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DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT PLAN (EMP) FOR OIL AND GAS EXPLORATION ALONG THE COASTAL AREAS OF BANGLADESH

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ABSTRACT

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The Coastal and Marine zones of Bangladesh comprise a rich and complex mix of ecosystems and natural resources. Human activities in the area include agriculture, aquaculture, salt production, industrial fishing, port and navigation activities. Hydrocarbon exploration is a new introduction to the existing human activities that impact upon the natural environment. Complexities of human interactions with the environment should be properly understood in developing the environmental management plan (EMP) for sustainable development of the resources. For completing this study three questionnaire surveys were conducted, one among local community (stakeholders), second one among peoples conducting exploration activities (mining engineers, GIS specialists, geologists and related key persons) and another among environmental experts (i.e. environmental scientists, environmental engineers, ecologists, biologists, chemists, forest officers, NGO workers, university teachers and others related academicians). From survey findings it is found that most of the local people have no clear idea about exploration program and its associated impacts but when informed, they feel the need for preparation of an extensive EMP and its proper implementation. However they have expressed their confusion about compensation system concerning the project. About 36% of people are not satisfied with existing damage compensation system. A great controversial thinking was found from their perception. A large no of people (90%) think that the distance of exploration sites of block-5 from the Sundarbans is not sufficient to protect highly sensitive mangrove ecosystem. Several environmental experts are not agreed with the exploration program along coastal blocks due to considering the vulnerability of the Sundarbans, shrimp ghers, other fisheries resources, forest and agricultural plantation, wildlife, biodiversity and other adverse impact on local people as well as possibility of firing accident. However they predict adverse environmental impacts of such projects and delineate the needs for preparation and effective implementation of an all-embracing EMP. They also outline a strategic EMP for exploration and production activities along coastal areas.

Key words: *hydrocarbon, exploration, ecosystems, impacts, compensation, accident, biodiversity, mangrove*

INTRODUCTION

Bangladesh is a proven natural gas-rich region. Presence of favorable geologic conditions required for gas accumulation has placed the area under study highly prospective category. Hydrocarbon exploration activity has been continuing within the territory of Bangladesh since the early days of the 20th century. Before 1972 only 28 wells were drilled with the discovery of 8-gas field. This activity gain momentum after the emergence of Bangladesh as on independent country. Exploration history in the region may be divided into three phases (Islam 2002).

Bangladesh contains small proven oil reserves of 56.9 million barrels and produces around 7,000 barrels per day (bbl/d), of which 6,000 bbl/d is crude oil. Until the beginning of the 1990s, state oil and gas Company Petrobangla, along with its eight operating companies (OCs), was the sole player in the Bangladeshi oil and gas sectors. Over the past few years, however, Bangladesh has encouraged foreign oil companies to do business in the country (Aman MAR-2002). At present, Cairn Energy, Tullow Oil, Niko Resources, Unocal, and UMC Bangladesh Corporation are active in exploration under six Production Sharing Contracts (PSCs) partnership with Petrobangla. To date, oil exploration has proven largely unsuccessful, although hopes continue. Petrobangla regulates the activities of foreign companies under PSCs, and serves as the sole purchaser of oil and gas from the companies. Around 65% of Petrobangla's gross revenues are paid to the government in the form of taxes and compulsory dividends (Petrobangla 2004). Petrobangla has been characterized in recent years by a low level of investment and a lack of sufficient financing.

Natural gas is Bangladesh's only significant source of commercial energy, with 2002 production of 384.9 billion cubic feet (Bcf). Bangladeshi natural gas production began in 1960 from the Chattak Field. There is much uncertainty and debate about the level of natural gas reserves in Bangladesh. Estimates from Petrobangla put net proven reserves at 15.3 Tcf as of mid-2004. The US Geological Survey has estimated that Bangladesh contains an additional 32.1 Tcf in additional "undiscovered reserves (Ullah ASM-2003)." Bangladesh may have the potential to become a major gas producer (as well as supplier to the vast potential market in neighboring India) at some point. Bangladesh also could use its natural gas resources to power vehicles (the government already has announced plans to convert government vehicles to compressed natural gas to help alleviate pollution problems in Dhaka, and also in response to high oil prices), to produce electricity, petrochemicals, and fertilizers, which it also could use both within the country as well as for export (Shah MS-2003).

Bangladesh is very bright and prospective areas for oil and gas exploration. But extensive exploration activities requires to discover that potential reserves. Exploration activity, comprising site clearing, drilling, blasting, loading of waste, transport of over burden, crushing etc. is having considerable impacts on the environment (Monaj *et al.* 2002). During exploration like seismic and drilling activities, the exhaust and run-off from exploratory wells might cause serious ecological and environmental damage along the coastal areas. Aquatic and terrestrial ecosystems correlate with such activities and cultural and historical resources like world largest mangrove forest Sundarbans can also be affected (Haque AKE-2006)).

The study aims to cover identification of negative environmental impacts of oil and gas exploration activities and evaluation of the magnitude of these impacts on environmental components, socio-economic conditions and quality of life.

MATERIALS AND METHODS

The questions for questionnaires, checklist & matrix for EIA (determine severity of impacts/follow up for EIA), Observations for environmental mapping and dope list for photographs were developed in pre-fieldwork. The questionnaires, checklist & matrix are subsequently tested before actual field survey and perception sharing. A multi-method approach for quantitative & qualitative data collection tools was applied. Several qualitative data were collected from secondary sources i.e. measurements from Department of Environment.

Semi-structured interview scheduled was prepared for different stakeholders on the basis of key points of the study issues related to the study objectives. Study tried to grasp the opinion and ideas from environmental experts, people conducting mining activities and local community. Three separate questionnaires are prepared to conduct the research.

Considering the objective of the study two checklists and one matrix are filled-up by sharing perceptions from environmental experts, technical persons and other related key persons. The EIA checklist and matrix are used to decide the severity of impacts and to determine whether to follow up with an EIA. Every stage of oil and gas exploration and production activities arranged against possible environmental, ecological and socioeconomic parameters. On the checklist, the affected parameters were marked on the existing environmental, ecological, physico-chemical and socio-economic condition of the study area and the impacts & management strategies are indicated by putting the values in the appropriate cells. 25 checklists and matrix are filled-up by related key persons.

To identify impacts and prepare management plan, stages of oil and gas exploration activities are arranged against environmental components. The matrix was completed by identifying all stages of the proposed programme and associated activities and by assessing the potential impacts of each operation upon individual environmental components.

To delineate the actions affecting resources and values and corresponding effects on the environment checklists are used. It specifies the type, duration and intensity of impacts. Checklists are comprehensive list of environmental effects and impact' indicators designed to stimulate the analysts to think broadly about possible consequences of contemplated actions. In this checklist, actions which may affect at the various types/phases of the project activities are listed and the degrees of Significant Environmental Impacts (SEIs) are defined.

The environmental factors are to be documented in an organized form. This states the activity and identifies the sources of all pollutants. It should focus on the relevant environmental factors for the proposed/existing development, and these should be agreed in consultation with the Environment Protection Unit and relevant public and government agencies. To assist with addressing the environmental factors the proponent may choose to document every activity, product and/or service that interacts or has the potential to interact with the environment. A series of management sources was tested and subsequently developed among specified environmental factors.

After accumulating information from various sources, an EMP is made. The EMP requires and depends on extensive assessment of impacts associated with oil and gas exploration & production against specific environmental factors. The EMP should provide a comprehensive description of the proposed/existing development including its location and a description of the proposed/existing development.

RESULTS AND DISCUSSIONS

Impact matrix

An impact matrix of the likely environmental effects of the seismic programme proposed is presented in Table 1. The matrix was completed by identifying all stages of the proposed programme and associated activities and by assessing the potential impact of each operation upon individual environmental components.

Within the Environmental Impact Matrix each potential interaction is represented by an impact category, as defined below:

Table1. Environmental impact matrix of oil and gas exploration program in Block 5

	Environment			**Biodiversity**								**Socio economic**				**Health**		
	Air	**Water**	**Land/Soil**	**Flora**	**Reptiles**	**Fish**	**Birds**	**Mammals**	**Turtles**	**Cultivated Land**	**Coastal Environment**	**Fishing**	**Agriculture**	**Compensation**	**Local community**	**Public health**	**Occupational health**	**Health facilities**
Land Clearance	1	1	1	1	-	-	1	0	-	1	0	-	0	-	1/+	-	0	-
Presence of camp	1	-	0	0	-	-	-	0	-	0	-	-	1	-	1/+	-	-	-
Hiring local workforce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Camp supplies	-	0	0	-	-	-	-	-	-	-	0	0	-	-	+	-	1	-
Waste handling & disposal	1	1	1	0	0	1	0	1	0	1	0	0	1	-	1	0	1	1
Drainage	-	1	1	0	-	0	-	-	-	0	0	0	1	-	0	0	2	0
Camp dismantling & restoration	1	1	2	1	1	1	1	1	0	1	1	1	1	-	-	0	1	0
Line opening in Cultivated land	0	-	1	0	0	0	-	0	0	2	1	0	0	-	2	0	0	-
Transportation of equipment to site	2	1	1	0	0	0	-	0	0	2	1	0	0	-	0	0	-	0
Drilling Shot-holes	0	0	2	0	0	0	-	0	-	2	1	0	0	-	0	0	-	0
Cable deployment & retrieval	-	-	0	0	0	0	-	0	-	1	0	0	-	-	-	-	0	-
Detonating charges	0	0	1	1	1	1	1	1	0	1	1	0	0	-	0	-	0	-
Recording	-	-	0	-	-	-	-	0	0	-	-	0	0	-	-	0	-	0
Logistic & supply	-	-	-	0	0	-	0	-	0	-	-	-	-	-	0	-	0	-
Waste handling & disposal	1	1	2	0	0	0	1	0	0	1	1	0	0	-	-	0	-	-
Exhaust emissions	2	0	0	0	0	0	1	0	0	1	1	-	-	-	0	-	0	
Accidental Events-																		
Small refueling spills	1	1	1	0	0	0	1	0	0	0	1	0	0	-	-	0	-	0
Misfire of charge	1	1	1	0	0	0	1	-	-	0	1	-	-	-	-	0	0	
Accidental explosion survey)	2	1	3	1	1	1	2	0	0	0	0	-	0	-	0	-	0	-
Fire in camp	3	1	2	0	0	0	2	0	0	0	-	0	0	-	-	-	0	

Source: Field survey, 2007-08

Impact Checklist

Two types of checklists have been used.

Impact checklist I

Seismic survey operations, depending on the season, might affect Important Environmental Components (IECs) directly through physical or behavioral changes. Seismic pressure waves virtually have no effect on the quality of river water or the subsurface geological structure, merely passing through or reflecting away. General definitions of impact magnitude, its scale and duration are provided below (Table 2).

Table 2. Checklist of impacts due to seismic program

Action affecting Resources and values	Effect on Environment	Types of Impacts	Duration of impacts	Intensity of impacts
Environmental concern due to setting of camp, access road and seismic lines				
Loss of crops	Loss of income and livelihood	A	Sh	L/M
Loss of homestead forest	Ecological loss and economic loss	A	Sh	L
Loss of aquatic plants and fauna	Ecological loss	A	Sh/Lo	L/M
Impediment to road traffic	Environmental loss	A	Sh/Lo	L/M
Workers health and safety	Economic and health loss, increased vulnerability	A	Sh/Lo	L/M
Air pollution due to dust emission	Environmental and economic loss	A	Sh	L/M
Noise and vibration	Health hazard leading to economic loss	A	Sh	L/M
Solid and liquid waste generation	Public health and environmental losses	A	Sh	L/M
Employment opportunity	Socioeconomic gain	B	Sh/Lo	L
Fishermen	Economic loss	A	Sh	L
Environmental concern due to shot hole drilling and cable lying				
Road traffic congestion	Loss of economy	A	Sh	L
Soil erosion and silt deposition	Change in topography and river geometry	A	Sh	L/M
Nuisance (Air pollution, dust, noise, vibration)	Environmental damage and public disturbances	A	Sh	L/M
Accidental hazard	Risk of workers health and safety	A	Sh	L/M
Solid and liquid waste disposal	Public health and environmental loss	A	Sh	L
Water quality	Public health and environmental loss	A	Sh	L
Loss of vegetation	Ecological loss	A	Sh/Lo	L/M
Loss of crop	Economic loss	A	Sh/Lo	L/M
Loss of soil fertility	Economic loss	A	Sh	L
Loss of aquatic plants and fauna	Economic loss	A	Sh	L
Employment opportunity	Socioeconomic gain	B	Sh	M
Environmental concern due to Acoustic signal generation				
Road traffic congestion	Environmental pollution	A	Sh	L/M
Nuisance (Air pollution, dust)	Public health	A	Sh	L/M
Loss of vegetation	Soil erosion	A	Sh	L/M
Loss of soil fertility	Loss of economy	-	-	-
Occupational health and safety	Public health	A	Sh	L/M
Water quality	Public health	A	Sh	L
Vibration nuisance due to detonation of explosive	Effect on existing structure	A	Sh	L/M
Noise nuisance due to detonation of explosive	Effects on living being (terrestrial and aquatic)	A	Sh	H/M
Emission hazard to detonation of explosive	Occupational health, nearby population, animal	A	Sh	L/M
Contamination	Soil (structure, fertility), water(surface and ground), air etc	A	Sh	L/M
Employment opportunity	Socioeconomic gain	B	Sh	L
Business opportunity	Socioeconomic gain	B	Sh	L
Fishermen	Economic loss	-	-	-

Environmental Concern Due to Production and Operation				
Soil erosion and silt deposition	Change in topography and river geometry	A	Sh/Lo	L/M
Nuisance (Air pollution, dust, noise, vibration)	Environmental damage and public disturbances	A	Sh/Lo	L/M
Accidental hazard	Risk of workers health and safety	A	Sh/Lo	L/M
Solid and liquid waste disposal	Public health & environmental loss	A	Sh	L
Water quality	Public health & environmental loss	A	Sh	L
Vibration nuisance due to detonation of explosive	Effect on existing structure	A	Sh/Lo	L/M
Noise nuisance due to detonation of explosive	Effects on living being(terrestrial and aquatic)	A	Sh	L/M
Emission hazard to detonation of explosive	Occupational health, nearby population, animal	A	Sh	L/M
Contamination	Soil(structure, fertility), water(surface and ground), air etc	A	Sh	M
Employment opportunity	Socioeconomic gain	B	Sh	L
Fishermen	Economic loss	B	Sh	L

Source: Technical Person survey, 2007-08
A=Adverse, B=Beneficial, Sh= Short-term, Lo=long term, L=Low, M=Moderate, H=High

Impact Checklist II

Identification of potential impacts due to the proposed programme has been done using a checklist. Checklists are comprehensive lists of environmental effects and impacts' indicators designed to stimulate the analysts to think broadly about possible consequences of contemplated actions. Table-3 represents the checklist developed for the proposed programme. In this checklist, actions, which may affect at the various types/phases of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms none, minor, moderate and major are used in checklist to classify the magnitude of SEIs. As can be observed from the checklist, most of the impacts are insignificant.

Table 3. Checklist of significant environmental impacts of seismic program in Block 5

Program phase	Environmental resources and values to be affected by different actions	Significant environmental impacts				Type		Comments/Observations
		None	Minor	Medium	Major	Adverse	Beneficial	
Setting up of Camps, Access Roads and Seismic Lines	Change in landscape		√	√		√		Nothing permanent, very temporary and localized. Nearly no impact. If it even occurs and will have both negative and positive impact as this is perceived differently to different people
	Visual intrusion		√	√		√		None or Minor very temporary impact
	Land value depreciation		√					No negative land value change anticipated, price night be higher
	Loss of and displacement from homestead land		√					No loss of and displacement from homestead land. no impact
	Significant land disturbance			√	√	√		Some impact, whatever disturbance may occur. will be temporary and localized
	Loss of and displacement from			√		√		Temporary loss of some agricultural land. No displacement from agricultural land will occur.
	Disruption to drainage pattern/hydrology		√	√		√		Site preparation may create very limited impact in local drainage pattern, but very temporarily and very localized. Nearly no impact
	Disturbance to gher farming			√		√		Some impacts anticipated, however measures will be in place to minimize the impacts.

	Damage to nearby operation			√		√		No significant impact anticipated
	Run off erosion			√		√		Site preparation and site rehabilitation may create very limited runoff during rainy season period, but no real filling required. Seismic program is planned mostly during dry period, therefore minor impact.
	Land subsidence/' Instability		√					No problem anticipated
	Road damage, accidents and traffic delays		√	√		√		No significant impact anticipated
	Worker accident			√	√	√		Always have chance to occur in field activity, needs careful management
	Sanitation diseases hazard			√		√		Concentration of labor force might create some un-hygienic condition, if proper cautionary measures are not taken
	Alteration of water courses		√					No negative impact anticipated
Shot hole drilling and cable lying	Noise/vibration hazard			√	√	√		During drilling, movement of the equipment and vehicles and detonation of explosives will create some noise and vibration
	Employment				√		√	Reasonably good employment opportunity for THE locals.
	Encroachment into Precious ecological resources		√					No encroachment into precious ecological resource; no impact
	Blockage of passage			√		√		No blockage anticipated; some disruption may happen no major impact
	Conflicts in water supply rights		√					No conflict in water supply and water use rights
	Surface water Pollution from liquid discharge		√	√				There is no process water as such. Camp wastewater will receive sanitary treatment. Impacts of significance is not anticipated
	Effects on quantity and availability of surface water or ground water		√					No negative impact of significance anticipated
	Salination of water or land		√					No negative impact of significance anticipated
	Odor hazard		√	√				No major odor problem anticipated
	Pollution from solid waste							Certain amount of solid waste. Have little negative impact.
	Air quality				√	√		Have impact. Emission from diesel driven equipment. Dust during the movement of the vehicles, cable lying, movement of people, site preparation and site rehabilitation.
	Occupational health hazard			√	√	√		Always might occur minor to medium impacts
	Traffic congestion		√	√		√		No problem of significance anticipated
	Use of water		√	√		√		Not significant and no excessive use anticipated, particularly as recycling of used water has been planned.
	Use of electricity/energy			√		√		No significant impact anticipated
	Accelerated use of resources for short term gain		√					No significant impact
	Loss of irreplaceable resources		√					Little but no measurable impacts

	Promoting undesirable rural to urban migration		√	√		√		None to minor but not significant impact anticipated
	Clearing or loss of vegetation/felling of trees			√	√	√		Always have chance to occur in field activity. needs careful management
	Blockage of passage of wildlife		√	√		√		Temporary blockage may occur
	Loss of biodiversity			√	√	√		During drilling, movement of the equipment and vehicles and detonation of explosives animals may migrate
	Further threat on endangered species		√	√		√		May threat to some endangered species
	Creation of new habitat		√					No new habitat create
	Indigenous people		√	√		√		None to minor impacts and sometimes impacts of positive nature
	Conflicts with native cultures, traditions and lifestyle		√	√		√		Several types of conflicts may arise with local people
	Resettlement		√	√		√		Resettlement and rehabilitation necessary
Production and Operation	Loss of irreplaceable resources		√					Site preparation may create very limited impact in local drainage pattern, but very temporarily and very localized. Nearly no impact
	Promoting undesirable rural to urban migration		√	√		√		Some impacts anticipated, however measures will be in place to minimize the impacts
	Clearing or loss of vegetation/felling of trees			√	√	√		No significant impact anticipated
	Blockage of passage of wildlife		√	√		√		Site preparation and site rehabilitation may create very limited runoff during rainy season period, but no real filling required. Seismic program is planned mostly during dry period, therefore minor impact
	Further threat on endangered species		√	√		√		Always have chance to occur in field activity. needs careful management
	Creation of new habitat		√					Concentration of labor force might create some un-hygienic condition, If proper cautionary measures are not taken
	Indigenous people		√	√		√		No negative impact anticipated
	Conflicts with native cultures, traditions and lifestyle		√	√		√		Site preparation may create very limited impact in local drainage pattern, but very temporarily and very localized. Nearly no impact
	Resettlement		√	√		√		Some impacts anticipated, however measures will be in place to minimize the impacts

Source: Technical People Survey, 2007-08
Note: '√' in more than one column indicates range

Environmental Elements Management Plan

Table 4. Summary of environmental elements management plan for exploration activities

ELEMENTS	MANAGEMENT PLAN
Water Quality Management Plan	▪ Limit the disturbed area and clearing progressively, immediately prior to construction activities commencing. ▪ Using temporary soil diversion mounds to control runoff within and divert water away from the construction site. ▪ Grade to a crown and provided efficient surface drainage to prevent runoff eroding either the road surface or the adjacent land. ▪ Where necessary, low mounds angled across the track will be constructed to divert runoff into adjacent arrears. ▪ Create cut and fill batters to a safe slope and stabilized by vegetation where practicable.

	▪ Where table drains need to be established, they will be designed to a broad dish shape, grassed or lined appropriately, to prevent erosion. ▪ All temporary construction tracks and lay down areas will be removed and rehabilitated when construction is completed. ▪ Limit the disturbance of vegetation in construction areas to a practical minimum. ▪ Limit disturbance of topsoil and vegetation along pipeline easements. ▪ Where significant disturbance of the ground surface is necessary topsoil will be removed from the area to be disturbed, and stockpiled as work commences. ▪ Establish vegetation growth or rock mulch in areas where diversion channels and culverts are proposed to divert flow and control runoff.
Air Quality Management Plan	o Reschedule vegetation clearing activities or earthworks during periods of high wind if visible dust is blowing off site. o Routing haul routes away from sensitive areas wherever possible. o Ensure that dust generation from construction roads is managed. o Regular watering or other treatment of exposed construction areas subject to vehicle and machinery movements. o Ensuring that vehicles and equipment are appropriately maintained or covered to minimize air emissions.
Noise Management Plan	L) Notify local residents of the project prior to commencement of the construction phase. The notification should include the type of works being undertaken, the duration of the proposed works and a contact for any questions or concerns. M) Ensure that all contractors on site have effectively controlled noise level from equipment. Effective noise controls include: o Regular inspection and maintenance of all vehicles and construction equipments working on-site. o Installation of sound suppressive devices (such as muffles) on all mechanical plant as necessary. o Where practicable, vehicles and machinery that are used intermittently should not be left idling for long periods of time. o Excessively noisy activities will be conducted between 7 am-7 pm if they are likely to be of annoyance to local residents. o Equipment used on site will be the quietest reasonably available. o Best available work practices will be employed on site to minimize occupational noise
Waste Management Plan	A waste management plan will be developed by the exploration contractors for the construction stage that includes: o Alignment with national existing waste management standards. o Top soil from excavation work will be stripped in layers, and where possible, reused for, landscaping and rehabilitation. o Where practical, any excess materials and used chemical containers will be returned to the supplier. o Wastes from the exploration site will be disposed of in the following manner: (i) Putrescible wastes will be disposed of at the prescribed land fill; and (ii) Sewage from the construction site will be pumped to the nearby sewage system for treatment and disposal.

Soil Contamination Management Plan	o Investigate the extent of contaminated soils in the areas to be excavated for the construction prior to completion of detailed engineering design. o Construction of appropriate spill containment facilities for all chemicals and fuel storage areas. o Establishing and maintaining a hazardous material register detailing the location and quantities of hazardous substances including their storage, use and disposal. o Training of operators and implementation of safe work practices for minimizing the risk of spillage.
Biodiversity Management Plan	Flora and Fauna Management Plan o The total area to be cleared for camp setup and line cutting will be restricted to the minimal area required. This area will be clearly marked prior to any works commencing. o Stockpile and equipment set-down areas and haul roads required during exploration will be clearly identified, so that weed establishment and potential spread of plant diseases and pests may be contained. o Monitoring of vegetation health adjacent to the construction activity area will be undertaken during and after exploration activities. o Construction workers will be prevented from transporting or keeping pets in the construction site. o Existing animal control programs will be updated to take account of construction activities. o Comply with the Standard Environment and Nature Safety Code of Conduct; o Avoid activities along breeding and feeding ground; o Protect nests and replace eggs at artificial nests, as appropriate; o Keep removal of vegetation to a minimum and not damage any medicinal plant; o Do not dispose of non-biodegradable waste on site; o Do not dispose/dump oil, grease or any toxic chemicals at the operational site; o Do not drive heavy vehicles outside the trail and route; o No hunting, shooting, trapping of wildlife and no collection of ornamental or medicinal plants, and o Pet animals and exotic plants will not be allowed on the operational site.

Source: Experts survey, 2007-08

Stepwise Impact Management Plans

Table 5. Summary of Environmental impacts and corresponding management measures of different stages of the project

PROJECT ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT MEASURES
A. Site preparation for setting up of camps, access roads and seismic lines	▪ Damage to growin crops ▪ Impediment to roa traffic ▪ Loss of homestea forest ▪ Air pollution due to dust emission ▪ Noise and vibration	▪ Croplands should be avoided as far as possible. Where unavoidable, farmers should be given appropriate compensation for crop losses. ▪ Required project activities may create impediments to road traffic. This can be minimized by ▪ Avoiding peak hours of traffic ▪ Carefully regulating the traffic during the time of project activities on the roads ▪ Giving early warning to road users of such activities through appropriate traffic control department ▪ Displaying proper sign for safe passage of traffic during project activities on the roads

B. Shot hole drilling and cable lying	▪ Loss of standing crops ▪ Loss of vegetation ▪ Disruption in shrim culture ▪ Soil erosion and silt deposition ▪ Congestion of road traffic ▪ Air pollution due to dust emission	▪ Crops land should be avoided as far as possible. ▪ Loss of vegetation due to numerous shot hole drilling and setting of seismic line alignments should be kept as minimum as possible. The loss should be replenished by undertaking appropriate plantation programme. ▪ Hatcheries and shrimp ghers should be avoided as much as possible. Where unavoidable, gher owners should be given adequate compensation for any damage or loss of production. ▪ Drilling of shot holes, particularly the deeper ones might loosen the surrounding soil structure thereby enhancing soil erosion. The top soil of the shot hole drilling locations must be protected for later use, for growing of vegetative cover and thus help reduce soil erosion.
C. Acoustic signal generation/ Detonation of Explosives	▪ Affects living being ▪ Impact on fish Breeding and Roosting ▪ Impact on shrimp culture ▪ Emission hazard due to detonation of explosives	▪ To suggest effective mitigation measures in order to offset any adverse effect on wildlife, terrestrial and aquatic animals including fish and shrimp. It is essential that a detail study on these living beings be undertaken to have a clear understanding of their life style. ▪ Breeding process of many animals including fish can be very sensitive to the noise and vibration that would be generated by detonation of explosives. It is therefore important that explosions do not take place during breeding season of fish and other animals. ▪ Appropriate protective measures must be taken to reduce emission from explosion.
D. Pipeline Setting, Production and Operation	▪ Disruption in shrimp culture ▪ Soil erosion and silt deposition ▪ Congestion of road traffic ▪ Air pollution due to dust emission ▪ Noise and vibration	▪ Drilling spoil/waste/waste water/solid waste should be appropriately disposed, so that they do not pollute adjacent water bodies. ▪ During earth work, care should be taken to restrict excessive movement of into adjacent water bodies. ▪ Equipment producing excessive noise should not be operated after dark to the extent possible. ▪ Breeding process of many animals including fish can be very sensitive to the noise and vibration that would be generated by detonation of explosives. It is therefore important that explosions do not take place during breeding season of fish and other animals.

Source: Environmental Expert Survey, 2007-08

CONCLUSIONS

Oil and gas exploration is a risky business in terms of Health, Safety & Environment (HSE), ecosystem and other concerns. Exploration activities may bring a great change in land use and natural ecosystems of the Sundarbans and other coastal areas by discharging wastes (solid and liquid) and gases on the surrounding environmental elements like land, air and water. Human settlement, infrastructures (physical, agricultural, socio-economic), fishing especially shrimp culture and agriculture, all of these in the study area may face a great threat due to this work.

Vulnerability of wildlife and biodiversity may come under threat for the activities as it disconnect ecological balance and natural settings of the area. We can not ignore the concerns as the experiences of Haripur, Magurchara (explosions in gas field) and recently Tengratila (firing in gas field) are still vivid in our mind. So accidents (firing or explosions) in gas fields are now considered as great concerns to initiating this type of exploratory projects. Considering this, an extensive EMP requires to be prepared and followed properly.

Most important issue of consequences of oil and gas exploration in this area is the Sundarbans and diverse coastal ecosystems. So government as well as oil and gas exploration companies has to permit or conduct exploratory activities in coastal blocks considering its long term impacts as if it sustain Sundarbans ecosystem and other diverse ecosystems for the betterment of our nation in future. In this regard it can be said that proper installation of EMP can be helps to avoid, offsets and lessen long term and short term environmental impacts.

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