, requirements of the local population, etc. and species are selected which are best suited to the site, in terms of climate and soil. In Table 22, selection criteria are grouped according to the main forest plantation systems. Table 23 represents the recommended species for different plantations of Bangladesh by FD.

Table 22: Criteria for Species Selection by Forest Plantation Systems

Large-scale industrial forest plantation	Large-scale non-industrial forest plantation	Small-scale village/ community forest plantation	Agroforestry systems
Yield over 10-15 m ³ /ha/yr Easy propagation Clonal propagation Marketing Valuable timber Suitable for monocultures Resistance to pests Fire/wind resistance Auto-tolerant Ease of pruning Good wood properties Availability of proven seeds Site-specific	Intensive root system Good survival and growth Suitable for marginal lands Undemanding Multiple uses Good natural regeneration Easy propagation Coppicing Soil improvement Robust against browsing Site-specific	Easy propagation Coppicing Multiple uses Fast growth Short rotation High acceptance Site-specific	Multiple uses N ₂ -fixation Deep rooting Coppicing Fast growth Light crowns High acceptance Site-specific

Source: Evans 1992, Pancel 1993b.

Table 23: Recommended species for different plantations of Bangladesh

Plantation Type	Type of Species	
	Local Name	Scientific Name
Mangrove Afforestation	Keora	<i>Sonneratia apetala</i>
	Baen	<i>Avicennia officinalis</i>
	Moricha Baen	<i>Avicennia marina</i>
	Sada Baen	<i>Avicennia alba</i>
	Gewa	<i>Excoecaria agallocha</i>
Mound Plantation	Babla	<i>Acacia Senegal</i>
	Babla	<i>Acacia nilotica</i>
	Jhaw	<i>Casuarina equisetifolia</i>
	Koroj	<i>Pongamia pinnata</i>
	Katbadam	<i>Terminalia catappa</i>
	Shingra	<i>Cynometra ramiflora</i>
	Puti jam	<i>Eugenia spp.</i>
Jhaw Plantation (Casuarina)	Jhaw	<i>Casuarina spp.</i>
Golpata Plantation (Nipa)	Golpata	<i>Nipa fruticans</i>
Enrichment Plantation	Gewa	<i>Excoecaria agallocha</i>
	Sundri	<i>Heritiera fomes</i>
	Kakra	<i>Bruguiera gymnorhiza</i>
Core Zone Plantation	Pusur	<i>Xylocarpus mekongensis</i>
	Koroi	<i>Albizia procera</i>
	Boilam	<i>Anisoptera glabra</i>
	Chickrash	<i>Chickrasia tabularis</i>
	Gamar	<i>Gmelina arborea</i>
	Jarul	<i>Lagerstroemia parviflora</i>
	Bakain	<i>Meila azadirachta</i>
	Neem	<i>Melia indica</i>
	Amloki	<i>Phyllanthus embilica</i>
	Arjun	<i>Terminalia arjuna</i>
	Bohera	<i>Terminalia bellirica</i>
	Horitoki	<i>Terminalia chebula</i>
	Buffer Zone Plantation	Koroi
Raj koroi		<i>Albizia richerdiana</i>
Boilam		<i>Anisoptera glabra</i>
Chickrash		<i>Chickrasia tabularis</i>
Kadam		<i>Anthocephalus kadamba</i>
Gamar		<i>Gmelina arborea</i>
Jarul		<i>Lagerstroemia parviflora</i>
Bakain		<i>Meila azadirachta</i>
Neem		<i>Melia indica</i>
Amloki		<i>Phyllanthus embilica</i>
Arjun		<i>Terminalia arjuna</i>
Bohera		<i>Terminalia bellirica</i>
Horitoki		<i>Terminalia chebula</i>
Mahogany		<i>Swietenia macrophylla</i>
Jam		<i>Syzygium cumini</i>
Tatul		<i>Tamarindus indica</i>
Amra		<i>Spondias mangifera</i>
Katbadam	<i>Terminalia catappa</i>	
Non-mangrove (buffer) Plantation	Koroi	<i>Albizia procera</i>
	Raj koroi	<i>Albizia richerdiana</i>
	Boilam	<i>Anisoptera glabra</i>
	Chickrash	<i>Chickrasia tabularis</i>

Plantation Type	Type of Species	
	Local Name	Scientific Name
	Kadam	<i>Anthocephalus kadamba</i>
	Gamar	<i>Gmelina arborea</i>
	Jarul	<i>Lagerstroemia parviflora</i>
	Bakain	<i>Meila azadirachta</i>
	Neem	<i>Melia indica</i>
	Amloki	<i>Phyllanthus embilica</i>
	Arjun	<i>Terminalia arjuna</i>
	Bohera	<i>Terminalia bellirica</i>
	Horitoki	<i>Terminalia chebula</i>
	Mahogany	<i>Swietenia macrophylla</i>
	Jam	<i>Syzygium cumini</i>
	Tatul	<i>Tamarindus indica</i>
	Amra	<i>Spondias mangifera</i>
	Katbadam	<i>Terminalia catappa</i>
Strip Plantation	Babla	<i>Acacia nilotica</i>
	Koroi	<i>Albizia procera</i>
	Raj koroi	<i>Albizia richerdiana</i>
	Kadam	<i>Anthocephalus kadamba</i>
	Jack Fruit	<i>Artocarpus heterophyllus</i>
	Chickrashi	<i>Chickrasia tabularis</i>
	Epilpil	<i>Leucaena leucocephala</i>
	Gamar	<i>Gmelina arborea</i>
	Jarul	<i>Lagerstroemia parviflora</i>
	Bakain	<i>Meila azadirachta</i>
	Neem	<i>Melia indica</i>
	Amloki	<i>Phyllanthus embilica</i>
	Arjun	<i>Terminalia arjuna</i>
	Bohera	<i>Terminalia bellirica</i>
	Horitoki	<i>Terminalia chebula</i>
	Mahogany	<i>Swietenia macrophylla</i>
	Jam	<i>Syzygium cumini</i>
	Tatul	<i>Tamarindus indica</i>
	Amra	<i>Spondias mangifera</i>
	Katbadam	<i>Terminalia catappa</i>
Raintree	<i>Samanea saman</i>	
Guava	<i>Psidium guava</i>	
Natai	<i>Pithecellobium dulce</i>	

Source: CRPARP

3.3.5 Guidelines to Establish Forest Plantation

The establishment of a forest plantation includes three stages:

- lay-out
- site preparation; and
- planting operation

Activities for each stage normally decrease in number and time required (investment) from large-scale forest plantations, enrichment planting to intercropping tree planting. For example, intercropping tree planting or agroforestry systems do not generally require thinning and fertilizing operations.

3.3.5.1 Lay-Out

For large-scale forest plantations, planning the plantation lay-out is complex as it must include the exact location and shape of the forest plantation; road network plan; location of waterways for fire-fighting purposes; subdivision into sub- units (compartments) with open lines between for fire breaks and access; spacing; marking; and mapping. For small-scale village/community forest plantations, lay-out planning consists of four activities. Table 24 provides guidelines on how to lay-out a forest plantation.

- spacing decision
- area survey and marking operation
- establishment of firebreak line around the forest plantation as boundary protection line, and
- mapping the location of the plantation

Table 24: Guidelines for Forest Plantation Lay-out

Activity	Methodology
Area survey/ marking boundaries	Instruments: Compass (or GPS) and distance tape
	Annual planting area (ha) = Total area of the planting project (ha) / rotation (yr)
	Permanent marking clearly visible for all corners and intersection points
Firebreak line establishment	Where there are no existing roads, paths or watercourses within the forest plantation
	Permanent line with no flammable vegetation or use fire resistant species (green break)
	Width of firebreak according to surrounding vegetation height (cleaning of 2-10 m)
Tree spacing	Spacing 1-2 m: Fuel wood, maximize yield, short rotation, no small size limit
	Spacing 2.5-4.5 m: Sawn timber, large log size 30 cm+ in DBH, long rotation, regular thinning
	Squared or rectangular spacing on flat land; triangular spacing on sloping land
Marking planting lines and pits	On slopes <15 degrees, establish base line (1 or more) parallel to a convenient road or track
	Mark the location of the start of the planting lines along the base line with poles
	Use compass and rope marked with fixed intervals to trace the planting line, at right angles to the base line
	Mark the planting pits with sticks/pegs along the marked rope
	In steep terrain, use a simple level (or A frame) to mark planting pits along contour Lines
Mapping	Scale 1:50 000: General planning of the location of forest plantation areas
	Scale 1:10 000: Activities planning for forest plantation or area >10 ha
	General planning of location for forest plantation of area <10 ha
	Scale 1:5 000/1:2 500: Activities planning for forest plantation of area <10 ha

Source: Samek 1974, FIDCO 1980b, Evans 1992, Pancel 1993a.

The decision on tree spacing is the most important one in the establishment of forest plantations because it is correlated to the success of the forest plantation regarding maintenance, stand stability, quality of wood and investment. Spacing is variable depending on the species and final product. Three types of spacing are frequently used: squared, rectangular and triangular. The calculation of the number of seedlings for these spacing types is explained in Table 25 below and illustrated in Figure 14. The silviculture of different types of plantation is presented in Figure 15.

Table 25: Calculation of Number of Seedlings according to Spacing Type

Spacing type	Formula ¹	Example	
		Spacing	No. of seedlings
Squared	$10,000 / (R \times P)$	4 m x 4 m	625
Rectangular	$10,000 / (R \times P)$	2 m x 8 m	625
Triangular ²	$10,000 / (R \times P)$	4.30 m x 3.72 m	625

¹R = distance between tree; P = distance between line.

²Triangle with 3 equal sides (R), P = height of the triangle (R x 0.866)

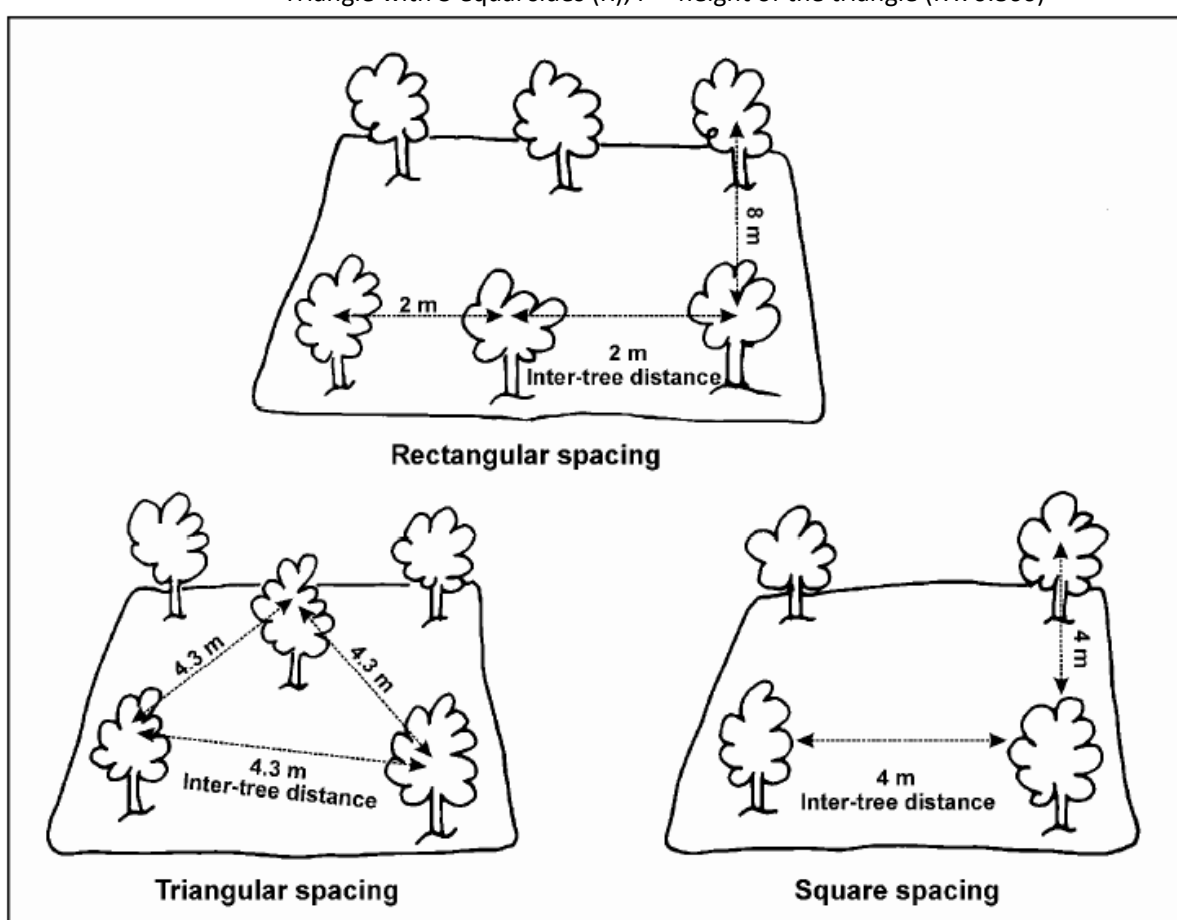


Figure 14: Frequently used Types of Tree Spacing

Table 26: Silviculture of Different Types of Plantations

Mangrove plantation	Mound Planation (non-mangrove)
1. Nursery: 40'x4' bed, Tk. 1.5/seedling, 5000 seedlings for planting of 4444/ha	1. Nursery: 7''x5'' bag, Tk. 5.75/seedling, raising 1760 seedlings for planting of 1600/ha
2. Planting 4444 seedling/ha (1.5m x 1.5m spacing)	2. Planting 1600 seedling/ha (1.5m x 1.5m spacing)
3. Community watching (1 st year 6 months and 2 nd year 12 months)	3. Maintenance (VF 1 st year 10%=160 seedling/ha)
4. Maintenance (VF 2 nd year 40%=1800 seedling/ha)	4. Beating up 10% and 3 weeding

5. Beating up 40% and 3 weeding 6. Maintenance (VF 3 rd year 20%=900 seedling/ha) 7. Beating up 20% and 2 weeding	5. Maintenance (VF 2 nd year 10%=160 seedling/ha) 6. Beating up 10% and 2 weeding
Dyke Plantation (non-mangrove)	Jhaw Plantation
1. Nursery: 7''×5'' bag, Tk. 5.75/seedling, raising 495 seedlings for planting of 450/ha (9 Dyke×50 seedling, 30 coconuts, 400 fruits and 20 tree/ha) 2. Plantation: 450 seedlings in 9 dyke/ha (9×50) (30 coconuts, 400 fruits and 20 tree)	1. Nursery: 7''×5'' bag, Tk. 5.75/seedling, raising 2750 seedlings for planting of 2500/ha 2. Planting 2500 seedling/ha (2m×2m spacing) 3. Maintenance (VF 1 st year 10%=250 seedling/ha) 4. Beating up 10% and 3 weeding 5. Maintenance (VF 2 nd year 10%=250 seedling/ha) 6. Beating up 10% and 2 weeding and pruning
Golpata Plantation	Enrichment Plantation (mangrove)
1. Nursery: 40'×4' bed, Tk. 10/seedling, 1100 seedlings/km for planting of 1000/km 2. Plantation: 1000 seedling/km 3. Watcher and boat hire, planting 0 year (save seedling from fishing push net) 4. Maintenance (VF 1 st year 10%=100 seedling/km) 5. Beating up 10% and 2 weeding 6. 2 nd year maintenance: weeding and clearing	1. Nursery: 16''×9'' bag, Tk. 1.5/seedling, raising 315 seedlings for planting of 300/ha 2. Planting 300 seedling/ha (1.5m×1.5m spacing) 3. 1 st year maintenance Climber cutting including transportation
Core Zone Plantation	Buffer Zone and Buffer Zone Non-Mangrove Plantation
1. Nursery: 10''×6'' bag, Tk. 6.75/seedling, raising 2750 seedlings for planting of 2500/ha 2. Planting 2500 seedling/ha (2m×2m spacing) 3. Maintenance (VF 1 st year 10%=250 seedling/ha) 4. Beating up 10% and 3 weeding 5. 2 nd year maintenance 2 weeding and pruning	1. Nursery: 7''×5'' bag, Tk. 5.75/seedling, raising 2750 seedlings for planting of 2500/ha 2. Planting 2500 seedling/ha (2m×2m spacing) 3. Maintenance (VF 1 st year 10%=250 seedling/ha) 4. Beating up 10% and 3 weeding 5. 2 nd year maintenance 2 weeding and pruning
Strip Plantation	
1. Nursery: 7''×5'' bag, Tk. 5.75/seedling, raising 1100 seedlings for planting of 1000/km 2. Planting 1000 seedling/km 3. Watcher including cleaning @Tk. 6000/km/month 4. 1 st year maintenance, raising 200 seedling/km (participant will do the beating up) 5. Stack and shootly-200 no. @ Tk. 3.0	

3.3.5.2 Site Preparation

The extent of preparation needed for the planting site depends on four factors:

- purpose of plantation
- species to be planted
- existing vegetative cover, and
- soil conditions.

Site preparation comprises two main field activities: removal of the existing vegetation to reduce and/or eliminate competition and ground preparation to improve water retention and provide optimal soil conditions for the plantation's initial phase. Four methods can be used for vegetation clearance: manual, mechanical, by burning or use of weedicides. For ground preparation after vegetation has been cleared, different methods also exist, such as pioneer ploughing, subsoiling, pre-planting harrowing, planting pits and terracing.

Site preparation for a small-scale community plantation or agroforestry planting is less costly than for large-scale industrial forest plantations which requires the use of heavy equipment. A “minimum” amount of work to prepare the site for receiving the seedlings is essential because time and money have already been spent to collect and prepare the seeds and to raise the seedlings in nursery. In addition, the degree of site preparation needed directly reflects the species’ ability to compete for light, moisture, and nutrients on the site in question. For example, most eucalyptus species require a completely weed-free site for rapid early growth, while many pine species (including *Pinus caribaea*) are tolerant of grass competition.

Clearing of natural “primary” forest or old secondary forest simply for tree plantations is today generally considered to be unacceptable on grounds of conservation and risk of erosion. Careful management of secondary forest can render it productive as any plantation. Heavy equipment used in land clearing and preparation causes major disturbances to the soil such as compaction, erosion, etc., and can be used only where there are no site restrictions (i.e, sloping terrain, rockiness, logging debris, other material on a site). Also, vegetation removal by slash-burning may induce rapid alteration in soil properties; the ash layer following burning is rich in nutrients (exchangeable bases) which are often washed down after the first rain.

Table 27 presents different options for manual clearing depending on the competing or existing vegetation, as well as some special ground preparation techniques. It is worth noting that even where mechanical methods using heavy equipment are feasible or less costly than manual methods, the latter (utilizing light equipment) are more desirable in terms of a wider distribution of the employment benefits of plantation establishment.

Table 27: Guidelines for Preparation of Planting Site

Activity	Methodology
Removal of competing vegetation	
Open areas, grassland, abandoned pasture	Each planting spot is cleared individually Cleared area: one square meter or a circle of 1 meter radius Use a machete to cut high Gramineae and a hoe to cut grasses, including roots Clean, collect and put the cut material outside the cleared area
Areas with Shrubs (2-3 m height)	Clear a strip 2 meters wide following a pre-determined spacing between strips Cut the vegetation within the strip using a machete or axe 10 cm from the soil surface Clear and clean each planting spot within the strip as described above
Areas of secondary Forest	Clear a strip in an east-west direction at least 8-10 meters wide, and equidistance between strip center of 10-25 meters Mark and cut trees with market value for timber and/or fuel wood using an axe or chainsaw
	Clear completely a central line about 1 meter wide within the strip On both sides of the central line, remove the bush layer, smaller trees and climbers Reduce competition from overhead shade from the big trees within the strip
Special ground preparation	
Steep land	Stabilize the site and reduce erosion by the establishment of mini-terraces (terrace, mini-convertible terraces or hillside ditches) Use an agroforestry system; mixed multi-story tree and crop combinations
Sand dunes	Use physical barriers of wood or other material to slow sand movement and build up a level surface Follow by planting nitrogen-fixing shrubs or trees species with crown densities near the ground
Barren areas, Mine reclamation Areas	Before planting trees, establish a leguminous (native herbaceous) ground cover to restore the surface soil Dig planting pits, refill with loose soil mixed with organic matter

Activity	Methodology
Swampy sites, waterlogged areas	Prepare drainage system; outer and receiving ditches, drainage ditches and drains system Make mounds or ridges for planting trees

Source: FIDCO 1980b, Wadsworth 1997, Ruiz 2002

3.3.5.3 Planting Technique

The first variable influencing planting is timing. Throughout the tropics the occurrence of the rainy season usually determines the planting time. Evapotranspiration stress at planting is one of the main causes of initial death. To minimize planting stress, seedlings should be planted when the soil moisture level has returned to field capacity, i.e., after approximately 100 mm of steady rain has fallen; during cloudy days; and using well-watered seedlings (Evans 1992).

In Bangladesh, planting should be done during the short rainy season (April, May, June) and long rainy season (September, October, November). There is no restriction about the planting time during cloudy days but the best time is before noon on sunny days.

Two types of planting material are commonly used: bare rooted plants, including stumps, and container plants most commonly grown in plastic bags. The field planting methods for these two types of seedlings are described in Table 28. Figures 15 and 16 illustrates the correct planting technique and position of the seedling in the planting pit respectively. Occasionally, other types of planting methods and materials are used such as direct sowing, seedlings from natural regeneration and cuttings or vegetative propagation method.

If the planting is done during the rainy season, watering is not necessary. However, the forest plantation manager should plan for watering in case no rain falls in the first week after planting. The addition of fertilizer at planting is based on soil analyses, but it is essential on infertile sites where the purpose of the plantation is to improve poor soils or to rehabilitate mined bauxite lands. A quality control exercise should be carried out to evaluate the performance of the plantation in order to make the necessary adjustments to the planting method and for planning the replanting (beating up) in the following planting season.

Table 28: Guidelines for planting technique

Activity	Methodology
Planting method for bare root seedlings	Dig a small (20-25 cm deep) planting pit or open up a slit with a hoe or spade or mattock Seedlings are inserted up to the root collar level with the ground, using one hand Soil is carefully filled back with the other hand and pressed with the foot around the seedling
Planting method for container grown seedlings	Dig a small (slightly bigger than the container) planting pit with a hoe or spade or mattock Remove the container and position the seedling in the pit with the root collar level with ground Fill back with soil and firm with the foot around the seedling
Soil additives	Fertilizer applications should be based on prior soil analyses Infertile sites usually require addition of NPK (nitrogen, phosphorus, potassium) fertilizer Mix fertilizer with small amount of soil and place the mixture in the bottom of the planting hole In dry areas, it is advantageous to mulch the soil surface near the freshly planted seedlings
Watering	Rarely necessary if planting done during the rainy season In dry areas, or if no rain has fallen within 1 week of planting, watering is necessary to maintain an acceptable survival rate of seedlings

Quality control	Essential to identify most efficient techniques as well as causes of non-performance of plantation Quality control measures include: planting depth of seedlings; seedling root contact with surrounding soil (no empty spaces); firmness of seedlings; and seedling root position in the planting hole (roots not crowded together)
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Source: Evans 1992, Pancel 1993a, Ruiz 2002.

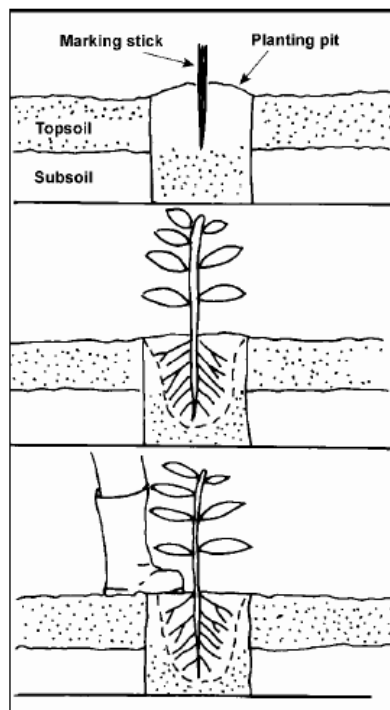


Figure 15: Method to Plant a Tree Seedling

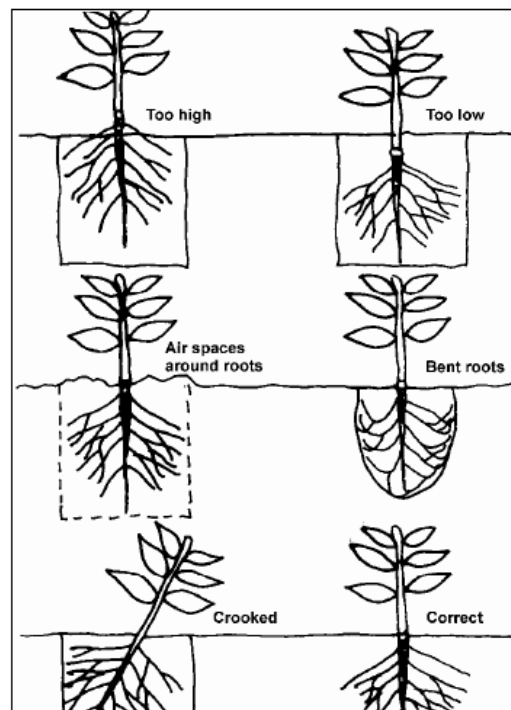


Figure 16: Correct Position of the Seedling and Seedling Roots in Planting Hole

3.3.6 Guidelines to Manage Forest Plantations

Here, the term “manage” includes all silvicultural activities between the establishment of the plantation and the replanting or regeneration after felling/harvesting. Management activities such as fire protection and guarding; replanting (beating up); weeding; pruning; thinning; and regeneration by new planting or coppice are generally applicable to solid block plantings (pure or mixed). Trees planted individually and enrichment planting, either as line planting or under-planting need variable management treatments which sometimes require no thinning or pruning.

Fire protection and fertilization activities were discussed earlier in the sections pertaining to planting lay-out and technique. A general schedule of the other silvicultural operations for an even-aged plantation is shown in Table 29 to assist in planning management activities based on the plantation’s stage of development.

Table 29: Development Stages and Silvicultural Operations in even-aged Forest Plantation

Age class	Time characteristic	Management operation
Young growth	From the start of plantation establishment until crown closure of plantation	Weeding
		Replanting (beating up)
Young Stand	From the start of crown closure until the dominant trees have reached a DBH of 15 cm	Low pruning
Pole wood	Mean DBH of the dominant trees is between 15 and 20 cm	Systematic pruning
		High pruning
Young timber	Mean DBH of the dominant trees is over 20 cm	Selective thinning
		Selective thinning

Source: Pancel 1993a.

3.3.6.1 Maintenance

The first maintenance activity for a successful plantation is the protection and guarding of the planted area from fire, animal damage by grazing/browsing and human trespass for cultivation/theft of trees. It is always necessary to clean all firebreaks on an annual basis. Guarding the plantation is an on-going job. Local people and the local forest management administration (LFMA) should play a key role in preventing, reporting and controlling these kinds of problems, both on private and public lands. If fire is a serious problem in the area, the LFMA should be equipped and trained to fight fire.

The second maintenance activity is weeding. Weeding requirements vary with the site, the tree species, as well as the existing weed species. In wet areas, herbaceous growth tends to smother even fast-growing trees and in dry areas, the weed plants compete with trees for scarce water. Annual weeding requirements will be high if the spacing between planted seedlings is large enough to allow sufficient light to penetrate and facilitate the rapid growth of weed plants.

If the initial seedling survival rate is too low, the most important rule is to carry out replanting (beating up) within the first year of plantation establishment, i.e., the following planting season, to ensure minimum variation of plantation ages. Replanting represents an added cost, therefore relatively high losses can be acceptable, provided the dead seedlings are evenly distributed. Table 30 presents the general guidelines which should be applied for the maintenance of forest plantation.

Table 30: Guidelines for maintenance of forest plantation

Activity	Methodology
Fire protection and guarding	Clean the firebreak established around the plantation in December and July, at the beginning of the long and short dry season Protect against fire, human encroachment and theft and animal browsing
Weeding	Cut grasses, Gramineae or shrubs using recurred hoe, machete or axe Cleaning: 1 m or more each side of the tree until tree height >2 m; for trees with height >2 m, remove only shade overhead and climbers (where 25%+ infested trees) Frequency: first year (twice); second and third year (once/year) until tree height >2 m Timing: after the rainy seasons, December to March and/or July to August
Replanting (Beating up)	For reliable estimation of survival rate, select randomly to cover the range of planting conditions Sample rows with fixed number (30) of trees in each and mark trees in order to keep the age difference low (1 year) Assessment should be done at the end of each planting season and the gaps filled the following season Failed patches large enough to allow serious weed invasion usually merit replanting; evenly distributed seedling losses as high as 50% could be accepted, since less thinning will be needed later

Source: FIDCO 1980b (for Caribbean pine), Evans 1992, Wadsworth 1997, Ruiz 2002.

3.3.6.2 Pruning

Pruning is a silvicultural prescription of removing branches in order to improve tree form or wood quality. This activity is planned only for timber production and almost exclusively for conifer plantations. If the spacing is appropriate, hardwood species normally tend to self-prune.

To improve wood quality and to allow trees to grow a long period, pruning must be done early. Early pruning or "low pruning" is done mainly to permit easy access to the plantation for thinning and is carried out on all trees. The second pruning takes place at the same time as thinning (often the second thinning) and is carried out when selection of the most promising trees takes place. This

pruning is called “high pruning” because higher branches, up to 5-7 meters, are removed which will maximize timber quality for final harvesting. Table 31 presents the general guidelines to carry out a correct pruning and Figure 17 shows the method to prune a tree.

Table 31: Guidelines for Pruning of Forest Plantation

Activity	Methodology
Low pruning	Where low branches are persistent (this will depend on species and spacing) Purpose: create easy access for thinning operations, produce knot-free timber, provide fodder, leaf mulch, fuel wood, etc. Remove branches for all trees as soon as this can be done, up to 2 m above the ground without exceeding half of total tree height Removal of branches is done with pruning scissors or a curved pruning saw mounted on a long pole Avoid the use of a machete or axe because it is difficult to make a clean cut If no thinning is planned, low pruning may not be necessary
High pruning	The most promising trees selected for final harvest are pruned, approximately 200 trees/ha, and is usually done at same time as thinning Pruning height is usually less than half of total tree height, approximately 5-7 m The pruning is done with curved pruning saw mounted on an extendable pole (4-5 m) Avoid the use of a machete or axe with ladder because it is difficult to make a clean cut Pruned branches should be removed from the base of tree to reduce fire risk

Source: Evans 1992, Wadsworth 1997, Ruiz 2002.

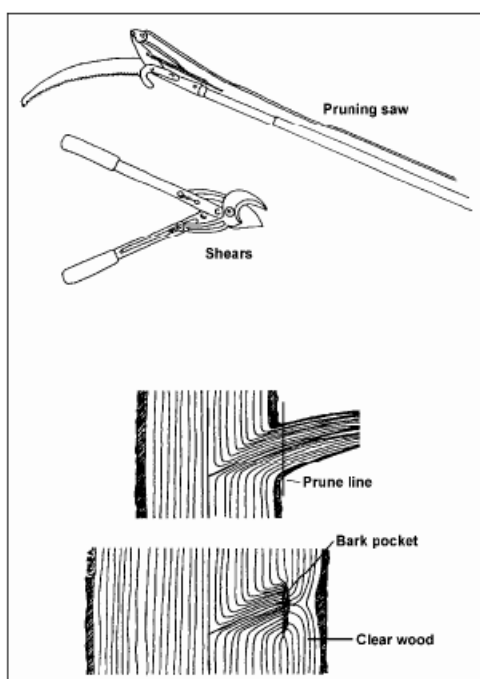


Figure 17: Method to Prune a Tree

3.3.6.3 Thinning

Thinning is a silvicultural operation that reduces the number of trees within the stand. The main reasons for thinning are:

- increase light penetration to develop crown and accelerate diameter growth
- increase the percentage of trees reaching maturity
- improve wood quality
- encourage root development, and
- maintain ground cover for erosion control.

Thinning modifies the initial spacing with the objective of maximizing the final desired product, i.e., timber, biomass, fruits, etc. Increased tree spacing allows for maximizing crown diameter which will positively impact on diameter at breast height (DBH).

There are three basic thinning decisions when managing a site for sustainable forest production:

- a) when to thin
- b) how many trees to leave; and
- c) which trees to leave

Table 32 shows an example for a general thinning schedule based on the ratio of crown diameter/DBH. For an average DBH of 30 cm on a 20-year rotation for timber production with pines and eucalyptus species, one thinning should be carried out. Two thinning should be planned to obtain an average DBH of 45 cm on a 30-year rotation for the other hardwood species.

In stands where the natural mortality is low, the rows are well laid out, tree form is good and there are plenty of good potential crop trees, the plantation manager should carry out a systematic thinning by either line or row thinning as the first thinning. The prescribed scheme is to cut every second row, i.e., 50% of trees removed, regardless of individual tree characteristics.

Table 32: Number of Trees to Leave in Thinning Operations

DBH (cm) ^a	Conifers and Acacia		Other species	
	No. of trees/ha before thinning	No. of removed trees/ha	No. of trees/ha before thinning	No. of removed trees/ha
0	1111	111	625	63
15	1000	433	563	220
30	567	315	343	191
45	252	252	152	67
60	-	-	86	86

^{An} Initial spacing: conifers and eucalyptus (3 x 3 m), other species (4 x 4 m).
Natural tree mortality (DBH: 0 to 15 cm) = 10%.
Desirable plantation spacing: conifers and eucalyptus (14 x DBH in m), other species (18 x DBH in m).

Source: Wadsworth 1997, Ruiz 2002.

In stands² where conditions are less favorable, e.g., high mortality, few potential crop trees, the recommended method for the first and second thinning is a selective thinning once potential crop trees have been identified. The thinning is called “from below” or low thinning when it is mainly the suppressed and intermediate trees that are removed. The thinning called “from above” or crown thinning involves the removal of large co-dominant and dominant trees to reduce crown competition and thus increase basal area. In first-generation plantations, variation in tree quality is so great that selection by form is desirable, removing all abnormal trees whether large or small (Wadsworth 1997).

Potential crop trees are selected on the following criteria:

- straighter stem with no external defects
- vigor, as measured by larger DBH; and
- crown with healthy appearance

²A stand is a contiguous area that contains a number of trees that are relatively homogeneous or have a common set of characteristics.

Normally a stand will be studied or managed as a single unit.

The selection of the trees for removal depends on the distance between the selected or potential crop tree and neighboring trees. General guidelines for the selection of trees to remove are presented in Table 33.

Table 33: Selection of Trees to Remove in Thinning Operations

D + d (cm) ^a	Minimum distance (m)
20	2.7
30	3.8
40	4.8
50	5.8
60	6.7
70	7.5
80	8.4
90	9.1
100	9.9
110	10.5
120	11.2

D = DBH of the future crop tree
d = DBH of each of its non-crop neighbors

Source: Wadsworth 1997, Ruiz 2002.

3.3.7 Harvesting and Starting the Next Forest Plantation

The last group of management activities is harvesting the mature forest plantation and starting the next plantation using artificial (replanting) or natural (coppice, seedlings) regeneration. Where a clear-felling system is used the objective of the harvesting plan must be to minimize damage to the site and time of exposed soils without vegetation.

3.3.7.1 Felling System

In large-scale industrial forest plantations, the clear-felling system and heavy equipment are generally used to harvest. In smaller forest plantations, the size of the clear-felling blocks can be more easily manipulated. The technique is to harvest the mature plantation in small blocks or groups over just a few years since the forest plantation has already reached economic maturity (Table 34).

Table 34: Suitability of felling systems under different constraints on plantation management

Type of Constraint	Example of constraints	Clear felling	Group felling
Environmental	Soil erosion is a high risk; conservation of native species found in plantations is a high priority; hurricane damage is a high risk.	Not suitable	Suitable
Social	Production of benefits for local communities is a high priority.	Not suitable	Suitable
Institutional	Silvicultural malpractice (due to an inadequate, poorly managed and/or untrained workforce) is a high risk.	Suitable	Not suitable
Economic	Maximising stand profitability is a high priority	Suitable	Not suitable

Source: Mayhew and Newton, 1998

The rotation periods used in Bangladesh for timber production varies from 12 years to more than 40 years (for hardwoods). The harvesting period using the “group felling system” should be 5 years if the entire mature forest plantation is enough large to apply the system. Table 35 lists rules for harvesting to minimize environmental impacts of the operations.

Table 35: General Rules for a Sustainable Harvesting of Forest Plantations

<ol style="list-style-type: none"> 1. Harvest in a way which minimizes damage to the site and does not prolong the period the soil is exposed. 2. Use chainsaws for big trees, bow saws, cross-cut saws or handsaws for small trees; cut trees as low as possible with careful control of felling direction (from uphill to the road into existing gaps), minimize the number of passes and suspend logging during wet periods. 3. The best extraction method to minimize damage to soil on steep slopes is a system using animals, e.g., horses, mules, etc.; the use of a small farm tractor is possible where the slope is gentle; it is recommended a portable sawmill be used to saw up cut logs on site. 4. Stream side buffer strips should be maintained of at least 20 meters on either side of the stream.
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Source: Evans 1992, Wadsworth 1997, Forestry Department 2001.

3.3.7.2 Regeneration System

For sustainable timber production, a new plantation is established by replanting the site after harvesting, with the same species or a new species after analysis of the previous production and the present characteristics of the site.

The capacity of many plantation species to sprout vigorously after harvest can minimize the cost of regeneration. In fuel wood/charcoal production, harvesting time is generally 6 years after the initial planting, and the coppicing method to regenerate the next tree crop is recommended. Coppiced stumps can usually regenerate 3 or 4 times, after which a new planting must take place.

Depending on the previous tree crop, the species and the purpose of the forest plantation, other types of regeneration/establishment can be practiced, such as direct sowing; trees planted individually or in lines in pastures or cultivated fields as boundary lines, intercropping, and enrichment planting by line planting or under planting.

Natural regeneration also has its advantages and could be applicable in some areas depending on the characteristics of the forest and immediate socio-economic environment. Table 36 presents guidelines for selecting a forest regeneration method: block planting, enrichment planting, coppice and use of natural regeneration (Evans 1992, Wadsworth 1997, Dawkins and Phillip 1998).

Table 36: Guidelines for the Selection of Forest Regeneration Method

Activity	Description
Replanting (Block planting)	<p>Natural regeneration is little used in large-scale forest plantations because artificial regeneration (replanting) provides an opportunity to introduce improved genetic stock or change the species.</p> <p>Spacing the plants is easy using the line of old stumps.</p> <p>For future access, planting in line of the old stumps is preferred.</p> <p>Small-scale or village/community forest plantations should be regenerated at least partly with the best trees in existing plantations.</p>
Enrichment Planting	<p>Method between full block planting and natural regeneration; planting of valuable timber species in cleared lines to improve low productivity secondary forests.</p> <p>Use close spacing along lines.</p> <p>Align the lines east-west in order to maximise sunlight.</p> <p>Use only species that are strong light-demanders capable of extremely fast height growth - about 1.5 m/year - in their juvenile stage and naturally straight and self-pruning, or use "stumps" or young trees that are at least 1 m high.</p> <p>Tend the whole forest area, not just the planted lines.</p> <p>Liberate the planted trees from overhead and lateral shade and root competition.</p>

Activity	Description
Coppice	<p>Forest crop raised from shoots produced from the cut stumps of the previous crop; for small round wood or poles or biomass for fuel wood/charcoal; coppicing minimises the cost of regeneration.</p> <p>Thin coppice shoots and keeps only one or two strong shoots for the production of larger size material.</p> <p>The number of coppice crops that may be obtained from a planting depends on the longevity of the coppicing power of the stumps; in practice, this number is often restricted to 3 or 4 because each time a few stumps die.</p> <p>Some species can coppice more readily, e.g. <i>Gmelina arborea</i>, <i>Eucalyptussaligna</i>, <i>Eucalyptus robusta</i>, <i>Tectona grandis</i>, <i>Cassia siamea</i>, <i>Leucaena leucocephala</i>, <i>Acacia</i> spp., <i>Albizia</i> spp., <i>Eugenia</i> spp.</p>
Natural Regeneration	<p>A low-risk investment with low capital requirements.</p> <p>Appropriate where population and local demand for timber products are low, and where there is little pressure for alternative land uses.</p> <p>Appropriate in forests with high conservation values.</p> <p>Requires a high degree of ecological understanding but less expertise in financial and investment management.</p>

Monitoring & Evaluation (General) Template **Annex-7**

Sector wise SMART indicator for monitoring & evaluation **Annex-8**

Checklist for Forest Sector Projects **Annex-9**

Template for Forest Sector Projects **Annex-10**

SMART indicator for Forest Sector Projects **Annex-11**

CHAPTER FOUR M&E GUIDELINES FOR IRRIGATION SECTOR

4.1 Glossary

- Irrigation** : Irrigation is the application of controlled amounts of water to plants at needed intervals. Irrigation helps to grow agricultural crops, maintain landscapes, and vegetation disturbed soils in dry areas and during periods of less than average rainfall.
- Khal** : Natural canal which may be perennial or non- perennial
- Command area** : The command area of a water source is the extent of area which can be reliably irrigated from that source. Reliable irrigation means that the availability of water is always larger than or equal to the irrigation need of a scheme.
- Net irrigation water requirement** : Net irrigation water requirement (NIWR) is the quantity of water necessary for crop growth. It is expressed in millimeters per year or in m³/ha per year (1 mm = 10 m³/ha). It depends on the cropping pattern and the climate. Information on irrigation efficiency is necessary to be able to transform NIWR into gross irrigation water requirement (GIWR), which is the quantity of water to be applied in reality, taking into account water losses.
- Reliable irrigation** : Reliable irrigation means that the availability of water is always larger than or equal to the irrigation need of a scheme.
- Water availability** : Water availability is the amount of water is available from the sources during irrigation period
- Topography** : Topography is the study of the shape and features of land surfaces. The topography of an area could refer to the surface shapes and features themselves, or a description (especially their depiction in maps)
- Cutting depth** : Cutting depth is the amount of vertical cutting according to design of canal/natural khal
- Side Slope** : Side slope means average vertical and Horizontal ratio (i.e. if Slope is 1:1.5 means for 1m vertical distance, horizontal distance will be 1.5m.)
- Cross Dam** : A Cross dam is a barrier that stops or restricts the flow of water or underground streams.
- uPVC pipe** : The full form of uPVC is un-plasticized polyvinyl chloride. Plastic pipe is a tubular section, or hollow cylinder, made of plastic. It is usually a circular cross-section, used mainly to convey substances which can flow—liquids and gases (fluids), slurries, powders and masses of small solids
- Header Tank** : A header tank is a container of liquid positioned at a higher level than a main tank, so that the level of pressure can be maintained.
- Outlet Risers** : The risers that serve as outlets from the pipeline to the field surface shall consist of three parts: the lower fixed vertical pipe that is connected to the main water transmission pipeline; coupler – the connection between the fixed and removable above-ground vertical pipes; and the removable top vertical pipe or alfalfa valve (depending on field elevations). The outlet operates by removing the above-ground vertical pipe from the coupler which or opening the alfalfa valve in order to allow water to exit from the main pipeline onto the field surface.

- Air Vent : Air Release/Vacuum Relief Valves provide vital protection to pipeline systems. They allow air to escape during system startup by preventing air restrictions, water hammer caused by large air masses, inaccurate flow meter readings, and explosive conditions from air being compressed by water. They also allow air to enter the pipeline during valve closure or system shutdown. This minimizes the collapse of mainline and sub-main pipes, back siphonage of dirt into emitters, and water hammer caused by sudden reversal of flows
- Pump : Irrigation pumps are used to pump water from a lower to a higher level from which the water then flows through channels to the fields requiring irrigation (lift operation) or to raise it to the required pressure head so that it can be sprayed on the fields via piping systems (sprinkling).

4.2 Introduction

Irrigation essentially means the watering of land to make it ready for agricultural purposes. An irrigation system is the supplying of water via artificial canals and channels to growing plants and crops in a field. Irrigation has been much appreciated for its significant contribution to global agricultural production and foodsecurity over the past 50 years. Currently, more than 40 percent of global agricultural products are produced on irrigated land, which constitutes close to 20 percent of the total global arable land. However, irrigation has also been criticized for inefficient water use, poor system performance and some negative externalities, including irrigation-induced soil salinization, groundwater depletion, water-borne diseases and water pollution. To meet the requirements of the world population, which is projected to be more than 9 billion by 2050, food production needs to be increased by 70 percent globally and by 100 percent in developing countries, and irrigations expected to be a major contributor (FAO, 2012a).

Irrigation is a critical factor for crop production in Bangladesh. Although, the share of agriculture in Gross Domestic Production (GDP) has been declining over the years, it still remains the largest sector of the Bangladesh economy. At present, agriculture accounts for about one-third of GDP and employs about two-third of the labor force. While the contribution of agriculture to the economy is likely to decline, it will continue to be the single largest contributor to income and employment of the rural population in the foreseeable future. The country's food production (fluctuate and in some years) stays below the level necessary to meet basic food needs, while its population continues to increase at a rate of 1.8 percent a year (M. Noajesh Ali, 2011).

4.3 Literature Review

Abul Hashem (2005) focused on the development of irrigation in Bangladesh has passed through a series of phases from its traditional manually lifted devices to the modern mechanized minor irrigation, and major canal irrigation. It aims to explore and document the historical perspective of the development of irrigation; to examine the consequences of different policies adopted on irrigation development; and to analyze the progress of irrigation coverage of the country. It documented the historical development of irrigation, the policies so far adopted and their impacts, and irrigation coverage of the country from ancient period, elaborating the development of modern irrigation.

Md. Mokim (2017) discussed that irrigation is the artificial water supply for dry agricultural land by means of dams, barrage, channels, or other devices. It focused on the history of irrigation, common irrigation devices used, and some familiar irrigation system of Bangladesh. It covered the irrigation methods of Bangladesh including the surface irrigation, sub-surface irrigation, sprinkler irrigation and drip irrigation and their types. It shows the patterns of modern irrigation techniques, important factors (soil, climate, water sources, labor, capital) affecting for irrigation and its importance for agricultural development. The positive impacts and negative impacts of irrigations selection of irrigation methods for specific areas are also discussed.

Asian Development Bank (2010) aims contribute to the increase in the food security and agricultural income of rural poor and disadvantaged groups in Nepal. It will contribute to Nepal's goal of increasing agriculture GDP per capita and the area under irrigation. It focused on the Small Irrigation Infrastructure development including rehabilitation of farmer managed gravity schemes, Pond/tank systems in the hills and mountains, Pumped irrigation Schemes, Shallow tube wells etc. It also targeted to ensure Sustainable Agricultural Livelihoods through Strengthened by Improved access to inputs, production skills and marketing; on farm Water management and micro irrigation; micro credit; and supplementary support for disadvantaged groups. The project also provides project

management and implementation support by capacity building of the executing agency, district staff, local body councils, village based support services, investment and financing plans.

The World Bank (2018) aims to improve irrigated agriculture productivity and management of selected irrigation schemes and enhance institutional capacity for integrated water resources management. It targeted to the irrigation management transfer in four agency-managed irrigation systems (AMIS) and essential structural improvements. It will ensure better resilience against water-induced hazards, such as droughts, floods, and changes in water availability during the agricultural seasons through Scheme modernization, improved performance of irrigation systems, Gains in crop production increases and crop diversification, Improved irrigated agriculture productivity etc. It provides Agricultural Production Support, Strengthening WUAs, Strengthening institutional capacity for improved water resources management for Sustainable and inclusive economic growth and increased rural incomes.

UN FAO (2018) illustrate that Irrigation has been much appreciated for its significant contribution to global agricultural production and food security. It identified the key elements and typologies of irrigation schemes, trends in the irrigation sector, status and further needs, and challenges faced by irrigation systems like water scarcity and competition, economy and agriculture transformation, environmental degradation etc. It describes the processing of the investment projects including the project identification, project preparation, appraisal and negotiation, project implementation, and monitoring and evaluation (M&E) with purpose, concepts and definitions. The innovative approaches and tools including water governance, Irrigation modernization planning and design, Agricultural water management (AWM) investment planning, Adoption of CFS-RAI in irrigation projects are also highlighted.

Virtually all of the country's cultivable land is already in use and each year, the farm sizes grow smaller and the number of landless laborers grows larger. The country has fertile soils in the combined flood plains of the Ganges, Brahmaputra and Meghna rivers. There is more than enough water if properly managed to triple the amount of currently irrigated land and substantially increase food production. Additionally, some innovative attempts like improved management techniques, operation and cost-effective maintenance of the existing irrigation projects may also substantially increase food production. The Government has given highest priority to the development of the agricultural sector and through a series of Five Year Plans that aim to increase food grain production. Under the plan, the Government has given highest priority to the maximum utilization of the existing facilities and improvement of productivity in areas already covered by irrigation facilities. Command area development, efficient water distribution, crop-water management practices, and participation of local people as beneficiaries of drainage and irrigation program are being encouraged (M. Noajesh Ali, 2011).

4.4. Modern Methods of Irrigation

These are more efficient systems of irrigation that were invented in the recent decades. These help us use water economically without wastage. Let us take a look at the two most important methods.



Advantages of modern irrigation system

- More focus on the selling output
- Machine intensive
- More sophisticated
- Rains are no longer the controlling force
- Irrigation has traditional resulted in excessive labor and non-uniformity in water application across the field
- Water and electricity should be optimally used in an agricultural field

- Modern irrigation system is required to reduce the labor cost and to give uniformity in water application across the field
- It is more efficient because crop get correct amount of water

Modern irrigation methods: The modern irrigation methods includes with the

- Drip Irrigation Method
- Sprinkler Irrigation Method
- Pot Irrigation Method

Modern Irrigation System	Photography
<p>1. Drip System of Irrigation: The most commonly used method of irrigation these days is the drip method. They lay the pipes in rows near the crops or plants. These plastic pipes have holes in them. Water seeps from these holes drop by drop, hence the name drip irrigation. This is an extremely efficient method of irrigation as it reduces water wastage.</p> <p>Advantages: A small amount of water is applied at frequent intervals in the form of water droplets. Drips through perforations in plastic pipes or through nozzles attached to tubes spread over the soil. It is used to irrigate a limited areas around the plant</p> <ul style="list-style-type: none"> • Here water is directly reach to the plant which take water to the plants in balanced quantities • It saves 30 % to 70% of water • Crop production is higher by 20% to 40% 	
<p>2. Sprinkler System: This system mimics the phenomenon of rain. Water is carried by pipes to central locations on the farm. Sprinklers placed here distribute the water across the fields. This is the most efficient method to irrigate the uneven land. Advantages:</p> <p>Sprinkler system also provides the best coverage regardless of the size of the farm. Water is distributed through a system of pipes usefully by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water droplets which fall into the ground</p> <p>There is increase in production and compactness. It is helpful in soil conservation. This system saves the crops from extreme temperature</p>	

3. **Pot Irrigation Method:** The buried clay pot or pitcher method is one of the most efficient traditional systems of irrigation known and is well suited for small farmers in many areas of the world. Buried clay pot irrigation uses buried, unglazed, porous clay pots filled with water to provide controlled irrigation to plants.

Advantages

- This is an adaptation of ancient methods of irrigation
- It uses the porous nature of clay pot to allow osmotic pressure to suck the water into the soil where it is needed
- It is best method for horticulture and vegetables
- In this method only the area near pot get irrigated not the whole area
- Its needs minimum technical knowledge



Problems in irrigation sectors: There are various problems in irrigation are given below-

- Lack of training, education and capacity building
- Lack of use modern technology and equipment
- The problems relating to the creation of new irrigation capacity in India have been large and varied in number
- Some of these can be spelled out as follows
- Delay in the Completion of Major Irrigation Projects
- Rising Costs
- Lack of relevant project/ programs or initiatives from Government and NGOs
- Inadequacy of Finance and Organization
- Underutilization of Potential
- Problem of Drainage
- Lack of Coordination between Irrigation and Agricultural Development
- Lack of public and private investment for expanding the irrigation system
- Poor efficiency in managing the irrigation system;
- Slow exploitation of irrigation potential from major and medium sources;
- Lack of rural electrification in the eastern region and high-cost diesel pump sets;
- Lack of conjunctive use of surface and ground water;
- Lack of subsidy in irrigation sector
- Poor irrigation knowledge of farmers
- Lack of field visit and inspection and monitoring of responsible department
- Farmers stakes in irrigation work be raised by conferring on them some degree of Co-ownership the irrigation system;
- Lack of comprehensive watershed management plan formulation and effectively implementation.

Source: Field study 2019 and revised from www.economicdiscussion.net

4.5 **IMED and Irrigation Management**

However, Bangladesh has been progressing rapidly by the supports of his own or donor supported projects yet under the prescription of mostly donors. Recently the project planners, implementers and managers including the apex planners/supervising body (Ministry of Planning) gained a lot of experiences under real field context. Poverty reduction focused projects mainly lies under rural agricultural water management and irrigation aspects. However, a few lacking or gaps of proper/appropriate M&E mechanisms and guidelines, the beneficiaries are some behind of getting optimum outputs of the projects. Under such circumstances the present steps taken by IMED at this stage is praiseworthy. At the inception of M&E, the overview of project documents and identify the nature, importance, leading indicators, the limits of project management and challenges facing including recent M&E practice of projects as well as what method would like to be followed is essential. However, the irrigation component of this task reviewed several projects of BMDA, BADC and DAE taken during financial year of 2012 to 2018 and prepared the following guideline notes or template or most considerable points for M&E that may be followed by IMED officials in case of systematic approach of M&E of particularly irrigation (a few different from others) or even in water management projects:

1. Developing a result based framework for M&E of Irrigation projects
 - Building results based framework including due commencement & completion date and baseline data to describe the problem or situation before the intervention
 - Specifying data collection, reporting and dissemination requirements
 - More focus on perceptions of change among stakeholders and mentioning Indicators for outcomes.
2. Logical Framework Analysis Critically
 - Review the logical framework matrix critically because, it is the most important part of tracking activities of development projects
 - Identifying the Strengths and weaknesses of logical framework approach
 - Finding the Stages in logical framework analysis that would like to locate the weakness.
3. Identifying and specifying indicators
 - Finding the leading indicators
 - Identifying and specifying impact and outcome indicators
 - Identifying and specifying cross-cutting indicators
 - Identifying and specifying exogenous or external indicators
 - Identifying and specifying input process, and output indicators
 - Citing the example of indicators for understanding & impressing Irrigation projects personnel's.
4. Linking project and M&E design for Irrigation projects
 - Illustrating the causal chains (project logic) of Flowchart diagrams for key interventions
5. Organizational alternatives for M&E of Irrigation projects
 - Conducting a 'readiness assessment' prior to design and implementation of a project
 - M&E system followed and Organizational arrangement for project M&E
 - Strengthening Sectoral level monitoring and evaluation
 - Whether Implementing Project M&E in time and how many times
 - Building capacity and sustainable M&E systems
 - Incentives and a management perspective

6. Data collection, processing, and analysis for M&E of Irrigation projects
 - Assessing data sources and stages
 - Core data collection methods for irrigation projects
 - Data analysis
 - Reporting and using M&E findings
 - Further Planning requirements or not
7. Design and implementation of baseline surveys for Irrigation projects
 - Building baseline information including procurement issues and requirements
 - Identifying baseline information that further should be collected
 - Matching between Baselines and targets (quantitative or qualitative)
8. Introducing Remote sensing and GIS applications in M&E of Irrigation projects
 - Citing Examples of application
 - Remarks (if any)
9. Strengthening E-Tendering and Procurement in M&E of Irrigation projects
 - Citing Examples of application
 - Procurement discipline maintained or not as to PPR and PPA
 - Remarks (if any)
10. Digitalizing the documents at least in Apex Body on priority basis
 - Finding the resource conservation mechanisms by digitalization of M&E
 - Citing examples of project duplications (find by digital program)
 - Remarks (if any)
11. Introducing a Good Governness Cell at Planning Commission
 - Activating by previous experienced ex-officio
 - Citing examples of other countries
 - It is a challenging and burning issue at the present context of Bangladesh
 - Remarks
12. Impact evaluation of Irrigation projects
 - Monitoring and evaluation: distinctness is yet complementary
 - Following the forms of evaluation in latest developed or donor projects
 - Overarching themes in impact evaluation
 - Citing Key concepts and techniques for impact evaluation
 - Key steps in designing and implementing impact evaluations for Irrigation projects
13. Irrigation projects and M&E of poverty reduction
 - The contribution of irrigation to poverty reduction and empowerment
 - Implementing the poverty reduction mandate of the ADP or donor
 - Taking poverty into account in Bank Irrigation projects
 - Defining poverty-related indicators in Irrigation projects
 - Monitoring and evaluating Irrigation project outcomes contributing to poverty reduction
 - Methods for M&E of poverty reduction and sources of data
 - Impact evaluation
14. Participatory monitoring and evaluation for Irrigation projects
 - Clarifying participatory approach of M&E involving local institutions

- Mentioning the time and process to use Participatory M&E in projects?
15. Actors in M&E of Irrigation projects
 - M&E actors in the ADP or donor project cycle
 16. ADP or donor procedures for project M&E
 - M&E and the ADP or donor project cycle
 - Main stages in the project cycle
 - Core procedures and requirements
 17. M&E for infrastructure rehabilitation and modernization components in Irrigation projects
 - Key activities in rehabilitation and modernization of I & D systems
 - Key performance indicators, data needs and analysis
 - Concluding remarks
 18. M&E for management, operation, and maintenance components
 - Key activities for improving management, operation, and maintenance
 - Key performance indicators, data needs, and analysis
 - Concluding remarks
 19. M&E for Water Users Association formation and support
 - Key activities for Water User Association formation and support
 - Key performance indicators, data needs, and analysis
 20. Institutional development in Irrigation projects
 - Typical institutional development components
 - Monitoring and Evaluation of institutional development components
 - Participatory Monitoring and Evaluation capacity building of the institution
 - Remarks
 21. Training of beneficiaries and Project personnel's
 - Sufficient Capacity building of both water users/beneficiaries and actors
 - It would like to project sustainability and maximize project benefits
 22. Benchmarking in Irrigation Projects
 - Finding the difference between project M&E result and benchmarking
 - Benchmarking stages
 - Examples of benchmarking in Irrigation Projects
 - Summary

N.B In accordance and searching the Toolkit for Monitoring and Evaluation of IMED and others as well as of Agricultural Water Management Projects of World Bank, including the field project documents of BMDA, BADC and DAE during the year of 2012-2018 of Bangladesh.

4.6 Irrigation Canal/pond/Dhigi re-excavation

Water application is getting water into the soil for optimal plant growth. There are many methods of water application have been devised thousands of years. Irrigation water may be application to crops by flooding in on the field surface, by applying the beneath the soil surface, by spraying it under pressure from above or by applying it in drops. The methods are broadly classified into four major groups.

- Surface irrigation
- Sub-surface irrigation
- Sprinkler irrigation and
- Trickle irrigation.

4.6.1 Need of Khal Re-excavation

The main purpose of khal re-excavation is to improve the drainage, particularly of beel areas. Isolated high intensity rainstorms in the pre-monsoon period causes water logging and damage Aus and Aman crops. Delay in evacuation of water in the post monsoon period due to drainage congestion impedes multiple cropping in these areas. Excavation of new canals will improve the drainage condition of these areas thereby reducing the risk of crop damage and increasing the land available for dry season cultivation.

Section of Irrigation canal/khal

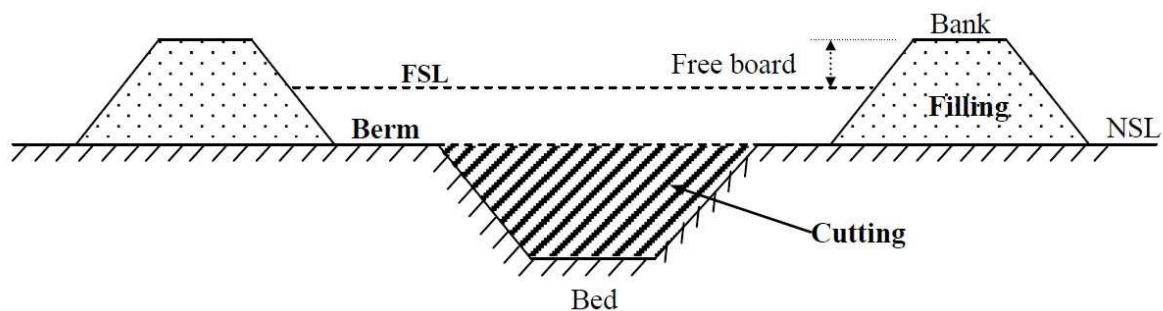


Figure 18: Typical Cross-section of an Irrigation Canal

Here, FSL is Full Supply Level and NFL is Natural surface level.

This section is partly in cutting and partly in filling and aims in balancing the quantity of earth work in excavation with that in filling.

Components of Cross- Section

- Side slope
- Berm
- Freeboard
- Bank
- Service road
- Back Berm or Counter Berm
- Spoil Bank
- Borrow Pit.




Figure 19: Khal re-excavation



4.6.2 Khal Re-excavation Steps

4.6.2.1 Khal Construction Equipment

Before starting the khal re-excavation activities it is desirable to get acquainted with the equipment that are usually used in earth excavation:

Table 37: Equipment generally used for Khal Construction

SN	Name of equipment	Images of the equipment
1.	<p>Excavator:</p> <p>Excavators are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform known as the "house". The house sits atop an undercarriage with tracks or wheels. A cable-operated excavator uses winches and steel ropes to accomplish the movements. They are a natural progression from the steam shovels and often called power shovels. Excavators are also called Diggers.</p> <p>It is used for various purposes, like:</p> <ul style="list-style-type: none"> • Digging of trenches, holes, foundations • Khal re-excavation work • Material handling • Demolition • General grading/landscaping • River dredging • Driving piles, in conjunction with a pile driver etc. 	

SN	Name of equipment	Images of the equipment
2.	<p><u>Pay loader:</u></p> <p>A loader (bucket loader, front loader, front-end loader, pay loader, scoop, shovel, skip loader, or wheel loader) is a heavy equipment machine used in construction and sidewalk maintenance to move aside or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, woodchips, etc. into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railroad car).</p>	
3.	<p><u>Dump Truck/Pickup:</u></p> <p>A Dump Truck (or, UK, dumper/tipper truck) is a truck used for transporting loose material (such as sand, gravel, or dirt) for construction. A typical dump truck is equipped with an open-box bed, which is hinged at the rear and equipped with hydraulic pistons to lift the front, allowing the material in the bed to be deposited ("dumped") on the ground behind the truck at the site of delivery. In the UK and Australia, the term applies to off-road construction plant only, and the road vehicle is known as a tipper, tipper lorry (UK) or tip truck (AU).</p>	
4	<p><u>Level machine:</u></p> <p>A level is an optical instrument used to establish or verify points in the same horizontal plane in a process known as leveling, and is used in conjunction with a leveling staff to establish the relative heights levels of objects or marks. It is widely used in surveying and construction to measure height differences and to transfer, measure, and set heights of known objects or marks. During re-excavation of khal, this instrument is used to maintain the cutting level.</p>	

4.6.3 Steps of Khal-Excavation

At first the required tools will have to be procured for re-excavation of the irrigation khal/channels. A schematic diagram showing centerline and layout plan will be made for the re-excavation and the design depth and width of excavation are to be noted.

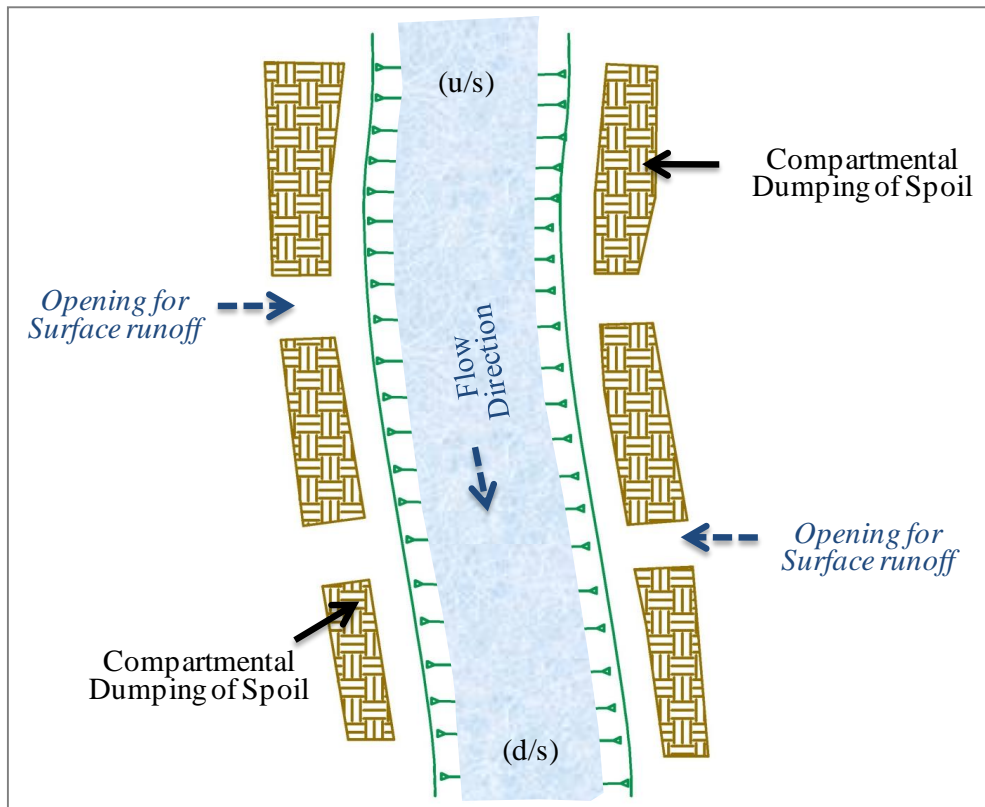


Figure 20: Plan form of a typical khal to be re-excavated

The construction methods are as follows:

- ◇ The entire channel will be divided into a number of reaches.
- ◇ The excavation will be started from the upstream of the channel.
- ◇ Cross dams will be provided at both ends of the final locations of the reach, and then soil from the channels will be removed up to required depth and width.
- ◇ During alignment, some control points at 100 to 200m distance are selected and marked. First excavations in these control sections will be done to the final grade.
- ◇ Then excavation between two control sections will be done by sighting through boring rods.
- ◇ The central portion of the canal/khal section is evacuated first and the side slopes are dressed or excavated subsequently.
- ◇ The side slope will be shape by using the slope template and string.
- ◇ After completion of excavation, the bed, slopes, and the banks should be compacted in specific manner.
- ◇ The excavated soil/sludge will be disposed into a suitable place, specified by the Engineer in charge, from where the sludge or soil will not affect the channel flow by any means.

After finalizing excavation of one reach, the other at its downstream would be excavated following some the above procedure mentioned above.



Modern construction practices have the following work phases:


- Pre-construction phases
- Contraction Phases

Pre-construction phase in actually a construction planning phase- Activities included in these phases are:

- ✓ Study of working drawing and specification
- ✓ Study of site conditions
- ✓ Study of available resources

Table 38: Pre-construction activities of Khal Re-excavation



SN	Pre-construction Activities	Images
1.	<p><u>Review working drawing and Specification</u></p> <p>This is a very important part of construction work. IMED officials should have clear understanding of the work and the contractual obligations of the parties involved.</p> <p>The key point of the study will be:</p> <ul style="list-style-type: none"> ✓ Purpose of the khal/canal ✓ Design consideration/specification of khal excavation. For example, if it is designed for irrigation purpose then what is the command area, crop water requirement, irrigation method, water availability, water demand, social acceptance, etc., will consider. ✓ Detail drawing of khal i.e. design cross section, long section, width and cutting depth, cutting volume, etc. ✓ What are the contractual obligations? <p>IMED officials will be observed above mentioned work before planning the construction activities/ any study report like feasibility. Mistakes and omission, if any, in the construction drawings and documents should be identified and rectified before construction.</p>	
2.	<p><u>Consideration of site condition</u></p> <p>IMED officials will be observed carefully following information regarding site:</p> <ul style="list-style-type: none"> ✓ Accessibility of the sites ✓ Topography of the sites (<i>see the existing long section and cross section</i>) ✓ Space available for storage of material construction equipment and laborers shed ✓ Sources of water, power and materials ✓ Safety and security measures <p>Above information are useful for construction scheduling and during execution of the work</p>	




SN	Pre-construction Activities	Images
3.	<p><u>Availability of resources</u></p> <p>A thorough study availability of resources like labor, equipment and other construction materials is very helpful for construction scheduling.</p>	

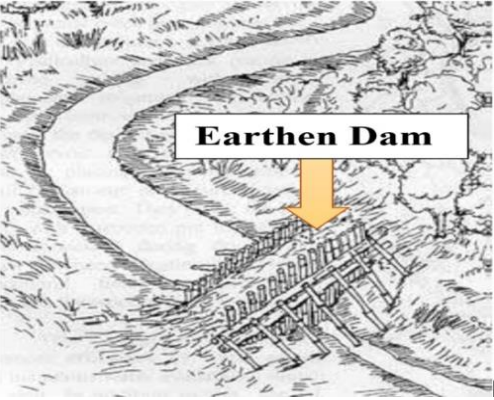


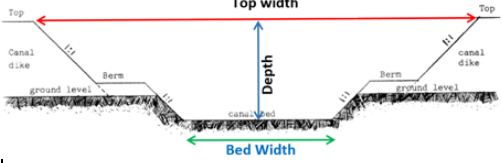

Re-excavation of khal/pond/dhigi might be divided following activities:

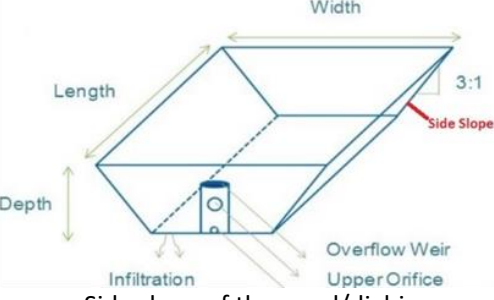

- Selection of contractor;
- Resources scheduling;
- Site layout plan and establishment of B.M
- Site preparation;
- Construction storage and labour shed;
- Construction of cross dam;
- Excavation of khal;
- Side slope shaping;
- Turfing side slope.

Table 39: Construction Activities of Khal re-excavation

SN	Construction Activities	Images
1.	<p><u>Selection of contractor</u></p> <p>The evaluation and selection of contractor leading to the award of construction contract is the vital part of the construction. Tender shall be invited for selection of contractor through competitive bidding process.</p> <p>IMED officials will evaluate the tender and contractor selection process for the implementation of the projects activity</p>	
2.	<p><u>Resources Scheduling</u></p> <p>Resources scheduling means programming for allocation of different types of resources that will be needed for construction of the project. For efficient and timely completion of the project, rate of resources supply should be commensurate to the construction schedule. Resources scheduling includes the following activities:</p> <ul style="list-style-type: none"> ✓ Material Scheduling ✓ Labour Scheduling ✓ Equipment Scheduling & ✓ Financial scheduling <p>IMED officials will observe physical and financial progress as well as present completion of work progress with the date of completion of the</p>	

SN	Construction Activities	Images
	<p>project (he will judge PMIS report with practically site work done)</p>	
<p>3.</p>	<p><u>Site layout plan and establishment of B.M</u></p> <ul style="list-style-type: none"> ✓ After the layout plan of khal/pond/dhigi has been finalized, the outline of the proposed intervention and other service areas should be laid out at the site. ✓ The layout of khal/pond/dhigi is usually done with rope and page or pillars and the outlines are marked with lime or another convenient marker. ✓ One of the most important activities in layout program is to fix the Bench Mark (B.M) at the work site. ✓ It should be fixed by fly leveling at least from two permanent bench marks in nearby areas. Then all the levels in the site will be fixed with respect to the Bench Mark establish in the site. <p>IMED officials will measure the cutting depth of the khal according to the temporary bench mark.</p>	 <p style="text-align: center;">Survey of Bangladesh Bench mark</p>
<p>4.</p>	<p><u>Site Preparation</u></p> <ul style="list-style-type: none"> ✓ The first work in a construction job is site preparation. Before starting of any construction activities, the site must be cleaned of all trees, bushes, rubbishes and other undesirable materials. ✓ For complex and comparatively large project site preparation usually done mechanically be tractor mounted blades, tractor mounted rakes and bulldozers. For smaller works, site clearance mostly done manually. <p>IMED officials will observe the site cleaning and preparation work.</p>	 <p style="text-align: center;">Site preparation (manual work)</p>
<p>5.</p>	<p><u>Construction storage and labour shed</u></p> <ul style="list-style-type: none"> ✓ The sheds and stores are usually temporary in nature. Shed are constructed to accommodation the labours and supervisory staff. ✓ The labour shed should be provided with adequate sanitary arrangements and other facilities that will ensure hygienic environment. ✓ Stores are constructed for temporary storage of construction materials and equipment. Size of stores should preferably be such that at least month storage can be ensured. <p>IMED officials will observe the location and storing condition of warehouse. They should also observe with high priority of labour shed, location and number of labour shed and its environmental, sanitation and health issue.</p>	 <p style="text-align: center;">Labour shed</p>

SN	Construction Activities	Images
6.	<p>Construction of cross dam</p> <ul style="list-style-type: none"> ✓ Cross dams will be provided at both ends of the final locations of the reach, and then soil from the channels will be removed up to required depth and width. <p>IMED officials will observe the cross-dam location and make sure it will be removed after construction.</p>	 <p style="text-align: center;">Earthen Dam</p>
7.	<p>Excavation of khal</p> <ul style="list-style-type: none"> ✓ The entire channel will be divided into a number of reaches. ✓ The excavation will be started from the upstream of the channel. ✓ During alignment, some control points at 100 to 200m distance are selected and marked. First excavations in these control sections will be done to the final grade. ✓ Then excavation between two control sections will be done by sighting through boring rods. ✓ After completion of excavation, the bed, slopes, and the banks should be compacted in specific manner. ✓ The excavated soil/sludge will be disposed into a suitable place, specified by the Engineer in charge, from where the sludge or soil will not affect the channel flow by any means. <p>IMED officials will observe the excavation process (mechanical/manual).</p> <p>Measure the Bed width, Top width and cutting depth of the khal/pond according to the design with measuring tape.</p>	 <p style="text-align: center;">Khal re-excavation by excavator</p>  <p style="text-align: center;">Khal re-excavation (Manual lifting)</p>  <p style="text-align: center;">Component of khals</p>
8.	<p>Side Slope shaping</p> <ul style="list-style-type: none"> ✓ After re-excavation of the khal/pond/dhigi up to the design level, the side slope should be dressed and shaped to its final grade with the help of a side slope template and string. ✓ The design slope should be compacted and dressed in stages to reach the final slopes. <p>IMED officials will observe the side slope of the khal/pond/digi as per design.</p>	 <p style="text-align: center;">Side slope of khal</p>

SN	Construction Activities	Images
		 <p>Side slope of the pond/dighi</p>
9.	<p><u>Turfing side slope</u></p> <p><i>Turfing means planted of grass on the side slope of khal/canal/pond to prevent erosion of side slopes by action wind and rain cut.</i></p> <ul style="list-style-type: none"> ✓ The grass that have too many leaves and grow high are not recommended as they hold lot of moisture and the slope wet for long time; ✓ Grasses that have slender leaves and grow slowly (e.g. Durba) are suitable as they don't hold much moisture and protect the soil efficiently; ✓ Turfing can be done by sodding or seeding. <p>IMED officials will observe the turfing work and species of grass according to detail design and BOQ.</p>	 <p>Turfing on the side slope</p>

4.7 Rubber Dam

Rubber dams are long tubular-shaped fabrics placed across channels, streams and medium sized rivers to raise the upstream water level when inflated and thus play a vital role in enhancement of irrigation capacity.

- ✓ It is a kind of a large bag which is inflated or deflated by injecting and discharging air or water;
- ✓ It is constructed across the river to retain water;
- ✓ Rubber bags are used for blocking to prevent water flow;
- ✓ It is practically used to prevent upward and downward flow of water.



Figure 21: Use of Rubber Dam

Rubber dam has various uses. The main purpose of its use in our country is to provide irrigation facilities of boro crops (one kind of paddy) during dry season (Nov-April) through retention of sweet water in the upland river system and prevention of ingress of saline water from downstream. Besides these, the broad use of rubber dam is as follows:

- ✓ The dam is used as flood control structure
- ✓ Water retention for irrigation
- ✓ Water retention for aquifer recharge
- ✓ Water retention for fish production
- ✓ Reducing or preventing salt water intrusion into fresh water areas
- ✓ Protect low-lying coastal areas from tidal flooding
- ✓ Sewage retention/separation during flood events

4.7.1 Advantages of Rubber Dam

The rubber dam has several advantages over its use as mentioned below.

- ✓ It replaces heavy gates, hoisting gears and piers of conventional structures by light rubber-nylon shell body. It saves huge amount of steel, cement, timber and other construction materials. Thus, it has been proved to be a cost-effective technology.
- ✓ The dam body can be fully deflated to lower it to flat level on base floor so that flood flow passes without any obstruction.
- ✓ Rubber dams can have spans as long as 100 meters without dividing piers.
- ✓ Load of dam body is evenly distributed on foundation.
- ✓ Construction and installation are quicker compared to conventional gated regulating structures.
- ✓ Total investment cost is approximately 30% lower than that of conventional gated regulating structures.
- ✓ No gates and hoisting gears required. So, it makes operation of the structure simple.

4.7.2 Main Component

Rubber dam is mainly divided into four parts: Main component of Rubber Dam are as follows

- ✓ Dam body or dam bag
- ✓ Anchorage system
- ✓ Control system (including water or air filling and emptying system, monitoring system and safety control system)
- ✓ Foundation (including base floor, abutment and side walls etc.).

Other component of rubber dam is

- Upstream and downstream massive concrete floor(Apron)
- Massive concrete base (Dam Base)
- Slope wall
- Inverted filter at river bed
- Filter material
- Bank protection Work

3D view and schematic diagram of a rubber dam is shown in Figure below

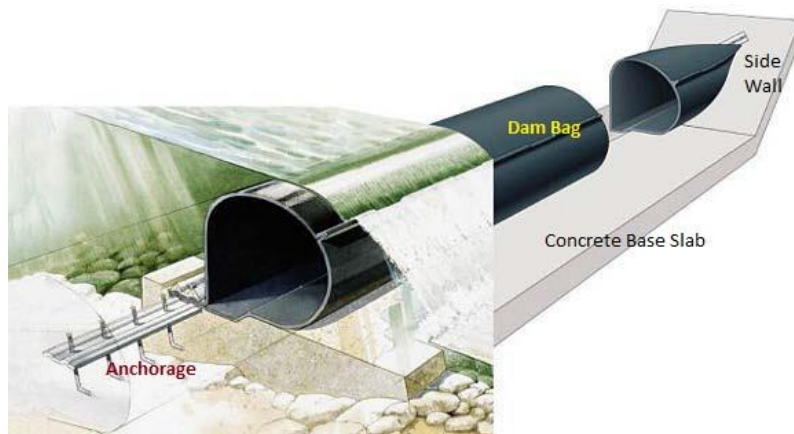



Figure 22: 3D view of Rubber Dam

4.7.3 Rubber Dam Construction Steps

4.7.3.1 Steps of Buried Pipe Construction

Table 40: Steps of buried pipe construction

SN	Pre-construction Activities	Images
1.	<p>Review working drawing and Specification</p> <p>Hard copies of As-Built drawings with detailed indexes and referencing must be provided. All drawings developed during the detailed design should be provided:</p> <ul style="list-style-type: none"> ✓ Index sheet with location plan, project title and list of drawings; ✓ Overall site plan; ✓ Detailed site plans with set out data ✓ Rubber dam design and diagrams ✓ Detailed civil and structural drawings; ✓ Single line diagrams should be produced for all electrical equipment; 	

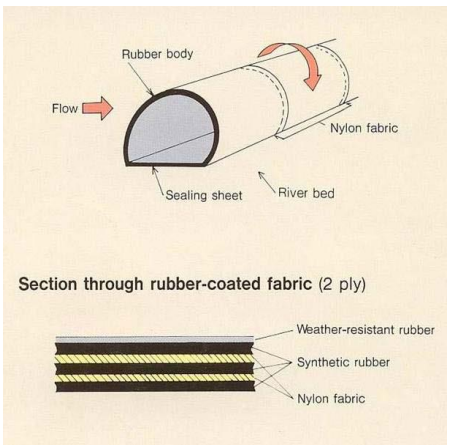
SN	Pre-construction Activities	Images
	<p>✓ Outline drawings showing equipment arrangement, overall dimensions, weights and foundation arrangements;</p> <p>IMED officials will observe above mentioned work before planning the construction activities.</p>	
2.	<p><u>Operation manual</u></p> <p>An Operation Manual should be provided for each piece of equipment. The manual should include:</p> <ul style="list-style-type: none"> ✓ A full description of the equipment with a tabulation of dimensions and performance ratings ✓ Principles of operation ✓ Basic working description and Design criteria ✓ Overview of how to monitor the equipment ✓ Safety management ✓ Environmental management ✓ Record keeping requirements ✓ Duty statements for operators ✓ Emergency response ✓ Cross references to the maintenance schedules 	

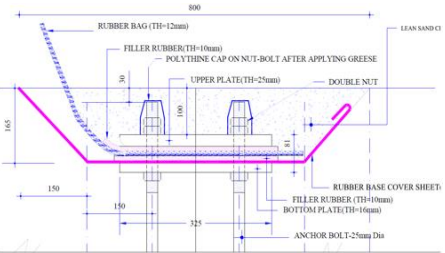
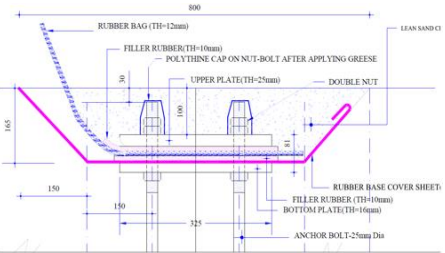
4.7.3.2 Construction Phase

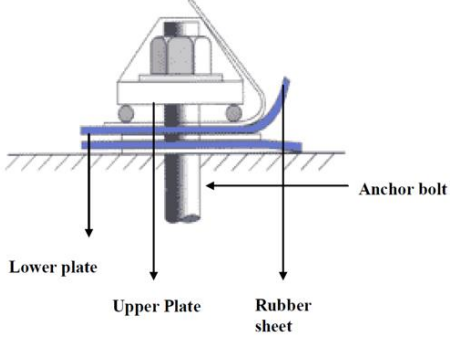
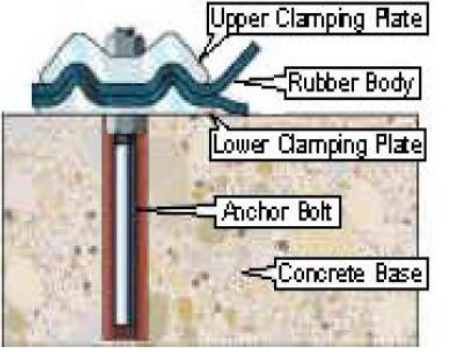
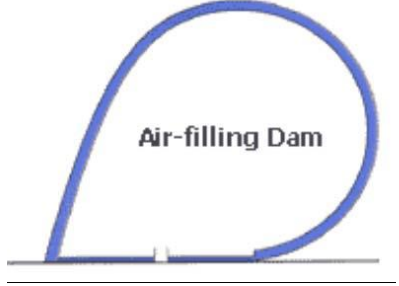

The construction of Rubber Dam system works including:



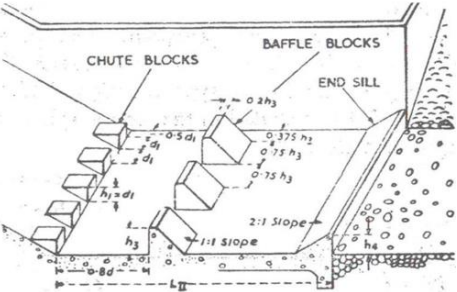

1. Dam Body
2. Fitting and Fixing of Rubber Dam
3. Filling and Emptying System
4. Foundation
5. Flexible Control
6. Oscillation Reduction
7. Side slope.

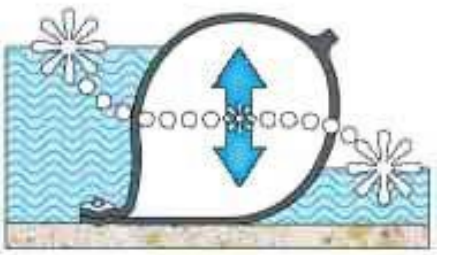
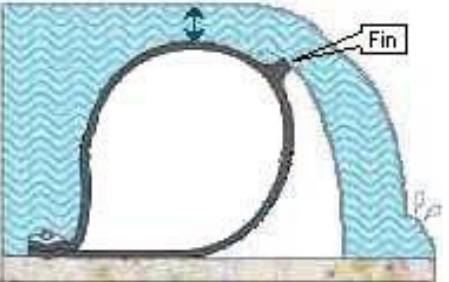

Table 41: Steps of the Construction of Rubber Dam System

SN	Activities	Images
1.	<p>Dam body is made of rubber reinforced by woven synthetic fabric that provides the tensile strength with rubber acting as the adhesive and water proofing elements.</p> <p><u>Consideration for Construction of a Rubber Dam Body:</u></p> <ul style="list-style-type: none"> ○ The material should be strong, resistant to tearing/puncturing and should not deteriorate with exposure to sunlight; ○ The thickness of the rubber dam body should not be less than 10.0mm and to be reinforced by not less than 2 layers of nylon canvas; ○ The body of the dam should be supplied in one unit to avoid the need for site welding of seams; 	

SN	Activities	Images
	<ul style="list-style-type: none"> ○ Rubber dam tube is made of high strength canvas and rubber layer that convey the assurance of airtight; ○ Rubber layer include outer layer, middle layer and inner layer; ○ Outer layer is the rubber with characteristic heat-resisting, wearing-resisting and ozone-resisting; ○ Middle layer has the function to defend the canvas and joint canvas layers; ○ Inner layer defends the canvas and keep watertight and airtight. <p>IMED officials will observe the above-mentioned specification of the rubber bag. Particular they should measure the length, width and thickness of rubber bag.</p> <p><u>Material of Rubber dam</u></p> <p>Main material use in Rubber dam is rubber bag which control the flow of water. Some characteristics of rubber bag are;</p> <ul style="list-style-type: none"> ○ It is made up of multi-layer fabric of synthetic fiber (usually nylon). The fabric is quite flexible and exhibits good wear-resistance characteristics; ○ The fabric-bag should be water resistant, water tolerant, corrosion resistant and durable in atmosphere; ○ The layers of rubber coated fabric are joined together in the longitudinal direction. The actual number of layers of rubber coated fabric for each rubber body depends on the height and the tension; ○ The rubber sheet may be of single layer, double layer and multi-layer as per its height and strength. <p>IMED officials will visually inspect the materials of rubber bag and rubber sheet layer.</p>	<p style="text-align: center;">Rubber Layers</p>  <p>The diagram illustrates the cross-section of a rubber dam structure. It shows a central rubber bag (12mm thick) supported by an upper plate (25mm thick) and a bottom plate (16mm thick). The structure is anchored to a concrete foundation using anchor bolts (25mm diameter) with double nuts. Other components include a polythene cap on the nut-bolt after applying grease, a rubber base cover sheet, and lean sand. Dimensions are provided for various parts: 800mm for the rubber bag width, 165mm for the dam height, 150mm for the base width, 180mm for the bottom plate width, 325mm for the anchor bolt spacing, and 100mm for the upper plate height. Labels include: RUBBER BAG (TH=12mm), FILLER RUBBER (TH=10mm), POLYTHENE CAP ON NUT-BOLT AFTER APPLYING GREASE, UPPER PLATE (TH=25mm), DOUBLE NUT, RUBBER BASE COVER SHEET, FILLER RUBBER (TH=10mm), BOTTOM PLATE (TH=16mm), and ANCHOR BOLT (25mm Dia).</p>
2.	<p><u>Fitting and Fixing of Rubber Dam</u></p> <p>Dams are secured to the concrete foundations using a single or dual core clamping plates. Plates are clamped to the membrane using anchor bolts. For fitting and fixing of rubber sheet on the bed, steel clamp elements and stainless-steel anchor bolts and nuts are used.</p> <p><u>Installation methods:</u></p> <ul style="list-style-type: none"> ○ At first, the anchoring slot is kept open for second stage concrete for positioning and fitting and fixing the anchor bolt with dowel bar of the slot. ○ Then lower anchoring plate is fixed with the help of anchor bolt and the anchor bolt is fixed with dowel bar with welding work. ○ The design level of lower plate is done with the help of machine and this level is adjusted with the help of bottom nut of anchor bolt. 	<p style="text-align: center;">Anchorage System of Rubber Dam</p>  <p>The diagram illustrates the anchorage system of a rubber dam. It shows a cross-section of the dam structure with various components labeled. The components include: RUBBER BAG (TH=12mm), FILLER RUBBER (TH=10mm), POLYTHENE CAP ON NUT-BOLT AFTER APPLYING GREASE, UPPER PLATE (TH=25mm), DOUBLE NUT, RUBBER BASE COVER SHEET, FILLER RUBBER (TH=10mm), BOTTOM PLATE (TH=16mm), and ANCHOR BOLT (25mm Dia). Dimensions are provided for various parts: 800mm for the rubber bag width, 165mm for the dam height, 150mm for the base width, 180mm for the bottom plate width, 325mm for the anchor bolt spacing, and 100mm for the upper plate height.</p>

SN	Activities	Images
	<ul style="list-style-type: none"> ○ Then second stage concrete is cast up to bottom level of lower plate. The thickness of lower and upper plate is designed with the height of rubber dam. ○ The works are done very carefully with maintaining proper alignment of the anchor bolt, because any deviation of anchor bolts will create problems in fitting of anchor plate <p><u>Consideration for Fitting and Fixing of Rubber Dam:</u></p> <ul style="list-style-type: none"> ○ The clamping materials and anchoring bolts shall be of either galvanized steel or stainless-steel material and shall have at least two ridges to form dual sealing line to prevent any leakages; ○ Dual anchoring line is required to cater for the situation when upstream water level is higher than downstream water level or visa-versa. ○ Safety factor of clamping bolts shall be more than 3 times against tensile strength of materials used under normal loading condition. <p>IMED officials will inspect the anchorage system particularly the clamping bolts, materials as per design specification and casting quality of the concrete.</p>	 <p>Anchorage System of Rubber Dam</p>  <p>Steel Clamps with Anchorage Bolts</p>
3.	<p><u>Filling and Emptying System</u></p> <p>The dam bag can be inflated either by filling with air or water. Air filling is quicker but it needs relatively sophisticated pumping and pipe-valve system. Water filling is relatively slow but ordinary centrifugal pump is used for water filling purpose.</p> <p>Water filling dam body is recommended because of when water passing over the dam body, air inflated dams have vibration problems.</p> <p><u>Commissioning method</u></p> <p>The fixation of level of Rubber dam is done through trial and error method.</p> <ul style="list-style-type: none"> ✓ At first, the design level is fixed from the design calculation. ✓ The water coming from the upstream side is directly entered through the pump house. ✓ According to the design level, water is filled in the bags by centrifugal pump and the level of height of bags is measured. 	 <p>Air filled Rubber Dam</p>  <p>Water filled Rubber Dam.</p>

SN	Activities	Images
	<ul style="list-style-type: none"> ✓ If desired height is not found, then the level of over flow pipe will be adjusted until getting the desired level of the dam body. ✓ After getting the desired height of the dam body, the over flow pipe will permanently be fixed. This work will be done at dry condition as well as in water retained position. <p><u>Caution during dam inflation</u></p> <ul style="list-style-type: none"> ✓ Generally, the dam bag is filled with water from the U/S of the dam; ✓ The filling water may carry finer soil particle (sand or silt) which create clogging the dam body; ✓ To avoid siltation, a wire mesh frame wrapped with geotextile filter is used on the mouth of the intake pipe; ✓ Filling system also usually includes safety measures against overfilling through overflow outlets and pressure manometers. 	 <p style="text-align: center;">Commissioning of Rubber Dam</p>
4.	<p><u>Foundation:</u></p> <p>Foundation includes base floor, apron, stilling basin and slope protection.</p> <p><u>Design consideration:</u></p> <ul style="list-style-type: none"> ✓ The width of the base floor should be considered for the requirement of the additional deformation in dam body. ✓ The stability analysis has been made taking into account all horizontal and vertical loads. <p><u>IMED officials will inspect the following component</u></p> <ul style="list-style-type: none"> ✓ Measure the base floor length, width and height as per design ✓ Check the number of chute block and baffle block as per drawings; ✓ Check the specification and quality of MS rod, cement, sand, gravels and other construction materials as per design consideration. 	 <p style="text-align: center;">Component of rubber dam</p>  <p style="text-align: center;">Stilling basin</p> 

SN	Activities	Images
5.	<p><u>Flexible Control:</u></p> <p>Inflation & deflation can be manual or automatically controlled. The automatic control system can monitor the upstream water level and adjust the air pressure in the dam to maintain a prescribed water level in the upstream pool.</p>	 <p style="text-align: center;">Flexible control</p>
6.	<p>The early experience using air filled dam were unsuccessful owing to oscillation caused during heavy flow because they did not have the ballast that water provided. Also, these dams suffered excessive premature wear owing to oscillation included abrasion.</p> <p>Oscillation Reduction</p> <p>When inflated, the FIN structure works as a deflector to create aeration below the fin. This effectively reduces the phenomenon of oscillation up to a 50% overflow when compared to FIN-LESS bladders.</p>	
7.	<p><u>IMED officials will inspect before commissioning Rubber Dam:</u></p> <ul style="list-style-type: none"> ✓ Inspection any serious damage in rubber dam; ✓ Check the nuts and bolts of the anchorage system whether it become loose or not ✓ Make sure that the inlet & outlet pipes are blocked or not; ✓ Assure the mechanical and electrical problem in the pump system; ✓ Damage & erosion in the preventive work should be checked; ✓ Check for foundation settlement 	

4.8 Buried Pipe Irrigation System

4.8.1 Components of Buried Pipe Irrigation System

Main component of buried pipe irrigation are as follows

1. Header Tank
2. Flow Control Structures
3. Standpipes (air vents)
4. Outlets (Risers)
5. Escapes (standpipe overflows)
6. Washouts.

4.8.1.1 Header Tank

The height of the tank is determined by the pipeline design and necessary head to supply irrigation water to all the outlet risers. A freeboard of 0.5-0.6 m is usual. There are three main compartments as shown on the figure below.

- **First component:** It receives water from the delivery pipes and facilitates settlement of sediment.
- **Second component:** Baffle walls calm the flow before it passes over gated (broad crested) weirs into the second compartment,
- **Third component:** This compartment contains 90° V-notch weirs which are used to measure the flow.

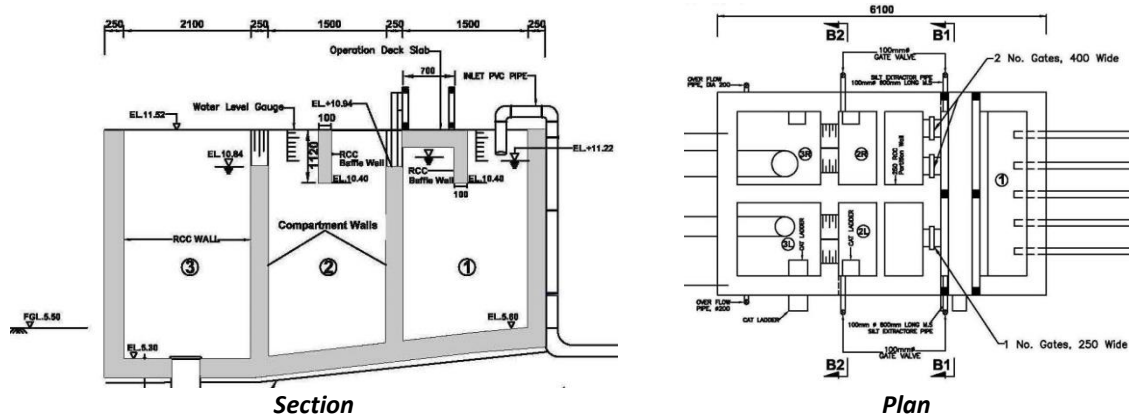


Figure 23: Header Tank

4.8.1.2 Flow Control/Masurement Structure

Flow control/measurement structures should be located at the head of each rotation/main pipe unit to facilitate equitable flow distribution, allow flow rotations during periods of relatively low irrigation demand, as well as closure of part of the pipe system for emergency repair/maintenance without closing the whole system. It is RC structure with gates/shutters and V-notch weirs. In some cases, for small uPVC pipes valves may be adopted instead of gates.

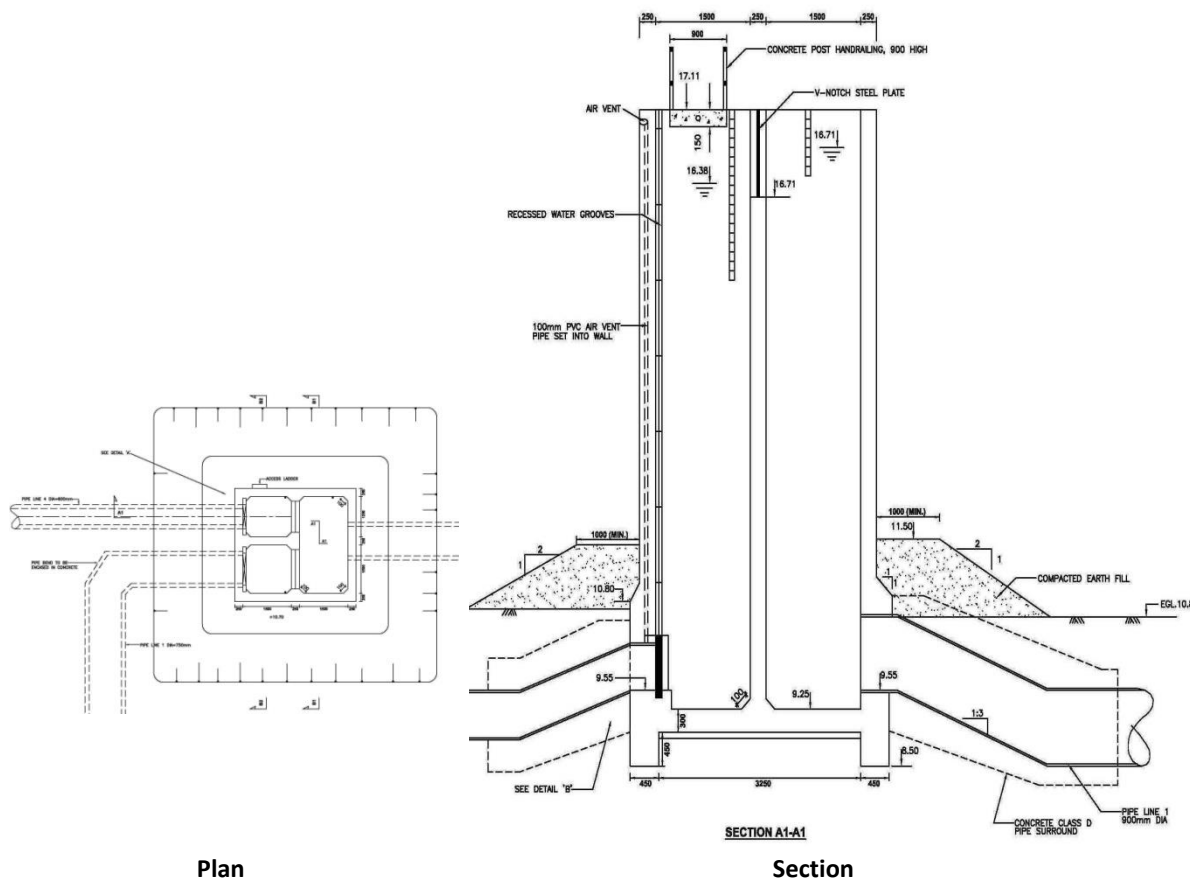


Figure 24: Flow Control/Masurement Structure

4.8.1.3 Outlet Risers

Outlets typically comprise a uPVC pipe leading to riser pipe fitted with an alfalfa valve. A masonry / concrete distribution box is located over the riser pipe. It is advised, particularly for uPVC pipes, that the outlet box is offset from the main pipeline to avoid damage to the pipeline and allow access to the pipeline in event of repairs being required. To prevent tampering of the alfalfa, valve a lockable screen should be provided.

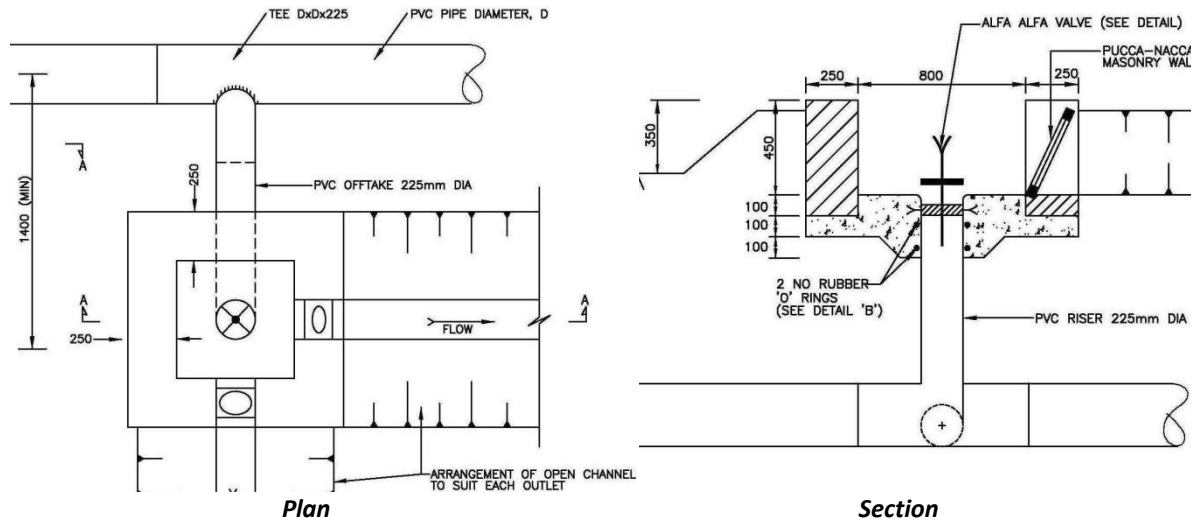


Figure 25: Outlet risers

4.8.1.4 Air vent and Escape Standpipes

Air-vent and escapes are similar structures comprising vertical (uPVC / concrete) standpipes leading from the top of the pipeline as shown on the figure below. The main differences between them are as follows:

- i. Air vents are located at high points and, on-average, just upstream of every 2nd outlet. They ensure pressures within pipeline remains within design limits and allow air to vent. The top of air vent standpipes is usually 0.6 m above the design hydraulic grade line (pressure head) at the standpipe location.
- ii. Escapes are located at a few key locations and allow excess flow to discharge safely into a drainage ditch. The top of escape standpipes is usually set just 0.3 m above the design hydraulic grade line.

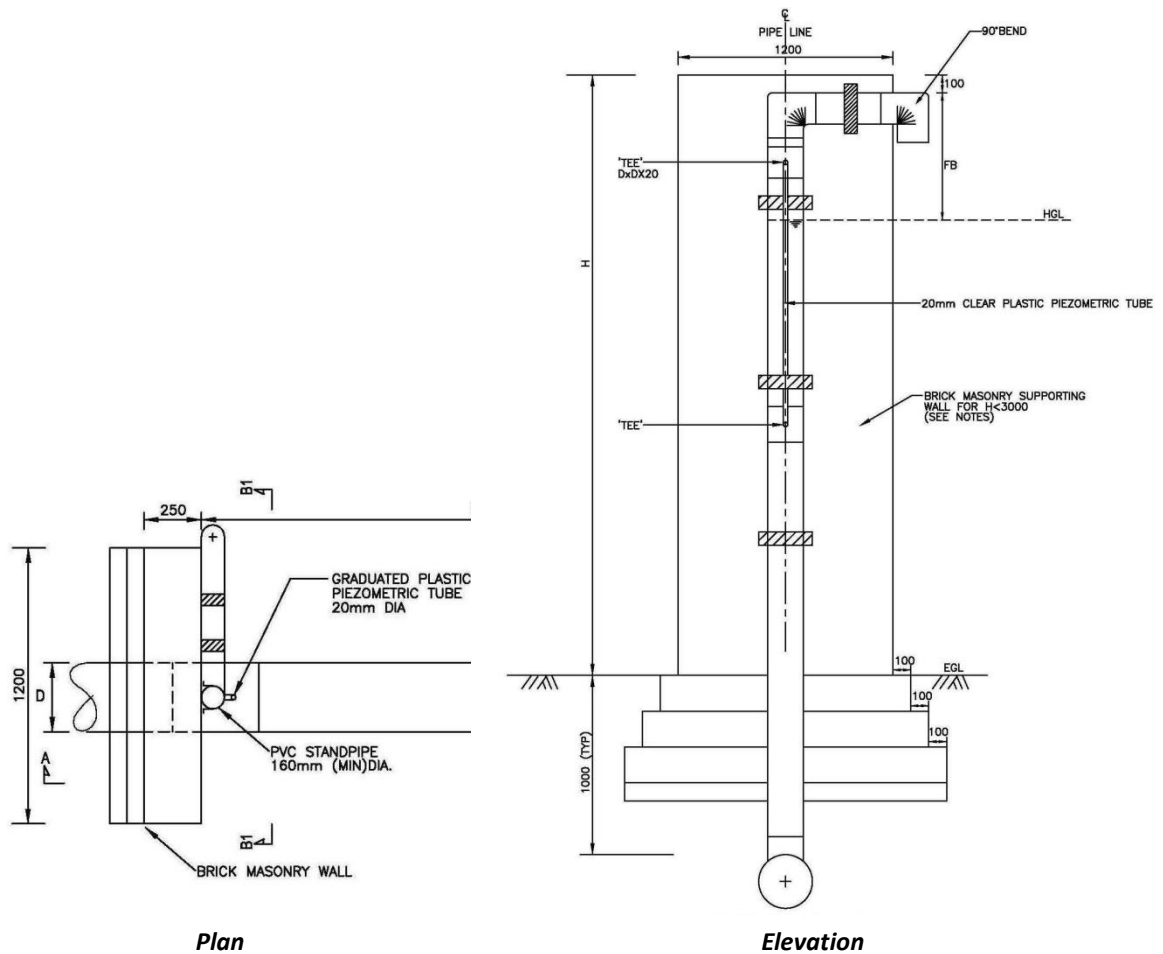


Figure 26: Air Vent and Escape Standpipes

4.8.1.5 Washouts

Washouts comprise a side pipe off-take from the parent pipeline fitted with a control (gate) valve and concrete/masonry protective box. They should be located at low point(s) along the pipelines to allow periodic flushing and emptying for repairs and removal of sediment.

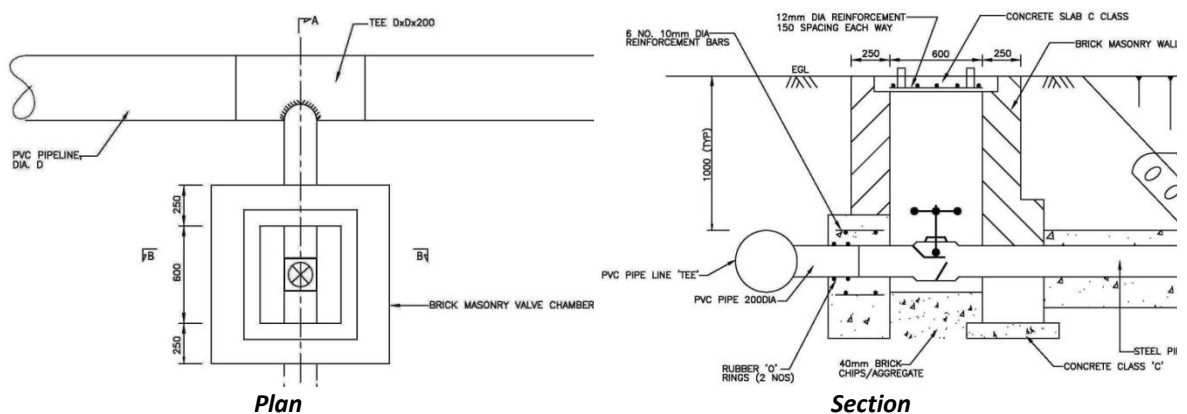


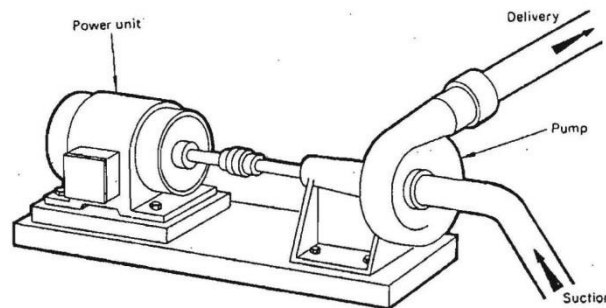
Figure 27: Washouts Pipelines Cross-section

4.8.1.6 Pumps

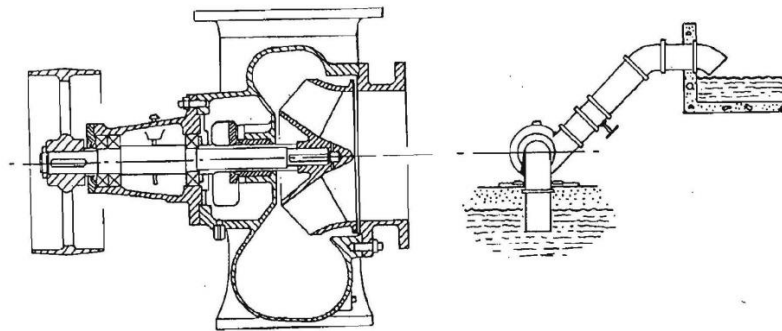
The source of water for the irrigation project is typically a perennial river/water bodies or ground water. The pump sets (comprising pump and motor) are used to supply water to the crop field. Pumps fall into the following categories: (i) axial flow pumps – low head and high discharge; (ii)

centrifugal pumps – high head and low discharge; and (iii) mixed flow pumps. They are all designed to run at a constant speed and their performance is described by the following characteristics:

- Pumping head and discharge;
- Power Requirement; and
- Efficiency of operation



Centrifugal Pump



Mixed Flow Pump

Figure 28: Central and Mixed Flow Pumps

4.8.1.7 Power Unit


Power sources are either an electric motor or an internal combustion engine. Major cases, electric motors are usually adopted using mains (national grid) electric power. Correct determination of the power requirement is important to ensure that a suitable electric connection and transformer is provided.

4.8.2 Buried Pipe Irrigation System Construction Steps

4.8.2.1 Pre-Construction Phase

Table 42: Pre-construction phase of buried pipe irrigation system

SN	Pre-construction Activities	Images
1.	<p><u>Review working drawing and Specification</u></p> <p>Hard copies of As-Built drawings with detailed indexes and referencing must be provided. All drawings developed during the detailed design should be provided:</p> <ul style="list-style-type: none"> ✓ Index sheet with location plan, project title and list of drawings; ✓ Overall site plan; ✓ Detailed site plans with set out data and pipelines; ✓ Piping and Instrumentation Diagrams 	<p>A photograph showing several pairs of hands pointing at and discussing technical drawings (blueprints) spread out on a table. One person is holding a yellow pencil, and another is using a pair of compasses.</p>



SN	Pre-construction Activities	Images
	<ul style="list-style-type: none"> ✓ Detailed civil and structural drawings also including pipe long sections; ✓ Single line diagrams should be produced for all electrical equipment; ✓ Outline drawings showing equipment arrangement, overall dimensions, weights and foundation arrangements; ✓ Schedule of components included in the equipment together with the name of the manufacturer; ✓ Internal layouts of individual electrical panels are required identifying each component; ✓ Comprehensive drawings to aid maintenance (as distinct from construction) should be supplied. These drawings should be supplemented to include instrumentation and mechanical information as appropriate to allow ease of maintenance. 	
2.	<p><u>Operation manual</u></p> <p>An Operation Manual should be provided for each piece of equipment. The manual should include:</p> <ul style="list-style-type: none"> ✓ A full description of the equipment with a tabulation of dimensions and performance ratings ✓ Principles of operation ✓ Basic working description and Design criteria ✓ Overview of how to monitor the equipment ✓ Safety management ✓ Environmental management ✓ Record keeping requirements ✓ Duty statements for operators ✓ Emergency response ✓ Cross references to the maintenance schedules 	


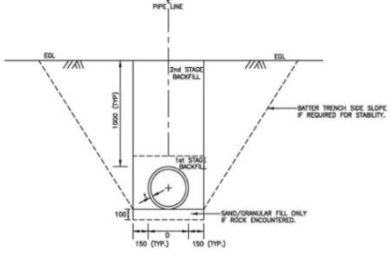
4.8.2.2 Construction Phase


The construction of buried pipe irrigation system works including:



1. Pipe sizes, wall thickness and material specification;
2. Pipe storage and handling;
3. Pipeline layout and location of structures;
4. Trench construction;
5. Pipe placement and jointing;
6. Structure connections;
7. Thrust control; and
8. Pipeline testing and backfill.


Table 43: Construction Phase of Buried Pipe Irrigation System

SN	Activities	Images
1.	<p>uPVC Pipes and Fittings Appearance and Sizes</p> <p><u>Appearance</u></p> <ul style="list-style-type: none"> ✓ When viewed without magnification the internal and external surfaces of the pipes and fittings shall be smooth, clean and free from scoring, cavities and other surface defects. ✓ The material shall not contain visible impurities. ✓ The ends of the pipes and fittings shall be clean and square to their axes. ✓ The colour of the pipes and fittings shall be grey. <p>IMED officials will observe the appearance of the pipe and fitting.</p> <p><u>Pipe and Fitting Sizes and Wall Thickness</u></p> <ul style="list-style-type: none"> ✓ The base material from which the uPVC pipes are produced shall be un-plasticized Polyvinyl Chloride (PVC"u") with additives as necessary for manufacture. ✓ Wall thicknesses of uPVC pipes and pipe fittings shall be commensurate with a working pressure rating of 3.25 bar (32 m head). Required wall thickness shall be determined from detail design. ✓ The pipes shall have one end socket and one end spigot (plain). The spigot end shall be chamfered to facilitate insertion into the socket of the adjacent pipeline / fitting. The socket shall be machine made. <p>IMED officials will measure the fitting size and wall thickness of the pipe. The specification of the pipe will be written on the surface of the pipe.</p>	 <p style="text-align: center;">Appearance of uPVC pipe</p>
2.	<p><u>Pipe testing and Marking</u></p> <p>Pipe testing shall be conducted for uPVC pipes on representative samples of each diameter of pipe required. Testing shall be carried out in any reputable laboratory as required by the Engineer. The testing of pipe as follows:</p> <ul style="list-style-type: none"> • Dimension testing • Short Term Hydrostatic Test • Heat Reversion Test • Impact Strength • Resistance to Acetone • Specific Gravity <p><u>Pipe & fitting marking</u></p> <p>The pipe shall be permanently marked which will contain following information:</p> <ul style="list-style-type: none"> ✓ Manufacturers name or trademark ✓ Nominal outside diameter ✓ Pipe material (uPVC) ✓ Standard (ISO 4065: SDR 81) ✓ Date (and time) of manufacture 	 <p style="text-align: center;">Manufacture of uPVC Pipes</p>

SN	Activities	Images
	<ul style="list-style-type: none"> ✓ Implemented organization (BMDA/BADC/LGED) IMED officials will observe the pipe marking. 	
3.	<p><u>Pipe Handling and Storage</u></p> <p><u>Receiving Pipes and Fittings</u></p> <ul style="list-style-type: none"> ✓ All pipes and pipe fittings received on Site shall be visually inspected for damage which may have occurred during transit. ✓ Ends of pipe shall be checked for any cracks or splits or other damage. ✓ The pipes shall also be checked for any severe deformation which could later cause jointing problems. ✓ Any damaged pipes and fittings should not be accepted in the permanent works. <p><u>Handling</u></p> <ul style="list-style-type: none"> ✓ The pipes and fittings should be handled with reasonable care. They are relatively light and must not be thrown around and / or dropped from any height. ✓ Pipes and fittings should not be dragged / pushed / dropped from a truck bed. Loose pipes may be rolled down on a timber support but care must be taken that they do not fall on each other or on any hard or uneven surface. <p><u>Storage</u></p> <ul style="list-style-type: none"> ✓ Pipes should be stored on level ground which is dry and free from sharp objects. Different pipe sizes should be stored separately. ✓ The pipes and fittings shall be protected from the sun. ✓ Pipes should be continuously supported along its length. If this is not possible the spacing of supports should not exceed 1.0 m. ✓ Pipes shall not be stacked to a height in excess of 2 m, or 6 layers, whichever is the lesser. 	 <p style="text-align: center;">Storage of uPVC pipes</p>
4.	<p><u>Pipeline Layout and Location of Structures</u></p> <ul style="list-style-type: none"> ✓ The concern in-charge field engineer shall confirm the pipeline layout and lengths of each size of pipe required under the contract by setting out the pipeline(s) prior to trench excavation, marking all pipe bends and structure locations with marker flags. The marker flags shall be at least 1.6m in height. ✓ The locations of riser outlets shall be confirmed. 	
	<p><u>Trench Construction</u></p> <ul style="list-style-type: none"> ✓ The trench shall be excavated to a depth to ensure cover to the top (crown) of the pipe of typically 1.0 m, and at least 0.8 m. ✓ The trench grade (longitudinal slope) shall be as shown on the drawings. ✓ The trench below the top of the pipe shall be only wide enough to permit the pipe to be easily placed and joined, and to allow for initial backfill material to be uniformly placed under the haunches and along the side of the pipe. The usual trench width shall be $D + 0.3$ m where D is the pipe outside diameter. 	

SN	Activities	Images
	<ul style="list-style-type: none"> ✓ The trench bottom shall be uniform so that the pipe is fully supported without “bridging”. Clods, stones and uneven spots that can damage the pipe or cause non-uniform support shall be removed. ✓ A small layer of bedding material (sand) may be spread over the bottom of the trench to facilitate uniform support to the pipe. ✓ Where rocks, stones or uneven material are encountered, the trench bottom shall be cut 100 mm below the required grade, and backfilled with bedding material (sand). ✓ Excavated material shall be placed along one side the trench, allowing easy access from the other side for placement of pipes prior to laying. 	
5.	<p><u>Pipe Placement and Joining</u></p> <ul style="list-style-type: none"> ✓ Small holes shall be excavated for the socket ends of the pipes to permit the pipe body to be uniformly supported along its whole length. ✓ Pipe laying may start from any structure location and shall proceed in a downstream direction. ✓ Pipes shall be carefully placed in the excavated trench for joining after removal of all foreign matter or dirt. Prior to joining the connecting surfaces of the spigot and socket shall be cleaned with a rag or brush. ✓ The pipe socket (bell end) should be aligned downstream. Ensure that the rubber gasket is placed correctly in the socket and that lubricant is applied to the spigot of the adjacent downstream pipe. The spigot should be smoothly chamfered – if necessary any minor irregularities may be filed off. ✓ The two pipes should be carefully aligned and the spigot of the downstream pipe inserted into the socket (bell end) of the upstream pipe applying firm pressure, either by hand or using a “bar and block” assembly. A small twisting motion may be useful for smaller pipe diameters. Care should be taken to avoid over entry of the spigot into the socket. 	
6.	<p><u>Structure Connections</u></p> <ul style="list-style-type: none"> ✓ Minor settlement of rigid structures will not usually cause shear breakage of the uPVC pipe, and the pipes may be placed directly into concrete structures. ✓ To minimize differential settlement initial pipe backfill within 1 m of the structure shall comprise sand. Further to accommodate any differential settlement, rubber “O” ring pipe joints shall be provided to all pipelines within 1 m of the structure. 	

SN	Activities	Images
7.	<p><u>Thrust Control</u></p> <p>Thrust control (joint restraint) is required to prevent pipe movement and damage at the following locations:</p> <ul style="list-style-type: none"> (i) Changes in pipe direction (e.g. tees, bends, elbows, etc.); (ii) Change in pipe size; (iii) Dead ends (end caps). Thrust control shall comprise Class D concrete placed between the pipe and the (vertical) side of the excavated trench to resist movement. 	
8.	<p><u>Initial and Final Backfill</u></p> <p><u>Initial Backfill</u></p> <ul style="list-style-type: none"> ✓ Initial backfill shall be by hand and shall comprise soil or sand that is free from stones larger than 15 mm in diameter. ✓ At the time of placement, the moisture content of the material shall be such good compaction can be achieved. Initial backfill shall not be carried out during wet weather. ✓ Initial backfill shall be placed under and around the pipe and to provide 50 mm cover to the pipe top (crown). Initial backfill shall be compacted firmly to provide adequate lateral ✓ Pipeline testing and commissioning shall be carried out after initial backfilling of the pipeline trench, but before final backfill unless otherwise approved / directed by the Engineer-in-Charge. ✓ Grounds for carrying out final backfill prior to testing may include: (i) a real and identified risk of pipe floatation; (ii) safety hazard – particularly near settlements; (iii) blocking of right of way, etc. <p><u>Final Backfill</u></p> <ul style="list-style-type: none"> ✓ Final backfill may be by hand or machine. ✓ Final backfill material shall be free from large stones and other debris larger than 75 mm in diameter. The material shall be placed and spread in approximately uniform layers to fully fill the trench. Final backfill shall be placed and compacted by iron rammer in 250 mm thick compacted layers. <p><u>Concrete Backfill</u></p> <ul style="list-style-type: none"> ✓ To ensure against floatation and/or scour and exposure of the pipeline where it crosses natural drainage lines, the initial backfill material may comprise concrete Class D placed and compacted under and around the pipe and to a depth of 100 mm over the top of the pipe. ✓ Concrete backfill shall also be used where the pipeline crosses under road embankments. 	

SN	Activities	Images
	<p><u>Pipeline Testing and Commissioning</u></p> <ul style="list-style-type: none"> ✓ The pipeline shall be tested for leakage and to ensure that design flows are supplied to all outlets along the pipeline before final backfilling. ✓ As part of the commissioning process, in addition to checking of flows at each outlet, water levels in the standpipes shall be measured and adequacy of freeboard confirmed at the design flows. ✓ Any leaks or damaged pipes / pipe seals shall be repaired and the pipeline retested. 	
9.	<p><u>Pumping Plant, Transformer and Electrical Connection</u></p> <p><u>Pumping Plant</u></p> <ul style="list-style-type: none"> ✓ The number, pumping discharge and pumping head of the required pumps, as well as indicative power requirements are indicated as appropriate in the Particular Specifications. <p><u>Transformer and Electrical Installation</u></p> <ul style="list-style-type: none"> ✓ A complete electrical installation shall be provided for operation of the pumping plant. ✓ Since night time operation is envisaged a 65 Watt tubular fluorescent light or similar approved shall be provided, as well as electrical meter, power sockets, switchboard and pumping plant transformer all as required. These shall be located at / near the pumping / header tank site as directed by the Engineer-in-Charge. ✓ The switchboard, electrical meter, power sockets and lighting shall be wall mounted, for water proofed construction and with protective cover(s) for security and water proofing, unless located inside a building that may or may not be available on Site. ✓ All cables shall be adequately supported and present a neat appearance. Cables shall be fixed using proper cable cleats or saddles. ✓ The wall mounted switchboard shall receive power from the transformer and distribute it to the pumping plant. <p><u>Electrical Transmission Line</u></p> <ul style="list-style-type: none"> ✓ The concern person/contractor shall supply and install an overhead electric cable connection complete with supporting poles from the existing electrical distribution system to the pumping plant transformer. <p><u>Testing and Commissioning of Electrical Equipment</u></p> <ul style="list-style-type: none"> ✓ The concern person/contractor shall test and commission the electrical equipment along with the pumping plant whether sourced under this contract or some other arrangement all in accordance with requirements of the Power Development Board and as directed by the Engineer-in-Charge. 	

4.9 Conclusion

Water availability situation over the year compels Bangladesh to address issues like irrigation, flood control and drainage, which are contradictory in nature. Therefore, water environment forces Bangladesh for irrigated agriculture supported by flood control measures and provision of drainage facilities. With the water potential of the country, about 76% of the cultivable area can be irrigated of which about 64% are presently under irrigation. Due to fluctuation in availability and lack of control over surface water, about 79% of the irrigated area use groundwater. Cost of production of major crops is high in Bangladesh and power use in agriculture is low compared to even neighboring countries. Furthermore, whatever is produced, a bulk of it is lost after harvesting (post-harvest losses). Therefore, efficient use of irrigation water, effective use of irrigation facilities, use of machine for agricultural operation and saving/minimizing post-harvest losses are required to make agriculture cost effective in Bangladesh.

Major constraints to face for irrigation, flood control and drainage systems development and operation are; lack of continuity in policy supports, withdrawal of surface water at upstream, lack of timely availability of fuel, oil and electricity for smooth operation of irrigation systems, funds and interest for maintenance of

*Checklist for Irrigation Sector Project **Annex-12***

*Template for Irrigation Sector project **Annex-13***

*SMART Indicator for Irrigation Sector project **Annex-14***

CHAPTER FIVE M&E GUIDELINES FOR WATER RESOURCES SECTOR

5.1. *Introduction*

Water is central to the way of life in Bangladesh and the single-most important resource for the well-being of its people. It sustains an extremely fragile natural environment and provides livelihood for millions of people. Availability of water, including rainwater, surface water, and groundwater, in usable forms calls for its sustainable development, a responsibility that has to be shared collectively and individually by members of the society. Water resources are sources of water that are useful or potentially useful to humans. It is important because it is needed for life to exist. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually these entire human uses require fresh water. Only 2.5% of water on the Earth is fresh water, and over two thirds of this is frozen in glaciers and polar ice caps. Water demand already exceeds supply in many parts of the world, and many more areas are expected to experience this imbalance in the near future (Global Water Partnership, 2009).

Today, most countries are placing unprecedented pressure on water resources. The global population is growing fast, and estimates show that with current practices, the world will face a 40% shortfall between forecast demand and available supply of water by 2030. Furthermore, chronic water scarcity, hydrological uncertainty, and extreme weather events (floods and droughts) are perceived as some of the biggest threats to global prosperity and stability (Global Water Partnership, 2009).

5.2. *Literature Review*

WARPO (2001) aims to contribute in the balanced fashion to the overall national goals of economic development, poverty alleviation, food security, public health and safety, descent standard of living for the people and protection of the natural environment. To operationalize the directives, work as framework plan to guide developing and managing water resources and services; institutional and implementation capacity building and rationale and strengthening institutional capacity are also its target areas. The report discussed about the plan components and their expected impacts, how these fit into management information system, risks and risks management strategies. The plan components and funding requirements, key linkages, monitoring & evaluation and action required are also discussed.

Ministry of Water Resources (1999) aims address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner. It is working to ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children. It will supportive to accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing.

Abedur Rahman and Mohammad Mehedi Hasan (2016) aims to evaluate the performance of Buraghat Rubber Dam project and to identify the constraints embroiled to its efficient water management. The performance is evaluated by means of some technical parameters including Command area efficiency, Management performance ratio, Water-use efficiency and Benefit-cost ratio. It is observed from the study that the CAE of scheme-1 and scheme-2 of the project is 30.71% and 27.14% respectively and MPR is 0.019 and 0.021 in that order indicating substandard. Therefore, a considerable number of performance constraints of the Buraghat Rubber Dam irrigation project are identified to achieve the targeted fruitful outcomes.

Sondipon Paul (2017) aims to Calibration and validation of MIKE 11 and MIKE SHE models; analysis of future groundwater level without rubber dam using MIKE 11 and MIKE SHE; Analysis of future groundwater level with rubber dam using MIKE 11 and MIKESHE. The study covered the Rainfall and evaporation data collection, analysis and processing for model input; Groundwater level (GWL) data collection, trend analysis and processing for model input; Surface water level (SWL) and discharge data collection and processing for model input; and Bore-log and aquifer test data collection and understanding of geological pattern in the study area. It is expected that Spatial distribution of groundwater level for present condition; existing groundwater level hydrograph and trend analyzed; Spatial distribution of future groundwater level for construction of rubber dam; exchange volume between river water and groundwater in present condition; exchange volume between storage water in river due to rubber dam and groundwater are analyzed.

BEDB (2017) aims to mainstream the local community and stakeholders in water management to ensure Integrated Water Resources Management (IWRM) in the country. The main elements of this approach are to reform and strengthen the key institutions involved in water sectors like Bangladesh Water Development Board (BWDB); ensure local user community participation at all stages of the cycle of water management projects; minimize adverse effects of water sector interventions on fisheries and the environment; ensure environmentally sustainable utilization of existing facilities through rehabilitation and effective O&M, including the transfer of management of FCD/FCDI schemes to Water Management Organizations (WMO). This framework will be supportive to climate resilient agricultural water management and would continue the programs for establishing a sustainable and effective Water Management System in Bangladesh through participatory approach.

BWDB (2007) aims to strengthen the participatory integrated water management plan for the selected FCD/I scheme; enhanced livelihood and livelihood opportunities impacted by integrated water resource management as a result of increased user participation and improved decentralization service delivery; strengthening institutional and project management capacities in planning, implementing, operating maintaining and monitoring demand driven participatory integrated water management plans.

Ministry of Water Resources (2007) focuses on the planning and management of water resources, public and private involvement, economic and financial management, stakeholder's participations, and institutional policy etc. It aims to elaborate the provisions incorporated in NWPo, in respect of stakeholders participations/ involvement; make available harmonized guideline for participatory water management for application in the field; increase or improve stakeholders participation/ involvement in water management; give a local stakeholders a decisive voice at all stages of water management; raise environmental awareness among local stakeholders and the implementing agencies involved with the participatory water management. It also describes the capacity building; gradually establish ownership of the local stakeholders in participatory water management.

Global Water Partnership (GWP) and the International Network of Basin Organizations (INBO) 2009 aim to sustainable development and management of water resources at all levels. It provides practical guidance for improving the governance of freshwater resources, in particular through effective application of the integrated water resources management (IWRM) approach in lake and river basins, and aquifers. It complements IWRM efforts already underway or planned at national and international levels. It focused on the Problems and challenges facing water managers, and identifying the addressing strategies for the challenges. It describe the Integrated water resources management in basins, basin management as an iterative process, entry levels for integrated water resources management in basins, establishing basin management systems, and roles and types of basin organizations etc.

International Water Management Institute (2016) discussed the process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. It focused on the participatory planning process that is the heart of this supportive environment. It is a planning tool for local structures for one 'loop' or cycle in the iterative process of planning, implementation and after-care of a water intervention.

Water Management

“Water Management is defined as the activity of planning, developing, distributing and managing the optimum use of water resources”. Water management is to complete demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands (Sadashiv Sitaram Mengal, 2017).

Water resource management

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. The field of water resources management will have to continue to adapt to the current and future issues facing the allocation of water.

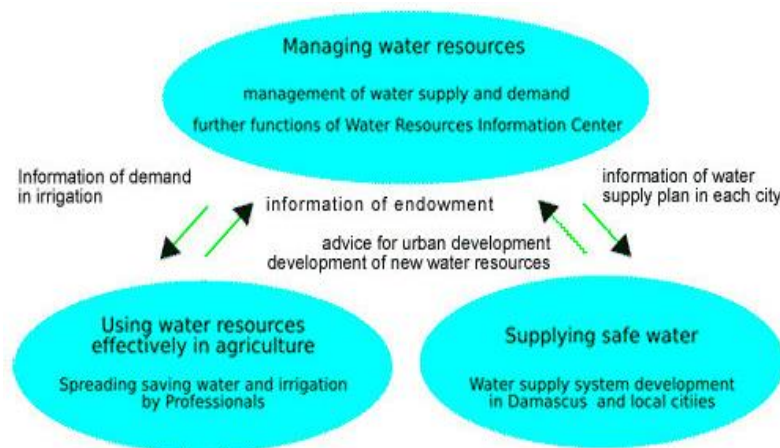


Figure 29: Water Resource Management and effective use

Source: www.jica.go.jp/syria/english/activities/02.html

5.3. The Importance of Water Management

Life cannot exist without water means water is a source of life. It preserves all living things. Water is our most important thing for live. Water provides the Earth with the capacity of supporting life. Every living thing doesn't have to be told how much essential water is to their existence. While it may occur that the Earth has sufficient water resources because water covers almost 71% of its surface, it is important to recognize that of the total available supply, 97% water containing salts and 2% is fresh water frozen in glaciers. The remaining 1% is easily ready for use to support cooking, drinking, bathing, agriculture, sanitation, industry, recreation, washing clothes, and other needs within the global community.

Water Management is important since it helps determine future Irrigation expectations. Water management is the management of water resources under set policies and regulations. Water, once an abundant natural resource, is becoming a more valuable commodity due to droughts and overuse. Here are links to articles that address water management subjects such as the optimization of water usage. Water resource management is the activity of planning, developing, distributing and

managing the optimum use of water resources. It is a sub-set of water cycle management. Ideally, water resource management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands. As with other resource management, this is rarely possible in practice. Water is an essential resource for all life on the planet. At present only about 0.08 percent of all the world fresh water is exploited by mankind in ever increasing demand for sanitation, drinking, manufacturing, leisure and agriculture. Water Management uses as Irrigation and Drainage Systems.

5.4. Selection of Projects for Study

Total of five projects of BWDB has been selected for study to prepare M&E Guidelines. The following are the projects with their locations

Table 44: Selected Project List for Water Resources

Sl.No	ID #	Assignments and Location	Nature of Work				
			Flood Control	Drainage	River Bank protection	Re-Excavation	Bamboo Banddling
D-1	,4705-5145	Shibpur Flood Control, Drainage and Irrigation Project under Shibpur Upazila in Narsingdi District;	Yes	Yes			
D-2	4705-5019	Development of Drainage System in Dhaka-Narayanganj Demra DND area; Location: Dhaka District (Outskirt of Dhaka)		Yes			
D-3	4705-5002	Preservation of the Left bank of the river Padma from Doairbazar, Dohar upazila in Dhaka district to Braha bajaraghata			Yes		
D-4	4705-5076	Re-excavation of Arialkha River, Haridoya River, Brahmaputra River, Paharia River, Meghna Branch River and Old Brahmaputra Branch River Project under Narsingdi District;				Yes	
D-5	4705-5098	The Pilot Project in Different Areas of Bangladesh using Bamboo Bundling Structures to Reduce River Bank Erosion, Land Reclamation and increase navigation					Yes

The main activities of the five selected projects are the following five broad activities:

1. Flood Control;
2. Drainage;
3. River Bank Protection;
4. Re-excavation of River; and
5. Bamboo Bundling structures to reduce river bank erosion etc.

In view of covering all the five projects the three aspects will be adopted:

- A. As such, a common discussion will be made out for the above five broad aspects;
- B. Subsequently, specific discussion will be as per project requirement; and
- C. Methodology to bring all the activities under M&E program

Also, common discussions will be to indicate as captioned below mentioning Steps of carrying out Physical Works:

- Equipment;
- Steps /sequences of Physical activities;
- Modern Construction practices
 - Pre-construction phases
 - Construction phases

5.5. Literature Review on Flood Control/ River Bank Protection/Drainage/Re-excavation of River/Bamboo Bundling Structures to Reduce River Bank Erosion etc.

5.5.1 Flood Control

This chapter discusses the layout and design of these River Training and Riverbank Protection Works, which can together be termed as aspects of River Engineering. Of course, river engineering includes much more, like dredging to keep the pathway of ships in a river navigable, or techniques of setting up jetties for ships to berth, but they are not discussed in this lesson. When excess water flowing in the river overflows and submerges the flood plain and both the river bank causing destruction and losses of live sand properties is called Flood. Flood is of two types:

- Excessive height of water but flood water retention in a short duration;
- Height of flowing water is not high but flood water retention in a long duration;

5.5.1.2 Measures of Flood Control

Flood control means that project which makes arrangement to remove the potential causes of floods before occurring flood and if flood occurs then it can be controlled and to prevent the adjoining areas from flooding. Also identification of potential flood occurrence will be possible after observing the situation and to announce early warning on flood. If flood occurs, post flood measures such as to rehabilitate the flood stricken people and properties. Flood control measures are given below:

1. The need for river training
2. Guide bunds for restricting the flow path of river waterway
3. Afflux bunds, approach embankments, groynes, spurs, etc. for river waterway control
4. The issue of riverbank failure and lateral migration of rivers
5. Different modes of bank failure
6. Techniques for bank stabilization

5.5.1.3 Some Physical Flood Control Structures

1. **Construction of Dyke:** To construct dyke in both the side of river and the height shall be higher than Highest Flood Level(HFL)
2. **Reservoir:** In the riparian side of flood protection area, reservoir can be constructed.
3. **To stabilize and conserve the soil at that area**
4. **To dredge** the river, canal and tributaries

5.5.1.4 Guide Bunds or Banks

Alluvial rivers in flood plains spread over a very large area during floods and it would be very costly to provide bridges or any other structure across the entire natural spread. It is necessary to narrow down and restrict its course to flow axially through the diversion structure. Guide bunds are provided for the purpose of guiding the river flow along desired channels without causing damage to its banks. These are constructed on either or both on the upstream and downstream of major infrastructure and on one or both the banks as required.

- ❖ **Classification of Guide Bunds:** Guide bunds can be classified according to their form in plan as (i) divergent, (ii) convergent, and (iii) parallel and according to their geometrical shape as straight and elliptical with circular or multi-radii curved head.

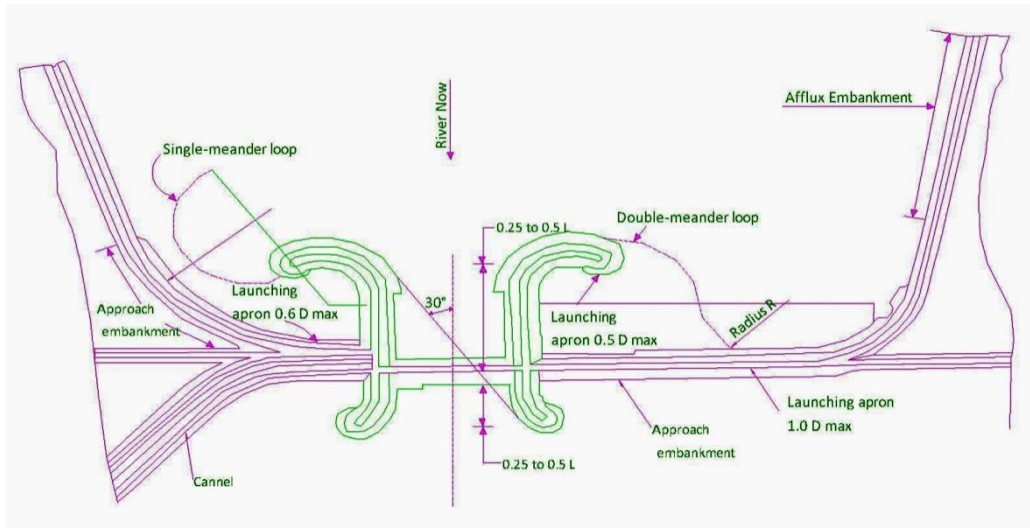


Figure 30: Typical Layout of River Training Work

❖ **Design of guide bunds**

The following components:

- **Top width of guide bund**
- **Free board for Guide Bund**

A free board of 1 to 1.5 m above the following mentioned two water levels has to be provided and the higher value adopted as the top level of the upstream guide bund:

- **Side slopes of guide bund**

The side slopes of guide bund have to be fixed from stability considerations of the bund which depend on the material of which the bund is made and also its height. Generally the side slopes of the guide bund vary from 2:1 to 3:1 (H:V).

- **Size of stone for pitching**

- On the rear side, turfing of the slope is normally found to be adequate.

❖ **Launching Apron**

Just as launching apron is provided for the main structure both on the upstream and downstream it has to be provided for guide bunds also in the bed in continuation of the pitching. The different aspects to be looked into are the size of the stones, depth of scour, thickness, slope of launched apron, shape and size of launching apron.

❖ **Approach embankment**

Where the width of the river is very wide in an alluvial plain, the diversion structure is constructed with a restricted waterway for economy as well as better flow conditions. The un-bridged width of the river is blocked by means of embankments called Approach embankments or tie bunds.

5.5.1.5 Groynes or Spurs

Groynes or spurs are constructed transverse to the river flow extending from the bank into the river. This form of river training works performs one or more functions such as training the river along the desired course to reduce the concentration of flow at the point of attack, creating a slack flow for silting up the area in the vicinity and protecting the bank by keeping the flow away from it.

❖ **Classification of Groynes or spurs**

Groynes or spurs are classified according to:

- i. the method and materials of construction;

- ii. the height of spur with respect to water level;
- iii. function to be performed; and
- iv. (iv) special types which include the following:

These are

- ✓ Permeable or impermeable
- ✓ Submerged or non-submerged
- ✓ Attracting, deflecting repelling and sedimenting and
- ✓ T-shaped (Denehey), hockey (or Burma) type, kinked type, etc.

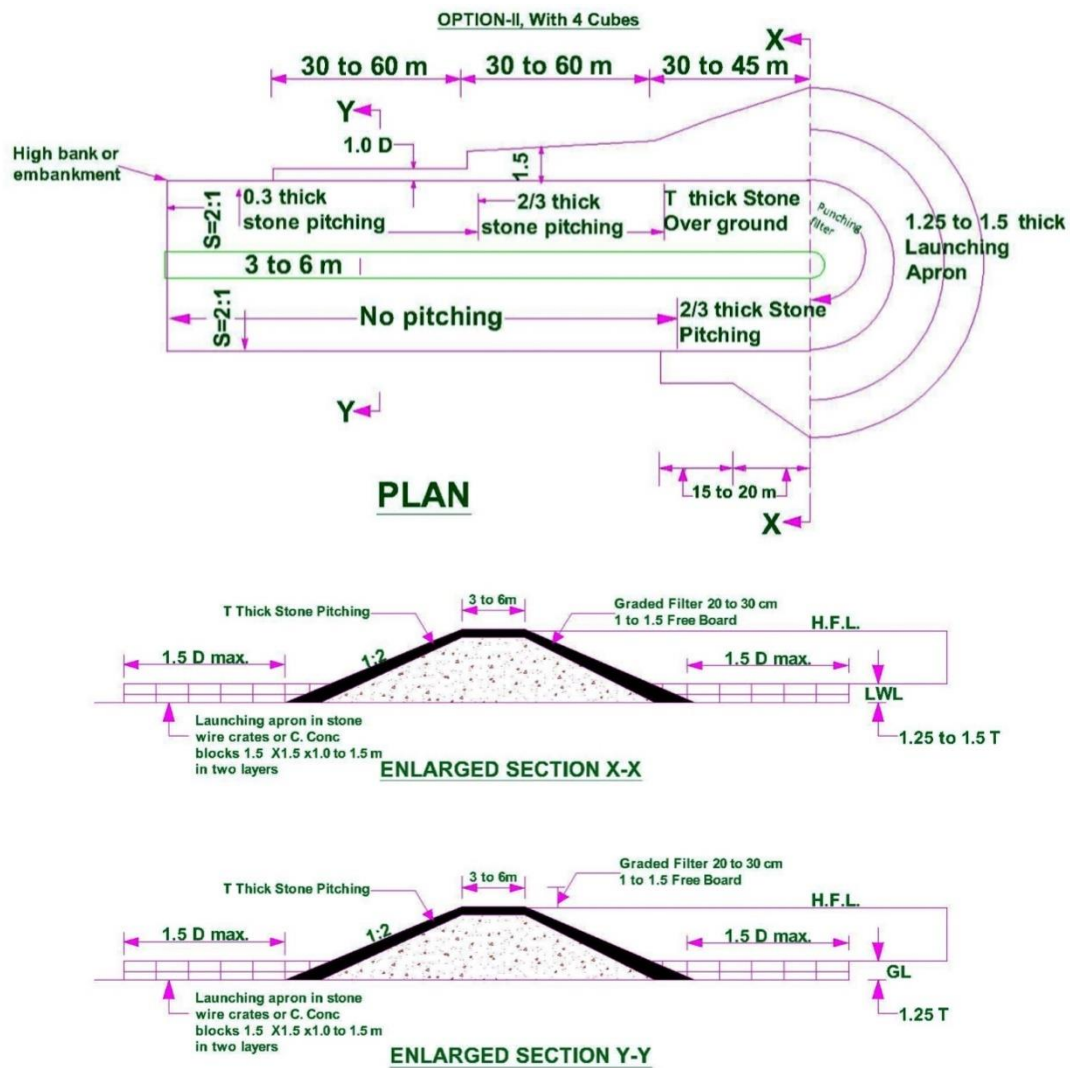


Figure 31: Typical Layout and Section Spur

5.5.1.6 Cut Off

Cut-offs as river training works is to be carefully planned and executed in meandering rivers. The cut-off is artificially induced with a pilot channel to divert the river from a curved flow which may be endangering valuable land or property or to straighten its approach to a work or for any other purpose. As the cut-off shortens the length of the river, it is likely to cause disturbance of regime upstream and downstream till readjustment is made. A pilot cut spreads out the period of readjustment and makes the process gradual. Model tests come in handy in finalizing this form of river training works wherever needed.

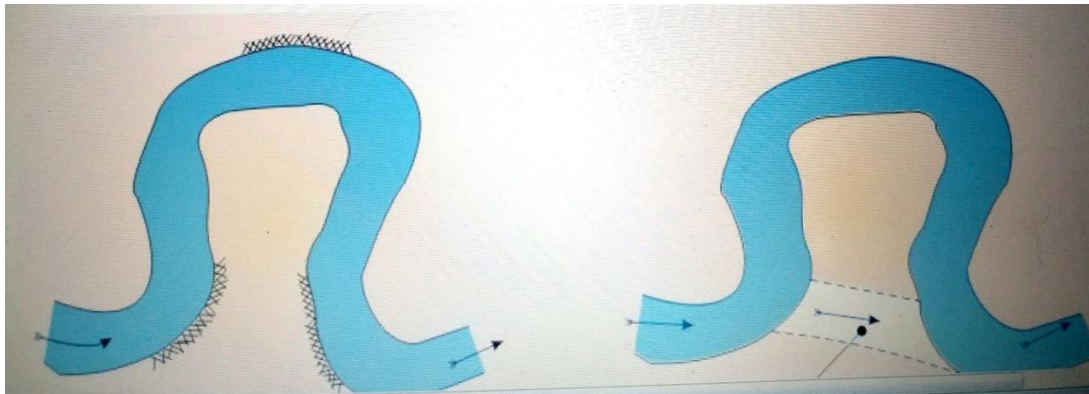


Figure 32: Typical Instance of a Cut-off

5.5.1.7 Marginal Embankments

These are earthen embankments, also known as levees, which are constructed in the flood plains of a river and run parallel to the river bank along its length. The aim of providing these embankments is to confine the river flood water within the cross section available between the embankments. The flood water of a river is thus not allowed to spill over to the flood plains, as normally would had been (Figure 33). This kind of protection against flooding has been provided for most of the rivers of India that are flood prone with low banks and have extensive flood plains in the last century. This may be apparent from the maps of any riverine area, as shown typically in Figure below.

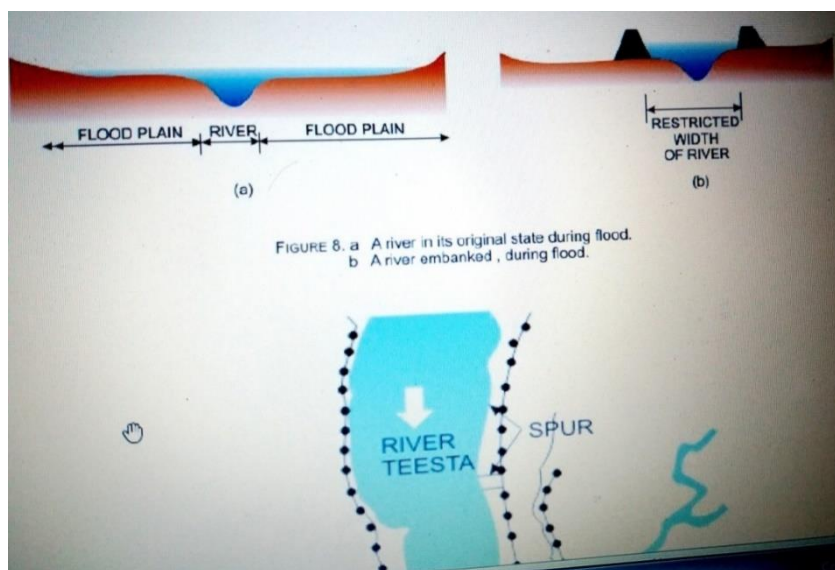


Figure 33: Marginal Embankment Picture

5.5.1.8 Example of Spur from River Teesta

Legend for Figures: (A) SILT DEPOSITION SPREAD OVER FIVER AND FLOOD PLAINS IN ORIGINAL STATE

SILT DEPOSITION RESTRICTED TO RIVER BED BETWEEN EMBANKMENTS

HIGH WATER LEVEL DURING FLOOD THREATEN ADJACENT HABITATION

5.5.2 River Bank Protection

5.5.2.1. Techniques for Bank Stabilization

There could be two broad ways of stabilizing banks-firstly the direct methods of protecting the slope, and secondly the indirect way by providing structures that extend into the stream channels and redirect the flow so that hydraulic forces at the channel boundary are reduced to a non - erosive level.

Amongst the direct methods available for bank stabilization, the following broad categories are as follows:

- Self-adjusting armour made of stone or other materials
- Rigid armour
- Flexible mattress

The advantages of this type protection are that armoring the surface of the bank is a proven approach which can be precisely designed for a given situation, and which provides immediate and effective protection against erosion. Also, existing or potential problems from erosion by overbank drainage can be effectively addressed integrally with the design of the stream bank armor work. Disadvantages for these types of bank protection include preparation of the bank slope is usually required, either for geotechnical stability or to provide a smooth surface for proper placement of the armor. This may result in high cost, environmental damage, and disturbance to adjacent structures. The extent of earthwork associated with an armor revetment will be especially significant if the existing channel alignment is to be modified either by excavation or by placing fill material in the channel. The following sections describe the three types of bank protection works.

As for the indirect methods for bank stabilization, these may be classified into the following categories.

- Dikes - Permeable or Impermeable
- Retards - Permeable or Impermeable
- Other flow deflectors like Bend way weirs, Iowa vanes, etc.

5.5.2.2. Self-Adjusting Armour of Stone or Other Material

Stone armour can be placed in four general configurations, the most common being a "riprap blanket". Other forms, known as "trench fill", "longitudinal stone toe," and "windrow" (referred to in some regions as "falling apron"), can be very useful in certain situations.

A stone armor usually consists of "graded" stone, which is a mixture of a wide range of stone sizes; the largest sizes resist hydraulic forces, and the smaller sizes add interlocking support and prevent loss of bank material through gaps between larger stones. Hand-placed stone in a smaller range of sizes is occasionally used. The various types of stone armors are discussed below:

- Riprap Blanket
- Trenchfill
- Windrow
- Longitudinal stone toe
- Concrete blocks

- Sacks/ Sand Sacks
- Soil Cement bags.

5.5.2.3. Rigid Armour

Rigid armour is an erosion-resistant material which has little or no flexibility to conform to bank irregularities occurring after construction. Typically, the armour is placed directly on the bank slope in a fluid or chemically reactive state, then hardens.

The most common rigid armours are:

- Asphalt
- Concrete
- Grouted riprap (or other grouted armour material), and
- Soil-cement

The main advantages for rigid armour are: The most common rigid armours will withstand high velocities, have low hydraulic roughness, and prevent infiltration of water into the channel bank. They are practically immune to vandalism, damage from debris, corrosion, and many other destructive agents. The most common rigid armours are easily traversed by pedestrians.

However, a rigid armour requires careful design and quality control during construction, and unfavorable weather conditions can cause construction delays. Provision for draining groundwater and preventing the built-up of excess positive pore water pressures, in the form of a filter or subsurface drains, must usually be provided for impermeable armours, which may significantly increase the cost of the project. Most rigid armours are difficult or impossible to construct underwater, although this difficulty can be alleviated for concrete by using one of the commercially available fabric mattresses. Asphalt has been placed underwater in some mattresses. Rigid armour, being inflexible, is susceptible to breaching if the bank material subsides or heaves. Increased wave run-up on smooth rigid armour may be a concern for some projects.

5.5.2.4. Flexible Mattress

The basic concept of a flexible mattress is that material or objects which cannot resist erosive forces separately can be fastened together or placed in a flexible container to provide adequate resistance to erosive forces, while partially retaining the desirable characteristics of adjustable armour, especially that of flexibility.

The most common flexible mattress materials are:

- Concrete blocks;
- Fabric; and
- Gabions.

The advantages of this type of riverbank protection work includes its flexibility to adjust to scour or settlement and still remain in contact with the bed and bank is the most obvious shared trait. Most mattress materials which are sold under trade names share another advantage they are available in various configurations, thus can be applied to a variety of situations. Flexible mattresses can be placed underwater with a relatively high degree of confidence. If properly anchored to a geotechnical stable bank, they can be placed on steep slopes. They can be walked upon easily, thus are suitable for slopes used by pedestrians.

However, it must be kept in mind that mattress components are subject to deterioration from the elements and vandalism.

5.5.3 Drainage in DND Area

Planning for modern drainage in greater Dhaka city including DND area through diverse technologies will ensure sustainable water logged & flood free zone through the introduction of high-value mechanical equipment with efficient and strong discharge potential.

DWASA has to transform the drainage demand into reality in order to achieve water logging free DND area, a number of interventions have to be initiated to develop short-, medium- and long-term strategic drainage plans.

5.5.3.1 Summary of Structural and Non-Structural Measures

- **Non-Structural Measures**
 - i. Regular maintenance, Public awareness, Institutional Reformation,
 - ii. Capacity building and training program, Legal and political support, Cost recovery process, etc.
- **Structural Measure**
 - i. Drainage Network Construction/Improvement
 - ii. Canal/ Khal(DND) Improvement
 - iii. Water Detention/ Retention Areas
 - iv. New Pump Stations
 - v. GPTs (Gross Pollutant Traps)
 - vi. Outfall Structures

These Structural and Non-Structural measures are described below in brief.

Non-Structural Measures

Non-structural measures are mainly formulated in previous studies on the basis of three major perspectives and those areas

- Implement effective solid waste management
- Legal and Institutional strengthening
- Socio-economic issues

Other non-structural measures can be summarized as:

- Provide adequate solid waste disposal system.
- Secure of Right of Way for all drainage channels.
- Proper operation and maintenance of all drainage and flood proofing structures by Dhaka WASA.
- Establish collaboration for managing flood and drainage in the city, developing a flood forecasting system as well as preparing early warning activities between BWDB and Dhaka WASA.
- Free existing natural drainage routes from encroachment immediately by all parties, especially Dhaka WASA and DCC.
- Regular cleaning, utilizing advanced technologies by all parties especially Dhaka WASA and DCC, of the drains/pipes/khals before the arrival of monsoon storms with adequate funding available by October each year.
- Effective maintenance of conveyance channels from sluice gates to rivers.
- Acquire all open and unoccupied lands beside the western flood embankment within the protected area and utilize these for constructing retention ponds and conveyance channels.
- The existing natural drainage channels should be acquired and protected to prohibit encroachment that would ensure indiscriminate land filling.

- Dhaka WASA, within DND jurisdiction, to ensure developers provides adequate space for drainage and funds for developing facilities. Also, along with the DC Office, immediately prohibit developers from encroaching khash (Government) lands.
- RAJUK to develop and implement building codes for preserving drainage facilities in the urban areas, most importantly, of low lying terrain. The DC Office to protect natural canals of DND from the land grabbers and encroachers, and ensure khash (Government) lands and natural canals would not be leased to private developers.
- Storm water drainage in DND can only be successfully performed if all government agencies and real-estate developers work in collaboration. Form a high-level steering committee including Ministers of relevant Ministries to facilitate Storm water management in Dhaka.
- Create public awareness regarding necessity for conserving and protection of the drainage systems, man-made or natural.

5.5.4 Bamboo Bundle Structure

5.5.4.1. Bamboo Bundling Structures to Reduce River Bank Erosion, Land Reclamation and Increase Navigation

Bangladesh is a land of rivers. There are about 310 rivers in Bangladesh including the main three rivers: the Padma, the Meghna and the Jamuna. Most of the river basins comprise alluvial deposits. During the monsoon, the river banks are eroded and engulfed by the river itself. The river width is increasing and depth is decreasing. Every year these same situations arise. As a result, the agricultural lands have been decreasing all over the country through river bank erosion, which is a national disaster in Bangladesh. In this paper, the performance of the low-cost techniques (bamboo bundling structure) is applied which is constructed for the river bank erosion protection. This structure is constructed near the river bank erosion prone area of the Jamuna River for its erosion protection. The sediment available in the flowing water in the river deposits downstream & between the constructed bamboo bundling structures due to the comparatively lesser flow velocity behind and in between the bunds.

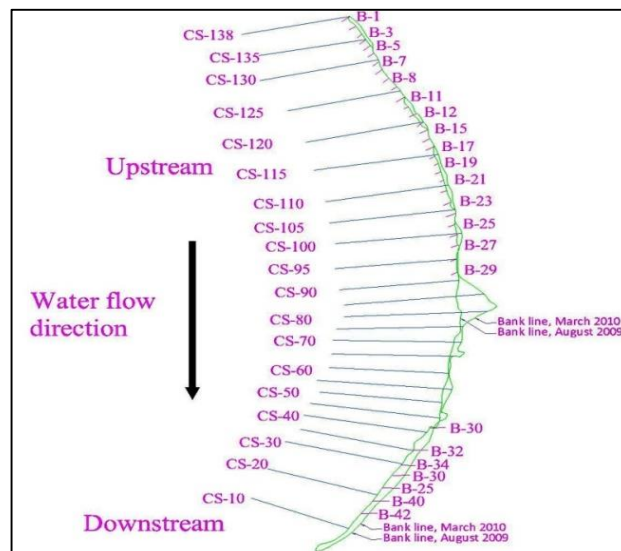


Figure 34: Typical Layout of Bamboo bundle structure

Case Studies – Success Stories

The Jamuna River: The River Jamuna in Bangladesh is a braided river whose braiding index varies spatially as well as with time. In general, the braiding index and the overall width are large at the upstream than in the downstream, probably due to the effects of higher slope and grain sizes. The

overall width of the river exhibits an increasing trend and there is tendency of shifting westwards, especially at the upstream part of the river within Bangladesh. The widening can be attributed to an advancing alluvial fan or to the not yet completed adaptation process after the shift to its new course according to FAP 24 (1994). The shifting rate of the first-order channel of the Jamuna River is 75 to 150 m per year. The second-order channels change continuously, large channels being abandoned and new ones developing in a few years only (Klassen, G.J. and Masselink, G., 1992). A bank erosion rate of the second-order channels of 250 m to 300 m/ year is common and in extreme cases, it can be more than 800 m/year (Klassen, G.J. et al, 1993). There are some attempts made to address the river bank erosion protection issues (Rahman, M.L. et al, 2009). The river systems of Bangladesh are shown in Figure below in which so many agricultural lands engulfed by the river systems.

Below Picture shows the Recovery of Agricultural Land through River Bank Protection by Bamboo Bundling



Figure 35: Recovery of Agricultural Land through River Bank Erosion Protection



Figure 36: Crop Plantation within the Recovered Agricultural Land




5.6 Planning, Design and Construction

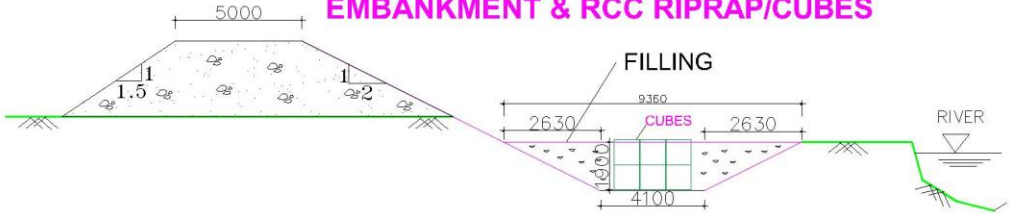
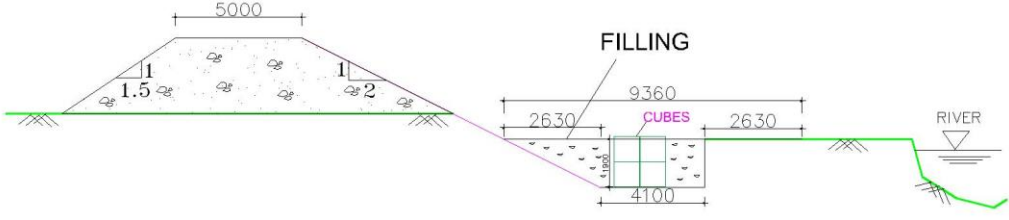


5.6.1 Flood Control/River Bank Protection / Re-excavation of River/ Drainage

5.6.1.2 Construction Equipment

Before starting the above activities, it is desirable to get acquainted with the equipment that is usually used in earth excavation:

SN	Name of equipment	Images
For Flood Control/River Bank Protection / Re-excavation of River		
1.	<p><u>Excavator:</u></p> <p>Excavators mechanical construction equipment consisting of a boom, stick, bucket and cab on a rotating platform known as the "house". The house sits atop an undercarriage with tracks or wheels. A cable-operated excavator uses winches and steel ropes to accomplish the movements. They are a natural progression from the steam shovels and often called power shovels. Excavators are of different load carrying capacities.</p> <p>It is used for various purposes, like:</p> <ul style="list-style-type: none"> • Digging of trenches, holes, foundations • River bank and bed excavation work • Construction Material handling • Demolition • General grading/landscaping • River dredging 	 
2.	<p><u>Dump Truck/Pickup:</u></p> <p>A truck used for transporting loose material (such as sand, gravel, or dirt) for construction is called Dump truck. A typical dump truck is equipped with an open-box bed, which is hinged at the rear and equipped with hydraulic pistons to lift the front, allowing the material in the bed to be deposited ("dumped") on the ground behind the truck at the site of delivery. In the UK and Australia, the term applies to off-road construction plant only, and the road vehicle is known as a tipper, tipper lorry (UK) or tip truck (AU).</p>	
3.	<p><u>River Bank Protection</u></p> <p>Concrete cube blocks and slab</p> <ul style="list-style-type: none"> - Riprap Blanket - Trench fill - Windrow - Longitudinal stone toe - Concrete blocks - Sacks - Soil Cement bags • Photo Shows the River Bank protection for Slope with 150 mm thick RCC slab at slope 	

SN	Name of equipment	Images
4.	Photo Shows the placing of Cubes at foot of Embankment	
5.	Photo Shows the casting of Cubes to be placed at the foot of river protection Embankment	
6.	Photo Shows the casting of RCC Slab to be placed in slopes of Embankment	

SN	Name of equipment	Images
	<p>A. OPTION-I, With 6 Cubes</p> <p>RIVER BANK PROTECTION WORKS WITH EMBANKMENT & RCC RIPRAP/CUBES</p>  <p>B. OPTION-II, With 4 Cubes</p>  <p style="text-align: right; font-size: small;">Md. MIZANUR RAHMAN</p>	
7.	<p><u>Total Station Survey machine:</u></p> <p>Previously level instrument was used to establish or verify points in the same horizontal plane in a process known as leveling, but in current practice most modernize survey equipment is TOTAL Station Machine. It has been most precisely used in to establish the relative heights levels of objects or marks and distances. It is widely used in surveying and construction to measure height differences and to transfer, measure, and set heights of known objects or marks. During re-excavation of any kind, the use of total station is unique</p>	
8.	<p>Close View of Total Station Survey Equipment showing Key board for onsite data entry and processing</p>	

5.6.1.3 Steps of River Bank Protection and Flood Control

The River bank protection and Flood Control includes a number of activities starting from:

- ✓ Reconnaissance Survey;
- ✓ Topographic survey;
- ✓ Geo-technical survey;
- ✓ Socio-Economic Survey;
- ✓ Feasibility Study followed by Detailed Design; and
- ✓ Floating of Tender and award of Work to Contractors; and
- ✓ Construction followed by O&M.

These above general activities are valid for all kinds of Construction works.



Figure 37: Under Construction River Bank Protection with Slab and CC cubes

- ❖ **Reconnaissance Survey will include:**
 - ✓ Overall field site investigations requiring the identification of major obstacles (if any) and other prospects.
- ❖ **Topographic survey:**
 - ✓ This will include the area measurement, configuration of the area, showing existing structures, habitation and elevation including mentioning highest flood level etc.
- ❖ **Geo-technical survey includes the sub-soil investigation indicating:**
 - ✓ *Standard Penetration Test @1.5m intervals*
 - ✓ *Extraction of soil samples*
 - *Undisturbed Soil Sampling: 1 sampling / 1 boreholes, cohesive soil, NX size, Piston sampler*
 - *Disturbed Soil Sampling: 1 sampling bottle / SPT, NX size*
 - ✓ *Measurement of Groundwater table: All boreholes*
 - ✓ *Measurement of SPT energy: 1 EA / 1 boring machine*
(To obtain corrected N values corresponding to 60% energy efficiency)
- ❖ **Laboratory tests**
 - Classification Test**
Natural Moisture Content/Density Test, Complete Grain Size Analysis, Atterberg

Limits,

Specific Gravity Test: 1 EA / 1 borehole (SPT Sample), 1 EA / 1 Undisturbed Sample

- ❖ **Socio-Economic Survey** includes the Economic and social Status of the Inhabitants with any requirement for resettlement and requirement for Land Acquisition;
- ❖ **Feasibility Study** will include the study for the project whether or not it is feasible or not. Mainly it will include the outline engineering design with Project Cost Estimates The study will include the Financial analysis for IRR, Sensitivity analysis, Environmental study etc.
- ❖ **Floating of Tender and award** of Work to Contractors will include the Invitation of Tender either by ICB or NCB, Tender evaluation and awards; and
- ❖ Construction followed by O & M.

The construction methods as a whole are as follows (**based on River Bank protection with embankment construction**):

- ✓ The entire River will be divided into a number of sections.
- ✓ The construction of Embankment along the river (earthen or any other materials that to be carted to site)
- ✓ The embankment earth excavation will be started taking from the upstream or downstream of immediate vicinity land.
- ✓ A parallel temporary short height and width shall be constructed beside the proposed embankment in the river side to protect the under-construction embankment in wet condition.
- ✓ During alignment, some control points at 100 to 200m distance are selected and marked. First excavations in these control sections will be done to the final grade.
- ✓ Then excavation between two control sections will be done by sighting through boring rods.
- ✓ The central portion of the embankment is to be filled first and compacted with road roller etc. and then go to the slope side.
- ✓ The side slope will be shaped and compacted by using the slope template and string using pneumatic roller. The minimum slope shall be 1:2 and 1:1.5 in the River and country side respectively.
- ✓ After completion of excavation, the bed, slopes, and the banks should be compacted in specific manner finally.




Modern construction practices have the following work phases:

- Pre-construction phases; and
- Contraction Phases

Pre-construction phase in actually a construction planning phase. Activities included in these phases are:

- ✓ Study of working drawing and specification
- ✓ Study of site conditions
- ✓ Study of available resources.

Table 45: Pre-construction activities of river bank protection and flood control



SN	Pre-construction Activities	Images
1.	<p><u>Review working drawing and Specification</u></p> <p>This is a very important part of construction work. Every individual concerned with the construction work should have clear understanding of the work and the contractual obligations of the parties involved.</p> <p>The key point of the study will be:</p> <ul style="list-style-type: none"> ✓ Design consideration/specification of River protection by embankment. ✓ Detail drawing of River protection i.e., embankment details mentioning type of fill materials, design cross section, long section, width and cutting depth, cutting volume, etc. ✓ Any other contractual obligation? <p>This aspect shall be re-checked before planning the construction activities. Mistakes and commission, if any, in the construction drawings and documents should be identified and rectified before construction.</p>	
2.	<p><u>Concerning site condition</u></p> <p>Carefully study of the site will provide the following information:</p> <ul style="list-style-type: none"> ✓ Accessibility of the sites ✓ Topography of the sites (<i>see the existing long section and cross section</i>) ✓ Make Space available for storage of material construction equipment and labours shed ✓ Provision of Sources of water, power and materials ✓ Check on Safety and security measures 	
3.	<p><u>Resources for Constructions</u></p> <p>A thorough study availability of resources like labour, equipment and other construction materials is inevitable for construction scheduling.</p>	





For carrying out the above construction following activities are grouped:


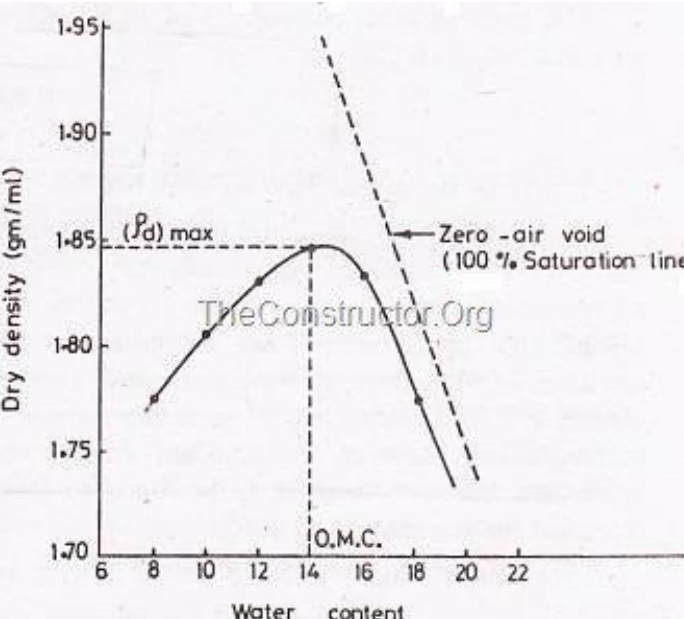
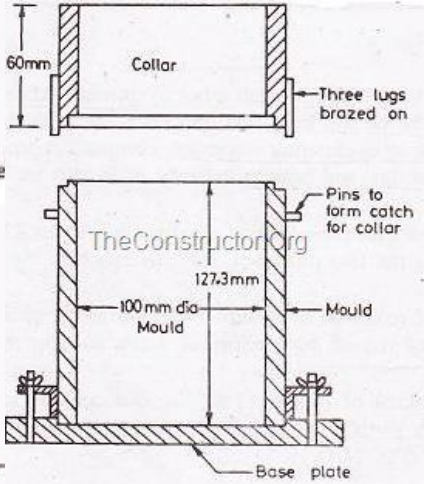

- Selection of contractor;
- Resources scheduling;
- Site layout plan and establishment of B.M
- Construction Site preparation;
- Construction storage and labour shed;
- Construction of Permanent and temporary Embankment;
- Stabilization of Side slope shaping;
- Casting and Placing of Cubes at the foot of Embankment;

- Casting and Placing of RCC 150 thick slab at the slope towards River side
- Construction of groyens/spur
- Turfing side slope to the slopes of Country side.




Table 46: Construction activities of river bank protection and flood control



SN	Construction Activities	Images
1.	<p><u>Selection of contractor</u></p> <p>The evaluation and selection of contractor leading to the award of construction contract is the vital part of the construction. Tender shall be invited for selection of contractor through competitive bidding process.</p>	
2.	<p><u>Resources Scheduling</u></p> <p>Resources scheduling means programming for allocation of different types of resources that will be needed for construction of the project. For efficient and timely completion of the project, rate of resources supply should be commensurate to the construction schedule. Resources scheduling includes the following activities:</p> <ul style="list-style-type: none"> ✓ Material Scheduling ✓ Labour Scheduling ✓ Equipment Scheduling & ✓ Financial scheduling 	
3.	<p><u>Site layout plan and establishment of B.M</u></p> <ul style="list-style-type: none"> ✓ After the layout plan of khal/pond/dhigi has been finalized, the outline of the proposed intervention and other service areas should be laid out at the site. ✓ The layout of River bank with River. ✓ Major task in layout program is to fix the Bench Mark (B.M) at the work site. ✓ To be done to fix by fly Levels at least from two permanent nearby bench mark done by others for fixing the BM for the subject project. 	
4.	<p><u>Site Ready for Works</u></p> <ul style="list-style-type: none"> ✓ Prior to start construction site preparation shall be made that includes cleaning of all trees, bushes, rubbishes and other undesirable materials. ✓ For complex and comparatively large project. The Site preparation might require mechanically (i.e.by tractor with chute, tractor mounted rakes and bulldozers).Usually for smaller works and almost clean site, site clearance may be manually. 	

SN	Construction Activities	Images
5.	<p><u>Storage and labour shed</u></p> <ul style="list-style-type: none"> ✓ Temporary construction of sheds and. Shed is constructed to accommodate the labours and supervisory staff. ✓ The environmental friendly labour shed should be constructed with all necessary living utilities. ✓ Temporary storage of storing construction materials and equipment (for at least two-month storage 	
6.	<p><u>Construction of temporary embankment</u></p> <p>This dam shall be constructed at the toe of main embankment and in the river side to protect the river water during construction of embankment and bank protection works</p>	
7.	<p><u>Construction of Main River Bank Embankment</u></p> <ul style="list-style-type: none"> ✓ The embankment shall be constructed section wise to match with difference in GL to maintain grade. ✓ The excavation may be from nearby land either from river or country side. ✓ Before excavation finalize the place of excavation if it is the private land. ✓ Then excavation between two sections shall be done by observing using staff or boring rods. ✓ After completion of excavation, the bed, slopes, and the banks should be compacted in specific manner using rollers, etc. 	
8.	<p><u>Embankment Slope</u></p> <ul style="list-style-type: none"> ✓ After filling the embankment for both permanent and temporary up to the design level, the side slope should be dressed and shaped to its final grade with the help of a side slope template and string. ✓ The design slope should be compacted and dressed in suitable filling depth. 	
9.	<p><u>Placing of RCC Slab and Turfing side slope</u></p> <ul style="list-style-type: none"> ✓ To prevent erosion of side slopes by action wind, rain and mild waves with suitable grass is planted on the slopes of country side. ✓ In the river side slope will be provided with RCC slab and at the toe a multiple layer both in horizontal and vertically with CC cubes; 	

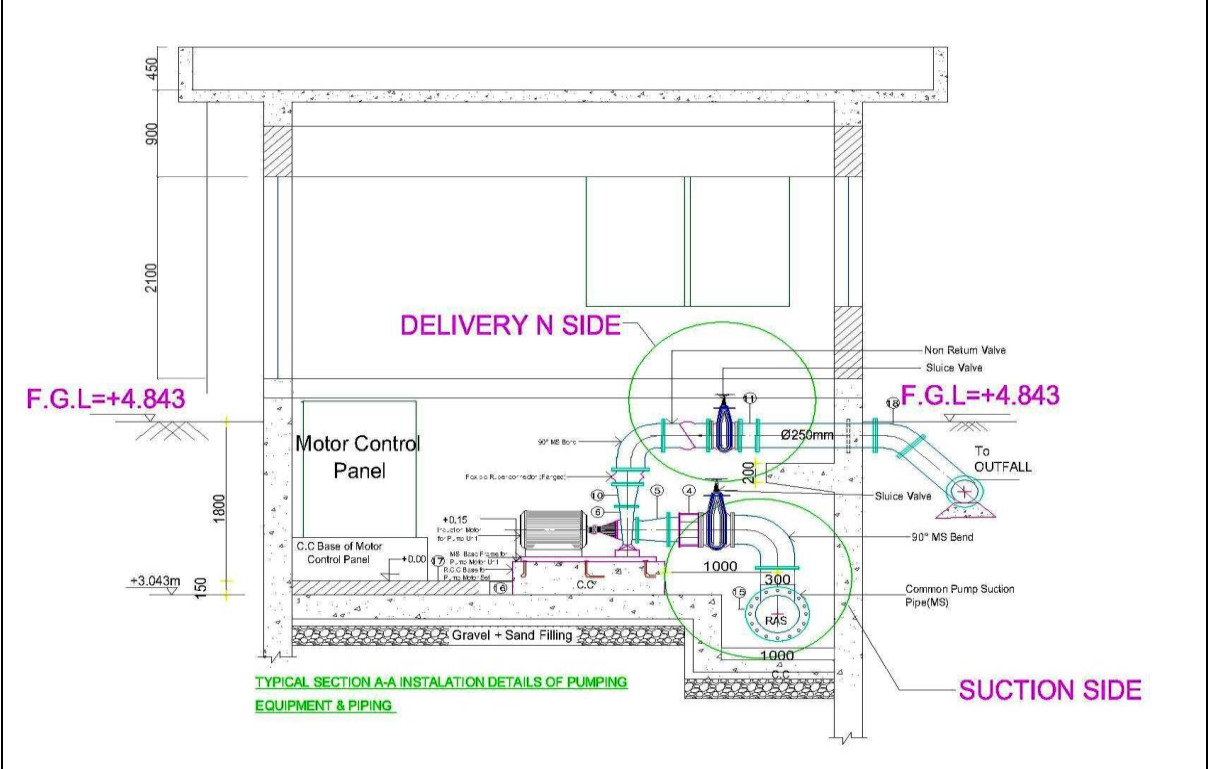
SN	Construction Activities	Images
10.	<p>Soil Compactors</p> <p>✓ There are a variety of soil Compactors such as. Compactor/Roller, Vibrating Roller, Vibrating rammer etc.</p>	 <p>Compactor/Roller</p>
11.	<p>In-Situ Dry Density of Soil By Sand Replacement Method</p> <p>To obtain proper compaction of filled soil/sand for embankment, field in-situ soil degree of compaction shall be carried out during the construction period. Usually 90 to 95% compaction are done for obtaining maximum dry density at optimum moisture content. Proper compaction is done by knowing the optimum moisture content and hence it is very important.</p> <p>This test is done to determine the in-situ dry density of soil by sand replacement method as per IS: 2720 (Part XXVIII) – 1974. The apparatus needed is</p> <ol style="list-style-type: none"> Sand-pouring cylinder conforming to IS: 2720 (Part XXVIII) -1974 Cylindrical calibrating container conforming to IS: 2720 (Part XXVIII) – 1974 Soil cutting and excavating tools such as a scraper tool, bent spoon Glass plate – 450mm square and 9mm thick or larger Metal containers to collect excavated soil Metal tray – 300mm square and 40mm deep with a 100mm  	 <p>Cylinder for in-situ Compaction Test</p> <ul style="list-style-type: none"> Standard Proctor Test (Compaction Test) Compaction Curve(left)

SN	Construction Activities	Images
OTHER MEDIUM TYPE OF SLOPE PROTECTION WORKS FOR RIVER,CANAL WITH GABION		
1.	<p><u>Gabion Wire Mesh</u></p> <p>Types of Gabions There are number of gabion configurations that can be selected based on their cost and function. Common types of Gabion are as follows:</p> <p>1. Gabion baskets</p> <ul style="list-style-type: none"> • It is a net wire mesh that produced in box-shaped and in different sizes. • Used in highway and railway works. • It would be economical unless filling materials are available from quarries near the project site. 	
2.	<p><u>Gabion mattresses</u></p> <ul style="list-style-type: none"> • Gabion mattresses, also known as reno mattresses. • Gabion mattresses height is shorter than the other types of measurements as it might be observed from the Fig. 3. • It is employed in the channel coating for preventing erosion. So, it tackles wave and erosion induced velocity. • Common size, 6 m long by 2 m wide by 0,3 m high. 	
3.	<p><u>Gabion mattress</u></p>	
4.	<p><u>Gabion sacks</u></p> <ul style="list-style-type: none"> • This type of gabions is formed quickly. • It has a porous and flexible structure. • Gabion sacks are usually used in hydraulic works in emergency conditions. 	

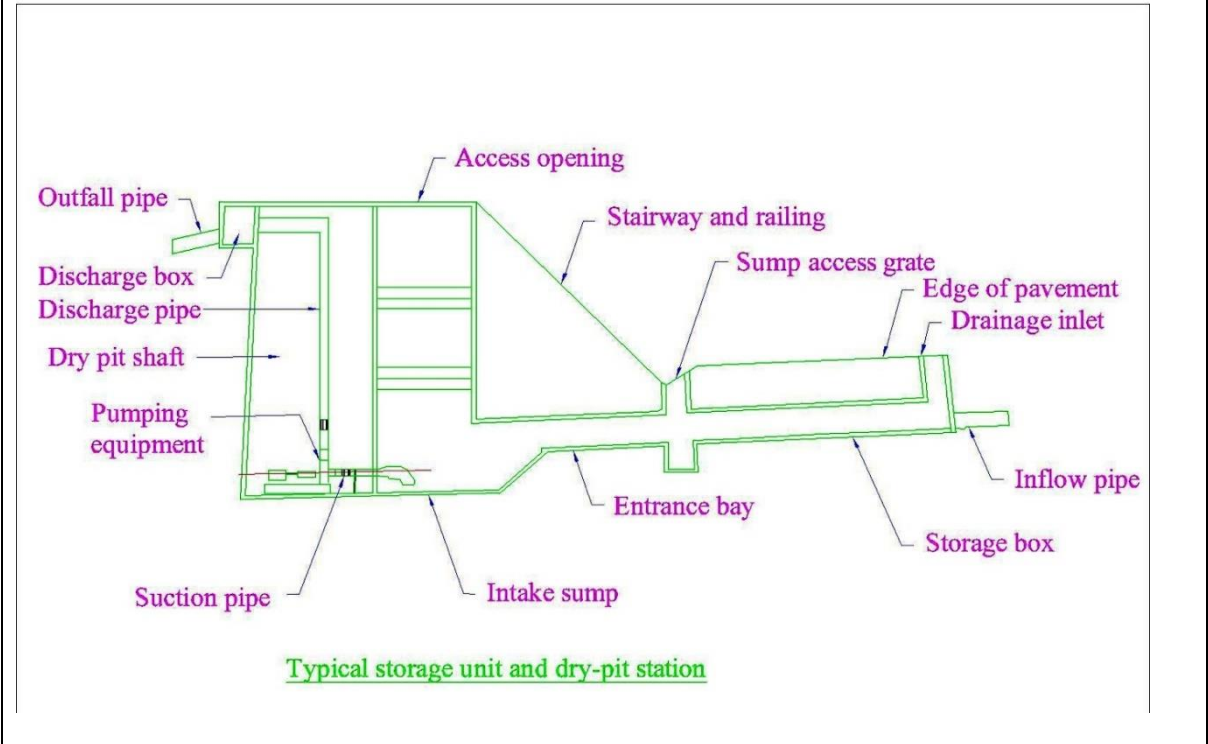
SN	Construction Activities	Images
5.	<p><u>Gabion wire mesh</u></p> <ul style="list-style-type: none"> • It is utilized to keep the possible rock and stone fall on the highway and railway surfaces. • Gabion wire mesh maintains stability of the slope close to highway and railways. • It is applied for anti-erosion to slope. • It enhances embankment soil strength in combination with geogrid reinforcement. 	
6.	<p><u>Decorative Gabion Elements</u></p> <ul style="list-style-type: none"> • It is used indoor and outdoor decoration, garden design and landscaping. • Gabion elements offer suitable environment for the growth of plant roots 	
7.	<p><u>Applications of gabions</u></p> <p>Gabions are used in several engineering projects and serve various purposes. common applications of gabions are as follows:</p> <ul style="list-style-type: none"> • Retaining structures such as retaining walls (Fig. 7), revetment and toe walls to embankments and cuttings. • Corrosion prevention structures for instance sea walls, river bank defenses, canal banks (Fig. 8), dams, weirs, groynes and for the protection of reservoirs and lakesides. • Cylindrical metal gabion is used for dams or in foundation construction. • It is employed as a noise barrier. • Gabions are also used as a temporary flood walls. • It is utilized to change the direction of the force of flood water around weak structure • Stepped gabions improve energy dissipation in channels. • Finally, it is used for aesthetic purposes 	

SN	Construction Activities	Images
8.	<p><u>Soil Reinforcement</u></p> <p>Soil Reinforcement is in the form of a weak soil reinforced by high-strength thin horizontal membranes. A large variety of materials such as rubber, aluminum and thermoplastics have been used successfully</p>	
9.	<p><u>Geotextiles, Jute Bag</u></p> <p>Geotextiles are porous fabrics manufactured from synthetic materials, which are primarily petroleum products and others, such as polyester, polyethylene, polypropylene and polyvinyl chloride, nylon, fibreglass and various mixtures of these. Geotextiles are used as separators, filters, Drains, reinforcement, geomembranes etc. A better and eco-friendly alternative is jute bag.</p>	 <p style="text-align: center;">Geocell</p>  <p style="text-align: center;">Geotextile</p>
DRAINAGE		
<p>The drainage components are:</p> <ol style="list-style-type: none"> i. Civil works as similar mentioned above ii. Installation of Pumping Equipment iii. Selection of Pump type: <ul style="list-style-type: none"> ✓ For drainage: Non-Clog any kind of Pump 		

SN	Construction Activities	Images
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SHOWING DIFFERENT SECTION OF PUMP WITH PUMP HOUSE



SHOWING DIFFERENT SECTION OF PUMP WITH PUMP HOUSE-INLET & OUTLET

SN	Construction Activities	Images
	 <p>INLET & DELIVERY OF STORM WATER DRAINAGE</p>	
	 <p>PIPE DRAIN CLEANING VACCUM PUMP</p>	

5.7 Conclusion

One of the biggest concerns for our water-based resources in the future is the sustainability of the current and even future water resource allocation. As water becomes scarcer the importance of how it is managed grows vastly. Finding a balance between what is needed by humans and what is needed in the environment is an important step in the sustainability of water resources. Water resources management in Bangladesh faces immense challenge for resolving many diverse problems and issues. The most critical of these are alternating flood and water scarcity during the wet and the dry seasons, ever-expanding water needs of a growing economy and population, and massive river sedimentation and bank erosion. There is a growing need for providing total water quality management (checking salinity, deterioration of surface water and groundwater quality, and water pollution), and maintenance of the eco-system

The sustainable water resources management will have to continue to adapt to the current and future issues facing the allocation of water. With the growing uncertainties of global climate change and the long term impacts of management actions, the decision-making will be even more difficult. It is likely that ongoing climate change will lead to situations that have not been encountered. As a result, new management strategies will have to be implemented in order to avoid setbacks in the allocation of water resources.

*Checklist for Water Resource Management Sector Project **Annex-15***

*Template for Water Resource Management Sector Project **Annex-16***

*SMART Indicator for Water Resource Management Sector Project **Annex-17***

CHAPTER SIX

M&E GUIDELINES FOR SHIPPING SECTOR

6.1 Glossary

Aids to Navigation	Markers with known charted positions located and designed to enable mariners to avoid dangers and fix their positions. An Aid to Navigation (ATON) is any device external to a vessel specifically intended to assist navigators in determining their position or safe course, or to warn them of dangers or obstructions to navigation. Examples are buoys, ranges, and electronic aids.
Amplitude	The maximum value of a fluctuating or oscillating (usually periodic) variable or quantity from the mean value. For a harmonic sinusoidal water wave, the amplitude is one-half the wave height.
Anchorage	A customary, suitable, and usually designated area in a harbor set aside for vessels to anchor and await berthing space, repairs, etc. A sheltered area in a harbor reserved, legally or by custom, for anchoring vessels. Usually designated by the U.S. Army Corps of Engineers and depicted on appropriate nautical charts.
Basin	A comparatively large excavated space at a dock or in a waterway or channel, configured to permit the turning or other maneuvering of vessels to enter a dock or berth or depart from port.
Bathymetry	The measurement or portrayal of the underwater portion of navigation channels, coastal areas, or ocean topography; typically, a map of a region with depths and contours shown over the area.
Backhoe dredgers	Backhoe dredgers are a very common type of dredging machine which is usually not self-propelled. The most important part of the machine is the hydraulic excavator dredging from a pontoon.
Beacon	A fixed aid-to-navigation marker located on the edge of a channel or in shoal water for use by mariners.
Beam	One of the three principal dimensions of a ship; the width of a vessel in a transverse horizontal direction at its widest point.
Bend	A channel turn that is designed as a continuous curve with a given radius; usually provided for large channel changes (or turn angles) in direction.
Berth	A vessel position at a dock or wharf for loading or unloading cargo and designed to provide safe mooring. Generally, the space allocated to a vessel when secured at a pier or float, either moored or at anchor. More generally, a place where a vessel is moored at a wharf or lies at anchor.
Breakwater	A structure made of riprap, stones, or concrete blocks built to reduce wave effects and create a harbor or improve navigation conditions at a harbor entrance channel.
Bulk vessel	All vessels designed to carry bulk cargo such as grain, fertilizers, coal, ore, and oil.
Buoy	Floating marker moored to the bottom in a specific place used as an aid to navigation marking the edge of channels or indicating wrecks, rocks, or other navigation hazards.
Canal	An excavated watercourse, usually artificially cut through land area, without any existing channel, designed for navigation. Canal edges or

	borders usually extend above the water surface with visible banks and important ship and bank interaction effects.
Channel	The deeper, navigable portion of a waterway, usually marked and designated on the appropriate navigation charts with known widths and depths. Part of a watercourse used as a fairway for the passage of shipping. May be formed totally or in part through excavation, such as dredging
Channel depth	The vertical distance from the water surface to the bottom of a channel; normally referred to some datum, such as mean lower low water (MLLW) in a tidal channel i.e. chart datum
Charts	Maps of water areas provided to mariners and intended for navigation. Charts usually provide land and underwater depth data as well as location of aids to navigation. Other useful navigation information, such as shore contours, hazards, and landmarks are also provided
Chart datum (CD)	A chart datum is the level of water that charted depths displayed on a nautical chart are measured from. A chart datum is generally a tidal datum; that is, a datum derived from some phase of the tide. Common chart data are lowest astronomical tide and mean lower low water (MLLW)
Container Terminal	An area designated for the handling, storage, and possibly loading or unloading of cargo into or out of containers, and where containers can be picked up, dropped off, maintained, stored, or loaded or unloaded from one mode of transport to another (that is, vessel, truck, barge, or rail).
Current	A generic term referring to the horizontal movement of water caused by various forces, as river currents or tidal currents. Currents may be described by magnitude and direction; the latter being presented as the angle toward which the current flows
Cutter Suction Dredger (CSD)	A dredger equipped with a rotating cutter head cutting hard soil into fragments. The cut soil is then sucked in by dredge pumps. Cutter suction dredgers are mostly stationary suction dredgers that cut the soil according to a pre-set profile. The material is then pumped ashore using pumps and a floating pipeline or loaded into a split hopper barge moored alongside, which in turn can then dump the dredge spoil at the set location
Datum	The plane or level to which soundings, elevations, tide heights, and channel depths are referenced. Usually, some low-water datum is used, such as mean lower low water (MLLW)
Draft (or Draught)	The depth of a ship while in the water. Measured as the vertical distance between the waterline and the lowest edge of the keel. This varies with the amount of cargo carried and distribution of the cargo in the vessel. Draft determines the minimum depth of water a ship or boat can safely navigate
Design draught	The maximum distance from the waterline to the lowest point of the keel when the vessel is fully laden.
Design Vessel	The design vessel is the vessel for which the main channel dimensions are determined, and is usually the vessel which will constitute the greatest risk of incident in the channel. For design purposes, a real vessel from the

	current or future fleet using the port, or a hybrid encapsulating the worst features of a range of vessels is often used.
Deadweight Tonnage (dwt)	The rated carrying capacity of ships in tons. The capacity will vary with actual ship draft. The total weight of cargo, stores, crew, fuel, fresh water, etc., which a ship can carry.
Dredging	Removal of sediment to deepen access channels, provide turning basins for ships, and maintain adequate water depth along waterside facilities
Dredged Depth	The Admiralty Charts is the distance from Chart Datum (CD) to the top of the sea bed.
Dry bulk	Loose, mostly uniform cargo, such as agribulk products, coal, fertilizer, and others, that are transported in bulk carriers
Fairway	A navigable pathway in an open and unobstructed waterway, such as a bay, lake, sound, or strait, usually leading into a harbor from the open sea. Includes waters convenient for navigation outside a buoyed channel, ordinarily used by vessel traffic, and so designated by appropriate authority.
Harbor	A fully or partially enclosed body of water offering safe anchorage or reasonable shelter to vessels against adverse environmental conditions; a protected water area that may be natural, artificial, or a combination.
Hydrographic Survey	Hydrographic survey is the science of measurement and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration/offshore oil drilling and related activities.
Jetty	Generally a solid structure built out into the sea or along the shore as a part of a port. Also used to protect a harbor entrance channel from wave effects and to decrease shoaling from littoral material
Maneuverability	The quality of a ship used to describe the ability to change course or to move off track while underway by the application of steering and engine controllers.
Maneuvering	That branch of naval architecture used to describe vessel response; relates the ease of changes in direction and speed with rudder and engine control parameters.
Neap Tide	Tide height variation of decreased range and resulting smaller tidal currents occurring every 2 weeks during the lunar month, the lowest tide.
Pilotage	The act of assisting the master of a ship in navigation when entering or leaving a port or in confined water.
Port	A place in which vessels load and discharge cargoes and passengers. Facilities normally include berths, cargo handling equipment and personnel, cargo storage facilities, and land transportation connections. Often with a city, town, or industrial complex.
Shallow Water	A descriptive term to characterize navigation in waterways where the depth of water is shallow enough to cause significant ship hydrodynamic responses. Normally, at depth to draft ratios of 5 or less.
Ship	A self-propelled, decked vessel used in oceangoing, deep-water navigation for military purposes or waterborne commerce.
Shoal	An area of shallow water, usually near a channel or in a waterway, usually consisting of deposited material, and particularly considered a hazard to navigation

Starboard	The right side of a ship, while facing forward; in piloting, a right turn.
Spring Tide	Tide of increased range and current that occurs about every 2 weeks during the lunar tidal cycle; the highest tide.
Tidal Advantage	The additional channel depth and thus ship draft that can safely be brought into a port by taking advantage of vertical tide fluctuations and the additional available water when the tide level is higher than the channel depth datum (usually mean lower low water)
Tide	The periodic rising and falling of the water that results from gravitational attraction of the moon and sun acting on the rotating earth. The tide should be distinguished from tidal current.
Transit	A passage of a vessel from point to point in a waterway.
Trailing Suction Hopper Dredger (TSHD)	A ship that has a full sailing capacity used to maintain navigable waterways, deepening the maritime channels that are threatened to become silted. This is made possible by large powerful pumps and engines able to suck sand, clay, silt and gravel. A trailing suction hopper dredger is self-loading/unloading and sometimes equipped with a pressurized discharging system
Tug boat	A strongly built, highly powered vessel specially designed to pull or push other vessels while maneuvering at low speeds.
Turning basin	An open area along or (more usually) at the end of a waterway or navigation channel to allow vessels to bring about to change direction of ship transit.
Turning circle	The circle a vessel describes when turning with rudder hard over. The Turning circle is the path of the ship's pivot point as it executes a 360° turn.
Vessel	A general term referring to all types of self-propelled watercraft including ships, towboats, barges, tugs, yachts, and small boats.
Waterway	A navigable body of water connecting two or more geographical points in which vessels travel, including connecting basins, canals, and berthing areas.
Wave	A disturbance or undulation of the surface of the sea that usually moves across the water surface.

6.2 Introduction

Shipping plays a vital role in world trade and is the backbone of the world economy. Around 90% of world trade is carried by the international shipping industry. Without shipping the import and export of goods on the scale necessary for the modern world would not be possible. Seaborne trade continues to expand, bringing benefits for consumers across the world through competitive freight costs. (ICS, 2017).

Bangladesh is a maritime nation with 166,000 sq. km area of sea, abundance with living and non-living resources (Alam, 2004). There are more than 200 rivers all around the country, with a total length of about 22,155 km, which occupy about 11% of total area of the country. Here rivers and water transports play a vital role for economic and commercial activities in Bangladesh. Major export and import of Bangladesh (about 85%) is also traveled by sea (CPA, 2007). At present more than 5,000 inland/coastal ships have been plying all over the country, which carry more than 90% of total oil product, 70% of cargo and 35% of passengers. More than 100,000 skilled workers and 150,000 semi-skilled workers are employed in this labor-intensive industry (Hossain and Zakaria, 2008). All inland ships are constructed and repaired in local shipyards. Bangladesh harbors the second largest ship breaking industries in the world. They are the prime source of raw material including plate, frame, stiffener, and longitudinal pipe, old engine/generator, and even auxiliary machinery, for most of the local private shipbuilding yards. Those are used as raw material in manufacturing and repairing inland shipping fleet (Alam, K. 2004).

6.3 Literature Review

The World Association for Waterborne Transport Infrastructure (2014) describe as the Ports are nodal points or hubs in the transport network who's industrial and business areas add value to the transported goods. This report focused on the sustainable development and green growth of ports and the related logistic chain and added value activities for development. This report has prepared for the Long-term vision which strives towards an acceptable footprint on environment and nature. This report will supportive for transparent stakeholder participation and stakeholder approved strategies to operate and grow. Shifting from sustainability as a legal obligation to sustainability as an economic driver (economic development and sustainable development as complementary factors) of a country, active sharing of knowledge with other ports and stakeholders are also discussed. The continuous striving towards innovation in process and technology development is also highlighted in this guide.

Japan International Cooperation Agency (JICA) 2018 purposes of this survey is to examine the scope of the proposed project including procurement method, project cost, construction cost, the implementation body, the management system and required environmental and social consideration to determine whether the project can be carried out under yen loan assistance. This survey focused on the analysis on the international maritime network and coastal shipping, and providing data to the outline design; navigational channel and basin sedimentation; shoreline change; offshore dumping of dredged material; existing access road, bridges and surrounding area etc. The report illustrate the Future Traffic Demand Forecast, Outline Plan of port development, Dredging plan, Conceptual Design of Port Facility, Cost Estimation, Planning and schedule, Implementation System, Operation, Maintenance and Management, Environment and Social Considerations, Response to climate change and mitigation measures, Economic/Financial Analysis and Performance Indicators etc.

Pilbara Ports Authority (2016) aims to provide proponents with a guide for the preparation of a Construction Management Plan (CMP). This document provides general information on the format and content of a CMP that is acceptable to PPA. The CMP is required to provide an overview of the

construction methodology, plant and equipment to be used in delivering the project. It also includes the key activities of the project and details of work method statements and procedures related to the construction stage. Elements covered by a particular CMP may vary according to the nature, size and complexity of the proposed development. It also considered the various management plans at different phases like communications plan, community and stakeholder management plan, environment management plan, risk management plan etc.

ESCAP (1992) targeted to minimize these adverse effects that may be created by port development projects the techniques of Environmental Impact Assessment (EIA). It focused on the environmental impacts of various activities at different phase of a Port development that may create a wide range of impacts on the environment by dredging, construction work, landfills, discharges from ships and waterfront industries, cargo operations, and other port related activities. The potential adverse effects of port development encompass water pollution, contamination of bottom sediments, loss of bottom habitat, damage to marine ecology and fisheries, beach erosion, current pattern changes, waste disposal, oil leakage and spillage, hazardous material emissions, air pollution, noise, vibration, visual pollution, and other unhealthy socio-cultural impacts.

Japan International Cooperation Agency (JICA) 2017 aims to explaining the significant impacts that merge cause by every activity of Patimban new Port to Components of Chemical Geophysics, Biology, Social-Economical-Cultural, and Public Health; determine activity steps to handle/overcome negative impacts and improve positive impacts of Patimban New Port which have evaluated and declared as significant impact; clearing governmental institutions or bodies which have duty to supervise those activity steps for effort to manage and handle environmental impacts. This report also considered the Environmental Monitoring Plan (EMoP) activity with purpose to fulfill government provision about environment monitoring and implement policy of development with environmental insight.

City Group (2018) Guide Lines of New Shipbuilding Monitoring & Evaluation for Shipyard Engineering and Material Management. This guideline covers the Basic Design Review, Material Preparing and Supply Chain Planning, Working/Production Drawing Preparing, Inspection and Testing Plan Preparing, Production Planning, Ship Building Process (Production) etc. It also focused on the Material Processing, Hull / Steel Fabrication, Piping System Fabrication and Routing, Outfitting Item Installation, Machinery and Equipment Installation and Commissioning, Painting and Surface Protection, Electrical Switchgear Installation, Cable Laying and Commissioning, Navigational and Communicational Equipment Installation and Commissioning. The total Quality Control And Management, Material Certificate Checking, Hull Fabrication and Welding Quality Control , Tank Test, Hydro Test & Commissioning Data Checking And Reporting, Pre-Launching Documentation, Light Ship Survey And Documentation, Test-Trial And Final Documentation , Vessel Handed Over To Owner also described in this guideline.

Specific ports in operation (Port of Hong Kong)

The Port of Hong Kong is the world's third largest container port based upon TEU throughput. It has nine container terminals with 24 berths and 2,009 kilometers of paved roadways. By 2020 six additional berths are expected to be in operation. Its container terminals are operated by five terminal operating companies: Modern Terminals, Hong Kong International Terminals (HIT), COSCO-HIT Terminals (a joint venture between China Ocean Shipping Company and HIT), DP World, and Asia Container Terminals. In addition to containers, liquid bulk (petroleum) and solid bulk (coal) cargoes, as well as cruise vessel passengers, are handled by the port. Hong Kong is a deep-water port with water depths of 15.5 meters in its approach channel and at its berths. The port is located on a relatively small amount of land, thereby necessitating the stacking of stored containers. Transtainers are used in the stacking and unstacking of containers to and from its six-container-high stacks.

The Port of Hong Kong is a major transshipment container port, i.e., 21.2 percent of its total TEU throughput in 2006 was transshipment throughput (Wallis 2008). Hong Kong's throughput growth slowed in 2007 due in part to the growth in container throughput in the ports of southern China, especially at the Port of Shenzhen (Hong Kong 2008). The high cost of trucking cargo from China to Hong Kong has resulted in a number of southern China shippers choosing southern China ports over Hong Kong, e.g., truckers are required to have a license (at a cost of \$HK800 or more) to transport containers from southern China to Hong Kong. As a result, the cost of transporting a 40-foot container from the east side of China's Pearl River delta to the U.S. West Coast is \$HK277 higher through Hong Kong than through the Port of Shenzhen (Wallis 2008).

The Port of Hong Kong is at a competitive price disadvantage with southern China ports (for cargo originating in southern China) given its relatively high trucking and terminal handling prices. However, it has a competitive service advantage over southern China ports in terms of its (1) fast vessel turnaround times (averaging 13 hours per container vessel in 2006) and (2) accessibility to other major ports in the world, given that a large number of shipping lines call at the port, including the world's top-ten largest container shipping lines.

In 2003, China's government endorsed the concept of constructing a 22-mile bridge-tunnel complex linking Hong Kong with seaports in the Pearl River Delta region of southern China. However, it was not until 2008 that a financial plan emerged to pay for its construction (estimated between \$HK4 to \$HK6 billion dollars). Hong Kong, the administrative region Macau, and the province of Guangdong agreed to pay 50.2, 14.7, and 35.1 percent of the bridge-tunnel construction cost, respectively (Dibenedetto, 2008). The estimated completion date is 2015. The Zhuhai-Macau-Hong Kong bridge-tunnel is based on the Chesapeake Bay bridge-tunnel in the U.S. state of Virginia. The two bridges for the former bridge-tunnel will be 18.2 miles in total length and six lanes in width. The tunnel will be more than 4 miles long and laid 70 feet below the water surface. Two artificial (manmade) islands, each more than a half-mile long, will be built to join the two ends of the tunnel to bridge segments.

A significant growth in container barge traffic (in response to the high trucking costs) has occurred in recent years. Hong Kong has a vessel traffic service (VTS) system that monitors the movement of vessels in its waters for the prevention of vessel accidents. The Harbor Patrol Section patrols the Hong Kong harbor to prevent and investigate pollution activities.

Dry-dock

Bangladesh has about one hundred dockyards or shipyards as of now in and around Dhaka, Narayanganj, Chattogram, Khulna, Mongla & Barishal. These dockyards are operating predominantly under individual management, with some overseeing from the government. Most of the private dockyards use plate, engine, component and machinery of old merchant ship; which collect from Bhatary ship break-yards in Chattogram. At present, some private dockyards or shipyards already attained international standard and are manufacturing vessels for international market. Private dockyards employ great number of skilled, semi-skilled and unskilled labours. Recently few of these dockyards specially Ananda Shipyard & Slipway Ltd (ASSL), Dhaka and Western Marine Shipyard (WMS), Chattogram have attained the capability to manufacture export quality ships. Seven more local dockyards are capable to build ships up to 10000 tonnes capacity as per international standards. High speed Shipyard has 50 years of shipbuilding history. High speed constructed five deep-sea fishing trawlers for local owners and built up eight food grain carriers' cargo vessels in 1980s for FAO (Food and Agricultural Organization of UN). It built the first barge-mounted power plant for Rural Power Company Ltd. (RPCL), several oil tankers, and fast-moving patrol boats for Bangladesh Navy and troop's carrier for the Bangladesh Army. Some private dockyards are also manufacturing very good quality small and medium new ships for international market. These local dockyards are

receiving orders from the foreign ship buyers since 2000. In 2008, Ananda Shipyard delivered a ship of 2850 tones capacity to a Danish company, built at a cost of US\$ 7 million.

In the public sector, the most significant is the Chattogram Dry Dock Limited (CDDL). It is the only dockyard, comparatively modern and equipped with advanced machinery and facilities to build up ocean going ship with a capability of 20000 tones. It earns millions of dollars by repairing local and international ships. But, other two publicly owned dockyards have become losing concerns. The oldest public Dockyard and Engineering Work Ltd (DEW), Narayanganj, is providing services to new shipbuilding and repair sectors in this region since 1926. It's present capability of building and repairing versatile types of vessels up to 5000 tones.

After being modernized in 1989, the yard has constructed some world Class Ro-Ro ferries under a Danish aided project for BIWTC. But DEW has declined in its reputation now. After declaring as a sick industry in 2002 it was closed and finally handed over to Bangladesh Navy on Dec 07, 2006. Presently DEW is running by Bangladesh Navy and Modernization or BMRE is going on.

Another public Dockyard, Khulna Shipyard Ltd (KSY), was commissioned about 43 years ago. It was also declared as a sick industry and later Bangladesh Navy took it over. But there was no sight of profit for a long time. But now KSY is earning profit. Gun Boat, Cargo Vessels, Floating Cranes, Water Barge, Water Boat, Tug, Oil Tanker, Pontoon, LCT, Trawlers, launch etc. of up to 5000 tones capacity have so far been designed, constructed, repaired and renovated at the KSY. Its versatile dock facilities can accommodate sixteen medium size vessels at a time for repair or new building. Since 1957 Khulna Shipyard has built 350 vessels and renovated as repaired over 2300 vessels. Bangladesh Navy owns the country's only floating dock, BNFD Sundarban. It can dock up to 3000 tones vessel for repairing and manufacturing. However, Bangladesh Navy used this floating dock for repairing of its warships.

At present about 2000 coastal Tanker, Cargo, Multipurpose and trawlers plying in the coastal area and the ocean are entirely made by Bangladeshi dockyards of which only 400 are registered at Mercantile Marine Department (MMD). Bangladeshi dockyards also make various cargo and passenger inland ships for inland routes. About two million people are directly or indirectly related either with the ship building industry. BANGLADESH INLAND WATER TRANSPORT CORPORATION's (BIWTC) own 24 passenger steamers, 33 ferry steamers, 20 coasters, 7 inland barges, 10 sea trucks, 12 tankers and 227 other vessels.'

The vessels built in various Bangladeshi dockyards are: Multipurpose vessel or Coaster, Dry Cargo Vessel, Passenger Vessel, Dredging Barge, Tanker, Landing Craft, Tug, Supply Barge, Ro-Ro Ferry, Hospital Ship, Tourist ship, Deck Loading Barge, Pleasure Craft/Yatch, Crane Boat, Speed Boat, Hydrographic Survey Boat, Double Decker Passenger Vessel, Troops Carrying Vessel, Cargo Coaster, Inspection Vessel, Self-Propelled Barge, Pontoon, Pollution Control Vessel, Deep Sea Trawler, Fast Patrol Boat, Container vessel, Pilot Boat, Water Taxi, Catamaran Vessel, Sand Carrier or Small Cargo Carrier, Dump Barge etc. [Source: Banglapedia]

6.4 Stages of Port Development

6.4.1 Pre-Construction Phase of the Project

- **Site Selection**

The choice of location for the installation of a port or terminal, referred to as “site selection”, is one of the most important decisions for the success of any project. The more judicious in the study of site selection, the greater the chances of the project viability. The ideal place to build a port has, among other characteristics: adequate depth, shelter from waves and sea currents, good logistic access and proximity to areas with export and import demands. These particularities, besides

directly influencing the cost of implementing the project, are a relevant factor in the definition of project viability and are directly related to the attractiveness of the port location.



Figure 38: An Ideal Location for Port Construction

The development of a single or multi-user port facility must start with a commercial or market feasibility study. This should show the requirements and opportunities for loading and offloading over time in a particular region, the potential product types and mix. Some measures need to comply in the selection process that includes navigational facilities, well road connectivity, land availability for future expansion, barren land/ land that is not suitable for agricultural productivity, have accessibilities of necessary utilities such as road, gas and electricity, skilled and unskilled manpower availability.

- **Land Acquisition and Resettlement**

The project should start after acquisition of required land. The process of land acquisition should comply with the Land Acquisition Act, 1894 and The Acquisition and Requisition of Immovable Property Ordinance 1982 and subsequent amendments in 1994, 1995, 2004. If there is any issue of resettlement then the project authority should prepare the Resettlement Action Plan (RAP).

- **Area Demarcation**

The demarcation of the project area includes survey the land and marked the area by temporary marking or the fence. The project authority can also construct the boundary wall to make visible of the project boundary.

- **Arrangements of Necessary Utilities**

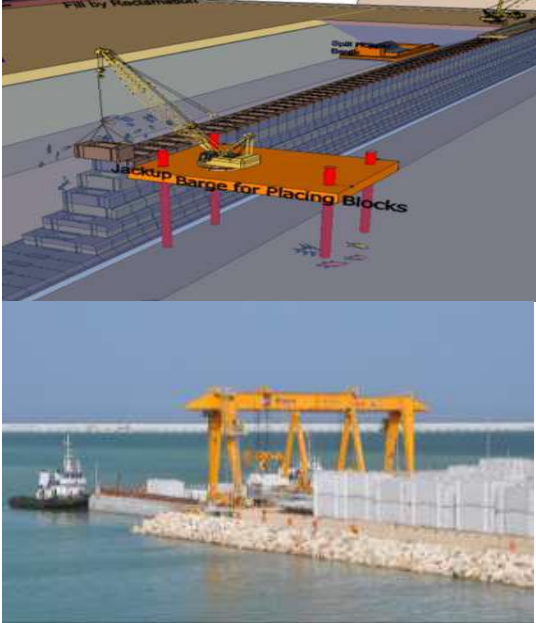
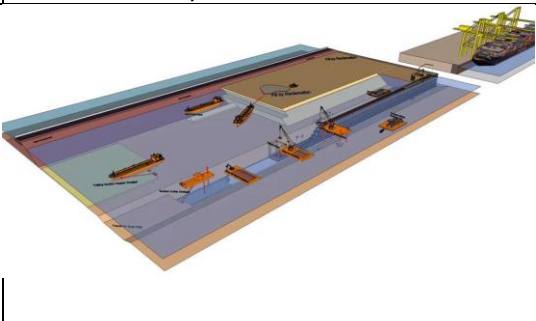
Once the commercial viability of the new project has been established the next step is to determine the construction of the facility. To do this a trade-off study should be carried out to establish what type of facility is most suitable; a near shore facility, or offshore facility accessed by a trestle, is dredging required, is a breakwater required to shelter the berth, are support facilities like a tug harbor required, or support vessel or barge berths. The trade-off studies allow a quantitative approach to assessing the optimal general arrangement of the facility. Once this is established the cost and development schedule can be produced.




From the logistics point of view, attention should be paid to the distances and quality of access to the future port by road, rail, pipeline, conveyor or a combination of these. In addition, it is essential to identify the availability of on-shore area for terminal construction, product storage and future expansions. Computer simulations can assist with defining the logistics solution.


6.4.2 Port Construction


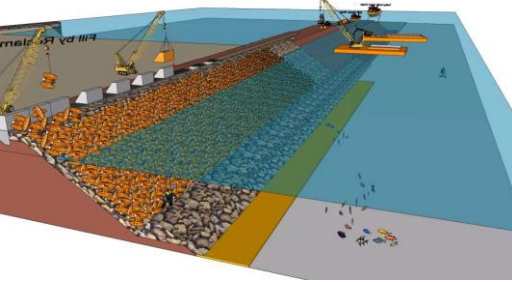

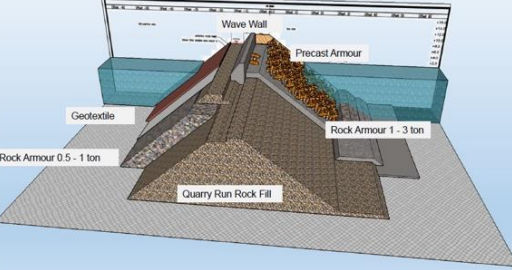

The main components for port construction are as follows-






1. Quay wall
2. Breakwater and wave wall
3. Precast yard and jetty
4. Dredging and reclamation
5. Vibrio compaction
6. Surveying and setting out
7. Port operation
8. Site facilities and temporary work
9. Safety and environment
10. Program and process monitoring



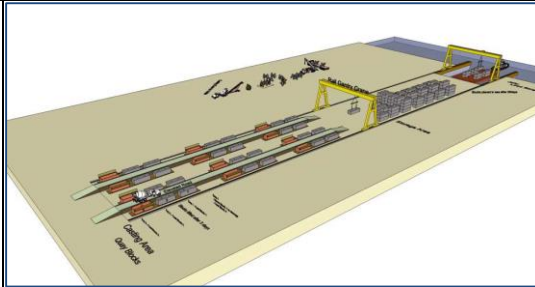
SN	Name of the Items	Images
1.	<p><u>Quay wall</u></p> <p>The quay wall is constructed using precast reinforced concrete hollow blocks that weigh up to 160 tons. The blocks were cast in the on-site precast yard and loaded onto barges at the temporary loading jetty that had a 200 tons capacity gantry crane.</p> <p>A screening frame that extended from the sea bet to above water was used to place the bedding layer to the correct level. Up to 22 blocks were placed per day using a barge with a crane. Part of the coping beam was cast in-sit-u in sections using concrete pumps positioned on the reclaimed land behind the quay wall.</p>	 <p style="text-align: center;">Quay wall construction</p>
1.1.	<p><u>Sequence & Methods to Construct Quay Wall</u></p> <p>Quay walls can be built in different ways. Specific methods have evolved for each region and harbor, depending upon the local topography, soil conditions and the availability of materials and equipment. A reinforced concrete superstructure supported by a sheet-pile bulkhead on the water side and a pile bent or rows of battered piles on the land side has been typical for the Port.</p>	




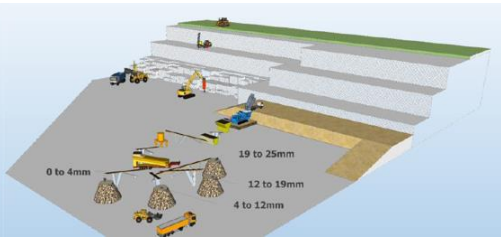

SN	Name of the Items	Images
1.2.	<p><u>Placing Precast Quay Blocks</u></p> <p>Precast concrete elements are used for the construction of the quay wall, furthermore for the construction of a concrete wall for a pier and for the construction of the breakwater wall protecting the vessels in the port.</p> <p>Plain precast blocks are typically unreinforced giving advantages of increased longevity. Due to the generally aggressive exposure conditions of maritime works, reinforced concrete elements are often formed with a combination of protected reinforcement, increased cover and corrosion resistant concrete.</p>	 <p>Placing Precast Quay Blocks</p>
1.3.	<p><u>Screed Frame for preparing Granular Foundation</u></p> <p>A floor screed is usually a cement material made from a 1:3 or 1:4.5 ratio of cement to sharp sand. It may be applied onto either a solid in-situ concrete ground floor slab or onto a precast concrete floor unit. There are many proprietary screeds on the market and information about these can be obtained from the manufacturer.</p>	
1.2.	<p><u>Quay Wall Beam</u></p> <p>The quay wall beam is executed as a combined wall of steel tubular king piles with steel sheet pile infill elements. The anchorage of the quay wall consists of tie rods each connected to the tubular king piles a tied back to a sheet pile anchor wall. On top of the combo wall a concrete coping beam with its top elevation at +3.45m CD and with section lengths of approximately 12 meters provides load distribution of forces from bollards, fenders and non-uniform tie rod forces.</p>	 <p>Quay Wall Beam</p>


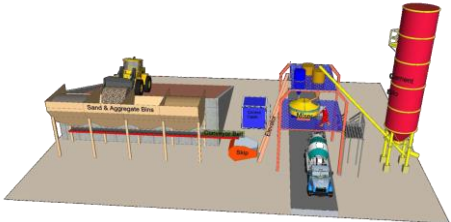


SN	Name of the Items	Images
1.3.	<p><u>Screed Frame</u></p> <p>The screening frames determine the shape and thickness of the floor. They are made of steel. The screening frame is connected to the table by the hinges located at the back. The front part of the frame is equipped with two square hooks forming the upper part of the lock.</p>	 <p>Construction of Screed Frame at Al Duqm Port & Dry-dock, Oman</p>
1.4.	<p><u>Mooring Bollards & Marine Fenders</u></p> <p>Mooring bollard is a vital component of any mooring system. It is the anchor point for mooring lines to be fixed in order to secure the vessel. It is usually a short post on a quay / jetty.</p> <p>Since the beginning of maritime history, people has been using wooden posts or iron structures for this purpose. With newer advanced manufacturing technology, reputable manufacturers of today study the strength and durability of materials while having a safety factor as a safety cushion. Designing and choosing the right components is a big part. Ductile iron, cast steel and stainless steel are some of the main materials used to make marine bollards.</p>	 <p>Mooring Bollards & Marine Fenders</p>
2.	<p><u>Breakwater &Wave wall</u></p> <p>The breakwater is constructed using core rock, rock armour, precast armour units and geotextile. The core rock is placed using split hopper barges in deep water and by lorry tipping and dozers in shallow water where the risk of slippage is minimal.</p> <p>The precast armour units are placed using crawler cranes fitted with a real-time visual aid system that enabled 70 placements per day. The wave wall is cast in-sit-u in 6-metre-long sections.</p>	

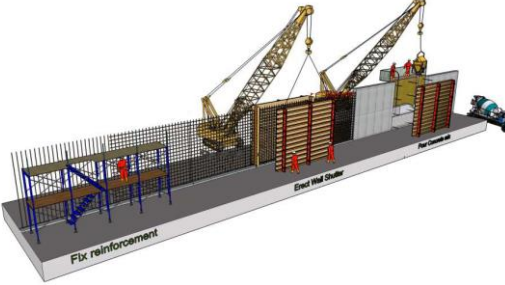

SN	Name of the Items	Images
		 <p>Breakwater & Wave wall for port construction</p>
2.1.	<p><u>Sequence & Methods to Construct Breakwater & Wave wall</u></p> <p>The main aim of the construction of breakwater and wave wall is to protect port from the erosion. The sequential methods of breakwater and wave wall are given in the following sections.</p>	 <p>3D view of Breakwater and wave wall construction</p>
2.2.	<p><u>Breakwaters</u></p> <p>A breakwater is a structure constructed for the purpose of forming an artificial harbor with a basin so protected from the effect of waves as to provide safe berthing for fishing vessels. There are many different types of breakwaters; natural rock and concrete, or a combination of the two, are the materials which form 95 percent or more of all the breakwaters constructed.</p>	 <p>Breakwaters</p>
2.2.1.	<p><u>Parameters for the Construction of a Breakwater</u></p> <p>When a breakwater is to be built at a certain location, and the environmental impact of such a structure has already been evaluated and deemed environmentally feasible, the following parameters are required before construction can commence:</p> <ul style="list-style-type: none"> • A detailed hydrographic survey of the site; • A geotechnical investigation of the sea bed; • A wave height investigation or hind casting; • A material needs assessment; and • The cross-sectional design of the structure 	 <p>Breakwater Cross-section</p>
2.2.2.	<p><u>Filling Barge with Rock – Temporary Jetty</u></p> <p>This is mainly done for used as the temporary use of the jetty.</p>	

SN	Name of the Items	Images
2.2.3.	<p><u>Placing Rock Fill</u></p> <p>The granular compacted sediments or rock are placed for the construction of the breakwaters.</p>	<p>Filling Barge with Rock – Temporary Jetty</p>  <p>Placing Rock Fill</p>
2.2.4.	<p><u>Placing Rock Armour</u></p> <p>Riprap or rock armour or rock or other material used to armour streambeds, bridge abutments, pilings and other shoreline structures against scour or water erosion. It is used to protect coastlines and structures from erosion by the sea, rivers, or streams.</p>	 <p>Placing Rock Armour</p>
2.2.5.	<p><u>Barges for Rock Fill</u></p> <p>Usually barge is used for rock fill in the sea for onshore breakwater construction.</p>	  <p>Barges for Rock Fill</p>
2.2.6.	<p><u>Geotextile</u></p> <p>Geotextiles are a kind of geosynthetic material that has become more and more popular over the past fifteen years. The material owes its success in more than 80 applications to a large extent to its resistance to biodegradation. Geotextiles are indeed textiles, however not in the traditional sense of the word. They are no natural materials like cotton, wool or silk. Geotextiles are synthetic fibers that can be made into a flexible, porous, nonwoven needle felt fabric. They are porous to water flow, to a varying degree.</p> <p>Geotextiles are an ideal protection from erosion of earth embankments by wave action, currents or</p>	 <p>Geotextile</p>

SN	Name of the Items	Images
	<p>repeated drawdown. A layer of geotextiles can be placed so as to prevent leaching of fine material. They can be used for rock beaching or as mattress structures. They can even easily be placed under water.</p>	
2.2.7.	<p><u>Precast Sea Armour</u></p> <p>Precast Sea Armour artificial barriers are specifically designed to provide protection for marine life, attract living organisms and diffuse waves. Additionally, when a source of sand is available, they can actually help rebuild shorelines.</p>	 <p>Precast Sea Armour</p>
2.2.8.	<p><u>Rock Sea Armour</u></p> <p>Rock Sea Armour an effective solution to protect coastlines and structures from erosion by the sea, rivers, or streams maintain coastlines.</p> <p>Large boulders interlocked together to form rock revetments can be used to control erosion by armouring the beach face and dissipating wave energy. Rock Armour is also used to provide effective scour protection to underwater structures.</p>	 <p>Rock Sea Armour</p>
3.	<p><u>Precast Yard & Loading Jetty</u></p> <p>Full-scale sample castings are constructed to demonstrate and document that all the requirements of the concrete and the execution of the work are fulfilled using the actual methods and performed by personnel that will carry out the future castings. One concrete component of each type is produced for approval. The approved castings were retained in a dedicated area for quality assurance purposes.</p>	

SN	Name of the Items	Images
	<p>All works were inspected in accordance with the Inspection & Test Plan on an ongoing basis, in accordance with the site Project Quality Plan. The ITP set out in matrix form the sequence of inspection steps, the governing document (specification, standards), the standard to be achieved, the persons witnessing and the supporting documents to be produced.</p>	 <p>Precast Yard & Loading Jetty</p>
<p>3.1.</p>	<p><u>Pre-casting Quay Blocks</u></p> <p>The precast quay block is used to construction of quay wall and breakwater. This is mainly a granular shaped of precast concrete</p>	
<p>3.2.</p>	<p><u>Precast Sea Armour</u></p> <p>High-strength precast concrete Sea Armour is the perfect solution for protecting marine life and halting shoreline erosion. That realization has generated increased interest and acceptance of artificial reef barriers created from precast concrete, such as Precast Sea Armour.</p> <p>Precast concrete Sea Armour artificial barriers are specifically designed to provide protection for marine life, attract living organisms and diffuse waves. Additionally, when a source of sand is available, they can actually help rebuild shorelines.</p>	 <p>Precast Sea Armour</p>
<p>3.3.</p>	<p><u>Quarry & Aggregate Production</u></p> <p>Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. Crushed aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel.</p>	 <p>3D view of Quarry & Aggregate Production</p>
<p>3.3.1.</p>	<p><u>Quarry</u></p> <p>A quarry is a type of open-pit mine in which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate is excavated from the ground.</p> <p>The word quarry can also include the underground quarrying for stone, such as Bath stone.</p>	

SN	Name of the Items	Images
		 <p>Quarry</p>
3.4.	<p><u>Concrete Batching Plant</u></p> <p>Concrete batching plant comprises - concrete mixer, control cabin, silos for cement and fly ash, aggregate bins and conveyor belt system to feed the mixer. Also aggregate storage bays and water storage tanks.</p> <p>The mixing is computer controlled and has a dynamic screen display, showing the process. Material storage capacity to match two days concrete production</p>	 <p>Concrete Batching Plant</p>
3.4.1.	<p><u>Silos, Ice Flake Plant, Chilled water, Mixer</u></p> <p>The main equipment's in the construction yard is the Silos, Ice Flake Plant, Chilled water, Mixer. This is mainly used for precast concrete construction and preparation of concrete block.</p>	 <p>Silos, Ice Flake Plant, Chilled water, Mixer</p>
1.4.	<p><u>Storage bays for aggregates</u></p> <p>Storing fine and coarse aggregates is a tricky business and they need to be stored in a manner that reduces degradation and keeps them well-protected.</p> <p>Concrete panels are easy to assemble and robust, sturdy storage bays can be built with the minimum of fuss. The panels are high strength to cope with significant loads, and you can more machinery around with confidence, knowing that the walls can withstand the odd bump or knock.</p>	 <p>Storage bays for aggregates</p>

SN	Name of the Items	Images
1.5.	<p><u>Reinforced Wall Construction Sequence</u></p> <p>The sequence to construct a reinforced concrete wall is as follows:</p> <ul style="list-style-type: none"> • Tie the reinforcement. • Erect stop-ends and the wall shutters. • Pour and vibrate the concrete mix. • Remove the shutters after the concrete has hardened. 	 <p>Reinforced Wall Construction</p>
1.6.	<p><u>Concrete Mix</u></p> <p>A concrete mix contains 5 major elements: cement, water, coarse aggregates, fine aggregates (sand) and air in different proportion. Additional elements such as pozzolanic materials (fly ash, silica fumes or slag) and chemical admixtures can also be incorporated to the mix to increase its properties.</p>	 <p>Concrete Mix</p>

4. Dredging & Reclamation

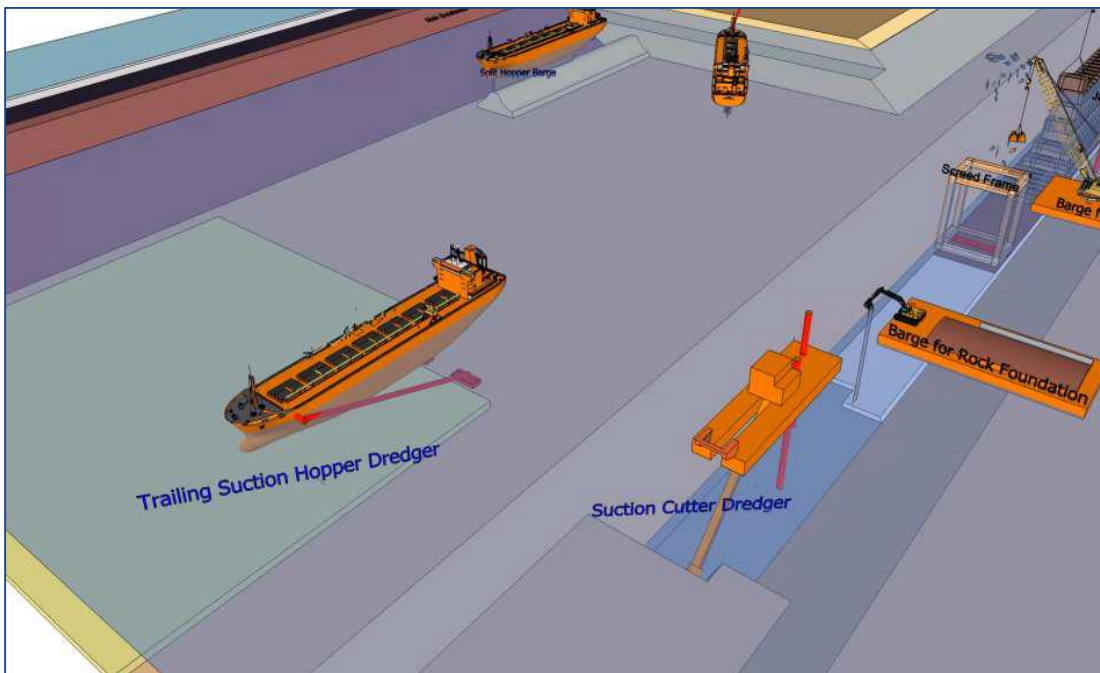


Figure 39: 3D view of Dredging and Reclamation


Dredging is the removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies. It is a routine necessity in waterways around the world because sedimentation - the natural process of sand and silt washing downstream-gradually fills channels and harbors. Dredging vessels are designed for excavation activities. These are usually carried out underwater, in shallow or fresh water areas, with the purpose of gathering bottom sediments and disposing of them at a different location, mostly to keep waterways navigable. for port extensions, or for land reclamation.

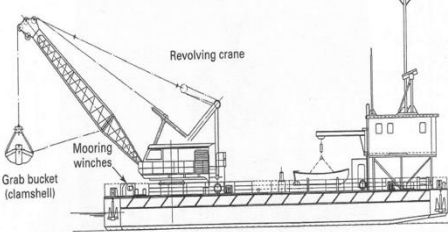




Dredging technology helps to improving the utilization of its fleet in terms of efficiency, dredging works accuracy and quality and for investing in its people to improve their competency and skills standard. It also supports to ensure adequate demonstration, evaluation, and reporting of new or innovative dredging technology application.




For conducting the dredging activities there are different dredgers are used in this field like Grab Dredger, Plain Suction Dredger, Dipper or Black Hoe Dredger, Bucket Ladder Dredger, Cutter Suction Dredgers (CSDs) Trailing Suction Hopper Dredgers (TSHDs), and Backhoe Dredgers (BHDs) are commonly used.

Dredging Measure Equipment


Before introducing to dredging activities, it is desirable to get acquainted with the equipment that is usually used in dredging:

SN	Name of Equipment	Image of the Equipment
4.1.	<p>Bucket Ladder Dredger</p> <p>A bucket ladder dredger has a series of buckets mounted on an endless loop that scoop material from the waterbed and deposit it through a chute to a barge.</p> <p>Bucket-ladder dredgers can be effectively used for dredging a wide variety of materials up to and including soft rock. This includes certain specific tasks, such as removing stiff clays and weak rock layers, trench dredging and maintenance in some ports.</p> <p>Work Method of The Bucket-Ladder Dredger</p> <p>The loop of the bucket-ladder dredger is powered causing the buckets to travel downwards in such a way as to scoop the material from the bottom, and then carry the material in the upright buckets up the ladder to the top. At the top, the buckets rotate into an upside-down position and their contents falls into a chute. The material is then sent through the chute to barges or scows alongside the dredger. As with other mechanical dredgers, barges or scows are used to transport the dredged material to the placement or relocation sites. Bucket sizes vary from 30 liters to 1200 liters. Rock bucket dredgers may have a double set of buckets: a small rock bucket and a bigger soft soil bucket. The bucket-ladder dredger is usually stationary but some are self-propelled and can travel on their own to the dredging site.</p> <p>Specification:</p> <ul style="list-style-type: none"> • The size of these vessels is about 60m in length and 15m in width, having a draft of about 2.5 to 3m. • The capacity of bucket is about 1cubic meter. • The digging depth commonly extend to 1 cubic meter • The output is the range of 250 cubic meter/hr 	 <p>Bucket Ladder Dredger</p>

SN	Name of Equipment	Image of the Equipment
<p>4.2.</p>	<p><u>Grab Dredger</u></p> <p>Grab or clamshells dredgers are very commonly used, rather simple and easy to understand stationary vessels, with and without propulsion.</p> <p>Work Method of Grab or Clamshell Dredgers</p> <p>Grab or clamshell dredgers have either a rotating cab or fixed A-frame-type barge-mounted equipment. They have hoisting and control systems and use grab (clamshell) digging devices or buckets rigged on cables to excavate the material from the waterbed at or near its in situ density and transport it vertically out of the water and into barges for subsequent transport to the placement area. Normally they are stationary, being fixed at the excavation site using anchors or spuds. The discharge of the material is usually done by transporting it with barges. However, some grab cranes are placed on self-propelled hoppers, so the material is transported by the dredger itself. Also, for grab dredgers used for winning sand and gravel, material may be discharged to a separator installation through conveyor belts.</p> <p>Specification:</p> <ul style="list-style-type: none"> • The Hull is generally 30m to 60m long and 15m cross, the boom is being 15m long. • The capacity of a grab dredger is expressed in the volume of the grab. • Grab sizes varies between less than 1 m³ up to 200 m³. • The opening of the grab is controlled by the closing and hoisting wire or by hydraulic cylinders. 	   <p>Main Feature of Pontoon Mounted Grab dredger</p>
<p>4.3.</p>	<p><u>Dipper or Black Hoe Dredger</u></p> <p>The dipper dredger is a powered bucket mounted on a barge which scoops material with a forward motion like a shovel toward the dredger.</p> <p>Work Method</p> <p>A bucket is firmly attached to the ladder structure and is forcibly thrust into the material to be removed. To increase digging power, the dredge barge is moored on powered spuds that transfer the weight of the forward section of the dredger to the bottom. A dipper dredger plus scow barges and other equipment are transported to the work site. Some of the weight of the dredger is placed on the forward spuds to stabilize the vessels. The scow barge is moored onto the dredger with cables and winches. The dipper will scoop up the material within reach of its bucket, and the dredger will move forward by lifting the forward spuds and maneuvering with the bucket and stern spud. In this way, the dipper dredger,</p>	 

SN	Name of Equipment	Image of the Equipment
	<p>although not self-propelled, moves itself forward during the dredging process. The loaded barges are towed to the disposal area and emptied by bottom dumping if an open-water disposal area is used, or they are unloaded by mechanical or hydraulic equipment if diked disposal is required.</p> <p>Specification:</p> <ul style="list-style-type: none"> • This type of dredge can dig in depths up to 15m of water. • Dipper capacity varies from 1 to 4 cubic meter and heavy capacities of about 12m³ are used in Panama Canal. 	 <p>Dipper or Black Hoe Dredger</p>
4.4.	<p>Plain Suction Dredger</p> <p>The characteristic of a plain suction dredger is that it is a stationary dredger, consisting of a pontoon anchored by one or more wires and with at least one sand pump that is connected to a suction pipe. The discharge of the dredged material can take place via a pipeline or via a barge-loading installation.</p> <p>Working method:</p> <p>The working method of the suction dredger depends on both the progressive collapsing of the breach/bank and the loosening of the sand near the suction mouth by eddies created by the flow of water caused by the sand pump. The progressive collapse of the breach/bank resulting from the dislodgement of particles of soil or of masses of soil as a result of localized instabilities is termed “breaching”.</p> <p>These operate by sucking through a long tube, like some vacuum cleaners but on a larger scale. A plain suction dredger has no tool at the end of the suction pipe to disturb the material. This is often the most commonly used form of dredging.</p> <p>Specification:</p> <ul style="list-style-type: none"> • The Dredging depth is about 15m. • Bucket capacity is about 6cubic meter, and then it’s used for soft material. • If a smaller capacity bucket of about 4 cubic meters, then it’s used for dredging hard material. 	  <p>Plain Suction Dredger</p>

SN	Name of Equipment	Image of the Equipment
4.5.	<p>Cutter Suction Dredger</p> <p>A cutter-suction dredger's (CSD) suction tube has a cutting mechanism at the suction inlet. The cutting mechanism loosens the bed material and transports it to the suction mouth. The dredged material is usually sucked up by a wear-resistant centrifugal pump and discharged either through a pipe line or to a barge.</p> <p>Cutter-suction dredgers are most often used in geological areas consisting of hard surface materials (for example gravel deposits or surface bedrock) where a standard suction dredger would be ineffective. In recent years, dredgers with more powerful cutters have been built in order to excavate harder rock without the need for blasting.</p> <p>Work Method</p> <p>All CSDs are equipped with a rotating cutter head, which is able to cut hard soil or rock into fragments. The cutter head is a rotating mechanical device, mounted in front of the suction head and rotating along the axis of the suction pipe. The cut soil is then sucked in by dredge pumps. CSDs cut the soil according to a pre-set profile. The dredged material is then pumped ashore using pumps and a floating pipeline or loaded into a split hopper barge moored alongside, which in turn can then offload the dredged sediment at the designated location. The cutting action of a CSD is powerful and, combined with the suction action, the material can be 'cut' into suitably sized pieces. These pieces are then sucked into the suction pipe as a solid/water slurry and pumped to the surface using pumps mounted on a structural device which extends towards the seabed known as 'the ladder'.</p> <p>Specification and advantages:</p> <p>Cutter-suction dredgers are most often used in geological areas consisting of hard surface materials (for example gravel deposits or surface bedrock) where a standard suction dredger would be ineffective. In recent years, dredgers with more powerful cutters have been built in order to excavate harder rock without the need for blasting.</p> <ul style="list-style-type: none"> ➤ Cutter power ranges from 50 Kw up to 5000 Kw depending on the type of soil to be cut. ➤ Pump capacity varies from 1200 m³/hr to 3500m³/hr ➤ Dredging depth varies from 10 meter to 15 meter ➤ Discharge distance 1200 meter to 2000 meter 	 <p style="text-align: center;">Cutter Suction Dredger</p>

SN	Name of Equipment	Image of the Equipment
	<ul style="list-style-type: none"> ➤ Engine power varies from 540 kw to 1231kw ➤ Good accuracy of the excavated profile ➤ Increase of suspending sediment specially the fine grained materials ➤ Dilation due to hydraulic character of the transport, water is added to the transportation of soil purpose ➤ Accuracy of dredging depth ➤ Automatic fuel consumption and costing status ➤ High probability of implementation ➤ Digital measuring or counting system ➤ Higher level capacity to dredging ➤ High speed to movement and transportation of materials ➤ Easy to inspection and take reading ➤ Easy to operate and maintenance and monitoring activities ➤ The actual dredging processes creates less suspending sediment ➤ Operational Efficiency-Enhancing Presentation and Automation Options 	
4.6.	<p><u>Trailing suction Hopper Dredger</u></p> <p>A trailing suction hopper dredger (TSHD) trails its suction pipe when working, and loads the dredge spoil into one or more hoppers in the vessel. When the hoppers are full, the TSHD sails to a disposal area and either dumps the material through doors in the hull or pumps the material out of the hoppers. Some dredges also self-offload using drag buckets and conveyors.</p> <p>Working Method</p> <p>A trailing suction hopper dredger is self-loading/unloading and sometimes equipped with a pressurized discharging system. From the side of the ship one or two suction pipes descend to the bottom of the seabed. On the end of the pipe a so-called trailing drag head is connected. This head is comparable to a large vacuum cleaner and is trailed along the seabed. In the head there are nozzles connected to a high pressure water installation that are capable of loosening the material on the seabed. Due to lower pressure in the pipe, the material will be sucked inward and discharged in the hopper.</p> <p>Specification:</p> <ul style="list-style-type: none"> • The normal dredging varies from 10 to 30m • The hopper capacities vary from 300-11000cubic meter. • Majority of these dredgers are in the range of 500-3500cubic meter. 	 <p style="text-align: center;">Trailing Suction Hopper Dredger</p>

5. Vibrio Compaction - Fill behind Quay Ground Improvement using deep vibrio-compaction.

Purpose is to provide protection against liquefaction during a seismic event. Also, to provide a specified minimum ground bearing capacity. Vibrio-compaction was used to compact the Dubai man made islands that were constructed from dredged sand.

Equipment

Vibroflot with extension tube, hydraulic power pack mounted on crane, diesel engine driven water jetting pumps, compressors, crawler cranes 60 tonne capacity, water tank, de-watering pump

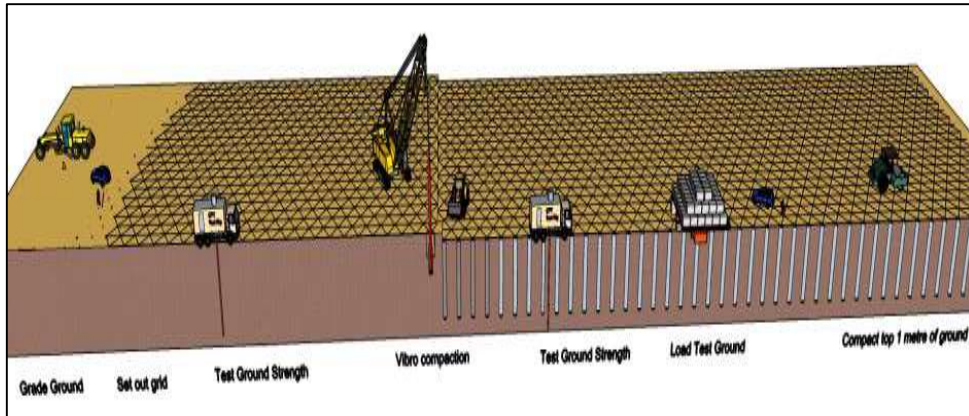


Figure 40: 3D image to show Sequence, Method & Plant.

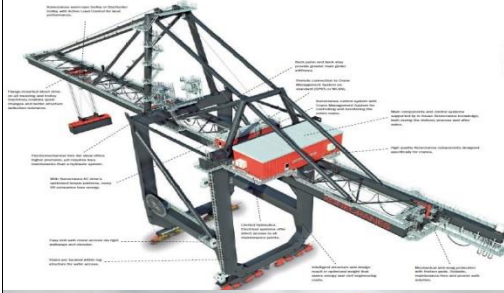





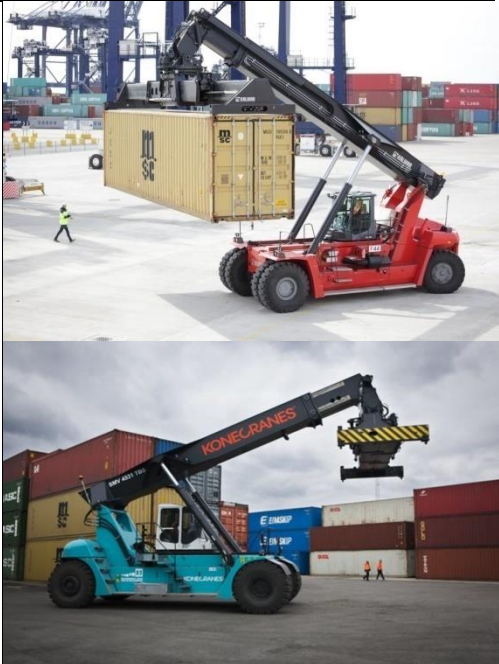

Vibrio Compaction - Fill behind Quay

Vibrio Compaction - Fill behind Quay

Figure 41: Vibrio Compaction - Fill behind Quay

6. Equipment for Port Operation


SN	Name of Equipment	Image of the Equipment																							
<p>6.1.</p> <p><u>Ship-To-Shore Gantry Cranes</u></p> <p>Containers are loaded to and from containerships (while moored at a port's wharf) by ship-to-shore gantry cranes. These cranes may be dock cranes (located on the dock or wharf of the port) or ship-mounted cranes (mounted on the containership). Since most modern containerships are non-self-sustaining (i.e., without ship-mounted cranes), they require the use of dock cranes while in port. The majority of ship-to-shore gantry dock cranes are rail cranes (although some are rubber-tired). Typically, they run along rail tracks on the port's wharf, thereby allowing several to be "ganged together" for working (i.e., unloading and loading containers from and to) large containerships simultaneously.</p> <p>The crane's spreaders straddle rows of containers on a ship, picking containers from and placing containers onto the ship. They fit on the corner castings of containers and lock to these castings (fittings) via twist-locks. Dock cranes are sometimes referred to as bridge or quay cranes. In loading and unloading containers onto and from ships, their booms when lowered over the ships appear as bridges over these ships. The largest dock cranes in operation (Suez dock cranes) can span across twenty-six rows of containers on a containership.</p> <p>SPECIFICATION</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Range</th> </tr> </thead> <tbody> <tr> <td>Rated hoisting capacity under spreader</td> <td>35~80 t</td> </tr> <tr> <td>Outreach</td> <td>25~70 m</td> </tr> <tr> <td>Back reach</td> <td>8~28 m</td> </tr> <tr> <td>Span</td> <td>16~42 m</td> </tr> <tr> <td>Hoisting height above rail</td> <td>10~45 m</td> </tr> <tr> <td>Hoisting height below rail</td> <td>12~18 m</td> </tr> <tr> <td>Hoisting speed full load</td> <td>40~90 m/min</td> </tr> <tr> <td>Hoisting speed empty load</td> <td>70~150 m/min</td> </tr> <tr> <td>Trolley traversing speed</td> <td>120~300 m/min</td> </tr> <tr> <td>Gantry traveling speed</td> <td>25~60 m/min</td> </tr> <tr> <td>Max. raising/lowering angle</td> <td>80</td> </tr> </tbody> </table>	Parameter	Range	Rated hoisting capacity under spreader	35~80 t	Outreach	25~70 m	Back reach	8~28 m	Span	16~42 m	Hoisting height above rail	10~45 m	Hoisting height below rail	12~18 m	Hoisting speed full load	40~90 m/min	Hoisting speed empty load	70~150 m/min	Trolley traversing speed	120~300 m/min	Gantry traveling speed	25~60 m/min	Max. raising/lowering angle	80	   <p style="text-align: center;">Ship to Shore Gantry Cranes</p>
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<p>6.2.</p> <p><u>Forklift Truck</u></p> <p>A forklift (also called lift truck, jitney, fork truck, fork hoist, and forklift truck) is a powered industrial truck used to lift and move materials over short distances. The forklift was developed in the early 20th century by various companies, including Clark, which made transmissions, and Yale & Towne Manufacturing, which made hoists. Since World War II, the use and development of the forklift truck have greatly expanded worldwide.</p>																									

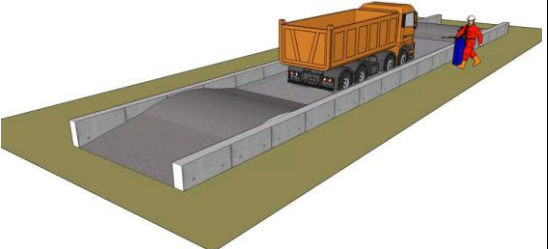
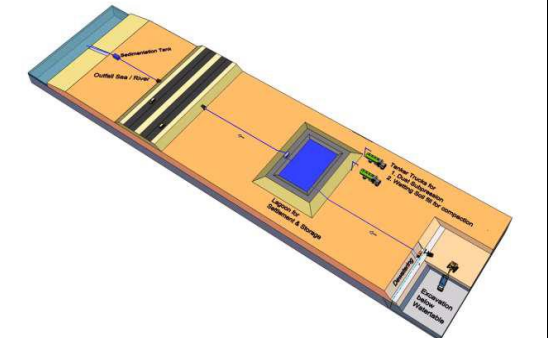
SN	Name of Equipment	Image of the Equipment
	<p>Forklift truck can not only handle large-tonnage cargo, but also support maintenance, discharge and installation of important equipment. With special attachments, it can handle steel, stone, concrete, wood, 20' container, etc. the forklift is reliable and highly efficient with hoisting capacity from 10 to 46 tons. Various attachments and masts are provided to meet different requirements.</p>	 <p>Forklift truck for port operation</p>
<p>6.3.</p>	<p><u>Reach Stacker</u></p> <p>Reach stacker is a vehicle used for handling intermodal cargo containers in small terminals or medium-sized ports. Reach stackers are able to transport a container short distances very quickly and pile them in various rows depending on its access. Reach stackers have gained ground in container handling in most markets because of their flexibility and higher stacking and storage capacity when compared to forklift trucks. Using reach stackers, container blocks can be kept 4-deep due to second row access.</p> <p>Reach stacker is engineered with power, rugged construction, operator visibility and maneuverability. Designed to easily handle 20-, 30-, 40-foot standard containers, the reach stackers can hoist and place up to 50 U.S. tons with precision. Tube, log stacking and tilting attachments extend its versatility. Whether working in a port, intermodal yard or rail facility, reach stackers get the job done.</p>	 <p>Reach stacker for port operation</p>
<p>6.4.</p>	<p><u>Portal Slewing Crane</u></p> <p>Portal slewing cranes with single boom system are available with rated hoisting capacity of 40/45/80t, radius from 9.5-38m, rail span of 10.5/16m. Maximum hoisting speed is up to 25/28m/min, luffing speed 25/35m/min, gantry speed 25/26m/min, and slewing speed from 0.6 to 1.2rpm.</p> <p>The main components of portal slewing crane is as follows</p> <ul style="list-style-type: none"> • Wire rope • Hook • Jib (The jib is an operating arm that extends horizontally from the crane) • A-bracket • Turntable • Rotary gear • Cylinder • Door frame • Travelling mechanism 	 <p>Portal slewing cranes for port operation</p>

SN	Name of Equipment	Image of the Equipment
6.5.	<p><u>Empty Container Handler</u></p> <p>The Empty Container Handler (ECH) is a large forklift type piece of equipment that is being utilized at the Port and is used to handle the storage of 20, 40 and 45 foot empty containers in the designated Empty Containers Yard. This 'light-weight' contender of container handling equipment, lifts up to 8 metric tons; can stack empty containers up to 5 high, and has an average weight of 35 metric tons. Its maneuverability makes it ideal for stacking containers in tight spaces.</p>	 <p>Empty Container Handler</p>
6.6.	<p><u>Straddle Carrier</u></p> <p>A straddle carrier or straddle truck is a freight carrying vehicle that carries its load underneath by "straddling" it, rather than carrying it on top like a conventional truck. The advantage of the straddle carrier is its ability to load and unload without the assistance of cranes or forklifts. The lifting apparatus under the carrier is operated by the driver without any outside assistance and without leaving the driver's seat.</p> <p>The most common use of straddle carriers is in port terminals and intermodal yards, where they are used for stacking and moving ISO standard containers. The carrier straddles its load, picking it up and carrying it by connecting to the top lifting points using a container spreader. The machines have the ability to stack containers up to four high. They travel at relatively low speeds (up to 30 km/h or 20 mph) with a laden container. Drivers of the carrier sit at the very top and face the middle, so they can see behind and in front of them. Straddle carriers can lift up to 60 t (59 long tons; 66 short tons), which equals up to two full containers.</p>	 <p>Straddle carrier for port operation</p>

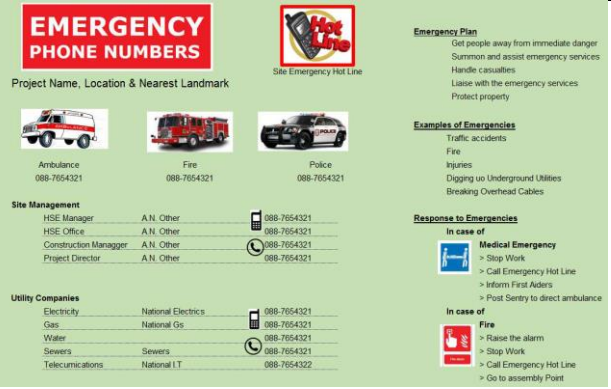

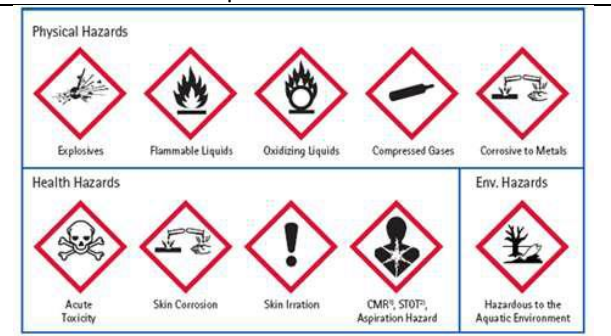
SN	Name of Equipment	Image of the Equipment
6.7.	<p><u>Automated Guided Vehicles (AGV)</u></p> <p>Several container ports around the world utilize automated guided vehicles (AGVs) — transport vehicles that are automated and driven by automatic control systems. AGVs transport containers from the stack storage area to the terminal's apron and vice versa. A port's AGV control/management system consists of the vehicle (the AGV), the vehicle's onboard controller, a centralized management system with a data link to the vehicle, and the vehicle's navigation system. The vehicle may be electrical or fuel powered, having its propulsion, braking, steering, and other functions controlled by an onboard controller. The centralized management system is responsible for the dispatching, routing, and traffic control of AGVs within the port. The vehicle's navigation system guides the vehicle to its destination and promotes safety by being able to detect obstacles along the vehicle's travel route.</p> <p>There are two types of AGV — the traditional AGV and the cassette AGV. Containers are loaded on traditional AGVs for transport by these AGVs. Alternatively, containers are not loaded on cassette AGVs but rather on detachable cassettes for transport by these AGVs.</p> <p>The advantage of the cassette AGV over the traditional AGV is that the former can hold more than one container on its detachable cassette, thereby allowing for the transportation of more than one container at a time.</p>	 <p>Automated Guided Vehicles (AGV)</p> <p>Automated Guided Vehicles (AGV)</p>

7. Site Facilities Other Necessary Infrastructures

SN	Facilities	Photograph
7.1.	<p><u>Site Facilities and Temporary Works</u></p> <p>A number of facilities are required on construction sites to provide adequate welfare for workers. The Construction (Design and Management) Regulations (CDM Regulations) require the provision of:</p> <ul style="list-style-type: none"> • Sanitary conveniences. • Washing facilities. • Drinking water. • Changing rooms and lockers. • Facilities for rest. <p>In addition, sites may include other facilities, such as:</p> <ul style="list-style-type: none"> • Welcome facilities and entry control. 	 <p>Site Facilities & Temporary Works</p>

SN	Facilities	Photograph
	<ul style="list-style-type: none"> • Site offices. • Meeting rooms. • Training and induction facilities. • Wheel washing facilities. • Site canteen. • Off-loading facilities. • Laydown area. • Temporary storage and storage areas. • Sub-contractor facilities. • Car parking. • Waste management and recycling facilities. • Fabrication facilities. • Facilities for the construction of mock-ups for testing. 	
7.2.	<p><u>Wheel Wash Drive-through</u></p> <p>A wheel washing system is a device for cleaning the tires of trucks when they are leaving a site, to control and eliminate the pollution of public roads. The installation can be made in or above the ground for either temporary or permanent applications. There are two types of wheel washing systems: roller and drive-through systems.</p> <p>The Drive-Thru type wheel washer has a simple structure with high durability. It only requires low cost maintenance and very easy to use. Therefore, this product fits in working sites where the traffic is heavy such as stone pits, quarries, mines, landfills, aggregate pits, etc.</p>	 <p style="text-align: center;">Wheel Wash Drive-through</p>
7.3.	<p><u>Dewatering system facilities</u></p> <p>Dewatering and construction dewatering are terms used to describe the action of removing groundwater or surface water from a construction site. Normally the dewatering process is done by pumping or evaporation and is usually done before excavation for footings or to lower water table that might be causing problems during excavations. Dewatering can also refer to the process of removing water from the soil by wet classification.</p> <p>Construction dewatering from open excavation or trenches can be done by several methods. However, the most simple of all is gravity drain using drainage channels carrying away water from the area to be worked to the discharge point. Other feasible ways for dewatering are water pumping.</p>	 <p style="text-align: center;">Dewatering system facilities</p>

8. Health, Safety & Environmental

SN	Facilities	Photograph																						
8.1.	<p><u>Emergency Phone Numbers & Response</u></p> <p>During an emergency, there may not have time to make alternative plans. They may also not be aware of who to listen to for instructions. That's why it is important to know who to call and what to do under different circumstances. That's why Emergency Phone Numbers & Response is important for safety issues.</p>	 <p>EMERGENCY PHONE NUMBERS</p> <p>Project Name, Location & Nearest Landmark</p> <p>Site Emergency Hot Line</p> <p>Emergency Plan Get people away from immediate danger Summon and assist emergency services Handle casualties Liaise with the emergency services Protect property</p> <p>Examples of Emergencies Traffic accidents Fire Injuries Digging up Underground Utilities Breaking Overhead Cables</p> <p>Response to Emergencies In case of Medical Emergency -> Stop Work -> Call Emergency Hot Line -> Inform First Aiders -> Post Sentry to direct ambulance</p> <p>In case of Fire -> Raise the alarm -> Stop Work -> Call Emergency Hot Line -> Go to assembly Point</p>																						
8.2.	<p><u>Safety Precautions</u></p> <p>Safety in the workplace begins with a proper safety plan that is put into place by management and observed by all employees. Safety precautions must be strictly adhered to because if they are not, some employees can put other employees at risk.</p>	<table border="1"> <thead> <tr> <th>Procedure / Resource</th> <th>Purpose</th> </tr> </thead> <tbody> <tr> <td>Method Statements</td> <td>Ensure Safe System of Work is planned and implemented</td> </tr> <tr> <td>Risk Assessments</td> <td>Identify risks and put in place measures to guard against, eliminate or reduce risks</td> </tr> <tr> <td>COSHH Sheets & MSDS (Material Safety Data Sheets)</td> <td>To control substances that are hazardous to health and put in place measures to prevent or reduce exposure to hazardous substances.</td> </tr> <tr> <td>Permit to Work System</td> <td>To control work, ensure that all identified control measures are in place prior to permit (consent) being issued</td> </tr> <tr> <td>HSE Site Project Procedures</td> <td>Procedures for executing work activities with risks which have a safe practice established</td> </tr> <tr> <td>Safety training, Briefings, Inductions</td> <td>To educate & to familiarise staff with task procedures and associated risks and the control measures required to be implemented.</td> </tr> <tr> <td>HSE Supervision, Daily Observations, Weekly Management Inspections.</td> <td>Monitor and give guidance on HSE matters. To ensure compliance with the Method Statement, Risk Assessment and recognisable work procedures and practices.</td> </tr> <tr> <td>Site Emergency Response Plan</td> <td>Set out what to do in an emergency. A pre-planned response briefed out to all on the way in which suitable action will be taken in the event of an emergency.</td> </tr> <tr> <td>Health Safety & Environmental Plan</td> <td>Set out HSE procedures. An approved document which identifies the way in which activities will be executed in a safe manner. It also identifies how the work is monitored and the system is audited.</td> </tr> <tr> <td>PPE, First Aid Kits, Welfare Facilities, Waste Collection, Site Clinic, Fire Engine</td> <td>Make the site safer, additional considerations and facilities provided to comply with legal requirements and to ensure that the site is a safe and healthy working environment.</td> </tr> </tbody> </table> <p>Sample of a Safety Precautions Charts</p>	Procedure / Resource	Purpose	Method Statements	Ensure Safe System of Work is planned and implemented	Risk Assessments	Identify risks and put in place measures to guard against, eliminate or reduce risks	COSHH Sheets & MSDS (Material Safety Data Sheets)	To control substances that are hazardous to health and put in place measures to prevent or reduce exposure to hazardous substances.	Permit to Work System	To control work, ensure that all identified control measures are in place prior to permit (consent) being issued	HSE Site Project Procedures	Procedures for executing work activities with risks which have a safe practice established	Safety training, Briefings, Inductions	To educate & to familiarise staff with task procedures and associated risks and the control measures required to be implemented.	HSE Supervision, Daily Observations, Weekly Management Inspections.	Monitor and give guidance on HSE matters. To ensure compliance with the Method Statement, Risk Assessment and recognisable work procedures and practices.	Site Emergency Response Plan	Set out what to do in an emergency. A pre-planned response briefed out to all on the way in which suitable action will be taken in the event of an emergency.	Health Safety & Environmental Plan	Set out HSE procedures. An approved document which identifies the way in which activities will be executed in a safe manner. It also identifies how the work is monitored and the system is audited.	PPE, First Aid Kits, Welfare Facilities, Waste Collection, Site Clinic, Fire Engine	Make the site safer, additional considerations and facilities provided to comply with legal requirements and to ensure that the site is a safe and healthy working environment.
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8.3.	<p><u>Personal Protective Equipment (PPE)</u></p> <p>Personal protective equipment (PPE) is protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer from injury or infection.</p>	 <p>Personal Protective Equipment</p> <p>WHAT IS PPE? PPE is defined in the Health Regulations 1988 as 'self-protective clothing, footwear, or similar protective equipment, or any special or extra suit for his health or safety, and any addition or attachment designed to meet that objective'.</p> <p>WHAT DO THE REGULATIONS REQUIRE? PPE must be provided and used by employees to protect them from risks to their health and safety that cannot be adequately controlled by other means. PPE is provided and used by employees to protect them from risks to their health and safety that cannot be adequately controlled by other means. PPE is provided and used by employees to protect them from risks to their health and safety that cannot be adequately controlled by other means.</p> <p>PPE SIGNAGE PPE signage must be provided and maintained by employers. PPE signage must be provided and maintained by employers. PPE signage must be provided and maintained by employers.</p> <p>THE RISKS AND TYPES OF PPE Eye protection Head protection Breathing protection Hearing protection Hands and arms Body protection Feet and legs</p> <p>ASSESSING SUITABLE PPE It is essential to assess the risks to health and safety of employees before selecting PPE. The assessment should take account of the nature of the work, the tasks to be performed, the substances and equipment used, and the environment in which the work is carried out.</p> <p>EMPLOYERS, EMPLOYEES & EQUIPMENT Employers MUST: - Assess the risks to health and safety of employees. - Select PPE which is suitable for the work. - Provide training in the use of PPE. - Check employees are wearing it. Employees MUST: - Use the PPE provided. - Report any damage or loss of PPE. Equipment MUST: - Be relevant for the work conditions. - Be maintained in good condition. - Be used in accordance with the manufacturer's instructions. - Be replaced when worn or damaged. - Be replaced when the manufacturer's instructions require it. - Be replaced when the manufacturer's instructions require it.</p>																						
8.4.	<p><u>Hazardous Substances Symbols</u></p> <p>COSHH stands for the Control of Substances Hazardous to Health Shown are the new hazard symbols</p>	 <p>Physical Hazards Explosives, Flammable Liquids, Oxidizing Liquids, Compressed Gases, Corrosive to Metals</p> <p>Health Hazards Acute Toxicity, Skin Corrosion, Skin Irritation, CMR¹, STOT², Aspiration Hazard</p> <p>Env. Hazards Hazardous to the Aquatic Environment</p>																						

6.5 Jetty

A Jetty is for the loading or unloading of goods carried in ships and other Vessels. Design and construction of a Jetty can be and should be a complex affair in Bangladesh. Diverse issues come into play:

1. Architectural Design & Engineering of Jetty
2. Civil Construction
 - Soil Testing
 - Jetty Piling
3. Maintenance Plan and Logistics
4. Existing structures and rehabilitation
5. Hazard analysis and Risk Assessment
 - Bridgend utility Pipelines In the vicinity of the proposed Jetty
6. Boat/Vessel Transport/Logistics
7. Type of Vessel needed during construction and during full operation
8. Floating Jetties as Alternative

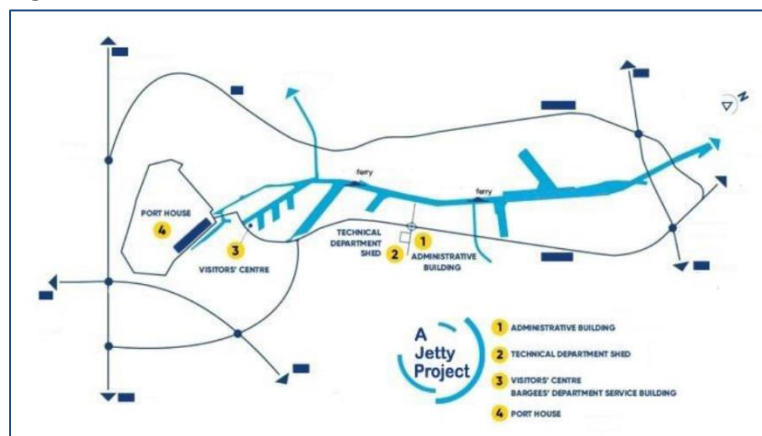


Figure 42: Conceptual design of a jetty

6.5.1 Architectural Design & Engineering of Jetty

Typical Jetties in Bangladesh tend to be very functional. While Jetties are for the loading or unloading of goods and people carried in ships and other Vessels, they do not need be dull and messy. Some foreign Jetties are center pieces of the Tourism industry. Bangladesh is interested in developing a rich tourist Industry. So, Architecture and Design should play a more important role in developing new Jetties.



Figure 43: A newly constructed Jetty in Europe

6.5.2 Civil Construction

6.5.2.1 Soil Testing

Conducting Soil Test of a selected place is necessary to know conditions of soil beneath the surface to obtain full information on the type, size, length and capacity of the piles. Designer of the Pile takes into consideration the result of the soil test and fixes its parameters. Soil testing near water bodies tend to be even more important to protect the shores and other special circumstances.



Figure 44: Soil test for jetty construction

6.5.2.2 Jetty Piling

Piling forms the basis of construction, including marine construction, as it provides the fundamental support needed for any kind of structure to be built. Piling is the procedure of setting deep foundations into the ground, usually using wood, steel or concrete. This creates a robust and stable base for construction to commence.

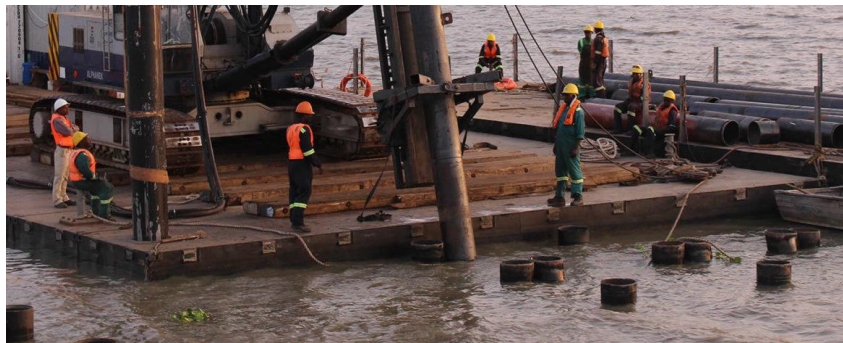


Figure 45: Load Test for Jetty Piling

6.5.2.3 Offshore Piling

Underwater piling is the process of building deep foundations into the ground below waterbed level to support buildings and structures that are offshore. There is a great level of complexity involved when piling underwater, which is why it's imperative that only certified professionals undertake underwater piling. Qualified contractors with decades of experience in conducting underwater piling are needed. These contractors must be well acquainted with the ground conditions in the Jetty area.

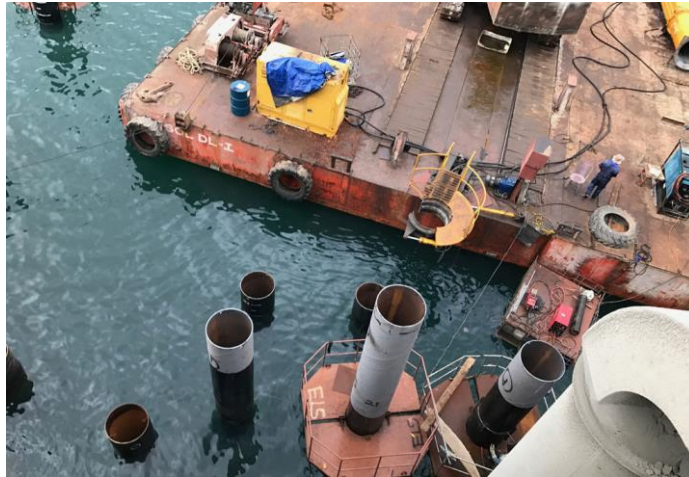


Figure 46: offshore piling work in the sea

Jetty and underwater piling includes:

- CHS Piles
- I Beams
- Concrete Piles
- Piles of up to 800mm in diameter

Most common piling projects include:

- New floating pontoons
- Mooring piles
- Fixed jetties
- Private jetties
- Piles for general anchorage of vessels and other structures

6.5.3 Maintenance Plan and Logistics

Jetties near a body of water and the manmade structures surrounding it must sufficiently shelters a vessel from wind, waves, and currents, enabling safe anchorage or the discharge and loading of cargo and passengers.

The construction of Jetties offers some of the most unusual problems and challenges in civil engineering. The continuous and immediate presence of the water provides the engineer with an adversary certain to discover any weakness in the structure built to resist it.

The principal objectives of such works fall broadly into two classifications:

- Improvement of transportation,
- Reclamation and conservancy of land

Under the first fall works directed at providing facilities for the safe and economical transfer of cargo and passengers between land vehicles and ships; fishing ports for the landing and distribution of the harvest of the sea and rivers; Safe refuge for ships and small craft; and marinas for the mooring or laying up of small private craft.

Under the heading of reclamation and conservancy come works directed to the protection of the land area from encroachment by the sea/river, to the recovery and conversion to land use of areas occupied by the sea, and to the maintenance of river estuaries as efficient means for the discharge of inland runoff. In many places, without continuous attention to such maintenance, the coincidence of high tides with heavy rainfall would lead to frequent disastrous flooding of inhabited areas.

6.5.3.1 Existing Structures and Rehabilitation

The civil engineering techniques used for either of these objectives are broadly similar, and indeed the realization of both objectives at the same time will frequently be a feature of the same project. An operation of maintaining a river estuary at a depth sufficient for navigation, for example, may at the same time greatly improve its capacity for the drainage of upland floodwaters.

6.5.4 Jetty/Ferry Ghat Construction Methodologies

6.5.4.1 Jetty Details

The jetty structure will be a timber deck bolted together in modules and supported on timber piles fixed onto the steel stilts and shoe. The deck top will consist of timber slats bolted onto the deck structure with regular gaps.



Figure 47: Isometric view of Jetty looking towards mainland

6.5.4.2 The Process

The proposed design is a timber platform structure supported on timber columns fixed on steel stilts. This design is the most accepted type of jetty into marine environments. Jetties on stilts do not interfere with marine hydrodynamic processes since the footprint impingement into the lagoon comprises only the cross-sectional areas of the stilts which are insignificantly small.

Thus, the jetty will start on the beach and extend along the line of existing derelict rocks. Where it will be built above the rocks, the only insertion being the steel shoes into which the wooden structure will be bolted. Once the sea is reached the same top timber structure will continue; only the steel shoes will be hammered into the sandy base using a sledge hammer. We know from jetting trials that the galvanized bars will reach a 2m depth, solid enough for the jetty to be built on top.

6.5.4.3 Land based Works

- The rocks will provide the base from which the wooden walkway will be supported above them.
- Rows consisting of two 32mm diameter holes will be drilled into the solid rock base at regular intervals.
- We will use a core driller or a hydraulic hammer drill to make these holes. This process is dry and will result in a rock powder to be produced. The rock powder will be collected and carted away from the shore.
- A galvanized steel pin with shoe base will be secured into place using epoxy resin.
- Onto the shoe, the jetty structure will be built.

6.5.4.4 Marine Based Works

- Once the walkway leaves the rocks and moves into the sea, the galvanized steel stilt with shoe base will be piled (driving in pre-galvanized shoe bars) into the sandy sea floor.
- One operative will operate in the lagoon and hold the steel stilt in place. The piling will be done into 2m depth on the sandy floor and hammered by hand from a small floating platform. Using sledge hammer or variant – the shoe structure will be protected during this driving process with a pre-fabricated block.
- The wooden uprights will thereafter be bolted onto these bases.
- The platforms will be pre-fabricated off site and then assembled in modular form onto the uprights.

6.5.4.5 Materials to be Used



The materials to be used for the jetty are as follows:

- Galvanized Steel stilts with inbuilt shoe
- 2 pack epoxy resin
- timber columns
- timber beams and trusses
- timber slats
- Stainless steel bolts

6.5.5 Equipment for Jetty Construction

The equipment proposed for use during the jetty construction is as follows:

SN	Name of Equipment	Image of the Equipment
1.	<p><u>Hydraulic rock drill (Stanley Hydraulic Drill)</u></p> <p>This equipment has 50m of hydraulic hose so the engine/hydraulic pump will be based inland and the drill alone will be used to drill the hole on the rocks.</p>	

SN	Name of Equipment	Image of the Equipment
2.	<p><u>Small floating platform</u></p> <p>This floating platform will be used to provide footing to labour for the driving in of the steel piles and shoe assembly into the sandy bottom</p>	
3.	<p><u>Arc Welding Machine and Generator</u></p> <p>This equipment will only be necessary in case adjustment to steel stilts and shoe assemblies are required during the works</p>	
4.	<p><u>Metal Grinder (5" (125mm) Medium Angle Grinder)</u></p> <p>Features</p> <ul style="list-style-type: none"> ● 12-amp AC/DC, 11,000 rpm motor provides high speed for fast material removal ● High power-to-weight ratio for greater efficiency and reduced user fatigue ● Adjustable guard can be adjusted to redirect sparks away from user ● Rear handle design for greater comfort and control ● External brush caps for easy servicing ● Sealed ball and roller bearings for extended motor life ● This product runs off of AC/DC power <p>Specifications</p> <ul style="list-style-type: none"> ● AMPS -12.0 AMPS ● HORSEPOWER -2.5 HP ● MAX WATTS OUT -1,837 W ● NO LOAD SPEED -11,000 RPM ● POWER TOOL TYPE -CORDED ● SPINDLE LOCK -YES ● SPINDLE THREAD -5/8"-11 ● TOOL LENGTH -14.33 ● IN TOOL WEIGHT -7.4 LBS ● USE WHEELS RPM ABOVE -11,000 RPM 	

6.5.6 **Dredging and Reclamation**

Please refer to the section 4

6.6 **Ship Building and Repair (Dry-Dock)**

6.6.1 **Introduction**

Shipbuilding is a Made-to-Order industry with short lead times. This fundamental fact significantly influences the design and production processes of building a ship. In order to generate the enormous quantities of information for each ship in a relatively short period, it is necessary to design hull structures, machinery, equipment and electrical systems concurrently. Consistent/detailed

information for the production process has to be prepared through the collaborative involvement of teams of designers and production personnel. It is of paramount importance to integrate the whole information from initial design through to production and also to support concurrent work. A new ship manufacturing project accomplished in guidance of “Technical Specification” of Vessel, duly signed by both Ship Owner and Builder (Shipyard). Based on this signed technical specification designer will prepare Ships Basic Design and submitted to Class to getting Approval, then total BOQ and production design will produce as per approved basic design. Production design are followed to build the complete Ship and finally handed over to the Owner as per signed Contract Agreement.

6.6.2 Basic Design Review

To start a Ship Manufacturing Basic Design review is one the major and first job of a shipyard. This design reviewing will be performed according to Technical specification. Where all technical matters, equipment list, manufacturing process, navigation route and all others criteria elaborately described. Ship manufacturing all activities will be executed based on this basic design.

6.6.3 Material BoQ Preparing and Supply Planning

The following material BOQ to be prepared based on design data and technical specification.

1. All kinds of Steel Material
2. Pipe, Pipe Fittings, Valves & Accessories Item
3. Main Propulsion System and Generators
4. Pumps, Equipment & others Engine Room Machinery Item
5. Deck Machinery Item
6. Hull Outfitting & Accommodation Item
7. Electrical, Navigation & Communication Item
8. Ship Operational and Delivery Item

Material supply phase identification and ensuring is most important issue to completion of new ship manufacturing within the stipulated time frame. In generally block fabrication method is suitable for medium to large ship. The production method depends on shipyard logistics facilities and practice. Material planning should be synchronized with production planning.

6.6.4 Production Drawing Preparing

In production drawing whole Ship to be subdivided into several mega blocks and every mega block also divided in several numbers of block, and as per modern shipbuilding practice block wise piping production drawing to accumulated with block structure drawing.

6.6.5 Inspection and Test Plan

Every phase of ship building process there has a lot of inspection and tests need to be done at various stage of production. Without a well planning there have a chance to missing some inspection and test in every stage of production. In any phase if any test is missing it cannot be perform in next stage, so in a quality ship building process incorporation of Inspection and Test Planning is most important.

6.6.6 Ship Building (Production) Process

There are two basic activities involved in construction of a complete ship, steel erection and outfitting. At some point these two major efforts come together, depending on the construction methods being employed. The process involves application of the four basic resources that are available in a shipyard.

1. Manpower

2. Material
3. Logistics Facilities and
4. Time.

The manner in which all of the above is carried out is unique to each shipyard.

6.6.6.1 Material Processing & Handling

Block wise material processing is performing as per block workshop drawing, where each part is identified with the material from which it will be made, and each part also identified with the piping system to which it belonged as per geographical location within the ship. Also, some integrated production system equipment and fittings are identified with their system and position. So, as per fabrication order materials should be procured and supplied to the fabrication yard.

An important factor influencing the efficiency of the ship building is a logical and well-planned material flow. The flow should be unidirectional as far as possible and flexible enough so as not to be unduly disrupted by any necessary variation in the production sequence.

6.6.6.2 Integrated Ship Fabrication

In modern ship construction process the following work steps are performing to construct a ship hull structure.

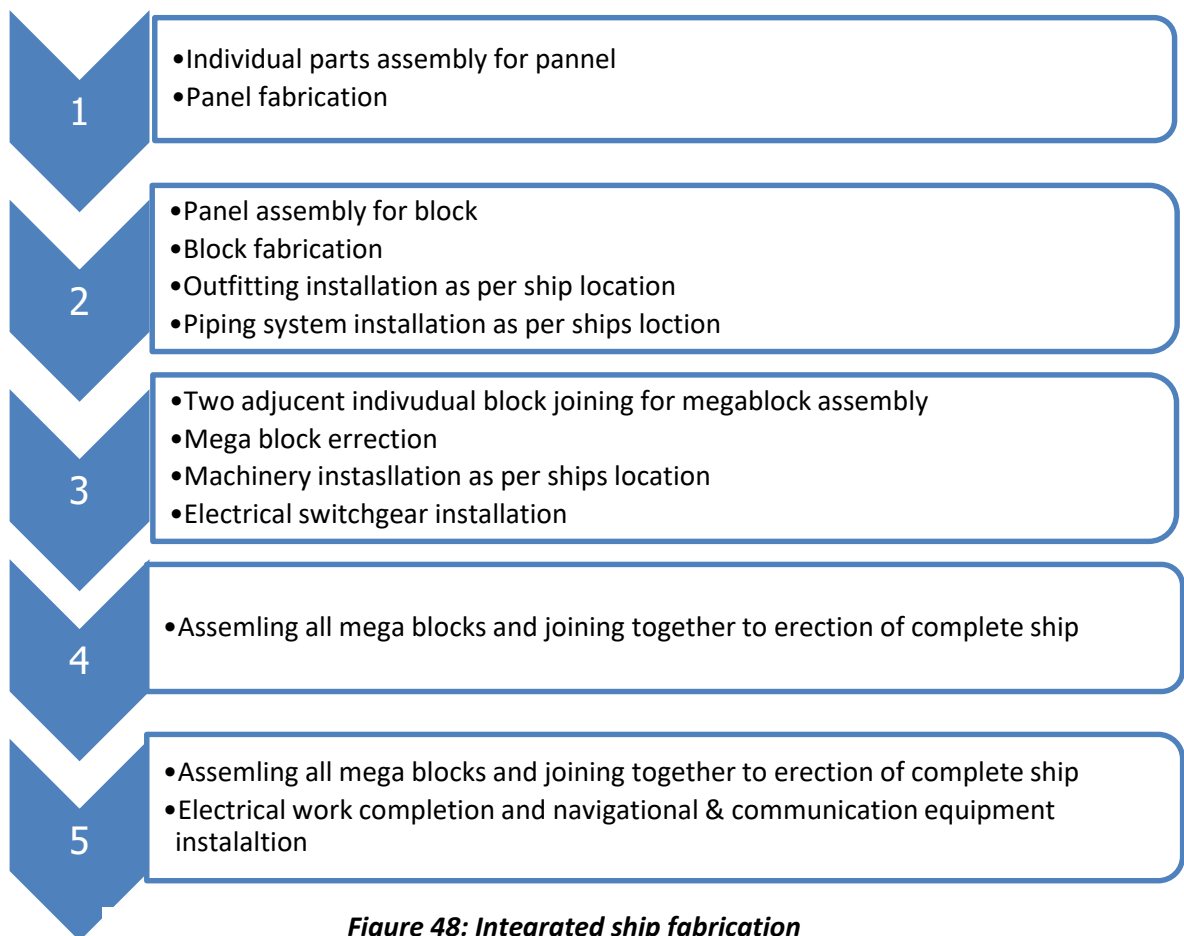


Figure 48: Integrated ship fabrication

6.6.6.3 Protective Painting and Coatings

Ships life depends on its protective coating and their applications. Protective coatings are started from very beginning of steel processing and it continues up to hand over of complete vessel. In generally following steps were followed at every stage of ship manufacturing.

1. Prime coating: a thin prime coating is applied on steel surface after properly blasted before starting material cutting.
2. Final coating: a wide range of painting works are performing after completion of block fabrication. Before final painting it should be ensure that all kinds of hot work have been done and none of welding and tank test missing in specific location. After completion of standard surface preparation surface to be checked & inspected by paint inspector the paint to be applied as per paint scheme described in "Technical specification".

6.6.6.4 Test Trial & Commissioning

All mechanical and electrical systems are tested and commissioned before delivery of the Ship to the buyer after successfully launched into water at float condition. The systems that are tested and monitoring will include the following:

Hull Part

- Speed and endurance.
- lightweight and CG and
- Steering and maneuvering system

Engine Room Systems:

- Main engine propulsion performance and fuel consumption
- Auxiliary machinery
- Pumping systems and
- Electrical systems, including monitoring, controls and alarms.

Deck Systems:

- Cranes (if any)
- Hatches
- Mooring gear, anchor handling
- Navigation
- Communications devices and
- Rescue and Safety System

Accommodation:

- Lighting and others electrical fixtures
- Ventilation and air conditioning and
- Galley equipment and
- Alarms

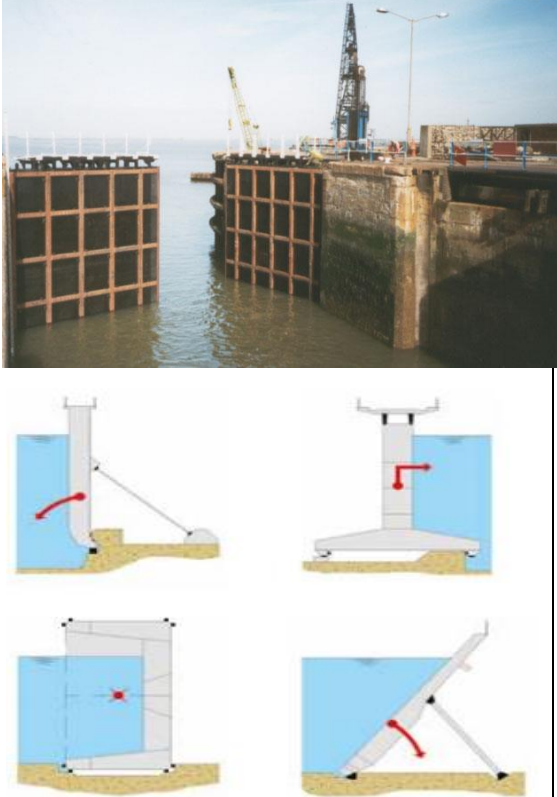
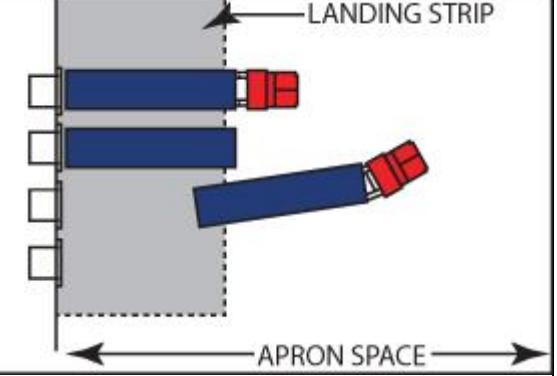
A test and commissioning program is used to define at what stage testing is carried out and allows as much integration of testing into the construction program as possible. This reduces the time between launch and delivery. The ship's main engine propulsion system and performance is tested after launch during sea trials, during which the speed/power curve for the ship is determined along with other trials such as maneuvering, stopping and mooring. Rescue and safety systems are also being tested and commissioned such as the operation of the lifeboats and fire and deck wash lines.





Any defects found during the testing program are noted and repairs carried out where necessary, after discussions with the Owner's representatives and regulatory bodies.





6.6.7 Dry-Dock

A dry dock (sometimes dry-dock or dry dock) is a narrow basin or vessel that can be flooded to allow a load to be floated in, then drained to allow that load to come to rest on a dry platform. Dry docks are used for the construction, maintenance, and repair of ships, boats, and another watercraft.




6.6.7.1 Dry-Dock related Infrastructure

SN	Name of Infrastructure	Picture of Infrastructure
1.	<p><u>Dock Gate</u></p> <p>Flap gates are supported by hinges to the entrance sill of a dock or basin and are opened by lowering them down into the water so they lie on the seabed below the sill. Flap gates are usually provided with buoyancy tanks to minimize the operating load on the winches or hydraulic rams. The gate is open and closed by a continuous wire rope, anchored at one end, threaded through sheaves and attached to a single winch located possibly below cope deck. The winch is estimated at capacity of 50 tons pull.</p> <p>Dry Dock Entrance Gates</p> <ul style="list-style-type: none"> ○ Flap Gates: box, cantilever, propped ○ Caisson Gates: spanning, gravity ○ Mitre Gates <p>Dry Dock Intermediate Gates</p> <ul style="list-style-type: none"> ○ Inverted 'Y' ○ Lambda ○ Stop Log 	 <p style="text-align: center;">Dock gate</p>
2.	<p><u>Apron Flushing</u></p> <p>The flap gate recess outside dock entrance (apron area) is often prone to siltation. At the detailed designed stage, consideration will be given to mitigate the siltation of this area. The system often incorporates jetting pipes in sill, connected to dewatering pump discharge pipe. Each time dock is dewatered, jetting pipes discharge water under pressure to clear silt from gate recess.</p> <p>For large silt depositions, it may be required to install dedicated silt pump for frequent jetting.</p>	

SN	Name of Infrastructure	Picture of Infrastructure
3.	<p><u>Dock Dewatering</u></p> <p>It is proposed that low tension (400 volts) submersible pumps be considered for the dock dewatering in favor of the more traditional long shaft pumps driven by high voltage motors. This is to mitigate the considerable risk of flooding in the motor room due to the exceptionally high tidal levels (MHWS = 5.5 m) prevailing in the river and the possibility of river overflowing. The use of submersible pumps has been proven and there are a number of European manufacturers (KSB and Sulzer ABS) producing such pumps.</p>	 <p style="text-align: center;">Dock Dewatering</p>
4.	<p><u>Pump House Complex</u></p> <p>The pumps are submersible types and seated at the bottom of the pump wells. The water in the dock is flows into the sump below the wells and is lifted to the level of the weirs where it flows over into a culvert connecting to the river.</p> <p>The location of the circuit breakers will have to be considered with care given the possibility of abnormal over the cope swells. Power is supplied from mobile generators to minimize the cost of transformers and heavy copper cables.</p>	  <p style="text-align: center;">Pump House Complex</p>
5.	<p><u>Winches</u></p> <p>Winches in dry dock is mainly used for opening and closing the dock gate. 'hauling-in' winches to assist with the docking and un-docking of vessels and winches to assist with maneuvering ships' propellers during repair and maintenance</p>	 <p style="text-align: center;">Winches</p>
6.	<p><u>Cut-off Curtain Wall</u></p> <p>To minimize the inflow of water beneath the dock walls, it is necessary to construct a curtain cut off wall around the periphery. The depth of this wall will be determined after soil investigation results are made available during detailed design stage.</p>	

SN	Name of Infrastructure	Picture of Infrastructure
7.	<p><u>Entrance Wheel Rubber Fenders</u></p> <p>Wheel Rubber Fenders are usually installed to guide ships in restricted spaces like walls of dry docks. They can also be used on corners and lock entrances where lower energies are needed. Wheel Rubber Fenders use stainless steel and composite bearings which give a very low rolling resistance and require virtually zero maintenance.</p>	  <p>wheel rubber fender for dock corner</p>
8.	<p><u>Hauling-in System</u></p> <p>To facilitate docking of large vessels we have considered a hauling-in system be incorporated along each side of the dock wall.</p>	 <p>Hauling-in System</p>
9.	<p><u>Dock Side Cranes</u></p> <p>It is proposed that the provisions be made in the design of the dock to permit the installation of dockside cranes on either side with capacity not exceeding 50 tons.</p> <p>This capacity will be sufficient to cater for the lifting of most hatch covers, machinery equipment, propellers and rudders of vessels in the target range. Some rudders and propellers</p>	

SN	Name of Infrastructure	Picture of Infrastructure
	<p>are heavier than this but such situations are infrequent.</p> <p>The crane beams will run from the entrance to the head of the dock. There shall be storm anchors and jack up points for maintenance purposes along the crane track as well as buffers at each end.</p>	<p>Dock Side Cranes</p>
<p>10.</p>	<p><u>Gantry Crane</u></p> <p>Gantry crane is mainly used for lifting of vessel or equipment in the operation of dry dock.</p> <p>A gantry crane is a crane built atop a gantry, which is a structure used to straddle an object or workspace. They can range from enormous "full" gantry cranes, capable of lifting some of the heaviest loads in the world, to small shop cranes, used for tasks such as lifting automobile engines out of vehicles. There are several kind of gantry crane such as</p> <ul style="list-style-type: none"> • Ship-to-shore crane • Full gantry crane • Rubber-tyred gantry crane • Portable gantry crane 	 <p>Gantry Crane</p>
<p>11.</p>	<p><u>Inlet and Outlet Valves</u></p> <p>Proprietary big capacity inlet and outlet valves are expensive and difficult to maintain. Use of yard fabricated inlet valves and the avoidance of outlet valves by discharging over a weir.</p>	
<p>12.</p>	<p><u>Mobile Air Compressors</u></p> <p>In some older shipyards, compressed air is delivered from a central source. This practice is not energy efficient. Frictional losses are costly and leakages frequent.</p> <p>When a small part of the yard requires compressed air the entire central plant is energized. The pipes that are not leading to the point or usage are unnecessarily pressurized.</p>	 <p>Mobile Air Compressors</p>

SN	Name of Infrastructure	Picture of Infrastructure
13.	<p><u>Mobile Cranes</u></p> <p>A mobile gantry or travel lift facility typically consists of a rubber-tyred gantry running over a twin pier construction. The vessels to be slipped are floated in between the piers and then hoisted out of the water by the mobile gantry or travel lift using polyester straps.</p>	 <p style="text-align: center;">Mobile Cranes</p>
14.	<p><u>Gangway Access Towers</u></p> <p>The access tower provides the access to the gangway linking the vessel on the dock.</p>	 <p style="text-align: center;">Gangway Access Towers</p>
15.	<p><u>Jetties</u></p> <p>The best configuration for the design of a ship repair berth is that of a finger pier where ships may be moored on either side with a crane runway atop of the pier. This however is not always possible in a river of limited width. The next best option is a contiguous wharf or quay running parallel to the shore. The “jetty” configuration often used in bulk handling of liquid cargoes for vessels with drafts too deep for it to come nearer to shore is not suited for repair berths for a number of reasons</p>	 <p style="text-align: center;">Jetties</p>

Checklist for Shipping Sector Project **Annex- 18**

Template for Shipping Sector Project **Annex- 19**

SMART Indicator for Shipping Sector Project **Annex- 20**

7. Conclusion

In Bangladesh, more than one-fourth shipyards are ready or to be ready with little renovation for construction of small and medium sized vessels of international standards. The lowest labor cost has kept the direct cost of ship production to a minimum level. The Shipping industry is playing an important role in assisting the national defense, promoting shipping and industrial development, increasing employment and foreign currency inflow etc.

CHAPTER SEVEN CONCLUSION AND RECOMMENDATIONS

7.1. Conclusions

Monitoring and evaluation (M&E) of development projects and programmes is of high priority. Monitoring and evaluation when carried out correctly and at the right time and place are two of the most important aspects of ensuring the success of many projects. Unfortunately, these two although known to many project executers tend to be given little priority and as a result they are done simply for the sake of fulfilling the requirements of the sponsoring ministries, funding agencies and of Planning Commission and IMED without the intention of using them as a mechanism of ensuring the success of the projects.

It should also be noted that each project may have unique requirements, so IMED should attempt to develop general as well as sector specific monitoring and evaluation tools. It is recommended herethat in the M&E officials be adequately trainedto use the M&E tools for periodic monitoring and field visits. The IMED should help them clearly understand the purpose of the M&E and encourage using appropriate M&E tools.

As per strategic and logistic support for the ongoing project this guideline will help the IMED personnel with project implementation team to review progress of the projects.

7.2. Recommendations

7.2.1. General Recommendations for IMED

This guideline will enhance regular progress monitoring of ongoing projects against physical and financial targets. It will help involved officials particularly to review progress in the field level. The study team recommends following to enhance monitoring capability of the IMED:

General Recommendations

1. A technical unit may be formed/ establish in IMED with justification that will be supportive to Assess needs and provide direction for the Technical Services Program, including investigating new technology, proper M&E with new dimensions, and developments in the field.;
2. A monitoring & evaluation cell should be strengthened in each ministry as part of planning wing (need basis)
3. Timely monitoring should be emphasized and be strengthened specially for procurement management including tendering process;
4. Online monitoring system should be developed and madefunctional;
5. SMART indicators be defined clearly in the DPP and effective M&E template format should be developed and used;
6. Create balance in project expenditure with respect to yearly/ quarterly targets of ongoing works;
7. It should be ensured that the quality of the ongoing project is specified in their technical specification and its implementation procedure be based on project cost estimates as in the DPP;
8. Time schedule should be maintained in deploying manpower and procuring works, goods (equipment, machineries etc.) and services;
9. Project maintenance system should be developed and strengthen from the beginning;
10. Capacity building training for each project should be specified for IMED staff, ministry and agency level planning and monitoring staff those will conduct field inspection and M&E practices from benning to end;

11. Appropriate person should be selected for conducting field inspection and M&E those have relevant knowledge;
12. Enthusiasm should be created for field visit/ field inspection among the M&E staff;
13. Risks allowance may be provided for M&E staffs during field inspection;
14. Communicate with the steering committee members and keep them updated with the project progress, issues and problems;
15. Mid-term/ in-depth monitoring/ evaluation should be conducted for every project;
16. The Land acquisition process is slow and time consuming, it should be strengthened;
17. Strengthen the knowledge and capacity building of IMED M&E officials for information gathering and report preparation;
18. IMED monitoring officers should widely use of field project information and review relevant reports;
19. Result based monitoring system should be strengthen and practice in the field by using SMART indicators and template;
20. IMED should gather/collect reliable data through use of specified prescribed template for M&E;
21. IMED should recruit adequate and skilled manpower for effective M&E;
22. Project Directors should be more efficient and devote more time in project implementation and M&E rather than mainly involved in administration and audit;
23. Research and development facilities should be strengthened;
24. Required logistic support/vehicles should be provide for inspection/field visit;
25. Monitoring and Evaluation should be mandatory for all ongoing project under ADP;
26. Ministry/department/authority should more concentrate in M&E activities and reporting system of projects/ programs.

7.2.2. Sector specific Recommendations

Forestry sector	Irrigation sector
<ol style="list-style-type: none"> 1. Effective utilization of fallow land/ unused land into forest coverage 2. Plantation of local indigenous species like fruits and medicinal plants should be prioritized 3. Non-eco-friendly/ foreign species should be avoided 4. Plant species should be selected according to the nature of land/ soil condition 5. Decentralized the management system and encourage the local body& community management 	<ol style="list-style-type: none"> 1. Use of local knowledge and practices should be enhanced through community consultation and participation 2. Digging new ponds/ khal and re excavated pond/ khal and other water bodies be prioritized rather than too much depending on ground water 3. New sustainable irrigation project should be encouraged 4. Management system should be strengthened through participation of local people participation
WRM sector	Shipping sector
<ol style="list-style-type: none"> 1. Enhance surface water resource management system 2. Reduce dependency on ground water irrigation 3. Local indigenous practices should be appreciated 4. Frequent field inspection should be conduct by M&E officer and senior management team members and 	<ol style="list-style-type: none"> 1. Digital dredgers should be introduced(auto counting and measuring system) 2. Modern technology should include Cutter Suction Dredgers (CSDs) 3. Shipment process should be more smoother with the loading and unloading access

<p>observed field project/ program activities</p> <ol style="list-style-type: none">5. Cost effective interventions like groyen, bamboo bundle, Geo-tex, Vinna grass plantation be emphasized rather than CC blocks unless very essential6. Interventions like large embankment must take in to consideration of social (affecting farmers, fishers, aquaculture, resettlement) and environmental issues (aquatic biodiversity)	<ol style="list-style-type: none">4. Decentralized the management system and encourage the local body management5. Frequent field inspection should be conducted by M&E officer and senior management team members of IMED and observed field project/ program activities regularly/ frequently6. Port development should be subject to serious technical feasibility taking in to account of likely silt deposit per year, cost of capital dredging and need for yearly maintenance dredging, likely closure of channel by silt deposit and cost benefit analysis.
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LIST OF GENERAL ANNEXURE

Annex-1: Terms of Reference (Tor) of the Study

'Preparation of Monitoring & Evaluation (M&E) Guideline on Forestry and Irrigation'

(To address Forestry, Irrigation, Water Resource and Shipping Sector related Projects of Annual Development Plan)

1. Background of the study

- I. Implementation Monitoring and Evaluation Division (IMED) is the apex body of the Government of Bangladesh to monitor and evaluate the implementation of the public-sector development projects included in the Annual Development program (ADP). The prime function of the IMED is to monitor and evaluate the implementation of development projects in order to enable the Ministries and Executive Agencies to ensure their proper implementation. Through monitoring and evaluation, it points out to the project implementing ministries and other appropriate authorities the progress of implementation and problems encountered, if any, in the field relating to the quality, time, cost etc. for taking remedial measures. For timely and proper management of these activities along with the main functions a comprehensive strengthening program has been gravely felt for long time. Therefore, IMED has undertaken the development project, entitled 'Strengthening M&E Capabilities of IMED (SMECI)' funded by the GOB.
- II. Beside many other functions that are performed by the IMED, an important function is to carry out regular field review of development projects to keep itself abreast with the latest progress of projects in the field. It informs the relevant ministries and agencies with the impending problems as well as current problems affecting the progress of projects, for taking remedial actions at their end, so that project's physical and financial progress are accelerated
- III. For the purpose of carrying out field review a comprehensive guideline is necessary. Therefore, IMED intends to develop a Monitoring & Evaluation Guideline on Forestry and Irrigation (To address Forestry, Irrigation, Water Resources and Shipping sector related projects of Annual Development Program) sector projects. Since agriculture sector is considered the main stay of the Bangladesh economy, contributing almost 50% of the GDP and spending substantial allocation of the annual development budget, its development activities have attracted greater attention of the government and that demands more focused and intensive quality monitoring by the IMED.

2. Objective of the assignment

The main objective of the assignment is to prepare an M & E Guideline covering all important areas of Forestry, Irrigation, Water Resources and shipping related projects, which will help as a tool of monitor for IMED officials during ongoing project monitoring and evaluation of project after termination.

The specific objectives of the assignment are the following:

1. Review the existing available relevant documents/guidelines on project review;
2. Review the existing available relevant documents/guidelines of other similar countries and Development Partner agencies;
3. Analyze objectives of the assignments thoroughly;
4. Develop a guideline that can be effectively used by the IMED officers during project monitoring and evaluation;
5. Develop an identical M&E template for relevant sector;
6. Guide the officers of the IMED in building systematic approach to field visit through use of the Guideline;

7. Ensure the project management knowledge areas (such as scope, time, cost, procurement, quality, integration, human resource, stakeholders, communication and risk);
8. Help accelerate progress of the development projects.

3. Scope of services

The scope of the services broadly includes as follows:

1. Prepare a study design to carry out interviews of the stakeholders to know the actual requirement of Forestry, Irrigation, Water Resources and Shipping related projects for preparation of the guideline;
2. Identify weaknesses and limitations in the monitoring and evaluation process of the related projects;
3. Identify key areas of project development activities, and also identify/select smart indicators for effectively monitoring and evaluating related projects;
4. Identify the components of different development projects, and describe the parts of each component for effective monitoring and evaluation;
5. Study monitoring and evaluation reports, in-depth study reports and other related reports of the projects of the concerned sector and identify monitoring and evaluation weaknesses etc.;
6. Study other relevant documents and M&E procedure of Forestry, Irrigation, Water Resources and Shipping projects/program of in country and other countries that can be helpful in preparing M&E Guidelines;
7. Consultant/s will interact with the relevant ministries, agencies, projects and identify areas of interest that can be helpful in carrying out the assignment;
8. Consultant will deliver comprehensive M&E guideline and M&E templates for Forestry, Irrigation, Water Resources and Shipping in English and Bangla;
9. Any other related works assigned by the client.

4. Qualifications and Experience of the Firm

4.1. Firm: the assignment will be undertaken by a firm having similar experience in development of guidelines and having adequate staff with appropriate professional qualifications and suitable experience:

- a) Firm registered with the Government of Bangladesh;
- b) At least three (03) years working experience in conducting similar type of assignment;
- c) Demonstrated capability in monitoring and evaluation of projects as evidenced by the qualifications and experience of the professional staff;
- d) Excellent understanding and knowledge of project implementation procedures;
- e) Proven track record of data/Information collection, compilation, analysis and analytical report generation;
- f) Advantage will be given for experiences of preparation guideline (s) in public sector;
- g) Skills in translation of documents/Guideline in English to Bengali.

4.2. Team Composition

SN	Type of professionals	Educational qualifications	Experience required
1.	Team Leader	At least Masters' degree in Forestry or in any Agricultural discipline.	<ul style="list-style-type: none"> • At least 15 years of experience in relevant project /program monitoring and evaluation field. • Must have experience on developing guidelines/ manuals. • Demonstrated team leadership experience in similar/comparable position for 2 years.

SN	Type of professionals	Educational qualifications	Experience required
		Ph.D. degree will be preferred	<ul style="list-style-type: none"> Required organizational, communication and report writing skills; Preferably have working experiences with government-executed donor-funded projects in Bangladesh; Experience can be relaxed in case of exceptionally qualified candidate.
2.	Forestry Consultant	Minimum B.Sc. in Forestry/ Agro-forestry	<ul style="list-style-type: none"> At least 5 years' experience in relevant field Project/program monitoring and evaluation experience will be given advantage Preferably have working experiences with government-executed donor-funded projects in Bangladesh
3.	Agricultural Engineer (Irrigation)	Masters in Agriculture Engineer (Irrigation)	<ul style="list-style-type: none"> At least 5 years' experience in relevant field Project/program monitoring and evaluation experience will be given advantage Preferably have working experiences with government-executed donor-funded projects in Bangladesh
4.	Civil Engineer	B.Sc. in Civil Engineering	<ul style="list-style-type: none"> Expertise in water resources management will be given advantage At least 5 years' experience in the relevant field; Project/program monitoring and evaluation experience in projects related to Ministry of Water Resources and Ministry of Shipping will be given advantage; Preferably have working experiences with government-executed donor-funded projects in Bangladesh.
5.	Mechanical Engineer	Minimum B.Sc. in Mechanical Engineering Expertise in water resources management will be given advantage	<ul style="list-style-type: none"> At least 5 years' experience in the relevant field; Project/program monitoring and evaluation experience in projects related to Ministry of Water Resources and Ministry of Shipping will be given advantage; Preferably have working experiences with government-executed donor-funded projects in Bangladesh; Knowledge related operations & maintenance, Instrument& Control, Structural, Engineering Management, Procurement, Quality and Environment, Safety and standards, planning, management of and monitoring the Water resources management construction activities, Safety performance measurement and monitoring, leading the relevant site staff and delivering the works to the agreed scope. Managing the contractors,

SN	Type of professionals	Educational qualifications	Experience required
			material and conditions of contract etc. will be added advantage.

5. Duration of assignment

Duration of assignment shall be **04 (four) months** from the date of signing the contract.

6. Consulting Firm Responsibilities

- 6.1. The Consulting Firm must propose services of consultants having good academic background and knowledge of the subject (assignment), so that quality M & E Guidelines and templates can be prepared and delivered within the stipulated time frame;
- 6.2. Consulting firm shall propose an appropriate methodology for the study in the context of objective of the assignment and scope of services;
- 6.3. Prepare and finalize M & E Guideline based on the study of documents, objective of the assignment and the data/information collected from various internal and external sources. M & E Guideline should cover maximum areas of monitoring activities / components of specific item;
- 6.4. Arrange a Workshop/Seminar for dissemination of the study findings and finalizing the guideline incorporating comments/observations of the participants.

7. Expected Deliverables/ Reporting

The following deliverables are expected (from the date of contract signing):

S N	Deliverables	Number of reports	Delivery timeline (after signing contract)
1.	Inception report (Inclusive of detailed work plan, methodology, sample size, questionnaire and strategy)	16	3
2.	Submission and finalizing the data collection instruments after field testing	-	4
3.	Information collection from stakeholders and preparation of draft report (Guideline)		8
4.	Submission of 1 st draft report	16	8
5.	Submission of 2 nd draft report	16	12
6.	Workshop with stakeholder for finalization of draft report Guideline)	140 copies in English	13
7.	Submission of final report (Guideline) incorporating feedback from stakeholders.	25 copies in English & 25 copies in Bangla (Unicode) & soft copies	15

* Cost of deliverables shall be borne by the consulting firm.

8. Client's Input, Logistics and Support Arrangements

- 8.1. Project Director, Strengthening Monitoring and Evaluation Capabilities of IMED (SMECI) will be the Client, and will make available all relevant reports, documents, information for the Consultant and designate counterpart personnel, if available;
- 8.2. The client will facilitate the consultancy activities like data collection, meeting/seminar arrangement and other arrangement related to the proposed assignment;
- 8.3. The Consultant will make own arrangement for necessary equipment (Desktop / Laptop, Printer, Scanner etc.) and facilities (home office space with telephone, fax, Internet connectivity etc.)

essential for providing the services. The client will arrange temporary necessary working space when required to review the documents at client premises The Consultant will make own arrangement for all sorts of transportation.

9. Contents of Guideline

The Guideline will be user friendly. Illustrative example/ Case study and images might include for better understanding for the users Page size: A4.

Annex-2: Checklist of DPP for the proposed study

1. Project Title:
2. Objectives of the project:
3. Estimated cost of the project total GoB PA (RPA)
4. Mode of financing:
5. Components of the project:

SN	Aspects to be answered/covered	Yes/No	Remarks
6.	Whether log frame in the DPP is correctly drawn to achieve the objective of the project		
7. a)	Whether required manpower as mentioned in the DPP has been deputed from existing setup, recruited directly or recruited by outsourcing		
7. b)	Whether recruitment of personnel has been made following government recruitment rules and regulations		
7. c)	Whether recruited/deputed personnel have requisite qualification and experience as mentioned in the DPP		
8.	Whether there is a steering committee and Project Implementation Committee (PIC) for reviewing the progress of project (monthly/quarterly/half yearly		
9.	Whether procurement plan of goods, works and services are being executed following the PPA-2006 and PPR-2008		
10. a)	Whether item wise physical components as approved in the project document, differ from those being executed in the field.		
10. b)	Whether physical components target and progress as reported in the 02, 03 IMED formats are consistent with the field up to last quarter		
10. c)	Whether year wise financial phasing as approved in the DPP matches with the yearly ADP allocation.		
10. d)	Whether year wise fund release and expenditure are consistent with the reported figures in the IMED formats		
11. a)	Whether project authority has clearly identified the Reimbursable Project Aid (RPA) expenditure items of the project and is making the RPA claims from Dollar Special Account (DOSA), Convertible Taka Special Account (CONTASA), Special Account for Foreign Exchange (SAFE), Impressed, etc. accounts properly and timely		
11. b)	Whether claims of RPA expenditures are being submitted quickly for reimbursement		
12.	Whether Benefit-Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) figures provided in the approved project document are inconsistent with the present figures (for completed profit earning industries)		
13. a)	Whether mitigation programs for environmental impact has been taken care of by the project authority as mentioned in the DPP		
13. b)	Whether the project in anyway is contributing to the poverty alleviation, empowerment of women and regional disparity as mentioned in the DPP		
14.	Whether the project is contributing to the Poverty Reduction Strategy (PRS) and Millennium Development Goals (MDGs) as mentioned in the DPP.		

SN	Aspects to be answered/covered	Yes/No	Remarks
15.	Whether any project aid conditionality mentioned in the DPP is affecting implementation of the project		
16. a)	Whether rehabilitation/resettlement of affected persons/families program is taken up by the project authority		
16. b)	Whether the cost involvement as mentioned in the DPP for rehabilitation/resettlement will remain within the approved estimate		
17.	Whether project implementation period is likely to be extended		
18.	Whether there is a possibility of time over run and cost over run		
19.	Whether internal and external audits are being carried out when last internal and external audit was done		
20.	Whether site register/book is being maintained at project site and visiting supervisory officials are recording their observations on progress and quality of work etc.		
21.	Whether Annual Work Plan has been prepared by the project authority/PD		
22.	Whether Critical Path Method (CPM)/ Bar Chart, for smooth execution of the project, has been prepared and being followed		

Annexure -3: Checklist for TPP

1. Project Title:
2. Objectives of the project:
3. Estimated cost of the project total GoB PA (RPA):
4. Mode of financing:
5. Components of the project:

SN	Aspects to be answered/covered	Yes/No	Remarks
6.	Whether there is a possibility for cost and time overrun.		
7.	Whether PD/NPD is a full time or a part time appointee.		
8.	Whether financing arrangement has been finalized.		
9.	Whether loan/credit/grant and other amounts as approved in the TPP is the same		
10.	Whether TOR of the consultants adequately covers the areas related to the objective of the TPP		
11.	Whether PPR 2008 has been followed in selecting consultants		
12.	Whether adequate step have been taken by the project authority to ensure transfer of technology.		
13.	Whether consultant's performance is being monitored regularly		
14.	Whether educational qualifications and experience of the consultants are relevant to the assignments they have been engaged.		
15.	Whether the counter-part personnel attached to the consultants have required educational qualifications and experience as mentioned in the approved TPP.		
16.	Whether educational qualification and experience of the support staff matches with information provided in the approved TPP.		
17.	Whether letter of agreement with implementing agency and the development partner has been signed.		
18.	Whether project steering committee has been formed to review the progress of work.		
19.	Whether auditing of the project is being carried out. When the last audit was done?		
20.	Whether project work is progressing as per approved implementation works schedule provided in the TPP.		
21.	Whether total procurement plan as envisaged in the approved TPP is being implemented in the light of PPR 2008. Individual contracts should be analyzed in the Checklist for Procurement of Forestry, Irrigation, Water Resource Management and Shipping related Works -- Annexure.		
22.	Whether approving authority is exercising financial authority as per Delegation of Financial Power published by ministry of finance.		
23.	Whether CPM/ Bar Chart, for smooth execution of the project, has been prepared and being followed.		

Annex-4: Checklist for Key Informant Interview (KII)

Type of Respondents: PD/M&E Officers of Department/Agency/Organization/Field Officers

General Information

- 1. Name of the Informant: _____
- 2. Designation: _____
- 3. Name of the project: _____
- 4. Name of implementing agency: _____
- 5. Location of the project: _____

Practice of M&E by the agency

- 6. Do you have any M&E guidelines/manual/template? Yes/No
- 7. If yes please share your M&E template/guidelines.
- 8. What is the implementation status of the proposed project for what I come here?
- 9. Did you prepare any M&E plan for this proposed project?

Field Visit Template

SN	Component of the project	Activities	Description of Technical Specification	Image/Picture
1.				
2.				
3.				
4.				
5.				

Checklist for Key Informant Interview (KII)

Type of Respondents: IMED Officials

General Information

1. Name of the Officer:
2. Designation:
3. Department: Monitoring/Evaluation
4. Sector:

M&E Related Questions:

5. How many years you are working in project M&E?
6. What kind of projects you generally monitoring in IMED?
7. What kind of projects you have evaluated in IMED for last two years?
8. What methods you use during monitoring and evaluation of the projects?
9. Do you use any guidelines/manual/template during monitoring and evaluation of the project?
10. What difficulties you faced during monitoring and evaluation of the project?
11. Do you ever feel to need an M&E guideline for specific sector of IMED?
12. Do you think proper M&E guideline would help IMED officials for effective monitoring and evaluation of the projects?
13. Shahidul Consultant is appointed by IMED to develop M&E guidelines on Forestry, Irrigation, water resource and shipping sector, do you have any suggestions in this case so as to make the manual workable for you?

Annex-5: Project List of Relevant Sectors of Bangladesh (As per ADP)**LIST OF PROJECT IN ADP: 2018-2019 (FORESTRY SECTOR)**

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Eco Restoration of the Northern region of Bangladesh	DoF	4531-5000	749.00
2.	Plantations in the five coastal districts		4531-5001	300.00
3.	Strengthening National Forestry Inventory and Satellite Land Monitoring System in Support of Red in Bangladesh		4531-5002	700.00
4.	National Garden and ballad gardens, Preservation and Further Development of Dhaka		4531-5003	472.00
5.	UN-REDD Bangladesh National Programme		4531-5004	397.00
6.	Integrating Community Change Adaptation into Afforestation and Reforestation Program In Bangladesh		4531-5006	1,457.00
7.	Expanding the Protected Area System to Incorporate Important Aquatic Ecosystem		4531-5009	588.00
8.	Support to DPP Preparation of Sustainable Forest and Livelihoods		4531-5010	1.00
9.	Sustainable Social Forest Development Project in the Greater Rangpur District		4531-5011	500.00
10.	Establishment of Sheik Russel Aviary and Eco-Park at Rangunia, Chattogram (2nd Phase)		4531-5013	3,000.00
11.	Afforestation in Coastal Region Including the Newly Accreted Chars of Bay of Bengal		4531-5018	1,500.00
12.	Establishment of plant gardens in the area of Lalmai hills		4531-5024	1.00
13.	Char Development and Settlement-4 (Department of Forest Component)		4531-5060	19.00
14.	Development, Management and Conservation of the Biodiversity of Saint Martin Island through Ecological Management	DoE	4541-5004	400.00

LIST OF PROJECT IN ADP: 2018-2019 ON IRRIGATION SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Enhancement of Crop Production through Improved On-farm Water Management Technologies	DAE	4331-5027	1583.00
2.	Excavation of Dug Well in Brind Area for Cultivation of Crops by Soft Irrigation	BMDA	4305-5007	1,500.00
3.	Expansion of Irrigation Facilities by Increasing Availability of surface water and removing water logging in Naogaon district		4305-5049	1313.00
4.	Enhancement of Irrigation Efficiency Through Construction of Sub-Surface Irrigation Channel		4305-5051	2248.00
5.	Digitalization of Survey and Monitoring for Development of Minor Irrigation (Phase-IV)	BADC	4305-5009	1,950.00
6.	Sylhet Division Minor Irrigation Development Project		4305-5035	2,087.00
7.	Barishal Division Minor Irrigation Development Project		4305-5042	2,217.00
8.	Greater Khulna and Jashore District Minor Irrigation Development Project		4305-5054	5,000.00
9.	Expansion of irrigation through utilization of surface water by double lifting-3rd phase		4305-5055	3,000.00
10.	AshuganjPalash Agro-Irrigation (5th stage)		4305-5056	450.00
11.	Greater Bogura and Dinajpur district Minor Irrigation Development Project		4305-5057	3,736.00
12.	Noakhali, Feni and Laksmipur District Minor Irrigation Development Project		4305-5061	4,720.00
13.	Pilot Project of Surface Water Based Irrigation Expansion Model at Shaniajan Union of Hatiabandha Upazila under Lalmonirhat District		4305-5062	1,040.00

LIST OF PROJECT IN ADP: 2018-2019 ON WATER RESOURCE SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Rehabilitation of Polders (67/A, 67, 67/B and 68) along Naf River at Ukhia and Teknaf Upazilas for improving the security on Bangladesh-Myanmar border in Cox's Bazar	BWDB	4705-0026	2,000.00
2.	Rubber Dam Construction and River Dredging in Mohananda at Chapainawabganj district		4705-0027	1,200.00
3.	Protection of Dakhin Satar Nadirkul and Monipur Area under Chagolnaiya & Fulgazi Upazila of Feni District from the Erosion of left Bank of The Muhuri River		4705-0028	19,00.00
4.	Drainage improvement of Upper Bhadra river, Horihar river, Buri-Bhadra River & adjacent khals in Monirampur & Keshebpur sub district, District- Jashore		4705-0029	1,000.00
5.	Protection from Bokshi launchghat to Badurhat launchghat area from the Erosion of Tentulia River including Dredging Work and Flood Protection in Kukri-Mukri Island at Charfession upazila under Bhola District		4705-0030	3166.00
6.	Protection of Lord Hardinge and Dholigour nagar Bazar of Lalmohon subdistrict from the erosion of the Meghna River in Bhola District		4705-0031	3,000.00
7.	Construction of Cross dam at Hargila from Protection of left bank of Jamuna River in Islampur Upazila of Jamalpur District		4705-0033	200.00
8.	Rehabilitation of Polder no. 36/1 in Bagerhat		4705-5000	5,000.00
9.	Protect of polders 56/57 from the erosion of the Meghna River at Burhanuddin and Daulatkhan upazila of Bhola district		4705-5001	10,000.00
10.	Preservation of the left bank of the river Padma from Doairbazar, Doharupazila in Dhaka district to Brahabajaraghata		4705-5002	1.00
11.	Bank Protective work against erosion of the Meghna River at Rajapur and East Ilisha Union of BholaSadar Upazila in Bhola District		4705-5003	6,000.00
12.	River Bank Protection work for protection of Tajumuddin upazila Sadar in Bhola District from erosion of Meghna River		4705-5006	10,000.00
13.	Conservation of Charfashion Municipality of Bhola district from the breakdown of the Meghna river		4705-5009	6334.00
14.	Protecting from the Right Bank break of Teesta river at Gangachara and Rangpursadar upazilas in Rangpur district		4705-5013	1950.00
15.	Protection from the breakdown of the Padma, from SonaiKandi in Rajshahi city to Bulanpur area		4705-5014	7,000.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
16.	Removal of Water Logging and Sustainable Water Management in Bhairab River Basin Area		4705-5015	10,000.00
17.	Rehabilitation of Ganga-Kapotakkha Irrigation Project		4705-5016	1.00
18.	Development of drainage system in Dhaka-Narayanganj Demra DND area		4705-5019	15,000.00
19.	Reconstruction of Bhadra and Salta river for resolving the waterlogging of Khulna district		4705-5023	3,000.00
20.	Rehabilitation for the development of prevention, drainage and irrigation system of the infrastructures of the Polder no. 61/1 (Sitakunda), 61/2 (Mirsarai) and 72 (Sandwip) in the sub-basin area under BWDB of Chattogram district		4705-5024	4,000.00
21.	Polder no. 62 (Patenga), Polder no. 63/1a (Anwara), Polder no. 63/1 B (Anwara and Patiya) rehabilitation of Coastal Area of Chattogram district		4705-5025	6,000.00
22.	Protection of Dhaka-Mawa-Bhanga-Khulna national highway adjacent to Haji Shariyatullah Bridge from the river erosion of the Arialkhan river		4705-5026	1,750.00
23.	Rajoir Kotalipara Flood Control, Drainage and Irrigation		4705-5027	5,360.00
24.	Mirsarai of Chattogram district Bangladesh Economic Zone Beja flood control, road and embankment Protection and drainage		4705-5031	25,000.00
25.	Development of flood and drainage system for discharging waterlogging in Noakhali area		4705-5033	10,000.00
26.	Flood Control, Drainage, Irrigation and Dredging of Banskhal river of Cox's Bazar		4705-5034	12,000.00
27.	Sureswar canal re-excavation and drainage		4705-5042	3,396.00
28.	Construction of integrated water containment structures in Punarbhaba for providing supplementary irrigation during dry season in Gauripur, Sadar, district of Dinajpur district		4705-5043	3,600.00
29.	Jobaibeel flood control, drainage and irrigation under Sappahar and Porsha upazilas of Naogaon district		4705-5044	3,183.00
30.	Protection from the River Erosion the of the Karatoya river from former Nazirganj and Daikhata enclaves of Bodaupazila of Panchagarh district		4705-5047	20.00
31.	Reconstruction of the Kumar River		4705-5048	5,000.00
32.	Protection of Ramnawaz Launchghat area under Manpura upazila from Bhola District Meghna river erosion and Ghoshcharhat		4705-5049	10,000.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
	Launchghat area under Charfashion upazila from Tetulia River			
33.	Reconstruction of 83 rivers/canals in Bagerhat district and increased navigability of Mongla Ghasiyakhali Channel		4705-5050	5,000.00
34.	River bank protection pilot project in Jamalpur district and Sherpur district through the Bamboo bundling		4705-5051	1.00
35.	River bank protection pilot project for the protection of the area of Jamalpur Sadar Melandah upazila, due to the breakdown of the old Brahmaputra river and tenani river of Jamalpur district through the Bamboo Bundling		4705-5052	1.00
36.	Reservation of river banks along the left and right bank of the Dharla river in Ghosparha, Dualteri and Bostari area of Bamkakata enclave 119 in Patgram upazila of Lalmonirhat district		4705-5055	375.00
37.	Bangladesh Flood Management Planning.		4705-5059	1,314.00
38.	Protraction of the Both Bank of Halda River by Bank Protective Work at Different Locations in Hathazari & Rauzan Upzaila in Chattogram District		4705-5061	4,500.00
39.	Strengthening Hydrological Information Services and Early Warning System (Component-B)		4705-5075	6841.00
40.	Re-excavation of Arialkha River, Haridoya River, Brahmaputra River, Paharia River, Meghna Branch River and Old Brahmaputra Branch River Project under Narsingdi District		4705-5076	10,000.00
41.	Rajbari Town Protection Project (Phase-II)		4705-5077	5,000.00
42.	Protection of Horina Ferryghat Area in Sadar Upazila and Charbhairabi Katakhal Bazar in Haimchar Upazila in the District Chandpur from the Erosion of the Meghna River		4705-5078	5,000.00
43.	Protection of Left Bank of Jamuna River from Kaolibari bridge to Shakharia (Bhuapur-Bot Tala) in Gopalpur & Bhuapur Upazila of Tangail District		4705-5079	3,000.00
44.	Border Rivers Bank Protection and Development Project(Phase -2)		4705-5081	4,000.00
45.	River Bank Protection Work with CC Block along the Left Bank of Dhaleswari River from km 10.920 to 13.050=2.130km to Protection the Embankment, GachKumulli, Baropakia & Ghonapara in Upazila Delduar & Nagorpur Dist-Tangail		4705-5083	3,000.00
46.	Protection of Khudbandi, Singrabari and Shuvogacha Area of Kazipur Upazila in		4705-5089	10,000.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
	Sirajganj District from Erosion of the Jamuna River			
47.	Protection of Bhuapur-Tarakandi road through Protection of Left Bank of Jamuna River in Sharishabari Upazila of Jamalpur District		4705-5090	4,000.00
48.	Protection of Left Bank of Jamuna River in between Kulkandi Hard Point Gutail Hard point at Belgacha Union of Islampur Upazila in District -Jamalpur		4705-5093	3,500.00
49.	Re-habilitation of Erosion Prone Area with Slope Protection Work in Polder no-72, Sandwip, Chattogram		4705-5094	4,000.00
50.	Strengthening of Vulnerable Locations of Haizda Embankment in Mohangonj Upazila under Netrokona District		4705-5096	2,000.00
51.	River Bank Protection Work to Protect Charbaria Area from the Erosion of Kirtonkhola River at Barishal sadar Upazila in Barishal District		4705-5097	3,000.00
52.	The Pilot Project in different Areas of Bangladesh using Bamboo Bundling Structures to Reduce River Bank Erosion, Land Reclamation and Increase Navigation		4705-5098	1,100.00
53.	Construction of Cross Dam over the Maskata River for Land Reclamation as well as Improvement of Communication between Mehendigonj Upazila Sadar and Barishal Sada		4705-5100	1,000.00
54.	Naboganga River Re-Excavation Project		4705-5103	2,000.00
55.	River Bank Protection Project Work for Protection of Arjuna Area from the Erosion of Jamuna River in Bhuapur Upazila of Tangail District		4705-5104	4,000.00
56.	Rehabilitation of Satla-Bagda Project Polder in Barishal District		4705-5105	1,000.00
57.	Old Dakatia-New Dakatia River Irrigation and Drainage Project in the district Cumilla		4705-5106	1,200.00
58.	Protection of Different Infrastructures from the Right Bank Erosion of Jamuna River at Gaibandha Sadar & Fulchari Upazila including Ganakabor in Gaibandha District		4705-5107	9,500.00
59.	Protection of Singra Poursava Area from Erosion of the River Atri and Nagor in Natore District		4705-5115	1,200.00
60.	Bhutiari Beel of Khulna District and Barnal-Salimpur-Kolabashu Khali Flood Control, Drainage Project (2nd Phase)		4705-5122	7,429.00
61.	Blue Gold Program (BWDB Component)		4705-5123	13,235.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
62.	Coastal Embankment Improvement Project - Phase-1 (CEIP-1) in Satkhira, Khulna, Bagerhat, Patuakhali, Pirojpur, Barguna & Patuakhali District		4705-5124	80,000.00
63.	Feasibility Study for Flood Control Drainage and Irrigation System at Gowainghat in Sylhet District		4705-5126	255.00
64.	Flood and Riverbank Erosion Risk Management Investment Program (Tranche-1)		4705-5130	19730.00
65.	Irrigation Management Improvement Project (IMP) (for Muhuri Irrigation Project)		4705-5131	6,452.00
66.	Protection of Ramgati and Komol Nagar upazila and adjacent areas under Lakshmipur district from the continuing erosion of Meghna River (Phase-1)		4705-5133	1,400.00
67.	Haor Flood and Livelihood Improvement Project (BWDB Part)		4705-5135	27,000.00
68.	Rehabilitation of Damaged polders under the District of Cox's Bazar		4705-5137	8,000.00
69.	Rehabilitation of BWDB infrastructures Damaged by Natural Disaster in the Coastal Area of Polder No.64/1A, 64/1B & 64/1C at Banskali Sub district in Chattogram District		4705-5138	4,500.00
70.	River Bank Protection work on both Bank of Sangu & Chandkhali River in Chandanaish and Upazila of Chattogram District		4705-5139	1.00
71.	Shibpur Flood Control, Drainage and Irrigation Project under Shibpur Upazila in Narsingdi District		4705-5145	1.00
72.	Re-Excavation of Titas River (Upper) under Brahmanbaria District		4705-5146	2,500.00
73.	Development of irrigation and re-excavation of Curzon canals and adjacent branches of Cumilla district		4705-5147	8,50.00
74.	Construction of Retired Embankment including Protection of Right Bank of the Jamuna River from Kurnibari to Chandanaisha at Sariakandi Upazila in Bogura District		4705-5148	5,000.00
75.	Southwest Area Integrated Water Resources Planning and Management (Phase-2)		4705-5151	7,530.00
76.	Feasibility Study in Connection with Construction of Water Treatment Plant for Ponding Area of Goran-Chatbari Pump House, Dhaka		4705-5153	270.00
77.	Technical Feasibility Study and Environment & Social Impact Assessment (ESIA) of Embankment-cum-Road and Water Management Systems for Economic Zone-4		4705-5154	300.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
	at Sonadia- Ghotibhanga Islands, Moheskhali, Cox's Bazar			
78.	Protection of Right Bank of Padma River at Naria & Janjira Upazila of Shariatpur District		4705-5155	5,000.00
79.	Institutional Development and Capacity Building of River Research Institute (Phase-II)		4705-5156	1,064.00
80.	Bank Protection Wrok of the Sangu and Dalu Rivers in Satkania and Lohagara Upazilas of Chattogram District		4705-5157	1,000.00
81.	Protection of Proposed Economic Zone and Development of Reclaimed Land from Jamuna River in Sirajganj District		4705-5158	3,000.00
82.	Feasibility Study with ESIA for Resuscitation of Ichamoti River in Pabna District		4705-5162	307.00
83.	Implementation of dam construction and defense work in Sea-Dike part of Polder No. 68 on Shahpiree Island, Teknaf upazila of Cox's Bazar district		4705-5555	4,000.00
84.	Buriganga River Restoration (New Dholesori-Pungli-Bongshi-Turag-Buriganga River System)		4705-6010	10,000.00
85.	Gazner Bill Link River Excavation, Development of Irrigation Facilities and Fish Cultivation Project at Sujanagar Sub district in Pabna District (BWDB part)		4705-8200	15,720.00
86.	Procurement of Dragger and Relevant Machine Tools for Dragging River of Bangladesh		4705-8260	10,000.00
87.	Char Development and Settlement-4 (BWDB)		4705-8310	1,719.00
88.	Kalani - Kusiara River Management Project		4705-9324	10,000.00
89.	Pre-Monsoon flood Protection and Drainage Improvement in Haor Areas		4705-9589	15,000.00
90.	Feasibility Study and Detailed Engineering Design of Brahmaputra Barrage	WARPO	4705-5054	4,849.00
91.	Study for Investigation and Expansion of Ground Water Irrigation in Habiganj, Moulavi bazar, Sylhet, Sunamganj, Netrokona and Kishoreganj Districts	Bangladesh Haor & Wetlands Dev. Board	4731-5000	550.00
92.	Study of Interaction Between Haor and River Ecosystem Including Development of Wetland Inventory and Wetland Management Framework		4731-5002	1,500.00

LIST OF PROJECT IN ADP: 2018-2019 ON SHIPPING SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Establishment of 4 Marine Academies in Bangladesh (Pathna, Barishal, Sylhet & Rangpur)	Ministry of Shipping	5201-5011	6,300.00
2.	Development of Maritime Legislation of Bangladesh		5231-5000	200.00
3.	Installation of GADSS & Integrated Maritime Navigation System		5231-5010	9,300.00
4.	Modernization of three DGPS stations, including control stations and monitoring stations.	BIWTA	5205-5005	1,708.00
5.	Bangladesh Regional Inland Water Transportation Project-1 (Construction of related facilities including excavation of Chattogram-Dhaka-Ashuganj and connected waterways and terminals)		5205-5009	10,500
6.	Re-construction of RCC Jetty at Guptachhara, Sandwip		5205-5012	2,692.00
7.	Procurement and Installation of Digital Gauges and Data Collection Through Global System for Mobile (GSM) Network		5205-5014	1,500.00
8.	Establishment of Ship Personnel Training Institute, Madaripur		5205-5016	1,700.00
9.	Establishment of Ferry Ghat including Allied Facilities at Balashi and Bahadurabad		5205-5024	5,500.00
10.	Capital Dredging of 53 Route of Inland Water Ways (in 1st phase, 24 Route)		5205-5026	21,000.00
11.	Improvement of Navigability from Mongla to Pakshi River Route Via Chandpur-Mawa-Gualanda		5205-5027	15,000.00
12.	Feasibility Study for Modernization of Port Facilities for Khulna Narsingdi, Barguna and Development of Galachipa, Mongla, Sunamganj Takerghat, Gharashal, Kachpur Port, Bhairab, Daudkandi-Bausia River Port		5205-5042	300.00
13.	Collection of Helpful Machinery and Equipment along with dredger		5205-5062	55,000.00
14.	Establishment of Ashugonj Internal Container River Port		5205-7320	75.00
15.	Dredging of 12 Important Waterways		5205-7490	8,000.00
16.	Procurement of 10 Dredgers, Craneboats, Tugboats, Officers Houseboat and Crew Houseboats with other accessories	5205-9738	5,370.00	
17.	Gobrakura Karaitoli Land Port Development	BLPA	5205-1113	500.00
18.	Construction of the head office of Bangladesh Land Port Authority		5205-5002	500.00
19.	Improvement of Balla Land Port		5205-5013	1,000.00
20.	Bangladesh Regional Connectivity Project-1: Development of Sheola, Bhomra, Ramgarh Land Ports and Upgradation of Security System of Benapole Land Port		5205-5015	5,300.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
21.	SASEC Road Connectivity Project: Development land port of Benapole & Kurigram		5205-5029	3,700.00
22.	Development of Bilonia Land Port		5205-5041	500.00
23.	Development of Tamabil Land Port		5205-5044	1.00
24.	Replacement of 2 Dump Ferry by Improved K Type Ferry	BIWTC	5205-0523	904.00
25.	Infrastructure Development and Establishment of Dok-3 Marine Workshop for BIWTC		5205-0526	435.00
26.	Construction of Passenger vessel for providing efficient services in Chattogram-Swandip-Hatiya-Barishal Coastal Route		5205-9728	1,014.00
27.	Procurement of 2 New Traveller's Ship for Dhaka-Barishal Inland Water Rute		5205-9730	1,012.00
28.	Collection of Tugboat for Mongla Port	MPA	5205-1112	1,000.00
29.	Capital dredging in the channels from Mongla port to Rampal power plant		5205-5004	6,000.00
30.	Improvement of Existing Infrastructures Roojvelt Jetty of Mongla Port Authority		5205-5021	1,000.00
31.	Dredging at the Outer Bar in the Mongla Port Channel		5205-5023	7,500.00
32.	Installation of Vessel Traffic management and Information System (VTMIS)		5205-5043	1,500.00
33.	Construction of CPA Hospital Complex in place of existing Hospital	CPA	5205-0515	200.00
34.	Procurement of Equipment for New Mooring Container Terminal (NCT)		5205-0518	80,000.00
35.	Shifting and Re-construction of service Jetty located near dock office to the upstream of Jetty no 1		5205-0524	1,500.00
36.	Collection A toga board with high-performance (3200 BHP)		5205-0525	1,500.00
37.	Improvement of Navigation by Dredging in Karnafuly River from Sadar Ghat to Bakaliar Char		5205-0528	8,000.00
38.	Construction of Potenga Container Terminal		5205-0529	30,000.00
39.	Strategic Master Plan for Mongla Port		5205-0530	250.00
40.	Newmuring & Varco Container Yard Construction		5205-0531	9,000.00
41.	Collection of 06 (six) new ships (03 new oil product tanker and 03 new bulk carriers) each almost accomplished 39,000 DW	BSC	5231-5064	58593.00
42.	Payra Deep Sea Port Operations Infrastructure / Facilities Development	PPA	5205-5066	50,000.00
43.	Establishment of National Maritime Institution Madaripur	NMI	5236-5000	1,000.00

LIST OF PROJECT IN ADP: 2017-2018 ON FORESTRY SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Community Based Sustainable Management of Tanguar Haor (Bridging Stage)	Ministry of Environment and Forest	4501-5000	260.00
2.	Strengthening the Environment, Forestry and Climate Change Capacities of the Ministry of Environment and Forests and its Agencies		4501-5012	140.00
3.	Promotion of Climate Change Unit in Co-ordinating the Bangladesh Climate Change Strategy and Action Plan (BCCASP)		4501-5013	600.00
4.	Clean Air and Sustainable Environment (Ministry of Environment and Forest Component)		4501-7240	54.00
5.	Clean Air and Sustainable Environment (Dhaka City Corporation Component).		4501-7358	8,000.00
6.	Eco restoration of the Northern region of Bangladesh	DoF	4531-5000	578.00
7.	Plantations in the five coastal districts		4531-5001	442.00
8.	Strengthening National Forestry Inventory and Satellite Land Monitoring System in Support of Red in Bangladesh		4531-5002	809.00
9.	National Garden and ballad gardens, Preservation and Further Development of Dhaka		4531-5003	603.00
10.	UN-REDD Bangladesh National Programme.		4531-5004	1,043.00
11.	e½eÜz †kL gywRe mvdvix cvK© MvRxcyi Gi G†cÖvP moKcÖm~"KiY I Ab"vb" cÖ†qvRbxq AeKvVv†gv Dbœqb		4531-5005	6,125.00
12.	Integrating Community Change Adaptation into Afforestation and Reforestation Program in Bangladesh		4531-5006	1,530.00
13.	বাংলাদেশ ফরেস্ট ইনভেস্টমেন্ট প্রোগ্রাম ফরেস্ট ইনভেস্টমেন্ট প্ল্যান প্রিপারেশন		4531-5008	100.00
14.	এক্সপ্যান্ডিং দি প্রটেক্টেড এরিয়া সিস্টেম টু ইনকরপোরেট ইমপার্টেন্ট একুয়াটিক ইকোসিস্টেম		4531-5009	654.00
15.	Establishment of plant gardens in the area of Lalmai hills		4531-5024	269.00
16.	Bengal Tiger Conservation activity		4531-5025	997.00
17.	The development of training facilities of institution of the forest department		4531-5026	893.00
18.	Climate Resilient Ecosystem and Livelihoods (CREL) (Department of Forestry part)		4531-5027	249.00
19.	Char Development and Settlement-4 (Department of Forest Component).	4531-5460	314.00	
20.	Bangabhandhu Shekh Mujib Safari Park, Gazipur (1st Revised) Project	4531-7397	886.00	
21.	Establishment of Regional Bamboo Research and Training Center at Domar Upazila in Nilphamari District	BFRI	4535-5000	1,130.00
22.	Survey of the vascular flora of the Chattogram and Chattogram Hill Tracts	Bangladesh National Herbarium	4537-5011	436.00
23.	Establishment of Pressure Treatment plant to Process Rubber Wood at Sylhet Zone	BFIDC	4505-0001	1,504.00

LIST OF PROJECT IN ADP: 2017-2018 ON IRRIGATION SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Drinking Water Supply from Irrigation Deep Tubewell Project - phase 3	BMDA	3705-5043	1,200.00
2.	Production of low irrigation crops in Barind area due to drilling of Pattukua		4305-5007	1,000.00
3.	Rehabilitation of Old DTW in Rajshahi, Naogaon and Chapai Nawabgonj District.		4305-5027	791.00
4.	Extension of Irrigation in Barind Area through Conservation of Water in Canal		4305-5038	3,714.00
5.	Farmer training programs, supply and production of standard seed for crop production		4305-5046	76.00
6.	Expansion of Irrigation Facilities by Increasing Availability of surface water and removing water logging in Naogaon District		4305-5049	3,000.00
7.	Enhancement of Irrigation Efficiency Through Construction of Sub-Surface Irrigation Channel		4305-5051	5,000.00
8.	Deep Tubewell Installation Project (2nd Phase)		4305-7630	2,054.00
9.	Marketing the Agricultural Products through Development of Rural Communication Project		4305-7790	1521.00
10.	Barind Rain Water Conservation & Irrigation Project (second phase)		4305-8081	1,952.00
11.	Construction of rubber Dam to Utilize Surface Water for Enhancing Agricultural Production	BADC	4305-5003	4,000.00
12.	Sylhet Division Minor Irrigation Development Project		4305-5035	3,000.00
13.	Barishal Division Minor Irrigation Development Project		4305- 5042	3,500.00
14.	Expansion of irrigation through utilization of surface water by double lifting-3rd phase		4305- 5055	3,800.00
15.	Ashuganj Palash Agro-Irrigation (5th stage)		4305- 5056	570.00

LIST OF PROJECT IN ADP: 2017-2018 ON WATER RESOURCES

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Rehabilitation of Polder no. 36/1 in Bagerhat	BWDB	4705-5000	6,000.00
2.	Protect of polders 56/57 from the erosion of the Meghna River at Burhanuddin and Daulatkhan upazila of Bhola district		4705-5001	8,000.00
3.	Preservation of the left bank of the river Padma from Doairbazar, Doha upazila in Dhaka district to Braha bajaraghata		4705-5002	9,000.00
4.	Bank Protective work against erosion of the Meghna River at Rajapur and East Ilisha Union of Bhola Sadar Upazila in Bhola District		4705-5003	6,500.00
5.	Rehabilitation of Kashimpur Pump House under Manu River Irrigation Project		4705-5005	6,516.00
6.	River Bank Protection work for protection of Tajumuddin upazila Sadar in Bhola District from erosion of Meghna River		4705-5006	7,500.00
7.	Strengthening of Dumping Zone of Protective work & Rehabilitation of embankment Road of Jamalpur Town Protection Project in Jamalpur Sadar Upazila of Jamalpur		4705-5007	1,224.00
8.	Temporary Protection works on the left bank of the West Narisha Bazar of Dohar upazila of Dhaka district and the left bank of the Padma River		4705-5008	100.00
9.	Conservation of Charfashion Municipality of Bhola district from the breakdown of the Meghna river		4705-5009	7,000.00
10.	Armored work by CC block at the length of 2000 meters on both sides of the Mohagnagar municipal Sialzani canal at Mohganj upazila in Netrokona district		4705-5012	400.00
11.	Protecting from the Right Bank break of Teesta river at Gangachara and Rangpur sadar upazilas in Rangpur district		4705-5013	9,000.00
12.	Protection from the breakdown of the Padma, from Soni Kandi in Rajshahi city to Bulanpur area		4705-5014	8,500.00
13.	Removal of Water Logging and Sustainable Water Management in Bhairab River Basin Area.		4705-5015	4,500.00
14.	Rehabilitation of Ganga-Kapotaksha Irrigation Project.		4705-5016	450.00
15.	Re-excavation of Palashbari canal of Manda upazila and conservation of the river bank of three areas of Patnitala upazila from the breakdown of the Atrai river		4705-5017	2,000.00
16.	Development of drainage system in Dhaka-Narayanganj Demra DND area		4705-5019	14,500.00
17.	Protection of the right bank of the Matamuhuri river at Bandarban Ali Kadam cantonment		4705-5022	1,900.00
18.	Reconstruction of Bhadra and Salta river for resolving the waterlogging of Khulna district		4705-5023	3,500.00
19.	Rehabilitation for the development of prevention, drainage and irrigation system of the infrastructures of the Polder no. 61/1 (Sitakunda), 61/2 (Mirsarai) and 72 (Sandwip) in the sub-basin area under BPaubo of Chattogram district		4705-5024	5,254.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
20.	Polder no. 62 (Patenga), Polder no. 63/1a (Anwara), Polder no. 63/1 B (Anwara and Patiya) rehabilitation of Coastal Area of Chattogram district		4705-5025	7,000.00
21.	Protection of Dhaka-Mawa-Bhanga-Khulna national highway adjacent to Haji Shariyatullah Bridge from the river erosion of the Arial Khan river.		4705-5026	2,000.00
22.	Rajoir Kotalipara Flood Control, Drainage and Irrigation		4705-5027	3,500.00
23.	Protection of 465 meters from 0.430 to 0.895 km on the right bank of Bhairab river adjacent to the Bangladesh Navy's Khulna (Banoz) Titumir		4705-5029	1,616.00
24.	Mirsarai of Chattogram district Bangladesh Economic Zone Beja flood control, road and embankment Protection and drainage		4705-5031	24,500.00
25.	Preservation and dredging of left bank of Madhumati river of Dignagar/Prabonbhav area of Alfadanga under Faridpur district		4705-5032	1,500.00
26.	Development of flood and drainage system for discharging waterlogging in Noakhali area		4705-5033	4,000.00
27.	Flood Control, Drainage, Irrigation and Dredging of Banskali river of Cox's Bazar district (1st stage)		4705-5034	5,590.00
28.	Sureswar canal re-excavation and drainage		4705-5042	3,500.00
29.	Construction of integrated water containment structures in Punarbhaba for providing supplementary irrigation during dry season in Gauripur, Sadar, district of Dinajpur district.		4705-5043	2,000.00
30.	Jabail flood control, drainage and irrigation under Sappahar and Porsha upazilas of Naogaon district		4705-5044	2,000.00
31.	Construction of Water Bhaban		4705-5046	7,000.00
32.	Protection from the River Irrusion the of the Karatoya river from former Nazirganj and Daikhata enclaves of Boda upazila of Panchagarh district		4705-5047	1,500.00
33.	Reconstruction of the Kumar River.		4705-5048	8,000.00
34.	Protection of Ramnawaz Launchghat area under Manpura upazila from Bhola District Meghna river erosion and Ghoshcharhat Launchghat area under Charfashion upazila from Tetulia River		4705-5049	8,000.00
35.	Reconstruction of 83 rivers/canals in Bagerhat district and increased navigability of Mongla Ghasiyakhali Channel		4705-5050	7,500.00
36.	River bank protection pilot project in Jamalpur district and Sherpur district through the Bamboo bundling		4705-5051	1,200.00
37.	River bank protection pilot project for the protection of the area of Jamalpur Sadar Melandah upazila, due to the breakdown of the old Brahmaputra river and tenani river of Jamalpur district through the Bamboo Bundling		4705-5052	1,200.00
38.	Reservation of river banks along the left and right bank of the Dharla river in Ghosparha, Dualteri and		4705-5055	1,500.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
	Bostari area of Bamkakata enclave 119 in Patgram upazila of Lalmonirhat district.			
39.	Climate Smart Agriculture Water Management Project (CSAWMP)		4705-5057	355.00
40.	Bangladesh flood management plan		4705-5059	1,422.00
41.	Dredging of the Padma river in connection with the Protection of the " Kuthibari" of Great Poet Robindranath Tagore and its adjacent area under Kushtia District (01/07/2016-30/06/2020)		4705-5060	2,000.00
42.	Protraction of the Both Bank of Halda River by Bank Protective Work at Different Locations in Hathazari & Rauzan Upzaila in Chattogram District		4705-5061	6,000.00
43.	Strengthening Hydrological Information Services and Early Warning System (Component-B)		4705-5075	2,500.00
44.	Protection of Atatuli Area of Chapainoabgonj District from Erosion of Padma River		4705-5109	3,150.00
45.	Bhutiari Beel of Khulna District and Barnal-Salimpur-Kolabashu Khali Flood Control, Drainage Project (2nd Phase).		4705-5122	7,000.00
46.	Blue Gold Program (BWDB Component)		4705-5123	13,760.00
47.	Coastal Embankment Improvement Project-Phase-1(CEIP-1) in Satkhira, Khulna, Bagerhat, Patuakhali, Pirojpur, Barguna & Patuakhali District		4705-5124	40,000.00
48.	Utilization of the Bangladesh Water Rules, 2013 to Implement the Integrated Water Resources Management		4705-5127	115.00
49.	Flood and Riverbank Erosion Risk Management Investment Program (Tranche-1)		4705-5130	27,235.00
50.	Irrigation Management Improvement Project (IMP) (for Muhuri Irrigation Project)		4705-5131	6,871.00
51.	Protection of Ramgati and Komol Nagar upazila and adjacent areas under Lakshmipur district from the continuing erosion of Meghna River (Phase-1)		4705-5133	3,570.00
52.	Haor Flood and Livelihood Improvement Project (BWDB Part)		4705-5135	20,000.00
53.	Protection of Left Bank of Meghna River through Bank Revetment work at Maniknagar of Nabinagar Upazila in Brahmanbaria District		4705-5136	716.00
54.	Rehabilitation of Damaged polders under the District of Cox's Bazar		4705-5137	8,000.00
55.	Rehabilitation of BWDB infrastructures Damaged by Natural Disaster in the Coastal Area of Polder No.64/1A, 64/1B & 64/1C at Banskhalia Upazilla in Chattogram District		4705-5138	12,000.00
56.	River Bank Protection work on both Bank of Sangu & Chandkhali River in Chandanaish and Upazila of Chittatogram District		4705-5139	3,500.00
57.	Protection of the "Kuthibari" and adjacent areas of Great Poet Robindranath Tagore along the Right Bank of Padma River under the Kushtia District		4705-5140	10,000.00
58.	Shibpur Flood Control, Drainage and Irrigation Project under Shibpur Upazila in Narsingdi District		4705-5145	1,500.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
59.	Re-Excavation of Titas River (Upper) under Brahmanbaria District		4705-5146	3,000.00
60.	Development of irrigation and re- excavation of Curzon canals and adjacent branches of Cumilla district.		4705-5147	252.00
61.	Construction of Retired Embankment including Protection of Right Bank of the Jamuna River from Kurnibari to Chandanaisha at Sariakandi Upazila in Bogura District		4705-5148	10,000.00
62.	Protection of the Rajshahi Cadet College and adjacent important establishment from the erosion of the Padma Rive		4705-5149	1,400.00
63.	Southwest Area Integrated Water Resources Planning and Management (Phase-2)		4705-5151	7,000.00
64.	Implementation of dam construction and defense work in Sea-Dike part of Polder No. 68 on Shahpree Island, Teknaf upazila of Cox's Bazar district		4705-5155	4,500.00
65.	Buriganga River Restoration (New Dholeshori-Pungli-Bongshi-Turag-Buriganga River System)		4705-6010	6,000.00
66.	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP) (BWDB Part)		4705-8050	17,860.00
67.	Gazner Bill Link River Excavation, Development of Irrigation Facilities and Fish Cultivation Project at Sujanager Upazilla in Pabna District (BWDB part)		4705-8200	6,000.00
68.	Procurement of Dragger and Relevant Machine Tools for Dragging River of Bangladesh		4705-8260	15,000.00
69.	Char Development and Settlement-4 (BWDB)		4705-8310	5107.00
70.	Tista Barage Project (Phase-2)		4705-9160	2,000.00
71.	Kalani - Kusiyara River Management Projec		4705-9324	5,000.00
72.	Pre-Monsoon flood Protection and Drainage Improvement in Haor Areas		4705-9589	7,500.00
73.	Feasibility Study and Detailed Engineering Design of Brahmaputra Barrage	WARPO	4705-5054	950.00
74.	Study for Investigation and Expansion of Ground Water Irrigation in Habiganj, Moulavi bazar, Sylhet, Sunamganj, Netrokona and Kishoreganj Districts	BHWDB	4731-5000	500.00
75.	Impact Assessment of Structural Intervention in Haor Ecosystem and Innovation for Solution		4731-5001	208.00
76.	Study of Interaction Between Haor and River Ecosystem Including Development of Wetland Inventory and Wetland Management Framework		4731-5002	2,000.00

LIST OF PROJECT IN ADP: 2017-2018 ON SHIPPING SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)	
1.	Establishment of 4 Marine Academy in Bangladesh (Pathna, Barishal, Sylhet & Rangpur)	Ministry of Shippin	5205-5011	11,523.00	
2.	Development of Maritime Legislation of Bangladesh	Department of Shipping	5231-5000	200.00	
3.	Installation of GADSS & Integrated Maritime Navigation System		5231-5010	5,400.00	
4.	Construction of port facilities at various landing stations in west regions	BIWTA	5205-0520	1,272.00	
5.	Modernization of three DGPS stations, including control stations and monitoring stations		5205-5005	1,000.00	
6.	Bangladesh Regional Inland Water Transportation Project-1 (Construction of related facilities including excavation of Chattogram-Dhaka-Ashuganj and connected waterways and terminals)		5205-5009	1,800.00	
7.	Feasibility Study for Development of Teknaf, Cox's Bazar (Kasturaghat), Chhatak, Faridpur, Ghorashal River Points: Ferry Ghats & Jetties at Various Location		5205-5011	498.00	
8.	Re-construction of RCC Jetty at Guptachhara, Sandwip		5205-5012	1,500.00	
9.	Establishment of Ship Personnel Training Institute, Madaripur		5205-5016	2,000.00	
10.	Capital Dredging of 53 Route of Inland Water Ways (in 1st phase, 24 Route)		5205-5026	22,800.00	
11.	Collection of Helpful Machinery and Equipment along with dredger		5205-5061	53,000.00	
12.	Establishment of Ashugonj Internal Container River Port		5205-7320	1.00	
13.	Dredging of 12 Important Waterways		5205-7490	10,000.00	
14.	Procurement of 10 Dredgers, Craneboats, Tugboats, Officers Houseboat and Crew Houseboats with other accessories		5205-9738	6,288.00	
15.	Sonahat land Port Development.		BLPA	5205-5001	2,300.00
16.	Construction of the head office of Bangladesh Land Port Authority			5205-5002	100.00
17.	Improvement of Balla Land Port	5205-5013		700.00	
18.	SASEC Road Connectivity Project: Development land port of Benapole & Kurigram	5205-5029		3,589.00	
19.	Development of Tamabil Land Port	5205-5044		2,900.00	
20.	weAvBwUwmi Rb" 2wU wgwB BDwUwjwU #dwi msMÖn	BIWTC	5205-0027	781.00	
21.	Construciton of High-Rise Head Office Building Complex of BIWTC at 5, Dilkusha C/A, Dhaka		5205-0517	500.00	
22.	Replacement of 2 Dump Ferry by Improved K Type Ferry		5205-0523	1,252.00	
23.	বিআইডব্লিউটিসির ডাক-৩ এ মেরিন ওয়ার্কশপ স্থাপন ও অবকাঠামো উন্নয়ন		5205-0526	760.00	

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
24.	Construction of Passenger vessel for providing efficient services in Chattogram-Swandip-Hatiya-Barishal Coastal Route		5205-9728	1,000.00
25.	Procurement of 2 New Traveller's Ship for Dhaka-Barishal Inland Water Rute		5205-9730	1,500.00
26.	Collected ship carrying vessel for Mongla port	MPA	5205-5003	1,400.00
27.	Capital dredging in the channels from Mongla port to Rampal power plant.		5205-5004	5,500.00
28.	Dredging at the Outer Bar in the Pashur Channel		5205-8190	1.00
29.	Construction of CPA Hospital Complex inplace of existing Hospital	CPA		560.00
30.	Procurement of Equipment for New Mooring Container Terminal (NCT)		5205-0518	24,000.00
31.	Shifting and Re-construction of service Jetty located near dock office to the upstream of Jetty no.1.		5205-0524	2,500.00
32.	Collection A toga board with high-performance (3200 BHP)		5205-0525	2,000.00
33.	Procurement of one Oil Tanker in 3400 DWT	BSC	5231-0003	31,500.00
34.	Collection of 06 (six) new ships (03 new oil product tanker and 03 new bulk carriers) each almos accomplished 39,000 DWT		5231-5064	40,500.00
35.	Payra Deep Sea Port Operations Infrastructure/Facilities Development	PPA	5205-5066	40,000.00

LIST OF PROJECT IN ADP: 2016-2017 ON FORESTRY SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Strengthening the Environment, Forestry and Climate Change Capacities of the Ministry of Environment and Forests and its Agencies	Ministry of Environment and Forest	4501-5012	675.00
2.	Promotion of Climate Change Unit in co-ordinating the Bangladesh Climate Change Strategy and Action Plan (BCCASP)		4501-5013	754.00
3.	Community Based Sustainable Management of Tanguar Haor Project (Phase-2)		4501-5030	83.00
4.	Clean Air and Sustainable Environment (Ministry of Environment and Forest Component)		4501-7240	97.00
5.	Clean Air and Sustainable Environment (Dhaka City Corporation Component)		4501-7358	3,643.00
6.	Clean Air and Sustainable Environment (Dhaka Transport Co-ordination Board-DTCB Component)		4501-7359	510.00
7.	Eco restoration of the Northern region of Bangladesh	DOF	4531-5000	1,694.00
8.	Plantations in the five coastal districts		4531-5001	696.00
9.	Strengthening national forest inventory and satellite land monitoring system in support of Red in Bangladesh		4531-5002	1,287.00
10.	Climate Resilient Afforestation and Reforestation		4531-5016	7,809.00
11.	Establishment of plant gardens in the area of Lalmai hills		4531-5024	1,275.00
12.	Bengal Tiger Conservation activity		4531-5025	2,130.00
13.	The development of training facilities of institution of the forest department		4531-5026	1,353.00
14.	Livelihoods and ecosystem with Climate Change Tolerant (Department of Forestry part)		4531-5027	1,769.00
15.	Sheikh Rasel Aviary and Eco Park Rangunia, Chattogram		4531-5330	126.00
16.	Char Development and Settlement-4 (Department of Forest Component)		4531-5460	786.00
17.	Further Development of Bangabandhu Shekh Mujib Safari Park of Cox's Bazar		4531-7360	551.00
18.	Bangabhandhu Shekh Mujib Safari Park, Gazipur (1st Revised) Project		4531-7397	2,480.00
19.	Strengthening Regional Co-operation for Wildlife Protection Project		4531-7407	4,750.00
20.	Survey of the vascular flora of the Chattogram and Chattogram Hill Tracts	Bangladesh National Herbarium	4537-5011	620.00
21.	Establishment of Pressure Treatment plant to Process Rubber Wood at Sylhet Zone	BFIDC	4505-0001	1.00
22.	Establishment of Rangunia Rabber Estate in Chattogram Zone (1st Phase)		4505-0002	599.00

LIST OF PROJECT IN ADP: 2016-2017 ON IRRIGATION

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Drinking Water Supply from Irrigation Deep Tubewell Project - phase 3	BMDA	3705-5043	2,500.00
2.	Extension of Irrigation in Barind Area through Conservation of Water in Canal		4305-5038	4,000.00
3.	Expansion of Irrigation Facilities by Increasing Availability of surface water and removing water logging in Naogaon District		4305-5049	2,000.00
4.	Enhancement of Irrigation Efficiency Through Construction of Sub-Surface Irrigation Channel		4305-5051	4,000.00
5.	Deep Tubewell Installation Project (2nd Phase)		4305-7630	1.00
6.	Marketing the Agricultural Products through Development of Rural Communication Project		4305-7790	5,064.00
7.	Panchagar, Thakurgaon, Dinajpur and Joypurhat Integrated Development Project		4305-7850	3,000.00
8.	Barind Rain Water Conservation & Irrigation Project (second phase)		4305-8041	3,749.00
9.	Barishal Division Minor Irrigation Development Project		4305- 5042	3,500.00
10.	Irrigation Extension Programme	BRDB	003805-8255	471.00
11.	Construction of Rubber Dam in Small and Medium Rivers in order to Increase the Food Productivity (LGED Component)	DAE	4331-5170	1,850.00
12.	Construction of rubber dams to increase the use of water for agricultural production on Earth Surface	BADC	4305-5003	4,700.00
13.	Pirojpur-Gopalganj-Bagerhat Integrated Agricultural Development (BADC Component).		4305-5014	3,500.00
14.	Eastern Region Integrated Command Area Development		4305-5019	1,878.00
15.	Irrigation Expansion in Poverty Prone Areas under Greater Rangpur District through Modern Minor Irrigation Practices		4305-5029	551.00
16.	Sylhet Division Minor Irrigation Development Project		4305-5035	3,000.00
17.	Barishal Division Minor Irrigation Development Project		4305-5042	2,800.00
18.	Expresuib of irrigation through utilization of surface water by double lifting-3rd phase		4305-5055	4,300.00
19.	Ashuganj Palash Agro-Irrigation (5th stage)	4305-5056	620.00	
20.	Pabna-Natore-Sirajgonj Small Irrigation Development Project (Phase 3)	4305-5081	3,200.00	
21.	Construction of Rubber Dam in Small and Medium Rivers for Increasing of Food Productivity (BADC Component)	4305-7440	591.00	

LIST OF PROJECT IN ADP: 2016-2017 ON WATER RESOURCE SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Rehabilitation of Polder no. 36/1 in Bagerhat	BWDB	4705-5000	3,000.0
2.	Protect of polders 56/57 from the erosion of the Meghna River at Burhanuddin and Daulatkhan upazila of Bhola district		4705-5001	4,000.00
3.	Preservation of the left bank of the river Padma from Doairbazar, Doha upazila in Dhaka district to Braha bajaraghata		4705-5002	5,000.00
4.	মেঘনা নদীর ভাঙ্গন হতে ভোলা জেলার সদর উপজেলাধীন রাজাপুর ও পূর্ব ইলিশা ইউনিয়ন রক্ষার্থে তীর সংরক্ষণ।		4705-5003	2,500.00
5.	স্ট্রেংদেনিং হাইড্রোলজিক্যাল ইনফরমেশন সার্ভিসেস এন্ড আলি সিস্টেম (কম্পোনেন্ট-বি)।		4705-5004	668.00
6.	মনু নদী সেচ প্রকল্পের আওতাধীন কাশিমপুর পাম্প হাউজ পুনর্বাসন		4705-5005	500.00
7.	নদীতীর সংরক্ষণের মাধ্যমে মেঘনা নদীর ভাঙ্গন হতে ভোলা জেলার তজুমুদ্দীন উপজেলা সদর সংরক্ষণ।		4705-5006	1,000.00
8.	জামালপুর জেলার সদর উপজেলাধীন জামালপুর শহর সংরক্ষণ প্রকল্পের অমৃতভূক্ত তীর সংরক্ষণ কাজের ডাম্পিং জোন শক্তিশালীকরণ ও বাঁধ কাম রাস্তার পুনর্বাসন।		4705-5007	200.00
9.	Rehabilitation of Ganga-Kapotaksha Irrigation Project		4705-5016	3,500.00
10.	Construction of Water Bhaban		4705-5046	5,000.00
11.	Protection of Atatuli Area of Chapainoabgonj District from Errosion of Padma River		4705-5109	11,000.00
12.	Bhoroongamari-Mothergonj Road Protection from Erosion of Dodhkumar River Adjacent of Sonaihat Bridge under Bhoroongamari Upazilla and Left Bank Protection of Testa River from Gonaigach to Bazra Senior Madrasa of Ulipur Upazilla of Kurigram District		4705-5110	2,007.00
13.	Left Bank Protection of Padma River from Komorpur to Jhaowdia under Ishwardi Upazilla of Pabna District and from Tilokpur to Gouripur of Natore District		4705-5113	9,500.00
14.	Protection of Boiragirhat & Chilmary Port under Chilmary & Ulipur Upazilla of Kurigram District from the Errosion of Right Bank of Brahmaputra River (2nd Phase)		4705-5114	6,600.00
15.	River Bank Protective Work of Left and Right Bank of Karnaphuli River, Boalkhali, Raikhali Khal at Boalkhali & Raujan Upazilla under Chattogram District.		4705-5119	1,746.00
16.	River Bank Protection of Vulnerable Part at Lalmohon Upazilla under Bhola District.		4705-5120	4,500.00
17.	Bhutiari Beel of Khulna District and Barnal-Salimpur-Kolabashu Khali Flood Control, Drainage Project (2nd Phase)		4705-5122	6,200.00
18.	Blue Gold Program (BWDB Component)		4705-5123	7,721.00
19.	Coastal Embankment Improvement Project - Phase-1(CEIP-1) in Satkhira, Khulna, Bagerhat,		4705- 5124	45,000.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
	Patuakhali, Pirojpur, Barguna & Patuakhali District			
20.	Utilization of the Bangladesh Water Rules, 2013 to Implement the Integrated Water Resources Management		4705-5127	140.00
21.	Re-excavation of Bhairab river project		4705-5129	2,760.00
22.	Flood and Riverbank Erosion Risk Management Investment Program (Tranche-1)		4705-5130	26,040.00 -
23.	Irrigation Management Improvement Project (IMP) (for Muhuri Irrigation Project)		4705-5131	9,244.00
24.	West Gopalganj Integrated Water Management Project		4705-5132	4,000.00
25.	Protection of Ramgati and Komol Nagar upazila and adjacent areas under Lakshmipur district from the continuing erosion of Meghna River (Phase-1)		4705-5133	6,068.00
26.	Bank Protection of Jamuneswary, Chikny and Charalkata river in Kishorganj, Taraganj and Badarganj Upazila		4705-5134	5,000.00
27.	Haor Flood and Livelihood Improvement Project (BWDB Part)		4705-5135	16,200.00
28.	Protection of Left Bank of Meghna River through Bank Revetment work at Maniknagar of Nabinagar Upazila in Brahmanbaria District		4705-5136	1,500.00
29.	Rehabilitation of Damaged polders under the District of Cox's Bazar		4705-5137	4,957.00
30.	Rehabilitation of BWDB infrastructures Damaged by Natural Disaster in the Coastal Area of Polder No.64/1A, 64/1B & 64/1C at Banskhalia Upazilla in Chattogram District		4705-5138	6,000.00
31.	River Bank Protection work on both Bank of Sangu & Chandkhali River in Chandanaish and Upazila of Chattogram District		4705-5139	5,000.00
32.	Protection of the "Kuthibari" and adjacent areas of Great Poet Robindranath Tagore along the Right Bank of Padma River under the Kushtia District		4705-5140	5,000.00
33.	Development of Smart Project Monitoring and Management Information System		4705-5141	176.00
34.	Protective Work along the Right Bank of Padma River at Philipnagar, Abed's Ghat and Islampur area of Daulatpur Upazila under the Kushtia District		4705-5144	5,000.00
35.	Shibpur Flood Control, Drainage and Irrigation Project under Shibpur Upazila in Narsingdi District		4705-5145	1,500.00
36.	Re-Excavation of Titas River (Upper) under Brahmanbaria District		4705-5146	1,500.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
37.	Development of irrigation and re- excavation of Curzon canals and adjacent branches of Cumilla district		4705-5147	825.00
38.	Construction of Retired Embankment including Protection of Right Bank of the Jamuna River from Kurnibari to Chandanaisha at Sariakandi Upazila in Bogura District		4705-5148	4,784.00
39.	Protection of the Rajshahi Cadet College and adjacent important establishment from the erosion of the Padma River		4705-5149	5,000.00
40.	Maliara-Bakkhain-Vandergoan Flood Control, drainage & Irrigation Project (2nd phase) in Upazila: Patiya, District:Chattogram		4705-5150	1,500.00
41.	Southwest Area Integrated Water Resources Planning and Management (Phase-2)		4705-5151	3,535.00
42.	Protection of Left Bank of the Jamuna River Erosion from Bahadurbadghat to futani bazar in Jamalpur and Pingna Bazar Area in Sharishabari upazilla and Horinadhar to Horgila in Islampur Upazilla under Jamalpur District		4705-6000	9,500.00
43.	Buriganga River Restoration (New Dholeshuri-Pungli-Bongshi-Turag-Buriganga River System)		4705-6010	3,000.00
44.	Capital (Pilot) Dredging of River System in Bangladesh		4705-6020	9,500.00
45.	Removal of Kapotakhkha River Water Logging Project (2nd Phase)		4705-7115	9,183.00
46.	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP) (BWDB Part)		4705-8050	14,580.00
47.	Garai River Restoration Project		4705-8150	4,000.00
48.	Charfashion and Monpura Town Protection Project in Bhola District		4705-8181	3,000.00
49.	Gazner Bill Link River Excavation, Development of Irrigation Facilities and Fish Cultivation Project at Sujanagar Upazilla in Pabna District (BWDB part)		4705-8200	6,000.00
50.	Right Bank Preservation of Jamuna River at Sirajgonj Sadar and Kazipur Upazilla in Sirajgonj District		4705-8250	8,000.00
51.	Procurement of Dragger and Relevant Machine Tools for Dragging River of Bangladesh		4705-8260	25,000.00
52.	Char Development and Settlement-4 (BWDB)		4705-8310	8,000.00
53.	Water Management Improvement Project		4705-8636	3,000.00
54.	New Dakatia and Old Dakatia Little Feni River Drainage Project		4705-9120	3,000.00
55.	Tista Barage Project (Phase-2)		4705-9160	1,300.00
56.	Kalani - Kusiara River Management Project		4705-9324	4,000.00
57.	Tarail-Pachuria Flood Control, Drainage & Irrigation Project (2nd Phase)		4705-9498	4,500.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
58.	Project for Protection of Shahbazpur Gas Field from the Erosion of River Meghna at Borhanuddin Upazilla of Bhola District (Phase-II)		4705-9533	900.00
59.	Protection of Right Bank of Jamuna from Nagarbari to Kazirhat at Bera Upazilla and Left Bank Protection of Padma in different Places at Sujanagar Upazilla in Pabna District		4705-9548	5,000.00
60.	Re-excavation of Langan, Bemalia and Balbhadra River in Brahmanbaria and Habigonj District		4705-9552	1,000.00
61.	Pre-Monsoon flood Protection and Drainage Improvement in Haor Areas		4705-9589	8,000.00
62.	স্টাডি ফর ইনভেস্টিগেশন এন্ড এক্সপানশন অব গ্রাউন্ড ওয়াটার ইরিগেশন ইন হবিগঞ্জ, মৌলভীবাজার, সিলেট, সুনামগঞ্জ, নেত্রকোনা এন্ড কিশোরগঞ্জ ডিস্ট্রিক্ট	BHWDB	4731-5000	1,000.00
63.	ইমপ্যাক্ট এ্যাসেসমেন্ট অব স্ট্রাকচারাল ইনভেশন ইন হাওর ইকোসিস্টেম এন্ড এনোভেশন ফর সলিউশন		4731-5001	302.00
64.	স্টাডি ইন্টারেকশন বিটুইন হাওর এন্ড রিভার ইকোসিস্টেম ইকুডিং ডেভেলপমেন্ট অব ওয়েবল্যান্ড ইনভেশনটরী এন্ড ওয়েটল্যান্ড ম্যানেজমেন্ট ফে'মওয়াক।		4731-5002	3,500.00
65.	Classification of Oyetalyands of Bangladesh		4731-5142	114.00
66.	Model Validation on Hydro-marapholajikyala process sabasidim Sylhet haors in the basin of the River systems		4731-5143	129.00

LIST OF PROJECT IN ADP: 2016-2017 ON SHIPPING SECTOR

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
1.	Establishment of 4 Marine Academy in Bangladesh (Pathna, Barishal, Sylhet & Rangpur)	Ministry of Shipping	5201-0511	7,500.00
2.	Bangladesh Trade and Transport Facilitation Studies Recipient Executed Trust Fund Project		5201-0512	808.00
3.	Installation of GADSS & Integrated Maritime Navigation System	Department of Shipping	5231-0510	5,476.00
4.	Expansion of Sadar Terminal Building under Dhaka Ports	BIWTA	5205-0519	700.00
5.	Construction of port facilities at various landing stations in Southern regions		5205-0520	1,000.00
6.	Improvement of road from Sadarghat to Cremation under Dhaka Port		5205-0521	1,000.00
7.	Development of Launch Ghat and Wayside Ghat in Rural Area of Bangladesh		5205-5017	1,500.00
8.	Capital Dredging of 53 Route of Inland Water Ways (in 1st phase, 24 Route)		5205-5026	16,800.00
9.	Collection of Helpful Machinery and Equipment along with dredger		5205-5062	16,162.00
10.	Establishment of Ashugonj Internal Container River Port		5205-7320	1.00
11.	Dredging of 12 Important Waterways		5205-7490	8,500.00
12.	Procurement of 10 Dredgers, Craneboats, Tugboats, Officers Houseboat and Crew Houseboats with other accessories		5205-9738	8,000.00
13.	Sonahat land Port Development		BLPA	5205-5001
14.	SASEC Road Connectivity Project: Development land port of Benapole & Kurigram	5205-5029		2,300.00
15.	Development of Tamabil Land Port	5205-5044		2,000.00
16.	Construction of High-Rise Head Office Building Complex of BIWTC at 5, Dilkusha C/A, Dhaka	BIWTC	5205-0517	800.00
17.	Rehabilitation of 2 Ferry Jashore and Cumilla		5205-0522	310.00
18.	Replacement of 2 Dump Ferry by Improved K Type Ferry		5205-0523	1,463.00
19.	Establishment of Ship Personnel Training Institute, Madaripur		5205-5016	1,500.00
20.	Construction/Acquisition of 4 no. 108 TEU's Self /Propelled Cellular Container Vessel of 100 TEU's for BIWTC		5205-9052	1,514.00
21.	Construction of Passenger vessel for providing efficient services in Chattogram-Swandip-Hatiya-Barishal Coastal Route.		5205-9728	1,216.00
22.	Procurement of 2 New Traveller's Ship for Dhaka-Barishal Inland Water Route	BIWTC	5205-9730	2,769.00
23.	Dredging at the Outer Bar in the Pashur Channel	MPA	5205-8190	1,500.00
24.	Procurement of Container and Cargo Handling Equipment for Mongla Port		5205-9722	2,000.00
25.	Capital Dredging of and Bank Protection with Jetty Facilities in Karnephuli River for Sadarghat Jetty and Third Karnephuli Bridge	CPA	5205-0506	500.00

SN	Name of Project	Name of Ministry/ Department	Project Identification No.	Allocation (In Lakh)
26.	Constructuon of CPA Hospital Complex in place of existing Hospital		5205-0515	1,400.00
27.	Procurement of Equipment for New Mooring Container Terminal (NCT)		5205-0518	500.00
28.	Shifting and Re-construction of service Jetty located near dock office to the upstream of Jetty no.1		5205-0524	500.00
29.	Procurement of one Oil Tanker in 3400 DWT	BSC	5231-0003	15,000.00
30.	collection of 06 (six) new ships (03 new oil product tanker and 03 new bulk carriers) each almos accomplished 39,000 DWT		5231-5064	50,107.00
31.	Payra port Authority Payra Deep Sea Port Operations Infrastructure/Facilities Development		5205- 5066	20,000.00

Annexure -6: Checklist for Procurement of Equipments/Installations Works

PART-A PROCURING ENTITY AND DESCRIPTION OF PROCUREMENT			
1. Ministry/Division			
2. Agency			
3. Procuring Entity			
4. Name of the Project	(if applicable)		
5. Source of Funds (Tick relevant boxes)	Government <input type="checkbox"/>	Development <input type="checkbox"/>	Revenue <input type="checkbox"/>
	Project Aid <input type="checkbox"/>	Own Funds <input type="checkbox"/>	
6. Procurement Plan	Status of Annual Procurement Plan (APP)		
	Approved <input type="checkbox"/>		Unapproved <input type="checkbox"/>
	Short Description (If necessary):		
7. Brief Description of Works			
8. Procurement Method (as in DPP or otherwise)			
9. Procurement Value (Estimated Cost)			
10. Type of Tender Document (Tick relevant one)	SRFQ (PW 1) STD (PW 2/PW 3/PW 4/PW 5) SPD (PQW 4/ PQW 5)		
11. Formation of TOC/POC and TEC/PEC	No of members in TOC/POC No of member from TEC/PEC No of members in TEC/PEC No of external members in TEC/PEC Authority approved TEC/PEC		

PART-B SCHEDULE OF ACTIVITIES (Pre-Qualification)				
SN	Activity (If not applicable indicate N/A)	Planned Date (As per procurement plan/ Flow Chart)	Actual Date	Remarks
1.	PRE-QUALIFICATION			
1.1.	Date of Advertisement of Invitation 1.1.1. Advertisement in Newspaper Published 1.1.2 Advertisement in CPTU Website Published 1.1.3 Advertisement published in own website, 1.1.4 Tenders/Proposals followed PPA-2006/PPR, 2008 1.1.5 Tenders/Proposals followed DP's Guidelines			
	1.1.6 No of Sale/Issuance of Tender/ Proposal Documents 1.1.7 No of Tenderer/Consultant participated 1.1.8 Days allowed per Rule for preparation and Submission 1.1.9 Date of Submission of Tender Doc./Applications			
1.2.	Date of Pre-Qualification Meeting (if any)			
2.	TENDERS/PROPOSALS EVALUATION			
	2.1 Days allowed per Rule between opening and completion/submission of evaluation 2.2 Days actual between opening and completion/submission of evaluation			

PART-B SCHEDULE OF ACTIVITIES (Pre-Qualification)				
SN	Activity (If not applicable indicate N/A)	Planned Date (As per procurement plan/ Flow Chart)	Actual Date	Remarks
	2.3 Responsiveness of Tender/Proposal 2.4 Re-invitation of Tenders/Proposals recommended by TEC/PEC 2.5 Procurement proceedings annulled/cancelled 2.6 Date of Submission of Evaluation Report with Recommended List			
	2.7 Approving Authority (AA) as per Delegation of Financial Power (DoFP) 2.8 Date of Approval of List 2.9 Authority approval date 2.10 Evaluation report was sent directly to the AA			

PART-C SCHEDULE OF ACTIVITIES				
SN	Activity (If not applicable indicate N/A)	Planned Date (As per procurement plan/ Flow Chart)	Actual Date	Remarks
1.	TENDER FOR WORKS			
1.1.	Date of Advertisement of Invitation for Tenders 1.1.1 Advertisement in Newspaper Published 1.1.2 Advertisement in CPTU Website Published 1.1.3 Advertisement published in agency's own website, 1.1.4 Tenders/Proposals followed PPA-2006, PPR-2008 1.1.5 Tenders/Proposals followed Dev. Partner's Guidelines			
1.2.	Date of Issue of Tender Document 1.2.1 No of Sale/Issuance of Tender/Proposal Documents 1.2.2 No of Tenderer/Consultant participated			
1.3.	Date of Pre-Tender (Pre-Bid) meeting			
	1.3.1 Days allowed as per rules for preparation and Submission 1.3.2 Date of Submission of Tenders			
1.4.	Date of Opening of Tenders			
1.5.	Date of Submission of Technical Sub-Committee Report (if applicable)			
1.6.	Date of Submission of Evaluation Report			
1.7.	Procurement processing lead-time i.e. days actual between opening and issuance of NOA/PO/Contract signing/LOI			
1.8.	Days actual between IFT/RFP and issuance of NOA/PO/Contract signing/LOI			

PART-C SCHEDULE OF ACTIVITIES				
SN	Activity (If not applicable indicate N/A)	Planned Date (As per procurement plan/ Flow Chart)	Actual Date	Remarks
1.9	Publication of award in CPTUs website/PE's website/others			
1.10	Contract award made within the initial Tender/Proposal validity period			
1.11	Date of Approval for Award of Contract			

Part-D Individual Contract Review				
1.	Contract Implementation:		Planned Date (As per procurement plan/ Flow Chart)	Actual Date
1.1.	Contract Reference	:		
1.2.	Contract Amount/ Value	:		
1.3.	Contract Signing Date	:		
1.4.	General Conditions of Contract (GCC) should be specific	:		
1.5.	Particular Conditions Contract (PCC) should be specific	:		
1.6.	Terms of Reference/ Activities (Item by item)	:		
1.7.	Work plan	:		
2.	Completion of Contract			
2.1.	Days per original contract time specified for supply/Execution/Delivery	:		
2.2.	Days actual for Supply/Execution/Delivery	:		
2.3.	Amount of LD imposed	:		
3.	Complaint, if any, lodged and reasons thereof	:		
3.1.	Resolution of complaints per Rules	:		
3.2.	Modifications resulting from resolution of complaints	:		
3.3.	Appeal of Independent Review Panel	:		
3.4.	Review Panel's decision and follow-on	:		
4.	Contract Amendment			
4.1.	No of times contract time extended and days	:		
4.2.	Variation/Extra Work/Repeat/Addl. Delivery Orders etc. made	:		
4.3.	No and amount of such orders	:		
5.	Contract Disputes unresolved			
6.	Fraudulence and Corruption			
7.	Procurement Management Capacity			
7.1.	HRD facilities	:		
7.2.	No. of Staff trained in procurement	:		

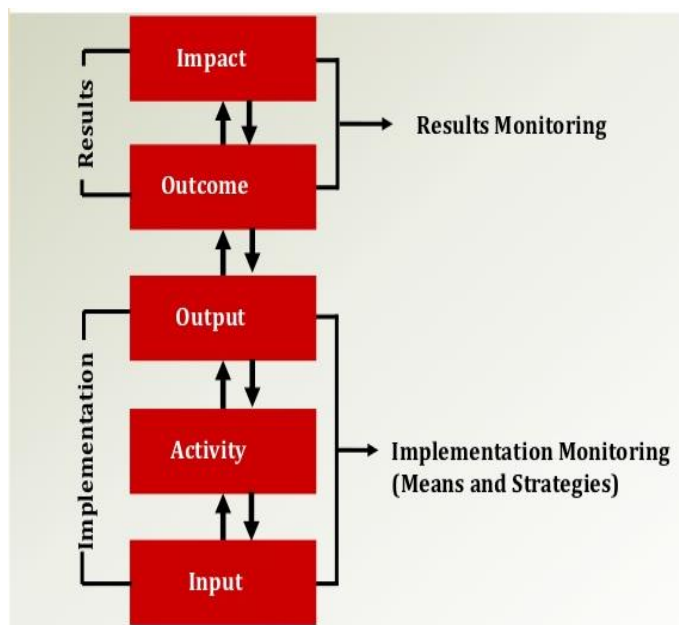
Annex-7: Monitoring & Evaluation (M&E) Template

The Template covered three types of monitoring and evaluation but focusing more on the monitoring of on-going projects as noted below:

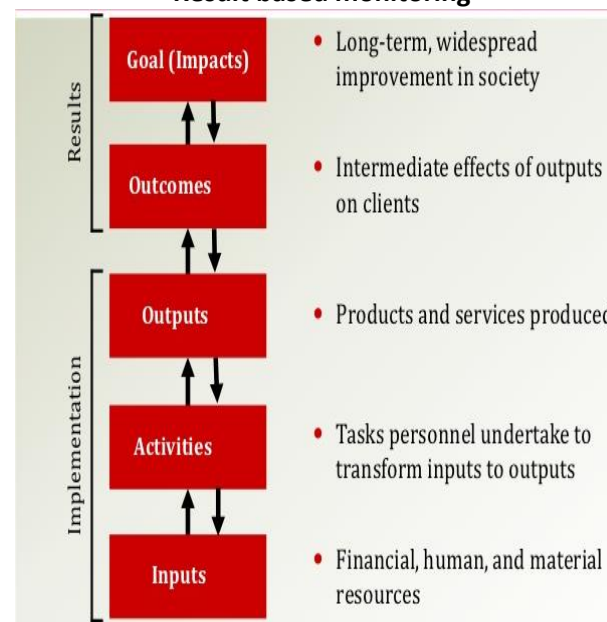
SN	Types of monitoring and evaluation covered	Nature of monitoring template	Level of focus
1	On-going project	Inspection template	High focus
2	Terminal evaluation	Information collection template	Moderate focus
3	Impact evaluation	Result Monitoring & Evaluation	Low focus

Area to be covered by Monitoring & Evaluation

Key types of monitoring



Result based monitoring



G 1. Monitoring at Kickoff Stage

Activity	Answers	Shortfall if any	Reasons for shortfall	Comments/ suggestions
Project inauguration session kickoff meeting: Date Participants Type & number Sponsor Outcome of meeting				
Forming Committees Composition, number of members Chair and Member Secretary				
Conduct meeting last 12 months				
Training conducted				
Project officer./ staff/ GOB officer/ staff number Person months Overseas Local				
Plantation lay-out preparation Method				
Site selection and site preparation Number of sites Area ha Duration				
Sapling procurement Number of nurseries established under the project and area acres GOB agency owned Private contract grower				
Areas covered (in hectores)				

Activity	Answers	Shortfall if any	Reasons for shortfall	Comments/ suggestions
Maintenance & management method				
Feeling system				
Regeneration system				

G 2. Procurement monitoring

SN	construction equipment	Present procurement status	Availability/ visibility	Functional status	Time	Procurement methods	Quality of goods	Availability of skilled Human resources	Comments
Packages	Works								
1									
2									
3									
4									
5									
	Goods/ Equipment								
1									
2									
3									
4									
5									
	Services								
1									
2									
3									
4									

G 3. Procurement Monitoring Detailed

SN	Activity/ procurement	Planned time of Completion	Present procurement Status	Completion time extended or not	Actual ongoing work progress	Visibility status	Need time to complete the project	Any modification of ongoing contract	Bill claimed by contractor	As per work activity plan need to payment	Defect liability for the ongoing contract	Remarks
1												
2												
3												
4												
5												

PROCESS MONITORING TEMPLATE

1. Project approval, allocation of fund, release of fund and fund utilization

- a. Name of project:
- b. Duration: Original First Revised Second Revised
- c. Total Cost:Original First Revised Second Revised
- d. Approval Status: Approved Revised Unapproved Unapproved
- e. Financing: Original GOB PA First Revised GOB PA Second Revised GOB PA
- f. Reporting Month
- g. Allocation and Utilization of fund by Component

SN	Description	DPP Cost	Allocation up to last FY	Utilization up to last FY	Allocation current FY	Fund Release current FY up to reporting month	Fund Utilized current FY up to reporting month	Cumulative Fund Utilization up to reporting month	Cumulative utilized (% of DPP)	Shortfall/ problem/ suggestion
	Component 1									
	Activity 1									
	Activity 2									
	Activity 3									

SN	Description	DPP Cost	Allocation up to last FY	Utilization up to last FY	Allocation current FY	Fund Release current FY up to reporting month	Fund Utilized current FY up to reporting month	Cumulative Fund Utilization up to reporting month	Cumulative utilized (% of DPP)	Shortfall/ problem/ suggestion
	Component 2									
	Activity 1									
	Activity 2									
	Activity 3									
	Component 3									
	Activity 1									
	Activity 2									
	Activity 3									

1. Engagement of Manpower

Requirement Type of person

SN	Description of Type of manpower	Needed qualification	Needed expertise/ Training	Number required	Person month required	Deployed from GOB agencies numb & PM	Deployed by project recruitment numb & PM	Deployed by outsourcing Numb & PM	Deployed under consultancy Numb & PM	Shortfall in number, PM, qualification, expertise, attitude	Causes of shortfall	Remarks/ Suggestions
	GOB Officer											
	Designation											

2. Monitoring of procurement under the project

Procurement Plan and its execution

SN	Description of items	Measuring Unit	Specification	Qty as per DPP	Progress up to last FY (Qty)	Plan for the reporting FY (Qty)	Procurement Method	Pre-shipment inspection in tender & actual	Quality checking at delivery & use (who, what result)	Any non-compliance observed, remedial measure	Actual quality, quantity, timeliness, usefulness, longevity	Cumulative Progress (% of DPP Target)	Remarks/ Suggestions
	Works												
	Goods												
	Services												

3. Project oversight and supervision For Senior Executives/ PMC/ PSC

SN	Area covered	Description	Note answers	Comment (timeliness/quality/effectiveness/suggestions)
1.	Committees formed and functions	Composition of the committee		
		Chair/ secretary		
		Other members (designation)		
		No. of meetings held (date)		
		Minuets of last two meetings		
		Decisions		
		Follow up		
2.	Existing Procurement Plan	Financial Year/ Period		
		No. of packages completed (Works, Goods, and services)		
		No of goods packages		
		No of works packages		
		No of Services packages		
		Objection if any (FAPAD, Development partners)		

SN	Area covered	Description	Note answers	Comment (timeliness/quality/effectiveness/suggestions)
		Number of objections fully resolves XX package FAPAD		
		Number of objections fully resolves XX package Development partners		
3.	Contractor Control Supervision	Name of Package		
		Type of work/ procurement		
		Quantity		
		Contract Period		
		Contract Value		
		Progress up to current period		
		Financial		
		Physical		
		Delay if any		
		Reasons for delay		
		Any Action taken to prevent delay ensure compliance		
		Quality		
4.	Conflict / Dispute Resolution	Visible notice board/ project site/ agency office		
		Visible complaint box/ project site/ agency office		
		Digital complaint recording (website)		
		Number of recorded complaints		
		Complaints resolved		
		Not resolved, reasons		

SN	Area covered	Description	Note answers	Comment (timeliness/quality/effectiveness/suggestions)
	Occurrence of natural calamities that affected project	Events Year Area affected Affected Activity Output Outcome Goal		
5.	Resettlement Issues	LA involved RAP prepared Number of PAPs Compensation Under Law Other compensation Livelihoods loss Common property access loss Loss of community property Progress in LA execution and resettlement		
6.	Stakeholder Satisfaction	Stakeholder analysis present Any survey of stakeholder satisfaction – result Stakeholder participation in project design, implementation and monitoring Transparency Public accountability		
7.	Overall project performance rating (High, Medium, Low)	As per desk review Field Inspection report Monitoring report received from the agency/ ministry		

4. Template for project progress monitoring of ongoing project at the initial stage

S N	Description of activities by component	Measuring units	Project target	Target for the FY	Achievement Cumulative up to end of last year	Cum Achievement FY Up to reporting quarter	Cumulative Achievement Up to current quarter	Total project cost	Expenditure up to end of last FY	Exp FY the up to reporting quarter	Cum Exp. Up to reporting quarter	% of financial achieveme nt	Remarks (Delay if any, causes of delay, suggestion s
1	2	3	4	5	6	7	8=(6+7)	9	10	11	12=10+11	13	14
	Component 1												
	Activity 1												
	Activity 2												
	Activity 3												
	Component 2												
	Activity 1												
	Activity 2												
	Activity 3												
	Component 3												
	Activity 1												
	Activity 2												
	Activity 3												

5. Template for mid-term evaluation

While monitoring at the initial stage will be activity based to assess physical and financial progress as noted in the previous format, the mid-term review/ monitoring will emphases more on the targeted outputs.

SN	Project outputs	Measuring units	Total project target (Qty)	Target for the year (Qty)	Target for the reporting quarter (Qty)	Achieved up to the last FY (Qty)	Achieved in the reporting quarter (Qty)	Achieved this year up to reporting quarter (Qty)	Cumulative progress up to reporting quarter (Qty)	Cum achieved % of DPP Target	Remarks: Shortfall if any, causes of shortfall & suggestions to remedy shortfall
1	2	3	4	5	6	7	8	9	10	11	12
	Comp 1										

SN	Project outputs	Measuring units	Total project target (Qty)	Target for the year (Qty)	Target for the reporting quarter (Qty)	Achieved up to the last FY (Qty)	Achieved in the reporting quarter (Qty)	Achieved this year up to reporting quarter (Qty)	Cumulative progress up to reporting quarter (Qty)	Cum achieved % of DPP Target	Remarks: Shortfall if any, causes of shortfall & suggestions to remedy shortfall
	Output 1										
	Output 2										
	Output 3										
	Comp 2										
	Output 1										
	Output 2										
	Output 3										
	Comp 3										
	Output 1										
	Output 2										
	Output 3										

6. Template for project monitoring for ongoing project at the terminal stage

SN	Project outcome	Measuring units	Total project target	Target for the year	Target for the quarter	Achieved up to the last FY	Achieved this quarter	Achieved this year up to current quarter	Cumulative progress	% achieved	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

7. Template for Terminal evaluation

SN	Description Project goal/ objectives	Targets	Baseline	Achieved up to reporting period	Source of information	indicators	Frequency	Responsible	Remarks/ shortfalls
1	2	3	4	5	6	7	8	9	10
1	Project goal/ objectives								
2	Outcomes								
3	Outputs								

8. Template for Impact Evaluation – minimum after one year of completing project

SN	Narrative Description as per DPP or reformulated based on DPP	Indicators	Baseline (Beneficiary Group)	Baseline Control Group	DPP Targets	Achievement (After project)		Any Shortfall? Reasons/ Learning& Suggestions for future project
						Benf group	Control group	
Impact	Likely contribution to sector goal as per DPP							
	Goal 1							
	Goal 2							
Outcome	Outcome							
	1							
	2							
	3							
	4							

9. Template for Cost Effectiveness Analysis of Development Project

Cost Effectiveness analysis of development project

Name of the Project:
 Executing agency:
 Date of Commencement:
 Date of Completion:
 Project location/ areas:
 Name of Project Director:

Sl.no	Cost Effectiveness analysis tools	Cost by year	Benefit by year	Discounted present value of Cost	Discounted Present Value of Benefits	Net Benefit by discounted present value
yr	2	3	4	5	6	7=6-5
1						
2						
-						
-						
20						
	Sum					
1						
2	Benefit Cost Ratio (BCR)	Sum of 6 / Sum of 5				
3	Pay Back period analysis : yeas needed to recover cost	Number of years from yr 1 to recover cost by sum of benefits Col 6 5 exceeding Sum of Cost of Col 5				
5	IRR analysis	Discountrate at which sum of 6 = sum of 5				
6	NPV	Sum of Col 7				
7	Cost overrun analysis	Actual cost of project at closing/ Estimated cost in the beginning				
11	Time overrun	Years needed to complete project/original DPP project duration yrs				

Activate Windr

Sector wise M&E template

M&E Template for Forestry Sector Project

Plantation/ forestry related activity M&E template

Project name:

Executing agency:

Project duration:

Project Location:

Type of forest/ existing land

Project Objective:

F 1. Monitoring During Implementation

SN	Activities	Answers	Shortfall, if any	Reasons for SF	Remarks/ Suggestions
1.	Site visit and public consultation				
2.	Number of consultation held				
3.	Dates				
4.	Number of participants by Type (community members- men & women, GOB officials, NGO representatives etc.)				
5.	Consultation outcome (describe)				
6.	Recorded minutes dates last two				
7.	Any follow-up and outcome				
8.	Preparation layout or design: Date				
9.	Planting Tree species selection and spacing,				
10.	Identification of suitable species for specific project				
11.	Plants species- Timber species,				
12.	Medicinal plants				
13.	Fruits				
14.	Ornamental				
15.	Local indigenous				

16.	Foreign Species				
17.	Number of trees planted by species				
18.	Management system- Community/Soc F, CCF, Local body, DoF, NGO partnership,				
19.	Survival rate of saplings after one year				
20.	Harvesting- Short term benefit and long term benefit sharing				
21.	Felling of trees for new plantation Number by Species Felling Method total or partial Benefit sharing if applicable Tendering method Valuation Value realized and deposited to account (treasury challan etc.)				
22.	Successes, failure, compliance				

M&E template for Irrigation Sector Project

I 1: Activity and progress monitoring template

SN	Activities (indicative)	Answers	Shortfalls if any	Reasons for SF	Remarks/Suggestions
1.	Irrigation- surface water: canal excavation or re-excavation length km, width m, earthwork cubm				
2.	Irrigation- ground water: DTW, STW, pumping system (surface/ submergible) Area covered (ha) Boro Aman Aus Crops Pddy Maize Wheat Potato Minor crops Nu of farmers				
3.	Rubber dam construction Number Discharge Cusec Area to cover Boro Aman Aus Crops Paddy Maize Wheat Potato Minor crops Nu of farmers				
4.	Command area increase Buried pipe irrigation system development Boro ---- ha to ---- ha				

	Other crops ----- ha to ----- ha				
5.	Command area increase other method Boro ---- ha to ---- ha Other crops ----- ha to ----- ha				
6.	Electricity connection to national grid Number of pumps Area to be covered ha				
7.	Electricity connection – Solar and renewable Number of pumps Area to cover ha				

I 2: Result monitoring

SN	Outcome	Narrative Summary	Indicators	Targets as per DPP	Achievement as % of DPP	Shortfall if any	Causes of shortfall	Remarks/ Suggestions
1	Increased area under irrigation ha.							
2	Increase production MT Boro paddy Aus Paddy Aman Paddy Maize Wheat Potato Others							
3	Number of farmers benefited							
	All Farmers							
	Small & Marginal Farmers							

M&E Template for Water Resource Management Sector Project

W 1. Brief description of monitoring

SN	Activities (indicative)	DPP Target	Achievement	% achieved	Shortfalls if any	Reasons for SF	Suggestions
1	Flood control						
2	Construct embankment km. Height m. Width m. volume of earth cutting cubm						
3	Dredging silt removal Cubic meter						
4	Channel straightening/ loop cutting Number silt removal Cubic meter						
5	River bank protection Groynes Spurs CC Block afflux bunds, revetments, pitching and vanes. Vinna grass plantation Sand filled GeoTex/ JuteTex Bag Length m						
6	Drainage Pumping station Nu of pumps cusec capacity Drainage Canal Km Width Depth Volume of earth cut cum Area benefited ha .						
	Target people Numb of hh Benefits						

W 2. Result monitoring

SN	Outcome	DPP Target	Achievement % of DPP Target	Shortfall if any	Causes of shortfall	Remarks/Suggestions
1	Increased area under flood control ha.					
2	Increase production MT Boro paddy Aus Paddy Aman Paddy Maize Wheat Potato Others					
3	Number of farmers benefited					
	All Farmers					
	Small & Marginal Farmers					
4	DRAINAGE					
	Area benefited by improved drainage					

M&E Template for Shipping Sector Project

S 1. Activities monitoring template

SN	Activities	Objectives	Process/ methods followed	Tools/ equipments used	HR involved	Technology transfer process
1	Planning, drawing & Design					
2	Port Development					
3	Jetty construction					
4	Material BBQ preparation and supply planning					
5	Ship building and repairing					
6	Ship building process/ steps					
7	Dredging and reclamation					
8	Maintenance Plan					

S 2. Brief description of process monitoring template

SN	Activities (indicative)	Answers	Responsible person	Physical targets	Achievement	% achieved	shortfalls	Reasons for SF	Suggestions
1.	Port Development								
2.	Jetty construction rehabilitation Number Sq m Capacity MT/day								
3.	Ship building and repairing Number Capacity MT								

4.	Capital Dredging Cum per year								
	Low-tide channel depth –m draft vehicle								
5.	Maintenance dredging Cum per year								
	Low-tide channel depth –m draft vehicle								
6.	Dock marine workshop construction								
	Rehabilitation of ferry Number								
7.	Construction of container terminal Number Handling Capacity/ MT/day								
8.	Construction of Deep sea port operation infrastructure Location Components								

S 3. Template for Port development monitoring

SN	Description of Activities	Equipments	Targets	Methods followed	Achievement	Time/duration	Handling Capacity	Procurement Methods	Installation status	Functioning status	Community support	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Pre-construction stage											
2.	Construction stage											
3.	Post construction stage											

S 4. Template for dredging activities M&E

SN	Description of Activities	Equipments	Targets	Achievement	Methods followed	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

S 5. Template for Jetty Construction and maintenance

SN	Description of Activities	Methods followed	Targets	Achievement	Equipments	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Drawing and Design development														
2.	Inspection and test plan														
3.	BoQ preparation and supply planning														
4.	Land based works														
5.	Marine based work														
6.	Materials based works														
7.	Recruitment														
8.	Training and capacity building														
9.	Necessary infrastructure														
10.	HR hiring status														

S 6. Template for Dry-Dock Construction and management

SN	Description of Activities	Equipments	Targets	Achievement	Methods followed	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Dock gate development														
2.	Apron flushing														
3.	Dock dewatering														

SN	Description of Activities	Equipments	Targets	Achievement	Methods followed	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/challenges and suggestions
4.	Pump house complex														
5.	Winches														
6.	Cut off curtain walls														
7.	Enhanced wheel rubber fenders														
8.	Hauling-in system														
9.	Dock side cranes														
10.	Gantry crane														
11.	Inlet and outlet valves														
12.	Mobile air compressor														
13.	Mobile cranes														
14.	Gang way access towers														
15.	Jetties														

S 7. Result monitoring template

SN	Outcome	Narrative Summary	OVI	Targets	Economic implication	Environmental implication	Total budget	Risks
1	Increased area cargo handling MT/Year							
2	Increase Export goods handling MT/ Year							
3	Increase Import goods handling MT/ Year							

Annex-8: Sector wise SMART Indicators for Monitoring & Evaluation

General and Sector wise SMART Indicators for Monitoring & Evaluation

SN	Sectors	Narrative & OVI	Data source for verification	Assumptions
1	General/ Overall indicators	1. Children stunting will reduce from XX to XX over 5 yrs	BBS Survey UN agencies World Bank Impact Evaluation	
	GOAL			
	Outcome	1. Income of Target Households increase by 50% in 5 years 2. Children of both sexes of target households have better intake of nutritious food (one egg, 200 ml milk)	Baseline Survey Terminal Evaluation	1. Target households have better access to public sector health services
	Output	1. Milk and egg production increase in the project area by 80% in five year 2. 10000 farmers rearing 2 extra cows producing 14 liters extra milk per farmer from yr 3 to yr 5 3. 10000 farmers have layer farm each with 300 layers producing 200 eggs per poultry per year from year 2.	Project Monitoring Report	1. Poor households do not sell all milk and egg and instead consume part of the produce to meet nutrition need within household
	Activity	1. Recruits 50 Vety Extension Assistants 2. Recruits 50 Community Facilitators 3. Recruits 1 Livestock Specialist and 1 M&E Specialist 4. Procure 1 jeep, 29 motor cycle, 50 bicycle, 10 computers with printer & UPS 5. Provides loan to 10000 farmers to purchase 2 heifers each and 350 layers each 6. Provide each farmer Tk 300,000 as loan	INPUT/ BUDGET	1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job mid-way 4. Good & responsive contractor available 5. Natural calamity does not affect project activities and operation.
2	Forestry Sector	1. Increase tree cover area from XX% to XX% in the northern region 2. Increase conservation of endangered species of trees XX number of endangered species reappear in the NW region	Dept of forestry survey UN agencies survey	
	GOAL			
	Outcome	1. Income of target households in local communities increase by X,XXX Tk monthly from community based afforestation	Baseline Survey and Terminal Evaluation	Community participation sustained
	Output	1. XX lac indigenous species tree planted survive 2. Awareness of local communities improve on conservation of biodiversity and tree coverage 3. Participation of local communities improve afforestation and reforestation	Project monitoring report	Cooperation of local administration and local councils, elected representatives ensured Natural calamities do not affect project implementation and survival of trees

SN	Sectors	Narrative & OVI	Data source for verification	Assumptions
	Input	<ol style="list-style-type: none"> XX,000 saplings produced, distributed and planted of target species Local community groups (X,000 groups with X,000 members) trained on silviculture practices XX vehicles procured XX manpower deployed & trained XX person month of consultancy support XX number of studies 	INPUT/ BUDGET	<ol style="list-style-type: none"> Fund released in time Procurement not delayed and of good quality Recruited and trained staff do not leave job mid-way Good & responsive contractor available
3	Irrigation	<ol style="list-style-type: none"> Reduce extreme poverty from XX% to XX% over 5 years 	Baseline Survey Terminal Evaluation	
	GOAL			
	Outcome	<ol style="list-style-type: none"> Increase crop yield (Mize from 7 MT/ha to 8 MT/ha) Wheat 3 MT/ha to 4 MT/ha Rice 4 MT/ha to 5 MT/ha 	DAE BBS	
	Output	<ol style="list-style-type: none"> Increase surface area irrigation XXXX ha Increased Burried pipe irrigation XXXX ha 	Project Monitoring Report	
	Input	<ol style="list-style-type: none"> Re-excavation of canal XX km (XXXXX CM earth work) Digging pond XX number XXXX ha, earthwork XX CM Burried pipe installation XX number XX km XX CM dia XX vehicles procured XX manpower deployed & trained XX person month of consultancy support XX number of studies 	BUDGET/ INPUT	
4	Water Resource Management	XX,000 holdings of DND area have improved drainage XX,000 farmers of haor area benefited for crop protection, XX,000 MT of rice yield saved XX,000 ha crop area and XX,000 ha fisheries protected benefiting XX,000 farmers	BDWB IDA	
	GOAL			
	Outcome	Drainage system improved in DND area XXX ha in 5 yrs Damage by early flood reduced in HAOR area XX,000 ha in 5 yrs Riverbank protection improved along Jamina Right Bank 50 kms	BWDB IDA	Improved structural interventions sustain
	Output	<ol style="list-style-type: none"> Embankment XX kms Re-excavation of canal XX km Grown XX numbers Bamboo protection XXX numbers 	Project Monitoring Report, BWDB	<ol style="list-style-type: none"> Sudden flood do not damage infrastructure Effective early warning system functional

SN	Sectors	Narrative & OVI	Data source for verification	Assumptions
	Input	Pre-design feasibility study Designing Pre-work estimates Work execution 1. XX vehicles procured 2. XX manpower deployed & trained 3. XX person month of consultancy support	Budget	1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job mid-way 4. Good & responsive contractor available
5	Shipping Sector	Reduce Balance of Trade Deficit and dependence on overseas development assistance	BBS, BSC, IDA, ADB	
	GOAL			
	Outcome	Increase volume of trade by Smooth handling of import and export XX.XXX MT/Yr to XX.XXX MT/Yr	BBS, BSC, IDA, ADB	International terms of trade remain favorable
	Output	1. Develop jetty in the port XX numbers handling XX,000 MT/yr 2. Capital dredging XX,000,000 cm 3. Maintenance dredging XX,000,000 cm 4. Build XX, ships of total XXX,000 MT carrying capacity 5. Rebuild XX, ships of total XXX,000 MT carrying capacity	Project Monitoring Report	Labor unrest within control Good political environment Contractor response favorable
	Activities	1. Procure dredger XX numbers 2. Procure equipment 3. Procure Vehicles 4. Engage manpower XX persons 5. Consultancy XXX person months 6. Studies XX numbers	Input/ Budget	1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job mid-way 4. Good & responsive contractor available

Annex-9: Checklist for Forest Sectors Project**CHECKLIST FOR MONITORING NURSERY SEEDLINGS**

SN	Aspects to be answered/covered	Yes/No	Remarks
1.	Whether nursery has been developed at 40'×4' bed for seedlings of mangrove plantations		
2.	Whether nursery has been developed at 7''×5'' bag for seedlings of mound (non-mangrove) plantations		
3.	Whether nursery has been developed at 7''×5'' bag for seedlings of dyke (non-mangrove) plantations		
4.	Whether nursery has been developed at 7''×5'' bag for seedlings of jhaw (coastal) plantations		
5.	Whether nursery has been developed at 40'×4' bed for seedlings of golpata plantations		
6.	Whether nursery has been developed at 16''×9'' bag for seedlings of enrichment plantations		
7.	Whether nursery has been developed at 10''×6'' bag for seedlings of core zone plantations		
8.	Whether nursery has been developed at 7''×5'' bag for seedlings of buffer zone and buffer zone non-mangrove plantations		
9.	Whether nursery has been developed at 7''×5'' bag for seedlings of strip plantations		

CHECKLIST FOR MONITORING PLANTATIONS

SN	Aspects to be answered/covered	Yes/No	Remarks
1.	Whether spacing has been kept at 1.5m×1.5m for mangrove plantations @4444 seedlings/ha		
2.	Whether spacing has been kept at 1.5m×1.5m for mound (non-mangrove) plantations @1600 seedlings/ha		
3.	Whether spacing has been kept at 2 m×2 m for jhaw plantations @2500 seedlings/ha		
4.	Whether spacing has been kept at 1 m×1 m for golpata plantations @1000 seedlings/km		
5.	Whether spacing has been kept at 1.5m×1.5m for enrichment plantations @300 seedlings/ha		
6.	Whether spacing has been kept at 2 m×2 m for core zone plantations @2500 seedlings/ha		
7.	Whether spacing has been kept at 2 m×2 m for buffer zone and buffer zone non-mangrove plantations @2500 seedlings/ha		
8.	Whether spacing has been kept at 1 m×1 m for strip plantations @1000 seedlings/km		

Annex-10: Template for Forest Sector Project **M&E Template for Forestry Sector Project**

Plantation/ forestry related activity M&E template

Project name:

Executing agency:

Project duration:

Project Location:

Type of forest/ existing land

Project Objective:

F 1. Monitoring During Implementation

SN	Activities	Answers	Shortfall, if any	Reasons for SF	Remarks/ Suggestions
1.	Site visit and public consultation				
2.	Number of consultation held				
3.	Dates				
4.	Number of participants by Type (community members- men & women, GOB officials, NGO representatives etc.)				
5.	Consultation outcome (describe)				
6.	Recorded minutes dates last two				
7.	Any follow-up and outcome				
8.	Preparation layout or design: Date				
9.	Planting Tree species selection and spacing				
10.	Identification of suitable species for specific project				
11.	Plants species- Timber species				
12.	Medicinal plants				
13.	Fruits				
14.	Ornamental,				
15.	Local indigenous				
16.	Foreign species				
17.	Number of trees planted by species				
18.	Management system- Community/Soc F, CCF, Local body, DoF, NGO partnership,				
19.	Survival rate of saplings after one year				
20.	Harvesting- Short term benefit and long term benefit sharing				
21.	Felling of trees for new plantation Number by Species Felling Method total or partial Benefit sharing if applicable Tendering method Valuation Value realized and deposited to account (treasury challan etc.)				
22.	Successes, failure, compliance				

Annex-11: SMART Indicators for Forest Sector Project

Forestry Sector	Description and OVI	Source of Verification Information	Assumption/Result for Desired Information
GOAL	<ol style="list-style-type: none"> 1. Increase tree cover area from XX% to XX% in the northern region 2. Increase conservation of endangered species of trees XX number of endangered species reappear in the NW region 3. Income of target households in local communities increase by X,XXX Tk monthly from community based afforestation 	Dept of forestry survey UN agencies survey	
Outcome	<ol style="list-style-type: none"> 1. XX lac indigenous species tree planted survive 2. Awareness of local communities improve on conservation of biodiversity and tree coverage 3. Participation of local communities improve afforestation and reforestation 	Baseline Survey and Terminal Evaluation	Community participation sustained
Output	<ol style="list-style-type: none"> 1. XX lac indigenous species tree planted in the NW region (Neem, Arjun, Jackfruit, Mango, Black Berry, Litchi, Coconut, Palm, Date palm, koro, raintree, sonaro, radhachura, krishnachura) 2. XXXX Participation agreement signed with local communities on tree plantation, tree caring and benefit sharing 3. XXXX plant nurseries established and run by target farmers 4. XX,000 saplings produced, distributed and planted of target species 	Project monitoring report	Cooperation of local administration and local councils, elected representatives ensured Natural calamities do not affect project implementation and survival of trees
Input	<ol style="list-style-type: none"> 1. XXXX local community groups organized with X,000 members 2. XXXX target group members trained on horticulture and silviculture practices 3. XX extension materials developed, XXXXX copies printed and distributed 4. XX vehicles procured 5. XX manpower deployed & trained 6. XX person month of consultancy support 7. XX number of studies 	INPUT/ BUDGET	<ol style="list-style-type: none"> 1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job mid-way 4. Good & responsive contractor available

Annex-12: Checklist for Irrigation Sectors Project
CHECKLISTS FOR INSPECTING QUALITY OF EQUIPMENTS AND INSTALLATIONS
CHECKLIST FOR FINISHING WORKS*

SN	Aspects to be answered/covered	Yes/No	Remarks
1.	Whether irrigation channel materials or fita/hose pipes are as to the specifications mentioned in DPP or procurement criteria		
2.	Whether the source of water (DTW/STW or surface water) has sufficient capacity (cu-sec) or reserve		
3.	Whether the Rubber Dam materials quality test is done by the related experts or with the participatory approach of beneficiary farmers association		
4.	Whether the Rubber Dam feasibility is done with the participatory approach of upper and lower site farmers		
5.	Whether channel lining or wall of tube well house (Pump house) or Office Building thickness (12mm thickness) or sand-cement ratio (1:4 or 1:6) is as per specifications		
6.	Whether RCC of building or rubber dam installment material is used as to the specifications or plastering surface of wall thickness is requisite and smooth or retaining capacity test		
7.	Whether plaster is done on properly wet wall		
8.	Whether curing is done for at least 7 days		
9.	Whether potable water for mixing cement and sand is available		
10.	Whether cement and sand were mixed properly before use		
11.	Whether digitalization program of minor irrigation is running fulfilling all criteria.		

In some cases, there are design requirement for doing Pointing Works rather than doing plaster on the brick wall. In that case, cement and sand mix of 1:2 ratio is used for pointing works.

*This is applicable for on-going construction work.

CHECKLIST FOR WOOD WORKS

Nowadays, normally wood is used in door frame, door shutter and stair railing.

SN	Aspects to be answered/covered	Yes/No	Remarks
1.	Whether wood used in office furniture's meets the specification in the tender schedule		
2.	Whether matured wood of specified thickness is used (if it is specified as 1.5-inch solid door shutter, then it is 1.5-inch solid door shutter after finishing)		
3.	Whether sap wood is supplied or used		
4.	Whether wood is mechanically seasoned before use		
5.	Whether wood having knot is used		
6.	Whether hole/cavity in the door shutter or door frame is properly filled with same wood dust (mixed with glue) or putty		
7.	Whether surface of the wood is smooth finished		
8.	Whether wood Varnish is used for polishing		
9.	Whether wooden fiber is exposed after polishing		
10.	Whether Enamel Paint is used for wood that is likely to come in contact with water		
11.	Whether in case of plastic or synthetic wood the quality test or market price quotation is done		

Annex-13: Template for Irrigation Sector Project**Activity and progress monitoring template**

SN	Activities (indicative)	Answers	Shortfalls if any	Reasons for shortfall	Remarks/ Suggestions
1.	Irrigation- surface water: canal excavation or re-excavation length km, width m, earthwork cubm				
2.	Irrigation- ground water: DTW, STW, pumping system (surface/ submergible) Area covered (ha) Boro Aman Aus Crops Paddy Maize Wheat Potato Minor crops Number of farmers				
3.	Rubber dam construction Number Discharge Cusec Area to cover Boro Aman Aus Crops Paddy Maize Wheat Potato Minor crops Number of farmers				
	Command area increase Buried pipe irrigation system development Boro ---- ha to ---- ha Other crops ----- ha to ----- ha				
	Command area increase other method Boro ---- ha to ---- ha Other crops ----- ha to ----- ha				
	Electricity connection to national grid Number of pumps Area to be covered ha				
	Electricity connection – Solar and renewable Number of pumps Area to cover ha				

Result monitoring

SN	Outcome	Narrative Summary	Indicators	Targets as per DPP	Achievement as % of DPP	Shortfall if any	Causes of shortfall	Remarks/Suggestions
1	Increased area under irrigation ha.							
2	Increase production MT Boro paddy Aus Paddy Aman Paddy Maize Wheat Potato Others							
3	Number of farmers benefited							
4	All Farmers							
5	Small & Marginal Farmers							

Annex-14: SMART Indicators for Irrigation Sector Project

Irrigation	Description and OVI	Source of Varification Information	Assumption/Result for Desired Information
GOAL	1. Reduce extreme poverty from XX% to XX% over 5 years	Baseline Survey Terminal Evaluation BBS Development partners	
Outcome	1. Increase crop yield (Mize from 7 MT/ha to 8 MT.ha 2. Wheat 3 MT/ha to 4 MT/ha 3. Rice 4 MT/ha to 5 MT/ha	DAE BBS	Price of crop increases compared to price of input and wages At least one third of the gross output price accrues to Tenant Farmers, one half to owner operator farmer, and maximum one third to landowner.
Output	1. Increase surface area irrigation XXXX ha 2. Increased Burried pipe irrigation XXXX ha	Project Monitoring Report	Natural calamities do not damage more than 20% of the potential crop yield.
Input	1. Re-excavation of canal XX km (XXXXX CM earth work) 2. Digging pond XX number XXXX ha, earthwork XX CM 3. Burried pipe installation XX number XX km XX CM dia 4. XX vehicles procured 5. XX manpower deployed & trained 6. XX person month of consultancy support 7. XX number of studies	BUDGET/ INPUT	1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job or transferred mid-way 4. Good & responsive contractor available

Annex-15: Checklist for Water Resource Management Sector Project

ANNEX FOR WATER RESOURCES SECTOR

CHECKLISTS FOR INSPECTING QUALITY OF CONSTRUCTION (RIVER TRAINING WITH RE-EXCAVATION, FLOOD CONTROL, RIVER BANK PROTECTION)

As the works comprise the River training with Re-excavation, Flood Control, River Bank protection, hence chiefly involves the excavation/re-excavation, filling and compaction of earth and sand with similar materials. As such The Checklist will include in details the above. Other Protective Works using concrete, bricks, reinforcement, polythene sheet etc. will also be brought under Checklist.

SN	Aspects	Yes/No	Remarks
A.	GENERAL - INITIAL SITE PREPARATORYWORKS, ACCOMMODATIONS& OTHER FACILITIES		
1.	Whether contractor is observing the current River flow along the existing partly/fully damaged river bank embankment before taking pre-work survey, necessary barricades etc.		
2.	whether contractor is providing and maintaining signs, markings, lights, barricades etc. as per Construction Norm manual		
3.	Whether contractor has constructed and provided furnished field office to the Engineer with approach road and his staff as per contract agreement		
4.	Whether necessary office supporting staff, computer operator, office equipment and necessary consumables have been provided for the office of the Engineer		
5.	Whether colored photographs of progress of work are being arranged every month by the contractor		
6.	Whether contractor has set up field testing laboratory concerning soil tests on types, compaction, field dry density, moisture content etc. by providing necessary equipment and consumable stores at site to carry out tests as per terms of the agreement.		
7.	Whether besides testing in field, off site tests are also being carried out by the contractor as per requirement and instruction of the Engineer		
8.	Whether contractor has provided qualified laboratory engineers, technicians, assistants, laborers etc. to carry out sampling and testing of materials and other tests.		
9.	Whether contractor is maintaining Site Register Book and supervising officers are recording their comments/ observations in it to address the problems.		
10.	Whether all test reports and records, including material tests and collected samples, are systematically maintained.		
11.	Whether contractor has mobilized construction equipment as per contract agreement		
12.	Whether required manpower for execution of the project as mentioned in the DPP is made available		
13.	Whether progress of work in the field matches with the project target mentioned in the Bar Chart/CPM given and approved by the project authority		
14.	Whether financial progress in the field is consistence with the physical progress		
15.	Whether there is any deviation of the contract agreement		

SN	Aspects	Yes/No	Remarks
16.	Whether there is any deviation of the approved DPP		
17.	Whether physical and financial target and achievement as reported in the 02 and 03 IMED's formats are in line with progress in the field		
18.	Whether Reconnaissance Survey and subsequent pre-work survey carried out and submitted the initial report to the Consultant.		
	DIRECT CONSTRUCTION WORKS, FOLLOW UP AND INSPECTION		
	Earth Excavation, re-excavation, backfilling, compaction and protection measures		
19.	Whether source approval of material has been taken by the contractor prior to begin work.		
20.	Whether compaction test of the final sand/soil layers have been carried out and test results have been approved by the Engineer		
21.	Whether construction materials are being tested in the laboratory and then used by the contractor according to the instruction and approval of the Engineer		
22.	Site Preparation: Has the Contractor received written approval from the Engineer after applying for work commence		
	Setting Out: Whether contractor has study drawings and fixed up the alignment, set the BM pillar, levels, pegs etc.is observing the current River flow along the		
23.	Whether Earth work for Cutting and filling charts prepared by the Engineer and to provide to the to sign as a token of his agreement		
24.	General Earthwork: Whether Earthwork is undertaken by the Contractor to the line and levels as shown on the drawing		
25.	Clearing of Sites: Cleaning of Site- Whether the Contractor has removed all sumps, roots, vegetation's and objectionable materials within areas of embankment. channel excavations, structure excavation and structure appurtenance		
26.	Demolition of Structures: Whether the Contractor has Demolished, existing structures and removed to a safe place.		
27.	Stripping: Whether the Contractor has stripping of top soil containing organic or other unsuitable matter of 100 mm thick or more shall be taken out.		
28.	Trim lung, Slips and Falls: Whether the Contractor exercised the greatest possible care and take all necessary precautions to prevent slips and falls of material from the sides of the excavation and embankments		
	Excavation for Embankment, Guide bank, dyke and similar works		
29.	Whether the Contractor excavated from nearby borrow pit to the lines, grades and dimensions shown on the Drawings.		

SN	Aspects	Yes/No	Remarks
30.	Whether the Contractor stockpiled for backfilling and embankment construction or deposited in spoil tips away from the top edge of cut slope that shall be away from cut slope.		
31.	River/canal cleaning that contains silt, debris stockpiled some away from the bank and allowed for some dry condition and finally remove the poi to a safe place.		
32.	Excavation and Re-excavation of Channels (Re-excavation may be for siltation at river bed or at bend that shorten the river width		
33.	Whether the Contractor has constructed Cross Bund and keep until the dewatering the bed		
34.	Whether the Contractor has Bailed out of water and continued until excavation or re-excavation to the design bed level and section is completed.		
	Fill Works		
35.	Whether the Contractor has completed the Fill works i.e., the construction, and backfilling to structures as shown in the Drawings and other minor fill works		
36.	Whether the Contractor has completed the fill work with suitable earth and that were not contain peat, logs, stumps, vegetation or other undesirable or organic matter and shall be capable of being compacted to the required standards		
	Embankments, General		
37.	Whether the Contractor has to raise embankment height that will be raised uniformly at all stages during construction. Each layer shall have a slight slope from the center of the fill towards the sides so that all water shall drain freely from the embankment with no pockets to collect water.		
38.	Whether the Contractor has constructed embankments and small irrigation dykes shall be manually compacted embankments as specified. Embankments other than flood protection embankments, such as compartmental dykes shall be uncompact embankments		
39.	Whether the Contractor has completed the embankment that shall be protected by grass sod turving in the Country side unless shown otherwise the Drawings or otherwise instructed by the Engineer.		
	Manually Compacted Embankment		
40.	Whether the Contractor has Filled in place and compacted in layers of 150 mm (maximum loose thickness), uniformly spread and compacted over the fill area of each layer		
41.	If unsatisfactory compaction the layer shall be removed and the unsatisfactory layer shall be re-compacted to satisfy the specification.		
42.	Whether the earth has it be compacted manually using rammers made of wood, iron or concrete weighing =>7 kg, fitted with shafts about 1.5 m long.		

SN	Aspects	Yes/No	Remarks
43.	Whether before the commencing ramming, the moisture content of the soil that shall be increased or decreased as necessary by sprinkling soil with water or by allowing natural drying of the soil necessary so that the ramming can achieve the compaction specified.		
44.	Whether the preceding operations were continued layer after layer until the top of the embankment is reached.		
	Mechanically Compacted Embankments and its River & Country side Slopes		
45.	Whether embankments designated on the Drawings or by tile Engineer be mechanically compacted that are compacted to the lines grades shown on the Drawings, or established by the Engineer		
46.	Whether Just prior to and during placement operations, the material's moisture content of not greater than 5 percent wet or less than 5 percent the of optimum moisture required for tile purpose of compaction, as determined by Test No.12 of BS 1337 E approved by the Engineer, and the moisture content shall uniform throughout each layer are done.		
47.	Whether If the moisture content is less than optimum for compaction, the moisture shall be supplemented by sprinkling and reworking the material at the site of compaction is done.		
48.	Whether If the moisture content more than optimum for compaction, tile material shall be dried by reworking, mixing with dry materials or other approved means that are done.		
49.	Whether If the material was being excavated from canal or other water-logged areas for use as embankment material is saturated, then it shall be initially stockpiled to drain the excess water before placing for construction of embankment that are done.		
50.	Whether when the material had been conditioned and placed as specified or directed, it shall be compacted with appropriate motorized vibratory compaction equipment or tampers of adequate weight and size as approved by the Engineer are done		
51.	Whether the material in compacted embankment on which a road is to be laid that shall be compacted unit the dry density of compacted material is not less than 90% of the laboratory maximum dry density determined by Test No. 13 of BS 1377 14.5 kg rammer method or similar approved test for the material being compacted are done.		
52.	Whether materials forming all other embankments on which limited vehicular traffic might be allowed after completion shall be compacted until its dry density reaches at 85% of the laboratory value as tested above. Has the Engineer taken samples of the material 1 compacted and perform tests required to determine that the compaction is meeting requirements of these Specifications are done.		

SN	Aspects	Yes/No	Remarks
53.	Whether the in situ dry density of the compacted fill shall be determined by the sand replacement method described in Test No. 15 of BS 1377 or similar approved test at locations ordered by the Engineer are done.		
	Structural Backfill		
54.	Whether placing backfill, all trash, metal, debris, lumber, bricks, soft materials and similar objectionable foreign materials are being removed from the area to be backfilled.		
55.	Whether any backfill that shall not place in standing water, on surfaces that are excessively soft, wet or against, concrete structures that have not cured for at least fourteen days or such other period as may be directed by the Engineer.		
56.	Whether mechanical compaction that shall only be undertaken by equipment approved by the Engineer and layer by layer are as specified (Manual compaction - 50 mm of loose materials. Mechanical compaction-230 mm of loose material) done.		
	Testing Fill		
57.	Whether layers of filling that shall be tested as directed by the Engineer, each compacted layer shall not be covered until the Engineer is satisfied that the specified degree of compaction has been achieved are done and show test result.		
58.	Whether the in-situ dry density of the sample points that shall be determined in accordance by either Test 15A, BS 1377 or ASTM Designation E-24 and compared to laboratory results to establish the degree of compaction are done.		
	Borrow Pits		
59.	Whether prior to the excavation of any material from the borrow pit the area shall be cleared and stripped are done.		
60.	Whether in case of borrow areas located on the river/sea side of the embankment that shall be not more than 30 m in length and shall be separated gaps of undisturbed ground of not less than 6 m in length measured parallel with the embankment.		
	Spoil Tips		
61.	Whether Spoil and excavated material from stripping and excavation which does not meet the specification for fill work, that shall be disposed of at the selected sites to be arranged by the Contractor within the specified site limits in locations approved by Engineer or within the specified site limits are done.		
	Temporary Cofferdams		
62.	Whether where necessary, the Contractor shall protect the Works from the effects of tidal or flood waters ensuring that the works constructed in the dry are done		

SN	Aspects	Yes/No	Remarks
63.	Whether the Contractor shall submit his proposed method of protect the construction works for approval ten days prior to the commencement of construction. If the cofferdam has not been detailed on the Drawings, the Contractor will be responsible its design and subsequent performance; the Engineer's approval of proposal will not relieve the Contractor of full responsibility for the design, maintenance and safety of the temporary coffer dam until its removal are done.		
64.	Whether the temporary cofferdam that shall not be removed without written permission, of the Engineer, following his satisfactory inspection of the works within 7 days are maintained.		
65.	Whether the Contractor has ensured that the cofferdam and associated elements are carefully and completely removed without causing any harm to the permanent Works are done		
66.	Whether contractor has carried out samples tests of all the materials in the laboratory, to be used in the embankment and taken approval of the Engineer are done.		
	Concrete Cubes in the toe of embankment in River side		
67.	Whether checking the mix ratio for Concrete cubes are done		
68.	Whether Water Cement ration are properly maintained as specified		
69.	Whether material tests for (coarse and fine aggregates, cement and sand) are tested for Abrasion test, aggregate crushing strength, compressive strength and water absorption test are done		
70.	Whether Shuttering for cubes are checked for any deterioration that might cause segregation of aggregates		
71.	Whether Insertion of lifting hooks/lugs are provided as per specifications		
	II Placing of Concrete cubes at embankment toe, RCC slab in riverside slope with turfing in country side, installation of Geo-cell/geotextile in another Bank protection works,		
72.	Whether curing of Cubes are done		
73.	Whether cubes are installed in the toe of the embankment true to line, and grade		
74.	Whether cubes are interconnected with each other by iron rope/MS bar of appropriate sizes		
75.	Whether interspaces among cubes filled with sand/earth or mortar with each other by iron rope/MS bar of appropriate		
76.	RCC slab in River side slope and turfing in the country side slope (the size and thickness of each shall be as per spec., Thickness is usually 150 mm to 200 mm based on river		
77.	Whether checking the as indicated above from Sl. # 65 to 68 for RCC slab are done		
78.	Whether before placing the RCC slab in the embankment slope, proper compaction the soil is done as mentioned above concerning manual and mechanical compaction using appropriate compaction equipment (refers. # 38-51)		

SN	Aspects	Yes/No	Remarks
79.	Whether reinforcement is provided two layers or not, if for one layer precaution are mentioned for handling stress to prevent it from any kind of crack(hair line or visible) are checked		
80.	Whether to ensure the reinforcement diameter and layer of arrangement for breaking at corner of the Slab than during installation and connection with other adjacent slab mending good the damages occurred during reinforcement checking		
81.	Whether the RCC slabs are connected each other as specified in true to line and grade and filled the interstices among slabs are filled with mortar		
82.	Whether tie up of the slabs are done from the top of embankment pavement road side and some CC casting are done at the top of slab to reach few centimeter parallel to top width of embankment		
83.	Whether repeated all operations before placing RCC Slab on River side slope for turving in the Country side		
84.	Whether specified turving is planted in the country side		
85.	Whether initially, water spraying is done for turving		
86.	Whether water spraying regularly for tufting till the turfs are permanently get stable and green		
	Embankment Top Road (usual width from 3 m to 5 m)		
	Embankment way Excavation		
87.	Whether Soil test shall be carried out along the road alignment to ascertain bearing capacity of the soil.		
88.	Whether material of the place can be used in embankment pavement road construction or not, shall be assessed before		
89.	Whether Measurement of useable materials should be taken beforehand.		
90.	Borrow pit as mentioned above		
	Embankment top road and Embankment materials		
91.	Earth fill materials shall be free from shrubs, trees, grass and grass roots structure etc.		
92.	Shall be approved by the Engineer as a suitable material for the purpose.		
93.	CBR of embankment material shall be more than 3%		
94.	Embankment materials, when compacted shall achieve 95% maximum dry density (MDD) determined in accordance with Standard Testing Procedure (STP)		
95.	Whether Places like ponds, marshes and canals in the alignment should be cleared and sand- filled, to strengthen the embankment. When this filled land shall be raised to a designed height level, that shall be compacted are done.		
	Subgrade of Embankment Top Road		
96.	150mm layer above the bottom earth layer or just below the sub-base course is known as Subgrade. Subgrade preparation with suitable soil and proper compaction		
97.	Subgrade is spread through entire breadth of the embankment including shoulder		

SN	Aspects	Yes/No	Remarks
98.	During construction of embankment on an existing road, entire earth up to 150mm depth should be removed so that new materials are completely mixed with the old materials.		
99.	Subgrade layers should be compacted to achieve 98% of maximum dry density (MDD).		
100.	Subgrade should have LL<50%, PI<15% and CBR>5% or as specified in the contract document		
101.	The depth of upper part of the prepared subgrade should be at least 50mm everywhere. The variation in subgrade at any place should not exceed ± 20 mm		
102.	The contractor must take approval of the subgrade before starting work of the pavement		
	Subgrade drain (Optional)		
103.	To consolidate the embankment, it is required to construct subgrade drain layer. It will let water pass through easily without damaging the embankment.		
104.	Subgrade drain should be constructed 200mm in width and 300mm in depth and should be made across the whole length of the embankment		
105.	Clean sand and gravel mix should be used to fill it and compacted as per specifications		
106.	Geotextile membrane should be placed on the drain to protect small particles from being washed away.		
	Improved subgrade(Optional)		
107.	Improved subgrade materials should be natural or artificial mixture of sand or other mineral aggregates free from vegetation, soft particles and excess clay.		
108.	Improved subgrade shall be compacted in 150mm layers or as per specification of the design, with vibratory roller to achieve 95% compaction. At this stage, optimum moisture content should be $\pm 2\%$ or as specified in the contract.		
109.	Improved subgrade shall be compacted in 150mm layers or as per specification of the design, with vibratory roller to achieve 95% compaction. At this stage, optimum moisture content should be $\pm 2\%$ or as specified in the contract.		
	Earthen Shoulder		
110.	Before shoulder filling work, subgrade preparation and subgrade drainage work shall be completed		
111.	Shoulders shall be constructed in layers approximately parallel to the finished grade of the roadbed. The layers should not exceed 150mm in thickness on completion of compaction		
112.	Shoulder fill material should be free from roots, sods, etc.		
113.	Each 150mm layer should be compacted to achieve not less than 98% MDD with $\pm 2\%$ optimum moisture content (OMC) or as specified in the contract document.		
114.	Compaction test (Field Dry Density) shall be carried out for every 500-sq. meter area of constructed shoulder or as specified in the contract document		

SN	Aspects	Yes/No	Remarks
	Sub base material:		
115.	Sub-base construction with well graded brick aggregates (with various shape and sizes) and sand mixed shall be done and compacted or it shall be done as specified in the contract		
116.	Sub-base materials should be natural or artificial aggregate material, free from vegetation, soft particles and excess clay. The material shall fully conform to the specifications and must have approval of the Engineer		
117.	The material should have 4-day soaked in water and CBR value >25% when compared to 98% MDD or it shall have value as specified in the contract		
118.	Aggregate crushing value (ACV) <38% and ten percent fine value (TFV) > 75kN or shall have value as specified in the contract		
119.	Contractor Shall submit all the test results for the engineer's approval		
	Sub base		
120.	Sub-base is the middle load bearing layer of the pavement. Sub-base materials are spread over engineer-approved sub-grade and compacted to desired specification		
121.	Sub-base materials should be spread mechanically or manually in more thickness so that after compaction, 150mm thickness or as per specification of the approved design is achieved. It shall be done by sprinkling water as required in the contract.		
122.	Sub-base materials should be spread mechanically or manually in more thickness so that after compaction, 150mm thickness or as per specification of the approved design is achieved. It shall be done by sprinkling water as required in the contract.		
123.	Three field dry density (FDD) tests shall be carried out for every 1000 sq. meter of compacted layer or as per specifications		
124.	At any place of the sub-base, the thickness shall be more or less than 10% of the required thickness or as specified in the contract document.		
	Base material (Aggregate):		
125.	There are two type of aggregate bases that are constructed.		
126.	Base Type I - It is constructed with crushed stone fragments with proportionate mix of sand or stone dust.		
127.	Base Type II -It is constructed with crushed brick fragments with proportionate mix of sand or stone dust.		
128.	Base materials shall be mixed of all size and shapes of aggregates i.e. it shall be well graded		
129.	When tested in accordance with SPT, the material shall have a minimum soaked CBR value at a compaction of 98% of MDD as determined by STP as follows: Base Type I - 80%		

SN	Aspects	Yes/No	Remarks
130.	Aggregate Crushing Value (ACV) shall be less than 30% for Base Type I and 35% for Base Type II or other test values as specified in the contract		
131.	Contractor shall obtain approval of all the test results of Base materials from the Engineer.		
	Aggregate base (laying):		
132.	Aggregate and sand shall be mixed thoroughly to obtain homogenous mix and water shall be added to keep mixed material moist and spread over the surface. Each layer shall be compacted (by vibrating hammer) to at least 98% of the MDD as determined by STP.		
133.	Density of the compacted aggregate base course shall be determined in accordance with STP (150 mm or 200 mm depending on layer thickness of design) with at least 3 tests to be carried out for each 1000 square meters		
134.	Final shaping and rolling of the shoulder to the full width shall be made after the base course is completed		
	Pavement Construction:		
135.	Pavements are generally of two types. These are: a. Rigid Pavement and b. Flexible Pavement		
	Rigid pavement: This pavement is made of R.C.C. or C.C. Although it is considered ideal in the weather condition like Bangladesh where rainy season is long and flooding is quite common phenomena. But very small portion of total KM of road is made of rigid pavement. Normally roads in hat and bazar where water logging is common and roads. That remain submerged during rainy season are made of R.C.C. or C.C. Construction cost per KM of this type of road said to be a bit higher compare to the cost of flexible pavement, but its (rigid pavement) maintenance cost is very low		
136.	Flexible pavement: Different types of surfacing are done for the subgrade, improved subgrade and base. Popular flexible pavements are bituminous or asphalt. Sometimes on top of the pavement, sealing is done by bituminous seal coat.		

SN	Aspects	Yes/No	Remarks
137.	<p>Generally, a bituminous wearing course is applied on the top of asphalt concrete. Depending on requirement of the design, top surface of the road pavement is made. Construction of road pavement involves various parameters of highly technical nature. Before starting work, the contractor shall submit in writing to the engineer a job-mix formula for each type of proposed asphaltic mixture. This shall state the sources and types of various materials to be used, the mixing proportions of the various constituents, the method of mixing, the method of heating bitumen and aggregate sand the means of transportation, laying and compaction. The formula so submitted shall stipulate a single definite temperature for the emptying of the mixture from the mixer, and for mixture to be laid hot, a single definite temperature at which the mixture is to be delivered on the road. The job-mix formula for the mixture shall indicate the percentage of aggregate passing each required sieve size and the percentage of bitumen to be added to the aggregate.</p> <p>The contractor shall not commence bitumen surfacing work until the job-mix formula has been approved in writing by the Engineer, including any adjustment to the job mix formula which the Engineer considers are necessary.</p>		
138.	A short illustration of frequently used terms in bituminous pavement work is also given below:		
139.	<p>Prime Coat: The principal function of prime coat in bituminous pavement is to protect the subgrade from moisture and weathering. Since the presence of moisture affects the strength of subgrade, the prevention of water entry during construction is essential to avoid the failure of the pavement. Prime coat is an asphalt which, when applied evenly to the surface of sub-base or subgrade, serves to seal the surface to hinder the penetration of moisture into subgrade. Vehicular traffic should be avoided on the surface sprayed with prime coat because the traction and tearing action of vehicles would damage this asphalt layer.</p>		
140.	<p>Following steps shall be taken before spreading bituminous layer over the surface:</p> <p>The Prime Coat layer shall be sprayed on completely dried and cleaned surface as per specifications or as per instruction of the engineer.</p> <p>Bitumen mix shall not be spread until Prime Coat layer is completely dried.</p> <p>The surface area shall be thoroughly cleaned before applying bitumen or bituminous layer.</p> <p>When upper surface is completely dried, possibility of rain is remote and condition of Road Bed is satisfactory then only bitumen mix layer shall be spread as per instruction of the engineer.</p> <p>Bituminous surfacing layer shall be compacted quickly by a specified roller to achieve result as per specifications.</p>		

SN	Aspects	Yes/No	Remarks
141.	<p>Following steps shall be taken before spreading bituminous layer over the surface:</p> <ul style="list-style-type: none"> - The Prime Coat layer shall be sprayed on completely dried and cleaned surface as per specifications or as per instruction of the engineer. - Bitumen mix shall not be spread until Prime Coat layer is completely dried. - The surface area shall be thoroughly cleaned before applying bitumen or bituminous layer. - When upper surface is completely dried, possibility of rain is remote and condition of Road Bed is satisfactory then only bitumen mix layer shall be spread as per instruction of the engineer. - Bituminous surfacing layer shall be compacted quickly by a specified roller to achieve result as per Specification. 		
142.	<ul style="list-style-type: none"> - The Work shall consist of cleaning of the surface to be Prime Coated and applying bituminous material in accordance with the specifications or as directed by the engineer Tack Coat: Tack coat is applied after the prime coat, to form an adhesive bond between the tack coat and the next layer of coating. The tack coat prevents slippage and may sometimes function as a more long-term sealer. - The work shall consist of applying bituminous material to a previously prepared Road Bed, in accordance with the specifications and to the width and the area required by the engineer. 		

Checklist for Quality Check of Bituminous Pavement on Embankment Pavement

The contractor shall not commence bitumen surfacing work until the job-mix formula has been approved in writing by the Engineer, including any adjustment to the job mix formula which the Engineer considers are necessary.

SN	Aspect	Yes/No	Remarks
1.	Whether Core Cutting machine test confirms bituminous layer above 50 mm thickness or as specified in the contract		
2.	Whether materials use in bituminous pavement re well graded and are as per specifications		
3.	Whether materials used in the bituminous pavement are as per specifications of the contract as per job mix formula approved by the engineer		
4.	Whether bitumen content in the bituminous pavement is ensured as suggested in job mix design or as per written instruction of the engineer		
5.	Whether temperature control of the materials mixing with bitumen is done as suggested in job mix design or as per instruction of the engineer		
6.	Whether temperature of laying of bituminous mix material is controlled as per instruction of the engineer		
7.	Whether bituminous layer compaction is done as per specifications		
8.	Whether Core cutting tests have been carried out by the department concerned as per specifications of the contract		

SN	Aspect	Yes/No	Remarks
9.	Whether road Camber during bituminous mix laying and compaction is maintained as per design		
10.	Whether bituminous layer has been laid mechanically or manually or as per instruction of the engineer		
11.	Whether use of Asphalt Plant/Bitumen mix Paver machine/Tyre Roller/ Steel Roller etc. is ensured as per contract agreement to ensure quality work.		

Checklists for inspecting quality of construction (ancillary /protection works)

Checklist for sand/plastering works for petty civil works concerning river bank protection, etc.

SN	Aspect to be covered	Yes/No	Remarks
1.	Whether fine sand (F.M.-1.2 or as per specifications) is free from silt and other foreign materials and organic impurities		
2.	Whether correct proportion (1:4 or 1:6 or as per specifications) of cement and sand is used		
3.	Whether wall plaster's thickness is as per specifications (12mm thickness)		
4.	Whether plaster surface is smooth		
5.	Whether plaster is done on properly wet wall		
6.	Whether curing is done for at least 7 days		
7.	Whether potable water for mixing cement and sand is available		
8.	Whether cement and sand were mixed properly before use		

Checklist for Iron/Reinforcing Bar Works

Flat Bar, Square Bar, MS Bar, MS Angle, GI/MS pipe, SS pipe etc. is also used in any kind of civil constructions for security reasons etc. Hence, it is desirable that all these materials are supplied and used as mentioned in the schedule of works. To ensure quality of works following steps should be taken:

SN	Aspect to be covered	Yes/No	Remarks
1.	Whether Anti-corrosive paint and anti-rust prime coat are used on all MS grills etc. or works like it		
2.	Whether Aluminum shutter and frame's thickness meet the requirement of the contract		
3.	Whether Flat bars, Angles, MS pipes, GI pipes etc. thickness used in the building are as per specifications of the contract		
4.	Whether joints in the Flat bars, Angles, MS pipe, GI pipe etc. are welded as per technical specifications (spot welding or running welding) mentioned in the contract		

Checklist for Testing Construction Materials

SN	Aspect to be covered	Yes/No	Remarks
1.	Whether organic impurities are removed from sand before use		
2.	Whether there is silt content in the sand		
3.	Whether 'fineness' test of the cement is done		
4.	whether 'setting time' test of cement is done as per requirement		
5.	Whether 'compressive strength' of cement is done		
6.	Whether stone/brick chips (aggregate) 'crushing strength' test is done		
7.	Whether 'Slump test' of concrete has been carried out		

SN	Aspect to be covered	Yes/No	Remarks
8.	Whether 'Cube/cylinder test' of concrete has been carried out		
9.	Whether 'Tensile strength test', 'Elongation test' and 'Bend Test' of reinforcement has been done		
10.	Whether 'Compressive strength' test of brick has been done		
11.	Whether 'water absorption' test of bricks has been done		
12.	Does the contractor has the right people/qualified engineers for supervision& testing;		
13.	Does the contractor has the necessary field drawings/designs to prepare for the work;		
14.	Are there the right type of people in the Department/Project office for checking the quality of work;		
15.	Does the Department has contractor's approved quality control program;		
16.	Whether necessary construction equipment is available with the department/ contractor;		
17.	Has the department set up implementation monitoring/inspection recording system at site		

Checklist for Handing & Taking Over Of Structures

The hand over to Public ownership is essentially needed in many aspects such as by committee forming for Users; Association or similar while for Public organization it is simply to hand over the site for Operation with all documents prepared by the Contractor if otherwise is not specified like, DBO, DB to BOT Contract, etc.

SN	Aspect to be covered	Yes/No	Remarks
1.	Whether a committee was formed to take over the completed work of the contractor (if required).		
2.	Whether formation of the committee was in line with normal practice of the department		
3.	Whether committee's report was accepted by the authority?		
4.	Whether contractor corrected/rectified the defects as per recommendations of the committee within the 'defects and liability period' and this period is usually one year		
5.	Whether building is formally handed over by the contractor and taken over by the project authority.		
6.	Whether performance guarantee money (usually 5%) has been released by the project authority in two stages: i) 50% On completion of the works; and the (ii) the remainder 50% of retention money after expiry of Defect liability period		

Checklist of Deployment Of Manpower For Execution And Operation

Usually, from Government side one incumbent namely Project Director (PD) is appointed and on the Consultant, side the head of Consultant and other Engineers are designated as "Project Manager/Team leader" and Engineer respectively.

Following information about the project implementation arrangement is usually obtained from the PD's office and analyzed to see their impact on the project progress and quality of works:

SN	Aspect to be covered	Yes/No	Remarks
1.	Whether necessary personnel of different category as approved in the DPP are placed		
2.	Whether PD has been timely appointed		
3.	Whether PD's appointment is for full time or half time		

SN	Aspect to be covered	Yes/No	Remarks
4.	Whether PD stays at the project site permanently		
5.	Whether necessary trained manpower has been deputed for overseeing quality control and other aspect		
6.	whether proper arrangement for physical and financial reporting has been made		
7.	Whether consultant/s has been appointed to provide technical supports		
8.	Whether PD holds regular meetings at site to review the progress of day today work etc.		
9.	Whether a committee has been formed to oversee the work of the contractor and consultant		
10.	Whether project logistics as approved in DPP/TPP are in place and are being used properly		
11.	Whether necessary steps have been initiated to recruit/depute manpower for operation after its completion		

Checklist for Testing Other Relevant Kits

SN	Aspect to be answered/covered	Yes/No	Remarks
1.	Whether flat bar or metal sheet measuring gauge is available		
2.	Whether camera/ video is available		
3.	Necessary testing kits to be identified and made available during site inspection		

Checklist of Site Documents on Quality Assurance (Qa) And Documentation

SN	Aspect to be answered/covered	Yes/No	Remarks
1.	Whether any "Quality Assurance Manual "is prepared and make effective		
2.	Whether site register or inspection book is maintained		
3.	Whether material register record is maintained		
4.	Whether daily progress report file is at site		
5.	Whether design& drawing record is maintained		
6.	Whether test records of materials are maintained		

Annex-16: M&E Template for Water Resource Management Sector Project

Brief description of monitoring

SN	Activities (indicative)	DPP Target	Achievement	% achieved	Shortfalls if any	Reasons for SF	Suggestions
1.	Flood control						
2.	Construct embankment km. Height m. Width m. volume of earth cutting cubm						
3.	Dredging silt removal Cubic meter						
4.	Channel straightening/ loop cutting Number silt removal Cubic meter						
5.	River bank protection Groynes Spurs CC Block afflux bunds, revetments, pitching and vanes. Vinna grass plantation Sand filled GeoTex/ JuteTex Bag Length m						
6.	Drainage Pumping station Nu of pumps cusec capacity Drainage Canal Km Width Depth Volume of earth cut cum Area benefited ha .						
7.	Target people Numb of hh Benefits						

Result monitoring

SN	Outcome	DPP Target	Achievement % of DPP Target	Shortfall if any	Causes of shortfall	Remarks/Suggestions
1	Increased area under flood control ha.					
2	Increase production MT Boro paddy Aus Paddy Aman Paddy Maize Wheat Potato Others					
3	Number of farmers benefited					
	All Farmers					
	Small & Marginal Farmers					
4	DRAINAGE					
	Area benefited by improved drainage					

Annex-17: SMART Indicators for Water Resource Management Sector**Project**

Water Resource Management	Description and OVI	Source of Varification Information	Assumptiom/Result for Desired Information
GOAL	XX,000 holdings of DND area have improved drainage XX,000 farmers of haor area benefited for crop protection, XX,000 MT of rice yield saved XX,000 ha crop area and XX,000 ha fisheries protected benefiting XX,000 farmers	BDWB IDA	
Outcome	Drainage system improved in DND area XXX ha in 5 yrs Damage by early flood reduced in HAOR area XX,000 ha in 5 yrs Riverbank protection improved along Jamuna Right Bank 50 kms	BWDB IDA	Improved structural interventions sustain and not damaged by sudden flood or other calamity particularly at the implementation stage
Output	1. Embankment XX kms 2. Re-excavation of canal XX km 3. Grown XX numbers 4. Bamboo protection XXX numbers	Project Monitoring Report, BWDB	1. Sudden flood do not damage infrastructure 2. Effective early warning system functional
Input	Pre-design feasibility study Designing Pre-work estimates Work execution 1. XX vehicles procured 2. XX manpower deployed & trained 3. XX person month of consultancy support	Budget	1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job or transferred mid-way 4. Good & responsive contractor available

Annex-18: Checklist for Shipping Sector Project
Checklist for Inspection of Ports, Jetties, Dry-Docks & Dredging Works

SN	Aspects	Yes/No	Remarks
1.	Whether contractor is maintaining navigational traffic flow along the existing navigation route through its proper maintenance by providing and maintaining temporary diversions, proper dredging, necessary barricades etc.		
2.	Whether contractor is providing and maintaining signs, markings, lights, barricades etc. in the construction site as per relevant laws, regulation and guidelines.		
3.	Whether contractor has constructed and provided furnished field office to the Engineer and his staff as per contract agreement		
4.	Whether necessary MLSS, computer operator, office equipment and necessary consumables have been provided for the office of the Engineer		
5.	Whether colored photographs of progress of work are being arranged every month by the contractor		
6.	Whether contractor has set up field testing laboratory and provided equipment and consumable stores at site that are necessary to carry out tests as per terms of the agreement for his use as well as for the use of the Engineer		
7.	Whether besides site testing, off site tests are also being carried out by the contractor as per instruction of the Engineer		
8.	Whether contractor has provided qualified laboratory engineers, technicians, assistants, laborers etc. to carry out sampling and testing of materials and other tests.		
9.	Whether contractor is maintaining site register book and supervising officers are recording their comments/ observations in it		
10.	Whether contractor ensuring the safety of the worker and providing sufficient PPEs to the worker		
11.	Whether source approval of material has been taken by the contractor		
12.	Whether compaction test of the final layers have been carried out and test results have been approved by the Engineer		
13.	Whether construction materials are being tested in the laboratory and then used by the contractor according to the instruction and approval of the Engineer		
14.	Whether subgrade drain have been constructed and covered with Geotextile Membrane as per drawings or as per instruction of the Engineer.		
15.	Whether sub base and aggregate base layers have been compacted to achieve the CBR values as per requirement of the contract		
16.	Whether sub base and aggregate base materials have been tested in the site laboratory and results have been okayed by the Engineer.		

SN	Aspects	Yes/No	Remarks
17.	Whether contractor has carried out samples tests of all the materials in the laboratory, to be used in the road, and taken approval of the Engineer.		
18.	Whether all test reports and records, including material tests and collected samples, are systematically maintained.		
19.	Whether contractor has mobilized construction equipment as per contract agreement		
20.	Whether required manpower for execution of the project as mentioned in the DPP is made available		
21.	Whether progress of work in the field matches with the project target mentioned in the Bar Chart/CPM given and approved by the project authority		
22.	Whether financial progress in the field is consistence with the physical progress		
23.	Whether there is any deviation of the contract agreement		
24.	Whether there is any deviation of the approved DPP		
25.	Whether physical and financial target and achievement as reported in the 02 and 03 IMED's formats are in line with progress in the field		

Areas for Quality Checks of Ports, Jetties, Dry-Docks & Dredging Works

SN	Aspects	Yes/No	Remarks
1.	Whether equipment/machinery positioned for the construction of foundation works and sub-structures are using methods/ techniques as mentioned in the drawings/design or as instructed by the engineer.		
2.	Whether in designing the ports Navigational Clearance has been taken into account		
3.	Check Whether in dredging work, is there necessary approval from relevant authority		
4.	Whether approval of all the construction materials in respect to its specifications and concrete mix design and its strength (compressive) have been taken from the competent authority.		
5.	Whether quality (Grade) of deformed M.S. bar to be used in the construction (tensile strength/ elongation test/bend test has been carried out.		
6.	Check the test reports for Setting Time and Compressive Strength of Cement Brand that is being used in the construction or it is as specified in the contract.		
7.	Check whether Artificial Island/Ring Bundh/Diversion has been completely removed after completion of the work		
8.	Check whether the bank protection has been done for the construction site and its surroundings areas.		
9.	Check whether the precast sea armor has been placed as per design and specification		
10.	Check whether RCC work of the foundation has been done as per design and specifications		

SN	Aspects	Yes/No	Remarks
11.	Check whether RCC work of Vertical Break Wall/wave wall/precast concrete has been done as per design and specifications		
12.	Check whether RCC work of Jetty has been done as per specifications		
13.	Check whether dredging work has been done as per specification		
14.	Whether work of Wheel Guard is done as per design and specifications		
15.	Whether Back Filling work is done as per design ad specifications.		
16.	Whether works of approach is done as per design and specifications		
17.	Whether length of Pile has been completed cast as per specifications.		
18.	Whether Curing of construction work is done as per specifications for specified duration.		
19.	Whether CC Block work has been done as per approved design and specifications		
20.	Whether Geo-Textile has been used in CC Block work as per design and specifications.		
21.	Whether Particle Size Distribution (PSD), Aggregate Crushing Value (ACV) and Flakiness Index tests of materials have been carried out		
22.	Whether workability Slump/Cylinder test and Compressive Strength test of concrete have been carried out		
23.	Whether Pile Integrity test and Load test have been carried out by the contractor before commencing the Service Pile work		

Annex-19: M&E Template for Shipping Sector Project**S 1. Activities monitoring template**

SN	Activities	Objectives	Process/ methods followed	Tools/ equipments used	HR involved	Technology transfer process
1	Planning, drawing & Design					
2	Port Development					
3	Jetty construction					
4	Material BBQ preparation and supply planning					
5	Ship building and repairing					
6	Ship building process/ steps					
7	Dredging and reclamation					
8	Maintenance Plan					

S 2. Brief description of process monitoring template

SN	Activities (indicative)	Answers	Responsible person	Physical targets	Achievement	% achieved	shortfalls	Reasons for SF	Suggestions
1.	Port Development								
2.	Jetty construction rehabilitation Number Sq m Capacity MT/day								
3.									
	Ship building and repairing Number Capacity MT								
4.									
5.	Capital Dredging Cum per year								

	Low-tide channel depth –m draft vehicle										
6.	Maintenance dredging Cum per year Low-tide channel depth –m draft vehicle										
7.	Dock marine workshop construction										
8.	Rehabilitation of ferry Number										
9.	Construction of container terminal Number Handling Capacity/ MT/day										
10.	Construction of Deep sea port operation infrastructure Location Components										

S 3. Template for Port development monitoring

SN	Description of Activities	Equipments	Targets	Methods followed	Achievement	Time/ duration	Handling Capacity	Procurement Methods	Installation status	Functioning status	Community support	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Pre-constructio n stage											
2.	Constructio n stage											

SN	Description of Activities	Equipments	Targets	Methods followed	Achievement	Time/duration	Handling Capacity	Procurement Methods	Installation status	Functioning status	Community support	Risks/ challenges and suggestions
3.	Post construction stage											

S 4. Template for dredging activities M&E

SN	Description of Activities	Equipments	Targets	Achievement	Methods followed	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

S 5. Template for Jetty Construction and maintenance

SN	Description of Activities	Methods followed	Targets	Achievement	Equipments	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/ challenges and suggestions
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Drawing and Design development														
2	Inspection and test plan														
3	BoQ preparation and supply planning														

SN	Description of Activities	Methods followed	Targets	Achievement	Equipments	Time/duration	Handling Capacity	Procurement Methods	HR involved	Installation status	Functioning status	Digital reading status	Community support	Ongoing M&E system (software system)	Risks/challenges and suggestions
4	Land based works														
5	Marine based work														
6	Materials based works														
7	Recruitment														
8	Training and capacity building														
9	Necessary infrastructure														
10	HR hiring status														

S 7. Result monitoring template

SN	Outcome	Narrative Summary	OVI	Targets	Economic implication	Environmental implication	Total budget	Risks
1	Increased area cargo handling MT/Year							
2	Increase Export goods handling MT/ Year							
3	Increase Import goods handling MT/ Year							

Annex-20: SMART Indicators for Shipping Sector Project

Shipping Sector	Description and OVI	Source of Varification Information	Assumptiom/Result for Desired Information
GOAL	Reduce Balance of Trade Deficit and dependence on overseas development assistance	BBS, BSC, IDA, ADB	
Outcome	Increase volume of trade by Smooth handling of import and export XX.XXX MT/Yr to XX.XXX MT/Yr	BBS, BSC, IDA, ADB	International terms of trade remain favorable
Output	<ol style="list-style-type: none"> 1. Develop jetty in the port XX numbers handling XX,000 MT/yr 2. Capital dredging XX,000,000 cmyrs 1-2 3. Maintenance dredging XX,000,000 cm/yryr 3 onwards 4. Build XX, ships of total XXX,000 MT carrying capacity 5. Rebuild XX, ships of total XXX,000 MT carrying capacity 	Project Monitoring Report	<p>Labor unrest within control Good political environment</p> <p>Contractor response favorable</p>
Activities	<ol style="list-style-type: none"> 1. Procure dredger XX numbers 2. Procure equipment 3. Procure Vehicles 4. Engage manpower XX persons 5. Consultancy XXX person months 6. Studies XX numbers 	Input/ Budget	<ol style="list-style-type: none"> 1. Fund released in time 2. Procurement not delayed and of good quality 3. Recruited and trained staff do not leave job or transferred mid-way 4. Good & responsive contractor available

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