Environmental Impact Assessment of Natural Gas Development in Bangladesh

A Project Report

by

Delawar Bakht

BANGLADESH UNIVERSITY OF ENGINEERING
AND TECHNOLOGY, DHAKA.

February, 1998

Environmental Impact Assessment of Natural Gas Development in Bangladesh

A Project Report

by

Delawar Bakht

BANGLADESH UNIVERSITY OF ENGINEERING
AND TECHNOLOGY, DHAKA.

February, 1998

Environmental Impact Assessment of Natural Gas Development in Bangladesh

A Project Report

by

Delawar Bakht

Submitted to the Department of Civil Engineering,
Bangladesh University of Engineering and Technology, Dhaka
in partial fulfilment of the requirement of degree
of
MASTER OF ENGINEERING IN CIVIL ENGINEERING

February, 1998

Environmental Impact Assessment of Natural Gas Development in Bangladesh

A Project Report

by

Delawar Bakht

Approved as to Style and Content by

(Dr. M. Firoze Ahmed)
Professor,
Civil Engineering Department
BUET, Dhaka

Chairman
(Supervisor)

(Dr. Nooruddin Ahmed)
Professor,
Chemical Engineeering Department
BUET, Dhaka.

Member

(Dr. A.B.M. Badruzzaman)
Associate Professor,
Civil Engineering Department
BUET, Dhaka.

Member

DECLARATION

I do hereby declare that the project work reported herein, has been performed by me and this work has neither been submitted nor is being concurrently submitted in candidature for any degree at any other university.

DELAWAR BAKHT

AKNOWLEDGEMENT

At the outset, the author acknowledges the blessings of Almighty Allah, The Beneficent, the Merciful for enabling him to complete the study successfully.

The author wishes to express his sincere and profound gratitude to Dr. M. Firoze Ahmed, Professor, Civil Engineering Department, Bangladesh University of Engineering and Technology (BUET) for his active support, advice, guidance and supervision throughout the study. Without his cordial guidance and invaluable suggestions at every stage, this work could never have been materialised.

The author is also thankful to Dr. Nooruddin Ahmed, Professor, Department of Chemical Engineering and Dr. A.B.M. Badruzzaman, Associate Professor, Department of Civil Engineering, BUET who were the members of the Board of Examiners for their useful comments and valuable suggestions.

Thanks are also due to the Management and Colleagues of Bangladesh Oil, Gas and Mineral Corporation (Petrobangla) and Titas Gas T and D Co. Ltd. (TGTDCL) for providing necessary data and facilities to complete this work. Thanks are particularly expressed to Major Md. Muqtadir Ali (Rtd.), Managing Director TGTDCL, for his kind permission to undertake the course and for continuous support until its completion.

Appreciation is also accorded to Dr. Md. Alee Murtuza, Professor, Civil Engineering Department, Dr. Ainun Nishat, Professor, Water Resources Engineering Department, Dr. M. Mazharul Haque, Professor and Dr. Mujibur Rahman, Professor, Civil Engineering Department and Dr. Aminul Haque, Professor, Electrical Engineering Department of BUET and Dr.M.R.Ullah former Head, Department of Chemical Engineering, Sultan Qaboos University, Oman for their inspiration and support in conducting this study.

Author is highly indebted to Mr. Mozammel Haque, Deputy General Manager, Environment and Safety Division of Petrobangla and Mr. Hasan Zahid, Publicity Officer, Department of Environment for spontaneously providing the invaluable reference materials required for the study.

On this auspicious occasion, I would also like to gratefully acknowledge the support and inspiration of Dr. Fred Otto and Dr. Laird Wilson of the University of Alberta, Canada and Management of the Institution of Gas Engineers, UK for inspiring to work for the course and to complete the same at the fastest possible opportunity.

It would be unjust, if the untiring efforts and contribution of Mr. Badruddin Ahmed Manager, Co-ordination to Managing Director, TGTDCL and Mr. Mohammed Aman Ullah of Marketing Division, TGTDCL in assisting the computer works and that of Engr. Prodip Ranjan Kundu of Metro Sales Department-3 of TGTDCL in sorting the data, tables, maps and figures presented in the report are not also sincerely acknowledged. Finally, the direct and indirect contribution of my father, Al-haj Dr. Firoze Bakht, my wife Nazneen and Daughters Sahira and Zafreen has no less been significant in the task and my warm greetings are to them too.

ABSTRACT

The history of natural gas development within the territory of Bangladesh dates back to 1910 when exploration and drilling activities commenced and so far, with a break during the world wars, went on to the discovery of a number of gas fields both on shore and off shore areas . This effort has been continuing with and without foreign collaboration. In the mean time. Petrobangla and Bangladesh Petroleum Corporation within the framework of the Ministry of Energy and Mineral Resources are supplying over 800 MMCFD (million cubic feet per day) of gas and over 5000 TPD (tons per day) of oil respectively to serve the daily domestic commercial and industrial needs of over 124 million people of Bangladesh.

Oil and gas sector, particularly natural gas sector is currently drawing ambitious programs to execute development projects to meet the ever increasing number of consumers including gas based power and fertiliser plants. Obviously, hectic activities in terms of seismic survey, drilling, exploration, production, processing and pipelines are in progress causing environmental impacts of different dimension and magnitude. The process of environmental evaluation before taking up any development project for operating and expanding existing ones has also been started following promulgation of environmental law of 1995. This is because EIA has been made mandatory for all petroleum and power sector projects. Accordingly, it is high time now that an environmental impact assessment be made on this sectoral issues. Further, Bangladesh is a disaster prone country and the natural conditions have made her subject to disasters and environmental hazards. Industrial and other pollution and hazards should no further be allowed to exceed the limits in the context of ensuring sustainable development of the sector.

Eventually, bearing these factors in mind, the study presented in this report has been attempted to cover identification of both positive and negative environmental impacts of natural gas exploration, production, distributions and consumption. The study includes evaluation of the magnitude of these impacts on environmental components of natural resources, socio-economic conditions and quality of life as well as delineation of possible mitigation measures to eliminate, reduce or offset the negative impacts thereof. This has been further reinforced with environmental management and monitoring aspects for a possible demonstration of compliance with any current and future standards, so that these are applied to the process of minimisation of relevant pollution and hazards and allows planners and decision makers to take these into consideration in project implementation. This report further includes two case studies, one to highlight the hazardous drilling failure and consequential environmental damage resulted from Magurcharra gas field, an example of severe negative impact in the natural gas development history of Bangladesh and the other case of fuel wood/kerosene conversion to natural gas leaving an appreciable positive impact of use of natural gas over wood fuel.

Conclusion has there after been drawn on the basis of the environmental base line of Bangladesh together with experience on environmental concern relating to natural gas vis-a-vis current regulatory process. Finally, recommendations have been made on the salient issues pertaining to environmental control with due emphasis on decontamination and reclamation process of the age old pipelines and plants which have never been subjected to such environmental impact assessment ever before.

Table of Contents

LIST OF TABLES

LIST OF TABLES

LIST OF MAPS

LIST OF MAPS

TERMINOLOGY AND SYMBOLS

Symbol	Terminology
A-B	Ashuganj to Bakhrabad
ACF	Assistant Conservator of Forest
ACGIH	American Conference of Government
ACM	Asbestos Containing Material
ADB	Asian Development Bank
AEAM	Adaptive Environmental Assessment and Management
BBL	Barrel of 36 gallons
BFA	Bakhrabad Franchise Area
BGSL	Bakhrabad Gas Systems Ltd.
BMGSR	Bangladesh Mineral Gas Safety Rules
BMM	Bureau of Mines and Minerals
BMM	Bureau of Mines and Minerals
BOD	Biochemical Oxygen Demand
BPC	Bangladesh Petroleum Corporation
BPDB	Bangladesh Power Development Board
BPI	Bangladesh Petroleum Institute.
CNG	Compressed Natural Gas
DESA	Dhaka Electricity Supply Authority
DN	Diameter Nominal
EES	Environmental Evaluation System
EIA	Environmental Impact Assessment
EMU	Energy Monitoring Unit
GNP	Gross National Product
GSB	Geological Survey of Bangladesh
GTCL	Gas Transmission Company Limited
HV	High Voltage
IE	Inspectorate of Explosives
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IOC	International Operating Company
JGTDSL	Jalalabad Gas Transmission & Distribution System Ltd.
KM	Kilo Metre
Kpa	Kilo Pascal
KV	Kilo Volt
LPG	Liquefied Petroleum gas
LTS	Low Temperature Separator
MMCFD	Million Cubic Feet per Day
MSDS	Material Safety Data Sheet
MW	Mega Watt

N/A	Not Applicable
NDT	Non Destructive Testing
NGL	Natural Gas Liquid
NGO	Non-Government Organisation
NGTP	Natural Gas and Thermoelectric Project
N-S	North-South
NS	Not Satisfactory
NTC	National Tea Company
OCGT	Open Cycle Gas Turbine
PC	Power Cell
PCB	Poly Chlorinated Biphenyl
PCD	Production Concession Division
PIA	Programmatic Impact Assessment
POL	Petroleum Oil Lubricant
PPL	Pakistan Petroleum Limited
PSC	Production Sharing Contract
Psig	Pounds per Squire Inch Gage
REB	Rural Electrification Board
ROW	Right of Way
RPGCL	Rupantarita Prakritik Gas Company Ltd.
S	Satisfactory
SCADA	Supervisory Control and Data Acquisition
SGFL	Sylhet Gas Fields Ltd.
TCF	Trillion Cubic Feet
TGTDCL	Titas Gas Transmission and Distribution Company Ltd.
TLV	Threshold Limit Volume
	Industrial Hygienists

CHAPTER -1
INTRODUCTION

1.1 General

Consideration of adequate energy supply in Bangladesh , a third world country with low per capita income, high population growth and low literacy rate for a faster development calls for an immediate and close look for the development of a balanced energy of both non-renewable and renewable origins. Inputs in terms of investment, technology and infrastructure should therefore be viewed with utmost importance towards attaining a prioritised and time bound out put.

Natural bounties in Bangladesh in respect of oil and gas resources are therefore in the process of discovery and exploitation since the fifties when gas reserves in the hill district of Sylhet was put to use in the Fenchuganj Fertiliser Factory. There after more and more gas fields have been identified and exploited gas has been transmitted to selected cities and towns in the country for generation of electricity, production of fertiliser and for making the same available for domestic, commercial and industrial uses. This has reduced dependence on other fuel like petroleum products, coal, timber and such items that were used in the past. Accordingly, in the mean time, a large number of oil and gas infrastructure projects in terms of exploration, drilling, production, processing, transportation, distribution and utilisation have been executed and now being operated with involvement of thousands of professional experts and other manpower to look after these facilities.

Further, in the process of accelerated exploration of these natural bounties, the country has in the meantime adopted new laws and amended existing ones to suit the prevailing and future demands of the sector. Following adoption of policies for free enterprise, Bangladesh has already opened up the landmass and the sea coast for the purpose to foreign investors who have both expertise and technical and financial resources for exploration works. This process may yield good results in terms of increased revenue earnings and more expenditures in development and thereby expedite the process of well being of the people at large.

But the precious land with all its flora & fauna must not be devastated beyond recovery in the bid to exploit resources as the sound ecological and environmental management is very much owed to the future generation. Further this must be well guarded against repetition of mishaps such as that happened in Magurchhara. In fine, what is highly needed now is to ensure a balanced trade-off between the process of development and protection of environment through the established and innovative actions in terms of planning, consultative, compliance, corrective and mitigative and research oriented responses to this end.

1.2 Objectives of the Study

The basic objective of this report is to identify the natural gas development activities in Bangladesh and assess the impact of the proposed development of new projects, operations of the existing ones and to determine whether the operations are acceptable in environmental terms. The assessment is based upon identification of natural, physical and socio-economic features of

the environment likely to be affected by new project facilities e.g. drilling, process plants, pipeline system and utilisation of natural gas including routine operations of the existing system associated with the execution and operations program .

Further, it is also intended to highlight the environmental components that may be at risk and /or are adversely affected by potential accidental events resulting from in adequacy in design, improper practice and/or mechanical failures.

In this process of environmental impact assessment, efforts have also been made to outline the extent to which any potential impacts from routine operations and accidental events may be mitigated. Accordingly, the other objective of this study is to show that with appropriate monitoring of any project facility in natural gas development program, satisfactory mitigation may occur in the design, planning and/or operation of the programme including selection of suitable alternatives.

The frequency of major accidental events is predicted to be law in general and it is presumed that there shall not be much unacceptable risks from the proposed operations. However, if the operations are conducted in accordance with standards and the appropriate mitigative measures are followed in time, any development and operational program should be acceptable in environmental terms.

1.3 Scope of the study

In order to apply an appropriate degree of attention to all of the significant impacts associated with any proposed project, it has been necessary to define the extent of the study area to be examined. The study area varies considerably depending upon the impact type under consideration. For instance, health and safety impacts are largely confined to within the site boundary itself whilst a preliminary atmospheric dispersion modelling exercise has suggested that a radius of 10 km should be used for the purposes of the air quality impact assessment.(MEP,1996). Following data in Tabular forms were found essential for due considerations :

Atmospheric Emission Limits of Bangladesh and World Bank (Table-1.1);
Ambient Air Quality Standards for Bangladesh (Table-1.2);
World Health Organisation and World Bank Ambient Air Quality Guidelines (Table-1.3);
Bangladesh and World Bank Liquid Effluent Limits (Table-1.4);
Additional Bangladesh standard Values for Industrial Effluents (Table-1.5) and
Ambient Noise Limits in Decibels (dbd) (Table-1.6).

Table - 1.1 Atmospheric Emission Limits for Bangladesh and World Bank

Parameter	Bangladesh Emission Limit	World Bank Emission Guide
Sulphur dioxide		
tons/day	-	100 (1994)
mg/Nm^3	120	2000(1995) (a)
tonnes/day/MW	-	0.10 (1994)
Nitrogen oxides		
mg/Nm^3	-	240(1995)(a)
ng/J	150	65
ppm		25*
Carbon monoxide		-
ppm	150(b)	-
Suspended particulate matter mg/Nm^3	150(b)	50

(WBD, 1997)

a) At 6% oxygen by volume in dry flue gas.
b) Legislation quoted for a gas fired boiler
* To be recalculated on appropriate conversion, if applicable

Table 1.2 Ambient Air Quality Standards for Bangladesh

Area	Ambient concentration in micro-grams per cubic metre			
	Category	SO_2	CO	NO_x
A	Industrial and mixed use	120	5000	100
B	Commercial and mixed use	100	5000	100
C	Residential and rural	80	2000	80
D	Sensitive	30	1000	30

(WBD, 1997)

Table 1.3 World Health Organisation and World Bank Ambient Air Quality Guidelines

Parameter	Averaging period	World Health Organisation Guideline (1996)	World Bank (1995) Guideline	Notes to World Bank (1995) Guidelines
Sulphur dioxide	Annual	50 $\mu g.m^{-3}$	80 $\mu g.m^{-3}$	annual median
	24-hour	125 $\mu g.m^{-3}$	250$\mu g.m^{-3}$	not to be exceeded >7 times/year
	1 hour	-	-	-
Nitrogen oxides (as nitrogen dioxide)	Annual	40-50 $\mu g.m^{-3}$	-	-
	24-hours	none given	-	-
	1-hour	200 $\mu g.m^{-3}$	400 $\mu g.m^{-3}$	200 not to be exceeded >7 times/year
Carbon monoxide	8-hour	10 ppm	-	-
	1-hour	25 ppm	-	-

(WBD, 1997)

Table 1.4 Bangladesh and World Bank Liquid Effluent Limits.

Parameter	Bangladesh Limit (Standard values into land surface water)	World Bank Guidelines
pH	6 to 9	6 to 9
BOD5	50	50 mg/litre
Heavy metals, total	5 mg/litre (1)	10 mg/litre
Oil and Grease	-	20 mg/litre
Total suspended solids	150 mg/litre	60 mg/litre
Chloride	600 mg/litre	-
Temperature	40°C summer 45°C winter	5oC above ambient temperature >28°C (at the edge of a designated mixing zone)

(WBD, 1997)

Table 1.5 Additional Bangladesh standard Values for Industrial Effluents

Parameters/determinants	Unit	Standard Value		
		Discharge into inland and surface water	Discharge into public sewer	Discharge on land (irrigable and non irrigable)
Acidity	mg/L	NYS	NYS	NYS
Alkalinity (total)	mg/L	NYS	NYS	NYS
Aluminium	mg/L	1	1	1
Ammonia (free as NH3)	mg/L	5	5	15
Cadmium	mg/L	0.05	0.5	0.5
Chlorine (free)	mg/L	1	1	1
Chlorine (residual)	mg/L	1	1	1
Chromium	mg/L	0.1	1	1
COD	mg/L	200	400	400
Coliform (faecal)	mg/L	100	100	100
D.O	mg/L	4.5-8	4.5-8	4.5-8
Zinc	mg/L	5	5	10

(WBD, 1997)

Table 1.6 Ambient Noise Limits in Decibels (dbd)

Category of Noise Receptor	Day Time	Night Time
Residential	55	45
Commercial	65	55
Industrial	75	70
Monitoring		

(WBW, 1994).

In general the concept of pollution in any environmental evaluation has been based on the result of the absence or presence of a pollutant in a part of the environment where it is considered to have deleterious effects. Pollution usually generates from human activities in

respect of getting rid of wastes at the least possible cost and occurs when as a result of such activities, enough of a substance is present in the environment to have harmful effects. Many substances which can become pollution are present naturally in the environment in lesser amounts and may be beneficial or even essential to it. No substances or form of energy is automatically a pollutant as this depends upon its effect which in turn depends on when in the environment it has been liberated. Specifically, for example, air pollution has been defined as the presence in the outdoor atmosphere of one or more contaminants such as dust, fumes, gas, mist, odour, smoke, or vapour in quantities, of characteristics, and of duration, such as to be injurious to human, plant or animal life or to property, or which unreasonably interferes with the comfortable enjoyment of life and property (Canter, 1977).

It was also noted that Bangladesh is in natural gas operations for last 30 years but the previous records of any environmental assessment could not be available and therefore could not be presented in this report except for the ones done in the recent past. Further, though a case study on Magurcharra incident has been presented in this report, any official findings could not be referred to because of the fact that the report of the probe committee is yet to be published.

1.4. Organisation of the Study

The basis of the objectives of the study, the study area, the concept of environmental pollution, and the organisation of the study have been outlined in chapter-1 and the overall content of the report comprises seven chapters in total.

Chapter 2 include present state of the art covering oil and gas sector demand projections and development projects taken there of including status of EIA of development projects in Bangladesh in general.

The procedure and methodology adopted in reviewing the oil and gas sector activities, including organisational framework and statistical features have been presented in chapter 3. Further, reference has also been provided to case studies made in respect to the positive & negative impacts of the sectoral activities in chapter 3 of the report.

Chapter 4 has been dedicated to environmental consideration in energy development process with particular reference of the natural gas and gas based industries and power plants including evaluation of the environmental impacts in economic terms. This chapter covers details of the case study on the incident on Magurcharra gas field explosion and consequential damage and degradation of the environment including environmental restoration and reclamation with possible mitigation. This chapter also covers energy related environmental issues in Bangladesh with positive and negative impacts.

Generic environmental impacts at different phases of the development and expansion process of the natural gas industry including EIA required and indication of the acceptable alternatives as well as environmental planning of new facilities have been provided at chapter 5.

Chapter 6 is primarily based on the environmental mitigation and monitoring measures including health & safety requirements for the new projects, alternatives and uncertainties. This chapter has further included EIA regulatory process for industrial projects particularly in respect of the oil and gas sector projects in Bangladesh. Further, different aspects of environmental management with due coverage of the decontamination and restoration have also been provided in this chapter.

Finally, conclusions drawn on the findings of the study along with due recommendations have been placed in the last chapter i.e. chapter 7.

CHAPTER - 2

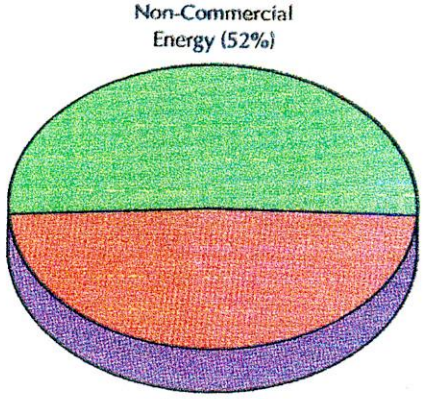
PRESENT STATE OF THE ART

2.1. Gas Supply and Demand Projections

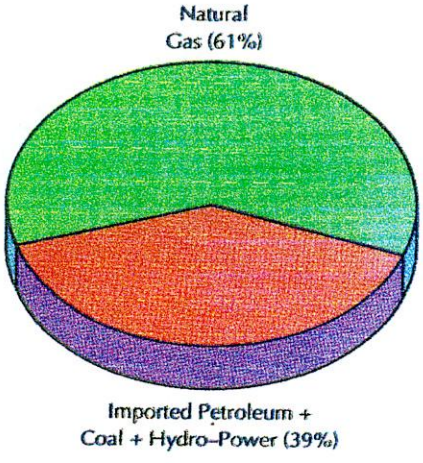
Bangladesh is blessed with substantial reserves of natural gas. At present 61% of the total commercial energy requirements is met by natural gas (Fig 2.1). It is expected Act about 1.5 TCF of natural gas will be withdrawn from about 10 TCF of known reserves during the next 10 years.

The existing and proposed extension to the gas transmission system in Bangladesh with the general principle of gas supply projections is outlined in the National Energy Policy, 1995. However, gas demand projections prepared by Petrobangla show that fertiliser sector demand remaining more or less constant, the power sector alone will have a demand in excess 700 MMCFD of gas by the year 1998/9, when the total maximum demand will be approximately 1400 MMCFD. By the year 2005, it is anticipated that the maximum demand in the power sector will be approximately 1050 MMCFD and the total demand will be in the region of over 1500 MMCFD.

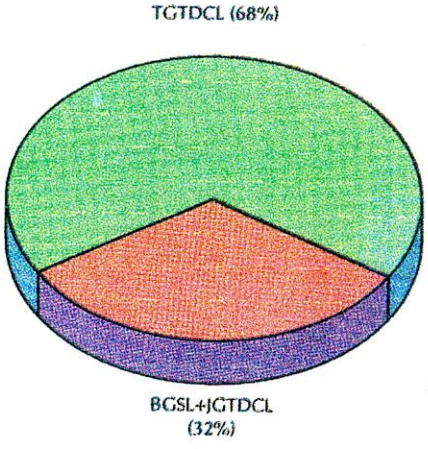
Energy Usage Scenario of Bangladesh



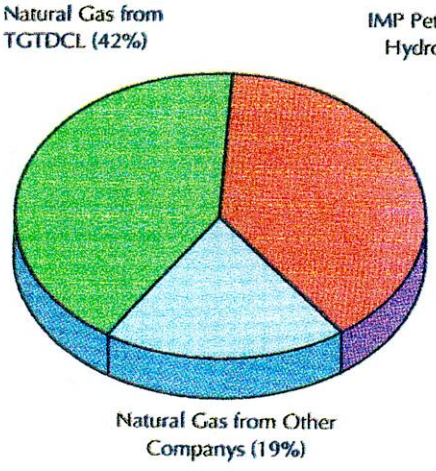
Total Energy Usage Scenario



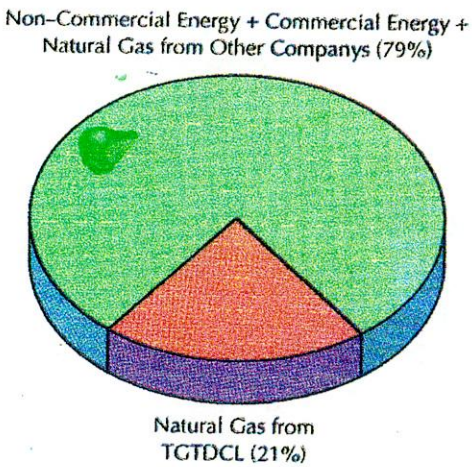
Commercial Energy Usage Scenario



Natural Gas Usage Scenario



Contribution of TGTDCL in Total Commercial Energy Usage



Contribution of TGTDCL in Total Energy Usage

Figure 2.1 Energy Usage Scenario of Bangladesh

(TGTDCL, 1997)

2.2. Power Sector Demand Supply Situation

The overall energy balance of Bangladesh has been shown in Table-2.1 and projected demand for commercial energy and electricity has been shown in Table-2.2.

Table 2.1 Bangladesh Overall Energy Balance in 1990-1991

(Thousand Tons of oil equivalent)

	Coal	Crude Oil	Condensate	Petroleum Products	Crude Oil Condensate & Petroleum Product	Natural Gas	Hydro Power	Nuclear	Electricity	Total Commercial Energey
Indigenous production	-	16	50	-	66	4510	280	-	-	4856
Flare & Loss	-	-	-	-	0	-	-	-	-	0
Imports	125	1205	-	725	1930	-	-	-	-	2055
Exports	-	-	-	(227)	(227)	-	-	-	-	(227)
Bunkers	-	-	-	(17)	(17)	-	-	-	-	(17)
Stock change	-	(83)	-	(8)	(91)	-	-	-	-	(91)
Primary energy requirement	125	1138	50	473	1661	4510	280	-	-	6576
Statistical difference	-	-	-	917)	(17)	-	-	-	-	(17)
Oil refining	-	(1138)	(50)	1174	(14)	-	-	-	-	(14)
Gas Manufacture	-	-	-	-	0	-	-	-	-	0
Power Generation:										
Fuel input	-	-	-	(54)	(54)	(2126)	-	-	-	(2180)
Power generated	-	-	-	-	-	-	(280)	-	711	431
Transmission & distribution loss	-	-	-	-	-	-	-	-	(254)	(254)
Energy sector own use & loss	-	-	-	-	-	(222)	-	-	(38)	(260)
Net supply available	125	-	-	1576	1576	2162	-	-	419	4282
Net domestic consumption	125	-	-	1576	1576	2162	-	-	410	4282
Residential	-	-	-	395	395	263	-	-	119	777
Commerce Services	-	-	-	-	-	82	-	-	37	119
Industrial	123	-	-	198	198	405	-	-	194	920
Transport	-	-	-	777	777	-	-	-	-	777
Agriculture/others	2	-	-	206	206	-	-	-	69	277
Non-energy use-	-	-	-	-	-	1412	-	-	-	1412

(Islam, 1993)

Notes by BBS:
Indigenous Production (+), Production losses (-), Imports (+), Exports (-), Stock change (+), Primary energy requirement (PER)
Data Source compiled by BBS : Petrobangla, Power Development Board, Foreign Trade Section (BBS), Bangladesh Petroleum Corporation

Table 2.2 Projected Demand for Commercial Energy and Electricity (Low economic growth scenario)

	1990	1995	2000	2005	2010	2015	20201
Population (million)	113	125	137	149	161	174	186
GNP Growth rate	4.5%	5.4%	6.4%	7.2%	7.7%	8.0%	8.0%
Per capita GNP ($)	190	217	262	334	441	596	816
Energy coefficient	1.62	1.37	1.37	1.37	1.08	1.08	1.08
Energy Growth rate	7.3%	7.4%	8.8%	9.9%	8.3%	8.6%	8.6%
Per capita k.o.c.	q56	72	96	137	201	280	395
Total energy (M.t.o.e.)	6	9	13	20	33	49	74
Total energy (PJ)	270	382	561	874	1388	2080	3146
MJ/$ GNP	13	14	16	18	20	20	21
Total GWH of electricity	8271	12377	19120	28280	40061	54570	82544
Per capita kWh	73	99	139	190	248	314	443
peak load MW (Gross)	1717	2523	5664	7885	10558	15705	

(MEP, 1996)

Note 1 It is estimated that commercial energy represents only 1/3 of the total energy consumed in Bangladesh.

Note 2 Commercial energy growth rate forecast are high and certainly supported by a strong but rather stable non commercial energy base. however coping with such growth rate means the ability to timely mobilise the necessary finance for building the infrastructure.

Note 3 Electricity demand prospects are slightly higher than those given by Acres (Draft final report, April 1995) in their reference forecast:

Gross generation

1995	10771 Gwh
2005	24161 Gwh
2015	52063 Gwh

At present, three electrical utilities operate in Bangladesh with the largest and most significant being the Bangladesh Power Development Board (BPDB) which is wholly responsible for the country's electricity generation. In addition to having the entire electrical generating capacity of the country, BPDB also own the majority of the high voltage (HV) grid serving approximately 25% of the country's commercial and domestic consumers in all urban centres apart from Dhaka. In 1994, BPDB supplied 3015.8 Gwh to over 1 million direct end users and accounted for almost 50% of the country's electricity sales. In 1991, the Dhaka Electricity Supply Authority(DESA) was established with the objective of taking responsibility for the distribution of electricity within Dhaka and its immediate surroundings. The Rural Electrification Board (REB) buys most of its power from the BPDB although a portion of the same is distributed via the DESA system. The REB system operates at either 33 kV or 11 kv. (MEP,1996).

2.3. Existing Generation Capacity

Bangladesh currently has an installed electrical capacity of 2497 MW, of which only 2376 MW can be considered as the available or 'derated capacity'. In addition to this installed capacity, a number of power plants are currently under construction, or are committed to be built. Those currently under construction include the second thermal unit at Rauzan which is 15 km east of Chittagong. A sixth 210 MW thermal unit of Ghorasal is expected to be in service by 1998 whilst a fifth 210 MW steam turbine will be in service at Siddhirganj by 1999.

In order to supplement the existing three 33 MW gas turbine units at the Haripur Open Cycle Gas Turbine (OCGT) plant, a fourth 33 MW unit is envisaged, together with two 38 MW steam turbines to convert the station to combined cycle operation. It is anticipated that the installation of the fourth gas turbine and conversion to combined cycle would be completed by 1999.

Finally, ADB funding has been arranged for a plant consisting of two 30 MW gas turbine units at Mymensigh and this project is anticipated to be the first semi-private generating plant in Bangladesh when it enters service in 1998/1999. Simultaneously Private Power Stations under construction in Khulna areas will have options to conversion to natural gas as soon as Shahbazpur Gas Field is made operational. Evaluation of electricity generating capacity and peak demand in Bangladesh has been shown in Table-2.3 and Figure 2.2 respectively (MEP,1996).

Table 2.3 Evaluation of Electricity Generating Capacity in Bangladesh.

	Net	Fiscal/Years											
	capacity NW	93/94	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	09/10
Area 1													
BARISAL	40	40	40	40	40	40	40	40	40	40	40	40	40
BHERAMARA	60	60	60	60	60	60	60	0	0	0	0	0	0
KHULNA	90	90	90	90	90	90	90	90	90	90	90	90	90
	28	28	28	28	28	28	28	0	0	0	0	0	0
	28	0	0	0	28	28	28	0	0	0	0	0	0
	50	0	0	0	50	50	50	50	50	50	50	50	0
	200	0	0	0	0	0	0	200	200	200	200	200	200
BANGLADESH	71	71	71	71	71	71	71	71	71	71	71	71	71
	71	0	0	0	0	0	0	71	71	71	71	71	71
	526	0	0	0	0	0	0	0	0	0	263	526	526
	2*86	0	0	0	0	0	0	0	0	0	0	0	0
BARAPUKURIA	230	0	0	0	0	0	0	115	230	230	230	230	230
SAIDPUR	20	20	20	20	20	20	20	20	20	20	20	20	0
RANGPUR	20	20	20	20	20	20	20	20	20	20	20	20	0
Sub-total Area 1		329	329	329	407	407	407	677	792	792	1055	1318	1188
Area 2													
Sub-total Area 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 3													
HARIPUR	90	90	90	90	90	0	0	0	0	0	0	0	0
	30	0	0	30	30	0	0	0	0	0	0	0	0
	208	0	0	0	0	208	208	208	208	208	208	208	208
SIDDHIRGANJ	50	40	40	40	40	40	40	0	0	0	0	0	0
	30	30	0	0	0	0	0	0	0	0	0	0	0
	200	0	0	0	0	200	200	200	200	200	200	200	200
	200	0	0	0	0	0	0	0	200	200	200	200	200
MEGHNAGHAT	526	0	0	0	0	0	0	0	263	526	526	526	526
Sub-total Area 3		160	130	160	160	448	448	408	871	1134	1134	1134	1134
Area 4													
KAPTAI	180	180	180	180	180	180	180	180	180	180	180	180	180
RAUZAN	200	200	200	200	200	380	380	380	380	380	380	380	380
	180	0	0	0	0	0	0	0	0	0	0	0	0
SIKALBAHA	50	50	50	50	50	50	50	50	50	50	50	50	50
	56	0	0	0	56	56	56	56	56	56	56	56	56
CHITTAGONG	3*860	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total Area 4		430	430	430	486	666	666	666	666	666	666	666	666
Area 5													
GHORASAL	91	91	91	91	91	91	91	91	91	91	91	91	91
	600	400	600	790	790	790	790	790	790	790	790	790	790
	190	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total Area 5		491	691	691	881	881	881	881	881	881	881	881	790
Area 6													
MYMENSINGH	60	0	0	0	60	60	60	60	60	60	60	60	60
Sub-total Area 6		0	0	0	60	60	60	60	60	60	60	60	60
Area 7													
ASHUGANJ	100	100	100	100	100	100	100	100	100	100	100	100	100
	425	425	425	425	425	425	425	425	425	425	425	425	425
	90	74	74	74	74	74	74	74	74	74	74	74	74
	60	56	56	56	56	56	56	56	56	56	56	56	56
Sub-total Area 7		655	655	655	655	655	655	655	655	655	655	655	425
Area 8													
FENCHUGANJ	90	0	90	90	90	90	90	90	90	90	90	90	90
SYLHET	20	20	20	20	20	20	20	20	20	20	20	20	20
	86	0	0	0	0	0	86	86	86	86	86	86	86
SHAHJIBAZAR	45	45	45	79	79	79	79	79	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	20	20	20	20	20	20	20
Sub-total Area 8		65	155	189	189	189	295	295	216	216	216	216	216
Others		11											
	86 each	0	0	0	0	0	0	0	0	0	0	86	258
	86 each	0	0	0	0	0	86	172	172	258	344	430	1462
	1540	0	0	0	0	0	0	0	0	0	0	0	1578
Sub-total others		11	0	0	0	0	86	172	172	258	344	516	3298
Grand total NW		**2141**	**2390**	**2454**	**2838**	**3306**	**3498**	**3814**	**4313**	**4662**	**5011**	**5446**	**777**

(MEP, 1996)

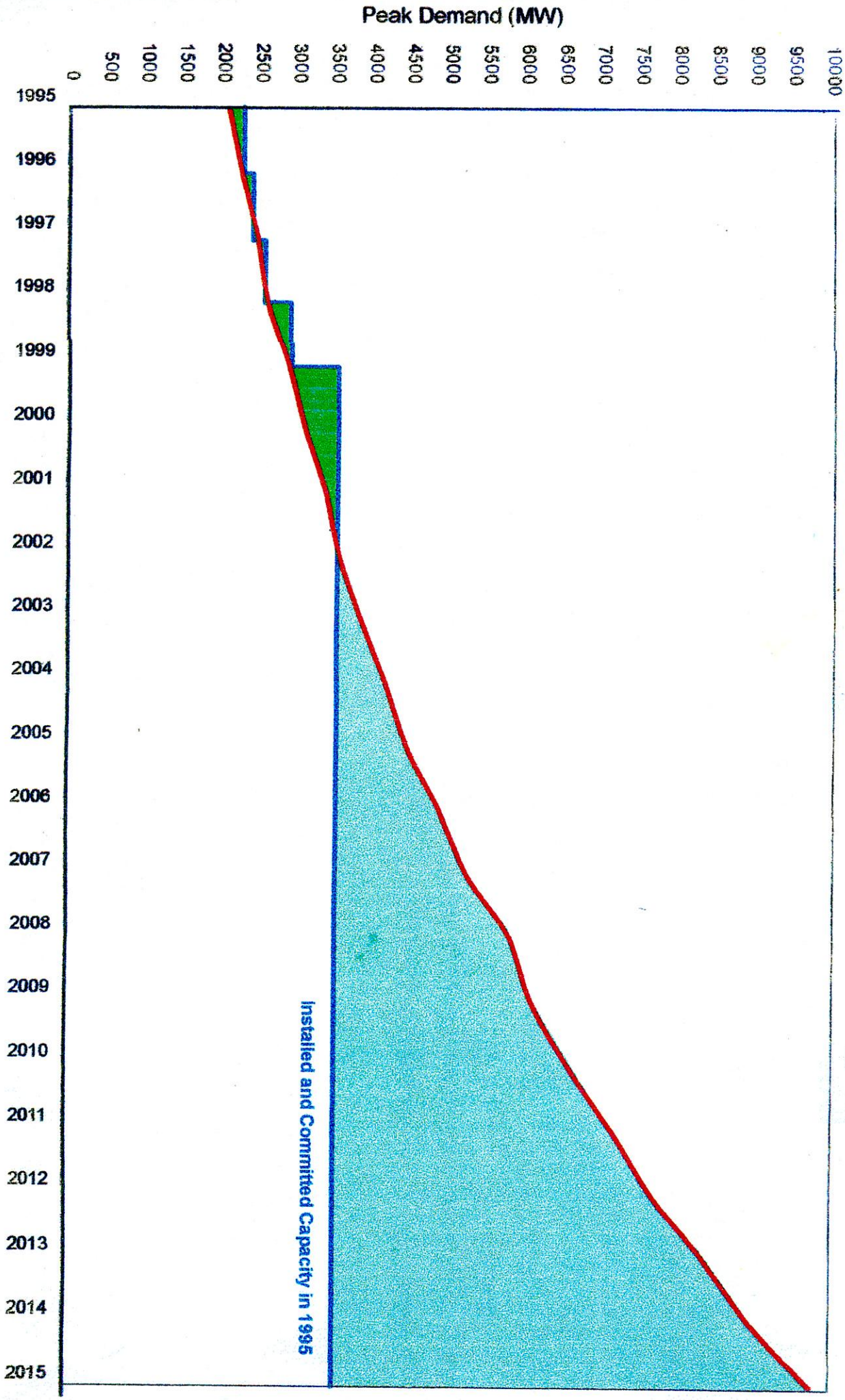


Figure 2.2 Peak Demand – 1995-2015

2.4. Current Oil & Gas Development Projects

Project Description

Kailashtilla Field Evaluation and Gas Development Well No. 4
Beani Bazar and Fenchuganj Field Development
Ashuganj NGL Plant
Shahbazpur Field Evaluation and 2 Development Well Drilling
Exploration , Evaluation and Development Well Drilling at Shalda River Field
Shalda-Bakrabad Transmission Pipeline
Padma Oil Installations
LPG Import and Bottling Plants
2nd Refinery Installations Feasibility
Eastern Refinery 2nd Fractionation Plant
Strengthening of the Hydrocarbon Unit of the Ministry of Energy and Mineral Resources
Kailashtilla LPG Plant
Greater Titas 2nd Phase Distribution Project
Gas Sector Safety
3rd Natural Gas Infrastructure Development Project.
GTCL Twining Project
Savar Gas Supply Project
Manpower Training and Development for Petrobangla and its Subsidiary Companies 20 inch DN 1090 Psig Natural Gas Transmission and 4 inch DN Condensate/NGL Pipeline from Beanibazar Gas field to Kailashtilla and 6 inch DN Gas Gathering Pipeline between Beanibazar Gas Field Location 1 and 2
20 inch DN 1000 Psig Pipeline from Narshingdi to Shiddirganj
30 inch DN 6 KM 1000 Psig Pipeline over Jamuna Bridge
24 inch DN 13.5 KM 1000 Psig Pipeline from Elenga to Jamuna Bridge east end.
30 inch DN 15 KM and 16 inch DN 5 KM from West Bank to Nalka and Nalka to Serajganj respectively
20 inch DN 35.53 KM Pipeline from Nalka to Baghabari.
26 KM Distribution network of different sizes for Serajganj
Addition of 260 MMCFD Gas from Shangu Valley Gas Field under Development by Cairn Energy
Gas Supply Network for 100 MW Power Plant at Baghabari, 3x100 MW at Serajganj, 60 MW at Mymensingh and 350 MW at Meghnaghat

2.5 EIA of Development Projects in Bangladesh

Although an increasing number of people in Bangladesh have began to recognise the importance of environmental degradation, incorporation of the environmental factors in development projects has remained very slow. The main reason is that the decision makers were not sufficiently aware of the benefits of Environmental Impact Assessment of projects. As a result, they were not quite convinced that minor alterations in plans and some additional costs in the construction phase could prevent major environmental, economic and social costs after

completion of project. They were also not familiar with the choices available to them or the impact of these options on the environment. Moreover, prior training of most professionals in charge of project development with environmental implications were not adequately taken up. Thus, there existed a lack of knowledge about the choices of implementation process. This was in most cases exclusively technology-focused and therefore, ignored the social, economic and technological, aspects leading their environmental impacts. The sound environmental approach which could ensure rapid and sustainable development of the oil and gas industry in the country was, therefore, not duly accounted for.

The present situation in Bangladesh however, has improved considerably since the proclamation of the Year 1990 as the Year of Environment. Incorporation of the Environmental Impact Assessment (EIA) process in future development projects has become mandatory for different catagories of the industries and development projects. The Jamuna Multipurpose, Bridge project appeared to be the single large development project in the country which incorporated a full scale EIA. This study employed cost-benefit method of impact assessment and was mostly conducted by expatriate consultants. Similarly EIA has been conducted in the power sector projects like Maghnaghat Power Station Project of BPDB and mitigation and monitoring of gas sector projects like Gas Infrastructure Development Project(GIDP) of Petrobangla etc.

This is particularly important for developing countries where non-availability of trained manpower and expertise is one of the primary drawbacks in currying out EIA studies. It has also been pointed out that, one of the reasons that the EIA is expensive in a developing country is limited technical data base upon which projects impacts are based. As a result, a large amount of baseline data must be collected and this is probably the most expensive and time consuming endeavour in an EIA (Rahman and Hossain, 1992).

Like in many other developing nations, Bangladesh, faced with constraint of time, expertise and cost, should consider selecting methodologies appropriate to its local conditions. The use of the methods such as checklists and/ or matrices require little technical or ecological data. They are simple, understandable and easy to use. Highly sophisticated approaches may be scientifically valid but may not be usable within the constraints of a specific environmental impact study. The important task ahead for Bangladesh is therefore to continue EIA application in development project within existing limited resources through the appropriate selection of methodologies. This will help alleviate difficulties and broaden the application of EIA in Bangladesh.

CHAPTER - 3

PROCEDURE AND METHODOLOGY

3.1 Coverage of Oil and Gas Sector Projects in Bangladesh

3.1.1 Oil and Gas Pipeline Project Facilities

Following seismic and drilling, production and processing activities both in on-shore and off-shore areas any oil and gas pipeline project also usually include the construction and operation of offshore, near-shore and/or overland pipeline to transport the products. Pipelines can range in size up to 2 meters in diameter. They can range in length from several kilometres to hundreds of kilometres. Overland and near-shore pipelines are generally buried. Offshore pipelines are generally located on the seafloor in waters as deep as 350 to 450 metres, but sub-sea pipelines have been laid below 1,500 meters in special cases.

The major facilities associated with oil or gas pipelines include the pipeline itself, access or maintenance roads, the receiving, dispatch and control station, and the compressor station or pump stations. Because of internal friction and changes in elevation encountered along the line, booster stations are required for long-distance crude oil and product pipelines at regular intervals e.g. approximately 70 kilometres. Compression stations are installed at appropriate intervals along gas transmission lines to maintain pipeline pressures. The pipeline may transport unrefined oil or gas from a wellhead to transfer or processing facilities. Refined oil and gas may be transported by pipeline to an end user, such as a petrochemical plant or power plant or other domestic, commercial and industrial users.

3.1.2 Oil and Gas Sector Activities

Activities in oil and gas sector arranged in chronological order, mostly refers to the following :

Seismic activities- affecting the ecology;
Drilling activities- environmental impacts of drilling;
Exploration;
Production;
Drilling mud, camps (sanitary aspects). rehabilitation, disposal of wastes ;
Pipelines;
Acquisition of land, right of way, resettlement, rehabilitation and
Mitigation or mitigative measures;

For sustainable development to occur, proper assessment of known resources is a primary consideration. There is a need for systematic assessment of known resources, based on which sectoral plans can be developed. The methodology of this report has taken into account that EIA is mandatory for all petroleum and power sectors projects. This would allow the planners and implementors to understand the environmental impacts and consequences of their projects. In general, trade off between development and adverse environmental impacts must be rational and transparent.(PITS,1995).

3.2 Environmental Hazards

Bangladesh is a disaster-prone country. The physiography, morphology and other natural conditions have made her vulnerable to disasters and environmental hazards. The major elements in the process are (CAPP,1988):

Floods;
Cyclones and storm surges;
Droughts;
Abnormal rainfall, hailstorm and lightning;
Nor'westers and tornadoes;
Erosion and landslides;
Earthquakes;
Industrial and other pollution;
Environmental degradation and hazards connected with ecological imbalances and Causes and effects of greenhouse gases, global warming, sea level rise and depletion of ozone layer etc;

3.3. Environmental Monitoring

Monitoring of certain parameters during both the construction and operational phases of the gas based power stations, fertiliser factories, industrial plants etc are essential to ensure that environmental impacts are fully evaluated and that necessary mitigation measures are applied. This is necessary to demonstrate compliance with any current and future standards. It is expected that monitoring is applied to the following (Bakht, 1996):

fuel quality;
stack emissions;
liquid discharges;
noise;
hazardous wastes;
ecology;
ambient air quality;
ambient water quality;
socio-economics and
public complaints etc;

3.4 Current and Prospective Natural Gas Structure of Bangladesh.

3.4.1 Organisation

Natural Gas Sector is being looked after by the Ministry of Energy and Mineral Resources of the Government of the People's Republic of Bangladesh. The Organisational set up of the Ministry consists of the following present functionaries :

Bangladesh Oil Gas and Mineral Corporation (Petrobangla);
Bangladesh Petroleum Corporation (BPC) ;
Bangladesh Power Development Board (BPDB);
Dhaka Electric Supply Authorities (DESA);
Rural Electrification Board (REB);
Geological Survey of Bangladesh(GSB);
Bureau of Mines and Minerals(BMM);
Inspectorate of Explosive (IE)
Energy Monitoring Unit (EMU);
Power Cell (PC) and
Hydrocarbon Cell (Proposed);

Among these, Petrobangla is primarily responsible for policy initiation and implementation so far as natural gas development and operational activities are concerned. Petrobangla Management is operating as a holding corporation and is comprising of the following Exploration, Production Transmission and Marketing Companies of the gas sector and a Petroleum Institute.

Bangladesh Petroleum Exploration Company (BAPEX) ;
Bangladesh Gas Fields Company Ltd. (BGFCL);
Sylhet Gas Fields Ltd (SGFL);
Gas Transmission Company Ltd. (GTCL);
Titas Gas Transmission and Distribution Company Ltd (TGTDCL);
Bakhrabad Gas Systems Ltd. (BGSL);
Jalalabad Gas Transmission and Distribution System Ltd.(JGTDSL) ;
Rupantarita Prakritik Gas Company Ltd. (RPGCL) and
Bangladesh Petroleum Institute. (BPI);

3.4.2 Natural Gas Statistics

Some pertinent statistics on Natural Gas Exploration, its Production and Marketing network, as of June 1997 in Bangladesh inclusive of operating features of all the companies are presented in Table-3.1 and Table-3.2

Table 3.1 Bangladesh Gas and Oil/Condensate Reserves

Bangladesh Gas and Oil/Condensate Reserves Last Quarter, 1994

Field	Date	Proven (Recoverable) Reserves of Natural Gas (Tcl)			Proven (Recoverable) Reserves of Condensate (mmbbls)		
		Original	Cumulative Production	Net Recoverable	Original	Cumulative Production	Net Recoverable
Bakhrabad	1969	0.87	0.38	0.49	2.13	0.60	1.53
Chhatak	1959	1.14	0.03	1.11	0.08	0	0.08
Habiganj	1963	1.90	0.43	1.47	0.10	0.02	0.08
Kamta	981	0.19	0.02	0.17	0.04	-	0.04
Kailas Tila	1962	2.53	0.07	2.46	27.56	0.70	26.86
Feni	1981	0.08	0.02	0.06	0.24	0.04	0.20
Sylhet	1955	0.26	0.15	0.11	0.89	0.53	0.36
Titas	1962	2.10	1.10	1.00	3.02	1.50	1.52
Begumganj	1977	0.02	-	0.02	0.01	-	0.01
Beanibazar	1981	0.11	-	0.11	1.82	-	1.82
Belabo	1990	0.13	-	0.13	0.31	-	0.31
Fenchuganj	1988	0.21	-	0.21	0.52	-	0.52
Jalalabad	1989	0.90	-	0.90	15.75	-	15.75
Kutubdia	1977	0.47	-	0.47	-	-	-
Meghna	1990	0.10	-	0.10	0.21	-	0.21
Rashidpur	1960	1.31	0.03	1.31	4.00	-	4.00
Semutang	1960	0.10	-	0.10	0.02	-	0.02
Total		12.42	2.20	10.22	56.70	3.39	53.31
Grude Oil (mmbbls)							
Sylhet (Haripur)	1986				6.00	0.57	5.43
Total Liquids					**62.70**	**3.96**	**58.74**

(AIL, 1995)

NATURAL GAS RESERVES (PROVEN & PROBABLE) AND ITS CHEMICAL COMPOSITION

Sl. No.	Name of Gas Fields	Year of Discovery	Nos of Wells	Daily Max Production Capacity (MMCF)	Proven & Probable Reserves (BCF)	Recoverable *6 (Proven + Probable) Reserves (BCF)	Cumulative Production (upto Dec. 96) (BCF)	Net Recoverable Reserve (BCF)	Chemical Composition of Gas (Volume percent)								Calorific Value Gross BTU/CFT	Specific Gravity	Remarks
									Methane	Ethane	Propane	ISO Butane	N-Butane	High Composition	Nitrogen	Carbon Dioxide			
A.	Under BGFCL																		
1.	Bakhrabad *1	1969	8	95	1432	867	501.31	365.7	94.20	3.65	0.72	0.20	0.10	0.24	0.42	0.47	1057.73	0.5970	Producing
2.	Begumganj *5	1977	0	0	25	15	0	15.0	95.46	3.19	0.64	0.17	0.04	—	—	0.30	1045.61	0.5833	Non-Producing
3.	Narsingdhi/Belabo	1990	1	23	194	126	3.607	122.4	94.79	2.49	0.60	0.20	0.15	0.13	0.34	0.60	—	0.6070	Producing
4.	Feni *2	1981	2	7	132	80	36.237	43.8	95.71	3.29	0.65	0.15	0.05	—	—	0.15	1049.84	0.5782	Producing
5.	Habiganj	1963	6	175	3669	1895	567.391	1327.6	97.60	1.31	0.27	0.08	0.04	0.06	0.38	0.07	1023.91	0.5700	Producing
6.	Kamta	1981	0	0	325	195	21.1	173.9	95.36	3.57	0.47	0.09	—	—	—	0.51	1043.13	0.5743	Abandoned
7.	Megna	1990	1	20	159	104	0	104.0	95.15	2.83	0.60	0.16	0.09	0.07	0.37	0.53	—	0.5910	Non-Producing
8.	Titas	1962	11	302	4138	2100	1353.394	746.6	97.33	1.72	0.35	0.08	0.05	0.06	0.30	0.11	1031.55	0.5720	Producing
9.	Shahbazpur	1995	0	0	514	333	0	333.0	93.68	3.94	0.71	0.20	0.07	0.04	0.46	0.90	1046.21	0.5800	Non-Producing
10.	Shaldanadi	1996	0	0	200	140	0	140.0	96.32	2.16	0.45	0.12	0.07	0.05	0.27	0.56	1032.60	0.5700	Non-Producing
	Sub Total (A)			622	10074	5382	2483.039	2898.961											
B.	Under SGFL																		
1.	Beanibazar	1981	0	0	243	167	0	167.0	93.68	3.43	1.10	0.29	1.23	0.17	0.99	0.12	1061.95	1.6000	Non-Producing
2.	Chattak	1959	0	0	1900	1140	26.5	1113.5	97.90	1.80	0.20	—	—	—	—	—	1005.71	0.5480	Abandoned
3.	Fenchuganj	1988	0	0	350	210	0	210.0	95.66	2.50	0.63	0.11	0.04	—	—	0.06	1043.33	0.5740	Non-Producing
4.	Sylhet/Haripur *4	1955	1	6	444	266	158.192	107.8	96.63	2.00	0.05	0.14	0.01	0.17	0.66	0.34	1050.68	0.5460	Producing
5.	Kailastilla *3	1962	4	100	3657	2529	108.561	2420.4	95.57	2.70	0.94	0.21	0.20	0.14	0.24	—	1056.00	0.5860	Producing
6.	Rashidpur	1960	4	82	2242	1309	80.174	1228.8	98.00	1.21	0.24	—	—	0.17	0.02	0.05	1012.00	0.5690	Producing
	Sub Total (B)			188	8836	5621	373.427	5247.573											
C.	Under IOC																		
1.	Jalalabad (Occidental)	1989	0	0	1500	900	0	900.0	93.50	—	—	—	—	—	—	—	—	—	Non-Producing
2.	Kutubdia	1977	0	0	780	468	0	468.0	95.72	2.87	0.67	—	0.31	—	0.36	0.07	1041.66	0.5860	Non-Producing
3.	Sangu (Cairns)	1969	0	0	1137	798	0	798.0	94.51	3.17	0.61	0.19	0.07	0.41	0.44	0.60	1058.00	0.5900	Non-Producing
4.	Semutang (Cairns)	1969	0	0	164	98	0	98.0	96.94	1.70	0.14	—	0.01	—	0.86	0.35	—	—	Non-Producing
	Sub Total (C)				3581	2264	0	2264											
	Grand Total (In BCF)				22491	13267	2856.466	10410.534											
	Grand Total (In TCF)				22.491	13.267	2.856466	10.410534											

Note : *1 Bakhrabad Gas Field : Production will gradually be reduced unless Recompletion is done at D upper or B Sand or Compressor is set up

*2 Feni Gas Field : Recompletion is to be considered

*3 Kailastilla Gas Field : In the event KTL # 4 is completed for gas production FY 1997-98

*4 Sylhet/Haripur Gas Field : Surma #1/2 is considered to be completed and brought under production from FY 1999-2000

*5 Begumganj Gas Field : To be worked over and recompleted and brought under production from FY 1998-99

*6 Considering abadonment Pressure of 500 Psig recoverable reserve may increase to 15 TCF.

Table 3.2 Natural Gas reserves (Proven and Probable)

(TGTDCL, 1997)

A world map showing gas reserves including that of Bangladesh and the one showing the afore-mentioned gas well, processing plants & transmission mains including locations of some of the Bulk Customers of Bangladesh are placed at Map No-3.1 and Map No-3.2 respectively. Schematic line diagram of Gas pipe line grid in Bangladesh, Bangladesh fields and wells and Petrobangla Acreage Map have been shown in Figure- 3.1, Map-3.3 and Map- 3.4 respectively (KIL,1995)

3.4.3 Major Gas Sector Development Projects.

Details of certain major gas sector Development projects undertaken for execution are placed below in terms of financing provisions of International Development Association (IDA) , Asian Development Bank (ADB) etc.

IDA : Gas Infrastructure Development Project

Development Drilling

6 wells at Rashidpur and Kailashtilla field
Surface facilities;
90 MMSCFD silica gel plant for gas processing and
Natural Gas Liquid (NGL) line upgrading.

Gas Transmission

58 Km 30 inch diameter Ashuganj to Bakrabad (A-B) pipeline off North-South (N-S) pipe line ,maintenance equipment for operationalisation of Gas Transmission Company primarily with N-S pipeline and A-B pipeline.

Grid Control

SCADA/Telecommunication system for N-S and A-B pipelines, metering stations and improvement of existing system.

Consultancy

Development drilling, surface facilities, transmission pipeline and SCADA.

Technical Assistance

Policy Support assessment of privatisation options and the scope for establishing a regulatory framework in the petroleum sector;
Institutional development of the Management Systems Improvement Program for accounting MIS, financial management, audit and computerisation improvements ;
strengthening of capabilities to fully operate the GTCL;
To negotiate international petroleum agreement with International Operating Companies (IOC);
Capacity building in the environment and safety areas and;
Sector investment planning and a feasibility study for Rashidpur- Habiganj - Ashuganj Pipeline.

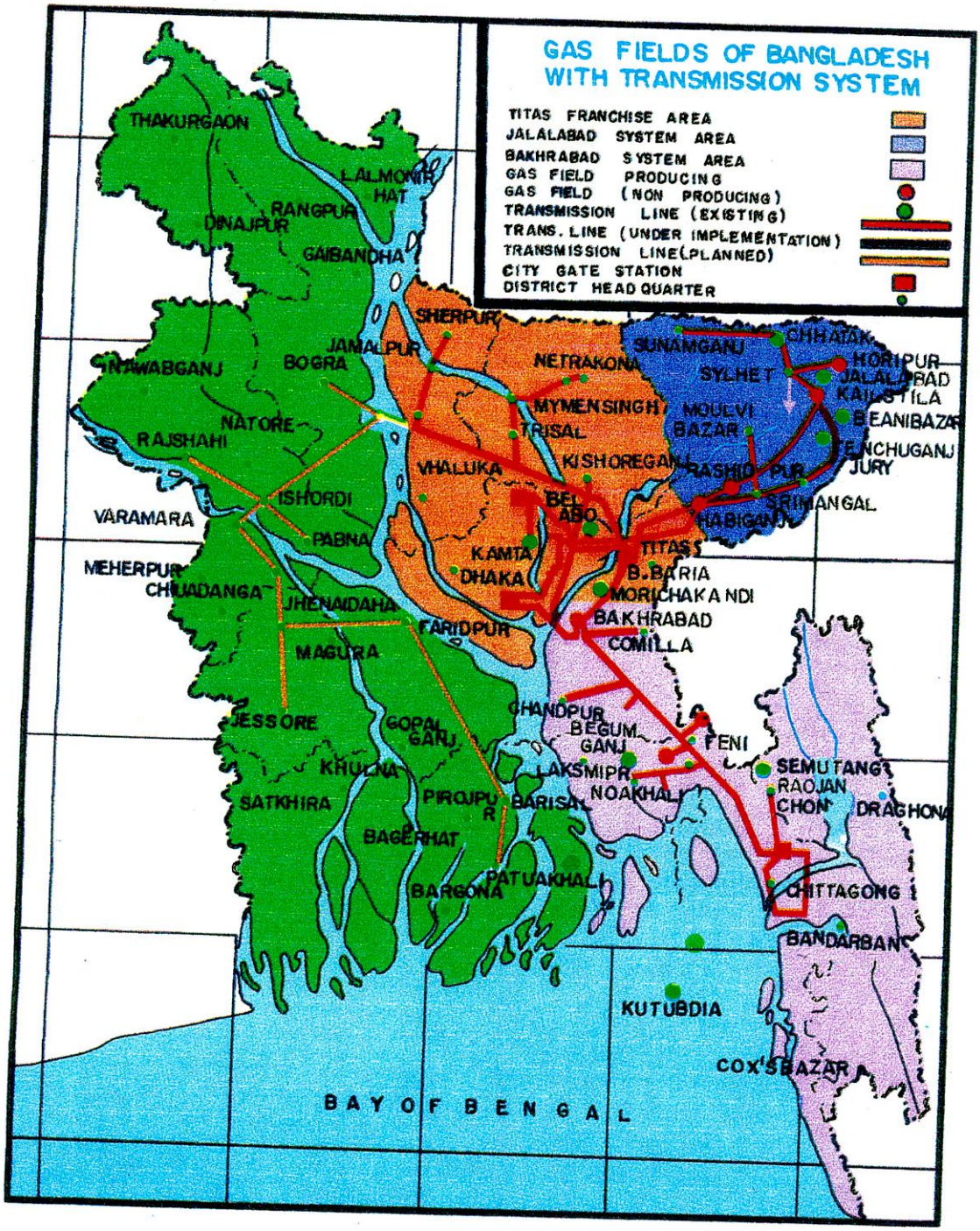
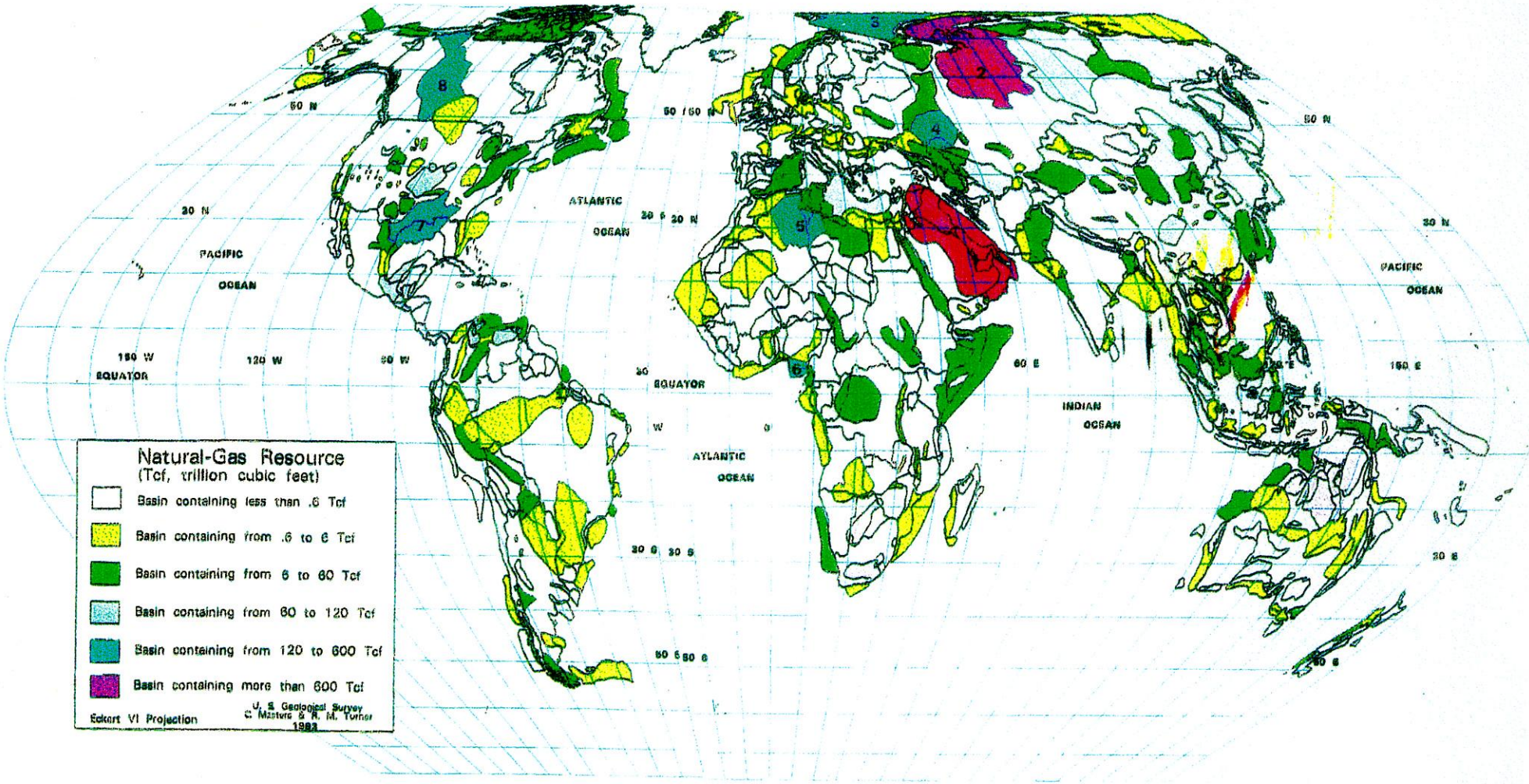


Figure 3.1 Gas Fields of Bangladesh with Transmission System

(TGTDCL, 1997)



Sedimentary basins of the world, showing conventional natural futures (the sum of identified reserves and undiscovered resources) in six quantitative categories. Higher gas prices in future may not necessarily equate to higher production in the United States—it may be cheaper to import gas. Compiled Charles D. Masters; data digitized by Robert Turner.
1, Arabian-Iranian basin; 2, West Siberia basin; 3, Barents Seasin; 4, North Caspian basin; 5, Algerian basins; 6, Niger Delta; 7, Gulf Coast basin; 8, Western Canada basin.

(CIPID , 1995)

Map No-3.2 **World Map Showing Gas reserves Position**

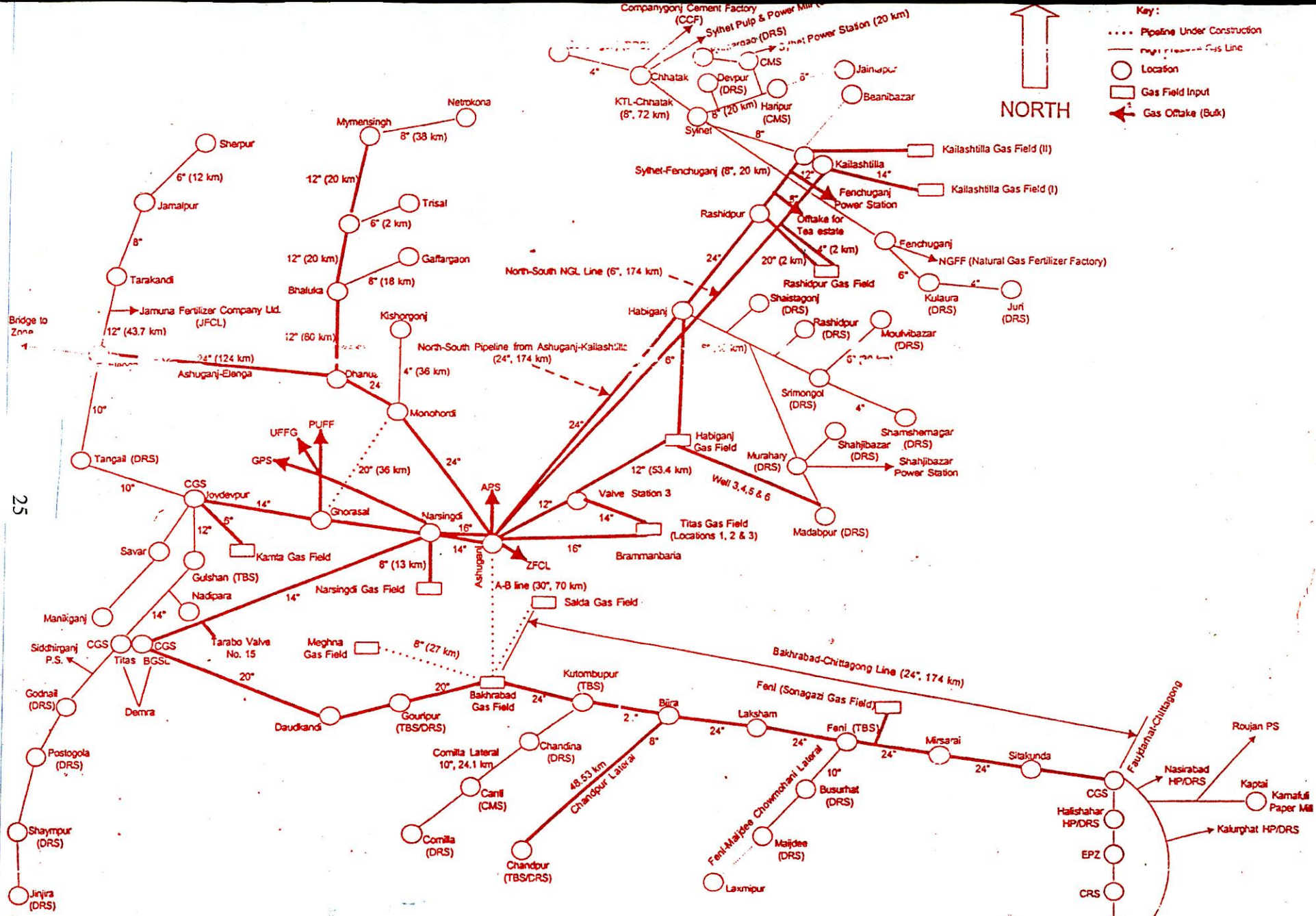
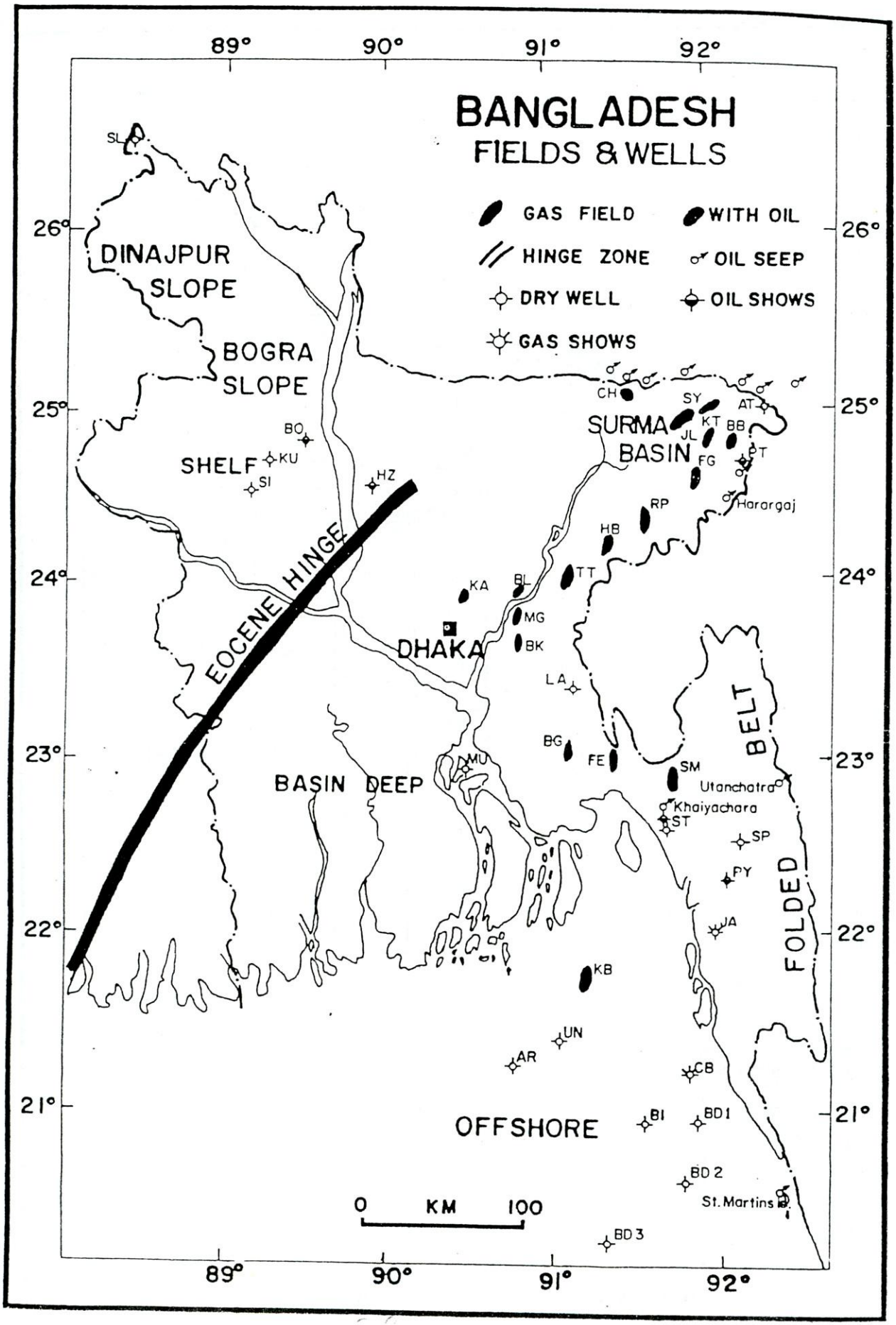
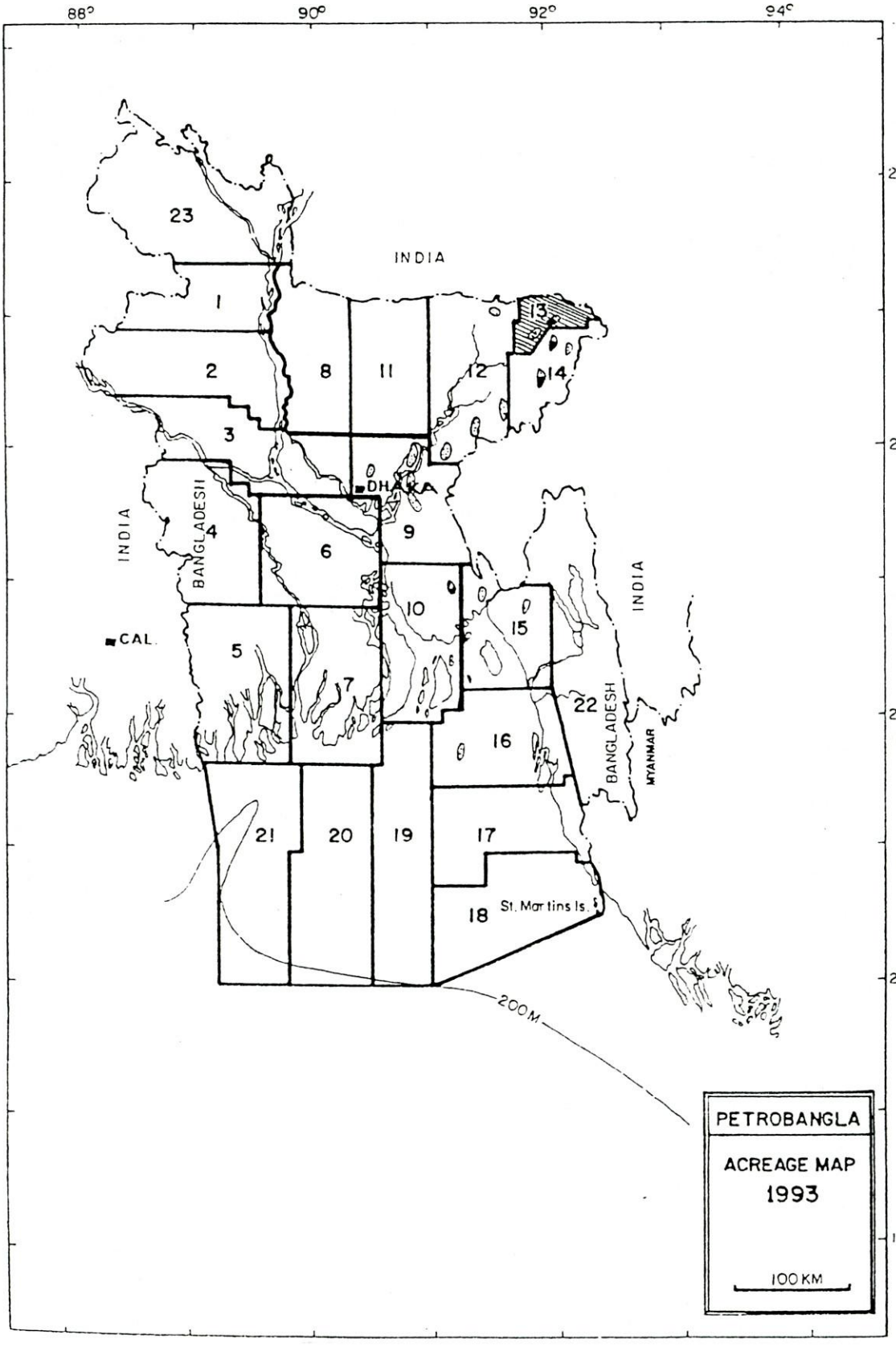


Figure 3.1 Schematic Line Diagram of Gas Pipeline Grid in Bangladesh



Map 3.3 Bangladesh Fields and Wells (BOGMC, 1993)



Map 3.4 Petrobangla Acreage Map

(BOGMC, 1993)

ADB : Third Natural Gas Development Project

Development Drilling

3 wells at Titas and 4 wells at Habiganj field, work-over of 4 wells at Titas field and 3 wells at Bakhrabad field

Surface Facilities

90 MMSCFD Low Temperature Separator (LTS) gas processing plant at Titas and 120 MMSCFD glycol plant at Habiganj Field, gas gathering pipelines and facilities.

Gas Transmission

32 Km 20 inch dia pipeline from Monohordi to Narsingdi (off Ashuganj- Elenga Pipeline) to meet growing demand of Ghorasal and Greater Dhaka and

15 Km 10 inch dia pipeline from Chowdhury Bazar to Kuchai and 42 km 8 inch dia Pipeline from Kailashtilla to Chhatak.

Grid Control

Establishment of centralised data acquisition and monitoring system and computerised network analysis system for TGTDCL(extension of Brahmaputra Project System);
Establishment of telecom system for BGSL and
Establishment of telecom system for JGTDSL.

Gas Distribution

Expansion and upgrading of gas distribution network in greater Dhaka, expansion of networks in other townships, installation of regulating and metering stations at TBS/ DRS and upgrading of 11 TBS/DRS of TGTDCL ;

Balancing and upgrading of distribution networks in Chittagong and Comilla, expansion of gas distribution system in 6 areas of BGSL and

Up-gradation and expansion of Sylhet Distribution Network of JGTDCL.

3.5 Review of Reports & Reference Materials

Within the study area of territory of Bangladesh, the reports so far prepared by different multinational consulting companies like Komex, Acres, British Gas , Mott-Eubank Preece, etc. have been used as reference for reflection of base line conditions and propositions put forward thereof. Similarly the guidelines and evaluations made by different donor agencies and international organisations like World Bank, ESCAP, ADB, etc. have been considered for

incorporation and compliance of suggestions where applicable. Further, the standard set forth by different regulatory authority of Bangladesh, e.g. Department of Environment, Inspectorate of Explosives, etc. and the International bodies like Environment Canada , Canadian Association of Petroleum Productions, etc. have been studied and recommendations as applicable have been adopted for consideration in the report.

At this point, it may be noted that environmental audits have come to the forefront as a response tool to reduce the risk of environmental liability. The role of environmental auditing is now being important aspects so far as verification and evaluation of some organisational compliance with regulations and acts, policies, standards and procedural control in respect of programmes and routine management e.g. facilities, record keeping, staff training, waste management. But since auditing functions are not directly involved within the EIA process, it has just been referred to in the management and monitoring sector of the report.

3.6 Case Studies

A case study relating to gas field explosion and fire incident at Magurcharra of Kamalganj of June 14 1997 in Moulvibazar district has been presented. Due environmental restoration and reclamation with possible mitigation measures have been outlined in this context. Reporting of results on another study relating to saving of fuel wood following conversion to natural gas has also been highlighted in the report.

CHAPTER - 4
ENVIRONMENTAL CONSIDE RATION IN ENERGY DEVELOPMENT AND ENVIRONMENTAL ISSUES IN BAGLADESH.

4.1. Integrated Approach

Any integrated approach in the development process of the energy industry, particularly oil and gas ones, involves satisfactory responses to certain important propositions e.g.:

Operating Procedures and Practices i.e. written operating procedures including emissions, effluent and solid waste limitations as required by regulations and standards in existence should be clearly understood and followed ;

Source Monitoring for the quantities and qualities of wastes and emissions from facility operations should be monitored regularly and the status of compliance should be demonstrated through these monitoring programs;

Maintenance should provide prompt corrective action to equipment which result in environmental risk ;

For monitoring of effects of emissions and wastes on the environment, the monitoring program must be effective. Samples should be taken, regularly and appropriate remedial actions should be taken promptly :

Spill Contingency Measures call for availability of written up to date responses to procedures including contingency plans and resources covering incidental discharges. These should also be accurate and easily implementable;

Environmental Training Awareness of implications of the operations should be present and the information flow should be effective too e.g. there should be unhindered access to technical literature, publications, and education programs;

Contractor Selection and Performance monitoring requires that the Contractors are made aware of company policy. They must have a good environmental record. Their responsibilities should be clearly defined and the company hired contractors should also duly monitor the works being performed by themselves;

For an effective external communication there should be a system set up to deal with complaints and requests for information from external sources ;

All relevant personnel should be trained, The frequency and method of training should also commensurate ate with the requirements and.

The facility should have special past, present and future environmental programs for unique problems. (ADB,1992)

4.2 Environmental Baseline in Bangladesh

General

The total population of Bangladesh was recorded to be 124.3 million with per capita GNP of US Dollars 276 during 1996-97 according to the indicator provided by Bangladesh Bureau of Statistics and reported in the Bangladesh Observer of November 22, 1997. 83% of these population live in rural areas and only about 17% in urban surroundings. The population growth rate of the country is 2.1% per annum, which although moderately high, is nevertheless a vast improvement over a rate of 2.8%, 20 years ago. By the year 2025, the population is projected to reach 180 million.

Bangladesh is small in area but excluding city states it has the highest population density in the world. With the exception of the eastern hill along the borders with India and Myanmar, the country is very flat. The country consists mainly of an alluvial plain due to the result of the centuries of flooding and siltation.

Only 76% of its total land area being cultivated, the average cultivated land per capita for the rural population is only 0.02 hectare(ha) roughly 1 ha per farm household. To make matters worse, much of the country is still subject to serious flooding from seasonal high river flows or from cyclones and tidal surges in the Bay of Bengal. Bangladesh is also a poor country with afore-mentioned GNP per capita compared to a world average of US $4,010 and an average for low-income countries of US $350.Within Bangladesh,50% of the population is below the poverty line, and 30% is in dire poverty.

About 14% of the land area is covered by forests. These include tropical evergreen and semi-evergreen forests in the eastern Hill Tracts (27% of forest area); moist/dry deciduous forests in temace areas (5%); tidal/mangrove forests in the Sundarban (26%); and "unclassified state forests" (42%) which are administered by district authorities but are subject to encroachment and degradation from economic development pressures.

Much of the south-western coastline of Bangladesh is mangrove swamp. The eastern section of coastline is better suited for economic development, although the whole coastal area is vulnerable to cyclones and tidal surges.

Most rivers in Bangladesh carry high sediment loads which are constantly being deposited along the river courses and out into the Bay of Bengal. The rivers are wide and have extensive active floodplains. With the exception of the hills in eastern Bangladesh and the alluvial terraces north of Dhaka and in the northern region, the majority of the country is, in fact, floodplain.

It is essential to preserve the rich but sensitive wildlife and biota, particularly in areas like the Sundarban, the Hill Tract forests and the Madhupur Jungle Sal forest north of Dhaka. Forests are currently being depleted at the rate of 10,000 ha annually, which is 0.5% of forest area. These natural habitats support an abundance of aquatic and terrestrial species, including tigers, crocodiles, turtles, monkeys and migratory birds. (AIL,1995).

Bangladesh is a signatory to a good number of international conventions and there are other conventions of relevance as may be seen from Annexure- B (WBD,1997).

4.3 Existing Experience with Environmental Concerns

So far as can be determined, the environmental concerns and/or impacts arising from the existing power plants and gas based industrial units have not been unduly serious except for some of the localised ones. All fuel for power plants in the East Zone is natural gas, and apart from NO_x emissions, there appear to be no known problems. The amount of oil used in the West Zone is comparatively small, for economic reasons and therefore oil spills appear not to have been a problem. Even the waters in the harbours at Chittagong and Mangla appear to be free from oil slicks and of course, at the present, oil pollution come from shipping and not power plants. There are no precise records of accidental spillage of the chemicals used in the water treatment of power plants, but so far as can be determined by eye, and from discussion with plant operators, this does not appear to be a problem. Figure-4.1 and Figure-4.2 explains 1hr NO_x concentration with increasing stack height and maximum ground level concentration of NO_x respectively for thermal power plants (MEP,1996).

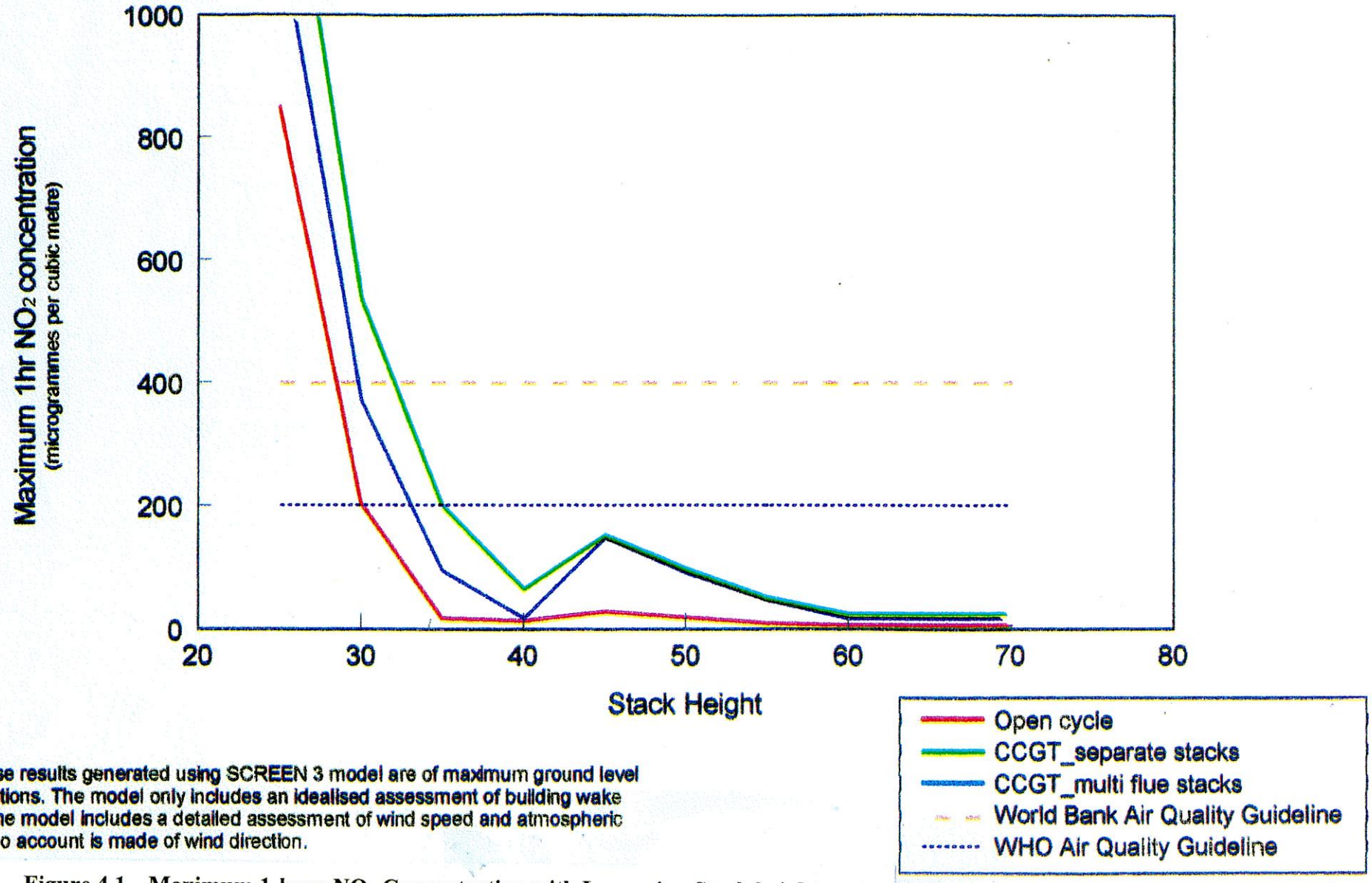
4.3.1 Thermal Plant Siting

The key environmental issues for siting thermal plants in Bangladesh are as follows :

land availability (displacement of good quality agricultural land) :
fuel transportation and handling (need for port facilities) ;
cooling water supply (intakes on main rivers or on coast) ;
avoidance of environmentally sensitive areas ;
proximity to load centres (minimise transmission lines) and
need for fill to protect site against floods (dredging fill material) etc.

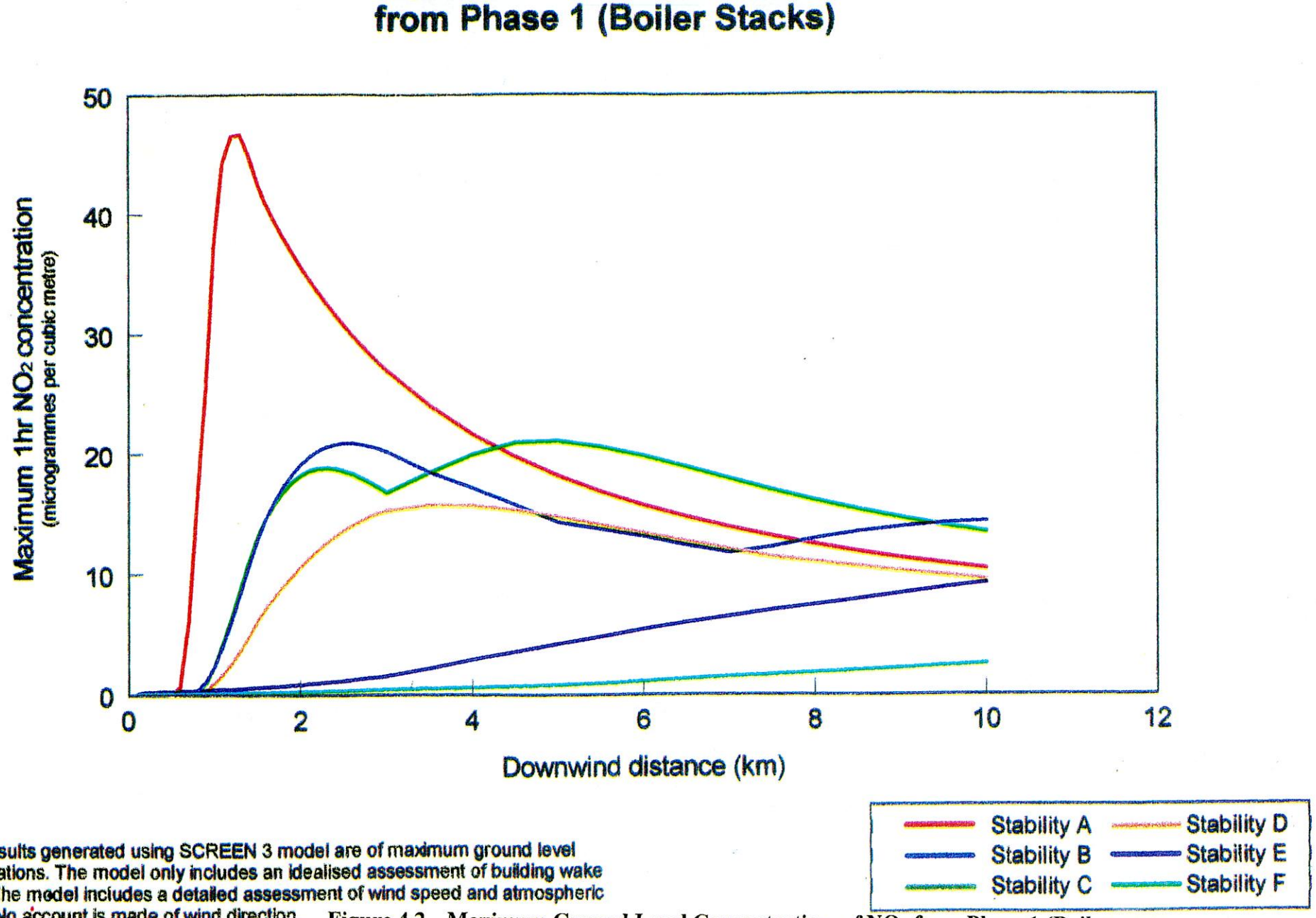
Water intakes can be designed to prevent the entrapment of aquatic life. This could be a concern along certain rivers and in coastal areas. The release of cooling water discharges is an issue in some water bodies, due to thermal shock on aquatic life, but with proper design; this can be overcome.

Some generating plants that are poorly maintained produce high levels of effluent discharge. These should be minimised, and all effluent should be treated before release to natural water bodies. Generally, there is room for improved operating procedures and plant operations should be closely monitored (AIL,1995).



Note:These results generated using SCREEN 3 model are of maximum ground level concentrations. The model only includes an idealised assessment of building wake effects. The model includes a detailed assessment of wind speed and atmospheric stability. No account is made of wind direction.

Figure 4.1 Maximum 1-hour NO_2 Concentration with Increasing Stack height (Phase 1)



These results generated using SCREEN 3 model are of maximum ground level concentrations. The model only includes an idealised assessment of building wake effects. The model includes a detailed assessment of wind speed and atmospheric stability. No account is made of wind direction.

Figure 4.2 Maximum Ground Level Concentration of NO_2 from Phase 1 (Boiler Stacks)

4.3.2 Thermal Plant Operations

The key environmental issues for operating thermal plants in Bangladesh may be summarised as follows :

acid gas emissions (total emissions and localised impacts);
aquatic effects of water intake and cooling water discharges;
wastewater and effluent discharges;
fuel handling (coal and fuel oil);
ash waste disposal and
Landscape and aesthetic etc.

The greatest environmental concern for thermal generating plants relates to the quantities of acid gas emissions. Natural gas is a relatively clean fuel, having very little sulphur and particulate matter. However, NO_x emissions can be significant and can lead to high concentrations of Ozone near ground level. In urban areas, under certain climatic conditions, this can produce smog and consequent eye and throat irritations. NO_x and Ozone can also lead to adverse impacts on some forms of plant life.

If fuel oil or coal is burned, measures will have to be taken to reduce SO_2 and particulate matter. Localised effects include potential damage to some crops and health problems for people. Regional effects include acid rain which, in the case of Bangladesh, would likely involve trans-boundary rather than domestic concerns. Impacts on the Sundarban, the Hill Tract forests and the Sal forests should be investigated further before any decisions are made to locate any new power plants. Figure-4.3 and Figure-4.4 explains the anticipated increase in traffic movements during the operation stages of power plant and emission per km from 1000 light/heavy duty vehicles. This is a consequential impact of building and operating a thermal power plant. (AIL, 1995).

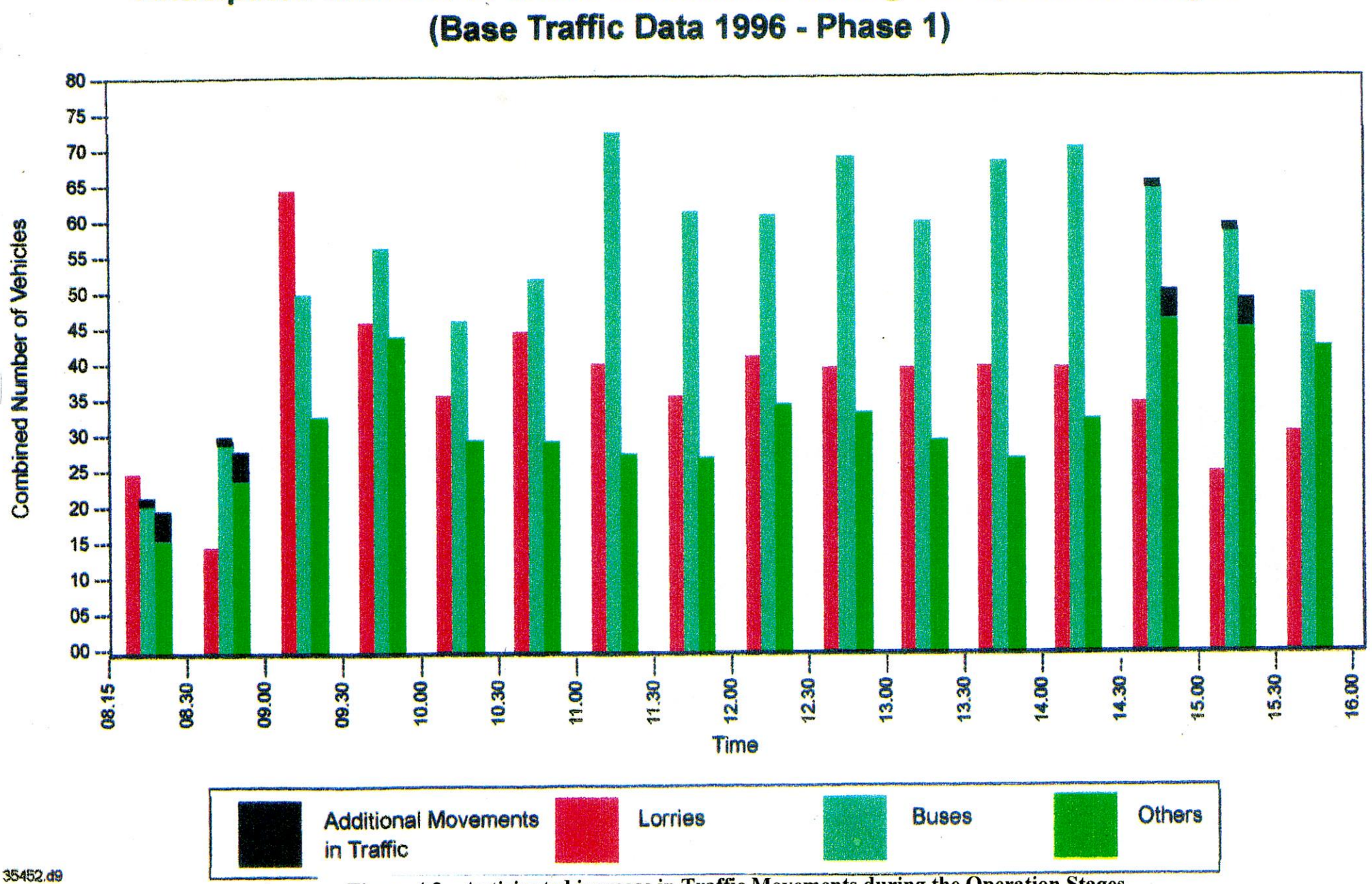
4.3.3 Rashidpur Gas Field

The existing facilities at the Rashidpur Gas Field presently provide a total of 130 MMCFD of gas to the N-S pipeline. The gas field comprises the following components :

four wells and emergency shutdown equipment at the well-sites (Reshidpur # 1 and # 2 located at the process facility site);

pipeline transmission lines (152 mm DN field gathering lines) including a pipeline corridor from the wells to the process facilities ;

two brick soled access roads (one to Rashidpur #4 from the local secondary road network and one to the process site);



35452.d9

Figure 4.3 Anticipated increase in Traffic Movements during the Operation Stages (Base Traffic Data 1996-Phase 1)

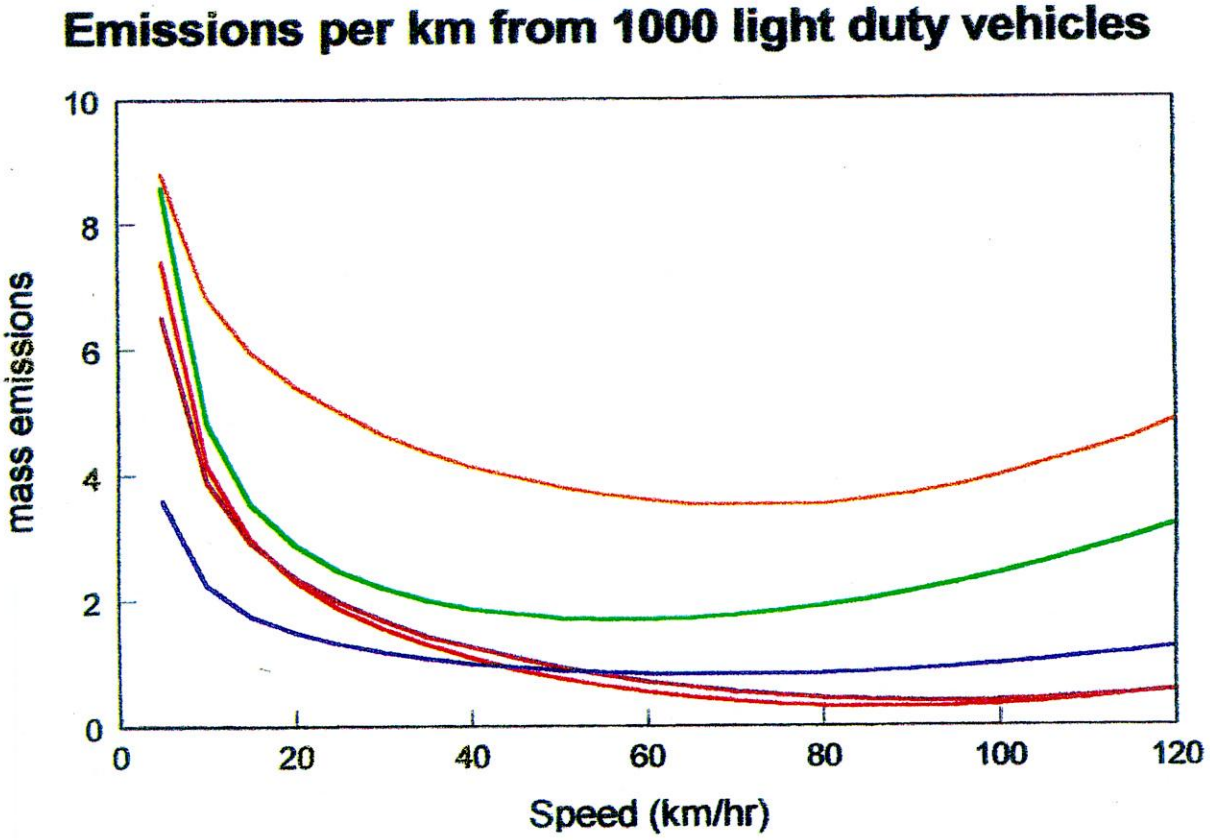
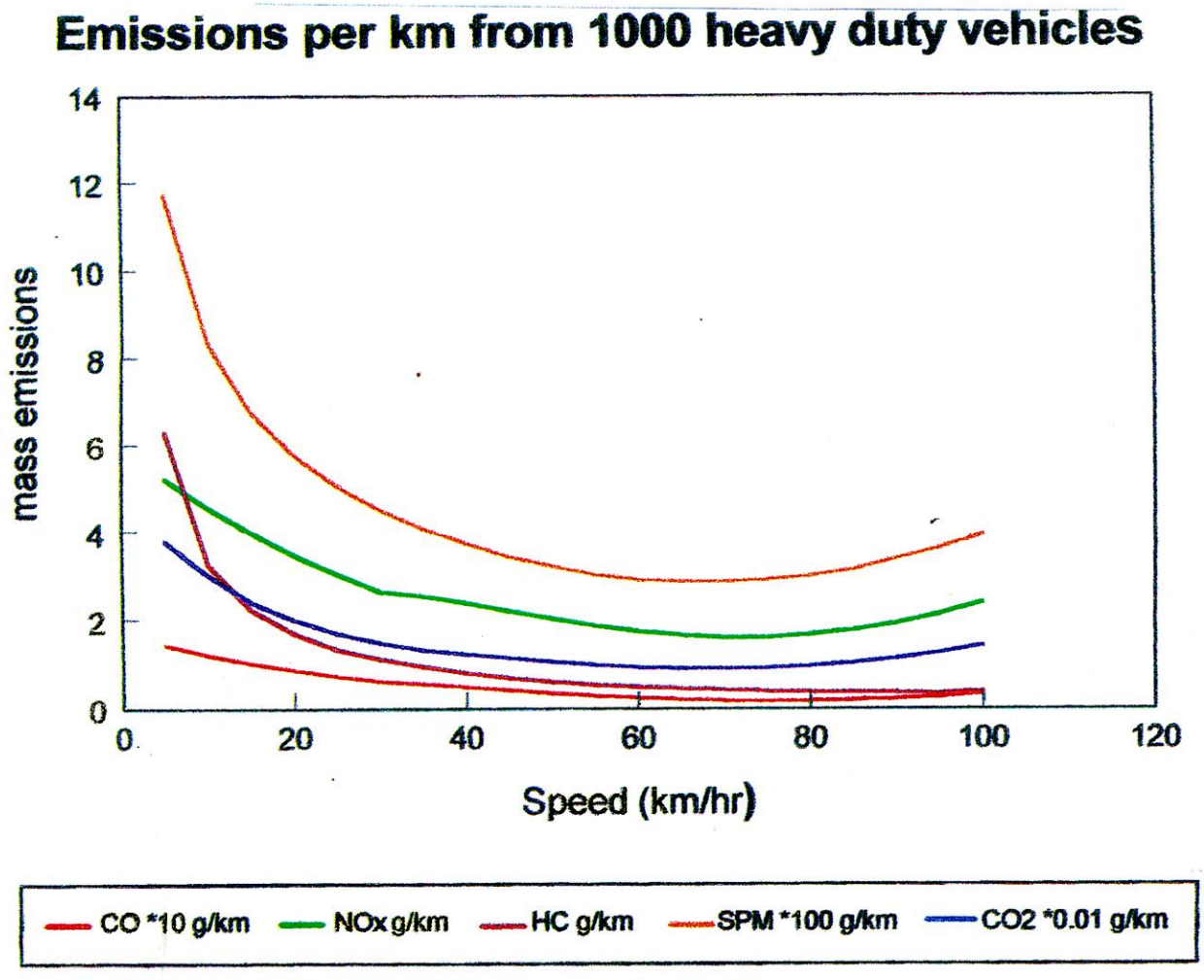


Figure 4.4 Emissions per km from 1000 light duty vehicles



the process facility (silica gel dehydration for gas from Rashidpur #2, #3 and #4 and glycol gas dehydration facilities for Rashidpur #1, condensate storage and load-out heaters and re-boilers, flare stack, oil water separator and soak pit, fire water pond, office facilities, and officers' accommodation areas);
a transmission pipeline from the process facilities to the North-South (N-S) pipeline at the valve station.
Ecological profile (North-South) of the Rashidpur Gas field area is shown in Figure-4.5.

4.3.4 Ashuganj-Bakrabad Pipeline

The existing N-S transmission lines can transport NGL and dry gas at high pressure to the Ashuganj Manifold Station. The Ashuganj-Bakrabad pipeline is delivering gas from this facility to the Bakhrabad facility located approximately 60 km south of Ashuganj through a 762 mm DN pipeline. This is allowing distribution of the gas to the Bakhrabad Franchise Area (BFA) to meet projected consumption demands.

The pipeline is buried with an earth cover of 1.2 m according to the Bangladesh Mineral Gas Safety Rules (BMGSR). Two mainline valves are constructed above ground and are fixed with gas driven actuators for automatic closure. This is to minimise loss in the event of a line break. The right of way (ROW) width was required to be 20 m and above ground facilities were limited to the two block valve stations which are elevated above seasonal flood levels requiring additional surface land area.

The route has crossed the Titas, Buri and Gumti Rivers. The Titas and Buri river crossings has been constructed using horizontal boring operations and the Gumti with a conventional open-cut system. The planning and construction has been recently completed (MIL,1995).

4.4. Valuation of Environmental Impact in Economic Terms.

Overall existing situation does not really consider the real cost as well as social cost of production.

The relationship of environmental costing of an enterprise, as it appears from the Figure-4.6, shows that, it is less costly to remove about 25% pollution, 50% removal is cost effective but more than 50% removal is costly. For example, wastewater that is generated in the Natural Gas and Thermo-electric Projects (NGTP) are not normally treated in Bangladesh. However, through dilution in every rainy flood season, these wastes are carried away. So it is not wise to go for 100% pollution removal but at least 25% removal have to be ensured so that assimilating capacity of the environment can cope with the discharged pollution. The economic solutions of the pollution problems are regulation, subsidies, withdrawal of harmful subsidies, tradable right, green taxes, user fees and pollution prevention bonds, etc. (Rahman, 1995).

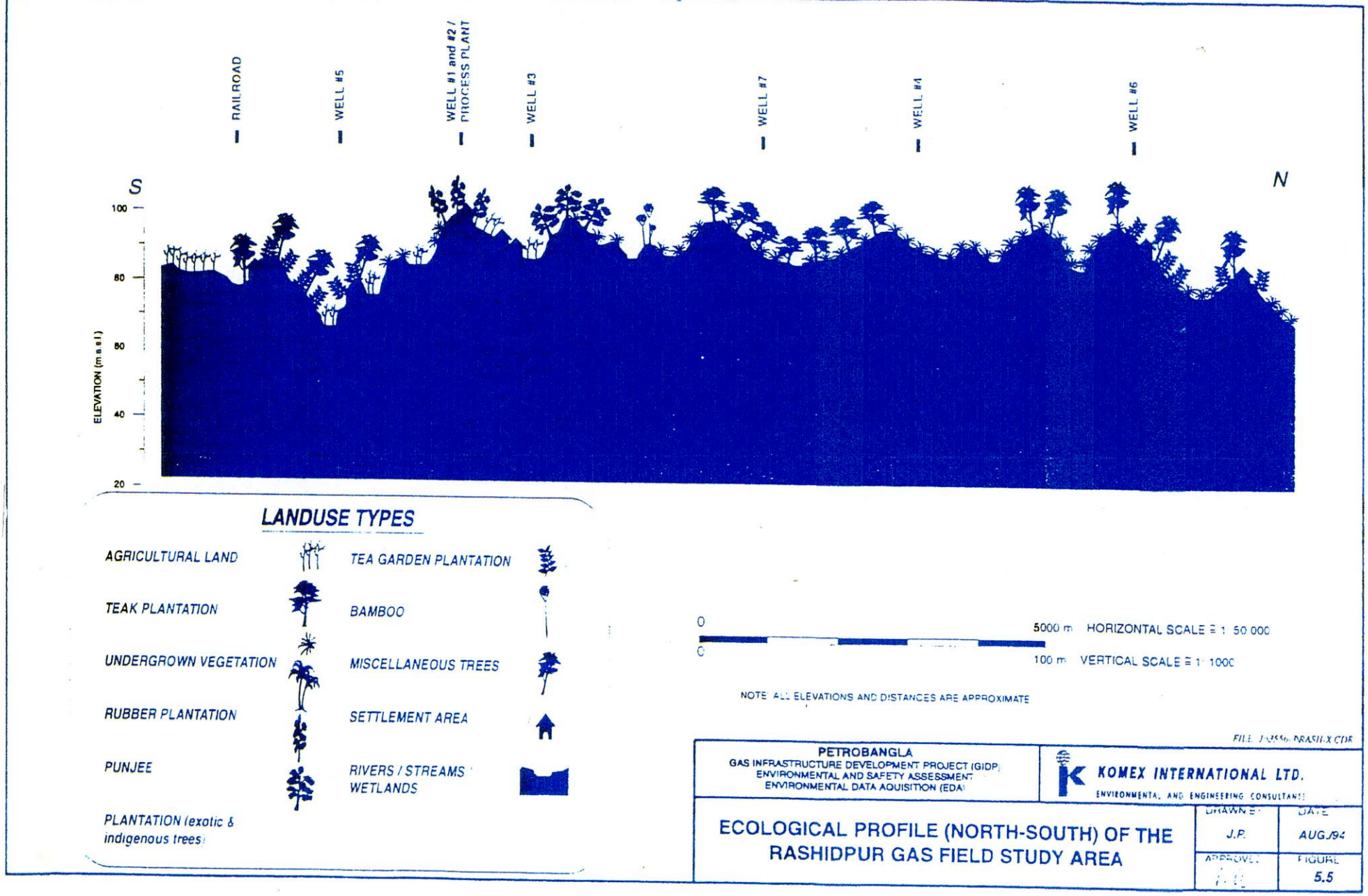
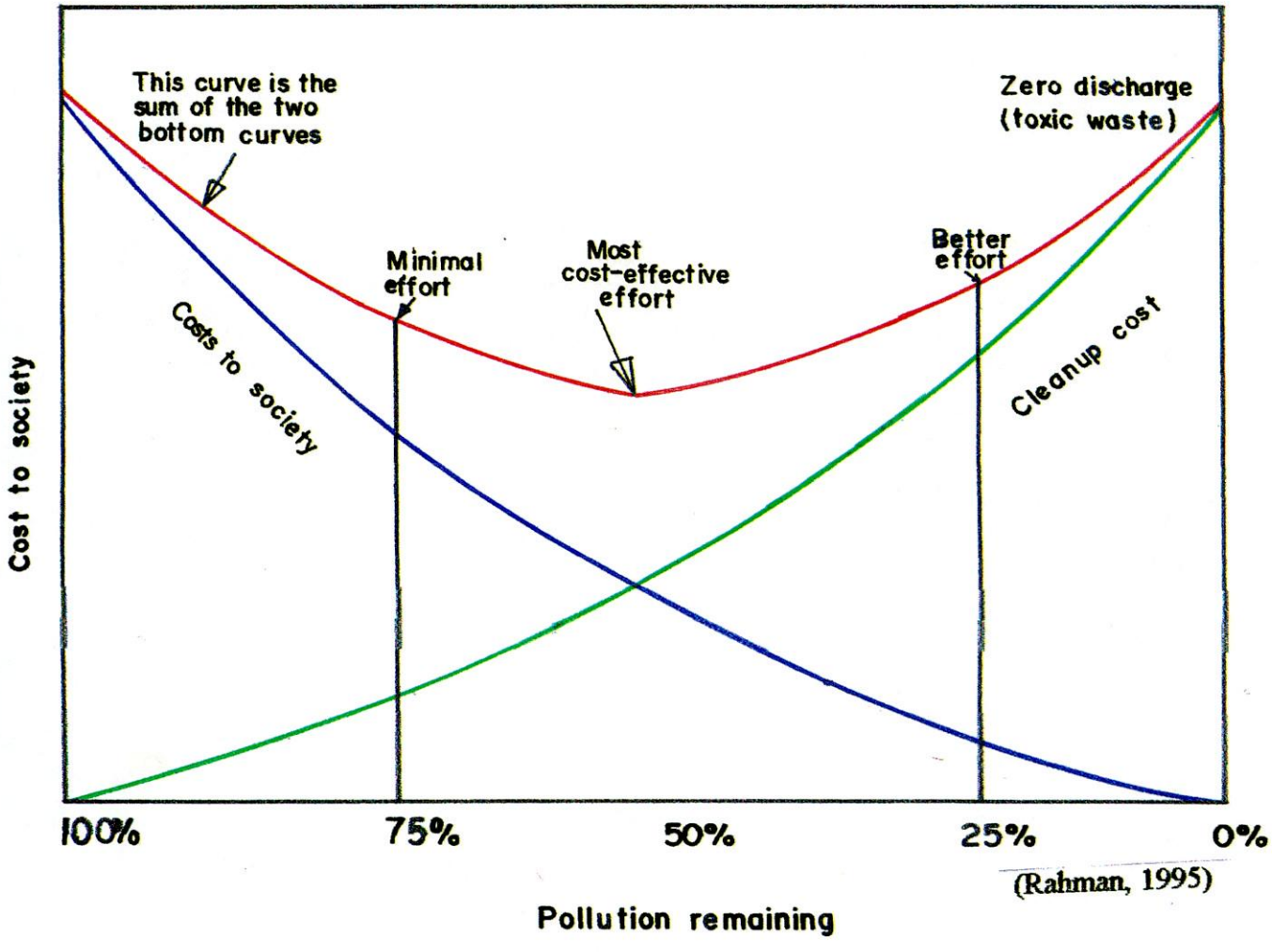


Figure 4.5 Ecological Profile (North-South) of the Rashidpur Gas Field Study Area

Figure 4.6 Environmental Costing Curve



(Rahman, 1995)

4.5. Positive Environmental Impacts

4.5.1 General

In some cases, oil and gas pipelines may be viewed as contributing to environmental quality by making cleaner fuels more available(e.g. low sulfur gas versus high sulfur coal) for energy production and/or industrial purposes. In offshore areas, unburied pipelines may create habitat for marine organism attracted to the new " artificial reef ".

4.5.2 Positive Impact of Use of Natural Gas Over Wood Fuel

It has been revealed from a study that savings of about 2 million tons of fuel wood and for that matter green forest is achieved per year through use of natural gas in urban and sub-urban areas of Bangladesh so far, in domestic, commercial and industrial sectors, where ever gas has been made available. The details of calculation is enclosed at Appendix -E (Kundu, 1997).

4.6 Energy Resources Structure of Bangladesh

Hydrocarbon exploration activity has been continuing in this territory since the early days of the 20th century. Exploration history may be divided into three phases. There are as follows (BOGMC,1993):

Phase -I : In the early days (1910-1943) of exploration, drilling was targeted near seeps in the fold-belt. In this phase six exploration wells were drilled by foreign companies without any discovery. The cumulative well depths were varying from 763 meters to 1,047 meters. The second world war disrupted the exploration activities until the middle of this century.

Phase - II : During the second phase(1951-1971) early forms of modern geophysical methods were used for the first time. During the 50's and 60's the onshore area was explored by major International Oil Companies, e.g., Shell, Stanvac, Pakistan Petroleum Limited(PPL) and the Oil and Gas Development Corporation. Gravity and surface magnetic reconnaissance surveys were followed by single fold seismic studies supplemented by geological information from wells and outcrops in the surrounding areas. The operators of the second phase drilled 22 exploratory wells with one in off-shore and discovered eight gas/condensate fields.

Phase-III : After the emergence of Bangladesh, the Bangladesh Petroleum Act 1974 was promulgated following which Petrobangla was formed in 1974 to promote and regulate exploration, production and distribution of petroleum. The years1974-78 were focused on offshore drilling by six international oil companies under production sharing contracts. From the beginning of the 80's exploration was targeted on liquid hydrocarbon and as a result Bangladesh has entered into the oil-era. In December 1986, crude oil was discovered from the well Sylhet-7. Oil flows were tested at Fenchuganj-2 and Kailas Tila-2 in this decade, which are a waiting further appraisal.

During the period 1972-1992,24 wells including 7 offshore wells were drilled by the national organisation Petrobangla and foreign oil companies. Petrobangla discovered 7 gas fields and the one oil field and the foreign companies discovered 2 gas fields of which one is in the offshore area.

During this period, shell and Scimitar were active in exploration along with the national organisation under Production Sharing Contract (PSC). During 1993, the PSC has been revised commensurate with government policy changes and new incentives have been offered to the industry.

The year 1993 is also a year marked for the formulation of the country's first Petroleum Policy and the declaration of new incentives to the investors for petroleum exploration.

Bangladesh possesses an extensive and long established petroleum infrastructure. There are five producing gas/condensate fields, one producing oil well and twelve other non-producing gas discoveries, all located in the eastern fold-belt region. An extensive pipeline network system of 1488 km brings gas to market for industrial, commercial and domestic utilisation. Major gas users include 12 power stations, six fertiliser plants, a cement factory and pulp and paper mills. The power and fertiliser sectors consume 77% of the production. The rest of the production is consumed by minor industries, tea estates, brick fields and domestic consumers. There is a single oil refinery at Chittagong, with a through put of 30,000 BBL per day. Crude oil is imported from Saudi Arabia, Iran and the UAE. With daily consumption at about 45,000 barrels the difference between demand and output of the Chittagong refinery is made up with the import of petroleum products. Table - 1.1 shows Bangladesh Exploration Phases.

Petrobangla was formed in 1974 to integrate exploration, production, transmission and distribution of hydrocarbon throughout Bangladesh. These activities are being implemented by Petrobangla's seven subsidiary companies. Among these, Bangladesh Petroleum Exploration Company Limited (BAPEX) was created in 1989 for carrying out hydrocarbon exploration in the country.

Gas is being produced by two subsidiaries of Petrobangla i.e. Sylhet Gas Fields Ltd. (SGFL) and Bangladesh Gas Fields Company Ltd (BGFCL) . Among these, SGFL is the oldest gas production company of the country. This company was also producing oil from a single well (Sylhet-7 at the of rate of 150 BBL per day).

The eastern part of the country i.e east of the river Jamuna, is served by a gas pipeline network. There are three gas transmission and distribution companies: Titas Gas Transmission & Distribution Company Ltd. (TGTDCL), Bakhrabad Gas Systems Ltd. (BGSL) and Jalalabad Gas Transmission and Distribution System Ltd. (JGTDSL).

To develop and popularise Compressed Natural Gas (CNG) in the country, Rupantarita Prakritik Gas Company Ltd. (RPGCL) was formed in 1991 . In order to ensure efficient gas transmission , the Government of Bangladesh has decided to establish a new gas transmission company (GTC) which is already in operation. The latest inclusion is the formation of western zone gas

arrangement body at GTCL to work for the gas pipeline over the Jamuna Bridge for feeding gas supply network on the other side of the river Jamuna.

To ensure availability and for giving the best deal to consumers in the price of POL, the government has set up the Bangladesh Petroleum Corporation (BPC) in 1976 . POL are marketed by several subsidiaries of BPC. To cater for research and training need , an institute named, Bangladesh Petroleum Institute(BPI) is also now operating in the sector.

4.7. Resources Effected by Environmental Impacts

Environment and development are two sides of the same coin. The need for development through socio-economic activities, especially with the growing population and a desire for higher standards of living is obvious. further, increased agricultural production with the limited availability of land for cultivation purposes, calls for increasing the rate of application of fertilisers as well as appropriate pest control through pesticides. Production and supply of adequate energy for the industries is essential for enhanced industrial production. Some basic indigenous sources of energy e.g. natural gas as fuel and feed stock for the power industry and for the chemical, fertiliser, or other industries, commercial and domestic units are integral parts for implementation and sustenance of any planned development.

Practically all socio-economic activities for example, industry, agriculture, transport, construction, road and housing etc. contribute to environmental degradation including water, soil, air etc. Further, development of any particular industry e.g. Natural gas industry with all its activities right from exploration, drilling, production, processing, transportation, distribution and utilisation from bottom hole of a well to burner tip of the customer encompasses the complexities of these problems. Involvement and interactions of the relevant parameters have necessitated a multi-disciplinary approach to environmental protection and pollution control different from the traditional concepts of any simple engineering.

Now for managing such complex and ever increasing environmental degradation due to industrialisation, different approaches have been developed and cited as follows :

One of the basic approaches there fore, depends on development of suitable standards for each factor responsible for air, water, noise and soil pollution and any violations are to be dealt with as per provisions of the law.

The second alternative is based on best practicable means where the industry is facing any problem to adopt any suitable method which is technically feasible as well as economically viable.

Accordingly, the procedure calls for the first possibility which makes it mandatory that each plant or operation would have a suitable device so that the level of each pollutant or activity is below the desired limit. The second possibility is to leave the matter entirely to the industry with certain guidelines so that they might adopt the best practicable methods available. And, the third alternative incorporates the advantages of the other methods as applicable.

The standards, in general should serve as guidelines and there should be complete flexibility so that the pace of industrialisation, particularly the processes involved in the natural gas industry may be maintained or accelerated as far as possible. The global and regional requirements as well as economic conditions may be kept in view while making statutory provisions for the standards for the industry. But whenever technical know-how is not available nor readily implementable because of logistical, technological, topographical or other limitation such know-how may be suitably generated and implemented on the principle ''polluters should pay".

However as an incentive, certain tax concession may be given to those industries which are well below the standards and certain amount of penalties may be imposed on those which are well above the desired limit depending upon the degree of deviation from standards prevailing in the industry (P&G -1994)

4.8. Negative Environmental Impacts

Offshore, near-shore and upland oil and gas pipelines have different environmental impacts according to different categories and locations of the pipelines and plants. The magnitude of their impacts depends on the type and size of the pipelines installed and the significance depends on the degree to which natural and social resources are affected. Potential negative environmental impacts with mitigating measures in oil and gas development have been described in detail and enclosed in Appendix-F (BCAS,1997).

4.9 Case Study : Magurcharra Gas Field Explosion and Consequential Effects on Environment.

4.9.1 Gas field Explosion

A gas exploration well at Kamalganj in Moulvibazar district caught fire on Saturday night when the gas blew out from 840 metre depth at the time of drilling. The flame from the blazing gas rose as high as 500 feet (Figure 4.7). The sudden fire in the gas well at Block No 14 seriously destroyed the drilling rigs and the machinery. Witnesses said that the fire originated at about 1.20 a. m. in a gas well being operated by Occidental of Bangladesh Ltd (The Bangladesh Observer June 16,1997).

Since the gas well is located at Fulbari tea estate beside the Srimangal-Kamalganj road, railway and road communication with Sylhet was suspended in the interest of the safety of the people. The local administration in the meantime so evacuated the people from the drilling areas that there was no loss of life in the gas fire. The blaze remained confined within 150 feet of the surroundings of the gas well. Local police, fire fighters, railway and road transport authorities were trying to bring down gas fire under control.

Figure 4.7 Magurcharra Incident : Janakantha 16.6.1997

Figure 4.8 Magurcharra Incident : The Independent 22.6.1997

The Occidental company of the USA which had signed the production sharing contract with Bangladesh government was drilling the gas exploration wells. The company immediately contacted Singapore and has taken steps to bring experts, fire fighting machinery and chemicals and other necessary materials by a special plane. They were also trying to bring experts and necessary fire fighting equipment from Houston.

The big blaze from the gas well was continuing in spite of the efforts made by the authorities to bring the fire under control. Fire fighters from eight stations of greater Sylhet district were deployed. But they could make little impact in bringing the fire under control. About three to four kilometre rail track were destroyed by fire bringing a halt to the railway communication between Sylhet and the rest of the country including Dhaka and Chittagong. The gas fire reached within four kilometres of Srimangal town. The flame of the blaze was visible from distant areas. Even people from Sylhet, which is 53 miles from the venue of the fire were watching the big blaze from the roof tops of their houses. The fire has spread panic among the people of Moulvibazer and Srimangal. The government has deployed the members of the Bangladesh Rifles(BDR) who ringed the surroundings of the blaze area to prevent people from approaching the fire.

The production Sharing Contract with Occidental Company of the USA was signed on January 11, 1995. Later on UNOCAL and IFC entered the sharing contract. But as reported, the Occidental USA would bear all responsibilities of the work as operator of other companies. After necessary survey including the geophysical condition of the area, company started drilling of the well from June 4, 1997.

Such accidents were not new in the drilling of exploration well. Similar accidents took place at Haripur in Sylhet in the fifties and Semutang of Chittagong in the sixties. The massive gas fire destroyed timber resources worth Taka 10 crore in the adjoining areas. Tea garden and reserve forest area of 600 acres were damaged by the fire. Law and order situation in the wake of the fire was maintained by the authorities by imposition of section 144 in and around the spot and people of the nearby villages were asked to remain on red alert to avert any catastrophe, few hundred people were also evacuated from adjacent areas.(The Bangladesh Observer June 20,1997).

4.9.2. The Cause & The Aftermath of Explosion.

Three experts Mr. Mike of Alert Disaster Company, Singapore, Mr. Richard Childree and Richard Hatteberq of International Oil Company, Houston U.S.A were observing the fire for working out a plan to extinguish it.

The loss caused by the accident at Magurchhara gas field as reported, might shoot up to TK. 20,000 crore as the whole upper structure of the gas field was on fire. A local geologist and a drilling engineer told UNB on condition of anonymity that the accident was caused by human error and carelessness. They said gross thickness of the upper zone of the gas field was around 80 metres and was expected to be encountered after 800 metres. The gross thickness of the lower zone was around 100 metres and was expected to be encountered at around 2150 metres. The blow up took place as the Occidental drilled up to 480 metres and gas encountered in the upper

zone could not be balanced which resulted in the accident they said. Explaining further, they said a dia metre of 17.5 inch of drilling hole, which was bigger considering the soft formation of the Surma basin due to shallow gas, made the accident inevitable. Drilling engineers and geologists, however, pointed their finger at the Production Concession Division (PCD) of Petrobangla for the accident which they said was also due to the negligence and weak monitoring by the division. The local experts thought that the well design of Occidental was risky and might be one reason for the accident. The experts blamed PCD officials for overlooking the risky well design and giving its approval for reason unknown. President of Occidental Mr. Nigel Hoop hoped that the cause of accident would be known after the enquiry of the prove committee (The Bangladesh Observer June 20, 1997).

It was expected on 22 June, 1997 that it would take another 15 days for the experts to start the crucial task of extinguishing the flames at Magurchhara gas field as the rig needed for digging the relief well was yet to reach Dhaka according to official sources. Bangladesh experts opined that the experts might also spray halogen gas from helicopter to tame the flame, but the process would not be applied if the height of the flame could not be reduced. The experts might also try to seal the gas well by using cement mould. Sands and crystalloid stones were still coming out from the well. The soil around the fire spot has become wet and water was coming out from soil. Mean while, the construction of two kilometre gas by-pass for supplying gas to the tea estates was going on in full swing . The forest sources said that the trees which were affected by the fire would perish in a month or two. No new trees would grow in the area for the next 50 years. The 10,000 acre rain forest around the burning gas field has some of the region's oldest and rarest species of trees including a type used for making perfume and the area was declared a national park in 1996 (The Independent June 22, 1997).

The damage caused by the Magurachhara gas field explosion on 14 June had a great impact in country's forest, railway, roads, tea plantation and of course, the adjacent Khasi Punjis (villages). Property worth TK 200 crore has been damaged. The forest department claims that the accident damaged trees and other forest resources worth TK.179 crore. The Magurachhara forest area is on 4.064 acres of land. On 22 June, 1997, Assistant Conservator of Forest(ACF) of Srimangal said that about 350 acres of forest land has been affected by the gas explosion of which 100 acres of forest land was severely damaged, which includes long rotation (40 years) bamboo groves on 15 acres and short rotation (18 years) forest trees like Segun, Mahogani Ekashira and other valuable trees. Like the Haripur incident in the fifties, some land would become fully barren where no tree or other plant would grow. This would have an adverse effect on environment, forest and people and the loss figure may increase there by See Figure- 4.8 and Figure 4.9.

Twelve tea gardens under Monudolai tea valley were directly and indirectly affected by the gas fire. Of these, Phulbari tea garden of Phulbari tea estates is the worst affected one. About 80 acres of tea plantation has been partly or fully damaged. Production of the rest 11 tea estates stopped totally due to gas supply disruption. These tea gardens were Chatlapore tea estate, Shamshernagar tea estate and Allynagar tea estate of Duncan Brothers, Nurjahan tea estate(private), Madabpore tea estate, Madanmohan tea estate, Sri Govindapur tea estate,

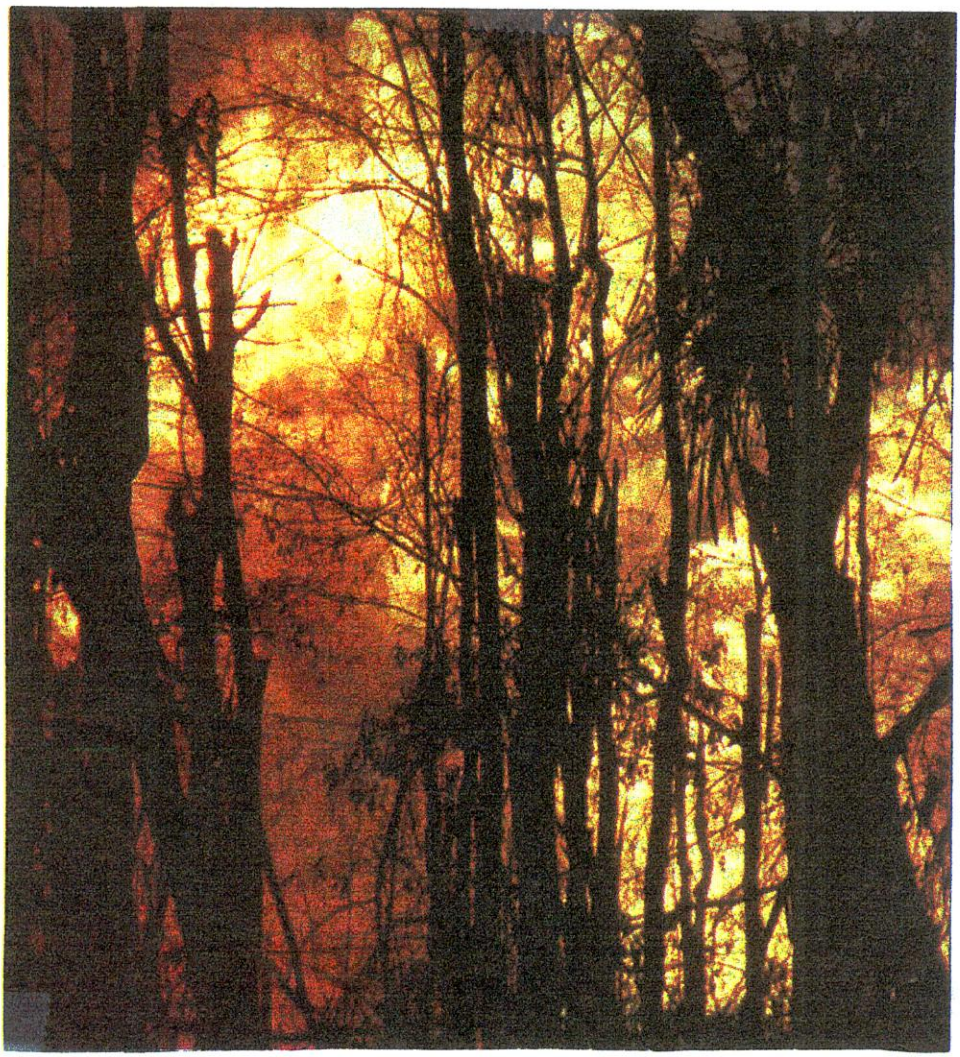


Figure 4.9 Magurcharra Incident : Janakantha 18.6.1997

Figure 4.10 Magurcharra Incident : Ittefaq 18.6.1997

Patrokhola tea estate, Kurma tea estate, Chaparai tea estate of National Tea Company (NTC) and Doloi tea estate and as a result, these 12 tea gardens could not dry up tea leaf and process green leaf in the factories resulting in a loss of 50 to 60 tonnes of tea worth about taka three core daily. (Dhaka Courier, 4 July 1997).

In a statement , the Petrobangla said that the people should not be afraid of the measures being taken by the Occidental for the sake of safety in the gas field area. Representatives of the Occidental said the company had built the base for setting up relief rig as per its earlier plan . But the leakage of gas had necessitated the shifting of rig base for safety (The Bangladesh Observer July 21, 1997).

4.9.3. Remedial Steps

Since the fire has subsided Figure 4.10 work was in progress to drill in new location to cement the well through deviation drilling process. Train line has been repaired for goods train to ply in early November,1997 while passenger train communication has been restored from 26th of November 1997 with subsequent interruptions. Tea gardens were being supplied with gas through construction of a by-bass gas line . But the sufferings of the people and damage as caused to the environment still continue.

4.9.4. Consequential Effects

An analysis of the effects of blow-out included but not limited to the following:
Thermal effects to nearby native vegetation and soil fertility;
Immediate loss of native forest and wildlife habitat;
Potential long and short term loss of soil fertility;
Uncontrolled discharge of water borne contaminants in surface run-off to sensitive down-stream areas;
Destruction of intact native forest for installation of a proposed gas relief well near the blow-out site Significant damage to ground water;
Unburned gas associated with condensate mixing up with air, thus polluting atmosphere;
Gas pressure producing tremendous noise creating disturbance for the habitat;

4.9.5 Environmental Damage and Deterioration .

Preliminary assessment of the environmental damage and deterioration caused by the incident in terms of natural resources, development resources and human interest has been made which reveals as follows (Ahmed, 1997) :

Natural Resources as affected are :

Natural forest (60 ha. complete damage) ;
Land (300ha.) - Completely burnt (100 ha) and partly burnt (Rest);
- Covered with ash and condensate;
- Landslide/Land subsidence;

Wildlife (foxes, monkeys, deer, birds, etc. destroyed or displaced);
Natural vegetation and soil capability (300 ha.) and
Water logging/pollution.

Development Resources as affected are :

Tea Garden (31 ha. completely damaged) ;
Infrastructure - Train line (100 m),2 culverts ;
- Metalled road (100 m),2 culverts;
- Gas line (100m) ;
Livestock (Cattle, hogs etc.) and
Fisheries.

Human Interest Suffered

Local people and Tea garden workers (3000 people affected)
Livestock feeding
Sufferings due to disruption of Communication and transport
Socio-economic disruption (loss of revenue, loss of gas, retardation of development process)
Population/market displacement
Air pollution

4.9.6 Environmental Restoration and Reclamation

Following environmental restoration and reclamation actions are necessary(Ahmed, 1997) Replacement and restoration of burnt soil; Reclamation of land capability of ash/sand covered areas and condensate; covered areas; Plantation and restoration of plant bio-diversity; Plantation and restoration of tea garden; Restoration of wildlife and wildlife bio-diversity; Restoration of gas line, railway, road and other infrastructures; Compensation of socio-economic losses and rehabilitation of displaced and disadvantaged people; Restoration of fisheries in nearby pond and canals that have been damaged and some of the tea gardens severely effected and may never be restored.

4.9.7 Possible Mitigation

Following mitigative measures are essential (Ahmed ,1997) :
Measure to stop the source of gas flow- kill the well;
Or, production well should be drilled close to the source for gas production. Thus gas pressure on blown-out well can be reduced;
Or, extinguish the blaze and cap the well;
Or, drill relief well(s) and then kill the well and
to improve environmental damage, short term and long term mitigation plan should be made.

4.9.8. Killing of Gas Well and Abandonment of The Gas Field

As reported in the Daily Bangladesh Observer of February 3, 1998. the Occidental Company abandoned the gas field on January 9, 1998 following killing of gas well (leaving the burned out properties of Taka 50 crores including Rig, heavy generators, big drilling machinery, steel pipes, toll houses and pajero jeep etc). At the same time the Company started shifting their machinery and equipment from camp sites i.e. Deviation Drilling Site from that date without settling the compensation claims of different parties. In the mean time, one person died and five others were injured in Magurcherra abandoned gas field while searching burnt out properties by digging the mud. Some people have engaged one elephant in carrying out the big iron scraps to a safe place. Train communication has become threatened due to continuous digging of mud near railway embankment in between Bridge No 167 and 168. At any moment a disaster might occur. Kamalgonj police identified the dead as tea labourer Madhusudan Paik aged 19.

Local people said that before leaving the camp-site Occidental foreign officials told their ex-workers to take away the properties of blown up field. From that day hundreds of people got engaged in the abandoned field where they were searching for damaged and burnt out properties of Bangladesh Government including 2 Pajero jeeps. 5 big electric generators, part of machines pipe, cranes, scraps etc. A horrible situation was still prevailing there and people were taking away the valuable iron and scraps from the field under the water by digging mud.

4.9.9. Compensation Claims Lodged

After the abandonment of the gas field by the Occidental, the question of settlement of claims of different government and non- government organisations, tea industries and other private parties who suffered damage and loss of approximately Tk 2500 million due to gas fire has become prominent as reported in the afore mentioned news item.

The break down of same as provided thereof may include but not limited to the following :

Railway	: Tk	300 million
Lauacherra forest	: Tk	1700 million
Khashia Families	: Tk	30 million
Tea Board	: Tk	460 million
Forest Mohalders	: Tk	5.3 million
Phulbari tea estate	: Tk	310 million

Rural Electrification Board : Damage cost of 3 km power line. Apart from above, individual and institutional claims for de-linking of roads and highways, gas pipeline, communication and public sufferings including administration, safety, low and order situation maintenance and other extra overhead involvement claims are likely to be lodged for consideration in due courses of time.

CHAPTER -5
GENERIC ENVIRONMENTAL IMPACTS

5.1. General

5.1.1 Common Themes in the EIA Definitions

It has been observed that the common themes in the EIA definition are as follows:

EIA is a planning tool and is concerned with identification, prediction and assessment of impacts arising from activities such as policies, plans and environment projects which may affect the environment and

The overall objective of EIA is to safeguard the environment and for that matter the major aim of EIA is to improve decisions on development by increasing the quality and scope of information on likely impacts presented to the decision makers and the public.

In fact EIA is not only intended to identify impacts resulting from development actions but also an environmental management planning tool to aid efficient utilisation of national and human resources in economic development.

5.1.2 Need For Methodologies

The need for methodologies arises from the following factors:

The Administrative procedures of EIA varies from country to country;

A national EIA procedure produces EIAs to be used for decision making and attempts to ensure that they are produced to a uniform standard;

but these procedures by themselves can not ensure that

EIA : Contain structured information
Produced in a scientific manner and
Easily understandable to decision makers.

EIA methodologies have been developed to aid;
Identification, Predication and Assessment of Impacts;
EIA methodologies therefore ensures that :
Best possible information from EIA procedures available to decision makers and the public.

5.1.3. EIA Methodologies in General :

Most frequently used EIA methodologies in general may be listed as follows :
Ad- hoc
Check lists : Simple Checklist, Descriptive Checklist;
Matrices : Simple Matrix, Graded Matrix, Weighted Matrix, Environmental ; Compatibility Matrix, Decision Matrix;
Networks;
Environmental Evaluation System (EES);
Overlays;
GIS;
Cost Benefit and
Adaptive Environmental Assessment & Management (AEAM).

5.1.4. Selection Criteria of the Methodologies

Each technique and method for evaluation of impact should have the following qualities and characteristics :

It should be systematic in approach ;
It should be able to organise large mass of heterogeneous data;
It should be able of quantify relatively accurately the impacts;
It should be capable of summarising such data;
It should be able to aggregate the data into sets with the least loss of information because of the aggregation ;
It should have a good predictive capability;
It should extract the salient features and
Finally it should be able to display the raw data and the derived information in a meaningful manner;

5.2. EIA for Energy Development Project.

5.1.2 General Procedures for EIA

Any full scale EIA for the Oil and Gas sector Development Project usually involve the following procedural steps :

Description of the Project;
Environmental Base Line Description;
Scoping;
Bounding;
Field Investigation;
Peoples Participation;
Impact Identification;
Impact prediction;

Classification of Impacts (Nature of Impacts)and
Assessment of Impact.

Following steps are involved in any environmental Impact Assessment:

Prediction : Calculation or judging the amount and direction of changes
Classification: Calculation or judging the type, timing, direction, duration and importance of predicted changes.
Evaluation : Assigning monetary or other values of the estimated impacts.
Correlation : Say, if moisture level reduces below a certain value, the trees may wither.

Assessment also involve evaluation of significance of impacts and identification of impacts that need mitigation and there fore, consideration of Mitigative measures and
Comparison of alternatives are two salient features of the same. Further, following procedural steps are under taken thereafter:

Impact Evaluation;
Costing of Environmental Impacts and
Presentation of environmental Impacts;

5.2.2 Programmatic EIA For Oil & Gas Project

Since any particular methodology as described above does not readily meet the requirement of EIA of the Oil and Gas development project it has been found to be more practical to apply Programmatic Impact Assessment (PIA) for such projects. This should, in general cover the following essential aspects :

Environmental Issues & Considerations;
Environmental Impacts;
Environmental Planning;
Environmental Management;
Environmental Monitoring and
Environmental Auditing.

5.3 Environmental Impacts Associated with Gas Development, Production and Transmission Projects.

Some of the generic environmental impacts associated with gas development, production and transmission project are listed below(WBD,1997)

Land occupation (for seismic surveys, drilling site, treatment plant, access road etc) resulting in involuntary movement of people, crop damage, occupational disruption land use changes, etc;
Erosion and sedimentation, atmospheric impacts;
Disturbance (nuisances such as noise, traffic congestion , interruption of services etc);
Change in water quality and water resources bars;
Impacts on flora and fauna;

Soil contamination;
Impact on cultural heritage including landscape and visual impact;
Impact on waste management;
Socio-economic impacts and
Safety and health related impacts;

The environmental impacts normally associated with establishment of gas based power plants and other industries are :

Change in land use;
Air pollution due to emission;
Thermal pollution of water resources;
Noise pollution;
Change in aesthetic environment;
Soil contamination, sediment and dust pollution;
During the construction phase;
Interference with path ways of wild life and birds and
Waste discharges.

5.4. EIA Requirement for Oil & Gas Development Projects.

Normally, EIAs undertaken to meet the World Bank standard would be expected to include the following (WBW, 1994) :

an executive summary;
a policy, legal and administrative framework;
a project description ;
information on baseline conditions;
examination of environmental impacts;
an analysis of alternative schemes;
a mitigation plan;
an environmental management and training plan and
an environmental monitoring plan;

In addition to the above, the EIA Report produced should also contain as a minimum requirement, lists of all assessment preparers and details of all inter agency meetings. The preparation of any report is consistent only with these requirements and each of the above issues has to be described in detail in relevant subsequent sections.

Essentially , an EIA system must include at least the following steps :

Preliminary activities to narrow down the scope of EIA studies;
Description of the proposed project and of any reasonable alternatives and
Assessment of the likely effect of the project on the environment, economic and social components indicating the nature of effects.

Finally, the selected methodology should be implementable in terms of manpower, funding, data and time requirements.

5.5 Direct and Indirect Impacts in Off Shore and On Shore Oil and Gas Development Projects.

5.5.1 Direct Impacts : Offshore Pipelines

Following statements may be presented to cover direct impacts in building and operating offshore pipeline (WBW,1994)

Installation of pipelines in offshore and near-shore areas may result in the loss of benthic and bottom-feeding organisms from trenching and /or turbidity associated with pipeline laying. The significance of these impacts will depend on the type of aquatic resources affected and the extent these resources are affected.

The construction of the pipeline can result in the temporary re-suspension of bottom sediments. The re-disposition of sediment may alter aquatic habitat characteristics and lead to changes in species composition. The significance of these effects will depend on the type and importance of aquatic organisms affected.

If pipeline trenching occurs in near-shore and offshore areas where toxic chemicals have accumulated in the sediments e.g. harbours near industrial out-falls of toxic chemicals such as mercury and polychlorinated biphenyl (PCBs), the laying of the pipeline can result in a re-suspension of these toxic sediments and temporarily lower water quality immediately above the pipeline. Bio-accumulation of these toxic chemicals may occur in aquatic organisms (e.g. fish and shellfish).

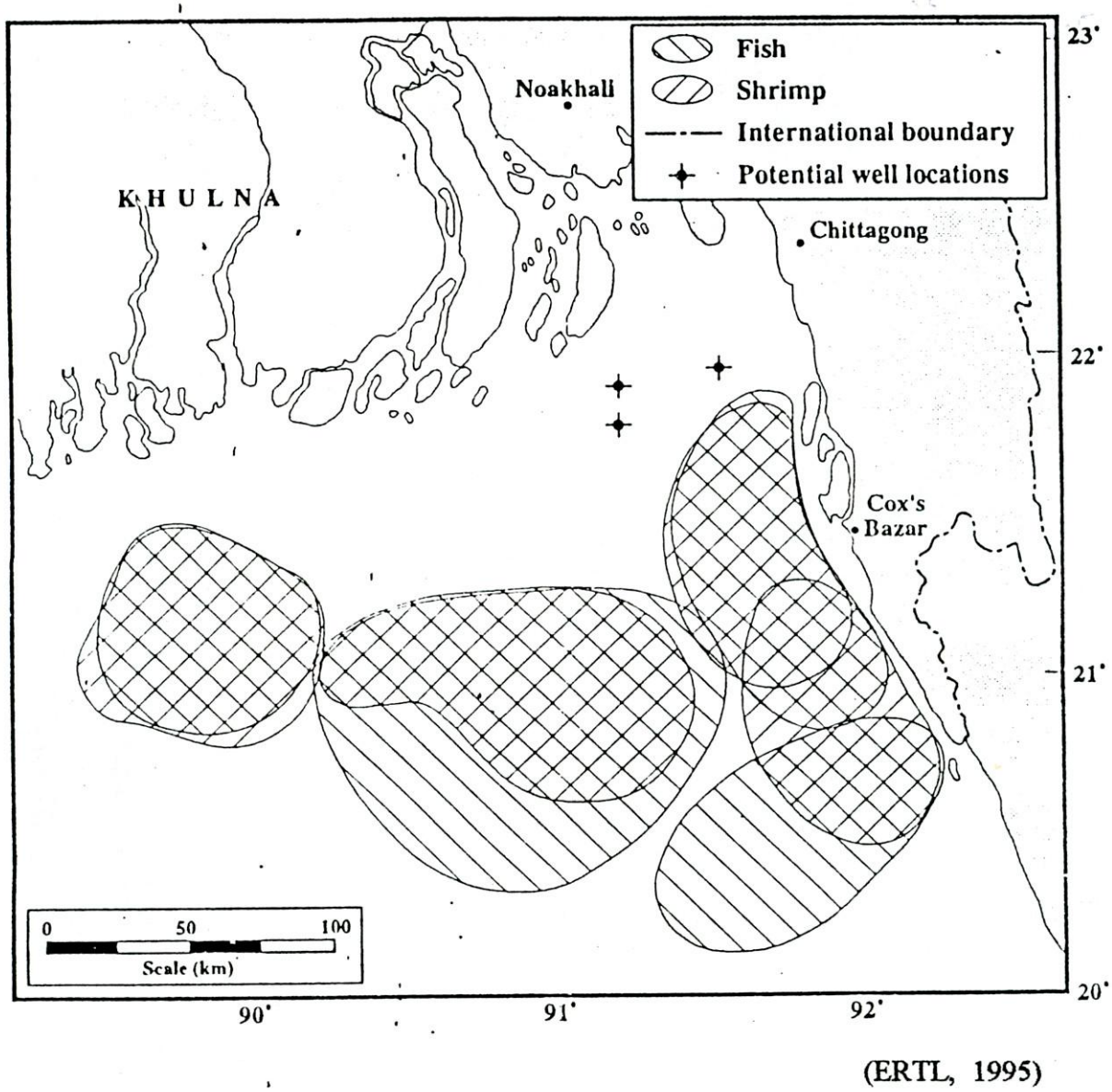
In near-shore and offshore areas used for bottom fishing, pipelines can interfere with bottom trawling, resulting in loss or damage to fishing equipment as well as accidental ruptures to pipelines. Anchor dragging can also result in pipeline damage and oil spills. Figure-5.1 explains distribution of shrimp and fish within 10-100m depth zone in the location of cairn's proposed exploration wells (ERTL, 1995).

5.5.2 *Direct* : Upland Pipelines

Essential environmental elements which are directly affected by upland pipelines may be noted as follows (WBD, 1995) :

Installations of pipelines can lead to erosion in the vicinity of the pipeline . In hilly areas, this can lead to instability in the soils and landslides. Runoff and sedimentation can lower water quality in rivers and streams during construction.

Installation of pipelines and maintenance roads can lead to alteration of drainage patterns including blocking water flow.



(ERTL, 1995)

Figure 5.1 Distribution of Shrimp and fish Within 10-100 m Depth Zone in the Location of Cairn's proposed exploration Wells

Creation of Right of Ways (ROW) can lead to the invasion of exotic plants which may interrupt native vegetation and habitat fragmentation of natural areas (e.g. wild-lands), resulting in the loss of species and lowering of bio-diversity.

In developed areas, oil and gas pipelines can result in the loss of land use and displacement of inhabitants due to the placement of pipeline and substations.

Above ground pipelines can create barriers for humans and migratory wildlife. This could be significant depending upon the length and location of the pipeline.

Archaeological sites are vulnerable to damage or loss during pipeline construction.

Pipeline construction can cause temporary interruption of traffic. This could be significant in developed areas, if the pipeline crosses major transportation routes.

Ruptures and leaks, as well as wastes generated at the pump and transfer stations, can result in to environmental damages in the developed areas, if the pipeline crosses major transportation routes.

Gas pipeline leakage or rupture can cause explosions or fire. In developed areas, such accidents pose significant human health risk too.

5.5.3 Indirect Impacts : Pipelines

The indirect impacts owing to pipe line construction may be as followed (WBD, 1994) Upland pipelines can result in inducing secondary development(e.g. squatters) within the pipeline ROW. This unplanned development can place strain on the existing infrastructure for an affected area.

Upland pipelines can allow access to otherwise inaccessible natural areas(e.g. wild-lands). This can result in degradation and exploitation of these areas.

5.5.4 Alternatives.

The environmental assessment for oil or gas pipeline should include an analysis of reasonable alternatives to meet the ultimate project objective. The alternative analysis may lead to design that are more sound from an environmental , social and economic point of view than that of the originally proposed project. The following alternatives should be considered :

the "no action" alternative (i.e. examine the feasibility of taking any action to meet the needed fuel capacity);
alternative means of delivering the oil or gas(e.g. tankers);
upgrading existing facilities;
alternative routes and substation sites;
alternative methods of pipeline construction including costs and reliability and
alternative pipeline design and materials (e.g. buried versus elevated pipelines)

The appropriateness and inappropriateness of these alternatives should be addressed in relation to technical, environmental and economic factors. Because, oil and gas pipelines are linear facilities, one of the most important alternatives available is in choice of routes. Many of the environmental impacts associated with oil and gas pipelines can be avoided or minimised by careful route selection.

5.5.5. Impact of Drilling : On shore and off shore

Potential environmental effects and their subsequent impacts introduced to the environment by any drilling programme for both on shore and off shore areas are largely attributed to the activities, discharges and emissions at different phases of the events. Such events under varying environmental conditions and characteristics are presented as follows :

Positioning : Rig mobilisation, camp erection/ware barge positioning and Rig positioning ;

Drilling operations : Cutting disposal, drilling mud discharge, well testing, well suspension and well abandonment;

Routine operations : Utility sewage discharges, garbage disposal, flaring, exhaust emissions and logistics and supply and

Accidental events : Chemical spill, small and large fuel oil spills, blow-out, shallow gas, fire and explosions.

Some of the salient features of the programme and associated activities leaving major, moderate or minor impacts on the environment are highlighted below (ERTL,1995.):

Drilling mud and drill cuttings : A variety of estimates exist for the relationship between the volume of mud required for drill cuttings generated. In water based mud drilling, this may vary from between 3 and 15 m^3 of mud per m^3 of cuttings. In addition, variation may occur as a result of the rock porosity and the drilling scheme. Therefore, it is not possible to estimate with any accuracy, the amounts of chemicals/mud that will be discharged with cuttings.

Usually non-toxic, biodegradable and water based mud are proposed for exploration programmes. Only in exceptional circumstances, such as stuck drill pipe, the need for use of oil based mud arise. All fluids and cuttings normally return to the rig where cuttings are passed through a solid control system. This allows the mud to be separated from the cuttings for re-circulation before the cuttings are discharged.

The actual composition of the mud may influence the onshore and sea bed organisms. Mud has relatively high level of organic components, which can give rise to organic environment effects. This may Significantly alter the benthic fauna. Components such as short chain polymers, for example, starches, are broken down readily by bacteria, providing a food supply for higher organisms. In contrast, the toxicity of some chemical components within the water based mud

can lead to the migration or mortality of local fauna or flora as well as a potential reduction in oxygen levels.

Sewage discharges : These include all sanitary wastes and grey water that is water from showers, sink and garbage disposal etc. In general, it is assumed that one person produces 100 litres per day of sewage effluent comprising 100g of faceal matter and 10g of urea. In addition, 220 litres per day is contributed per person as grey water. The later is usually water with traces of edible oils and soaps. Sewage discharges in off shore operations occur below the surface of the sea and may have a typical associated biological oxygen demand (BOD) of between 200 and 700 mg/l for 50 persons on the rig and support vessel. Thus a BOD release of 6.4 -22.4 kg per day (2.3-8.2 tonnes per year) may be expected from any such operation.

Drainage discharges : During exploration drilling as in most industrial processes, it is un-avoidable that their will be the requirement for the discharges to the environment and usually occur from a variety of sources on the rig. These include clean area floor drains, deluge drains, machine area floor drains, bunded area beneath fuel or chemical storage areas and over flow drains in diesel fuel tank systems. Non-oily waters are discharged without any cleaning and treatment. But the ones contaminated by oils or chemicals are routed to the oily water drainage. The levels of discharge will vary according to the levels of rainfall and phases of operations being conducted.

Wastes: A number of operational and non-operational solid wastes will be generated as part of any proposed drilling programme. This may include utility garbage, scrap, food packaging materials and special hazardous wastes such as, spent batteries, fluorescent tubing, paint tins and sharps. These are usually collected, appropriately segregated and stored and disposed of. Those wastes, for example paper goods wooden pallets, chemical sacks etc. which may be safely burnt are incinerated with negligible effects upon the environment.

Atmospheric Emissions : Atmospheric emissions from drilling operations may occur from a number of potential sources. These are dominated from diesel power generators and flaring of well test fluids. A number of environmental issues are associated with such emissions including air quality, acid precipitation, the production of green house gases and damage to the ozone layer. The following list describes the gases that may be potentially released with comments on their environmental implications :

Methane	(CH_4)	:	Green house gas
Carbon monoxide	(CO)	:	Toxic at high concentration
Carbon dioxide	(CO_2)	:	Green house gas
Nitrogen oxides	(NO_x)	:	Toxic and contribute to acid precipitation
Hydrogen sulphide	(H_2S)	:	Toxic
Sulphur dioxide	(SO_2)	:	Toxic and contribute to acid precipitation
Volatile organic compounds	(VOC)	:	Contribute to petrochemical smog

Certain meteorological conditions in the drilling area are not benefited from the dispersion of such emissions and wind strengths influence the concentration levels and thereby impact on environment. It has however been experienced that minor, insignificant bird kills some times result from venting or flaring operations in offshore platforms. This only affects those birds that are resting close to or on the flare tips. However , since a very small number of birds visit the rig the impact on birds are negligible.

Blowouts : A blow-out occurs when both primary and secondary well control procedures have failed to contain reservoir fluids .When a blow-out occurs, the entire column of mud is expelled with great force from the hold along with the drill string. This is followed by either gas, oil, water, or a mixture in gush which envelops the rig. In this instance, gas is expected and there is potential for these to ignite . If this happens, the entire rig is likely to be destroyed and contingency arrangements are necessary to deal with such a situation.

The environmental consequences are associated with the resultant gas. Until the blow out can be brought under control or the field depleted, a plume of gas, in this case, predominantly methane will travel down the rig. If this gas is ignited, a smoke plume will be produced that will contain CO_2, CO, unburnt CH_4 and contaminants from the rig and depending on height and dispersion level and proximity to habitats may threaten human and wild lives and result in major catastrophes.

Shallow gas: The resultant environmental effects of striking a shallow gas pocket are very similar to those of a blow out. Shallow gas occurs in the upper sediments as relatively small pockets. If hit by a drill bit, there is a rapid upward migration of gas from the pocket. In offshore drilling operation, shallow gas may disturb large areas of sea bed causing many particles to become re-suspended. This can disrupt the stability of the supporting legs of jack-up drilling rig causing the rig to sink. Similarly the water below a floating rig may become so gaseous that the rig sinks. One way of avoiding potential problems is to site the rig away from shallow gas areas and to use a directional drilling technique.

Fire and Explosion : A potential for fire and/or explosion exists in all environments with a suitable source of heat, fuel and oxygen . Thus, oil and gas exploitation activities run on elevated risk of fire either due to wrong design, bad practice or from mechanical failures. Such fire, unless controlled within reasonable time and extent may cause serious impact on the environmental elements apart from loss of lives and valuables on the rig and surrounding area. However, with introduction of appropriate training courses and operating practices most fires can be prevented.

5.6 Environmental Planning for New Facilities.

5.6.1 Study Objectives

"Wilderness is the raw material out of which man has hammered the artefact called civilisation." - Aldo Leopold

The above quote illustrates why it should be considered to use the limited available resources, treat them with love and respect, and conserve these for our next generation.

The requirements of long-term national development generate a need for proper identification, quantification and assessment of environmental effects. Understanding effects allows planning to mitigate against potential environmental impacts. Development options should be clearly identified by this process in order to minimise impacts. However, for accurate impact assessment, the connection between existing environmental conditions and development activities needs to be well understood.

Resource use and management systems should be integrated with these developments. The main environmental constraints to development, in consideration of future gas infrastructure expansion, require proper identification.

To this end, it is anticipated that existing trends of impacts from infrastructure programs for oil and gas developments can be used as indicators of incremental development impacts. By using the past as a key to the present it is intended that environmental sustainability of existing resource exploitation can be maintained by minimising impacts. To accomplish this , aspects such as population size and growth, agricultural development, terrestrial and aquatic habitat destruction or conversion, soil degradation, pollution, and other relevant factors must be considered.(KIL,1994).

5.6.2. Broad Objectives

The main objectives in broader sense for development and planning process with due environmental considerations for the new project are :

Development of comprehensive sets of safety standards and environmental protection regulations covering exploration, production, processing, transmission, distribution, marketing and end use.;

Development and implementation of an adequate environmental and safety management system for each operating company which shall include procedures for conducting mitigation and monitoring.;

Assess the human resources requirements of administering the environmental and safety aspects and assist in developing managerial and professional staff resources through a program of in-country and overseas training and new recruitment, and

Assist in putting into place a mechanism process for ensuring adequate public consultation and for stimulation of public awareness and support for enhancing environment protection and safety.

Confirmation of the environmental laws of Bangladesh is yet another aspect to be covered in such considerations. At present , not with standing other relevant acts, rules laws and conventions are in force, the prevailing law is the Environment Conservation Act-1 of 1995 (Appendix-A.B& C).

5.6.3 Scoping and Bounding of The Study Areas

A scoping process has to be used to identify and focus on the following :

environmental issues of importance to all interested parties and
identification of Important Environmental Components (IECs).

The scoping process is accomplished by integrating the knowledge from available sources, including the following:

archived information sources including literature and reports on previous projects ;
expert opinion from technical specialists, national, regional and local government officials and Non-Governmental Organisations (NGO's) and knowledge gained through reconnaissance and communication with local communities.

Following identification of IECs, these are evaluated in terms of :

distribution (within the study area and elsewhere);
quantity, quality and seasonally;
interaction with other resources and IECs (dependency or effect);
availability of substitutes and
historical or cultural importance.

A bounding process is used to identify the :

physical factors, especially watershed boundaries;
ecological boundaries, especially agro-ecological regions and sub-regions, which encompass the spatial and seasonal ranges occupied by biological populations and
social and administrative boundaries, including regions, districts and thana boundaries.

Watershed boundaries include areas both upstream and downstream of the immediate project site within which project effects are expected to occur. Boundaries also include the areas within which off-site and cumulative impacts need to be considered.

In environmental studies conducted so far, the foregoing principles have been followed and in general ,the bounding used the gas field as a fundamental unit of study. The study area was bounded by inclusion of all mauzas with Petrobangla field facilities. Where impacted areas extended beyond the mauza boundary, then the area was expanded to incorporate these limits. (KIL,1994).

5.6.4 Solid Wastes

Project sponsors are to manage solid wastes that are generated in the course of operating the facility through inclusion of the following practices :

Project sponsors should recycle or reclaim materials where possible and if recycling or reclaim is not practical, wastes must be disposed of in an environmentally acceptable manner and in compliance with local laws and regulations.

5.6.5. Other Environmental Requirements

The impact of the noise from the operation of the facility is to be taken into consideration during the design and operation of the facility. Noise levels from the project's operation, measured at noise receptors located outside the project property boundary, should not exceed the limits shown in Table - 1.6.

Effluents should be sampled and measured weekly for the common parameters such as BODs, suspended solids, P^H, oils and grease and flow. Project specific pollutants that are present in the effluent will have their sampling frequency specified by IEC. Leachates from solid waste disposal sites should be sampled and tested monthly using strategically located sampling points. Parameters to be tested will depend on the nature of the potential leachate and the frequency and method of monitoring pollutants in the stack discharge are specified by IEC.

5.6.6. Record Keeping and Reporting

The project sponsor is required to maintain records of air emissions, effluents, and hazardous wastes sent off site as well as significant environmental matters such as spills, fires and other emergencies that may have an impact on the environment. Information should be reviewed and evaluated to improve the effectiveness of the environmental protection plan . An annual summary of this information is to be provided to IEC in an Environmental Monitoring Report.

5.6.7. Key Issues for Environmental Control

The following Statement summarises the key production and control practices that will assist in meeting emission requirements :

Where feasible, choose energy efficient and environmentally sound processes;
Ensure that control, treatment and monitoring facilities are properly maintained and that they are operated according to their instruction manuals.

CHAPTER- 6
ENVIRONMENTAL MANAGEMENT AND MITIGATION AND MONITORING MEASURES

6.1. Health and Safety Requirements for New Projects

6.1.1 Environmental Health and Safety Issues of Natural Gas Transmission System.

The World Bank/IEC has written environmental guidelines that are used in new projects in which the Bank considers investing. The following general health and safety guidelines have been prepared to be used together with the environmental guidelines for new IEC projects.

The principal elements of World Bank policy regarding right-of-way alignment, land acquisition, compressor station siting and creation of access (e.g. roads) in otherwise inaccessible environmentally sensitive areas are summarised below. The sponsors' policies regarding alignment of these rights of way should be in relation to the applicable guidelines (WBW,1994).

All new rights-of-way should be aligned taking environmental factors into consideration, in a manner which will minimise to the extent possible, the need for physical alteration and the impact on sensitive natural environments, cultural resources, agricultural lands and residential and commercial areas;

Land acquisition must be carried out in accordance with World Bank resettlement guidelines which require identification and quantification of any impacts on land-based livelihood, and compensation to landowners and people relying on the land for their livelihood;

Where rights-of-ways are to be established through remote and currently inaccessible environmentally sensitive areas, the potential impacts on the natural environment, indigenous populations, population immigration and natural resource exploitation must be assessed and measures adopted to minimise these impacts. Typically, positive measures should be provided to control population influx to remote areas due to increased access created by the pipeline right-of-way, and to prevent associated secondary impacts. Environmental impacts of proposed projects should be minimised through such measures as visual impact considerations in siting and design, restricting right-of-way use by unauthorised persons, erosion and sediment control during and after construction, and use of low-impact maintenance procedures. Other guidelines specific to gas pipelines include but not limited to the following :

Positive pipe corrosion control measures;
Program of periodic inspection and maintenance;
Pressure sensors connected to alarms and automatic shutdown systems;
Metering system so designed to provide continuous input/output comparison for leak detection;.
Adequate engineering design providing adequate protection from likely external physical forces and Accurate and complete records of all inspections, leak incidents, unusual events and safety measures taken.

6.1.2 Workplace Air Quality

Periodic monitoring of workplace air quality should be conducted for air contaminants relevant to employee tasks and the plant's operations. Ventilation, air contaminant control equipment, protective respiratory equipment and air quality monitoring equipment should be well maintained. Protective respiratory equipment must be used by employees when the exposure levels for welding fumes, solvents and other materials present in the workplace exceed local or internationally accepted standards, or threshold limit values (TLVs) as annually published, for example, by the American Conference of Governmental Industrial Hygienists (ACGIH) in ''Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices''.

6.1.3 Ambient Noise

The impact of the noise from the operation of the facility is to be taken into consideration during the design and operation of the facility. Noise levels from the projects operation, measured at noise receptors located outside the project property boundary, should not exceed the limits shown in Table- 1.6

6.1.4 Works In Confined Spaces

Prior to entry and occupancy, all confined spaces (e.g. tanks, sumps, vessels, sewers, excavations) must be tested for the presence of toxic, flammable and explosive gases or vapours, and for the lack of oxygen. Adequate ventilation must be provided before entry and during occupancy of these spaces. Personnel must use air-supplied respirators when working in confined spaces which may become contaminated or deficient in oxygen during the period of occupancy. Observers/assistants must be stationed outside of confined spaces to provide emergency assistance, if necessary, to personnel working inside these areas.

6.1.5 Health - General

Sanitary facilities should be well equipped with supplies (e.g. protective screens) and employees should be encouraged to wash frequently, particularly those exposed to dust, chemicals or pathogens. Ventilation systems should be provided to control work area temperatures and humidity. Personnel required to work in areas of high temperature and/or high humidity should be allowed to take frequent breaks away from these areas. Pre-employment and periodic medical examinations should be conducted for all personnel and specific surveillance programs instituted for personnel potentially exposed to toxic or radioactive substances.

6.1.6 Safety - General

All installations shall be designed and operated to protect the health and safety of employees and the community. The following are recommended safety procedures and practices for the workplace :

Shield guards for guard railings should be installed at all belts, pulleys, gears and other moving parts;

Elevated platforms and walkways, and stairways and ramps should be equipped with handrails, toe-boards and non-slip surfaces;

Electrical equipment should be grounded, well insulated and conform with applicable codes;

Personnel should use special footwear, masks and clothing for work in areas with high dust levels or contaminated with hazardous materials;

For work near molten or high temperature materials, employees should be provided with non-slip footwear, gloves, safety glasses, helmets, face protection, leggings and other necessary protective equipment;

Eye protection should be worn by personnel when in areas where there is a risk of flying chips or sparks, or where intense light is generated;

Personnel should wear protective clothing and goggles when in areas where corrosive, reactive, ignitable or toxic materials are stored or processed.

Emergency eyewash and showers should be installed in areas containing corrosive materials;

A safety program should be established for construction and maintenance work and

A fire prevention and fire safety program should be implemented and include regular drills.

It may be noted that a complete list of hazardous substances and threshold quantities that require a hazard assessment is included in the World Bank publication ''Techniques for Assessing Industrial Hazards'' World Bank Technical Paper Number 55,1988, and a major hazard assessment is also required for any process operating at a pressure greater than 50 bars, when the product of pressure (in bars) and pressurised volume (in m3) exceeds 10,000 (WBW, 1994).

6.1.7. Drinking Water

The guidelines for drinking water quality apply when sponsors are responsible for the projects' drinking water supply. Sponsors should use the drinking water standards that are published by the World Health Organisation in "Guidelines for Drinking Water Quality, Health Criteria and the Supporting Information" or equivalent.

6.2. Occupational Health & Safety Records and Review.

Records of job related accidents and illnesses incidents shall be maintained. The records shall include all incidents resulting in an incapacity to work for at least one full workday beyond the day on which the accident or illness occurred. Records must also include the total number of days of absence from work as the result of an incident.

The sponsor should maintain records of significant environmental matters, including monitoring data accidents and occupational illnesses and spills, fires and other emergencies. This information should be reviewed and evaluated to improve the effectiveness of the environmental, health and safety program. An annual summary of the above information should be provided to IEC (WBW ,1994).

6.3 Mitigation Measures, Alternatives & Uncertainties

6.3.1 Mitigation Measures :

Mitigation measures including enhancement and monitoring primarily involve affirmative actions answers to the following :

Proposed mitigation measures should be appropriate and effective;
Reasons for mitigation measures for other impact categories should be indicated;
Mitigation measures Should be assessed, evaluated and documented ;
Proposed monitoring should be appropriate ;
Mitigation measures must establish their effectiveness;
Minimum degree of impacts should remain after applying mitigation measures;

Where adverse impacts are indicated, the EIA should explore measures for minimising and/or offsetting the same and opportunities for enhancing natural environmental resources/ value and

An appropriate plan should be developed and described for monitoring effectiveness of mitigation measures and projected impact.

6.3.2 Alternatives

It is expected that before firming up any mitigation measures, suitable alternatives are evaluated as follows :

The alternatives should make sense;
It should identify a set of possible alternatives in terms of location, equipment, operation procedure and engineering design ;

I has to quantify costs and benefits of each alternative including consideration of environmental effects ;

It should compare the benefits and costs of these alternatives ;

It should develop a set of selective criteria for selecting the best alternative and

There should be a selected set of feasible alternatives.

6.3.3 Uncertainties

Following steps are usually considered for assessing the uncertainties (ESCAP,1985)

It has to be found out what is known and with degree of certainty what is not known and with reasons (e.g. experimental difficulties, lack of theory thereof ;

It is also important to find out what could be known with reasonable additional investments of labour, facilities and money what should be known (i.e. not everything possible to know, it is necessary for prudent progress). Based on such assessment further actions are taken.

6.3.4 Training

Employees should be trained on the hazards, precautions and procedures for the safe storage, handling and use of all potentially harmful materials relevant to each employee's work area.

Training should incorporate information from the Material Safety Data Sheets (MSDSs) for potentially harmful materials including radiation hazards in Non- Destructive Testing (NDT) operations involving X-ray or gama ray radiography .

Personnel should be trained in environmental, health and safety matters including accident prevention, safe lifting practices, the use of MSD, safe chemical handling practices, and proper control and maintenance of equipment and facilities.

Training also should include emergency response including location and proper use of emergency equipment, use of personal protective equipment, procedures for raising the alarm and notifying emergency response teams and proper response actions for each foreseeable emergency situation.

6.4 EIA Regulatory Process for Industrial and Oil and Gas Sector Projects in Bangladesh

At the screening stage, industrial projects are classified into four categories e.g. Green, Amber-A, Amber-B and Red based on classification of industrial units by the Department of Environment (DOE, 1997). Details in respect of these categories are given below :

Projects categorised as "Green" do not require an Initial Environmental Examination (IEE). However the project proponent will have to submit an application in a prescribed format with general information pertaining to the industry, description of raw materials and finished product

accompanying no objection certificate (NOC) from local authorities. The environmental clearance has to be renewed every three years.

Projects categorised as "Amber-A " also do not require an IEE, but the application has to be submitted to the DOE, along with an NOC and process flow diagram, layout plan, effluent discharge system etc. in a prescribed format. After reviewing the application, environmental clearance could be given with or without conditions. The discharge permit is to be renewed every year.

The "Amber-B" projects require IEE and environmental management plant (EMP), an NOC, pollution mitigation plant (PMP), etc. for obtaining site clearance. Once it is given, environmental clearance has to be applied for. Upon review of the application, if permission is accorded, it has to be renewed every year.

"Red" projects, first require an IEE, EIA, NOC, PMP and out line of relocation plan for obtaining site clearance. Once site clearance is given, the proponent can go ahead with construction subject to conditions that may be stipulated while granting the site clearance. After which environmental clearance would be given by the DG, DOE, with suitable conditions. Such clearance will be subject to renewal after each one year period.

It may be observed from of the project categories that all mining projects including natural gas, fuel oil refinery and gas based industrial projects, fertiliser factories and power plants etc are placed in the red category and therefore, EIA process should proceed accordingly (WBD,1997).

6.5 Environmental Audit & Inspection.

6.5.1 Environmental Audit

It is just one component of an Environmental Management System and is similar to other types of the Management Systems. The three phases of management consist of Planning, Organisation, and Control. In this perspective Environmental Auditing is the verification and evaluation of an organisation's Compliance with regulatory requirements, Conformance with policies, standards, and procedures and Control's programs and routine management practices.

There are several types of environmental audits being conducted within the petroleum industry. The type of audit being used is primarily dependant on the facility or operation being audited and the purpose of the audit. There is always some differences between the different types of audits. Further, auditing standards also vary from audit to audit and from company to company and usually aimed to reflect the overall purpose of the audit being conducted.

Generally accepted environmental auditing standards have been evolved over the past years within the private and public sectors of the energy development industries. But the official auditing standards for oil and gas development projects have not been established yet either in Bangladesh or in other developed countries. For instance, the Canadian Standards Association is

currently developing auditing guidelines in conjunction with the Canadian Environmental Auditing Association and Environment Canada (PITS,1996).

In general there are 5 types of environmental audits. These are Management Audits, Exploration Audits,Production Audits, Baseline Audits and Maintenance/Operational Audits.

The benefits accrued from and environmental audit are, but not limited to the following (PITS, 1996) :

improved compliance;
improved effectiveness of environmental management;
improved awareness of environmental requirements;
better corporate decision making;
identification of priorities for limited resources;
improved communications within company;
improved communications with government;
improved health and safety on work-site;
basis for due diligence defence;
keep banks and insurers happy;
keep shareholders happy and
improved public relations.

6.5.2 Environmental Inspection

Any Environmental Inspection is carried out through well prepared checklist. In other words the Environmental Site Condition Checklist is designed to be used when inspecting smaller facilities such as batteries, satellites, compressor stations and individual well sites. The Audit Questionnaire should be used on the sour facilities and larger plants.

The checklist should be used as tool to remind the person or persons inspecting the facility to address the various categories if applicable. Once the inspection is complete, the information collected and documented on the checklist should be used to generate a report including recommendations that operations can use to correct the possible shortcomings. The check list may include but not limited to identification and remedial actions in respect to Wellhead Leaks, Wellhead Vent, Valves and Controls, Spill On Lease, Pit Condition, Lease Condition, Lease Identification, Fencing, Access Road, Erosion control, Chemical Storage, Fuel Storage, Tankage, Load Lines, Solid Waste Disposal, Liquid Waste Disposal, Relief Valves, Flare Stack, Spill Response, Building Condition, Equipment Protection, Pipeline Maintenance, Noise, Residences, Wildlife and Livestock.

List of all non-satisfactory categories are prepared and a very brief note is made on the problem, its priority and target date for action to be completed. All notes pertaining to the inspection are made and these notes are usually utilised for writing the report. Complete and comprehensive report on the inspection are then made accordingly.

6.6 Decontamination & Reclamation

6.6.1 Decontamination Versus Reclamation

Decontamination involves the removal or neutralisation of a chemical substance or hazardous material from a site to prevent, minimise or mitigate potential damage and liability e.g. contaminated soil and/or ground water. On the other hand land reclamation involves repairing a surface disturbance and such reclamation begins only after decontamination has taken place. Requirement of that clean-up is usually known from one or more of the following :

visible signs of spills;
flare pits and ponds;
results from environmental audits;
complaints e.g. water quality, lack of crop growth, livestock illness;
evidence obtained during decommissioning and
discussions with operations staff.

6.6.2 Environmental Restoration

Land is scarce in Bangladesh and all lands used or being used by development projects including well drilling, pipe laying and operation etc are required to be environmentally restored and reclaimed.

Environmental damage and degradation by oil and gas drilling include :

deterioration and destruction of land quality;
deterioration of water resources;
deterioration and destruction of biological resources;
disturbances and dislocation of wildlife and
disfiguration of landscape.

Environmental restoration & reclamation of land include all practicable and desirable methods for the following (PITS, 1996) :

designing and conducting a surface reconstruction in a manner that enhances the potential of disturbed land to be reclaimed to equivalent land capability;
removal and replacement of contaminated and degraded soils in a manner that ensures reconstructed soils have an equivalent soil capability relative to the soils that existed prior to disturbances ;
contouring the surface to meet the land capability objectives, as well as to ensure stability; protect the surface against wind or water erosion, provide for surface drainage and minimise hazardous conditions;
re-vegetating and managing the land to meet the land capability objectives and
re-establishing surface water resources.

6.6.3 General Development and Restoration Criteria

General Principles followed in the development & restoration process may be as noted below :

well defined restoration and development objectives;
adherence to conservation and restoration principles and
minimisation of adverse effect and disturbances.

Different environmental components considered in the restoration process include but not limited to water shed management, replacement of soil, re-vegetation and physical infrastructure. Each such individual components is further studied in the following perspectives :

Water Management :

watershed management;
water yield, on-stream water flow, water quality;
aquatic and fisheries habitat and
water supply and irrigation potentials;

Replacement of Soils :

elimination or control of undesirable materials;
back-filling and contouring;
slope stability;
soil replacement for restoration of agricultural capability;
commercial forestry capability and
soil quality.

Re-vegetation : grass cover, plantations, restoration of genetic bio-diversity, wildlife capability and recreational capability.

Physical Infrastructure :

The safety from potential hazards are identified taking into consideration of existence of the underground utilities e.g. gas, power and oil. Further, under ground storage tanks may contain flammable materials. Simultaneously aboveground piping and vessels are also checked for flammable materials and pressure situations. Further more, hazardous materials like asbestos, hydrocarbons, solvents, chemicals and H_2S etc as well as excavations, demolition including removals of overhead utilities and structure are also considered as sources and or causes of potential hazards.

6.6.4 Hazardous Materials and Wastes

The general guidelines as per World Bank recommendation states that any sponsors of new project facility shall, whenever possible, substitute the use of non-hazardous materials for

hazardous materials. All hazardous wastes, process residues, solvents, oils and sludge must be properly disposed of . Leachates that contain hazardous pollutants must not exceed the permissible liquid effluent levels . Management measures for handling hazardous wastes and materials should be implemented and can include the following (WBW, 1994) :

All hazardous reactive, e.g. flammable, radioactive, corrosive and toxic materials must be stored securely in containers or vessels.

Storage and handling of hazardous materials must be in accordance with local regulations, international standards and appropriate to their hazard characteristics.

Storage and liquid impoundment areas for fuels, raw and in-process materials, solvents, wastes and finished products should be designed with secondary containment e.g. dikes, berms etc to prevent spills and the contamination of soil, groundwater and surface waters .

Fire prevention systems and secondary containment should be provided for storage facilities, where necessary or required by regulation, to prevent fires or the release of hazardous materials to the environment.

Asbestos and asbestos containing materials (ACMs) are not to be used in new installations or products. The need to remove asbestos and ACMs from existing applications shall be evaluated on a case by case basis. Disposal of removed asbestos and ACMs should be done in accordance with the requirements and/or important environmental components (IECs) guidelines.

Formulations containing chromates should not be used in water treatment processes. Transformers or equipment containing polychlorinated biphenyls (PCB)s) or PCB contaminated soil should not be installed and existing equipment involving PCBs or PCB-contaminated soil should be phased out and disposed of in a manner consistent with the requirements of the host country and/or IEC's guidelines.

6.6.5 Safety from Potential Hazards

The following procedures are usually applied to safe work procedures and to attain safe operations of the decontamination activities :

disconnect and lock-out power, de-pressure and purge equipment with nitrogen, air, and water as applicable;
evacuate fluids from all tanks, lines, etc. and haul hydrocarbon based products to reclaimers; close off inlet and sales line by blind flange;
purge buildings of combustible gases;
unbolt piping connections to equipment and cut-off pipe welds;
disconnect power and instrument cables and remove lighting;
remove equipment and buildings, however, keep office if required and

remove aboveground and under ground piping and remove storage tanks including foundations (it may be noted that the depth of removal depends on land-use and amount of re-grading and sub-soiling required (minimum depth of removal=1.0m) and remove fencing (such removal is also dependent on land-use,. however, typically leave fencing in place until clearance is issued).

The following issues are pertinent in the decontamination process :

The utilities to be considered usually includepower, telephone, sanitary sewage, water supply, gas and other pipelines e.g. oil, gas, water. The utility companies often need notice up to 6 months.

Equipment Recovered Through Salvage Opportunities can be re-used at other locations or sold. Similarly piping and metals can be sold to re-cyclers as long as it is not contaminated.

Further, gravel and concrete can be buried on-site with landowners approval.

6.6.6 Pre-Construction Assessment

Objectives of pre-construction assessment are to define pre-construction control conditions and to satisfy regulatory requirements where conservation and reclamation approvals are required. Activities in such assessment includes visual inspection of document, landscape and vegetation both on-site and off-site to identify any disturbed areas. Soil sampling is yet another method to establish classification of different horizons, and determination of thickness of each of these horizons. Further, it has to be ensured that sufficient samples are taken to define variability across the site.

6.6.7. Pre-Reclamation Assessment

Objectives of Pre-reclamation assessment are to determine requirements for dismantling activities and equipment, extent of disturbance, presence, nature and extent of subsurface contamination, if any, and the amount of reclamation required.

Process of such assessment comprises of a 2-phase approach. Phase-I involves Site Reconnaissance and Preliminary Review and Phase-II involves Detailed Review and Site Investigation to be carried out if subsurface contamination is suspected.

The Objectives of Phase -I are to identify dismantling requirements, identify and characterise potential contamination, determine if Phase II is required, characterise soils and adjacent land-use, establish environmental setting of site, identify receptors and to estimate reclamation costs.

The Activities involved in pre-reclamation assessment include review of site files for listing of components and processes, operational history and spill records, chemical use e.g. sterilants, pesticides and construction and drilling records.

In this process site inspections are carried out to identify visual signs of contamination, on site and off-site, equipment and infrastructure to be removed, surrounding land-use, topography and vegetation, location of surface water and water wells, review of aerial photographs, locate and identify underground pipelines, electrical, phone, etc.

Further, relevant data review done for the purpose includes spill data base, facility applications and approvals as well as review of regional soil and groundwater data from published reports and water well drilling records.

The job of shallow soil sampling involved in the works are aimed to locate and assess volume and quality of topsoil, identify volume of gravel to be removed, evaluate lease subsoil utility including compaction, admixing and compare on-site conditions to background. The inorganic assessment with respect to electrical conductivity and P^H and organic assessment i.e. hydrocarbon vapours are also carried out in this stage.

Operations Staff are also contacted for identification of locations of reclaimed sumps and pits from drilling operations, locations of old flare pits/landfills, spill incidents, unproductive land locations and the clean-up procedures used.

Landowner/Tenants are also contacted to know the unproductive land locations, site history, problems, spills and their reclamation expectations.

At the end of all these activities, it is reviewed to see whether sufficient information is available to determine the equipment and facilities that are on-site and which need to be dismantled.

It is further checked whether sufficient information is available to determine whether or not soil, groundwater and/or surface water contamination has resulted from the operation of the site.

If so present, it is determined whether sufficient information is available to enumerate the extent and chemical nature of any soil, groundwater and/or surface contamination;

If the answer is yes to all, decommissioning and reclamation may proceed and

If the answer is no to any of the observations, then activities relating to Phase-II have to be undertaken.

In general Phase II activities involves sampling with the objective of determining nature and extent of subsurface contamination.

The components of phase II consists of planning, soil sampling, groundwater sampling, sludge sampling, geophysical surveys and analysis in field and in laboratory. The Sampling Planning process includes sample location selection in respect of background versus on-site versus down-gradient, direction of groundwater flow and sample composting. Discussions are also held with Analytical Laboratory to fix-up analytical parameters, volume of sample, type of sample

container, sample preservation, samples storage and transportation. Sample equipment cleaning is always ensured to avoid cross contamination.

6.6.8 Decontamination Options

The options involved in the decontamination operations are as follows (PITS, 1996) :

leave material in place;
land-spread on-site;
landfill;
road application;
oilfield reclaimer;
solidification/stabilisation;
thermal desorption;
soils washing;
bio-remediation;
salt cavern disposal;
carbon adsorption and
hazardous waste treatment facility.

References may be made to Recommended Oilfield Waste Management Requirements or equivalent for consultation .

6.6.9 Reclamation

The basic components of any reclamation process are soils handling and re-vegetation. However, the general procedures in reclamation process may be considered as follows (PITS, 1996):

carry out subsoil clean-up;
strip back topsoil to provide working area;
strip gravel from road and lease and screen to recover topsoil if mixed ;
recover and stockpile topsoil;
decompact subsoil;
grade subsoil to restore drainage patterns;
place topsoil;
add amendments if required ;
apply fertiliser;
apply seed and
foster plantation.

CHAPTER - 7
CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Bangladesh is blessed with substantial reserves of natural gas. At present 61% of the total commercial energy requirements is met by natural gas. It is expected about 1.5-2.5 Trillion Cubic Feet TCF of natural gas will be withdrawn from about 10 TCF of known reserves during the next 10 years.

Bangladesh is a disaster-prone country. The physiography, morphology and other natural conditions have made her vulnerable to disasters and environmental hazards. The major elements in the process are : floods, cyclones and storm surges, droughts, abnormal rainfall, hailstorm lightning Nor'westers and tornadoes, erosion and landslides, earthquakes, industrial and other pollution etc. Additional environmental stress by natural gas development is not desirable and should be avoided by EIA.

Oil and gas pipeline projects include drilling and construction and operation of offshore, near-shore and/or overland pipeline. The major facilities associated with oil or gas pipelines include the pipeline itself , access or maintenance roads, the receiving, dispatch and control station and the compressor station or pump stations.

In some cases, oil and gas pipelines may be viewed as contributing to environmental quality by making more cleaner fuels available e.g. low sulphur gas versus high sulphur coal for energy production and/or industrial purposes. In offshore areas, unburied pipelines may create habitat for marine organism attached to the new artificial reef.

Low frequency of unacceptable risks is usually predicted except for some issues like unprecedented drilling accident of Magurcharra Gas Fields operations leading to environmental damage .

So far as can be determined, the environmental concerns and/or impacts arising from the existing power plants and gas based industrial units have not been unduly serious except for some of the localised ones. All fuel for power plants in the East Zone is natural gas and apart from NO_x emissions, there appear to be no known problems. However, aquatic effects of water intake and cooling water discharges including waste water and effluent discharge have to be given due consideration along with preservation of the rich but sensitive wild life and biota wherever applicable.

Monitoring of certain parameters during both the construction and operational phases of the Power Stations, Fertiliser Plants, Petro-chemical Complexes and other Gas based Industries are essential to ensure that impacts are fully evaluated and that necessary mitigation measures are applied. This is necessary to demonstrate compliance with any current and future standards.

Environmental audits and inspections have come to the forefront as a response tool to reduce the risk of environmental liability. The role of environmental auditing as a vehicle to establish

pollution prevention programme and to assist in the protection of individuals or companies from environmental liabilities. Accordingly such auditing aspects and inspection are also needed to be highlighted.

Any integrated approach in the development process of the energy industry, particularly oil and gas ones, involves satisfactory Operating and Maintenance Procedures and Practices including due selection and monitoring of contractor's performance so far as environmental policy is concerned . Further, education, training including training frequency and methods are also points worthy of consideration to ensure an environment friendly array of the activities.

Finally it is expected that results of the study will assist in formulating and implementing necessary steps in the field of Natural Gas Development Projects' different phases. Operating Agencies will apply the expertise necessary to implement the Environmental Code of Practice and will operate in a manner consistent with corporate policies in respect of Planning ,Consultations, Compliance, Corrective Action, Emergency Response and Research. Still then it is expected that the members of public and the government wood demand that industries including Natural Gas, Thermoelectric Power and Fertiliser industries etc, would be required to find the solution to their own problems. Further, it is clear that the energy industry will most certainly be involved in efforts to evaluate, address, ameliorate and avoid the environmental problems that human populations of Bangladesh will face in the future.

7.2. Recommendations.

In consideration of the International Conventions it may be observed that in addition to the national legislation and funding review criteria, Bangladesh is also committed to a number of international conventions which are of environmental significance to any proposed project. For instance, Bangladesh has ratified the United Nations Framework Convention on Climatic Change which commits developed and developing countries to implement measures to abate global warming.

As with all fossil fuel fired power plant, any proposed development would emit carbon dioxide, the greenhouse gas throughout the lifetime of the project. Although mandatory restrictions for Carbon Dioxide emissions do not currently exist in Bangladesh, this issue has been targeted as a priority. Therefore, the significance of this convention for a proposed project may be studied in detail.

Future Trends in Environmental Research encompasses the global problems in respect of any oil and gas industry where ever it is located and situation in Bangladesh is no isolated one.

A study regarding the contamination of ground and surface water by the drilling fluids and other pollutants can be considered. This may be done by collecting and analysing the samples of water and soil from the periphery of the drilling, storage and discharge point of liquid wastes.

A combined treatment method can be suggested by collecting different types of oil and gas operational projects and gas based industrial projects including thermal power plants and fertiliser industries.

A study regarding the identification and minimisation of waste sources from different operational stages of natural gas and gas based industries may be considered.

A thorough study regarding the effective treatment of different gas industry and gas based industrial wastes before discharging to the environment may be done.

A detail study and investigation may be carried out over the whole year upon the fluctuation of the quality and the quantity of oil and gas industrial effluent with time.

A detail study of the activities of the project and its likely effect on the environment, economic, social, cultural and aesthetic issues should be evaluated with due search for suitable alternatives.

Adequate emergency response plans has to be studied for prompt remedial actions to heavy releases of gas and fluids including fire hazards and environmental damages.

Study may be made for an waste management plan with due application of '5R's i.e. 'Reuse', 'Recycle', 'Recover', 'Residue' and 'Reduce' methods.

A study on the underground pipelines and storage tanks within the processing plants & transmission systems built about 30 years back may be undertaken to investigate the current strength and future life for due remedial & replacement actions.

Flaring of waste and obnoxious gases within the gas fields and processing plant premises are carried and quantity and quality are varying on the load and plant operating conditions. An investigation and study may be carried out to analyse and detect the level of residual pollution being resulted from the fall outs of these flared gases.

A continuous search for new technology and processes may be made to ease out the decontamination and reclamation actions of the abandoned drilling rig and processing plant premises.

Study may be made to remove, repair and replace any defective or worn out components of the plants as fast as possible to stop or reduce the spillage, leakage and contamination, etc. from tanks, pipelines, process plants and scrap yards, etc. Simultaneously receiving water of the flowing river should not exceed the harm level of aquatic life.

An over all pollution mitigation plan may be worked out with due consideration of pollution inventory, characterisation and classification of wastes, minimisation of pollutants and wastes, and guide lines for handling, treatment and disposal as well as improvement of efficiency of such activities.

Study may be made to evaluate if there is any violation of existing legislation in respect of pollution of water, air and soil or producing or causing to produce excessive noise, an environmental hazard, transport of prescribed waste without permit and discharging of waste without licence aggravating pollution.

Although the gas development project activity itself and Natural Gas Thermal Power plants and other gas based industries are not solely responsible for global environmental problems facing society, its involvement in the development and supply of energy and industrial products to human populations cannot be overlooked . It is clear that these industries will most certainly be involved in efforts to evaluate address, ameliorate and avoid the environmental problems that human populations will face in the future. Many of these global concerns cannot possibly be addressed by one industry or country. Accordingly the solution to these problems lies with concerted international effort to change day to day practices and attitudes towards the environmental issues and its sustained development and use and therefore, continuous and diversified studies covering each and every potential issues of such concern may be further enumerated with due priority and importance.

References :

1. Acres International Ltd. (AIL), 1995. Environmental Considerations, Power System Master Plan Bangladesh Final Report Submitted to Bangladesh Power Development Board under Asian Development Bank under TA No. 1962-BAN.

2. Ahmed, M.F, 1992. Monitoring of Environmental Impacts, Dept. of Civil Engineering BUET.

3. Ahmed M.F, 1997. Environmental Restoration of Well Sites, Training Course Notes on Environment and Safety, Bangladesh Petroleum Institute.

4. Asian Development Bank, Manila. (ADB), 1992. Environmental Considerations in Energy Development.

5. Bakht, D, 1996. Term Paper on Pollution Control of Eastern Refinery Ltd. Chittagong, Dept. of Civil Engineering, BUET.

6. Bangladesh Centre for Advance Studies (BCAS),1995. An Unofficial English Translation of the Environment Conservation Act- 1995.

7. Bangladesh Oil , Gas and Mineral Corporation (BOGMC) , 1993. Exploration Opportunity in Bangladesh.

8. Bangladesh Oil, Gas and Mineral Corporation (BOGMC), 1997. Petrobangla MIS Report.

9. Beicip Franlab Petroleum Consultants (BFPC), 1995. Gas System Development Plan Vol-1, Asian Development Bank -TA No 2024-BAN.

10. Canadian Petroleum Association (CAPP), 1988. Environmental Operating Guidelines for the Alberta Petroleum Industry, Canada.

11. Canter, L.W, 1997. Environmental Impact Assessment, Mc Graw-Hill Inc, New York.

12. Department of Environment (DOE) ,1997. EIA Guidelines for Industries. Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.

13. Environmental and Resource Technology Ltd (ERTL), 1995. Environmental Impact Assessment for Drilling Operations Proposed for Offshore Bangladesh , IOE Group, Heriot- Watt University , UK.

14. Economic and Social Commission for Asia and the Pacific, United Nations, Bangkok (ESCAP),1985. Environmental Impact Assessment Guidelines for Planners and Decision Makers.

15. Islam, M.N. 1993. Environmental Assessment in the Energy and Mineral Resources Sector of Bangladesh : Policies and Strategies for Sustainable Energy Development, IEB Seminar.

16. Kabir, B.N, 1997. Environment and the Petroleum Industry-An Overview. Training Course Notes on Environment and Safety, Bangladesh Petroleum Institute.

17. Komex International Ltd. Calgary, Canada, (KIL), 1995. Mitigation and Monitoring Plan, Gas Infrastructure Development Project prepared for Petrobangla, Jalabhumi Centre for Wetland Research and Conservation, Dhaka and Petrobangla Environment and Safety Division.

18. Kundu, P.R, 1997. Fuel Wood Savings through Use of Natural Gas and Positive Impact on Environment . Titas Gas T and D Co. Ltd. write-up.

19. Mott Ewbank Preece, Brighton UK (MEP),1996. Meghnaghat Power Station Environmental Impact Assessment Draft Report, Progressive Consultants Ltd. Bangladesh Power Development Board and Asian Development Bank .

20. Petroleum Industry Training Service (PITS),1993,Environmental Auditing in the Petroleum Industry, Canada.

21. Petroleum Industry Training Service (PITS), 1995. Environmental Planning for Linear Development, Edmonton, Alberta, Canada.

22. Petroleum Industry Training Service (PITS), 1996. Decommissioning and Reclamation of Small Oil and Gas Sites, Canada.

23. Rahman, M.L, 1995. Small Industries Environmental Assessment and Control in Bangladesh, A Research Project Report, Loughborough University of Technology, UK.

24. Rahman, M.M. and Hossain, M.D, 1992. EIA Methodology- I and II Dept. of Civil Engineering BUET.

25. Titas Gas Transmission and Distribution Co. Ltd. (TGTDCL),1997.Annual Report1995-96.

26. World Bank Dhaka (WBD), 1997. Environment and Social Frame Work Infrastructure Development Company , Dhaka, Bangladesh Draft Report.

27. World Bank Washington D.C, (WBW) ,1994. World Bank Guidelines for Environmental Assessment of Energy and Industry Projects, Environmental Assessment Source Book -III.

APPENDICES

APPENDIX-A
(BCAS, 1995)

An unofficial English translation of the Environmental Conservation Act, 1995.

Whereas it is expedient to provide for the environment conservation, development of environmental standard and environmental pollution control and abatement; It is hereby enacted as follows :

SEC-1. Short title : Environment Conservation Act, 1995

ii) Commencement and extent : It shall come into force on such date as the government may, by notification in the official Gazette, appoint on this behalf and it shall come into force in different areas on different dates .

SEC 2. Definition : In this Act, unless there is anything repugnant in the subject or context-

a) "Department" means Department of Environment as provided under section 3 of this Act;

b) "Pollution" means changes in physical, chemical and biological properties of air, water and soil including temperature, taste, odour and density, through the discharge of solid, liquid, gaseous or radioactive substances which are harmful, nonbeneficial or destructive;

c) "Occupants" means, in the case of factory or premises, one who controls the property and, in the case of any material, a person who excscises right on it ;

d) " Environment" means water, air, soil and physical resources and the relationship amongst them or their relationship between man and other animals, vegetation or microbes;

e) " Environment Polletants"means any solid, liquid or gascous material and heat, sound and radiation which may be harmful/injurious or may help causing to be injurious to environment;

f) " Environment Conservation" means development and protection of the qualitative and quantitative standards of environmental elements ;

g) "Ecosystem" means the complex inter-relationship and balancing of environmental elements which help and influence conservation and evoluation of flora and fauna;

h) "Person" means any person or persons whether statutory or not. Any company, society or organisation will also be included in the definition;

i) "Use" means, in the case of material, its production processing activating, packaging, storing transporting, destroying, performing, proposing for sale, transfer or any such activity;

j) "Hazardous Substances" means such substances whose chemical or biochemical properties are such that their production, storage, release or uncontrolled transportation is hazardous/harmful to environment ;

k) "Rules" means rules framed under this Act;

l) "Wastes" means any liquid, gaseous, solid, radioactive substance which through emission/ discharge or dumping causes harm to environment;

m) "Director General" means the Director General of the Department;

SEC 3. Department of Environment :

I) Under this Act the government will establish a department called the department of Environment the Director General (D.G) will be the head of the department.

2) Director General will be appointed by the government and his service conditions will be decided by the government.

3. For carrying out the activities of the department properly required number of officers and employees will be recruited following the methods and conditions as provided in the regulations under this Act.

SEC 4. Power and responsibility of the Director General :

1) The Director General can undertake activities for the conservation of environment, development of the environmental standard and environmental pollution control and reduction which may be appropriate and necessary under the provision of this Act. He may delegate necessary power to any person in writing for carrying out his responsibilities provided under this Act.

2) All or any of the following activities, particularly and without hampering the totality of the power mentioned above, will be included in the responsibilities:

a) Co-ordinate the activities of any authority or organisation having aims and objects similar to the objectives of the Act;

b) Take safety measures and decision and give necessary directions to guard against possible accidents which may cause environmental degradation and pollution ;

c) Give necessary orders and advice to persons concerned on environmentally sound use, storage, transport, export and import of hazardous substances or their ingredients;

d) Collect data and carry out research on environmental, conservation development and pollution, and co-operate with other appropriate authorities and agencies in similar activities;

e) Examine any place, premises, plants, machinery, production or any other processes, ingredients or substances. With a view to develop environment give necessary orders and directives to concerned agencies and persons for environmental pollution abatement, control and reduction;

f) Collect, publish and circulate data/ information on environmental pollution;

g) Advise government to ban those production processes, substances/ materials which might cause environmental pollution;

h) Conduct monitoring programmes on the quality of drinking water and prepare report and advise all interested persons on quality standard of drinking water or give directives wherever necessary;

3) Orders/ directives given under this section may also contain the provision of closing down or exercising control over any industry or enterprise and processes, and the persons receiving such directives shall be bound to comply with them.

Provided that, prior to giving order for closing down or banning of any industry, enterprise or process, the Director General shall give reasonable opportunity, through written notice, to the owner of the concerned industry, enterprise or process to make its programmes environmentally sound.

Provided further that, in the event where there is possibility that public life might be in danger due to environmental pollution , and if the Director General considers that to be an emergency situation, then he shall give necessary orders/ directives instantly.

4) Time schedule may be fixed to perform the activities relating to the orders/ directives served under this section by the Director General.

Sec 5. Declaring ecologically critical area :

1) It the government is satisfied that due to environmental degradation, ecosystem of an area has reached or expected to reach critical level, in that situation government will declare that area as "ecologically critical area" through gazette notification;

2) The activities or processes which can be carried out or cannot be initiated in the "ecologically critical area" will be specified by the government through notification published under subsection (1) or by any separate notification ;

SEC 6. Regulations in respect of vehicles emitting smoke harmful for the environment:

1) Vehicles which emit smoke harmful for health and environment can not be used on the roads:

2) The Director General or any person who has been delegated with the power of the Director General, if satisfied to the extent that any vehicle is emitting smoke which is harmful to health or environment, then he may stop the vehicle instantly and examine it or may with necessary directions which are considered necessary in his opinion in the matter of its examination .

SEC 7. Causing harmful impacts, directly or indirectly, on the ecosystem- if it appears to the Director General that any specific project is causing harmful effect on an ecosystem, directly or indirectly, then he shall have the power to order/ direct the responsible person to undertake an assessment of such harm caused and to take mitigative measures. Such person will be bound to comply with such orders/ directives.

Sec 8. Informing the Director General about environmental pollution and degradation :

1) If any person who has suffered or is likely to suffer due to environmental pollution or degradation may, in the manner prescribed in the rules, inform the Director General by an application for mitigation of the potential harmful effect ;

2. The Director General may take necessary measures including public hearing in course of adjudication for the settlement of any pliant as made under this section.

SEC 9 Excessive discharge and emission of environmental pollutant etc:

1) In case of accidents or any other unexpected activities or incidents which are causing or likely to cause excessive emission/ discharge of environmental pollutant than what has been prescribed by the Rules, then the persons responsible for such emission/ discharge, and persons in charge of such sources of emission / discharge shall be bound to control or mitigate environmental pollution form those sources;

2. Activities or incidents mentioned in sub-section(1) Which have occurred or likely to occur, should be brought to the notice of the D.G. immediately by the concerned persons as mentioned in the sub-section;

3) The Director General when so informed about any incidents or accidents under this section will undertake necessary remedial measures for the control or mitigation of

environmental pollution as quickly as possible and persons responsible will be bound to render all assistance and co-operation to the Director General in this respect;

4. Any expenditure incurred for taking necessary remedial measures for the environmental pollution, control and mitigation will be realised as public demand from the persons mentioned in sub-section(1)

SEC 10. Power to enter building and premises:

1) Subject to the provision of this Act, a person who has been delegated with power by the Director General generally or specifically for this purpose, will have the power to enter into any building or premises at all reasonable hours with assistance considered necessary by him for the following purposes;

a) For discharging responsibilities vested in him under this Act or Rules thereunder;

b) For inspecting any work in that building or premises in accordance with any notice/ orders/ directives served under this Act or Rules, there under;

c) For examining or verifying any equipment, industrial plant record, register, document or any other related important item of article;

d) For conducting search in that building or premises with a view that an offence has been committed or he has reasons to believe that such offence has been committed through the breach of any rule or order/ directives/ notice etc. served under this Act;

e) For seizing any equipment, industrial plant, record , document or any other item which can be used as an evidence for establishing any offence which is punishable under this Act or Rules,. thereunder;

2) Any person who is running an industry, programme or processing or any person using hazardous materials will be bound to co-operate with the person who has been delegated with the power to perform the responsibilities under this Act.

3) In respect of all seizure and search, rules and procedure as laid down under the code of Criminal Procedure, 1898 (Act 5 of 1898) shall be followed.

Sec 11. Power to collect samples etc :

1. Any person with the powers delegated by the D.G. for this purpose, by following method as prescribed in the rules, may collect samples of air, water, soil or any other substance from any factory, premises or area;

2) The results of analysis of any sample which has been collected without following the rules laid down in sub-section (3) and (4) will not be accepted as evidence under sub-section(i) in any legal proceedings;

3) An Officer collecting sample under sub-section(1) "subject to the rules" provided in subsection(4):

a) Will express his intention to collect such samples from the place to the occupant or agent of such place by a notice as specified in the rules;

b) Collect the sample in the presence of that occupant or agent;

c) Keep the sample in a container and mark it with his signature and the signature of the agent or occupant and office a seal to it;

d) Prepare a report about the sample collected and put his signature and the signature of the agent and occupant on it;

e) Send the container to the laboratory as decided by the Director General immediately.

4) In a case where the sample has been collected under sub-section(1) and the officer collecting the sample has served a notice under sub-section(3) and if the agent or occupant of that place remains absent willingly during the collection of the sample or refuses to put his signature or the sample and report, in that case the sample collecting officer, in the presence of two witnesses, shall himself put his signature and authenticate it mentioning the absence or refusal of the agent or occupant to put his signature, whichever may be appropriate and send it to the laboratory as specified by the Director General.

SEC 12.Environmental Clearance : No industry can be established nor any projects can be undertaken any where without taking environmental clearance from the Director General in the manner prescribed by the rules;

Provided that, nothing under this section shall be applicable to such classes of industrial establishments or projects as may be decided for this purpose by the government from time to time.

SEC 13. Preparation of Environmental Guidelines - government can, from time to time, prepare and proclaim environmental guidelines regarding environmental pollution control and abatement and environmental conservation and development by official gazette notification;

14. Appeal

1) If any person is aggrieved by any notice, order or directive served under this Act or rule, may appeal against such notice, order or directive within thirty days from the day when they were served, to the appellate authority constituted by the Government and the decision of the appellate authority will be final and no suit can be brought against such decision in a court of law. Provided that if the appellate authority is satisfied as to the fact

that due to unavoidable circumstances the aggrieved person could not file an appeal to the appellate authority within the stipulated time, then the appellate authority may extend the time of submitting the appeal which will not exceed thirty days;

2) The appellate authority formed under sub-section(1) may consist of more than one member;
Provided that, if any such appellate authority consist of more than one member, then the government will appoint one of its members as chairperson.

3) Appeal made under this section will be adjudicated within three months from the date when the appeal was made.

SEC 15. Penalties -

1) If any person violates any provision of this act or rules, or fails to perform the responsibility as required by any order or directive served through notice under this Act or rule, then he may be imprisoned for a term not over 5 years or with a fine not exceeding Tk. 1 lac or both.

2) If any person who is running an industry, programme or process or any person who is using hazardous materials, fails to co-operate with the person delegated with powers from the Director General or willingly cause delay or obstructs him in discharging his duties will be liable to be punished with the punishment as mentioned in sub- section (1)

SEC. 16 Crimes committed by Companies- If a person violating any provision of this Act or if a person who has failed to perform his duties under orders or directives served by a notice under this Act or rule is a Company, then the owner, director, manager, secretary , or any other officer or agent of that company will be considered to have violated the provisions of the Act or the rules or have failed to perform duties as required by the notice unless he can prove that this violation or failure, as the case may be, has been committed beyond his knowledge or he has tried to the best of his ability to stop that violation or failure;

Explanation : under this section-

a) "Company" means any statutory statutory government authority, commercial establishment and society or organisation;

b) In case of commercial organisations "Director" means any owner or member of the Board of Directors.

SEC 17. Acceptance of any complaint for adjudication; No court shall accept any case under this Act for trial without a written complaint from any person who has not been duly empowered by the Director General.

SEC 18. Any action done in good faith- No civil or criminal case or any legal proceedings shall be entertained against the Government, Director General and any officer or employee of the Department.

SEC 19 Delegation of Powers

1) Government may delegate any power under this Act or Rules thereof to the Director General or any officer;

2) Director General may delegate any power under this Act or Rules thereof any officer of the department.

SEC 20. Power to frame Rules

1) Government may frame Rules to fulfil the objectives of this Act by gazette notification; particularly and without hampering the totality of the above mentioned power, rules may be framed in respect of all or any of the following subjects such as :

   a) Fix Quality Standards for air, water, sound, soil and other elements for different areas; provided that, application of such standards may be suspended, in full or in part, to those industries and projects which were in existence during the time of introduction of the standards for a particular period of time;

   b) Control of establishment of industries and other development project activities in the interest of protection of environment.

   c) Determination of safe methods of use, preservation and of transport of hazardous materials;

   d) Formulating safe methods and programmes for preventing such accidents which may be the causes of environmental pollution;

   e) Fixing limits of discharge and emission of wastes;

   f) Assessing the environmental impacts of different projects and activities and reviewing their methods of approval.

   g) Methods for conservation of environment and ecosystems;

   h) Fixing fees for clearance certificates and services.

SEC 21. Repeal

1) The Environmental Pollution Control Ordinance, 1977 (Act xiii of 1977) is hereby repealed;

2) Anything done under the Ordinance, in spite of the fact that the Ordinance has been repealed, will be considered to have been done in accordance with the provisions of this Act.

3) The Department Director General, officials and employees who employed before the promulgation of this Act. will be considered to have been appointed under section 3 of this Act.

AIMS AND OBJECTIVES

Environment is a multi-dimensional subject. Different countries of the world have given emphasis on the prevention against the increasing degradation of environment and the framing of legal structure for the conservation of the resource base. The Environmental Pollution Control Ordinance of 1977 being inadequate and, ineffective in many cases for the changing situation, it has been felt necessary to enact a comprehensive and appropriate environmental law. It may be mentioned that emphasis was placed on enactment of environmental law in the Environment Policy also. Further, Bangladesh has been making statements in favour of sustainable development in different international conferences including the UNCED.

In the above context, this Bill has been proposed with the objective for the Environmental Conservation, development and control and abatement of environmental pollution.

APENDIX- B
(WBD, 1997)

International Convention, Protocols Treaties of Relevance to Bangladesh

1. International Convention for the Protection of Birds, Paris, 1950.
2. International Plant Protection Convention, Rome, 1951.
3. International Convention for the Prevention of Pollution of the Sea by Oil, London, 1954 (as amended on 11 April 1962 and 21 October 1969).
4. Plant Protection Agreement for the South East Asia and Pacific Region (as amended) Rome, 1956.
5. Convention on the Continental Shelf,Geneva,1958.
6. Convention Concerning the Protection of Workers Against Ionizing Radiations, Geneva, 1950.
7. Vienna Convention on Civil Liability for Nuclear Damage,Viena,1963.
8. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water, Moscow, 1963.
9. Treaty on Principles Governing the Activities of States in the Exploration and use of outer Space Including the Moon and Other Celestial Bodies, London, Moscow, Washington, 1967.
10. International Convention of Civil Liability for Oil Pollution Damage (as amended), Brussels, 1969.
11. Protocol Relating to Intervention on the High Seas in Cases on Marine Pollution by Substances Other than Oil, London, 1973
12. Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar,1971 (Popularly Known as Ramsar Convention).
13. Protocol to Amend the Convention on Wetlands of International Importance Especially as Waterfowl Habitat Paris,1982
14. Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil hereof, London, Moscow, Washington, 1971.
15. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (as amended) Brussels, 1971.
16. Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons, and on Their Destruction, London, Moscow, Washington, 1972.
17. Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972.
18. Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (as amended), London, Mexico City, Moscow, (Washington), 1972.
19. International Convention for the Prevention of Pollution from Ships, London, 1993.
20. Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from ships, London, 1973.

21. Convention Concerning Prevention and Control of Occupational Hazards Caused by Carcinogenic Substances and agents, Geneva, 1974.
22. Convention on the Prohibition of Military or Any other Hostile use of Environmental Modification Techniques, Genera, 1976.
23. Convention Concerning the Protection of Workers Against Occupational Hazards in the Working Environment Due to Air Pollution, Noise and Vibration, Geneva, 1977.
24. Convention on the Conservation of Migratory Species of Wild Animals, Bonn, 1979.
25. Convention Concerning Occupational Safety and Health and the Working Environment, Geneva, 1981-28. United Nations Convention on the Law of the Sea, Montego Bay, 1982.
26. Vienna Convention for the Protection of the Ozone Layer,Vienna, 1985.
27. Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal 1987.
28. London Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer, London, 1990.
29. Convention Concerning Occupational Health Services, Geneva, 1985.
30. Convention on early Notification of a Nuclear Accident, Vienna, 1986.
31. Convention on Assistance in the Case of a Nuclear Accident of Radiological Emergency, Vienna, 1986.
32. United Nations Convention on Conditions for the Registration of Ships, Geneva 1986.
33. Agreement on the Network of Aqua-culture Centres in Asia and the Pacific, Bangkok, 1988.
34. Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, Basel, 1989.
35. International Convention on Salvage, London, 1989.
36. Convention on Civil Liability for Damage Caused During Carriage of Dangerous Goods by Road, Rail and Inland Navigation Vessels, Geneva, 1989.
37. Convention concerning Safety in the Use of Chemicals at Work, Geneva, 1990.
38. International Convention on Oil Pollution Preparedness, Response and Co-operation, London, 1990.
39. United Nations Framework Convention on Climate Change, New York,1992.
40. Convention on Biological Diversity, Rio de Janeiro,1992.
41. International Convention to Combat De-certification, Paris 1984.

APPENDIX - C
(WBD, 1997)

Relevant Environmental Legislation

The main sectoral environmental legislation in Bangladesh are :

1. The Environmental Protection Act 1995.
2. Territorial waters and Maritime Zones Act, 1974
3. Pesticide Ordinance of 1971 and 1983 and Pesticide Rules, 1985
4. Petroleum Act, 1984
5. Factories Act, 1984
6. Motor Vehicle Ordinance, 1939 (modifies up to 1983)
7. Mines Act, 1927
8. Dangerous Drugs Act 1930 and Dangerous Drug Control Order,1982
9. Forest Act, 1972
10. Local Govt.Ordinance,1982(Upazilla Parished and Upazilla Administriation Reorganisation
11. Pourashava Ordinance, 1977
12. Water Supply & Sewerage Authority Ordinance, 1963 (With amendment of 1989)
13. The Boilers Act, 1923
14. Agriculture and Sanitary Improvement Act, 1920
15. Water Hyacinth Act, 19 9
16. Tanks Improvement Act, 1936
17. Embankment and Drainage Act, 1952
18. Opium Act, 1978
19. Dangerous Drugs Act, 1930(Amended upon 1988)
20. Chittagong Hill Tracts Regulation , 1990
21. The Town Improvement Act, 1953
22. Labour Laws (Amended upon 1987)
23. The Municipal Ordinance 1983
24. The Explosive Substance Act, 1908(modified up to May 1983)
25. The Explosives Act, 1984
26. Poisons Act, 1919
27. the Factories Rules 1979
28. Bengal Smoke Nuisances Act, 1905
29. Local Government Ordinance (Union Parishads) 1983
30. Bengal Irrigation Act, 1979
31. Bangladesh Water and Power Developments Boards Ordinance 1972
32. Wildlife (Preservation) order 1973
33. East Bengal Conservation and Protection of Fisheries Act, 1950(amended in 1982)
34. The Bangladesh Fisheries Development Corporation Ordinance 1973
35. Marine Fisheries Ordinance 1983
36. Shops and Establishments Act, 1965
37. Bangladesh Pure Food Ordinance 1953

38. The Bangladesh Penal Code 1980(as amended from time to time)
39. Antiquities (Amended) Ordinance 1976
40. Antiquities Act, 1968
41. The Tea Plantation Labour Ordinance 1962 and rules of 1977
42. the Forest (Amended) Ordinance 1989
43. Merchant Shipping (Amendment) Ordinance 1988
44. the Inland Shipping (Amendment) Ordinance 1989
45. The Dhaka Municipal Corporation Ordinance 1983

APPENDIX - D

(Kundu, 1997)

Fuel Wood/ Kerosene Conversion Data Sheet

Statistical data in respect of usage of natural gas vis-a-vis number of customers including savings of wood fuel is placed below for 1996-97 :

Type of Customer	Domestic	Commercial	Industrial (Brick Field)	Total
No of Customer	7,54,095	8040	156	762,291
Qty. of gas in MMCM (1 million cubic metre)	646.44	93.42	13.68	753,34
% of wood fuel user prior to use of gas	70	10	90	
Quantity of gas used by customers who used to use wood fuel in MMCM	452.79	09.34	12.31	474.44
Equivalent quantity of wood fuel savings in 100,000 Tons.	19.02	0.39	0.52	19.93

In other words 19,93,000 tons of wood fuel savings has been achieved through use of natural gas through out the country during 1996-97. This is apart from the positive impact on environmental pollution in the process.

In the above calculations, it has been considered that gross calorific value of different types of wood fuel is 5000 BTU/lb and since wet wood is usually burnt, its calorific value is often not more than 70% and as such with consideration of net calorific value of 3500 BTU/lb for wood including that of 932 BTU/ SCF (1 Standard cubic feet) of natural gas, 1 MMCM of gas equivalence's to 4200 Tons of wood.

APPENDIX-E
(WBW, 1994)

Environmental Impacts Mitigation in Oil and Gas Development

Oil and Gas Development - Onshore

Potential Negative Impacts	Mitigating Measure
Direct	
1. Disturbance of cultural resources, historic sites, vegetation, wetlands, surface drainage and wildlife.	1. Require appropriate resource surveys of the areas that may be affected by the project prior to any disturbance. Typically this will include : an inventory of cultural and historic resources; an inventory of the flora and fauna of the region; identification of significant topographic features and an inventory of existing pipelines and cables. Mitigation measures based on identified resource conflicts may include: avoidance; timing of operations; recovery and archiving cultural and historic items and compensating for losses by protecting or enhancing comparable resources in region
2. Degradation of surface waters by soil erosion from disturbed areas, discharge of drilling slurries and produced waters, equipment servicing and sanitary and domestic wastes.	2. Require control of storm-water runoff and prompt re-vegetation on disturbed areas. Burial of drilling mud and cuttings. Re-injection of produced formation waters. Good housekeeping practices at drill and production sites to minimise leaks and spills. Treatment of sanitary/ domestic wastes and cleaning waters/ solvents to meet water quality standards before discharge. Prompt cleanup of oil spills(oil, mud, formation water) Water quality standards should be established for all waste water discharges.
3. Degradation of air quality from routine operational emissions	3. Require appropriate pollution control devices on diesel generators and pumps and hydrocarbon vapour control at all oil or gas transfer points. Require prompt cleanup of any oil spills. Minimise venting during production.
4. Mortality and reduced reproduction of wildlife from habitat disturbance or loss, road kills and hunting.	4. Prohibit or restrict disturbance of significant habitat and wetlands. Mark wildlife road crossings. Prohibit firearms possession in the area

5. Modification of vegetation and introduction of non-native species.	5. Require prompt reclamation of disturbed areas and re-vegetation with native species
6. Degradation/loss of vegetation (and soil productivity) from discharge or spills of produced water, oil, and drilling mud.	6. Require blow-out preventers and control and prompt cleanup of oil and formation water spillage. Keep soil disturbance and vegetation clearing to minimum required for operation and safety.
7. Land use conflicts	7. Consult with local land users in siting access, air fields, utility lines and to extent possible production facilities.
8. Degradation of remote areas through improved access and increased use .	8. Allow other land uses to continue on the site where compatible with the operations. Access remote areas by air during early exploration stage. Restrict use of access roads. Remove and reclaim any access roads at end of production. Minimise need for community development by rotating work crews and precluding permanent residence.
9. Road damage, accidents and traffic delays from increased truck traffic on local roads.	9. Observe road load limits. Design roads for adequate capacity and visibility ensure that roads are properly signed, vehicles are well maintained and drivers are trained and safety-conscious Require commuting workers car-pool or provide buses.
10. Visual intrusions from wells, tanks, and production facilities. Cleared linear rights-of way for pipelines utilities, and roads, and processing facilities.	10. Paint structures to blend with background (vegetation and sky). Avoid contrasting colours. Utilise utility corridors. Minimise clearing and blend vegetation where feasible
11. Disturbance of humans and wildlife by noise from seismic surveys, drilling pumping, and processing facilities.	11. Avoid seismic shots, low over-flights, and other sudden loud noises in critical wildlife areas, especially during mating or nesting season. Require proper mufflers on diesel equipment.
12. Loss of birds and animals in sludge ponds.	12. Minimise surface area and number of sludge pits, and require that they be promptly drained, closed, or covered (with netting) when not in use.
13. Injury/ loss of life from accidents.	13. Periodic training and continual safety reminders to all operating staff. Require periodic drills in emergency procedures. Ensure that all visitors are briefed on potential hazards and necessary safety precautions. Ensure that appropriate safety and rescue equipment is available and employees trained in its use. Install subsurface safety valves on gas producing wells

14. Contamination of groundwater aquifers.	14. Require proper drilling practices, casing and sealing off all aquifers during drilling. Ensure that all aquifers are properly sealed off prior to well completion or abandonment. Line all mud storage and waste fluid pits
15. Increased demands on services and facilities in local communities, social and cultural conflicts, concern with community stability (boom and bust scenario)	15. Require pre-development socio-economic study of potentially affected communities to identify possible impacts on services, infrastructure, dislocations and conflicts. These impacts can be addressed by : Community assistance grants loans. Pre-payment of taxes. Phasing the oil and gas development, Construc-tion needed community facilities. Co-operative and open working relations should be established early with local communities and maintained throughout the life of the project and Project workers should be encouraged to participate in community affairs.
16. Conflicts with native cultures, traditions, and life styles.	16. Brief all employees to ensure awareness of and sensitivity to the local cultures traditions and lifestyles. Ensure that native leaders are aware of the project activities, are assisted in identifying impacts that may be of particular concern to them, and have a voice in appropriate mitigation measures. Mitigation may include isolating the development work force from the native community
17. Subsidence of land surface.	17. Re-injection of produced formation water and injection of additional water to replace volume of oil removed.
18. Use of local surface water or groundwater	18. Obtain water from unutilised aquifers Non-potable water can be used for drilling, sprinkling roads, and irrigation

Oil and Gas Development - Offshore

Potential Negative Impacts	Mitigating Measures
Direct	
1. Disturbance of cultural resources, benthic communities, coral reefs, coastal barriers, wetlands, pipelines and cables (e.g. anchor dragging, bottom sampling, pipeline trenching, drill-ship positioning , platform siting and so forth).s	1. Require appropriate resource surveys of the offshore and coastal areas that may be affected by the project prior to any disturbance. Typically this will include : an inventory of cultural and historic resources an inventory of the flora and fauna of the region identification of significant topographic features on inventory of existing offshore pipelines and cables Mitigation measures based on identified resource conflicts may include: avoidance, timing of operations, recovering and archiving cultural and historic resources
2. Degradation of coastal and offshore waters by discharges during routine operations(e.g. drilling mud, sanitary waters, production waters, and spills).	2. Require separation of cuttings from drilling mud and washing before discharge. Disposal of drilling mud onshore Treatment of formation waters, sanitary and domestic wastes and cleaning waters/ solvents to meet water quality standards before discharge. Gutters and drip pans, at transfer points, to control platform spills. Water quality standards should be established for all waste water discharges. Drill cuttings checked for residual oil before discharge. Waters in vicinity of platform or drill ship monitored for oil sheen.
3. Degradation of air quality from routine operational emissions(e.g. combustion, venting, spills)	3. Require appropriate pollution control devices installed and operative on all diesel generators and pumps. Require hydrocarbon vapour control at all oil or gas transfer points and prompt cleanup of any oil spills. Minimise venting during production.
4. Mortality and/ or reduced reproduction of benthic organisms, coral communities, and other marine life through smothering(e.g. disturbed bottom sediments, drill mud cuttings).	4. Prohibit or restrict bottom- disturbing activities in vicinity of significant coral reefs and benthic communities. Discharged drill cuttings should be shunted to avoid these features. Spent drilling mud should be barge to shore or discharged well away from any significant live bottom communities.
5. Mortality and/or reduced re production of marine flora and fauna, waterfowl, sea birds and waterfowl through oil coating resulting from oil spills.	5. Minimise routine oil spillage through adherence to water quality, discharge standards, and good housekeeping practices on drill ships, platforms, shuttle boats, barges and tankers, and at transfer points. Prompt detection and effective responses to any operational catastrophic spills. Provision for treatment facilities for any oiled birds or aquatic mammals.

6. Disturbance of marine mammals by seismic surveys, drilling and ship noises	6. Prohibit use of explosives during presence of sensitive marine mammals.
7. Degradation of beach areas, coastal facilities, and boats by oil spills and littering(e.g. coating, tar balls, trash and debris from offshore facilities and transport.)	7. Solid waste disposal requirements including sanitary and domestic wastes. Require labelling of all loose materials and equipment on vessels and platforms(especially barrels, boxes etc).
8. Obstruction of boat traffic by offshore facilities	8. Do not site platforms in established shipping lanes.
9. Loss or reduction of fishing areas and recreation sites.	9. Do not site platforms in significant fishing or water oriented recreation areas.
10. Degradation of sea-ward vista(by siting of drilling ships and platforms).	10. Paint structures to blend with background (water and sky). Camouflage structures (however, reducing the visibility of drill ships or platforms may increase navigation hazards). Use subsurface or bottom production units where feasible.
11. Congestion and increased boating accidents in the coast (from increased ship traffic).	11. Establish and publicise sea-lanes for shuttle traffic. When possible, avoid areas of heavy recreational or fishing boat use.
12. Disturbance to humans and wildlife by increased noise levels in coastal area from aircraft over-flights, ship traffic and facility operations,	12. Minimise over-flights of populated areas.
13. Loss of beach areas to pipeline landfalls and support facilities (e.g. land use, impact of spill cleanup activities, use of disparsents, traffic, disturbance from cleaning activities, and soil contamination.)	13. Avoid heavily used recreational beaches.
14. Injury/ loss of life from accidents in transportation and facility operations.	14. Periodic training and continual safety reminders to all operating staff. Require periodic drills in emergency procedures. Ensure that all visitors are briefed on potential hazards and necessary safety precautions. Ensure that appropriate safety and rescue equipment is available and employees trained in its use. Install safety valves and alarms in subsurface well completion systems, with monitoring at production platforms and onshore location.

15. Contamination of groundwater aquifers(e.g. wells).	15. Require proper drilling practices, casing, and sealing off all aquifers during drilling. Ensure that all aquifers are properly sealed off prior to well completion or abandonment.
16. Increased demands on community facilities and services in the coastal area.	16. Require pre-development, socio-economic studies of potentially affected communities to identify possible impacts on services, infrastructure, dislocations, and conflicts. These impacts can be addressed by: Community assistance grants; Loans ; Pre- payment of taxes. Phasing the oil and gas development; Constructing needed community facilities and Co-operative and open working relations should be established early with local communities and maintained throughout the life of the project. Project workers should be encouraged to participate in community affairs.
17. Conflicts with native cultures, traditions, and life styles.	17. Brief all employees to ensure awareness of and sensitivity to the local cultures, traditions, and lifestyles. Ensure that native leaders are aware of the projected activities, are assisted in identifying impacts that may be of particular concern to them, and have a voice in appropriate mitigation measures. Mitigation may include isolating the development work force from the native community.

Oil and gas Pipelines

Potential Negative Impacts	Mitigating Measuring
Indirect	
1. Induced secondary development during construction in the surrounding area.	1. Develop comprehensive plan for location of secondary development. Construct facilities and provide financial support to existing infrastructure.
2. Increased access to wild-lands.	2. Develop protection and management plans for these areas. Construction barriers(e.g., fences) to prohibit access to sensitive wild-lands.
Direct	
1. Re-suspension of toxic sediments from construction of offshore pipeline.	1. Select alternate location for living pipeline. Use alternative pipeline construction techniques to minimise re-suspension of sediments(e.g. laying pipeline versus burying pipeline). Lay pipeline at a period of minimal circulation.

2. Interference with fishing activities from offshore and near-shore pipeline.	2. Select pipeline route away from known fishing areas. Mark and map location of offshore pipelines. Bury pipeline that must be located in critical fishing areas
3. Habitat and organism loss offshore and near-shore pipelines.	3. Select ROW to avoid important natural resources areas, Utilise appropriate clearing techniques(e.g. hand clearing versus mechanised clearing) along upland ROWs to maintain native vegetation near pipeline. Replant disturbed sites. Use alternative construction techniques (see No.1)
4. Erosion, runoff and sedimentation from construction of pipeline, grading for access roads and substation facilities.	4. Select ROW to avoid impacts to water bodies and hilly areas. Install sediment traps or screens to control runoff and sedimentation. Use alternative pipeline laying techniques that minimises impacts. Stabilise soils mechanically or chemically to reduce erosion potential.
5. Alternation of hydrological patterns	5. Select ROW to avoid wetlands and flood plains Minimise use of fill. Design drainage to avoid affecting nearby lands
6. Evasion of exotic species and habitat fragmentation	6. Select corridor and ROW to avoid important wild-lands and sensitive habitats. Maintain native ground cover(vegetation) above pipeline. Make provisions to avoid interfering with natural fire regimes.
7. Loss of land use due to placement of upland pipeline and substations	7. Select ROW to avoid important social (including agricultural) and cultural land uses. Design construction to reduce ROW requirements. Minimise offsite land use impacts during construction. For buried pipelines, restore disturbed land along row.
8. Creation of barriers for human and wildlife movement	8. Select ROW to avoid travel routes and wildlife corridors. Elevate or bury pipeline to allow for movement.
9. Increased traffic due to construction	9. Phase construction activities to control traffic. Construct alternative traffic routes
10. Chemical contamination from wastes and accidental oil spills.	10. Develop waste and spill prevention and cleanup plans. Utilise spill containment techniques. Clean up and restore affected areas.
11. Hazards from gas pipeline leakage or rupture.	11. Clearly mark locations of buried pipelines in high - use areas. Develop emergency evacuation plans and procedures. Monitor for leaks. Install alarms to notify the public of accidents.