



**NORTH-WEST POWER GENERATION COMPANY LTD., DHAKA
(AN ENTERPRISE OF BPDB)**

FINAL REPORT

on

Environmental Impact Assessment (EIA) Study

of

**UPGRADATION OF KHULNA 150 MW PEAKING POWER
PLANT TO 225 MW COMBINED CYCLE POWER PLANT
PROJECT**

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Submitted by:



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Abbreviations Used

ADB	-	Asian Development Bank
BBS	-	Bangladesh Bureau of Statistics
BIWTA	-	Bangladesh Inland Water Transport Authority
BOD	-	Biochemical Oxygen Demand
BPDB	-	Bangladesh Power Development Board
BWDB	-	Bangladesh Water Development Board
CC	-	Compensation Committee
CCPP	-	Combined Cycle Power Plant
CO	-	Carbon Monoxide
COD	-	Chemical Oxygen Demand
DA	-	District Administration
DO	-	Dissolved Oxygen
DoE	-	Department of Environment
DPP	-	Development Project Proforma
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
ETP	-	Effluent Treatment Plant
FGD	-	Focused Group Discussion
FPCO	-	Flood Protection
GOB	-	Government of Bangladesh
GRC	-	Grievance Redress Committee
IAM	-	Impact Assessment Matrix
IECs	-	Important Environmental Components
IEE	-	Initial Environmental Examination
IUCN	-	International Union for Conservation of Nature
JBIC	-	Japan Bank for International Cooperation
JICA	-	Japan International Cooperation Agency
JV	-	Joint Venture
JVT	-	Joint Verification Team
KI	-	Key Informants
KII	-	Key Information Interview
MW	-	Mega Watt
NO _x	-	Oxides of Nitrogen
NWPGCL	-	Northwest Power Generation Company Limited
PAP	-	Project Affected People
PD	-	Project Director
PEIA	-	Post Environmental Impact Assessment
PGCB	-	Power Grid Company of Bangladesh
PSMP	-	Power System Master Plan
PVAT	-	Project Value Assessment Team
R&R	-	Resettlement & Rehabilitation

Abbreviations Used

RAP	-	Rehabilitation Action Plan
RMS	-	Reducing Metering Station (Gas)
SOx		Oxides of Sulfur
SPM		Suspended Particulate Matter
SS	-	Suspended Solids
UC	-	Union Council
UNO	-	United Nations Organization
USDOT	-	United State Department of Transportation
WB		World Bank

EXECUTIVE SUMMARY

1.0 Introduction:

At present, one 150MW Dual Fuel Peaking Power Plant is being established beside Khulna Power Station (KPS) complex by NWPGL. Now, NWPGL intends to add one 75MW Steam Plant using exhaust gas from 150MW dual fuel power plant to convert this open cycle power plant in to combined cycle power plant to be used as base load power station with the financial assistance from Asian Development Bank (ADB).

NWPGL requires to conduct the Environmental Impact Assessment (EIA) to comply with the Environmental Laws of Bangladesh. As the first step of the project development, an Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) will be required to be completed to comply with Environmental Laws of Bangladesh. Also ADB Environment Policy 2002 and ADB Environmental Assessment Guidelines 2003 should be followed for assistance for this project.

Presently, environmental conservation is being given top priority worldwide. In Bangladesh also, for any new project, as well as plants under operation, it is mandatory to obtain environmental clearance from the Department of Environment (DoE), under Environment Conservation Act 1995, amended from time to time. According to Bangladesh Environment Conservation Rules 1997 (ECR), power plants come under the Red category, so far as environmental impact is concerned. Initial Environment Examination (IEE) followed by Environmental Impact Assessment (EIA), including Environmental Management Plan (EMP) are required for these types of installations for getting environmental clearance from DoE.

2.0 Project Justification:

In Financial Year 2010-11, the generation at the time of maximum demand supplied was only 4,890 MW although depleted generation capacity was 6639MW. Examining the reasons, it was found that the shutdown of the power plant resulting from maintenance or trouble and the shortage of gas supply. The actual demand was 6,765MW. So, there was a load shedding of 1,335MW. This requires quick action to be taken to launch a new power generation development project.

BPDB is working out power generation development planning according to the demand assumption of the base case carried out in PSMP 2010. In this assumption, the maximum load in 2014 was assumed as 9,268 MW.. To meet this assumption, it is necessary to build power plants having total power generating capacity of 2,629, in addition to the existing power generation capacity.

According to the Projects List in the PSMP 2010, Khulna Peaking Power Plant (150 MW) is planned as an important one in the western zone, which was planned to commence commercial operation in May 2013.

In order to improve the power supply in the western region, NWPGL has planned to convert this Khulna 150MW peaking power plant into 225MW combined cycle power plant. It is planned to install the additional components (HRSG, Steam Turbine with Generator, Power Transformer, Cooling water system and other accessories etc.) in the existing 40MW rental power plant area after dismantling it.

3.0 Description of the project

It has been planned to install additional components (HRSG, Steam Turbine with Generator, power transformer, cooling water system etc.) replacing the existing 40MW Agreeko Rental Power Plant area beside the Khulna 150MW Peaking Power Plant (south-western side of the well known Goalpara Power Station complex) for conversion of this peaking power plant into 225MW combined cycle power plant. Satellite image of the location of the proposed project site is given in **Figure-3.1**.

This proposed power plant is located beside Khulna Power Station complex of BPDB within the jurisdiction of Khulna City Corporation. Khulna Power station complex and graveyard are located on the east of the proposed power plant, Bhairab River and Khulna Power Co. Ltd. on the north, Burmah Oil Co. Ltd. and Kashipur area on the west, and BDC road on the south.

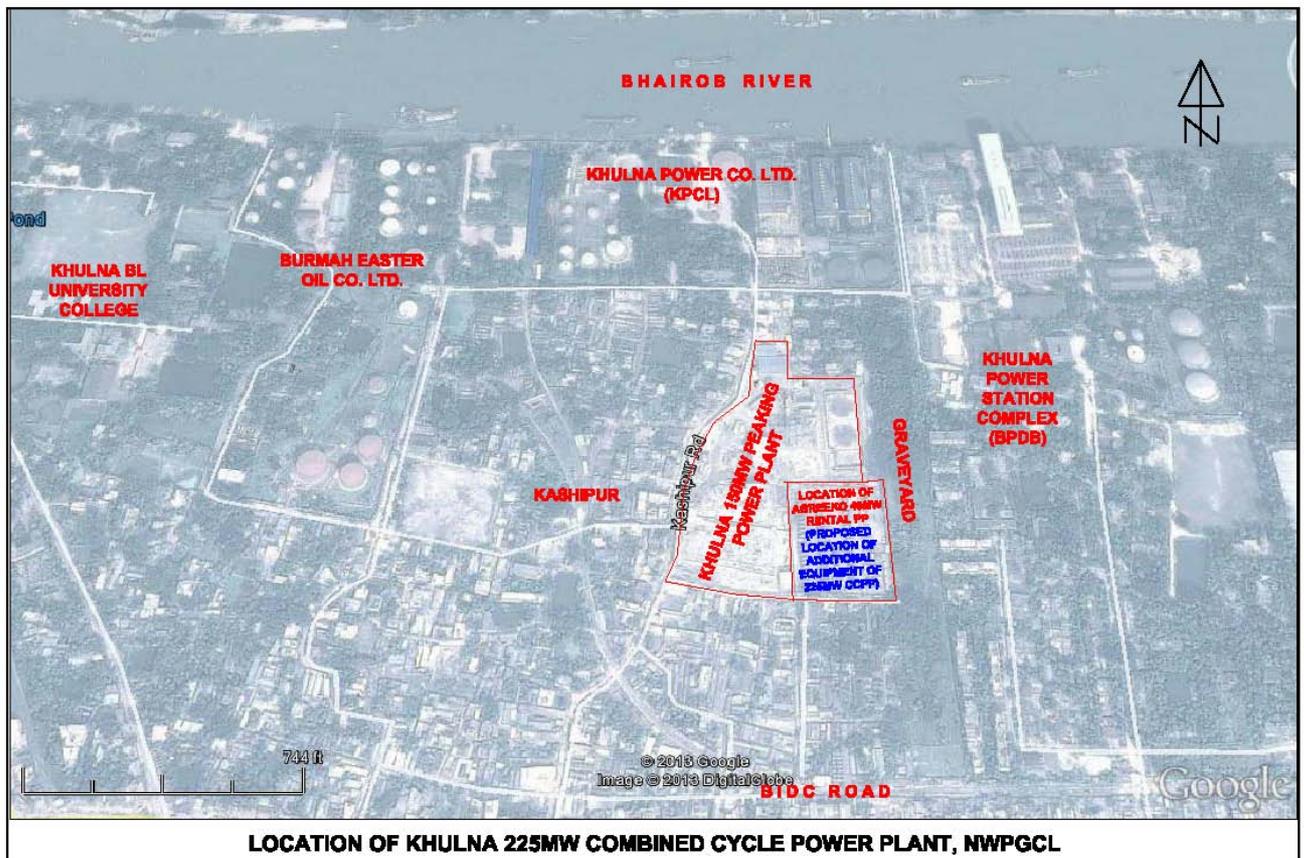


Figure-3.1: Satellite Image of the proposed Khulna 225MW CCPP project site

4.0 Existing Environment-Physical

A baseline survey was carried out in areas surrounding the proposed Khulna 225MW Combined Cycle Power Plant project site for the purpose of ascertaining Physical Environmental conditions. This has been done in order to gather information on the existing physical environment of the areas in and around the project site. During the survey, air and water samples were collected from pre-determined points in the area and analyzed in laboratory. Noise levels were also measured at definite points.

Relevant information on climate, drainage, hydrology and water resources was also collected.

Climate:

Bangladesh, a small country with generally low lying area, is located at the central part within the Asiatic monsoon region where the climate is tropical. Its climate has moderate variation in terms of temperature, rainfall, relative humidity and wind speeds.

There are two marked seasons in Bangladesh, the rainy season from May to October, during which more than 85% of the total annual rainfall occurs and the dry season from November to April. The beginning and ending of the rainy season vary from year to year. Heavy rains may commence anywhere between mid April and early June and may end anywhere between the end of September and mid November.

Climatic conditions of the study area were collected from the Meteorological Department at Dhaka and Khulna (Lat.: 22^o52'N, Long.: 89^o32.5'E). Rainfall, temperature, relative humidity and wind speed are described in the following paragraphs.

Rainfall:

During the monsoon (June to September), wind direction from the southwest brings moisture laden air from the Bay of Bengal, when the heaviest rainfall occurs.

Temperature:

Ambient air temperature varies with rainfall. During cool seasons, lowest rainfall occurs. Average Maximum temperature of **36.9^oC** was observed in May, 2009 and Average minimum temperature was **11.8^oC** in January, 2010.

Relative Humidity:

Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. the maximum Average Relative Humidity recorded by Meteorological Department Khulna station was 96% in August 2008. Whereas the minimum Average Relative Humidity recorded by Meteorological Department, Khulna station was 66% in April 2008 & 2009.

Wind Speeds and Direction

Wind directions at the project site are mostly from the south and southeast. During November to February the wind directions are from north or northwest and from March to October it is from south or southeast. It is apparent that the maximum wind speed of **5.3 knots** prevailed during October, 2008, from North-East.

Air Quality:

To ensure safety of power source and security of living beings including human, air samples were collected from 2 locations; one sampling point was located in front of 150MW peaking power plant gate another point was located in front of Administrative Building on May 4, 2013 with the help of Department of Environment, Khulna.. Department of Environment (DoE), Khulna has also carried out test of air samples collected from the project area. Test results are given in the following table:

Date	Sampling Point	SPM µg/m ³	SO _x µg/m ³	NO _x µg/m ³	CO PPM v/v
May 4, 2013	In front of Khulna 150MW Peaking Power Plant	197	20	21	0.9
May 4, 2013	In front of Administrative Building of 150MW PPP	180	18	23	0.9
Bangladesh Standard		200	80	100	9

Noise Level:

The noise level was measured by the department of environment, Khulna on May 4, 2013 at the specified locations. The environmental standards designated by Khulna Environmental Agency (DOE) are 75dBA during day hour (06:00 to 21:00hrs) and 70dBA during night (21.00 to 6.00hrs). Test results are given in the following table:

Date	Time	Location	Noise Level (dBA)	Remarks
May 4, 2013	1:45pm	In front of 150MW Peaking Power Plant Gate	74	Parameters are within limit
May 4, 2013	2:15pm	In front of Administrative Building of 150MW PPP	71	
May 4, 2013	2:30pm	Near East Side of Boundary of 150MW PPP	73	
Bangladesh Standard (day time for Industrial Area)			75	

Water Quality:

a. River water:

In order to test the quality of the Bhairab River, water samples were collected from two sampling points in the Bhairab river near the existing Khulna Power Station on May 4, 2013. The test was carried out by DoE, Khulna. Test results are given in the following table:

Item/Parameter	Unit	Near Khulna Power Station	100m up stream Khulna Power Station	Bangladesh Standard
		04/05/2013	04/05/2013	
Temperature(Surface)	°C	34.7	33.8	
pH (Surface)		7.65	7.65	6.5-8.5
EC	µS/cm			
Chloride	mg/l	3640	3630	
Turbidity	NTU	58.0	58.0	
SS	mg/l	45	42	
DO	mg/l	6.4	6.8	Above 5
BOD	mg/l	0.6	0.8	Below 10
COD	mg/l	68	64	-
Iron	mg/l	0.1	0.1	
N-Nitrite	mg/l	20	20	
Sulfate	mg/l	20	20	
Ammonium	mg/l	2.0	2.0	
Phenols	mg/l	<0.1	<0.1	
Copper	mg/l	0.1	0.1	
Zinc	mg/l	<0.01	<0.01	
Remarks	1. pH, DO and BOD are within national limit 2. High concentration of chloride and sulfate may be due to salinity of tidal river water			

b. Ground water:

Ground water sample was collected from deep tube well near the project site at Goalpara, Khulna on May 4, 2013. Water sample was tested at the laboratory of Department of Environment, Khulna. Test results are given in the following table:

Item/Parameter	Unit	Deep Tube Well water of the project area	Bangladesh Standard
		04/05/2013	
Temperature(Surface)	°C	24.5	20-30
pH (Surface)		7.59	6.5-8.5
EC	µS/cm		
Turbidity	NTU	8.23	10
TS	mg/l		
TDS	mg/l		

Item/Parameter	Unit	Deep Tube Well water of the project area	Bangladesh Standard
		04/05/2013	
SS	mg/l		
DO	mg/l	5.4	6
BOD	mg/l	0.1	0.2
COD	mg/l	<20	4
T Hardness	mg/l		200-500
Iron	mg/l		0.1-1.0
N-Nitrire	mg/l		
Sulfate	mg/l		
Phosphate	mg/l		
Chromium	mg/l		
salinity	mg/l		
Coli coloniess	No/100ml		
Remarks	All parameters are within limit		

5.0 Existing Environment- Ecological

Terrestrial Flora:

Terrestrial plants found during survey in and around the project area, on homesteads, roadside and agricultural lands have been listed. The project area provides the following major species of natural plants including herbs, shrubs, grasses and plants which are important both economically as well as for environmental sustainability of the area. The flora in and around the project area are dominated by the fruit plants, flower and ornamental plants.

The common fruits are the **mango, jackfruit, banana, papaya, guava, lemon, coconut, palm, tamarind, ata (*Anama reticulata*), karamcha (*Carissca carandas*), safeda (*Achras sapota*), wood apple, lichi, plums, watermelon, sweet melon etc. Non-fruit plants are arjun (*Terminalia arjun*), sandal tree, banayan tree, krishnachura (*Delonix regia*), palash etc.**

The flowering plants are fairly common in the project area where rose, kamini, champa (*Michelia champa*) etc. are available. The area produces good amount of vegetables and spices of which eggplant, okra, coriander, potato, pointed gourds, gourds, long beans, country beans, chilly, cabbages, bitter gourds etc. are worth mentioning.

Terrestrial Fauna:

The animals found 1 km around the site include a total of **62 species, 18 species** of mammalian animals, **36 species** of birds, **5 species** of reptiles, and **3 species** of amphibians. Of these, the animals given on the 2007 Red List of the International Union for Conservation of Nature (IUCN) contain 4 species of mammals and 3 species of birds. 2 mammals fall under the category of Least Concern (LC), 1 mammal endangered and 1 mammal vulnerable. 2 birds fall under the category of "Least concern" and 1 bird vulnerable.

Aquatic Flora

The freshwater dependant plants such as halencha (*Altermanthere philoxeroides*), kalmi (*Ipomoea aquatica*), dolkalmi (*Ipomoea fistulosa*), ichadal (*Potamo seton*) and water hyacinth (*Eichhomia crassipes*) are common in the ponds, borrowpits, ditches, canals and rivers around the project area. Khuda pana (*Lemna minor*), topapana (*Pistia stratiotes*) and chaicha (*Saipus articulatus*) are also common.

Aquatic Fauna

The Bhairab River abounds with fishes and crustaceans. They are the target of the fishing industry.

Good number of prawns including the most expensive ones, the giant prawns (*Macrobrahcium Rosenbergii*), are available in the river, adjacent to the Project area. The crabs are also common in the river, ditches and ponds. Fresh water snails (*Charonia Variegata*) and mussels (*Mytilus Edilis*) are the common or fairly common molasses.

The Khalishpur Upazila Fisheries Department has listed **67 species** of aquatic animals considered to inhabit the Bhairab River close to the site. Of these, 36 species are regarded as important by the Khalishpur Upazila Fisheries Department.

Rare and Endangered Fish Species

According to Dhaka DOE, rare or endangered species are not stipulated in the laws and regulations of Bangladesh. Some of the terrestrial animals listed in the IUCN red data were observed around the protected site of the power plant, but the plants or aqueous animals and plants listed in this data have not been observed.

Though this river is enriched with different species of fresh water fishes, but **11 nos.** of important species have been detected in the Bhairab River by the Khalishpur Upazila Fisheries Department

6.0 Existing Environment- Socio-economic:

The project is located in a semi-urban area of Khalishpur Upazila in the north eastern part of the district of Khulna. Most of the people living in the area are engaged in various industries and power plants of BPDB and IPP. Most of them are people of middle and lower middle class.

The socio-economic information/data have been collected from secondary sources. Sources of secondary data are different official records and published reports of Bangladesh Bureau of Statistics (BBS), Population Census Reports and also reports of other organizations.

On the basis of present socio-economic status of people in and around the project area, the impact of project implementation on the socio-economic situation can be determined. Decision or measures can then be taken for the implementation of the project with sustainable friendly environment.

7.0 Potential Environmental Impacts and Mitigatory Measures

To prepare impact assessment, the impacts anticipated from various projected activities were selected and measures for avoiding or alleviating such impacts were studied. The impacts assumed to be particularly serious were estimated on a quantitative basis whereby impact assessment was performed.

Whenever required, further measures for mitigating the impact were studied. Consideration was also given to the comments and views on the Khulna 225MW Combined Cycle Power Plant, presented by the inhabitants in the survey on the surrounding community and environment and at the stakeholders' meetings.

Table 7.1.(1) shows the overview of the selected assessment items during Construction period and Table 7.1.(2) shows the overview of the selected assessment items during Operation period.

Table 7.1(1) Overview of the selected assessment items (Construction period)

	No.	Assessment Item	Overall Rating	Construction Phase			
				Temporary impact by undertaking construction	Power Plant		
					Land formation of Earth work	Operating of construction machinery	Carrying construction materials in and out
Environmental contamination	1	Air pollution	B		B	B	
	2	Water pollution	B	B	B		
	3	Solid waste	B	B			
	4	Noise/Vibration	A		B	A	B
	5	Odor	B	B			
Natural environment	6	Climate					
	7	Hydrology					
	8	Flood					
	9	Underground water	B	B			
	10	Ground subsidence	B	B			
	11	Soil erosion	B		B		
	12	Sanctuary					
	13	Terrestrial ecosystem	B		B		
	14	River ecosystem	B		B		
15	Precious species	B		B			
Social environment	16	Involuntary resident resettlement					
	17	Employment /Livelihood	A	B	A		
	19	Local economy	A	B	A		
	20	Land utilization	A		A		
	22	Social infrastructure/service facilities	B	B	B		
	23	River traffic	B			B	
	24	Land traffic	B		B	B	
	25	Sanitation	B	B			
	31	Risks for infectious diseases such as (HIV/AIDS)	B	B			
26	Local custom						

	No.	Assessment Item	Overall Rating	Construction Phase		
				Temporary impact by undertaking construction	Power Plant	
					Land formation of Earth work	Operating of construction machinery	Carrying construction materials in and out
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indigenous people and such)	B	B	B	
	28	Uneven distribution of benefit and loss(damage)	B	B	B	
	30	Utilization/Right of water, including underground water	B	B		B
	32	Cultural heritage				
	33	Landscape	B	B		
	Other	34	Accident	B	B	B
35		Global warming	B			B

A: Serious impact is expected.

B: Some impact is expected.

No mark: No impact

Table 7.1(2) Overview of the selected assessment items (Operation period)

	No.	Assessment Items	Overall Rating	Operation Phase					
				Power Plant					
				Operation of Facilities				Carrying materials/stuff in and out	Solid waste
Intake of cooling water	Gas emissions	Waste water	Others						
Environmental contamination	1	Air pollution	A		A				
	2	Water pollution	B			B			
	3	Solid waste	B						B
	4	Noise/Vibration	A				A	B	
	5	Odor	B						B
Natural environment	6	Climate							
	7	Hydrology							
	8	Flood							
	9	Underground water	A	A		B			
	10	Ground subsidence	B	B					
	11	Soil erosion							
	12	Sanctuary							
	13	Terrestrial ecosystem							
	14	River ecosystem	B			B			
Social environment	15	Precious species	B			B			
	16	Involuntary resident resettlement							
	17	Employment /Livelihood	B				B		
	19	Local economy	B				B		
	20	Land utilization							

	22	Social infrastructure/service facilities	B				B		
	23	River traffic	B						
	24	Land traffic	B					B	
	25	Sanitation	B				B		
	31	Risks for infectious diseases such as (HIV/AIDS :	B				B		
	26	Local custom							
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indigenous people and such)	B				B		
	28	Uneven distribution of benefit and loss (damage)	B				B		
	30	Utilization/Right of water, including underground water	A	A					
	32	Cultural heritage							
	33	Landscape	B				B		
Others	34	Accident	B				B	B	
	35	Global warming	B		B				

A: Serious impact is expected.

B: Some impact is expected.

No mark: No impact

8.0 Environmental Management Plan (EMP) and Monitoring Plan:

Before starting the construction work, the Project Director (PD) of NWPGL is required to give sufficient consideration to the details of the construction work, and to make sure that the required EMP and Monitoring Plans are thoroughly understood by the contractor.

Thus, the Project Director (PD) of NWPGL is required to form the required organization.

Especially, there is an active inflow of the workers and many construction-related vehicles during the construction. The details of the construction work, schedule and mitigation measures should be sufficiently explained to the communities in the surrounding area. The countermeasures should be altered as appropriate, based on the correct understanding of the views of the residents.

The following are the major environmental impacts during the construction work.

- Inflow of workers and an increase in the number of construction-related vehicles
- Generation of construction wastes
- Generation of dust particles, and gas emission from vehicles and machinery
- Generation of noise from vehicles and machinery
- Occurrence of muddy water in the excavation area

Employing workers from local areas during the construction phase will have a favorable impact on the local economy. Sufficient consideration must be given

to the local employment, including implementation of the preliminary education and training program of the workers.

The EMP and monitoring plan should be worked out by sufficient discussions between the NWPGL and the contractor. To confirm the implemented plan and to study further measures, a report schedule should be worked out in such a way that the contractor will report the current situation of implementation in the form of a written statement. This report should be submitted to the Khulna DoE for further discussion.

Construction phase:

The Environmental Management Plan and Monitoring Plan during construction phase are given below:

Environmental Management Plan (EMP) during Construction phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Inflow of workers	<ul style="list-style-type: none"> ▪ Generation of sewage and refuse ▪ Outbreak of diseases ▪ Safety, accident prevention, land traffic ▪ Employment, income, livelihood, vulnerable groups, uneven distribution of benefit ▪ infrastructure 	<ul style="list-style-type: none"> ▪ Installation of sewage treatment facilities ▪ Can and bottle refuse is classified and are supplied to a third party for reuse ▪ Disposal at a predetermined disposal site. ▪ Installation of sewage treatment facilities ▪ Installation of medical facilities and implementation of periodic health checkups ▪ Education and training on health management of the workers ▪ Prevention of epidemics among workers (HIV/AIDS, dengue fever, malaria, hepatitis A) ▪ Elimination of potential breeding site for harmful insects, provision of preventive medicine as necessary ▪ Use of Bus for worker ▪ Avoidance of the time when students travel between school and home ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon) ▪ Priority of employment for local residents, development of employment standard ▪ Utilization of local service (cleaning, catering, materials) ▪ Implementation of the preliminary education and training programs with local authority ▪ Installation of medical facilities 	Contractor (NWP GCL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Installation of construction equipment	<ul style="list-style-type: none"> ▪ Safety, accident prevention, land traffic ▪ Noise ▪ Gas emission, flying sand and dust particles from vehicles ▪ River traffic 	<ul style="list-style-type: none"> ▪ Avoidance of the school commuting time ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon) ▪ No traffic at night ▪ Periodic inspection and maintenance management ▪ Periodic check of the concentration of vehicle emissions based on laws and regulations ▪ Stop the engine when idling ▪ Use of a cover to protect against dust, and periodic washing of vehicles ▪ Periodic cleaning of the surrounding roads ▪ Monitoring of resident areas ▪ BIWTA will be consulted to determine appropriate safety and/or scheduling standards to be followed. 	Contractor (NWPGL)
Excavating work and operation of construction equipment	<ul style="list-style-type: none"> ▪ Emission gas from machinery/sand and dust dispersion ▪ Noise 	<ul style="list-style-type: none"> ▪ Periodic watering of sediment disposition site and such ▪ Monitoring in residential area ▪ Operation in daytime only in principle ▪ Use of low-noise machinery (silencer, muffler) ▪ Construction of temporary fence around Project site ▪ Restriction of worker's prolonged exposure to noise ▪ Use of Personal Protective Equipment (PPE) 	Contractor (NWPGL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	<ul style="list-style-type: none"> ▪ Construction debris ▪ Soil runoff, turbid water, waste water from equipment cleaning ▪ Leakage of harmful substances ▪ Loss of habitat of flora and fauna ▪ Income, livelihood, vulnerable group 	<ul style="list-style-type: none"> ▪ Waste management program consisting of reduction, reuse, and recycling of materials. ▪ Prohibition on dumping of any contaminating material ▪ Appropriate segregation of waste and disposal into designated disposal site ▪ Installation of temporary settling tanks and sediment fencing ▪ Water used for equipment cleaning is collected in the temporary tank and treated before discharge ▪ Monitoring at the water outlet ▪ Mitigation measures to prevent leakage, installation of cleaning facility ▪ Installation of green buffer ▪ The agricultural products growing on the site is compensated according to the Bangladesh regulation. ▪ Explanation of the construction extent and procedure in the early stage. ▪ Preferentially employ local people predicting decrease in income. 	Contractor (NWP GCL)
	<ul style="list-style-type: none"> ▪ Safety, accident prevention, land traffic, infrastructure 	<ul style="list-style-type: none"> ▪ Develop a safety management plan and rules ▪ Swift transport to medical facility ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Installation of bypass for farm road and waterway within the site 	
Water intake	<ul style="list-style-type: none"> ▪ Lowering of groundwater level ▪ Ground subsidence 	<ul style="list-style-type: none"> ▪ Monitoring of underground water level in the surrounding wells ▪ Dig deeper wells as necessary ▪ Monitoring of underground water level in the surrounding wells 	Contractor (NWP GCL)

Environmental Monitoring Plan during Construction phase

Item	Parameter	Place	Frequency
Air quality	SPM, SO ₂ , NO ₂	Residential areas and schools	Monitor SPM every two weeks, and SO ₂ and NO ₂ every two months.
Water quality	TSS	Drain outlet	Every month
Noise	Noise level	Residential areas and schools	Every week when the amount of construction work is maximized
Underground water	Underground water level Water temperature, heavy metals (As, etc)	Residential area	Twice/year (dry season and rainy season)

Operation phase:

The Environmental Management Plan and Monitoring Plan during operation phase are given below:

Environmental Management Plan (EMP) during Operation phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Power generation	<ul style="list-style-type: none"> ▪ Generation of gas emissions 	<ul style="list-style-type: none"> ▪ Adoption of a high stack ▪ Installation of a continuous monitoring system for gas emissions ▪ Adoption of pre-mixing method and a low-NOx combustor ▪ Monitoring of atmospheric air ▪ Periodic maintenance and management 	NWPGCL
	<ul style="list-style-type: none"> ▪ Generation of cooling and waste water 	<ul style="list-style-type: none"> ▪ Construction of open channel for a distance for cooling the hot water ▪ Installation of a wastewater treatment system capable of coagulation sedimentation, neutralization, and oil separation ▪ Monitoring of waste water ▪ Monitoring of the river or local water ▪ Blow-off water from cooling tower is cooled by dilution 	
	<ul style="list-style-type: none"> ▪ Generation of noise and vibration 	<ul style="list-style-type: none"> ▪ Planting trees around the power plant ▪ Adoption of low-noise type machinery and installation of soundproofing covers ▪ Installation of low-vibration type machinery and the use of rigid foundations ▪ Periodic maintenance and management ▪ Monitoring around the border of the site and residential area ▪ Distribution of ear protectors to employees 	
Water intake	<ul style="list-style-type: none"> ▪ Lowering of Groundwater level ▪ Ground subsidence 	<ul style="list-style-type: none"> ▪ Monitoring the underground water level in the surrounding wells ▪ Did wells of appropriate deepness as necessary 	NWPGCL
Generation of waste	<ul style="list-style-type: none"> ▪ Generation of sludge from the wastewater treatment system 	<ul style="list-style-type: none"> ▪ Waste management program consisting of reduction, reuse, and recycling of materials. ▪ Systematic collection and protected-storage on-site 	NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	<ul style="list-style-type: none"> ▪ Generation of waste oil ▪ Generation of domestic waste 	<ul style="list-style-type: none"> ▪ Prohibition on dumping of any contaminating material ▪ Waste away from the site and their appropriate disposal in a designated municipal dumping site. 	
Presence of power plant, inflow of workers	<ul style="list-style-type: none"> ▪ Loss of habitat of flora and fauna ▪ Employment, livelihood, vulnerable people, uneven distribution 	<ul style="list-style-type: none"> ▪ Provision of vegetated buffer ▪ Preferential employment of local people ▪ Utilization of local service (cleaning, catering) and materials ▪ Implementation of the preliminary education and training programs with local authority 	NWPGL
	<ul style="list-style-type: none"> ▪ Land traffic 	<ul style="list-style-type: none"> ▪ Use of Bas for worker ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Speed limit in residential- and school area 	
	<ul style="list-style-type: none"> ▪ Social foundation ▪ Diseases 	<ul style="list-style-type: none"> ▪ Provision of emergency medical facility ▪ Medical facility and periodical health checkup ▪ Education and training on health management of the workers 	
	<ul style="list-style-type: none"> ▪ Accident and safety management 	<ul style="list-style-type: none"> ▪ Tank storage areas will be equipped with oil spill bank and countermeasure for underground oil seepage and designed as physical containment area. ▪ Implement gas leakage prevention procedures and have available on-site all preventive equipment and materials as part of the process of developing emergency plan. ▪ Fire protection equipment and facilities shall be made available at suitable locations in power plant including fixed fire protection system, fire hydrants, portable fire fighting equipment, fire vents, alarm system, fire compartments and fire exit signs. Preparation of safety standard. 	

Environmental Monitoring Plan during Operation phase

Item	Parameter	Place	Frequency
Gas emission	SPM, SO ₂ , NO ₂	Flue	Monitor SO ₂ and NO ₂ on a continuous basis (by a continuous monitoring system), and SPM every month.
Air quality	SPM, SO ₂ , NO ₂	Residential areas and schools	Monitor SO ₂ and NO ₂ every month, and SPM every two months.
Waste water/Effluent	pH, Water temperature, DO, SS, oil, BOD, and heavy metals (Pb, Fe etc)	Drain outlet	Every two months
Water quality	pH, Water temperature, DO, SS, oil, BOD, and precious metals	River	Twice a year (dry and rainy seasons)
Noise	Noise level	On the border of the site and in the residential areas	Twice a year
Underground water	Underground water level Water temperature, heavy metals (As, etc)	Residential area	Twice/year (dry season and rainy season)

9.0 Risk Assessment and Management:

The problem of protecting human health and the environment may best be defined as the management of risk. The failure to manage risk effectively and to establish priorities rationally translates ultimately into a failure to protect health, safety, and the environment. Through the use of risk assessment, concerned authorities can estimate the relative level of risks posed by different substances, products and activities and can establish priorities in determining whether, and how, to regulate.

Risk assessment is the technical process for estimating the level of risks posed by operational processes or products, i.e. the probability that a given harm will occur as a result of the processes or products. Risk assessment is applied to a substance, proceeds in four major steps:

Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause

- Dose - response assessment: predicting the degree of adverse effects at a given exposure level

- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

Risk management options are then evaluated in a proposed solution to provide reduction of risk to the exposed population. Specific actions that are identified and selected may include consideration of engineering constraints as well as regulatory, social, political and economic issues related to the exposure. Quantitative assessment of risks associated with hazard identification, dose-response assessment, exposure estimation and risk characterization were beyond the scope of the present study. However, this study takes a qualitative approach to identify common hazards within the power plant and recommends measures for managing these risks with accidents and external threats.

10.0 Public Consultations:

Public consultation forms an important part of the EIA study. The main objective of the consultation process is to apprise the local inhabitants about the proposed project and to seek their opinions regarding the possible impacts of the project. It was recognized that their opinions would be more useful as they are accustomed to construction and operation of a number of power plant units in the locality in last few years.

2 FGDs were conducted around the project area; one for male and another for female participants. The number of participants in each FGD varied between **7 and 12**. FGDs for male participants were conducted by one male member of the consultant's team and those for female participants were conducted by a lady member of the team.

Opinions of the participants are given below:

- The price of the land has increased. House rent has also increased. As a result, it is hard for the poor people to live with this increase in rent.
- Noise pollution from the 40MW rental Power Plant is very high.
- Smog emitted from this power plant is causing air pollution, which caused diseases like coughing, breathing difficulties, headache, deafness etc among the people.
- Due to noise pollution, the infants were scared and they could not sleep properly. The houses shake due to the noise. In the beginning, the sound was intolerable, but they hope that the sound will decrease in the upcoming days.
- Due to the old power plant, the water became toxic, and thus the rates of death of fishes have also increased.
- Foxes were seen at the graveyard previously, but nowadays, no people are buried over here and as a result, no foxes are seen.

- In the area of Goalpara, the level of water has decreased due to the presence of the industries and the power plant.
- Due to natural environmental problems, foxes, beji, vultures, owls, squirrels, parrots are seen seldom.
- Due to the establishment of the new power plant, many trees have been cut off.
- Before the establishment of this power plant, the place was free. At present times, for establishing the 150 MW and 75 MW (225MW) CCPP, the works are underway.
- The border boundary walls of the new power plant are always damp due to water. As a result, it is difficult for the local people to move
- Due to the establishment of the power plant, high frequency noises can be heard from the outside and as a result, this causes a lot of problem.

11.0 Conclusions & Recommendations:

Conclusions

In this study, the effects of the project activities on physico-chemical, ecological and socio-economic (i.e., human interest related) parameters during both construction and operation phases have been assessed. The impacts have been identified, predicted and evaluated, and mitigation measures suggested for both construction and operation phases of the proposed power plant. The important physico-chemical environmental parameters that are likely to be affected by the project activities include air and noise pollution.

The study suggests that most of the adverse impacts on the physico-chemical environment are of low to moderate in nature and therefore, could be offset or minimized if the mitigation measures are adequately implemented. Since the project site is located in a developed area that does not appear to be very sensitive ecologically, the impact of project activities on most ecological parameters (e.g., wet lands, homestead vegetation, forest cover, bushes and trees, wild life, species diversity) are mostly insignificant.

Some adverse impact during the operation phase of the plant will come from NO₂, emission from the power plant. However, modeling study suggests that the effect of increased NO₂, in the ambient air due to emission from the proposed power plants will not be very significant.

Noise level has been identified as significant potential impact of the proposed power plant during both the construction and operation phases. The noise generated from construction activities during the construction phase might become a source of annoyance at the residential Area to the project site.

There is no need for land acquisition. Additionally, there is no settlement in this designated area. Therefore, no population will be displaced and no resettlement will be required for the construction of the power plant.

During operation phase, no significant negative impact is anticipated on socio-economic environmental parameters.

During public consultations carried out as a part of the EIA study, people welcomed the proposed power plant project. However, they recommended installing a plant of good quality, which will be able to provide uninterrupted power and will be able to keep anticipated air and noise pollution to a minimum level.

Recommendations

The environmental assessment carried out for the proposed power plant at Khulna, suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the EMP. It is therefore recommended that the proposed Khulna 225MW Combined Cycle Power Plant may be installed, provided the suggested mitigation measures are adequately implemented. It is also recommended that the environmental monitoring plan be effectively implemented in order to identify any changes in the predicted impacts and take appropriate measures to off-set any unexpected adverse effects.

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation activities, the gas/oil fired power plant put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. An emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

Chapter 1: INTRODUCTION

1.1 Background

Khulna has been identified as an important area as because the second largest seaport Mongla and some export oriented industries are available around Khulna. The present installed capacity of electricity in Bangladesh as of February 2012 is 6693 MW with dependable generation capacity of 6061MW. As per Power system Master Plan (PSMP) Country's maximum electricity demand is 7518MW in the year 2012, 8349MW in 2013, 9268MW in 2014 and 10, 283MW in 2015. So there is a shortage of power because of shortage of supply in comparison to demand. To meet up the increasing demand in Bangladesh in the peak hour, a peaking power plant of 150MW capacity is being constructed beside Khulna Power Station at Goalpara, Khulna. But there is also need of base load power plant to meet base load demand. So, this Peaking Power Plant can be used as base power plant by converting it into combined cycle power plant by adding Heat Recovery Steam Generator (HRSG) to utilize heat of exhaust gas of this plant.

Under Power Sector Reform Program, generation, transmission and distribution branches are being separated from the mother organization, Bangladesh Power Development Board (BPDB), and in the process, North West Power Generation Company Limited (NWPGL) has been created for construction, operation and maintenance of power generation facilities in the North-Western Zone of the country. At present, one 150MW Dual Fuel Peaking Power Plant is being established beside Khulna Power Station (KPS) complex by NWPGL. Now, NWPGL intends to add one 75MW Steam Plant using exhaust gas from 150MW dual fuel power plant to convert this open cycle power plant in to combined cycle power plant to be used as base load power station with the financial assistance from Asian Development Bank (ADB).

NWPGL requires to conduct the Environmental Impact Assessment (EIA) to comply with the Environmental Laws of Bangladesh. As the first step of the project development, an Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) will be required to be completed to comply with Environmental Laws of Bangladesh. Also ADB Environment Policy 2002 and ADB Environmental Assessment Guidelines 2003 should be followed for assistance for this project.

Presently, environmental conservation is being given top priority worldwide. In Bangladesh also, for any new project, as well as plants under operation, it is mandatory to obtain environmental clearance from the Department of Environment (DoE), under Environment Conservation Act 1995, amended from time to time. According to Bangladesh Environment Conservation Rules 1997 (ECR), power plants come under the Red category, so far as environmental impact is concerned. Initial Environment Examination (IEE) followed by Environmental Impact Assessment (EIA), including Environmental Management Plan (EMP) are required for these types of installations for getting environmental clearance from DoE.

NWPGCL has initiated the environmental clearance from DoE and in the process, the company has already obtained site clearance from DoE (Please refer to **Annex-1** for Site clearance certificate issued by DOE). It is now required to obtain Environmental Clearance. NWPGCL has engaged Engineers Associates Limited (EAL), an experienced firm for such activities, for preparation of EIA for the project in accordance with the Terms of Reference given in **Annex-1.1**.

1.2 Project Outline

The proposed **Khulna 225MW Combined Cycle Power Plant** will be established in the same Khulna 150 MW Peaking Power Plant area and Agreeko 40MW Rental Power Plant area by adding 75MW steam plant with the Khulna 150MW Peaking Power Plant. The Khulna 150MW Peaking Power Plant is being constructed within the existing Goalpara (Khulna Power Station) complex of BPDB, about 5 KM West of Khulna city. In Goalpara, there are already several power plants e.g. 110 MW Steam, 60 MW Steam, a 110 MW Independent Power Plant (IPP), KPCL and 40MW Rental Power Plant. The location of the Khulna 150MW peaking power plant (under construction) is shown in **Figure-1.2(1)**. A model of layout of this peaking power plant is shown in **Figure-1.2(2)**. The major components of the plant consisted of a Simple Cycle Gas Turbine with Generator, Control Room, 132/11kV Power Transformer, 132 KV Switchyard, Liquid Fuel System, Natural Gas Fuel System, Lubricating System, Cooling System, Water Treatment Plant, Effluent Treatment Plant and other associated accessories. **The Gas Turbine will initially operate with High Speed Diesel and then with natural gas if natural gas will be available.** In order to know the sulfur contents in the HSD, sample of HSD has been analyzed. **The analysis report of High Speed Diesel (HSD) is given in Annex-1.2.**

In order to convert this peaking power plant into combined cycle power plant, it has been proposed to add Heat Recovery Steam Generator, Steam Turbine, 75MW Generator, Power transformer, cooling system etc. with the peaking power plant to be located in the existing rental power plant area after the existing rental power plant is dismantled.

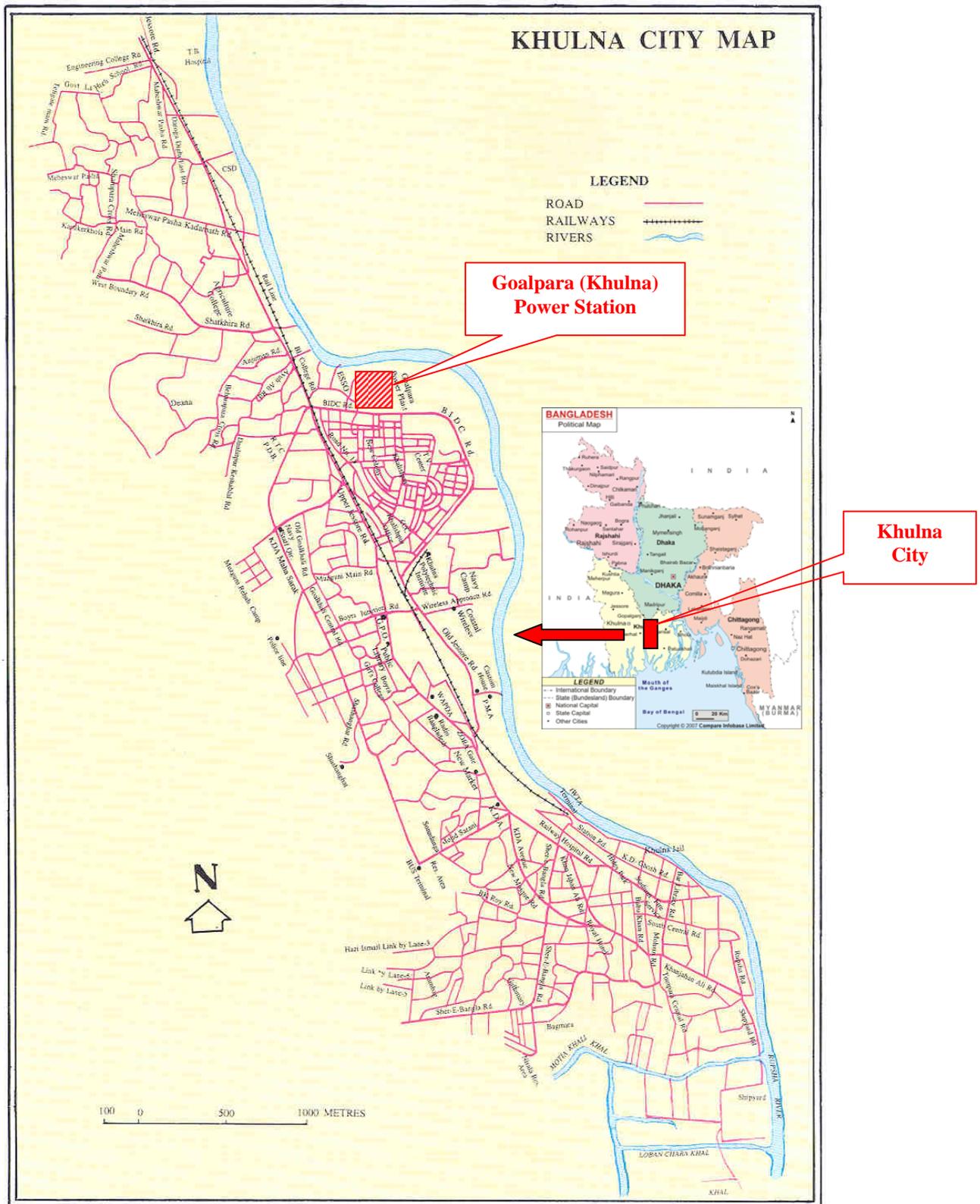


Figure-1.2(1): Location of Khulna 150MW Peaking Power Plant



Figure-1.2(2): A Model Layout of Khulna 150MW Peaking Power Plant

1.3 Policy, Legal and Administrative Framework

DoE, under the Ministry of Environment and Forest, Government of the Peoples' Republic of Bangladesh, is responsible for ensuring application of environmental laws and rules and issuance of necessary clearances in this regard. The Environmental Conservation Act has classified three categories of establishments, so far as degree of environmental pollution is concerned – Green, Amber and Red.

According to the Environment Conservation Rules 1997, power plants, transmission lines and gas pipe lines come under Red category, as has been stated earlier under 1.1 above. Under this Rule, it is mandatory for project proponents to obtain environmental clearance from DoE, by carrying out IEE, followed by EIA, including Environmental Management Plan (EMP). It has also been stated earlier that NWPGL has already obtained IEE clearance. NWPGL is now required to obtain EIA clearance from DoE.

In addition to Environmental Conservation Act and Rules, the following relevant National Policies and Legislations (with their amendments) relating to environment are also required to be adhered to for the project :

- a) National Conservation Policy, 1992
- b) National Conservation Strategy, 1992

- c) EIA Guidelines for Industries, 1997, issued by DoE
- d) Bangladesh Wildlife Preservation Act, 1973
- e) Bangladesh Antiquities Act,
- f) Power Policy, 1995
- g) Energy Policy, 1996
- h) Electricity Act and Rules, 1910 and
- i) Industrial Policy.

The project is being financed by Asian Development Bank and Government of Bangladesh

1.4 Study Area

The project will be located at the existing 40MW Rental Power Plant area beside Khulna 150MW Peaking power Plant at Goalpara Union in Khalishpur Thana under Khulna District. The area is located within the jurisdiction of Khulna City Corporation and beside the Bhairab river, which is on the north of the site. Khulna Power Station owned by BPDB is located on the north-eastern side of the proposed site. and Burmah Eastern Oil Depot on the western side. Welknown Goalpara power station of BPDB is about **5 km west** of Khulna city and **170 km south-west** of the capital city of Dhaka.

The EIA study covered an area of about 2 km around Khulna 150MW Peaking Power Plant. The study area showing on Khalishpur Thana map is given in **Figure-1.4**.

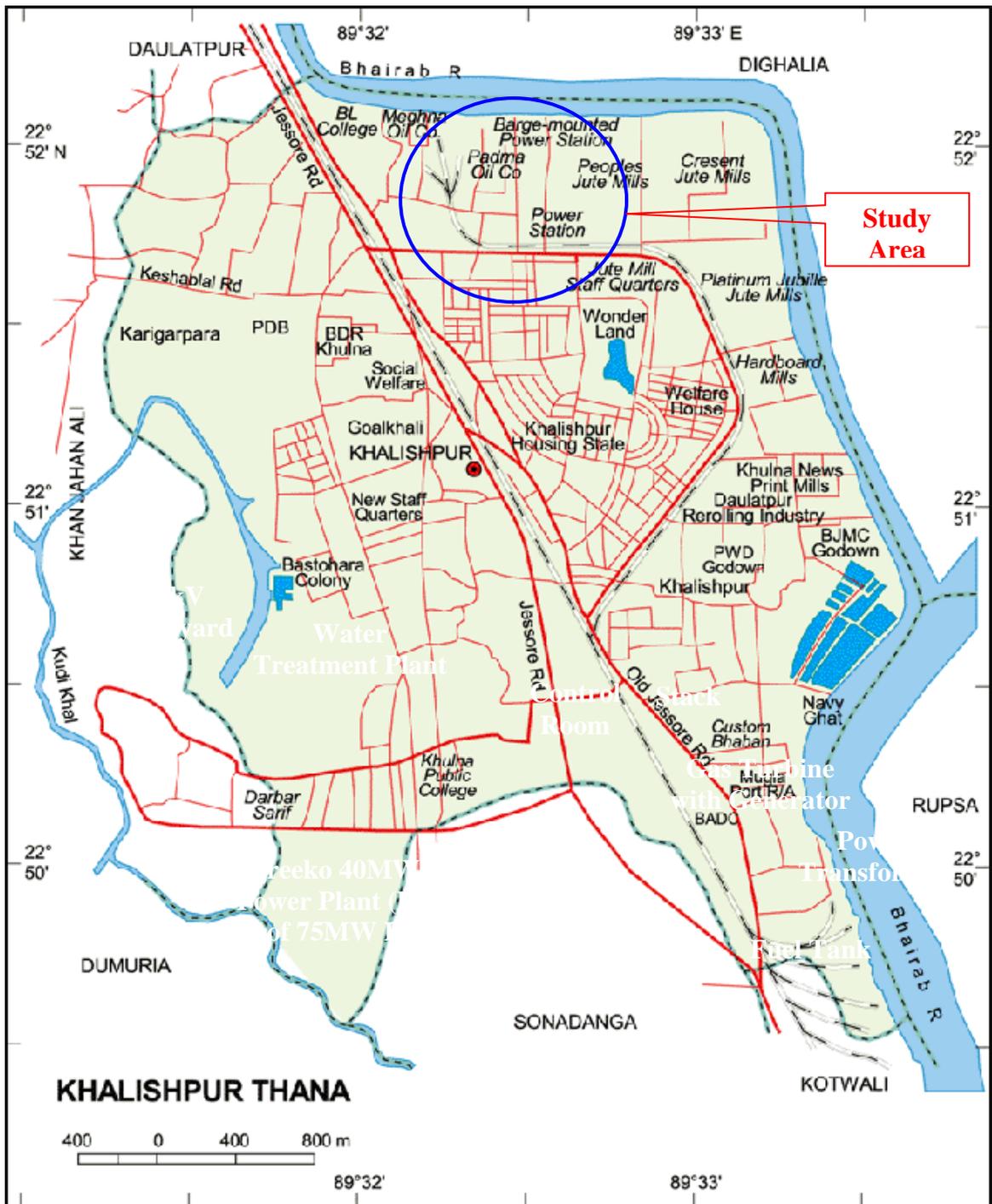


Figure-1.4: EIA Study Area showing on Khalishpur Thana Map

1.5 Outline of Methodology

1.5.1 Major Activities

For Environmental Impact Assessment study, the following major activities are required to be undertaken:

- (a) Study of the relevant documents on policy, legal and administrative framework and their review, particularly on environmental aspects and

effluent discharge limits, health and safety requirements, identification of sensitive areas and endangered species, land use etc.

- (b) Carrying out an environmental baseline survey covering areas in and 2 km around the project site i.e. Study Area.
- (c) Identification of major project activities, both during construction and operational phases of the project.
- (d) Identification and prediction of environmental impacts of project activities on the surrounding environment, including cumulative impacts of the proposed power plant and the existing and ongoing projects/industries on selected environmental attributes.
- (e) Identification of the most significant environmental and social impacts and suggestions for mitigation measures in order to reduce/eliminate negative impacts and to enhance positive impacts.
- (f) Arrangement of public consultation meetings to consult with potentially affected people.
- (g) Development of Environmental Management Plan (EMP) for both construction as well as operational phases of the project.
- (h) Development of Corporate Environmental Policy for the project authority regarding environmental protection and sustainability.
- (i) Analysis of the alternatives to the proposed project site, technology, design and operation.
- (j) Identification of environmental and health risks associated with major accidents, natural disasters and external threats and recommendations for measures to be taken for reduction of these risks. A quantitative risk assessment and characterization of individual hazards on human health was not performed due to the very limited time allocated for this study and also due to the lack of pertinent data in the absence of a detailed feasibility study and design of the project.

1.5.2 Study Team and Their Tasks

Study Team

A Study Team was constituted comprising of specialists on various aspects for conducting the environmental impact assessment of the project. The list of team members is given in the following table:

Sl. No.	Name of Specialist	Position
1.	Engr. Obaidul Alam, B.Sc. Engg. (EE)	Team Leader
2.	Dr. Khairul Bashar, Ph.D (Geology))	Environmental Expert-A (Natural Environment)

Sl. No.	Name of Specialist	Position
3.	Engr. Rama Nath Roy, Master of Engg.(EE)	Environmental Expert-B (Air, Water, Noise)
4.	Mr. Mizanur Rahman Kham,	Social Environmental Expert-A (Social Environment Study)
5.	Mr. Swapan Kanti Poddar, M.Sc. (Environmental Science)	Social Environmental Expert-B (Social Investigation)

Tasks assigned

Tasks assigned to the individual experts are as follows:

Team Leader

- (i) Monitor the activities of Social Environmental survey.
- (ii) Monitor the activities of Natural Environmental survey.
- (iii) Supervise the preparation of survey reports
- (iv) Liaison with Project Director (PD) of the project.
- (v) Attend meetings with concerned authorities.

Environmental Expert-A

- (i) Guide the Natural Environmental survey team in conducting the survey.
- (ii) Investigate and study the relevant documents.
- (iii) Compile the results of Natural Environmental survey and document investigation and study.
- (iv) Prepare Natural Environmental survey reports.
- (v) Attend meetings with the concerned authorities.
- (vi) Report to the Team Leader.

Environmental Expert-B

- (i) Supervise the measurements of air quality, water quality and noise level in and around the Study Area.
- (ii) Guide the Natural Environmental survey team in conducting the survey.
- (iii) Compile the results of air quality, water quality and noise level.
- (iv) Prepare Natural Environmental survey reports.

- (v) Attend meetings with concerned authorities.
- (vi) Report to the Team Leader.

Social Environmental Expert-A

- (i) Discuss the outcome of all survey results with all Team Members and concerned authorities.
- (ii) Summarize all survey reports.
- (iii) Attend meetings with concerned authorities.
- (iv) Report to the Team Leader.

Social Environmental Expert-B

- (i) Develop questionnaire for social survey.
- (ii) Organize Focused Group Discussions (FGD) in the project area.
- (iii) Train the field supervisors and field investigators in conducting social survey.
- (iv) Supervise social survey activities.
- (v) Compile the results of survey and prepare survey reports.
- (vi) Attend meetings with concerned authorities.
- (vii) Report to the Team Leader.

1.6 Report Structure

This EIA report for upgradation of 150 MW Khulna Peaking Power Plant to 225MW Combined Cycle Power Plant has been prepared after survey of natural and social environments of the Study Area, following the Guidelines for Industries, 1997, issued by DoE and in accordance with Environmental Conservation Act and Rules. The report contains all the elements of an EIA report as required by DoE, along with some additional elements to suit the requirements of the present study.

The report is divided into the following 11 Chapters:

Chapter 1: Introduction

This chapter presents the background and a brief outline of the proposed power plant project. It provides a brief description of the policy and legal framework with regard to the environmental aspects of the project in the context of Bangladesh, where the regulatory requirement of conducting an environmental assessment of the proposed project has been discussed. The chapter provides a brief description of the area covered by the present study and the methodology adopted for environmental assessment of the proposed project.

Chapter 2: Project Justification

It presents an analysis on the justification of the project, with brief discussion on the present demand-supply situation and the consequences of “no-project” scenario.

Chapter 3: Description of the Proposed Project

This provides a description of the different aspects of the proposed project, including project location, site development and construction activities, equipment and processes to be employed, electricity generation and transmission, gas transmission, water management, waste and emission management, fire fighting and operation and maintenance. An environmental baseline survey has been carried out within the Study Area as part of the present study. During the baseline survey, detailed information on the existing physical, ecological and socio-economic condition of the Study Area were collected.

Chapter 4: Existing Environment - Physical

This chapter provides a description of the existing physical environment of the Study Area. The elements of the physical environment of the Study Area described here include climate, topography and drainage, geology and soils, hydrology and water resources, air quality, noise level and water quality.

Chapter 5: Existing Environment - Ecological

It describes the existing ecological environment, including the terrestrial and aquatic eco system of the Study Area and the presence of rare and endangered species.

Chapter 6: Existing Environment – Socio-Economic

The existing socio-economic condition of the Study Area has been summarized in this chapter. It provides description of the land use and utilities, demographic characteristics, education, employment and economics of the Study Area. It also briefly describes the industry, agriculture, public health and transport issues of the Study Area.

Chapter 7: Potential Environmental Impacts and Mitigation Measures

This describes the potential environmental impacts of the proposed power plant project and the mitigation measures to reduce or eliminate adverse impacts, along with measures to enhance and monitoring positive impacts. For this purpose, the project activities have been divided into two phases – construction phase and operation phase. The major environmental impacts of the project activities during each phase have been identified. This chapter then provides an evaluation of these potential impacts and presents

suggested measures to reduce or eliminate adverse impacts and enhance positive impacts. An economic assessment of the impacts has also been presented at the end of the chapter.

Chapter 8: Environmental Management Plan and Monitoring

It presents the environmental management and monitoring plan for the proposed project, both during the construction and operation phases. Among other issues, it addresses the detailed monitoring plan (including monitoring parameters, monitoring schedule and resource requirements), occupational health and safety issues and institutional arrangement.

Chapter 9: Risk Assessment and Management

This chapter identifies common risks in a power plant associated with accidents that may occur, natural disasters and external threats and outlines important measures to minimize those risks.

Chapter 10: Public Consultations

It presents the findings of various consultations carried out as part of the environmental assessment, including consultation with statutory and non-statutory bodies and public consultations.

Chapter 11: Conclusions and Recommendations

This chapter presents the conclusions and recommendations of this environmental assessment study.

Chapter 2: PROJECT JUSTIFICATION

2.1 Introduction

In fiscal year 2011 the total installed capacity in the country was 6,639 MW, which comprised of thermal generation capacity (Derated) of 6,409 MW (96.54%), and a hydroelectric generation capacity of 230 MW (3.46%). In terms of fuels, natural gas-fired power stations represented 73.25% of the total capacity. In terms of the installed capacity of different electric power generation companies, as of June 2011, the installed capacity of Public Sector (BPDB, EGCB, APSCL, NWPGL) was 3,503MW while that of the IPPs (independent Power Producers) was 1231 MW. However, the percentage of power generating facilities that were inoperable due to aging was high, between 30% and 40%.

Although natural gas is the central pillar of domestic energy production in Bangladesh, because the gas fields are unevenly distributed, located primarily in the eastern zone of the country, the fuels used and the types of generating facilities differ between the eastern and western regions. In the east, all thermal power stations use natural gas as fuel, but in the west the main fuel is oil and for small portion, coal.

Because there is a chronic supply shortage in Bangladesh, electric power generation companies cannot afford to stop power stations for inspection and maintenance, and because periodic inspections are also not being sufficiently performed, the generating capacities of most thermal power stations is substantially less than the rated power.

Table 2.1.1 Power Generating Facilities using Fuel

Fuel	MW	%
Natural Gas	4,863	73.25
Furnace Oil	671	10.11
Diesel	655	9.87
Hydraulic Power	230	3.46
Coal	220	3.31
Total	6,639	100.0

(Source) BPDB Annual Report 2010-11

Table 2.1.2 Power Generating Facilities using a Generation Method

Fuel	MW	%
Hydro-Electric Power	230	3.46
Steam Turbine	2,211	33.30
Gas Turbine	932	14.05
Combined Cycle	1,166	17.56
Reciprocating Engine	2,100	4.58
Total	6639	100.0

(Source) BPDB Annual Report 2010-11

2.2 Demand-Supply Situation

In Financial Year 2010-11, the generation at the time of maximum demand supplied was only 4,890 MW although depleted generation capacity was 6639MW. Examining the reasons, it was found that the shutdown of the power plant resulting from maintenance or trouble and the shortage of gas supply. The actual demand was 6,765MW. So, there was a load shedding of 1,335MW. This requires quick action to be taken to launch a new power generation development project.

BPDB is working out power generation development planning according to the demand assumption of the base case carried out in PSMP 2010. In this assumption, the maximum load in 2014 was assumed as 9,268 MW.. To meet this assumption, it is necessary to build power plants having total power generating capacity of 2,629, in addition to the existing power generation capacity.

According to the Projects List in the PSMP 2010, Khulna Peaking Power Plant (150 MW) is planned as an important one in the western zone, which was planned to commence commercial operation in May 2013.

In order to improve the power supply in the western region, NWPGL has planned to convert this Khulna 150MW peaking power plant into 225MW combined cycle power plant. It is planned to install the additional components (HRSG, Steam Turbine with Generator, Power Transformer, Cooling water system and other accessories etc.) in the existing 40MW rental power plant area after dismantling it.

2.3 Consequences of No-Project Situation

It has been stated in section 2.2 that in 2011, against a demand of 6,765 MW in the country, only 4,890 MW was supplied. . So, there was a load shedding of 1,335MW. Khulna is the third largest load centre in the country, where the power supply situation is very serious, particularly in the evening. This is also the case with the whole country. This is the general phenomenon during the

whole year. Meeting the demand during peak hours in particular is a major problem for BPDB.

If the present project is not implemented, the load shedding will further increase, aggravating the sufferings of the consumers of electricity.

Chapter 3: DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

It has been planned to install additional components (HRSG, Steam Turbine with Generator, power transformer, cooling water system etc.) replacing the existing 40MW Agreeko Rental Power Plant area beside the Khulna 150MW Peaking Power Plant (south-western side of the well known Goalpara Power Station complex) for conversion of this peaking power plant into 225MW combined cycle power plant. Satellite image of the location of the proposed project site is given in **Figure-3.1**. Layout Plan of Upgradation of Khulna 150MW Peaking power plant to 225MW Combined Cycle Power Plant is given under **Annex-3.1**.

This proposed power plant is located beside Khulna Power Station complex of BPDB within the jurisdiction of Khulna City Corporation. Khulna Power station complex and graveyard are located on the east of the proposed power plant, Bhairob River and Khulna Power Co. Ltd. on the north, Burmah Oil Co. Ltd. and Kashipur area on the west, and BIDC road on the south.

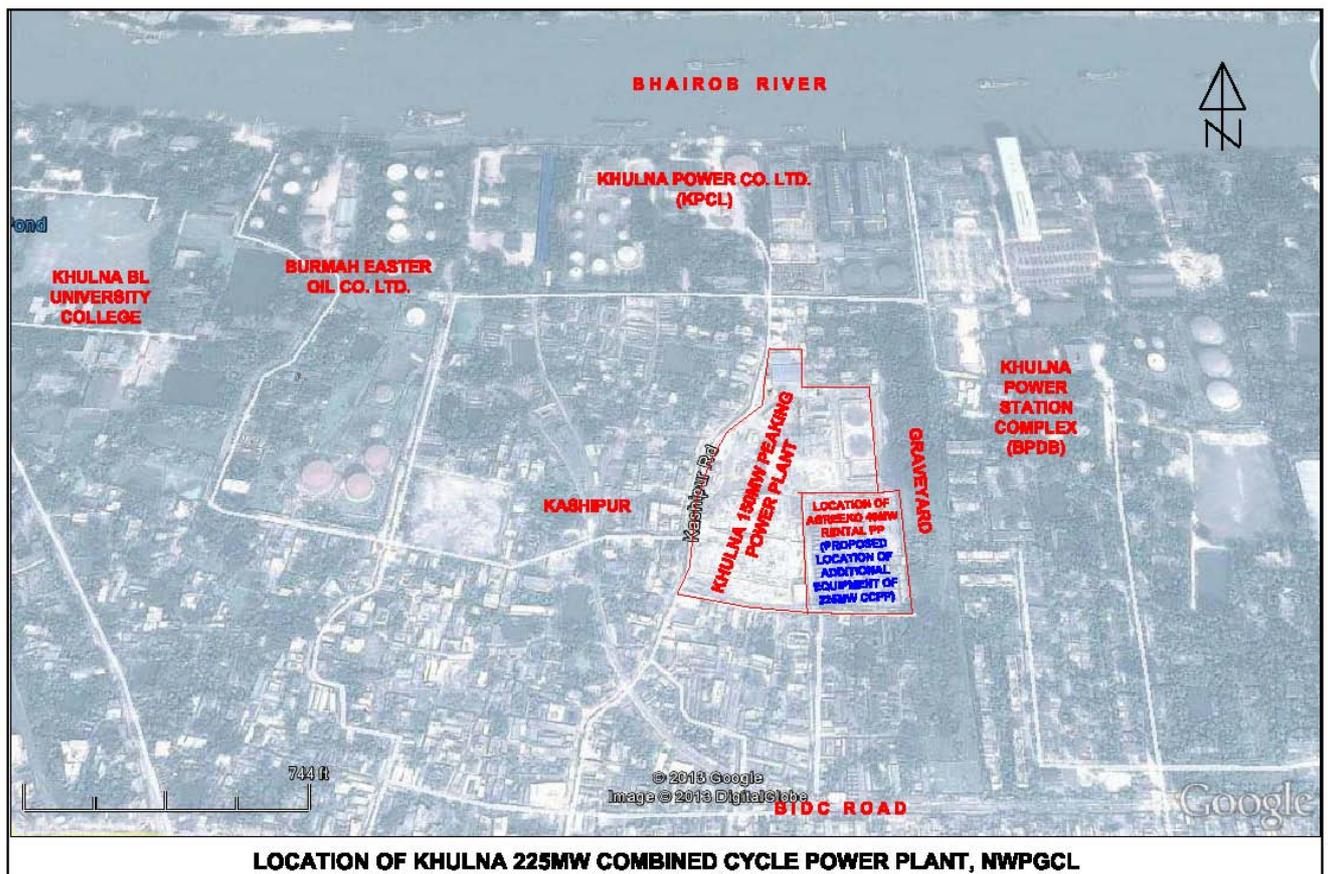


Figure-3.1: Satellite Image of the proposed Khulna 225MW CCPP project site

3.2 Site Development and Construction

40MW Agreeko Rental power plant is already located at the proposed site. There is no need for land development. However, soil investigation will be carried out. This investigation results will be utilized for detailed engineering plans and site development.

It is expected that the proposed project will consist of heavy plant equipment to be delivered to the site. The main components, HRSG, Steam Turbine, generator and transformer, will be assembled overseas and delivered to the site using river routes. The remaining plant and equipment will be erected at the site. For the construction and erection of the plant also heavy equipment, like cranes etc will be utilized.

3.3 Equipment and Processes

The following equipment will be required for converting the Khulna 150MW PPP into 225MW CCPP:

- I. Heat Recovery Steam Generator
- II. Steam Turbine
- III. Generator
- IV. Power Transformer
- V. Cooling water system
- VI. Bypass stack

The exhaust gas will be taken away from the stack of the Khulna 150 MW PPP and will be passed through **Heat Recovery Steam Generator (HRSG)** in which water from Bhairab river will be fed after treatment (demineralization & desalination) to produce the steam and then the steam will be passed through steam turbine coupled with generator to produce electricity at 11kV voltage level.

The output voltage will be stepped up to 132kV by power transformer to connect to the 132kV grid sub-station to evacuate power to the national grid. The flue gas will be discharged to the atmosphere through a bypass stack of adequate height.

In order to cool the steam out from steam turbine, recirculating wet cooling tower will be used. Raw water will be collected from Bhairab river and it will be used in the cooling tower and steam cycle for makeup water after proper treatment. Water flow schematic is shown in **Figure-3.2**.

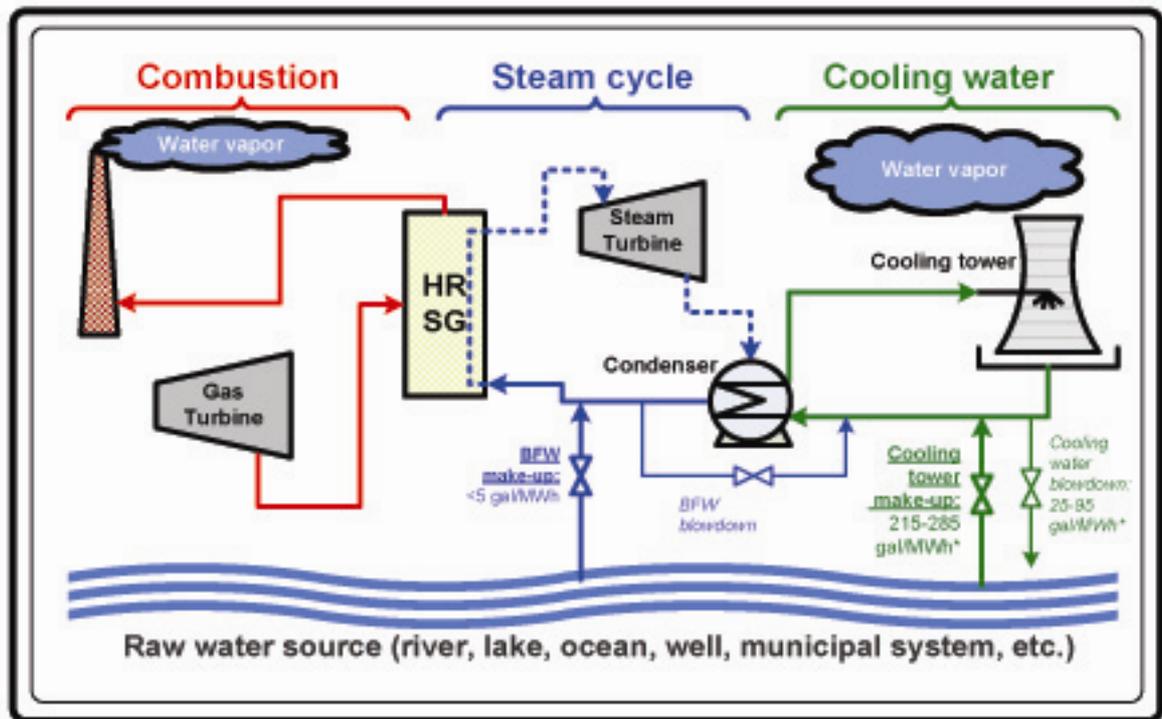


Figure-3.2: Water Flow Schematic utilizing wet Cooling Tower

From the study report of NETL, USA, water requirement for combined cycle power plant is **190gal/MWh= 0.72m³/hr per MW**. This water requirement includes makeup water for steam cycle and cooling tower. The makeup water is estimated roughly from evaporated water and blow down water in the cooling tower. From this base data, the water requirement for 225MW CCPP will be about **162m³/hr**. From baseline data of flow rate and water level of Bhaiab river, there will be no problem in withdrawing the said amount of water from the Bhaiab river. **But there is disadvantage of using this river water in the winter due to increase of salinity in river water. In that case, ground water may be utilized for cooling purpose** if the ground water investigation permits. This groundwater investigation and modeling can be carried out if it is intended to use groundwater for makeup water of cooling tower and steam cycle.

3.4 Electricity Generation and Transmission

Electricity will be generated in the proposed power plant at 10-11 KV, which is the normal voltage for such generators. The voltage will be stepped up to 132 KV through a step-up Transformer, to be installed close to generator outlets. This high voltage (132 KV) supply will be connected to the 132 KV Sub-station already installed to evacuate power from the peaking power plant.

3.5 Water Management

Potable and sanitary water will be supplied from the deep water pump and overhead tank installed already for peaking power plant. But cooling/process water for the plant, fire fighting water and water for miscellaneous services will be obtained from the Bhairab river, which is required to be demineralized and desalinated through pretreatment system in the Water Treatment Plant (WTP). A conceptual flow diagram of the two sources of water is shown in **Fig-3.5(1)**. The same diagram is also given in **Annex-3.5(1)**.

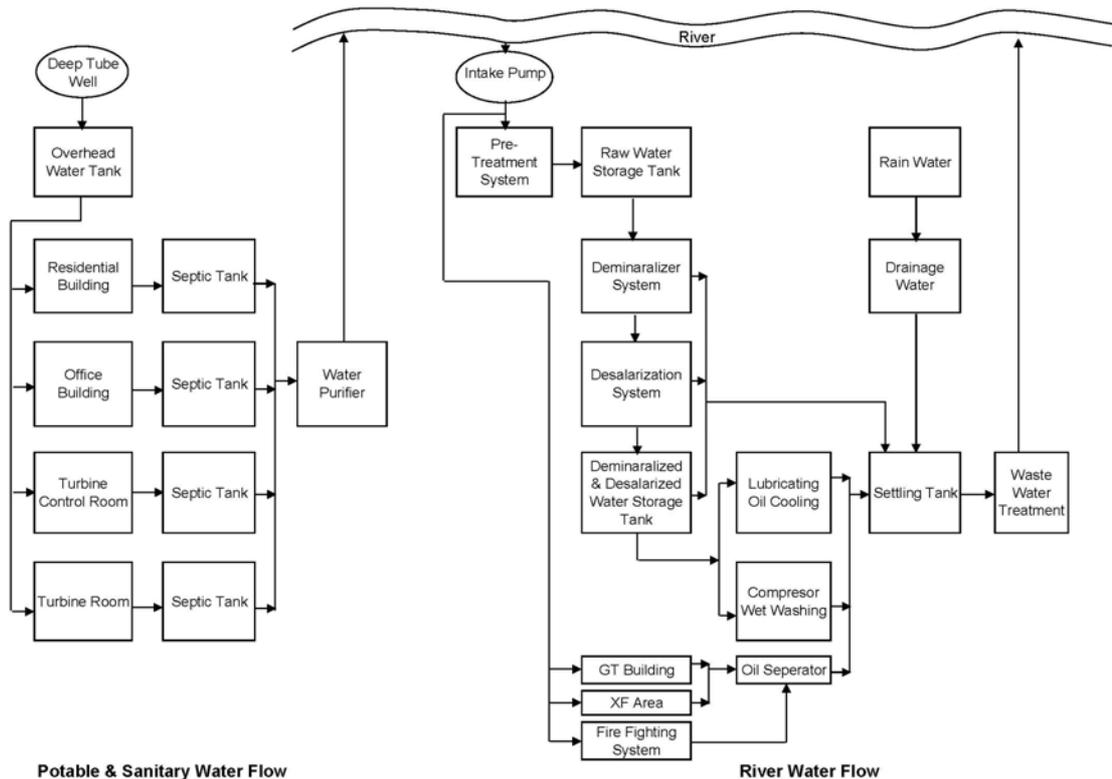


Figure 3.5.1: Conceptual Water Flow Diagram

Water, after cooling of lubricating oil and compressor wet washing, shall be treated and cleaned in separate equipment in the WTP. Sewerage and sanitary waste water shall be treated in purifying facilities. Floor drains from the Steam Turbine and contaminated yard drains from the Transformer area shall be treated in oil/water separators. After treatment, these clean waste water streams shall be discharged through the main drainage pipe to the river. A conceptual flow diagram of the waste water flow is shown in **Fig-3.5(2)**. The same diagram is also given in **Annex-3.5(2)**.

Waste Water Treatment Plant has been already installed in the existing Khulna 150MW Peaking power Plant for waste water management. The details of the existing Waste Water Treatment Plant is given under **Annex- 3.5(3)**

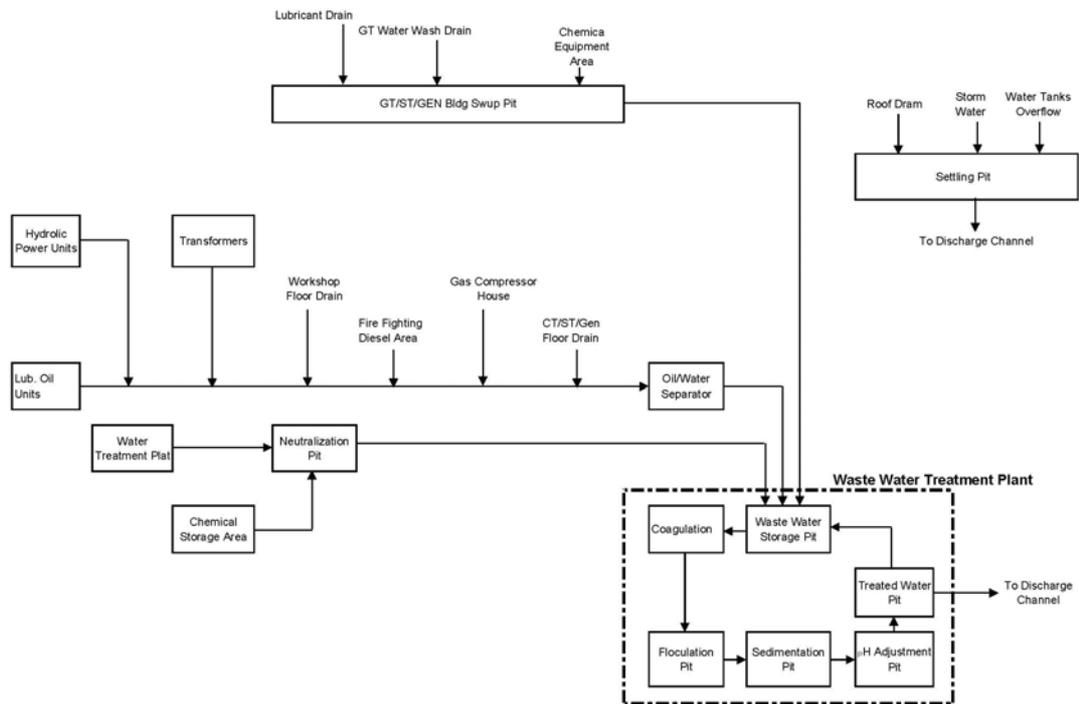


Figure 3.5.2: Conceptual Flow Diagram of Waste Water System

3.6 Waste and Emission Management

Waste generated during the construction phase of the project include construction debris and wastes (e.g. scrap iron, steel, wood, piping etc.) and some other solid wastes (e.g. from labor sheds), human wastes from people working at the project site and some liquid wastes from construction processes. Emissions would include those from operations of construction equipment and machineries, vehicles carrying construction materials to the site and taking construction debris out of the site. If construction equipment, such as stone crushers, are used at the site, this may result in significant emission of particulate matters during its operation. Since construction of the proposed power plant would most likely involve significant earthwork, increase in particulate matters in the air from wind-blown dust is also a concern, especially considering the close proximity of the residential area to the project site. Noise pollution from movement of vehicles and operation of construction equipment is also a concern for the same reason.

The proposed 225MW Combined Cycle Power Plant is of relatively cleaner technology for production of electricity. Emission from the plant is expected to produce minimum impact on the surrounding environment, other than temperature.

The appropriately designed wastewater disposal facilities of the proposed power plant will take care of human wastes to be produced within the plant. Solid wastes from offices of the power plant, to be generated during the operation of the plant would not be significant.

Management of wastes and emissions generated during the construction and operation phases of the project is a very important issue, details of which have been discussed in Chapter 8 of this report. In general, construction debris and other solid wastes generated at the construction site should not be mixed with domestic solid wastes generated within the complex. These solid wastes should be handled separately. It should be the responsibility of the contractor to properly store these wastes at the project site and then dispose them off in an appropriate manner (e.g. in a municipal land fill/waste dumping ground) outside the complex. Human wastes e.g. those generated in the labor sheds, should be appropriately disposed off, e.g. through construction of septic tank system.

Appropriate measures, as detailed in Chapter 8 should be taken to minimize generation of air pollutants during construction phase. Such measures may include, among others, controlled movement of vehicles and operation of equipment considering school hours, covering of construction materials (e.g. sand) and keeping exposed land surface wet to limit wind-bound dust concentration, no or limited operation of equipment producing excessive noise during school hours and late at night etc. Measurement of air quality and noise level during both construction and operation phases would also be part of the waste and emission management scheme (see details in Chapter 8).

3.7 Fire Fighting and Protection System

3.7.1 Fire Safety Philosophy

The proposed combined cycle Plant will be designed and built with the provision of a safe operating environment both for plant and personnel. This will be achieved by separation and segregation of equipment with sufficient distances and by selection of suitable materials and equipment.

Hazardous areas will be designated and suitable equipment will be selected for use in these. Different fire fighting systems will be installed depending on the operational characteristics of the equipment, area and building to be protected. The capacity of the proposed fire fighting plant will be such that it can operate continuously for 2 hours according to NFPA 850 and will be of a minimum of 300m³ and pressure of approximately 10 bars (Table 3.7.1).

The proposed plant will have its own water system for fire fighting, with a pump house. The fire water will be provided from the river/raw water tanks.

The new pump house will consist of:

- One (1) 100% electric jockey pump
- One (1) 100% electric driven main pump and
- One (1) 100% diesel engine driven main pump.

The water demand and required pressure under the worst condition will be ensured by electrically driven main pump. The diesel engine driven pump shall be on stand-by, for the case of main supply failure. The engine driven pump will be of the same capacity as the electric driven main pump.

Table 3.7.1 : List of protected areas and types of fire fighting and detection system

Sl. No.	Building or Area	Fire Fighting System
1.	Turbine	CO ₂ extinguishing system
2.	Generator Unit, Auxiliary and Step up Transformer	Spray water dry type
3.	Oil Tanks	Foam system, Dike protection
4.	Control Room	Cable basement: sprinkler system Control room: argonite or similar
5.	Electrical/Switchgear	Sprinkler system, if required and portable fire extinguisher
6.	Yard	Hydrants
7.	Common	Protective signaling for fire and gas detection systems with main panel in the control room

3.7.2 Fire Fighting System Description

The fire protection system of Khulna 225 MW Combined Cycle Power Plant will be provided for the plant as described in the following paragraphs. The fire protection system will generally follow the applicable stipulations of NFPA codes.

Extinguishers will be sized, rated and spaced in accordance with NFPA 10. Local buildings fire alarms, automatic fire detectors and the fire signaling panel will be in accordance with NFPA 72.

It will be assured that a dedicated two (2) hour fire water supply to cover the system design flow rate is available for the facility in accordance with NFPA.

A main firewater pipeline will be provided to serve strategically placed yard hydrants and supply water to the sprinkler and spray system.

The firewater distribution system will incorporate sectionalizing valves so that a failure in any part of the system can be isolated while allowing the remainder of the system to function properly.

Fuel oil tanks are furnished with foam fire fighting systems.

3.8 Operation and Maintenance

Major equipments of the power plant are HRSG, steam turbine, generator, transformer etc. Generally steam turbine has the most frequent failure among such major equipments. Therefore, the maintenance quality for the steam turbine makes great influence on the availability of the power plant.

During the operation of the steam turbine, consequently the degradation / damage of blades are more severe than any other part and it requires more frequent interval for inspection / repair / replacement. The expected life of those hot parts of steam turbine is specified by the original equipment manufacture (OEM) and the specified inspection / repair are required up to the life end.

3.9 Others

3.9.1 Facilities for Construction

(a) Jetty and Crane

There is a Jetty (Pier) and an overhead crane with the existing power plant in Goalpara, which is very close to the site of the proposed plant and will greatly facilitate handling of heavy weight and large cargoes transported by channel transportation. Barges carrying such heavy lifts and large cargoes will come right under the crane inside the pier and these will be lifted and carried over the running equipment of the existing plants (60 MW and 110 MW) up to the other end of the building housing the plants.

(b) Storage Yards

Storage yards are very important for construction of a plant, like the Khulna 225 MW Combined Cycle Power Plant. But there is not sufficient space for storage of power plant equipment as well as civil construction materials at the same time. It will, therefore, be necessary to schedule the construction in such a way that civil construction e.g. machinery foundation and building works are completed just before the arrival of power plant equipment and remaining civil construction materials are removed from the site to make room for equipment storage.

Chapter 4: EXISTING ENVIRONMENT: PHYSICAL

4.1 Introduction

A baseline survey was carried out in areas surrounding the proposed Khulna 225MW Combined Cycle Power Plant project site for the purpose of ascertaining Physical Environmental conditions. This has been done in order to gather information on the existing physical environment of the areas in and around the project site. During the survey, air and water samples were collected from pre-determined points in the area and analyzed in laboratory. Noise levels were also measured at definite points.

Relevant information on climate, drainage, hydrology and water resources were also collected.

The data collected on different items, results obtained from laboratory tests and measurements made are detailed in this Chapter. It describes the existing physical environment of areas in and around the project site based on the baseline survey and other studies carried out as a part of the present study. Air quality, noise level, water quality and other physical environmental conditions of the project site, as have been described in this Chapter, are very important in obtaining clearance from DoE. These are also very essential for designing the equipment for the project.

4.2 Climate

Bangladesh, a small country with generally low lying area, is located at the central part within the Asiatic monsoon region where the climate is tropical. Its climate has moderate variation in terms of temperature, rainfall, relative humidity and wind speeds.

There are two marked seasons in Bangladesh, the rainy season from May to October, during which more than 85% of the total annual rainfall occurs and the dry season from November to April. The beginning and ending of the rainy season vary from year to year. Heavy rains may commence anywhere between mid April and early June and may end anywhere between the end of September and mid November.

Climatic conditions of the study area were collected from the Meteorological Department at Dhaka and Khulna (Lat.: 22^o52'N, Long.: 89^o32.5'E). Rainfall, temperature, relative humidity and wind speed are described in the following paragraphs.

4.2.1 Rainfall

During the monsoon (June to September), wind direction from the southwest brings moisture laden air from the Bay of Bengal, when the heaviest rainfall occurs. Average monthly rainfall values for the study area are given in **Table 4.2.1**.

Table 4.2.1 : Rainfall characteristics of the study area, 2008-2010

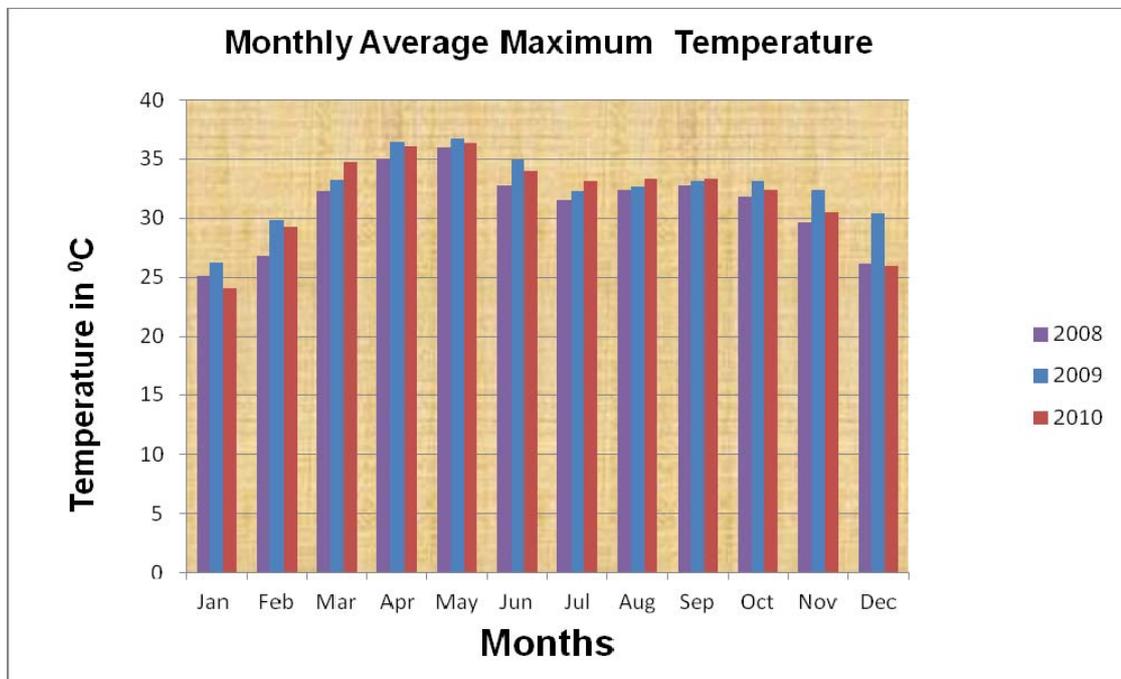
Station : Khulna Monthly & Yearly Total Rainfall(mm)

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Spt.	Oct.	Nov.	Dec.	Annual
2008	66	36	48	36	151	190	301	202	379	187	0	0	1596
2009	0	6	27	6	201	218	343	367	111	20	0	0	1299
2010	0	2	14	21	146	287	180	205	157	332	0	13	1357
Avg.	22	15	30	21	166	232	275	258	216	180	0	4	1417

Source: Bangladesh Meteorological Department

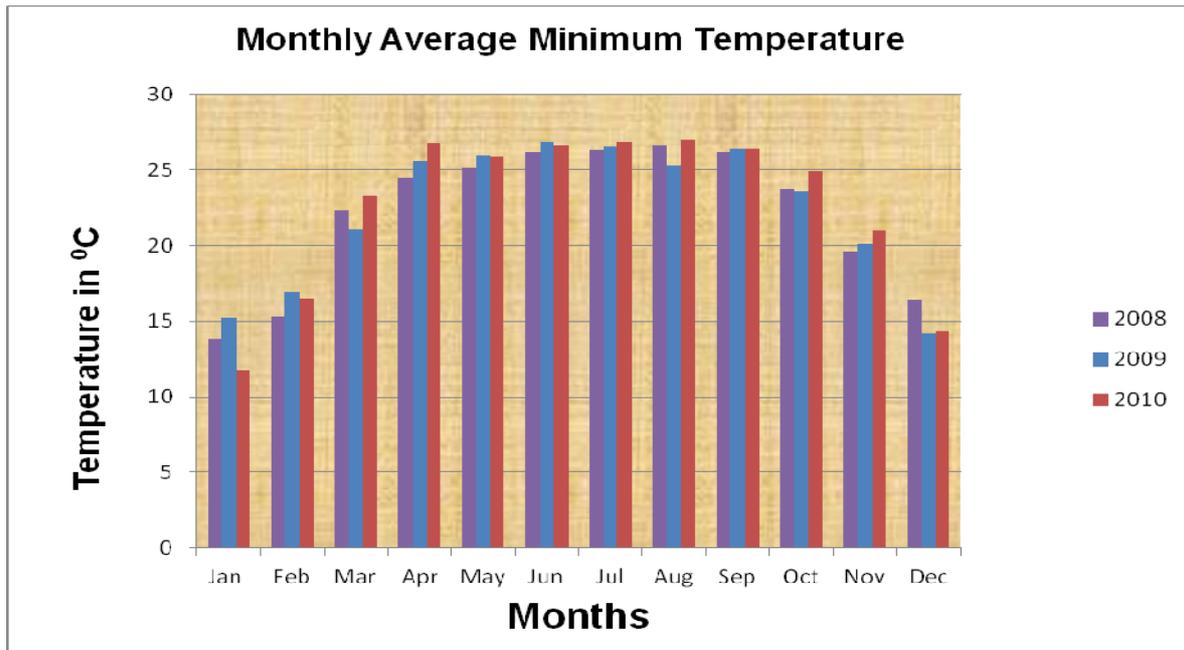
4.2.2 Ambient Air Temperature

Ambient air temperature varies with rainfall. During cool seasons, lowest rainfall occurs. Monthly average maximum and average minimum temperatures of the project area recorded at Khulna Meteorological Station are shown in **Figure 4.2.2(1)** and **Figure-4.2.2(2)** respectively. Average Maximum temperature of **36.9°C** was observed in May, 2009 and Average minimum temperature was **11.8°C** in January, 2010.



Station: Khulna

Figure 4.2.1(1): Monthly Average Maximum Temperature



Station: Khulna

Figure 4.2.1(2): Monthly Average Minimum Temperature

Monthly Average Maximum Temperature of the project area for the period of year 2008-2010 recorded at Khulna Meteorological Station are shown in **Table 4.2.2(1)** and Monthly Average Minimum temperature of the project area for the period of year 2008-2010 recorded at Khulna Meteorological Station are shown in **Table 4.2.2(2)**.

Table 4.2.2(1): Monthly Average Maximum Temperature for project area, 2008-2010

Year	Monthly Temperature in Degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	25.1	26.8	32.3	35	35.9	32.7	31.5	32.4	32.7	31.8	29.6	26.1
2009	26.2	29.8	33.2	36.5	36.8	34.9	32.3	32.6	33.1	33.1	32.4	30.4
2010	24.1	29.3	34.7	36.1	36.4	34	33.1	33.3	33.3	32.4	30.5	26.0

Station: Khulna

Table 4.2.2(2): Monthly Average Minimum Temperature for project area, 2008-2010

Year	Monthly Temperature in Degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	13.8	15.3	22.4	24.5	25.2	26.2	26.3	26.6	26.2	23.8	19.6	16.4
2009	15.2	16.9	21.1	25.6	26	26.9	26.5	25.3	26.4	23.6	20.1	14.2
2010	11.8	16.5	23.3	26.8	25.9	26.6	26.9	27.0	26.4	24.9	21.0	14.3

Station: Khulna

4.2.3 Relative Humidity

Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. The monthly average relative humidity from year 2008 to year 2010 are given in **Table 4.2.3**.

Table 4.2.3 Monthly Average Relative Humidity

Year	Monthly Relative Humidity (Maximum) in %											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	78	76	73	66	69	81	87	96	83	80	74	86
2009	81	69	66	66	69	77	86	78	83	78	76	80
2010	78	72	71	72	77	83	84	83	84	84	79	78

Station: Khulna

The monthly average relative humidity from year 2008 to year 2010 are also shown graphically in **Figure 4.2.3**.

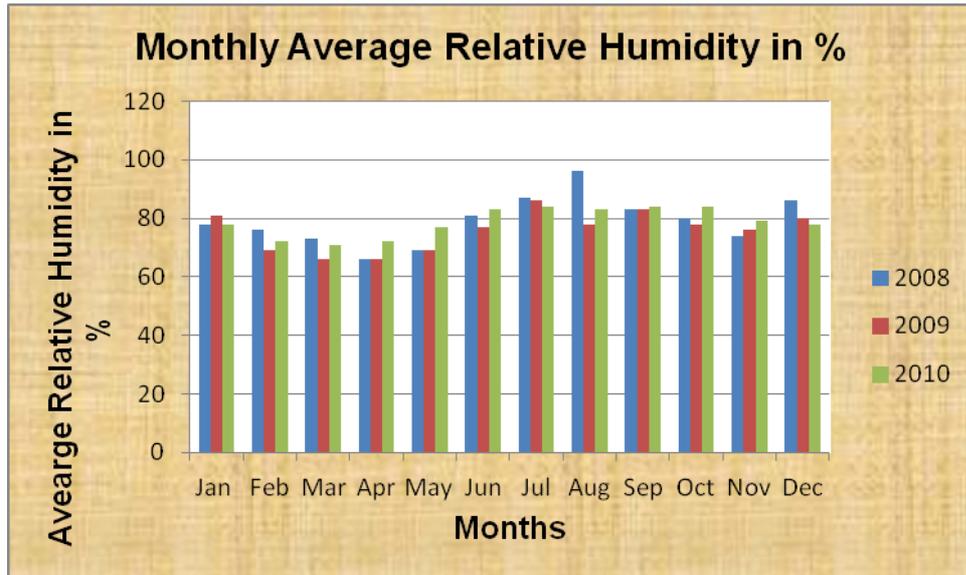


Figure 4.2.3 Monthly Average Relative Humidity

From the above tables and figures, the maximum Average Relative Humidity recorded by Meteorological Department Khulna station was 96% in August 2008. Whereas the minimum Average Relative Humidity recorded by Meteorological Department, Khulna station was 66% in April 2008 & 2009.

4.2.4 Wind Speeds and Direction

Wind directions at the project site are mostly from the south and southeast. During November to February the wind directions are from north or northwest and from March to October it is from south or southeast. From **Table 4.2.4** it is apparent that the maximum wind speed of **5.3 knots** prevailed during October, 2008, from North-East.

Table 4.2.4 : Yearly and Monthly Wind Speed and Direction, 2002-2008

Unit: Spd in knots

Year	January		February		March		April		May		June		July		August		September		October		November		December	
	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.	Spd.	Dir.
2000	2.3	N	2.1	N	4.7	S	4.5	S	4	S	2.7	S	2.7	S	2.5	S	2	S	2.1	S	1.5	NW	1.6	N
2001	1.6	N	2.1	NW	2.5	S	3.9	S	3	S	2.5	S	2.3	S	2.7	S	2.4	S	3	E	2.1	NE	1.8	N
2002	1.9	N	2.4	NW	3.2	S	4.3	S	3.7	S	2.8	S	2.2	S	2.3	S	2	S	3.4	E	2	NW	2	NW
2003	2.5	NW	2.7	N	2.7	S	3.5	S	2.8	S	2.7	S	2.3	S	2.5	S	2.6	SE	3.4	E	1.7	NW	2.4	NW
2004	2.8	N	2.4	NW	3.7	S	4.7	S	2.6	S	2.4	S	3.1	S	3.7	SE	2.6	S	2	NE	2	NW	2.3	N
2005	2.6	NW	2.8	NW	3.6	S	3.5	S	3.2	S	3.1	S	2.8	SE	2.3	S	2.9	SE	3.6	S	1.9	N	2.1	N
2006	2	NW	3.1	S	2	NW	2.8	S	2.7	S	2.4	S	2.4	S	4.7	SE	3.4	SE	2.5	NW	2.3	NW	2.6	NW
2007	2.5	NW	2.8	NW	2.8	NW	3.2	S	2.9	S	2.5	S	2.9	S	1.9	S	3.3	SE	2.4	NW	2.1	NW	1.4	NW
2008	1.4	NW	1.7	NW	1.6	S	1.8	S	1.7	S	2.6	S	1.7	S	2.1	S	3	SE	5.3	NE	1.5	NW	1.3	NW
2009	1.6	NW	1.5	NW	2.8	S	3.7	S	3.1	S	2.6	S	3.1	E										

Station : Khulna

4.2.5 Seismic Data

Before we discuss the Seismicity of the region, we are to know the basic geological structure of the area. The Gangatic plain was originally a deep depression or trough lying between the peninsula and the mountain region. The depression was, perhaps due to a sagging or subsidence of the northern part of the peninsula. As it arrested the orogenic movement or southward advance of the Himalyan mountain waves, the depression was rapidly filled up by alluvial deposits, which have completely shrouded the old land surface to a depth of several thousand feet. The deposition of the debris and the sinking of the trough must have proceeded side by side for about 30 million years, throughout the Miocene Pliocene and Pleistocene periods of Gaenozoic Era. The Bengal basin from Rajmahal Hills to Assam Hills, is, however, of latest origin.

So far as the Geology of Bangladesh is concerned, it is the part of this Bengal Basin, most of which has been slowly subsiding due to tectonic forces responsible for building the Himalayas. The Himalayas, though the loftiest mountains of the world, have not yet attained their Maximum elevation but are still rising. The slow subsidence is estimated to be about one inch per year in the coastal regions, as is evident from the present position of tree stumps cleared about a century back, in the Sundarban region, in the districts of Khulna and Barisal. This has practically nullified the sedimentation effect of huge amount, estimated to be about 2000 million tons per year of silt carried by the Ganges, the Jamuna and the Meghna. On the whole the coast line has not extended more than what had been mapped by James Rennel about 200 years ago in 1770. Rather a net loss of land area is observed.

This goes to show that the strata under the Himalayas and the adjoining area lying at their feet are in a state of tension and have not yet settled down to their equilibrium plane. By far the largest number of disastrous Indian earthquakes have occurred along these tracts.

Based on the seismicity, Bangladesh has been divided into three seismic zones as follows:

Zone-I	:	Severe (Seismic Factor - 0.08g)
Zone-II	:	Moderate (Seismic Factor – 0.05g)
Zone-III	:	Minor (Seismic Factor – 0.04g)

Seismic Zones of Bangladesh are shown in **Figure 4.2.5(1)**

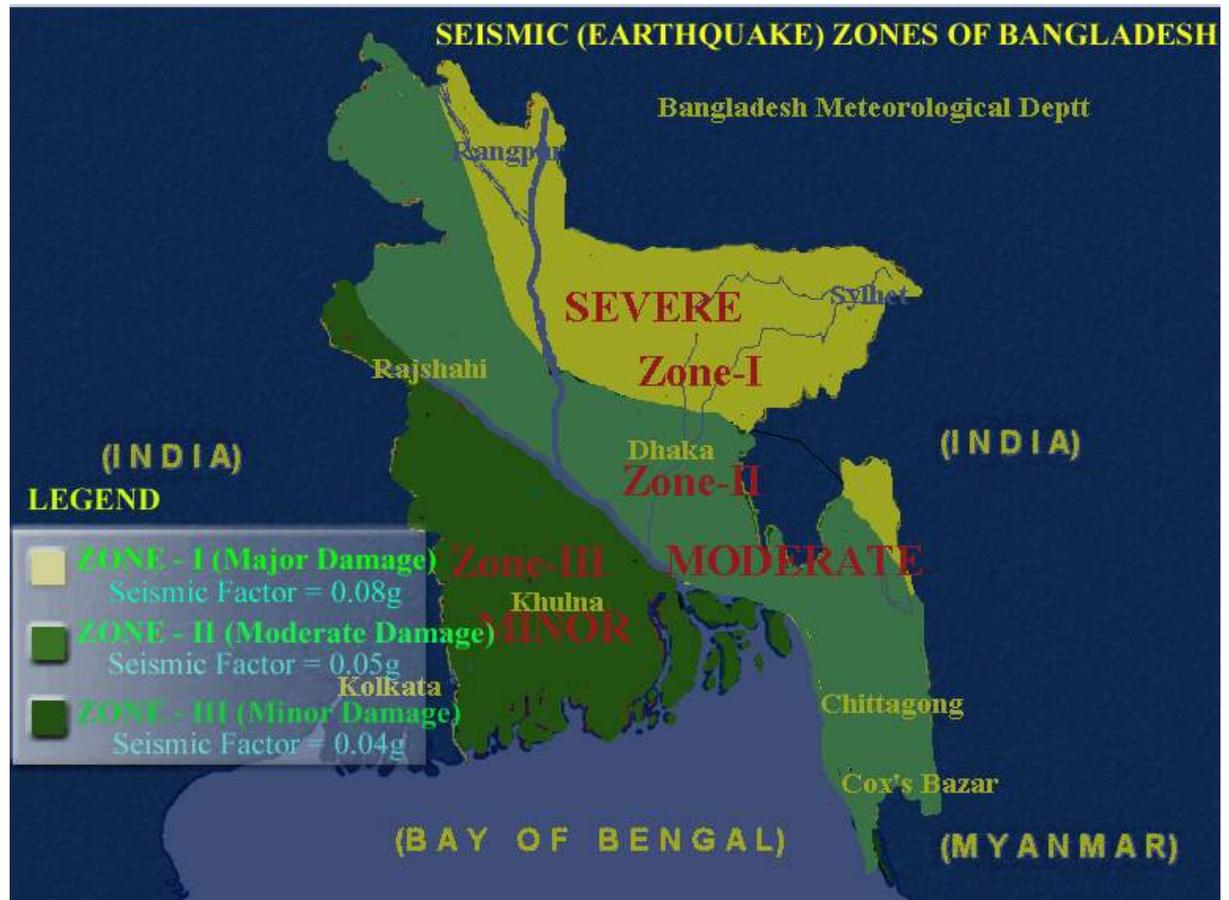


Figure 4.2.5(1) : Seismic Zones of Bangladesh

The proposed Khulna 225 MW Combined Cycle Power Plant falls under Zone-III (Minor Damage), whose Seismic Factor is 0.04g.

4.3 Topography and Drainage

The Khulna 225MW Combined Cycle Power Plant project area occupies the active **Ganges** Flood Plain. The elevation of the project area is ranging from approximately 13.35m to 17.5m. The general slope is from south to north. However, the elevation map shows that the land of the entire Goalpara Power Station area is almost on the same level. Since the land adjacent to the Bhairab river channel is slightly at a lower level and the slope is from south to north, the floodwater does not stand resulting no water logging. The topography does not inhibit drainage in the project site area.

There are no settlements in the project area. However there is dense population, on the western and southern side of the project site, but outside the power plant complex area. Heads of all the families residing there are employees of different industries of Khalishpur Industrial Area.

The land types in Bangladesh are flood depth phases of flood plain soils and are designated according to the maximum depth prevailing for a minimum three-day period during the peak season and occurring with an annual probability of about 1.5 (FPCO, 1992). According to the previous 30 years of flood record in the Bhairab River, it indicates that no large floods occurred in this area. The present areas are highlands (F_1).

The drainage pattern of the project area follows the land gradient, sloping from south to north, towards the Bhairab River. As the general slope of the project area is gradually from south to north, it (the slope) allows rapid drainage during the monsoon and post-monsoon periods.

A topographic map of proposed Khulna 225MW Combined Cycle Power Plant survey of the area within and around the proposed site was conducted. This is essential for design of the civil Engineering portion of the project. A copy of the survey map is given in **Figure-3.1**.

4.4 Geology and Soils

4.4.1 Geology

Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). The geology of the study area consists of Quaternary deltaic sediments, which have been strongly influenced by tectonic movements on deep-seated faults. The area lies on a tectonic block, which has been uplifted relative to the surrounding areas. In terms of crop production, the soils of Bangladesh can be categorized into three main classes: floodplain, terrace and hill soils. The proposed site is on a floodplain or alluvial soils. This type of soil mainly comprises sandy barns and sandy clay barns and tends to be gray to dark gray in poorly drained basins and brown on higher and better drained land.

Due to the erosion control and bank protection infrastructure, carried out by BWDB, the project area is free from Active Flood. All the sediments below this area are mainly sandy / silty of Ganges Floodplain deposits. The thickness of these alluvial sediments is more than a km. The detailed investigation can provide the actual strata graphic sequences of the area.

The project area falls in the seismic Zone-C. This is minor affecting zone. The highest possible magnitude in Richter's scale is 4.0. The seismic co-efficient or load factor of this zone is 0.04 g. The texture of soils of the project area is silt loam to sandy loam.

(Source: Geological Survey of Bangladesh)

4.4.2 Soils

The proposed site is located in Goalpara Mouza of Khalishpur Upazilla in Khulna District. It is located in the south west corner of the existing power plant complex of BPDB. On the east of the proposed site, there is 40MW Rental Power Station beside the graveyard, On the north of the proposed site, there is residential buildings of Goalpara (Khulna) Power station and Khulna Power

Company Limited (KPCL) which is located beside the Bhairab river. There is private settlement on the west and Road leading to Graveyard on the south. The land of the proposed plant is now being used by 40MW Rental power Plant.

According to the national classification, the proposed site is a part of the **Padma** River floodplain. In this region, the soil is predominantly silty with fine sand.

4.5 Hydrology and Water Resources

The hydrological regime of the project area is governed by the Bhairab river. Historically, spills from the river Rupsha were carried through the Bhairab River. It is the main drainage channel of the area. The general runoff pattern is from south to north through the Bhairab river. The project area lies within the tidal zone of the Bhairab River.

The tidal effects are most significant in the dry season when upland flows are lowest and least significant during the monsoon when high discharges in the river suppress tidal influence. As a result of this tidal flow, salinity of the river rises significantly in dry season.

The mean monthly water level of the Bhairab river at Goalpara power station gauge shows that there was no major flood in the project area which may cause any damage to homesteads, agriculture, industries or infrastructure.

4.5.1 River Water

4.5.1.1 River Network

The Bhairab river, flowing along the northern side of the proposed power plant site, is a combination of the rivers of Lower Bhairab and Begarti, both tributaries of the Padma, which is one of the three major river systems in Bangladesh. The river has tidal effect with more distinct range between high and low tide during lean periods (November-April). It meets the Rupsha river about 5 KM south-east of the site, which in turn flows into the Poshur, which ultimately goes to the Bay of Bengal.

4.5.1.2 River Water Level

Though the proposed area for power plant is not a flood prone area, water level in the Bhairab river which is tidal in nature has significance for water intake by power plant, discharging cooling water level and transport of oil tankers.

The water level records of nearby **BWDB station SW30** at Afraghat, Jessore were analyzed for last Six years (2007 - 2012). The water level records are given in **Table-4.5.1**.

Table-4.5.1: Water Level Records of Bhairab River at Afraghat Station of BWDB

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	Max WL	1.88	1.97	2.18	2.35	2.41	2.59	3.28	3.39	3.2	3.09	2.45	2.19
	Min WL	0.03	0.01	0.01	0.08	0.26	0.4	1	1.94	1.85	1.27	0.91	0.28
2008	Max WL	2.25	2.43	2.43	2.58	2.73	2.54	3.2	3.3	3.47	3.58	2.96	2.32
	Min WL	0.4	0.28	0.29	0.41	0.52	0.54	1.13	1.7	1.42	1.69	0.85	0.59
2009	Max WL	2.26	2.32	2.33	2.32	2.99	2.48	2.71	3.21		2.81	2.53	2.43
	Min WL	0.34	0.24	0.04	0.14	0.29	0.36	0.44	0.64		0.76	0.078	0.18
2010	Max WL	2.04	2.2	2.24	2.58	2.55	2.62	2.78	2.94	3.28	3.25	2.48	2.24
	Min WL	0.02	0.02	0	0.22	0.25	0.55	0.65	0.9	1.22	0.9	0.53	0.29
2011	Max WL	2.26	2.34	2.64	2.48	2.5	2.68	3.12	3.55	3.46	3.26		3.38
	Min WL	0.15	0.01	0	0.09	0.25	0.34	0.97	1.25	1.26	1		1.09
2012	Max WL	3.27	2.46	2.5	2.84	2.62	2.81						
	Min WL	1.13	0.13	0.13	0.22	0.33	0.58						

Source: WDB

From the above table, it was observed that maximum water level rose up to **3.58 meter (PWD) in October 2008** and minimum water levels up to **0.00 meter (PWD) in March 2010 and 2011**. The monthly maximum water level and minimum water level of Bhairab river at Afraghat station throughout the year are shown in **figure-4.5.1/1 and 4.5.1/2** respectively.

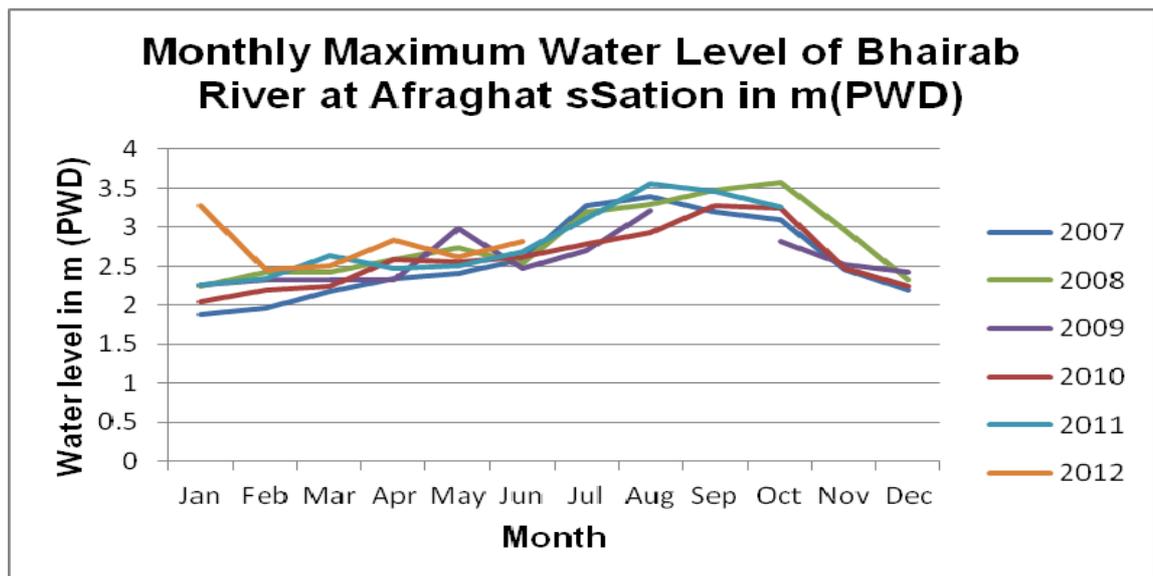


Figure 4.5.1/1 : Monthly Maximum Water Level in Bhairab River throughout the year (BWDB)

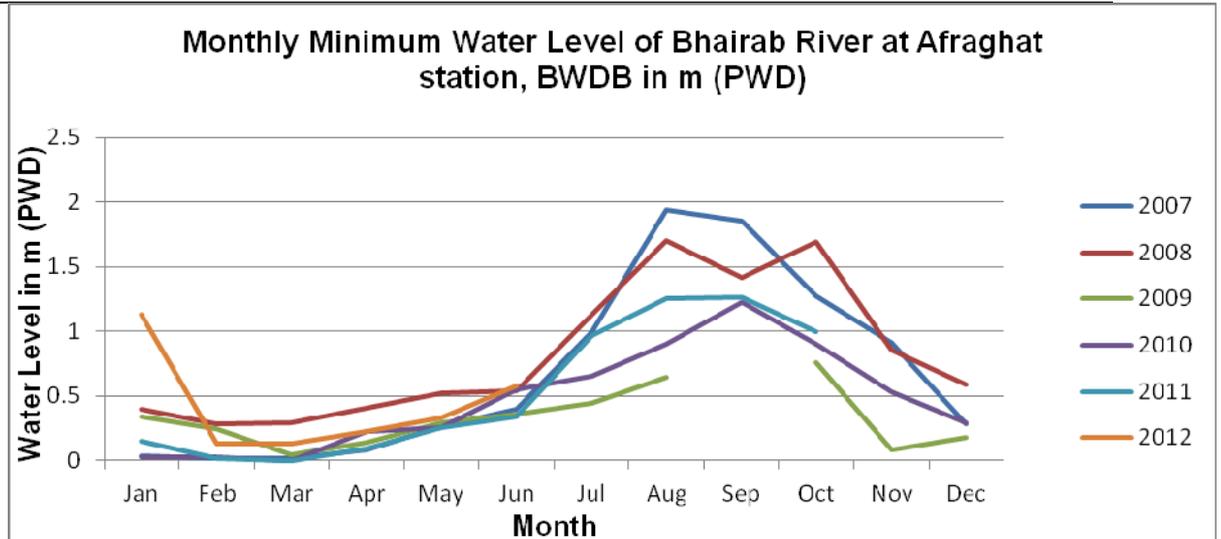


Figure 4.5.1/2 : Monthly Minimum Water Level in Bhairab River throughout the year (BWDB)

4.5.2 Groundwater

The Department of Public Health Engineering (DPHE) has investigated ground water in Rupsha near project site. From the investigation of DPHE, the following lithology and Hydrostratigraphy in the investigation area were found:

Lithology

Depth to Top (m)	Depth to Base (m)	Lithologic Description
0.00	30.00	Clay
30.00	54.00	Fine Sand
54.00	108.00	Medium sand
108.00	162.00	Reddish silty clay
162.00	240.00	Fine to medium sand
240.00	275.00	Coarse sand

Source: DPHE

Hydrostratigraphy

Depth to Top (m)	Depth to Base (m)	Hydrostratigraphy
0.00	30.00	Aquitard 1
30.00	108.00	Aquifer 1
108.00	162.00	Aquitard 2
162.00	275.00	Aquifer 2

Source: DPHE

There are two aquifers at two layers – 30m to 108 m from the top and 162m-240m from the top.

4.6 Air Quality

The air quality standard amended in July 2005 by the Government of Bangladesh vide SRO No. 220-Law/2005 is given in Table-4.6.

Table-4.6: Air Quality Standard (Source: Schedule-2 of ECR1997)

Air Pollutant	Standard	Averaging Time
1	2	3
Carbon Mono-oxide	10mg/cu- m(9ppm) ^(Ka)	8 hours
	40mg/cu-m(35ppm) ^(Ka)	1 hour
Lead	0.5µg/cu-m	annual
Nitrogen Oxide	100µg/cu-m (0.053ppm)	Annual
Suspended Particulate Matter (SPM)	200µg/cu-m	8 hours
Particulate Matter 10 (PM ₁₀)	50µg/cu-m ^(Kha)	Annual
	150µg/cu-m ^(Ga)	24 hours
Particulate Matter 2.5 (PM _{2.5})	15µg/cu-m	Annual
	65µg/cu-m	24 hours
Ozone	235µg/cu-m(0.12ppm) ^(Gha)	1 hour
	157µg/cu-m(0.08ppm)	8 hours
Sulfur Dioxide	80µg/cu-m(0.03ppm)	Annual
	365µg/cu-m(0.14ppm) ^(Ka)	24 hours

Abbreviation:

ppm: Parts Per Million

Notes: * In this schedule Air Quality Standards means Ambient Air Quality Standards
(Ka) Not to be exceeded more that once per year
(Kha) Annual Average value will be less than or equal to 50 microgram/cubic meter

- (Ga) Average value of 24 hours will be less or equal to 150 microgram/cubic meter for one day each year.
- (Gha) Maximum average value for every one hour each year will be equal or less than 0.12 ppm.

Khalishpur Upazilla, particularly the project area, is very heavily industrialized. Moreover, construction work of Khulna 150MW Peaking Power Plant is underway. The present ambient air quality of the concerned area, as a result, is contaminated.

To ensure safety of power source and security of living beings including human, air samples were collected from 2 locations; one sampling point was located in front of 150MW peaking power plant gate another point was located in front of Administrative Building on May 4, 2013 with the help of Department of Environment, Khulna.. Department of Environment (DoE), Khulna has also carried out test of air samples collected from the project area. The DoE's test report of air quality is enclosed under **Annex-4.6**. Pictures taken during collection of air sample are given below;



Collection of Air Sample at Project Site

The present condition of air quality as reported by DoE, Khulna is given in **Table 4.6(1)**. From the test results it is seen that SPM, SO_x, NO_x and CO of the ambient air in the sampling points are within normal limit of the atmospheric environmental standard.

Table 4.6(1): Result of Survey of Air Quality

Date	Sampling Point	GPS Location	SPM µg/m ³	SO _x µg/m ³	NO _x µg/m ³	CO PPM v/v
May 4, 2013	In front of Khulna 150MW Peaking Power Plant	22 ^o 51'54"N 89 ^o 32'7.23"E	197	20	21	0.9
May 4, 2013	In front of Administrative Building of 150MW PPP	22 ^o 51'58"N 89 ^o 32'11"E	180	18	23	0.9
Bangladesh Standard			200	80	100	9

Similar survey near the project site was carried out in the dry season in 2009. Air samples were collected from 2 locations; one sampling point was located near power station of Khulna power center and another point was located at Gate No. 4 of Khulna Power Station beside Khulna Power Company Ltd. (KPCL) on December 14, 2009 and December 15, 2009 respectively. Department of Environment (DoE), Khulna has carried out air quality test in the project area on December 14, 2009 and December 15, 2009 respectively. The air quality in the dry season as reported by DoE, Khulna is given in **Table 4.6(2)**. **From the test results it is seen that** SPM, CO, SO_x and NO_x of the ambient air in the sampling points are **far below** the atmospheric environmental standard for the industrial and mixed.

Table 4.6(2): Result of Survey of Air Quality

Date	Sampling Point	Duration	SPM/PM ₁₀ µg/m ³	CO µg/m ³	SO _x µg/m ³	NO _x µg/m ³
14 /12/2009	Near Power Station of Kfulna Power Center, Khalishpur, Khulna	8 hours	242	500	38	46
15 /12/2009	Near Khulna Power Co. Ltd. Gate , Khalishpur, Khulna	8 hours	245	800	36	42
Bangladesh Standard for Industrial and Mixed			500	5000	120	100

Source: EIA Report of Khulna 150MW PPP

4.7 Noise Level

4.7.1 General

Sound or noise is one of the most important factors in environmental pollution. Excessive sound has adverse effect on human health. It is, therefore very important to bring sound levels within limits of human tolerance. Sound is usually measured in decibels (dB). Sound (noise) levels can be measured and quantified using logarithmic decibel (dB) scale. The dB scale is logarithmic to accommodate the wide range of sound intensities found in the environment. **Table-4.7.1** shows typical sound levels generated by common indoor and outdoor activities, along with its effect on human.

Table-4.7.1: Sound Levels and Human Response

Common Sounds	Noise Level	Effect
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation; Air raid siren	140	Painfully loud
Thunderclap	130	Painfully loud
Jet takeoff (200 feet); Auto horn (3 feet)	120	Maximum vocal effort
Pile driver; Rock concert	110	Extremely loud
Garbage truck; Firecrackers	100	Very loud
Heavy truck (50 feet); City traffic	90	Very annoying Hearing damage (8 hours)
Alarm clock (2 feet); Hair dryer	80	Annoying
Noisy restaurant; Freeway traffic; office	70	Telephone use difficult
Air conditioning unit; Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room; Bedroom; Quiet office	40	Quiet
Library/soft whisper (15 feet)	30	Very Quiet
Broadcasting studio	20	Very Quiet
	10	Just audible
Threshold of hearing	0	Hearing begins

Source: Davis and Cornwell (1998)

4.7.2 Noise Sources

Noise attenuation is typically described as a set reduction in decibel level per doubling of distance from the source. Depending on the nature of the noise source, sound propagates at different rates. Measures of sound level from a source should specify the distance from the source. The standard reference distance for sound levels at the source is 50 feet. The two most common types of noise are point source and line source. These are briefly discussed below.

4.7.3 Point Source Noise

Point source noise is associated with noise that remains in one place for extended periods of time, such as with construction activities. A few examples

of point sources of noise are pile drivers, jackhammers, rock drills or excavators working in one location. Noise from a single traveling vehicle is also considered point source noise. Point source noise is commonly measured in peak decibel levels, or the highest value of a sound pressure over a stated time interval. Noise from a point source spreads spherically over distance where the wave spreading creates a dome effect, traveling in all directions equally from the source. The standard reduction for point source noise is 6 dB per doubling of distance from the source.

4.7.4 Line Source Noise

Line source noise is generated by moving objects along a linear corridor. Highway traffic is the best example of line source noise. Line source noise levels are measured as an average over time rather than peak levels as measured in point source noise. Noise from a line source spreads cylindrically, spreading outward along the length of a line. The standard reduction for line source noise is 3 dB per doubling of distance from the source (compared to 6 dB for point source noise). **Table 4.7.5** provides an example of noise attenuation of point and line source decibel levels at different distances from the source.

4.7.5 Noise Reduction Factors

Natural factors such as topography, vegetation and temperature can further reduce noise over distance. This section covers a few of the common factors and their applicability in increasing the noise reduction per doubling of distance from the source. Examples of noise reduction are shown in **Table 4.7.5**.

Table 4.7.5 : Example of noise reduction over distance from 95 dB source showing variation between point source and line source.

Noise Attenuation		
Distance from the source (ft)	Point source (-6dB)	Line source (-3dB)
50	95	95
100	89	92
200	83	89
400	77	86
800	71	83
1600	65	80
3200	59	77
6400	53	74

Source : NYDEC (2001)

4.7.6 Hard versus Soft Sites

Concrete, hard packed soil etc. are considered as hard sites and reflective grounds. Such surfaces do not provide any sound attenuation. On these kinds of surfaces, sound is not absorbed easily and it travels away from the sound source for greater distances. The standard attenuation rate for hard site conditions is 6 dB per doubling of distance for point source noise and 3 dB per doubling of distance from line source.

Soft sites are those where ground is covered with normal unpacked earth. When such sites exist between the sound source and receptor, the ground becomes absorptive to sound energy. Such surfaces effect an additional noise reduction at the rate of 1.5 dB per doubling of distance. Added to this standard reduction rate for soft site conditions, point source noise attenuates at a rate of 7.5 dB per doubling of distance, and line source noise decreases at a rate of 4.5 dB per doubling of distance.

4.7.7 Topography, Vegetation and Atmospheric Factors

Approximately, 5 dB reduction of sound level occurs, when there is a break in the line of sight between the noise source and the receptor. Dense vegetation also reduces noise levels by 5 dB for every 100 feet of vegetation, up to a maximum reduction of 10 dB (USDOT, 1995). Atmospheric conditions can also affect the rate of sound attenuation. During periods of high humidity and also in colder temperatures, sound travels for greater distances. Wind can also reduce noise levels by as much as 20 to 30 dB at long distances (USDOT, 1995).

It is often impossible to quantify the noise reduction due to the influences of vegetation, topography and atmospheric conditions. When there is no such barrier, sound travels farther. These factors are, generally, not taken into account in environmental noise analysis, as these are likely to result in predicted noise levels that are higher than actual ones.

4.7.8 Baseline Noise Conditions

In order to determine potential disturbances which might be caused by project activities existing ambient noise levels can serve as a baseline. These are also required to design the machinery of the power plant, so that ultimate noise levels are within limits prescribed by DoE.

4.7.9 Environmental Conditions

Environmental factors can greatly affect baseline noise. It can elevate baseline noise near the source, masking construction noise. The same environmental factors occurring near the receptor can change the receptor's perception of how loud construction noise is or hide it completely.

Wind or rainfall can increase baseline noise. It can also increase in locations near rivers or streams. Since these environmental factors are widely variable, they are rarely taken into account.

4.7.10 Traffic Noise

Baseline (ambient) noise condition also depends on traffic noise, which in turn, is dependant on amount and type of traffic, e.g. the volume of highway traffic (particularly volume of trucks), the speed of the traffic in the flow etc. (USDOT, 1995). Generally, when traffic is heavier, traffic speed is increased and when a greater proportion of the traffic flow is heavy trucks, the loudness of traffic noise increases. When traffic volume is 2,000 vehicles per hour, sound intensity is twice as loud as (or is 10 dB higher than) when traffic flow is 200 vehicles per hour (USDOT, 1995). This means that a noise that is increased by 10 dBA, sounds twice as loud to the listener.

Vehicle noise is a combination of noises produced by engines, exhaust and tires. The loudness of traffic noise can also be affected by the condition and type of roadway, road grade and the condition and type of vehicle tires. Predictions of noise from vehicles are usually based on *reference energy mean emission levels*, which correspond to the noise level expected from a single vehicle at the standard distances of 15m.

4.7.11 Construction Noise

Noise generated during various activities in the construction of a project is one of the easiest things to identify, but hardest to quantify. It is necessary to ascertain how much noise will construction activities generate, how often will it occur and how long will it last. In this section introduction is given to equipment noise characteristics that might be expected in typical construction projects. Noise associated with different phases of construction can vary greatly. General construction equipment, however, can be placed into one of three categories according to similarities in noise sources. These are : heavy equipment, stationary equipment or impact equipment.

(a) Heavy Equipment

(i) Earth-moving equipment, e.g. excavating machinery (excavators, backhoes, front loaders), (ii) handling equipment like graders, pavers, rollers and dump trucks can be defined as heavy equipment. From several studies, it has been found that noise levels vary between about 72 to 97 dB (**Table 4.7.11**) at a distance of about 50 feet away from heavy equipment. It has also been observed that noise is generated more or less at a constant level during those phases of construction when heavy equipments are deployed. Noise range at 50 ft. from construction equipment is shown in **Table 4.7.11**.

Table 4.7.11 : Noise ranges at 50 feet from common construction equipment

Equipment	DBA	Equipment	dBA
Heavy trucks (avg.)	82-96	Backhoe (avg.)	72-90
Grader (avg.)	79-93	Paver (+grind) (avg.)	85-89
Excavator (avg.)	81-97	Front Loader (avg.)	72-90
Crane (avg.)	74-89	Generator (avg.)	71-82
Pile driver (peak)	81-115	Jackhammer/rock drills (avg.)	75-99
Concrete mixer (avg.)	75-88	Roller (avg.)	72-75
Compressor (avg.)	73-88	Pumps (avg.)	68-80

Source : Western Highway Institute (1971)

(b) Stationary Equipment

Pumps, power generators, air compressors etc. can be termed as stationary equipment. Such equipments generally run continuously at relatively constant power and speed. At a distance of 50 feet from stationary equipment, noise levels can vary between 68 to 88 dB, with pumps typically in the quieter range. For each stationary equipment, a constant noise level may be assumed because of its fixed location and constant noise pattern.

(c) Impact Equipment

This category includes equipment where a tool bit touches the work with impact. Examples of such equipment are pile drivers, jackhammers, pavement breakers, rock drills and other pneumatic tools. The noise from these comes from the impact of the tool against the material. Noise levels can vary depending on the type and condition of the material. Impact equipment, including jackhammers and rock drills, can create noise levels between 75 to 99 dB at a distance of 50 feet away from the equipment.

Vibratory hammers can also be used on projects. Because vibratory hammers are not impact tools, noise levels are not as high as with impact pile drivers. However, piles installed with a vibratory hammer must often be proofed, which involves striking the pile with an impact hammer to determine its load-bearing capacity, possibly with multiple impacts. In this case, noise is elevated to levels associated with impact pile driving.

Impact of the hammer dropping on the pile, particularly when hollow steel piles are used, results in the highest in-air noise from pile driving. Noise assessments made by 'USDOT have documented peak levels of 110 dB and 105 dB, 50 feet away from driving steel piles. Pile driving noise consists of a series of peak events. For the purposes of this study, 110 dB is considered as typical peak noise levels associated with pile driving.

4.7.12 Combined Effect of Multiple Noise Sources

From studies in the past, the following information have been gathered:

(a) The combined effect of two separate sound sources are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total effect is only a 3 dB increase (to 53 dB), not a doubling to 100 dB. Thus, every 3 dB change in sound levels represents a doubling (or halving) of sound energy. Related to this is the fact that a change in sound levels of less than 3 dB is imperceptible to the human ear.

(b) Another property of sound is that if one source of noise is 10 dB (or more) louder than another source, then the total sound level is simply the sound level of the louder source. For example, impact of one source of sound at 60 dB combined with a second source of sound at 47 dB is 60 dB. The loudest sound is, therefore, most important, which should be considered in this study.

The sound level meter used to measure noise is a standardized instrument (American National Standards Institute [ANSI], 1983). It contains "weighting scales" to adjust the frequency response of the instrument to approximate that of the human ear under various circumstances. The weighting scale used for community noise surveys is the A-weighted scale (dBA). Sounds are reported as detected with the dBA of the sound level meter. A-weighted sound levels emphasize the middle frequency (i.e., middle pitched – around 1,000 Hertz sounds) and de-emphasize lower and higher frequency sounds. The dBA most closely approximates how the human ear responds to sound at various frequencies. Because the sounds in the environment vary with time, they cannot simply be described with a single number. Several sound level metrics commonly reported in community noise monitoring are described below.

- The equivalent level is the level of a hypothetical steady sound that would have the same energy (i.e., the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is also A-weighted. The equivalent level represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period.
- The maximum sound level (designated L_{eq}) is the greatest sound level measured within a stated time interval.
- Day-night average sound level, abbreviated as DNL and symbolized as L_{dn} , is the 24-hour average sound level, in dBs, obtained after addition of 10 dBs to sound levels during the night (from 10:00 pm to 7:00 am). The hourly L_{eq} sound level metric is used to calculate the L_{dn} .

4.7.13 Noise level around Project Area:

Area wise noise level standard were revised by the government of Bangladesh in September 2006 vide SRO No. 212-Law/2006. Revised Area wise noise level standard is given in Table-4.7.13 .

Table-4.7.13 Area wise Noise Level Standard

Sl. No.	Classification of Area	Standard decibel dB(A) Leq* unit	
		Day	Night
1.	Silent area	50	40
2.	Residential Area	55	45
3.	Mixed Area	60	50
4.	Commercial Area	70	60
5.	Industrial Area	75	70

Explanation:

(Ka) The period from 6:00am to 9:00pm is treated as day time

(Kha) The period from 9:00pm to 6:00am is treated as night time

- dB(A) Leq is time weighted average of noise level for certain period related to human hearing expressed in dB(A)

In order to measure the present noise level in the project area, three locations were selected as follows:

- (1) In front of 150MW Peaking Power Plant gate,
- (2) In front of Administrative Building
- (3) Near East Side of Boundary

The noise level was measured by the department of environment, Khulna on May 4, 2013 at the above specified locations. The environmental standards designated by Khulna Environmental Agency (DOE) are 75dBA during day hour (06:00 to 21:00hrs) and 70dBA during night (21.00 to 6.00hrs). For the residential area, 55dBA during day hour and 45dBA during night. Pictures taken during measurement of sound level at the project site are given below;



Measurement of Sound Level at Project Site

The present situation of the noise level around the site (**May 4, 2013**) is as shown in **Table 4.7.13**.

Table 4.7.13 Result of Noise Measurement around the Project site

Date	Time	Location	GPS Location	Noise Level (dBA)	Remarks
May 4, 2013	1:45pm	In front of 150MW Peaking Power Plant Gate	22°51'54"N 89°32'7.23"E	74	Parameters are within limit
May 4, 2013	2:15pm	In front of Administrative Building of 150MW PPP	22°51'58"N 89°32'11"E	71	
May 4, 2013	2:30pm	Near East Side of Boundary of 150MW PPP	22°51'51.12"N 89°32'13.53"E	73	
Bangladesh Standard (day time for Industrial Area)				75	

Note: Day 6am to 9pm. Night- 9pm to 6am

From the above test results, it is seen that noise level in the project area is within the acceptable limit for Industrial area of Bangladesh Standard limit. Noise level was recorded high because of construction of peaking power plant was underway at that time. DOE's Test Result of Noise level in the project area is given under **Annex-4.7.13**.

4.8 Water Quality

4.8.1 River Water

In order to test the quality of the Bhairab River, water samples were collected from two sampling points in the Bhairab river near the existing Khulna Power Station on May 4, 2013. The test was carried out by DoE, Khulna. Pictures taken during measurement of sound level at the project site are given below;



Collection of Bhairab River Water

The present situation of the water quality is given in **Table 4.8.1**.

Table 4.8.1 : Test Report of Bhairab River Water

Item/Parameter	Unit	Near Khulna Power Station	100m up stream Khulna Power Station	Bangladesh Standard
		22°52'7.80"N 89°32'19.35"E	22°52'7.93"N 89°32'14.98"E	
		04/05/2013	04/05/2013	
Temperature(Surface)	°C	34.7	33.8	
pH (Surface)		7.65	7.65	6.5-8.5
EC	µS/cm			
Chloride	mg/l	3640	3630	
Turbidity	NTU	58.0	58.0	
SS	mg/l	45	42	
DO	mg/l	6.4	6.8	Above 5
BOD	mg/l	0.6	0.8	Below 10
COD	mg/l	68	64	-
Iron	mg/l	0.1	0.1	
N-Nitrite	mg/l	20	20	
Sulfate	mg/l	20	20	
Ammonium	mg/l	2.0	2.0	
Phenols	mg/l	<0.1	<0.1	
Copper	mg/l	0.1	0.1	
Zinc	mg/l	<0.01	<0.01	
Remarks	3. pH, DO and BOD are within national limit 4. High concentration of chloride and sulfate may be due to salinity of tidal river water			

The test Report on the river water quality is enclosed under **Annex-4.8.1**.

Apart from the above survey, secondary data on intake water from the Bhairab river for the last five years were collected from the office of the Chief Chemist of Water Treatment Plant, Khulna Power Station. The Bhairab River Water Quality (Intake water for Water Treatment Plant, KPS) during non-saline period and saline period are given in **Table 4.8.1(1)** and **Table 4.8.1(2)**

**Table 4.8.1(1):Bhairab River Water quality during Non-Saline Period:
July-January**

Date	Temperature (°C)	High Electrical Conductivity (µS/cm)	Low Electrical Conductivity (µS/cm)	pH
31-01-2005	31	521	-	7.7
04-08-2004	30	-	126	7.5
31-01-2006	21	1999	-	7.6
25-08-2005	29	-	177	7.6
23-01-2007	21	2340	-	7.8
02-08-2006	30	-	192	7.4
27-01-2008	21	1075	-	7.5
03-08-2007	30	-	184	7.6
30-01-2009	21	1575	-	7.7
24-08-2008	30	-	184	7.6

Table 4.8.1(1):Bhairab River Water quality during Saline Period: February-June

Date	Temperature (°C)	High Electrical Conductivity (µS/cm)	Low Electrical Conductivity (µS/cm)	pH
25-05-2005	31	18237	-	7.5
24-08-2005	29	-	177	7.6
28-05-2006	28	25297	-	7.6
31-06-2006	30	-	188	7.5
19-05-2007	31	24868	-	7.4
03-08-2007	30	-	184	7.6
21-05-2008	30	23196	-	7.5
24-07-2008	30	-	184	7.6
25-05-2009	32	24162	-	7.7
30-08-2009	31	-	201	7.6

Maximum Acceptable Limit of Electrical Conductivity of Water:

For Water Treatment Plant, KPS : 1000 µS/cm

For Power Plant (Boiler), KPS : 0.3 µS/cm

Source: Water Treatment Plant, Khulna Power Station, BPDB

4.8.2 Ground Water:

Ground water sample was collected from deep tube well near the project site at Goalpara, Khulna on May 4, 2013. Water sample was tested at the laboratory of Department of Environment, Khulna. Pictures taken during collection groundwater sample at project site are given below:



Collection of groundwater at project siter

The ground water quality is given in **Table 4.8.2**.

Table 4.8.2 Ground Water Quality

Item/Parameter	Unit	Deep Tube Well water of the project area	Bangladesh Standard
		22 ^o 51'57.46"N 89 ^o 32'6.33"E	
		04/05/2013	
Temperature(Surface)	°C	24.5	20-30
pH (Surface)		7.59	6.5-8.5
EC	µS/cm		
Turbidity	NTU	8.23	10
TS	mg/l		
TDS	mg/l		
SS	mg/l		
DO	mg/l	5.4	6
BOD	mg/l	0.1	0.2
COD	mg/l	<20	4
T Hardness	mg/l		200-500
Iron	mg/l		0.1-1.0
N-Nitrire	mg/l		
Sulfate	mg/l		
Phosphate	mg/l		
Chromium	mg/l		
salinity	mg/l		
Coli coloniess	No/100ml		
Remarks	All parameters are within limit		

The test Report on the ground water quality is enclosed under **Annex-4.8.2**.

Chapter 5: EXISTING ENVIRONMENT: ECOLOGICAL

5.1 Terrestrial Ecosystem

In general terms an ecological system can be defined as an assemblage of organisms (plant, animal and other living organisms - also referred to as a biotic community) living together with their environment (or biotope), functioning as a loose unit. That is, a dynamic and complex whole, interacting as an "ecological unit". Ecosystems are functional units of interacting abiotic, biotic, and cultural (anthropogenic) components. All natural ecosystems are open systems where energy and matter are transferred in and out through the complex interactions of energy, water, carbon, oxygen, nitrogen, phosphorus, sulfur and other cycles.

The project site is located in a semi-urban area. There is no natural vegetation or forest cover within the project area. However, appropriate mitigation program should be undertaken to protect the existing ecosystem from gaseous emissions and water discharge from the proposed power plant.

5.1.1 Terrestrial Flora

Terrestrial plants found during survey in and around the project area, on homesteads, roadside and agricultural lands have been listed. The project area provides the following major species of natural plants including herbs, shrubs, grasses and plants which are important both economically as well as for environmental sustainability of the area. The flora in and around the project area are dominated by the fruit plants, flower and ornamental plants.

The common fruits are the **mango, jackfruit, banana, papaya, guava, lemon, coconut, palm, tamarind, ata (*Anama reticulata*), karamcha (*Carissca carandas*), safeda (*Achras sapota*), wood apple, lichi, plums, watermelon, sweet melon etc. Non-fruit plants are arjun (*Terminalia arjun*), sandal tree, banayan tree, krishnachura (*Delonix regia*), palash etc. Local, English and scientific names of the species found are given in the following **Table 5.1.1**.**

The flowering plants are fairly common in the project area where rose, kamini, champa (*Michelia champa*) etc. are available. The area produces good amount of vegetables and spices of which eggplant, okra, coriander, potato, pointed gourds, gourds, long beans, country beans, chilly, cabbages, bitter gourds etc. are worth mentioning.

Table 5.1.1 : List of plants confirmed around the site

No.	Local Name	English Name	Scientific Name
1	Lichu	Lichi	<i>Lichi Chinensis</i> Sonn
2	Am	Mango	<i>Mangifera indica</i> L. (Anacard)
3	Kathal	Jack Fruit	<i>Artocarpus heterophyllus</i> Lamk
4	Pepe	Papaya	<i>Carica papaya</i> L (caricaceae)
5	Golap	Rose	<i>Rosa centifolia</i> L. (Rosaceae)
6	Beli	Jasmin	<i>Jasmin sambac</i> Ait (Olea)
7	Narikel	Coconut	<i>Cocos nucifers</i> L. (Palmae)
8	Chameli	Jamane	<i>Jasminum grandiflorum</i> L. (Oleace)
9	Patabahar	Patabahar	<i>Codiaeum variegatum</i>
10	Peyara	Guava	<i>Psidium Guajava</i> (L) Bat. (Myrtaceae)
11	Kola	Banana	<i>Musa Paradisica</i>
12	Rangan	Rangan	<i>Ixora rosea</i> Will (Rubiceae)
13	Gashpul		<i>Zephyranthes tubispatha</i> Herb. (Amaryllidaceae)
14	Sajina	Drumstick	<i>Moringa oleifera</i>
15	Supari	Betel leaf	<i>Areca catechu</i> Linn
16	Jam	Black Berry	<i>Syzygium cumini</i> skiel. (Myrtaceae)
17	Shimul	Silk cotton tree	<i>Bombax ceiba</i> L. (Bombacaceae)
18	Sofeda	Sapodilla	<i>Manilkara Zapota</i>
19	Kadbel	Wood Apple	<i>Feronia limonia</i> (L.)
20	Bel	Indian apple	<i>Aegle marmelos</i> (L).
21	Tal	Palm Tree	<i>Borassus flabellifer</i> L. (Palmae)
22	Krishnachura	Delonix regia	<i>Delonix regia</i> (Boj.) Raf. (Leguminosae)
23	Bot	Banayan tree	<i>Ficus benghalensis</i> L. (Mora)
24	Pakur		<i>Ficus Infectoria</i>
25	Madar	Coral tree	<i>Erythriana variegata</i> L. var. <i>orientalis</i> Merr.
26	Jaba	China-rose	<i>Hibiscus rosa sinensis</i> L. (Malvaceae)
27	Man Kochu	Giant taro	<i>Alocasia macrorrhiza</i>
28	Kachu	Aroid	<i>Alocasia indica</i>
29	Jambura	Citron	<i>Citrus grandis</i>
30	Dumur	Fig tree	<i>Ficus hispida</i>
31	Koroi	Albizia	<i>Derris robusta</i> Benth.
32	Lebu	Lemon	<i>Citrus aurantifolia</i>
33	Mehogini	Swietenia fabrilis	<i>Swietenia mahagoni</i>
34	Kowa nim		<i>Melia sempervirens</i>
35	Pui Shak	Indian spinach (green)	<i>Basella alba</i> L.
36	Belaiti Siris	Rain tree	<i>Samanea saman</i>
37	Dol Kolme	Pink morning glory	<i>Ipomoea fistolosa</i>
38	Bansh pata		<i>Podocarpus nerifolia</i>
39	Mankata		<i>Xeromphis spinosa</i>
40	Babla	Acacia	<i>Acacia arabica</i> Willd.
41	Ulatkambal	Devill's cotton	<i>Abroma augusta</i>
42	Basak	Malabarnut tree	<i>Adhatoda zeylanica</i>
43	Muktajhuri		<i>Abroma augusta</i>
44	Rashun	Garlic	<i>Allium sativum</i>
45	Shatamuli		<i>Asparagus racemosus</i>
46	Neem	margosa	<i>Melia Azadirachta indica</i>
47	Nayantara	Periwinkle	<i>Catharanthus roseus</i>
48	Thankuni	Indian penny wort	<i>Centella japonica</i>
49	Kalo Dhutra	Dhutra, Thorn Apple	<i>Datura metea</i> L

No.	Local Name	English Name	Scientific Name
50	Mehedi	Henna	<i>Lawsonia inermis</i>
51	Ashoke		<i>Saraca asoca</i>
52	Arjun	Arjuna Myrobalah	<i>Terminalia alata</i>
53	Methi	Fenugreek	<i>Trigonella foenum-graecum</i>
54	Ashwagondha		<i>Withania somniferum</i>
55	Ada	Ginger	<i>Zingiber officinale</i>
56	Boroi	Indian Jujube	<i>Zizyphus rugosa Lam</i>
57	Tatul	Tamarind	<i>Tamarindus indica</i>
58	Jamrul	Star apple	<i>Syzygium samraogense (Bl.)</i>
59	Shegun		
60	Khajur	Date Plam	<i>Phoenix sylvestris</i>
61	Amra		<i>Spondius mangifera Willd</i>
62	Kamranga	Carambola	<i>Averrhoa carambola</i>
63	Dabdaru	Pine	
64	Ata	Custard Apple	
65	SHIULI		<i>Nyctanthes arbortristis Linn.</i>
66	Epil Epile	Ipil Ipil	<i>Leucaena Latisiliqua</i>
67	Sheshu	Shisu	<i>Dalbergia sissoo</i>
68	Dalim	Pomegranate	<i>Punica granatum L.</i>
69	Kath badam		
70	Shirij		

5.1.2 Forest and Homestead vegetation

There is no natural or social forest in and around the project area. However, there are dense vegetations in areas opposite the site, on the northern bank of the river Bhairab. Trees have been planted in the residential area close to the project site. Although there is no forest, but trees planted and homestead vegetation play an important role in environmental balance and economic life of the people of the project areas in terms of food and nutrition, construction material, biomass fuel, fodder, shelter and shade, windbreaks, organic matter, erosion control and balance between flood and drought.

5.1.3 Biodiversity

The project area has distinctive terrestrial and aquatic habitats. The homesteads and roads are the major components of the terrestrial habitat with flora and fauna. The aquatic habitats include mainly the river.

5.1.4 Terrestrial Fauna

The animals found 1 km around the site include a total of **62** species, **18** species of mammalian animals, **36** species of birds, **5** species of reptiles, and **3** species of amphibians. Of these, the animals given on the 2007 Red List of the International Union for Conservation of Nature (IUCN) contain 4 species of mammals and 3 species of birds. 2 mammals fall under the category of Least Concern (LC), 1 mammal endangered and 1 mammal vulnerable. 2 birds fall under the category of "Least concern" and 1 bird vulnerable. **Table 5.1.4** shows the terrestrial animals having been found.

Table 5.1.4 : List of animals found 1 km around the site

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
MAMMALS				
1	Ban biral	Jungle cat	<i>Felis chaus kutas</i>	LC
2	Mecho Biral	Fishing cat	<i>Felis viverrinus</i>	
3	Biral	Cat	<i>Felis : Catus</i>	
4	Kukur	Dog	<i>Cannis Familiaris</i>	
5	Shial	Fox	<i>Vulpes vulpes</i>	LC
6	Chagol	Goat	<i>Capra Hircus</i>	
7	Bhera	Sheep	<i>Bovidae : Ovis</i>	
8	Goru	Cow	<i>Bos Taurus</i>	
9	Katbirali	Squirrel	<i>Rodentia : Sciurus</i>	
10	Khorgosh	Rabbit	<i>Leporidae : Cuniculas</i>	
11	Ghora	Horse	<i>Equus caballus</i>	
12	Gadha	Ass		
13	Mohish	Buffalo	<i>Bubalus bubalis</i>	
14	Banor	Rhesus Macaque	<i>Macaca mulatta</i>	
15	Honuman			
16	Jati Sheyal	Bengol Fox	<i>(Valpes bekgalensis)</i>	EN
17	Hati	Elephant		
18	Gui Shap	Bengal Monitor/ Grey Monitor Lizard	<i>Varanus bengalensis (Daudin, 1802)</i>	VU
BIRDS				
1	Chorai	Sparrow	<i>Passer domesticus</i>	
2	Kak	Crow	<i>Corvus splendens</i>	
4	Shalik	Indian mynah		
5	Doyel	Magpie Robin	<i>Copsychus saularis</i>	
6	Paيرا	Pigeon	<i>Columba livia domestica</i>	LC
8	Dahuk	White Breasted	<i>Amauornis</i>	EN
9	Chil	Pariah Kite	<i>Milvus migrans</i>	LC
10	Finge	Black Drongo	<i>Dicrurus macrocercus</i>	
11	Tia	Parakeet	<i>Psittacula krameri borealis</i>	
12	Bak	Intermediate Egret	<i>Mesophoyx intermedia</i>	
14	Machhranga	Kingfisher	<i>Halcyn smyrensis</i>	
15	Bulbuli	Brown eared/Red vented Bulbul	<i>Microscelis amaurotis/ Pycnonotus cafer</i>	
16	Tuntuni	Tailorbird	<i>Orthotomus sutorius</i>	
17	Kat Thokra	Woodpecker	<i>Picoides pubescens</i>	
18	Babui	Baya Weaver	<i>Ploceus philippinus</i>	
19	Mohan Chura.	Hoopoe	<i>Upupa epops</i>	
20	Hottiti	Yellow wattled Lapwing	<i>Vanellus malabaricus</i>	
21	Pan kouri	Little Cormorant	<i>Phalacrocorax niger</i>	
22	Ghughu	Spotted dove	<i>Streptopelia chinesis</i>	
24	Konch Bak.	Pond Heron.	<i>Ardeola grayii</i>	
25	Banspaati	Green Bee-eater	<i>merops orientalis</i>	
26	Shamuk Khol.	Open Billed Stork	<i>Anastomus oscitans</i>	
27	Sipahi Bulbul	Red Whiskered Bulbul	<i>Pycnonotus jocosus</i>	
28	Kokil	Asian Koel	<i>Eudynamys scolopacea</i>	
29	Rajhaans	Goose		
30	Hash	Duck	<i>Anatidae : Anseriformes</i>	
31	Pecha	Owl	<i>Nocturnal : Strigiformes</i>	
32	Moyna	Hill Myna/Grackle	<i>Gracula religiosa Linnaeus</i>	
33	Koyel			

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
34	Shama			
35	Shokun	Rumped Vulture	<i>Gyps bengalensis</i>	
36	Kola Badur	Leschenault's Rousette	<i>Rousettus leschenaulii</i>	
REPTILE & MOLLUSCS				
1	Tiktiki	Lizard	<i>Sauria : Lacertidae</i>	
2	Bezi	Common Mongooose	<i>(Herpestes edwardsi)</i>	
3	Kumir	Estuarine Crocodile	<i>Crocodylus porosus</i>	
4	Kasim	Malayan Box Turtle	<i>Cuora amboinensis</i>	
5	Shamuk	Snail	<i>Pareas monticalu</i>	
AMPHIBIAN				
1	Geso Beng	Canyon treefrog	<i>Hyla arenicolor Cope</i>	
2	Brischik	Scorpion	<i>Archinida 1 : Scorpionida</i>	
3	Beng	Frog	<i>Anura : Ranidae</i>	

Note :

Category "LC" means "Least Concern Species"

EN- Endangered

VU- Vulnerable

5.2 Aquatic Ecosystem

5.2.1 General

Bangladesh is mainly a deltaic region of the three big rivers, the Ganges, the Brahmaputra and the Meghna and their tributaries. Aquatic ecosystems perform many important environmental functions. For example, they recycle nutrients, purify water, attenuate floods, recharge groundwater and provide habitats for wildlife. Aquatic ecosystems are also used for human recreation and are very important to the tourism industry, especially in coastal regions. The health of an aquatic ecosystem degrades when the ability of ecosystem to absorb a stress has been exceeded. A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment.

Fisheries resources occupy a key position in the agro-based economy of Bangladesh. Fishes are important economically, socially and nutritionally. About 80% of the animal protein in the diet in Bangladesh comes from fish. In the past there was abundance of fishes in water bodies like rivers, floodplains, beels, haors etc. While the large fish species migrate long distances in rivers for breeding, the small fishes migrate over shorter distances or reside in floodplains, beels and canals. Most inland water fishes are small. They are important for nutrition and supplemental income to the vast majority of the rural people, including the landless and the destitute. The miscellaneous species of fish and prawn are termed as "poor people's fish" and provide a support in their struggle against poverty.

During the EIA process, a baseline study of the aquatic ecosystem was undertaken to assess the existing ecological resources in the project area. Water samples at various points of the river Bhairab (near the project site) were collected and analyzed for the parameters such as temperature, pH, DO, BOD,

COD, TSS, Chloride, Nitrate, Sulfate, Iron etc. The tests were carried out in the laboratory of DoE, Khulna. Information relating to different species of fish and other aquatic organism were collected from local people.

The Bhairab river, flowing along the northern side of the proposed power plant site, is a combination of the rivers of Lower Bhairab and Begarti, both tributaries of the Padma, which is one of the three major river systems in Bangladesh. The river has tidal effect with more distinct range between high and low tide during lean periods (November-April). It meets the Rupsha river about 5 KM south-east of the site, which in turn flows into the Poshur, which ultimately goes to the Bay of Bengal.

There are many heavy industries on the banks of Bhairab, e.g. several Jute Mills, News Print Mill etc.

5.2.2 Aquatic Flora

The freshwater dependant plants such as halencha (*Altermanthere philoxeroides*), kalmi (*Ipomoea aquatica*), dolkalmi (*Ipomoea fistulosa*), ichadal (*Potamo seton*) and water hyacinth (*Eichhomia crassipes*) are common in the ponds, borrowpits, ditches, canals and rivers around the project area. Khuda pana (*Lemna minor*), topapana (*Pistia stratiotes*) and chaicha (*Saipus articulatus*) are also common.

5.2.3 Aquatic Fauna

The Bhairab River abounds with fishes and crustaceans. They are the target of the fishing industry.

Good number of prawns including the most expensive ones, the giant prawns (*Macrobrahcium Rosenbergii*), are available in the river, adjacent to the Project area. The crabs are also common in the river, ditches and ponds. Fresh water snails (*Charonia Variegate*) and mussels (*Mytilus Edilis*) are the common or fairly common molasses.

The Khalishpur Upazila Fisheries Department has listed **67 species** of aquatic animals considered to inhabit the Bhairab River close to the site. Of these, 36 species are regarded as important by the Khalishpur Upazila Fisheries Department. **Table 5.2.3** lists the fishes.

Table 5.2.3 : List of fish inhabiting the Bhairab River

Sl. No.	Local/ Common Name	Scientific Name	IUCN Red data Category (2007)
1	Aeor /cat fish	<i>Mystur aor</i>	Endangered
2	Bata	<i>Cirrhina reba</i>	
3	Tular dandy/ Hundra fish	<i>Sill ego dominv</i>	
4	Bele	<i>Glossogobius giuris</i>	
5	Parshey/Mullet	<i>Liza per sia</i>	
6	Bhagna bata	<i>Liza subviridis</i>	Endangered
7	Gool bata	<i>Liza tade</i>	
8	Vetki/Seabass	<i>Latis calcarfer</i>	

Sl. No.	Local/ Common Name	Scientific Name	IUCN Red data Category (2007)
9	NonaTengera/ Bagri Tengra	<i>Mystus gulio</i>	
10	Tapshey/Paradise Thread fin	<i>Polynemus paradiseus</i>	
11	Fesha	<i>Setipina taly</i>	
12	Phasa	<i>ihryssa mystax</i>	
13	Pangus	<i>Pangusius pungasius</i>	Critically endangered
14	Chapila	<i>Gudusia chapra</i>	
15	Ghoar chela	<i>Chella ghora</i>	
16	Chela	<i>Salmostorma bacaila</i>	
17	Kukurjib/ Fourmed tongue	<i>Cynoglossus bilineatus</i>	
18	Kukurjib/ Long tongue sole	<i>Cynoglossus lingua</i>	Endangered
19	Takhia/Fringe scale sardine	<i>Sardinell fimbriata</i>	
20	Bombay duck/ Loitta	<i>Harpodon neherius</i>	
21	Churi mach	<i>Lepturacanthus svella</i>	
22	Lai poa/Jaw fish	<i>Johnius argentatum</i>	
23	Datina	<i>Pomadasys hasa</i>	Endangered
24	Rup chanda	<i>Poma chinensis</i>	
25	Khoira	<i>sardinella gibbosa</i>	
26	Kazoli	<i>Ailichthys punctata</i>	Critically endangered
27	Mugil corsula	<i>Mugil corsula</i>	
28	Bhangan	<i>Mugil cephalus</i>	
29	Ilish	<i>Tenualosa ilisha.</i>	
30	Hobo kankra/Mud crab	<i>Scylla serreta</i>	
31	Lai kankra/ Feedler crab		
32	Anguilla	<i>Anguilla begalensis</i>	Vulnerable
33	Plotosus/Estuarine cat fish	<i>Plotosus cnius</i>	Vulnerable
34	Selnda	<i>Silonia silondia</i>	Endangered
35	Chali chingri	<i>Metapenaeus brevicornis</i>	Specific study on fish breeding ground in the Bhairab river yet not undertaken within one Km. up and down of Goal Para Power plant
36	Chaka chingri	<i>Penaeus indicus</i>	
37	Harina chingri	<i>Metapeneus monoceros</i>	
38	Bagda chingri/ Tiger prawn	<i>Penaeus monodon</i>	
39	Small chingri	<i>Palaemon spp.</i>	
40	Golda chingri/ Giant water Prawn	<i>Macrobrachium rosenbergii</i>	
41	Lotia chingri	<i>Macrobrachium mirabilie</i>	
42	Shapla pata	<i>Himantura uarnak</i>	Endangered
43	Katla/ Catla	<i>Catla Cattla</i>	
44	Rui/ Rohu	<i>Labeo rohita</i>	
45	Surma		
46	Takhi/snakehead	<i>Channa punctatus</i>	
47	Boal/Indian Trout	<i>Raiamas bola</i>	
48	Magur/Catfish	<i>Clarias batrachus</i>	
49	Koi/ Climbing Perch	<i>Anabastestudineus</i>	
50	Shing/ Indian torrent catfish	<i>Amblyceps mangois</i>	
51	Merigal/ Mrigal	<i>Cirrhinus mrigala</i>	
52	Chandha/ Elongate glass	<i>Chanda nama</i>	
53	Gulsha/(Gangetic Mistus)	<i>Mystus cavaslus</i>	
54	Tengra/ Assamese	<i>Batasio Tengana</i>	
55	Pabda/ Pabo Cat fish	<i>Ompak pabo</i>	EN
56	Shol/snake head murrel	<i>Channa striata</i>	
57	Kauya/		

Sl. No.	Local/ Common Name	Scientific Name	IUCN Red data Category (2007)
58	Puti/ Fry	<i>Puntius puntio (Hamilton)</i>	
59	Tatkini/ Reba carp	<i>Cirrhinuss reba</i>	
60	Badha/ Mottled nandus, mud	<i>Nandus nandus</i>	
61	Choundon/Toli shad	<i>Tenualosa toli</i>	
62	Gojal/ Great snake head	<i>Channa marulius</i>	
63	Kong kon		
64	Chital/(Humped Featherback)	<i>Notopterus chitala</i>	
65	Foli/(Grey Featherback)	<i>Notopterus notopterus</i>	
66	Tila Poa/Blackspotted croaker	<i>Protonibea diacanthus</i>	
67	Chingri/ Shrimp	<i>Macrobrachium rosenbengii</i>	

Source: Fisheries Department, Boyra, Khulna

5.3 Water quality

Water quality is very important for Aquatic Ecosystem. It includes physical, chemical and biological variables that affect fish production. Fish growth is not only dependant on water and food availability but also to a great extent on the favorable water quality. Macrophytes were present in some places near shore-line, the most prominent being water hyacinth (Kochuripana). According to fishermen, water quality is satisfactory during wet season. However, the ecosystem and water quality deteriorate rapidly due to low water level during dry season. The results of analysis of river water are tabulated under **section 4.8.1** of Chapter 4.

5.3.1 Temperature

The growth, reproduction and other biological activities of aquatic organisms are influenced by the temperature of the external environment. Water temperature closely follows air temperature; but in a tropical climate during both dry and wet seasons, the water temperature is high enough for good growth of fish (Boyd, 1990). Temperature at various points of the river were measured on **4/5/2013**. It varied from **33.8⁰ C to 34.7⁰ C** on the surface.

5.3.2 Dissolved Oxygen

Dissolved Oxygen is a critical factor for the survival of fish. Success or failure in fish farming often depends upon the availability of the appropriate quantity of dissolved oxygen. Prolonged exposure to sub-lethal low concentration of dissolved oxygen is harmful to fish (Boyd, 1990). Dissolved oxygen (DO) in the samples of water collected from the Bhairab River near the project site were found to vary from **6.4 to 6.8 mg/l** near the surface, which is suitable for fish growth.

5.3.3 pH

pH is the negative logarithm of hydrogen ion concentration. It indicates whether, water is acidic or alkaline. Fish cannot survive in waters below pH 4 and above

pH 11 for very long periods. The optimum pH for fish is 6.5 to 9. It was found that pH of the stretch of the Bhairab river from where the samples were collected on **May 4, 2013** was **7.65**, which is within the acceptable value.

5.3.4 Turbidity

Transparency, inversely related to turbidity is measured by Secchi disk to indicate light penetration into water. Turbidity refers to how opaque the water is. The greater the amount of total suspended solids (TSS) in the water, the higher the measured turbidity. The major source of turbidity in the open water zone is typically phytoplankton, but closer to shore, particulates may also be clays and silts from shoreline erosion and organic detritus from stream and/or waste water discharges. Dredging operations, canalization, increased flow rates and floods increase the turbidity of water. Very high levels of turbidity for a short period of time may not be significant and may even be less of a problem than a lower level that persists longer. Turbidity was found about **58 mg/l**, which are just within the limits suitable for fish.

5.3.5 Nitrogen-Nitrate

Inorganic forms of nitrogen found in water are nitrite, nitrate, ammonia and ammonium. The proportion of ammonia and ammonium varies with pH and temperature. Nitrogen is also present in soluble organic compounds and as a constituent of living and dead particulate organic matter. Ammonia has some toxic effects on fish. The European Inland Fisheries Advisory Commission stated that toxic concentration of NH_3 for fresh water fish for short term exposure are between 0.7 and 2.4 mg/L as NH_4^+ . N-Nitrate contents of water samples collected from the river Bhairab was **20mg/l**.

5.4 Protected Area (Sensitive Area)

Four types of natural protected areas including national parks are stipulated in Bangladesh. There is no nature conservation area, conservation forest or protected forest around Goalpara .

From reconnaissance survey and discussion with Upazilla administration, it appeared that there is no protected (sensitive) area around the proposed site, except the existing power plant of BPDB and some Jute Mills and News Print Mill.

Through collection of data and information from the local people of the project and its surroundings areas as well as from the Upazila Fisheries officer, the fish breeding place in the Bhairab river is not detected. No specific study on fish breeding ground in the Bhairab river has yet been undertaken within one km. up and down of Goal Para Power plant.

According to the opinion of the local people in and around the project area, migrating birds come into the Bhairab River every winter. Their place of wandering is situated between **1 km** upstream and **2 km** downstream from the project site.

5.5 Rare and Endangered Species

5.5.1 Rare and Endangered Fish Species

According to Dhaka DOE, rare or endangered species are not stipulated in the laws and regulations of Bangladesh. Some of the terrestrial animals listed in the IUCN red data were observed around the protected site of the power plant, but the plants or aqueous animals and plants listed in this data have not been observed.

Though this river is enriched with different species of fresh water fishes, but **11 nos.** of important species have been detected in the Bhairab River by the Khalishpur Upazila Fisheries Department. The list of the species are given in **Table-5.5.1**.

Table-5.5.1: Rare and endangered fish Species in Bhairab River

SI No.	Local/ Common Name	Scientific Name	Endangered
1	Aeor /cat fish	<i>Mystur aor</i>	Endangered
2	Bhagna bata	<i>Liza subviridis</i>	Endangerd
3	Pangus	<i>Pangusius pungasius</i>	Crtically endangered
4	Chapila	<i>Gudusia chapra</i>	
5	Kukurjib/ Long tongue sole	<i>Cynoglossus lingua</i>	Endangered
6	Datina	<i>Pomadasys hasa</i>	Endangered
7	Kazoli	<i>Ailichthys punctata</i>	Crtically endangered
8	Anguilla	<i>Anguilla begalensis</i>	Vulnerable
9	Plotosus/Estuarine cat fish	<i>Plotosus cnius</i>	Vulnerable
10	Selnda	<i>Silonia silondia</i>	Endangered
11	Shapla pata	<i>Himantura uarnak</i>	Endangered

5.5.2 Migratory Bird Species

List of Migratory birds is given in **Table-5.5.2**.

Table-5.5.2: List of Migratory Birds

Sl. No.	English Name	Scientific Name
1	Northern Pintail	<i>Anas acuta</i>
2	Northern Shoveller	<i>Anas clypeata</i>
3	Common Teal	<i>Anas crecca</i>
4	Falcated Teal	<i>Anas falcata</i>
5	Baikal Teal	<i>Anas formosa</i>
6	Eurasian Wigeon	<i>Anas penelope</i>
7	Mallard	<i>Anas platyrhynchos</i>
8	Garganey	<i>Anas querquedula</i>
9	Gadwall	<i>Anas strepera</i>
10	Greylag Goose	<i>Anser anser</i>
11	Bean Goose	<i>Anser fabalis</i>
12	Bar-headed Goose	<i>Anser indicus</i>
13	Baer's Pochard	<i>Aythya baeri</i>
14	Common Pochard	<i>Aythya ferina</i>
15	Tufted Duck	<i>Aythya fuligula</i>
16	Greater Scaup	<i>Aythya marila</i>
17	Ferruginous Pochard	<i>Aythya nyroca</i>
18	Marbled Duck	<i>Marmaronetta angustirostris</i>
19	Red-crested Pochard	<i>Rhodonessa rufina</i>
20	Ruddy Shelduck	<i>Tadorna ferruginea</i>
21	Common Shelduck	<i>Tadorna tadorna</i>
22	Demoiselle Crane	<i>Grus virgo</i>
23	Common Coot	<i>Fulica atra</i>
24	Spotted Crake	<i>Porzana porzana</i>
25	Baillon's Crake	<i>Porzana pusilla</i>
26	Water Rail	<i>Rallus aquaticus</i>
27	Common Sandpiper	<i>Actitis hypoleucos</i>
28	Ruddy Turnstone	<i>Arenaria interpres</i>

Sl. No.	English Name	Scientific Name
29	Sanderling	<i>Calidris alba</i>
30	Dunlin	<i>Calidris alpina</i>
31	Knot	<i>Calidris canutus</i>
32	Little Stint	<i>Calidris minuta</i>
33	Red-necked Stint	<i>Calidris ruficollis</i>
34	Long-toed Stint	<i>Calidris subminuta</i>
35	Temminck's Stint	<i>Calidris temminckii</i>
36	Great Knot	<i>Calidris tenuirostris</i>
37	Curlew Sandpiper	<i>Calidris ferruginea</i>
38	Spoon-billed Sandpiper	<i>Calidris pygmeus</i>
39	Fantail Snipe	<i>Gallinago gallinago</i>
40	Wood Snipe	<i>Gallinago nemoricola</i>
41	Solitary Snipe	<i>Gallinago solitaria</i>
42	Pintail Snipe	<i>Gallinago stenura</i>
43	Broad-billed Sandpiper	<i>Limicola falcinellus</i>
44	Jack Snipe	<i>Limnocryptes minimus</i>
45	Snipe-billed Godwit	<i>Limnodromus semipalmatus</i>
46	Bar-tailed Godwit	<i>Limosa lapponica</i>
47	Black-tailed Godwit	<i>Limosa limosa</i>
48	Eurasian Curlew	<i>Numenius arquata</i>
49	Eastern Curlew	<i>Numenius madagascariensis</i>
50	Whimbrel	<i>Numenius phaeopus</i>
51	Ruff	<i>Philomachus pugnax</i>
52	Eurasian Woodcock	<i>Scolopax rusticola</i>
53	Spotted Redshank	<i>Tringa erythropus</i>
54	Wood Sandpiper	<i>Tringa glareola</i>
55	Normann's Greenshank	<i>Tringa guttifer</i>
56	Greenshank	<i>Tringa nebularia</i>
57	Green Sandpiper	<i>Tringa ochropus</i>

Sl. No.	English Name	Scientific Name
58	Marsh Sandpiper	<i>Tringa stagnatilis</i>
59	Common Redshank	<i>Tringa totanus</i>
60	Avocet-sandpiper	<i>Xenus cinereus</i>
61	Eurasian Oystercatcher	<i>Haematopus ostralegus</i>
62	Pied Avocet	<i>Recurvirostra avosetta</i>
63	Kentish Plover	<i>Charadrius alexandrinus</i>
64	Little Ringed Plover	<i>Charadrius dubius</i>
65	Common Ringed Plover	<i>Charadrius hiaticula</i>
66	Greater Sand Plover	<i>Charadrius leschenaultii</i>
67	Lesser Sand Plover	<i>Charadrius mongolus</i>
68	Long-billed Ringed Plover	<i>Charadrius placidus</i>
69	Crab Plover	<i>Dromas ardeola</i>
70	Pacific Golden Plover	<i>Pluvialis dominicus</i>
71	Grey Plover	<i>Pluvialis squatarola</i>
72	Grey-headed Lapwing	<i>Vanellus cinereus</i>
73	Sociable Lapwing	<i>Vanellus gregarius</i>
74	White-tailed Lapwing	<i>Vanellus leucurus</i>
75	Northern Lapwing	<i>Vanellus vanellus</i>
76	Lesser Noddy / Whitecapped Noddy	<i>Anous tenuirostris</i>
77	Whiskered Tern	<i>Chlidonias hybridus</i>
78	White-winged Tern	<i>Chlidonias leucopterus</i>

Chapter 6: EXISTING ENVIRONMENT: SOCIO-ECONOMIC

6.1 Introduction

The project is located in a semi-urban area of Khalishpur Upazila in the north eastern part of the district of Khulna. Most of the people living in the area are engaged in various industries and power plants of BPDB and IPP. Most of them are people of middle and lower middle class.

The socio-economic information/data have been collected from secondary sources. Sources of secondary data are different official records and published reports of Bangladesh Bureau of Statistics (BBS), Population Census Reports and also reports of other organizations.

On the basis of present socio-economic status of people in and around the project area, the impact of project implementation on the socio-economic situation can be determined. Decision or measures can then be taken for the implementation of the project with sustainable friendly environment.

6.2 Geographical Location

Khalishpur is an urban thana of Khulna City Corporation. It came in to existence on the 1st July of 1986. Thana consists of 10 wards and 41 mohollahs, The thana occupies an area of 11.47 sq Km. It is located between 22° 50' North latitude and 89° 31' and 89° 34' East longitude. The thana is bounded on the north by Daulatpur thana. On the east by Dighalia Upazila. On the south by Sonadanga thana, on the west by Dumuria upazila.

6.3 Land Use and Utilities

Land use pattern of Khulna District for the years 2002-2003, 2003-2004, 2005-2006 and 2006-2007 is given in **Table 6.2.1**.

Table 6.2.1 : Land use Pattern of Khulna District for 2002-2003, 2003-2004, 2005-2006 and 2006-2007

Area in 000 acres					
Sl. No.	Type of Land Use	2002-2003	2003-2004	2005-2006	2006-2007
1.	Forest area	516	1,426	1426	1426
2.	Non-cultivable area	39	510	513	508
3.	Cultivable Waste area	80	35	31	30
4.	Current Fallow area	683	78	118	117
5.	Single Cropped area	272	682	700	701
6.	Double Cropped area	46	279	240	241
7.	Triple Cropped area	1,001	52	34	39
8.	Net Cropped area	1,319	1,013	974	981
	Total Cropped area	1,321	1,396	1,282	1,300

Source : Statistical Yearbook of Bangladesh 2006 & 2008

The land use pattern around the project area is covered by different rural infrastructure. The existing power station and its infrastructures are situated on

the BPDB land. The BPDB land area is quite congested. The Peoples Jute Mill is located on the east of the site and Oil Depot on the west. Adjacent to the project site, there are households in the residential area, where BPDB staffs are living.

6.4 Utilization of River Water

The Bhairab River is flowing on the northern side of the project area. This river is playing vital and important role in the lives of the people of the project area and its surrounding areas also. The people of the area use this river water for household purpose. People of area opposite the site use the river water for irrigation purpose. Transportation by boat, engine boat, launches are kinds of communication system in the area. Fishing activities are going on in the Bhairab River by fishermen in the area.

6.5 Utilization of Ground Water

The groundwater is used around the project area from shallow level and deep aquifer also. The shallow level ground water is used for household purpose by using hand tube wells. The shallow pumps are used for irrigation purpose in the area. But shallow level ground water **is arsenic contaminated** at increasing rate. Use of shallow level ground water is, therefore, hazardous for both household and irrigation purposes. There are **two** deep tube well pump stations in Khalishpur Upazila. One is installed by DPHE to supply water in Khalishpur Housing area and another is installed by existing power station authority to supply water in the power station area. Apart from this, two deep tube wells have been installed by NWPGL to supply groundwater to the Khulna 150MW Peaking Power Plant. The deep aquifer is arsenic free.

6.6 Landscape

The project area is a plain land. The slope of the ground directs from south to north. There is no undulation or there is no basin like depression in the project area. Two retired Gas Turbine power plants are present in the project area.

6.7 Demographic Characteristics

As of the 2001 Bangladesh Population Census, Khalishpur has 53,818 households and a population of 2,35,018 (both Sex). Male population is 1,28,474 and female population is 1,06,544.

In Goal Para mauza, there is only 1020 households having total population (both sexes) 4,015 out of which 2,188 male and 1,827 female.

6.7 Education, Employment and Economics

6.7.1 Education

In Khalishpur thana there are 29 Private High Schools, 4 Colleges, 8 Technical institutes, 3 Madrashes. However, there are 15 Govt. Primary Schools in Khalishpur. There is approximately 27 thousands (near about) students studying in this thana institutions. The literacy rate of Khalishpur thana according to 2001 census is 73.72% for both sex, 77.46% for male and 69.15% for female.

6.7.2 Employment

In Khalishpur, there are five categories of industries such as Bakery, Flour Mills, Jute Mills, Oil companies and Power plant. There are 23 industries in Khalishpur area in which about 12,275 workers are employed. 11,484 workers are male and the rest 791 are female. Summary of employment status of Khalishpur upazila is given in **Table-6.7.2**

Table-6.7.2: Summary of Employment Status of Khalishpur upazila

SI No.	Category of Industries/Factory	No. of Industries	Total No. of Employee /Labour	No. of Employee /Labour		Remark
				Male	Female	
01	Bakery/Factory	08	85	68	17	
02	Flour Mill	05	41	39	02	
03	Jute Mill	04	11,102	10337	765	
04	Oil Company	03	120	120	-	
05	Power Plant	03	927	920	7	
Total		23	12275	11484	791	

Source: Md. Mizanur Rahman, Deputy Chief Inspector (GM), Additional Charge, Ministry of Labour & Employment, Department of The inspection for Factories & Establishments, Govt. of the peoples Republic of Bangladesh, Khulna Division, Boyra, Khulna. Phone- 041-2850143 (Off), 01717-617597

6.7.3 Live stock/ Poultry/Bird/ information of Khalishpur

As of 2009, in Kahlisapur, there are 124 cattle farms with 493 cattles. On the other hand, there are 26 poultry farms having 29,590 birds.

6.8 Agriculture

In Khalishpur, there are in total of 1052 hectares of land. Among this land, 100 hectares of land is cultivated with boro paddy as crops. 945 hectares of land are non- cultivated. 7 hectares of land are used to grow vegetables such as lady's finger, bean, brinjal, and cauliflower, etc. Agriculture status of Khalishpur upazial is given in **Table-6.8**.

Table-6.8: Agriculture status of Khalispur

Status of Land	Quantity of Land (Hector)	Name of Crops	Remarks
Crops Cultivated	100	Boro Paddy	
Non-Cultivated	945	-	
Vegetable	07	Vegetable	Lady's finger, bean, brinjal, cauliflower, snake-gourd, kidney bean etc.
Total	1052		

Source: Ms. Zakia Sultana, Metropolitan Agriculture Office, near Shasivoshon school, Doulatpur, Khulna, Phone- 041-774073.

6.9 Fisheries

In and around the project area there are culture fisheries and open water fisheries in the adjacent Bhairab River. There are no ponds within the project site. There is, therefore, no opportunity of fish culture within the project area.

According to Khalishpur Upazila Fisheries Department, open season for commercial fishing in Bhairab River is from September to July. The mainly fishing area in the River is around **2km up and down the streams** of project site. Riverbank on the side of the power plant has no fish catch. However, fish catch is larger at the riverbank on the other side.. The main fishing areas in the Upazila are canals, ponds and so on.

According to the interview done with the fishermen around the construction site , fish catch reaches the peak in October to November. Fishing tools used are Drag net, Gill net, Trap, long lines etc. for Hilsa, Pangas, Golda and Bagda shrimps, Air, Kalibaush, Ritha, Bata, Khorsola, Shole, Piali, Bacha, Bele, Bashpata, Pabda etc..

6.10 Public Health

Treatment facilities for minor sicknesses are available within the Power Station complex. Upazila Health Complex mainly provides public health services in the area. This Complex is providing immunization and family planning services including Mother and Child Health (MCH) and basic health services in Khalishpur Upazila. Beside this, **17 private hospitals and clinics** are providing health services in the Upazila.

Different NGOs like BRAC, Proshika, NGO Forum etc. are conducting awareness raising programs on different health services as well as hygienic promotion activities through their sanitation programs. Department of Public Health Engineering (DPHE) is providing sanitary latrines, ring slab toilets through sanitation health program from their Upazila office. They are providing arsenic free water supply to the people of the area.

6.11 Transport

Road transport, railway communication and river transport are available in the area. On the western side of the project area Dhaka - Khulna national highway, on the northern side river communication through Bhairab River and on the western side through Daulatpur railway station easy communication with the site is established. From Daulatpur railway station a railway track is communicating with the present power station for transportation of different goods and fuel oil. Since the Bhairab River is adjacent to the project area, the river communication is an additional advantage. As a result, road, railway and river communication and consequently, transportation system with the project area is well established.

Additionally, the available jetty, as an extension of the existing power plant, is an added advantage for unloading the project equipment.

6.12 Heritage

Khulna District has **two cultural** heritages under Antiquities Act .XIV (1968, which do not belong to Khalishpur Upazila but to another Upazila.

The Sundarbans, situated almost all along the south coast of Khulna, is the most important heritage of the District. If evidence of any other ancient heritage or any archeological symbol is found during execution of the project, actions will be taken in accordance with relevant GOB acts and rules.

6.13 Social Environment around the Project Site

6.13.1 General:

In recent times, our country's one of the biggest concerning problem is the shortage of power supply. This is a national crisis. In these circumstances the whole country has to rescue from the shortage of production of power supply. In order to reach this goal, new and better power plants have to establish. By this way, unemployment rate will decrease and will play a vital role in the betterment of the people in our country. So, in order for this to take full effect, each and every power plant that will be established from now on have to be environment friendly and have to be free of pollution and thus, in this particular area, the Govt. and the general people of this country have to play a vital role in order to prevent environmental pollution. Because, there is no other alternative rather than creating environment friendly power plant and thus prevent any sort of possible havoc.

6.13.2 Methodology:

Data have been collected in two ways from yje proposed power plant area. Qualitative and quantitative data collection have been approached according to the terms of reference. For quantitative data collection, detailed house hold questionnaire (socio economy and environmental impact) has been used. . A sample of questionnaire is enclosed under **Annex-6.13.2** for ready reference. First of all, households in and around the project area have been listed.. Then the sample households have been selected randomly.. Photographs of the selected respondents have been taken. On the other hand, incase of quality

approach, two focus group discussions, one male and one female group have been conducted. The female group is from the direct environmental impact area and another focus group discussion from Khalishpur areas fishermen which are from the general environmental impact area. In-depth interview have been also taken from the upazila administrative authority by using in- depth questionnaire such as, (fisheries officers, agricultural officers etc.).

6.13.3 Findings:

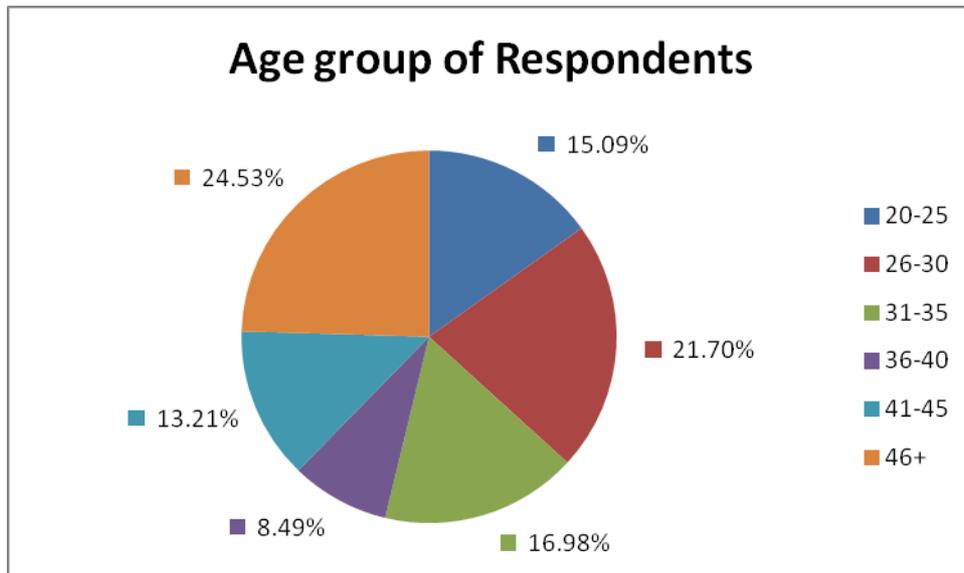
The findings of the survey are enumerated below:

a) Age Group of the Respondents:

Age groups of the respondents are given **Table-6.13.1**

Table-6.13.1 Age Group Distribution of the Respondents

S.L No	Age Group	No. of Respondents	Percentage	Remarks
1	20-25	16	15.09%	
2	26-30	23	21.70%	
3	31-35	18	16.98%	
4	36-40	9	8.49%	
5	41-45	14	13.21%	
6	46+	26	24.53%	
Total		106	100.00%	

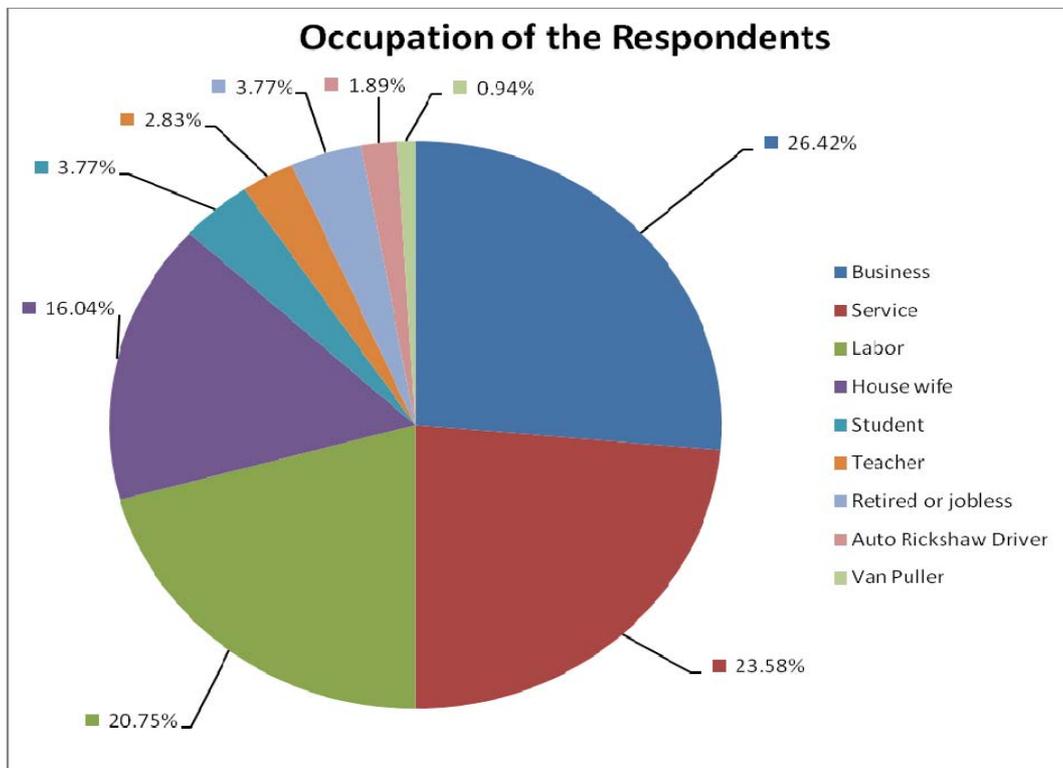


b) Occupation of the Respondents:

Occupations of the respondents are given **Table-6.13.2**

Table-6.13.2 Occupation of the Respondents

S.L No	Occupation of the Respondents	Number of Respondents	Percentage	Remarks
1	Business	28	26.42%	
2	Service	25	23.58%	
3	Labor	22	20.75%	
4	House wife	17	16.04%	
5	Student	4	3.77%	
6	Teacher	3	2.83%	
7	Retired or jobless	4	3.77%	
8	Auto Rickshaw Driver	2	1.89%	
9	Van Puller	1	0.94%	
Total		106	100.00%	

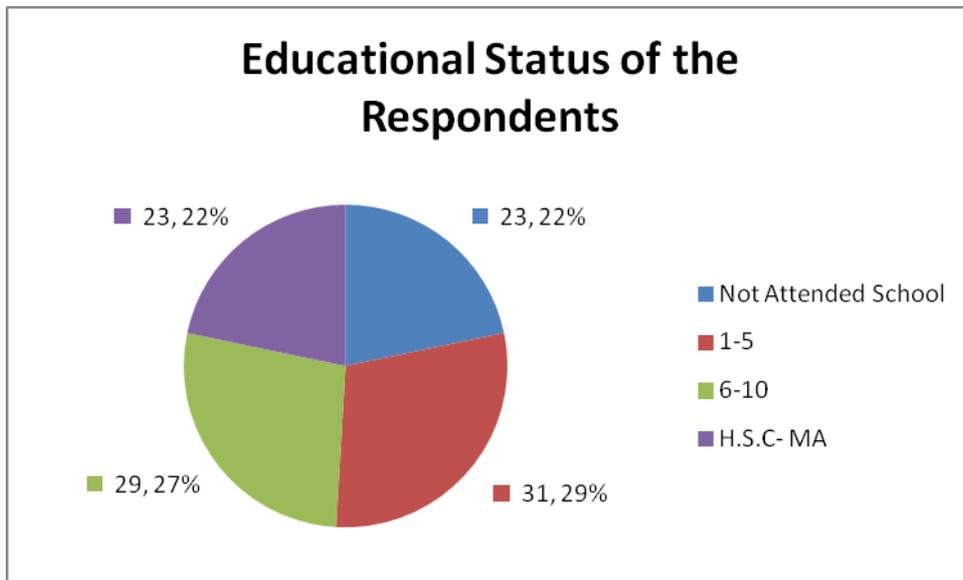


c) Educational Status of the Respondents:

Educational status of the respondents are given **Table-6.13.3**

Table-6.13.3 Educational Status of the Respondents

Highest Class passed	Number	Percentage %	Remarks
Not Attended School	23	21.70%	
1-5	31	29.25%	
6-10	29	27.36%	
H.S.C- MA	23	21.70%	
Total	106	100.00%	

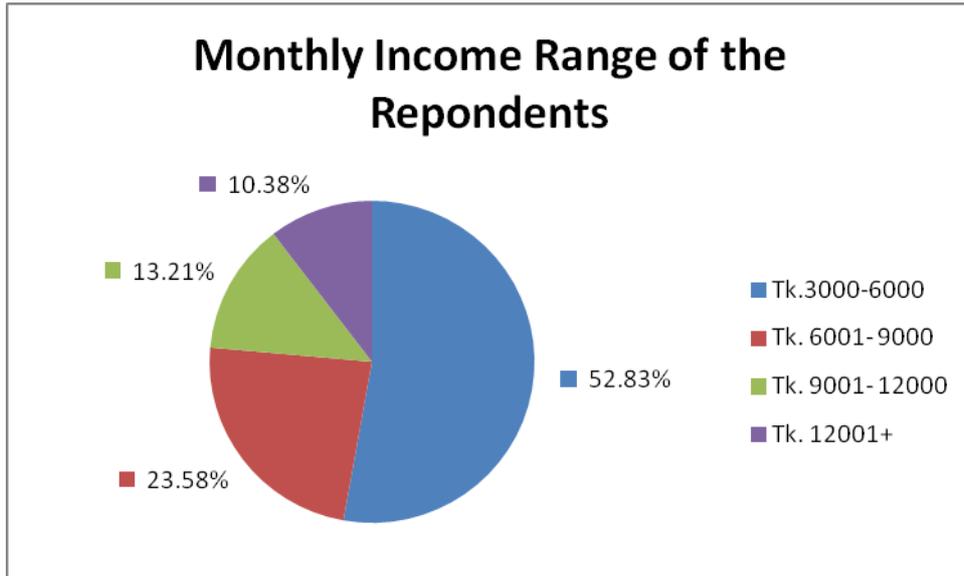


d) Monthly Income of the Respondents:

Monthly Income of the respondents are given **Table-6.13.4**

Table-6.13.4 Monthly Income of the Respondents

SL. No.	Monthly Income Range	No. of Respondents	Monthly Taka	Average	Remarks
1	Tk.3000-6000	56	296000.00	5285.71	
2	Tk. 6001- 9000	25	171750.00	6870.00	
3	Tk. 9001- 12000	14	157500.00	11250.00	
4	Tk. 12001+	11	201850.00	18350.00	
Total		106			

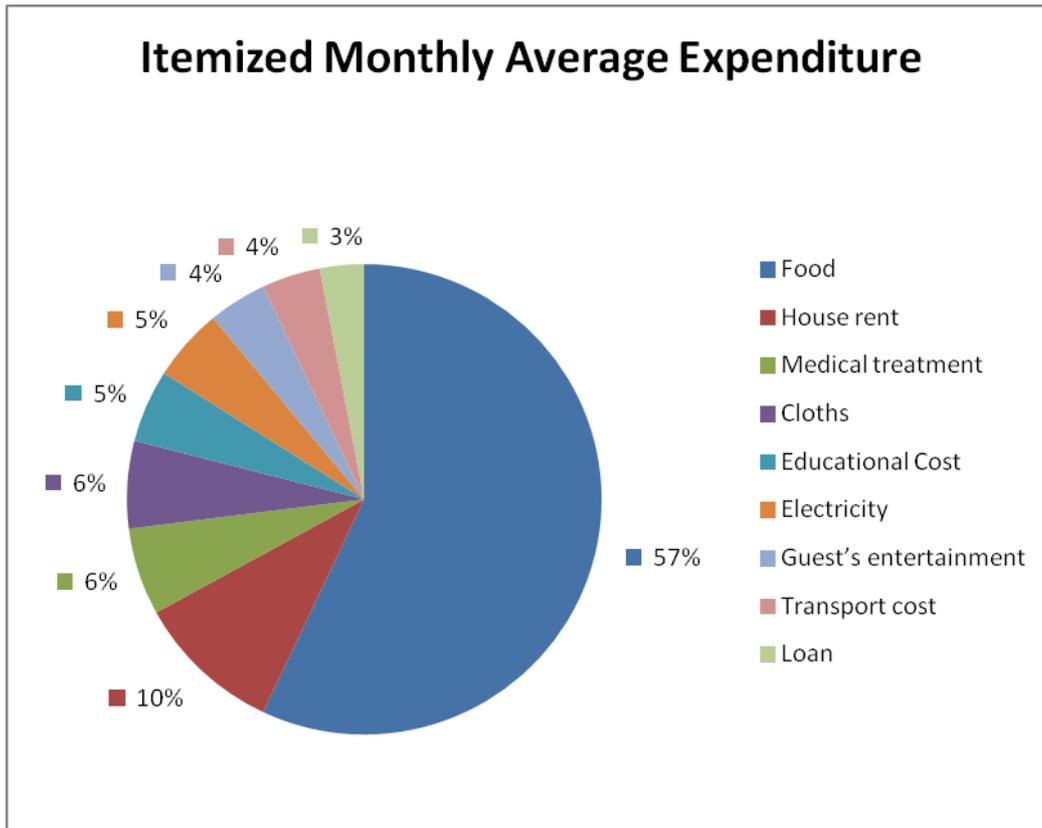


e) Itemized Monthly Average Expenditure of the Respondents:

Itemized Monthly Average Expenditure of the respondents are given **Table-6.13.5**

Table-6.13.5 Itemized Monthly Average Expenditure of the Respondents

SL. No.	Expenditure Item	Itemized Monthly Average Expenditure in Tk.	in Percentage	Remarks
1	Food	4252.00	57%	
2	House rent	746.00	10%	
3	Medical treatment	447.00	6%	
4	Cloths	448.00	6%	
5	Educational Cost	373.00	5%	
6	Electricity	373.00	5%	
7	Guest's entertainment	298.00	4%	
8	Transport cost	298.00	4%	
9	Loan	224.00	3%	
Total		7459.00	100%	

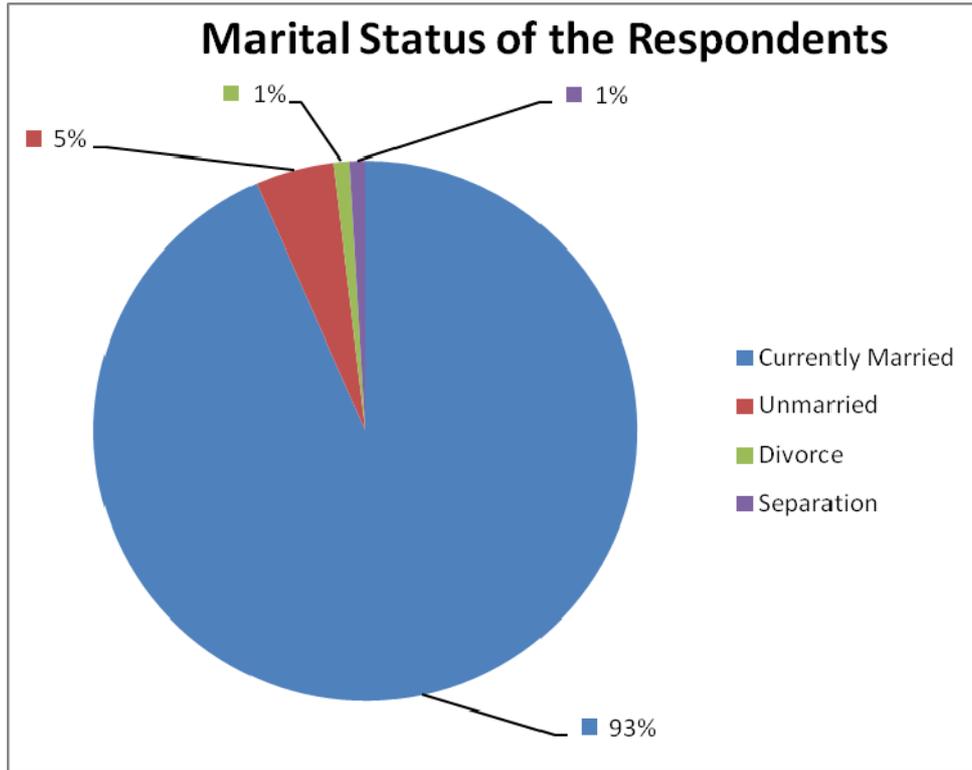


f) Marital Status of the Respondents:

Marital Status of the respondents are given **Table-6.13.6**

Table-6.13.6 Marital status of the Respondents

SL. No.	Marital Status	No of Respondents	Percentage %	Remarks
1	Currently Married	99	93%	
2	Unmarried	5	5%	
3	Divorce	1	1%	
4	Separation	1	1%	
Total		106	100%	



g) Family Size of the Respondents:

Family size of the respondents are given **Table-6.13.7**

Table-6.13.7 Family Size of the Respondents

No .of Respondents	Total Family member	No. of Member Sex		< 5 Year Child		Average Family Size	Remarks
		Male	Female	Male	Female		
106	497 (100%)	223 (50%)	235 (50%)	18	21	4.68	

h) Migration of the Respondents:

Migrations of the respondents are given **Table-6.13.8**

Table-6.13.8 Migrations of the Respondents

No. of Respondents	Own Birth Place	Migration in	Reason for Migrating in	No. of Respondents
106 (100%)	46 (43%)	60 (57%)	* Due to better work/ Service Transfer	35 (33%)
			* Due to Business Facilities	15 (14%)
			Due to Study	03 (3%)
			No Cause	07 (7%)

i) Health Care of the Respondents

Health care status of the respondents are given **Table-6.13.9**

Table-6.13.9 Health Care Status of the Respondents

SL. No.	Health Care Facilities	No. of the Respondents.	Remarks
1	Govt. Hospital	35	
2	Quack Doctor	31	
3	Pharmacy/M.B.B.S Doctor	22	
4	Private clinic/Graduate Doctor	18	
Total		106	

Multiple Answer = 135 (The multiple answer is 135 because some people take treatment from more than one places)

Among the total 106 respondents, the maximum number of respondents goes to Govt. Hospital for their medical treatment, The rest of the respondents go to different places to seek medical attention, namely, 31 respondents goes to the Quack Doctor, 22 Respondents goes to Pharmacy/M.B.B.S Doctor for their treatment and rest (18) of the minor group of respondents goes in random places for treatment like, Private clinic and Graduate Doctors.

j) Houses of the Respondents

Houses of the respondents are given **Table-6.13.10**

Table-6.13.10 Houses of the Respondents

Condition	Type of Roof	No.	Condition	Type of Wall	No.	Condition	Type of Floor	No.
Roof	Tin	77	Wall	Concrete	70	Floor	Concrete	76
	Concrete	15		Bamboo	24		Clay	30
	Thatch/hay	11		Tin	05			
	Tiles	03		Thatch/hay	05			
	Total =	106		Clay	02			
	Total =			106	Total =		106	Total=		106

According to the remarks of the respondents, the material that is being used in their respected house hold is as follows. Among the 106 respondents, the material that is being used in their house hold's roof is, Tin 77, Concrete 15, Thatch/hay 11, and Tiles 03. The material that is being used in their wall is, Concrete 70, Thatch/hay 05, Bamboo 24, and Clay 02. The material that is being used in their floor is, Concrete 76 and Clay 30.

Source of Drinking Water

*Total 106 (100%) respondents said they use and drink the tube well water and also said that there is no arsenic in the tub well water and it

is completely pure. In that area. This supply water is used by the respondents in various purposes like, bathing, cooking, cleaning etc. But, they use only tube well water as their only source of drinking water.

k) Electricity

Electricity facilities available to the houses of the respondents are given **Table-6.13.11**

Table-6.13.11 Electricity Facilities available to the Houses of the Respondents

Total Respondents	With Electricity in House	With no Electricity in House	Use of Electricity	No. Responses
106 (100%)	104 (98%)	02 (2%)	Fan, Light, TV, Heater, CD player, Iron, Radio, Mobile Phone Charge	98
			Factory	73
			Office, different Business, Shop	68
			School, Collage	16
			Computer	12
			Welding	06
			Shrimp Culture	06
			Road light, Generator, Motor, Saw Factory	04

Among the 106 respondents, 104(98%) respondents have electricity in their household, and 02(4%) respondents do not have electricity in their household. 98 respondents use fan, light, television, heater, CD player and iron as electronic appliances in their household. 73 respondents use electricity in the factory, 68 respondents told that they use electricity in office, different business and shops. 16 respondents use electricity in school/college, 12 respondents use electricity for Computer, 6 respondents in welding, 6 respondents in Shrimp Culture 06 and 4 respondents road light, generator, motor, Bakery/Factory..

l) Respondents Perception on Electricity Use:

Perception of the respondents about the use of electricity is tabulated in **Table-6.13.12**

Table-6.13.12: Perception of the respondents about the use of electricity

Total No of Respondents	Merits	No of Responses	Demerits	No of Responses
106	General people will be benefited for establishment of new power plant.	20	To minimize the noise pollution.	89
	Student can read and write	14	Exhaust smog causes environmental pollution	22
	Less Load shedding	20	Burning sensation in the eye due to the exhaust of the fuel	10
	Factory can run more time	18	Day by day bill will increasing	25
	Can be used in the household	10		
	Job facilities are increase	05	Due to the situation of the power plant in both residential and industrial area, the environmental pollution will be even more.	38
	People can walk easily at night	04	Frequent load shedding	30
	Increase in the income of the household	07		
	Less use of kerosene	03		

The merits and demerits of the use of electricity in their respected areas are discussed thoroughly by the total 106 respondents with different point of views, and their comments are shown above.

The respondents also demand the power plant that the power plants have to environment friendly.

When the respondents were asked about the merits and demerits of the use of electricity, they gave multiple answers spontaneously. Over all impression of respondents they want power plant for the greater interest of the nation.

m) Comments of the Respondents about the establishment of the new Power Plant:

Comments of the Respondents about the New Power Plant in their Locality have been tabulated in in **Table-6.13.13**

Table-6.13.13: Comments of the Respondents about the New Power Plant in their Locality

Total No of Respondents	Comments of the New power plant	No of Responses
106	Modern Equipment/technology used, as a result load shedding decreased.	43
	Government established more power plant for minimize the load shedding.	35
	The new power plant should be established away from the residential area	55
	There should be no Sound Pollution	48
	Exhausting smog and noise pollution should be controlled	30
	Opportunity of employment	22
	Load shedding will decrease	28
	The problem of lack of power in our country will be minimized	20
	Power Plant should be established in such an area where there are no existence of any residence	12
	The entire nation will be benefited	96
	Factory, Industry will be profited on their business	35
	The chimney should be at a greater height and have to be environmental friendly	18
	The local people of Khulna will be benefited	45
Benefit in reading and writing	27	

The comments, remarks and different point of views quoted by the total 106 respondents are discussed above. The numbers of responses are also stated. Here, stated multiple responses are recorded.

n) Cooking Materials used by the Respondents:

Cooking Materials used by the respondents are given **Table-6.13.14**

Table-6.13.14 Cooking Materials used by the Respondents

SL. No.	No. of Respondents	Material used for cooking	No. of Respondents	Remarks
01	106	Wood	91	
04		LP/Liquid gas	09	
05		Kerosene	04	
06		Electric heater	02	

Among the total 106 respondents, the majority of the people use wood as the material to act as a fuel in their cooking in their respected household

(122 responses). 09 responses stated the use of natural garbage in their house hold as a fuel, 06 manure, 03 LP/Liquid gas, 02 Electric Heater and the remaining 04 uses kerosene in their house hold as a fuel to aid their cooking purposes.

But, there are some respondents who stated the use of more than one material in their house hold, so in that case multiple answers are taken.

o) Household Assets of the Respondents:

Household assets possessed by the respondents are given **Table-6.13.15**

Table-6.13.15 Household Assets of the Respondents

SL. No.	Available Household Assets	No. of Respondents
01	Radio	03
02	TV	85
03	By Cycle	17
04	Sewing machine	12
05	Al Mira	39
06	Bed	81
07	Chair/Bench	82
08	Watch	65
09	Mobile	100
10	Refrigerator	15
11	Rickshaw/Van	08
12	Land Phone	02
13	Motor Cycle/ Auto Rickshaw	07

p) Impact of the Existing Power Plants:

Impacts of the existing power plant are given **Table-6.13.16**

Table-6.13.16 Impacts of the existing power plant

Direct Environment Impact Area			General Environment Impact Area		
Sl. No.	Reason of problem	Responses	Sl. No.	Reason behind the damage	Responses
01	Victim of harassment	06	01	Did not help much	02
02	Cannot live for sound pollution	100	02	Load shedding did not decrease	04
03	It is too closely situated	71	03	Far distance from the locality would have been better	15
04	Problem to study	80	04	Problem to study	05
05	It have to be without smog and noise	25	05	Environmental pollution due to air pollution	18
06	Problem to pregnant woman and children	01	06	For environmental issues, the rate of disease infection have increased	12
07	The chimneys are too small	07	07	Little problem occurs due to noise pollution	26

Direct Environment Impact Area			General Environment Impact Area		
Sl. No.	Reason of problem	Responses	Sl. No.	Reason behind the damage	Responses
08	Noise and environmental pollution	06	08	Don't know	10
09	Tenant are leaving	02			
10	People are affected by different diseases	04			
11	Breathing problems	22			
12	Cardiac problems	25			
13	Problems to children	07			
14	Cannot listen properly/ Problem in air	89			
15	Doors and windows have to be closed	12			
16	Problems increases in summer	03			
17	Headache	28			
18	Vomiting	16			
19	Physical weakness	07			
20	Hearts beat increases	09			
21	Children cannot play in the street	06			
22	Leaves of the tree turned black and fruits does not grow	32			
23	Trees and plants does not grow	12			
24	Black smog is harmful to the body and also to the clothes	05			
25	Heat wave is produces/ Heated air	16			
26	Carbon is inhaled while we breath	04			
27	Noise and air pollution	15			

q) Diseases due to the Existing Power Plants:

There is increase of diseases around the project area due to the existing power plant. The diseases affecting the people around the project area are given in **Table-6.13.17**

Table-6.13.17 Diseases affecting the People around the Project Area

Direct Environment Impact		
Sl. No.	Diseases affecting people around the existing power plant	No. of affected respondents
01	Ear problem	62
02	Heart disease	25
03	Headache	22
04	Asthma	20
05	Breathing problem	15
06	Allergy/skin disease	23
07	Fever	35
08	Abortion	06
09	Diarrhea	12

In terms of having diseases, multiple opinions of a total of 106 respondents from the Goalpara area. The maximum number of responses concerns having problems in their ear, heart disease, fever, Asthma, headache etc.

r) Trees & Plants available in the Project Area:

The trees and plants found in the project area are given in **Table-6.13.18**

Table-6.13.18 Existing Trees and Plants around the project Area

Environmental Impact		
Sl. No.	Available trees and plants	Respondents
01	Mango, jam, jack fruit, guava, coconut, papaya, cool, akashmoni, banana, koroi, shishu, mahogany, nut tree, lichi, kamranga, dates, mint, lemon, jamrul, epilepsy, shirij.	106

Note: (1) The type of trees and plants mentioned by the 106 respondents of the area that are seen in present times are mentioned above.

(2) The above trees have been found before the power plant was constructed.

s) Animals available and extinction around the Project Area:

List of animals available around the project area and towards extinction are given in **Table-6.13.19**.

Table-6.13.19. Present and towards extinction animal of the areas.

Environmental Impact			
Serial No.	In Present times	Towards Extinction	
01	Animal- cow, goat, lamb.	Animal- Horse	
	Birds – crow, eagle, magpie, robin, parrot, sparrow, pigeon, migrating birds, duck, crane, chicken, kingfisher.	Birds – eagle, owl, vulture, falcon.	
	Animals – dog, cat, fox, mongoose, snake.	Animals – do not know.	

The animals and birds that are seen present time under direct environmental impact are listed above. The animals that are towards extinction is only horse, and birds that are leading towards extinction are eagle, owl, vulture and falcon.

t) Threatened Fishes/ Reptiles around the Project Area:

The list of threatened fishes and reptiles around the project area is given in **Table-6.13.20**. The listed fishes and amphibians are nearing extinction in the Bhorib rivers of Khalishpur.

Table-6.13.20: Threatened Fishes/Reptiles around Project Area

No.	Local (Bangladeshi) Name	English Name	Scientific Name	IUCN Local Status
Fishes				
01	Air/Aor	(Long Whiskered cat fish)	<i>Aorichthys (Mystus) aor</i>	VU
02	Bacha	(Batchwa Bacha)	<i>Eutropicchthys vhacha</i>	CR
03	Bele	Scribbled goby	<i>Awaous gutum</i>	VU
04	Kajli / Banshpata	(Jamua ailiz)	<i>Ailia punctata</i>	VU
05	Pungash (River)	Yellowtail catfish	<i>Pangasius pagasius</i>	CR
06	Nuna Tangra	Long whiskers catfish	<i>Mystus gulio</i>	-
Amphibians				
01	Kumir	Estuarine Crocodile	<i>Crocodylus porosus</i>	CR
02	Kasim	Malayan Box Turtle	<i>Cuora amboinensis</i>	EN
03	Shamuk	Snail	<i>Pareas monticalu</i>	

Source: Mr. Profulla Kumar Pal , District Fisheries Officer , Khulna, Phone-01199386020

Chapter 7: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATORY MEASURES

7.1 Selection of Assessment Items

Khulna 225 MW Combined Cycle Power Plant is planned to be installed at the site of the existing Agreeko 40MW Rental Power Plant after dismantling it. It shows that this project will select a site where there is no need for relocation of the inhabitants. River water can be used for the cooling system and groundwater can be used for domestic and office use. River water can also be used during construction works of the Power Plant.

Since waterborne traffic will be used for the transportation of heavy equipments, the existing pier will be used for unloading such equipment and an access road will be built to connect between the pier up to the storage yard and construction site.

Impact assessment has been designed, on the basis of the factors affecting the environment at the time of construction and operation of the plant, for all the related facilities.

For the impact assessment, reference has been made of the guidelines of the following Bangladesh and international organizations:

- EIA Guideline for Industries (DOE, 1997)
- ADB Environmental Policy 2002
- ADB Environmental Assessment Guidelines 2003
- JICA Guideline for Environmental and Social Considerations (JICA, 2004)
- JBIC Guideline for Confirmation of Environmental and Social Consideration (JBIC, 2004) &
- Pollution Prevention and Abatement Handbook (WB, 1999).

The ODA department of JBIC has been integrated with JICA since 2008. The guideline used here is the previous one before integration.

To prepare impact assessment, the impacts anticipated from various projected activities were selected and measures for avoiding or alleviating such impacts were studied. The impacts assumed to be particularly serious were estimated on a quantitative basis whereby impact assessment was performed.

Whenever required, further measures for mitigating the impact were studied. Consideration was also given to the comments and views on the Khulna 225MW Combined Cycle Power Plant, presented by the inhabitants in the survey on the surrounding community and environment and at the stakeholders' meetings.

Table 7.1.(1) shows the overview of the selected assessment items during Construction period and Table 7.1.(2) shows the overview of the selected assessment items during Operation period. The details are given in the following sections.

Table 7.1(1) Overview of the selected assessment items (Construction period)

	No.	Assessment Item	Overall Rating	Construction Phase			
				Temporary impact by undertaking construction	Power Plant		
					Land formation of Earth work	Operating of construction machinery	Carrying construction materials in and out
Environmental contamination	1	Air pollution	B			B	B
	2	Water pollution	B		B	B	
	3	Solid waste	B	B			
	4	Noise/Vibration	A		B	A	B
	5	Odor	B	B			
Natural environment	6	Climate					
	7	Hydrology					
	8	Flood					
	9	Underground water	B	B			
	10	Ground subsidence	B	B			
	11	Soil erosion	B		B		
	12	Sanctuary					
	13	Terrestrial ecosystem	B		B		
	14	River ecosystem	B		B		
	15	Precious species	B		B		
Social environment	16	Involuntary resident resettlement					
	17	Employment /Livelihood	A	B	A		
	19	Local economy	A	B	A		
	20	Land utilization	A		A		
	22	Social infrastructure/service facilities	B	B	B		
	23	River traffic	B				B
	24	Land traffic	B		B		B
	25	Sanitation	B	B			
	31	Risks for infectious diseases such as (HIV/AIDS)	B	B			
	26	Local custom					
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indogenous people and such)	B	B	B		
	28	Uneven distribution of benefit and loss(damage)	B	B	B		
	30	Utilization/Right of water, including underground water	B	B		B	
	32	Cultural heritage					
33	Landscape	B	B				
Other	34	Accident	B	B	B	B	B
	35	Global warming	B			B	

A: Serious impact is expected.

B: Some impact is expected.

No mark: No impact

Table 7.1(2) Overview of the selected assessment items (Operation period)

	No.	Assessment Items	Overall Rating	Operation Phase					
				Power Plant					
				Operation of Facilities				Carrying materials/stuff in and out	Solid waste
				Intake of cooling water	Gas emissions	Waste water	Others		
Environmental contamination	1	Air pollution	A		A				
	2	Water pollution	B			B			
	3	Solid waste	B						B
	4	Noise/Vibration	A				A	B	
	5	Odor	B						B
Natural environment	6	Climate							
	7	Hydrology							
	8	Flood							
	9	Underground water	A	A		B			
	10	Ground subsidence	B	B					
	11	Soil erosion							
	12	Sanctuary							
	13	Terrestrial ecosystem							
	14	River ecosystem	B			B			
15	Precious species	B			B				
Social environment	16	Involuntary resident resettlement							
	17	Employment /Livelihood	B				B		
	19	Local economy	B				B		
	20	Land utilization							
	22	Social infrastructure/service facilities	B				B		
	23	River traffic	B						
	24	Land traffic	B					B	
	25	Sanitation	B				B		
	31	Risks for infectious diseases such as (HIV/AIDS :	B				B		
	26	Local custom							
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indigenous people and such)	B				B		
	28	Uneven distribution of benefit and loss (damage)	B				B		
	30	Utilization/Right of water, including underground water	A	A					
32	Cultural heritage								
33	Landscape	B				B			
Others	34	Accident	B				B	B	
	35	Global warming	B		B				

A: Serious impact is expected.

B: Some impact is expected.

No mark: No impact

7.2 Impact assessment and measures for avoiding or mitigating the Impact

Impact assessment has been made by studying the measures for avoiding or mitigating the impact with respect to various forms of environmental items. The measures for avoiding or mitigating the impact are shown in the Environment Management Plan (EMP) in **Chapter-8**.

7.2.1 Construction phase

Some of the items where the need for impact assessment by construction work is assumed are separately described below:

7.2.1.1 Environmental pollution

1) Air pollution

IMPACTS:

With the progress of construction work, SO_x, NO_x, smoke and soot will be generated from the construction machinery and transportation vehicles and earth, sand and dust particles will be scattered. This may cause air pollution.

MITIGATION MEASURES:

Periodic inspection and maintenance control will be conducted to reduce exhaust discharged from construction machines and vehicles. To minimize scattering of earth, sand and dust particles, protective covers will be provided, and washing of the vehicles and cleaning of the surrounding roads will be performed on a periodic basis, whereby impact of air pollution will be reduced.

2) Water pollution

IMPACTS:

Drainage caused by rainfall, effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from washing of aggregate and sand.

If these are inadequately handled, river water and underground water will be contaminated.

Contamination will occur during the civil construction work. This may cause river pollution.

MITIGATION MEASURES:

To prevent earth and sand from flowing out due to rainfall, a fence against earth and sand deposition will be installed around the site where excavation is performed. To drain the sewage, a settling tank will be installed on a temporary basis, whereby the supernatant will be removed.

Regarding effluent resulting from washing the equipment, a tank will be installed on a temporary basis, because chemicals may be used at the time of washing the equipment. Then the waste water will be discharged after having been adequately handled.

The waste generated with the progress of the construction work will be adequately handled according to the procedures shown in the following item.

In the civil construction work and washing of aggregate and sand, adequate fencing will be constructed around aggregate and sand storages and around construction site, so as to prevent flow of waste into the river along with water.

To avoid contamination by sewage, adequate sanitary tanks will be constructed and sewage will be thoroughly treated before the resulting water is discharged into the river.

These measures will minimize the impact of contamination of river water and underground water.

3) Solid Waste

IMPACTS:

Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and river water will be contaminated, and sanitation problems will arise.

MITIGATION MEASURES:

Basically, a waste management program including the plan for reduction in the amount of waste, reuse and recycling of waste will be worked out regarding Metal chips, waste plastic, wood shavings, waste glass and waste oil. Measures taken include adequate classification of waste and adequate disposal at the disposal site for each type of waste.

To reduce the amount of solid waste discarded by the workers during the construction work, efforts will be made to employ the local workers wherever possible, so that the amount of household solid waste will be minimized.

The aforementioned measures will be taken to ensure that water pollution or sanitary problems resulting from waste do not arise.

4) Noise and vibration

IMPACTS:

With the progress of construction work, noise will be generated from the construction machinery and transportation vehicles.

Noise problem of the existing power plant has been taken up by the inhabitants of the surrounding area. Sufficient consideration must be given to minimizing noise impact.

The following major works will be carried out during the construction of the proposed Combined Cycle Power Plant:

- Installation of Heat Recovery Steam Generator (HRSG)
- Installation of Steam Turbine and Generator
- Installation of Power Transformer
- Installation of Cooling Tower
- Unloading of heavy equipment.

MITIGATION MEASURES:

In the actual construction work, the scheduled management will be performed to ensure leveling of the sound level of construction work wherever possible, and the state-of-the-art low-noise equipment will be introduced. Thus, efforts will be made to minimize the noise impact.

Material and equipment transportation vehicles will be placed under the scheduled management to ensure that the sound level of the construction work will be leveled. Measures for reducing generation of noise such as requirements for installation of mufflers and speed reduction in the residential area will be taken wherever possible, whereby vehicle noise impact will be minimized.

5) *Odor*

IMPACTS:

The amount of household solid waste will increase due to inflow of a great number of workers. If such waste is inadequately handled, odor may be produced by putrefaction.

MITIGATION MEASURES:

Before starting the construction work, the workers will be instructed to classify and collect garbage. Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction. These measures will be taken to minimize generation of odor.

7.2.1.2 **Natural environment**

1) *Underground water*

IMPACTS:

The surrounding wells may be affected by reduction of underground water level resulting from underground water intake during the construction work.

MITIGATION MEASURES:

For construction work, the maximum amount of the water taken is estimated at **1,000 m³** per day. This amount is very small, and is about 1/5th of the amount of water taken for residential and office uses.

It is estimated that groundwater can be taken without any substantial decrease of the water level even in the period of high water intake during summer.

For this reason, it is presumed that no significant decline of groundwater level at surrounding wells will occur due to water intake used for construction. Monitoring of groundwater levels of the wells for residential and office use will be conducted for confirmation.

2) Ground subsidence

IMPACTS:

If there is a considerable reduction of underground water level resulting from underground water intake during the construction work, ground subsidence may occur.

MITIGATION MEASURES:

As described above, there will be no substantial reduction in the underground water level of the surrounding wells as a result of underground water intake during the construction work. This indicates that there will be no ground subsidence as a result of underground water intake.

3) Soil erosion

IMPACTS:

With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall.

The unloading yard will be built on the side of the river, and earth and sand may flow out at the time of rainfall.

MITIGATION MEASURES:

Measures will be taken to avoid outflow of the earth and sand where a fence will be installed against subsidence of earth and sand.

As a mitigation measure, the actual civil construction will be implemented during dry seasons.

4) Terrestrial ecosystem

IMPACTS:

With the progress of excavation work, the habitat of the plants and animals may disappear.

The proposed Power Plant site and its surrounding areas have already been converted into industrial and the area opposite the river into agricultural land and are used for artificial purposes. There is no natural forest in these areas.

MITIGATION MEASURES:

The plants are restricted to fruit trees and ornamental plants.

5) River ecosystem

IMPACTS:

With the progress of construction work, river water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.

Contamination will occur due to civil construction work. This may have an adverse effect on many forms of life in the river.

MITIGATION MEASURES:

The measures indicated in the description of "Water pollution" will be taken against the river water pollution resulting from drainage during the construction work and installation of equipment, whereby the impact on the river plants and animals will be minimized.

6) Precious species

IMPACTS:

With the progress of excavation work, the habitat of the plants and animals will not be affected. However, the life of the precious species, if any, may be endangered.

Around the Power Plant site, there are **four** species falling under the category of the light concern species (LC) of the IUCN red list. They are a **jungle cat, fox, pigeon and kite**. They are all characterized by a high degree of mobility. The concerned area is not their major living place for building nests, for example. Accordingly, they will not be much affected by the construction work.

With construction work, water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.

MITIGATION MEASURES:

The Bhairab River is inhabited by fishes as precious species of this district. The impact of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

7.2.1.3 Social environment

1) Employment and livelihood, land utilization, burden on vulnerable groups, uneven distribution of benefit and loss

IMPACTS:

The construction work requires a great number of workers. There are a high percentage of day workers around the site. They want to be hired on a steady basis as regular employees.

When the Bhairab River will be used to transport heavy items, activities relating to fishery may be interfered.

MITIGATION MEASURES:

Before starting the construction work, priority will be given to employment of the local residents.

It is assumed that the inhabitants around the site have deficiency in technical level required for the construction work. Measures are required to be taken so that prospective indigenous workers can acquire relevant skills for construction through preliminary education and training program in cooperation with local municipalities from an early stage of construction, so that local people are given priority for employment opportunity.

In addition, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure. The aforementioned priority employment policy will be implemented to ensure that their livelihood will not be affected by the reduced income, if any.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishery activities.

Further, the scope and processes of the construction work will be explained so that relocation of the work site can be achieved quickly.

2) Local economy

IMPACTS:

The potential increase in income of inhabitants and local companies owing to this project may be contributed to local economic revitalization.

MITIGATION MEASURES:

As described with reference to "Employment and livelihood", before starting the construction work, priority will be given to employment of the local residents.

Cleaning and catering services as well as local materials supply will be provided by the local companies.

In addition, the mitigation measures shall be taken so that income levels of local people and fishermen will not be declined.

Moreover, it is important to cooperate for the fostering of new local industries through consultation with local municipality.

3) *Infrastructure and service facilities*

IMPACTS:

Local workers will be hired wherever possible; as such, construction of new infrastructure facilities will not be necessary.

An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community.

MITIGATION MEASURES:

Regarding material installation and staff mobilization vehicles due to the construction work, measures will be taken as is shown in '6) Land traffic' described below.

Efforts will be made to ensure that the existing medical facilities for the workers can be improved and expanded and also can be used by construction workers as well.

5) *River traffic*

IMPACTS:

The Bhairab River will be used to transport heavy items. River traffic may be affected.

MITIGATION MEASURES:

For the transportation of large-sized heavy equipment by ship, an adequate and safe traffic schedule will be worked out through consultation with Bangladesh Inland Water Transport Authority (BIWTA) as an organization having jurisdiction over river traffic.

6) Land traffic

IMPACTS:

Priority will be given to employment of the local residents. There will not be much number of vehicles for workers from the outside. But some increase in the number of vehicles for construction work may affect land traffic in the surrounding area.

MITIGATION MEASURES:

In order to ensure reduction of speed of vehicles used to transport the material and equipment required for the construction work, traffic signals and marks will be installed. To carry the workers, measures will be taken to use buses. Education on safe-driving practices in the school-commuting roads and residential areas will be conducted.

7) Sanitation

IMPACTS:

Priority will be given to employment of the local residents. The local inhabitants use underground seepage type toilet facilities, and this may be unsanitary.

MITIGATION MEASURES:

During the construction work, workers will be engaged in the work within the project site and lack of hygiene may be further aggravated.

The mitigation measures include the installation of the septic tank treatment system and an education and training course on sanitation management.

8) Risk of infectious disease

IMPACTS:

Workers and engineers coming from the outside area may carry infectious disease, which may spread among other workers.

MITIGATION MEASURES:

The following measures will be taken against infectious diseases:

- Installation of medical facilities and periodic medical checkup

- Education and training for sanitation management of the workers
- Protection of construction workers against HIV/AIDS, dengue fever, malaria and hepatitis A,

9) Utilization and Right of water (including groundwater)

IMPACTS:

There is a possibility to have a negative effect to fishery activities in the river due to water pollution caused by inappropriate waste water disposal generated by construction activities.

Furthermore, turbidity generated by the construction also may cause an adverse effect to the fishery activities in the river.

Regarding the effect of water use at surrounding wells due to groundwater level decrease, although it is presumed that no significant decline of the water level will occur, as is shown in '1) Underground water of b) Natural environment'.

MITIGATION MEASURES:

These possible causes of water pollution (waste water disposal and the civil construction) will be reduced through the mitigation measures indicated in the section of 'Water Pollution'.

Monitoring of the water levels at residential wells will be conducted for confirmation.

10) Landscape

IMPACTS:

Fences will be installed around the site on a temporary basis during the period of construction work.

The construction work period is limited, and impact on landscape will be small.

MITIGATION MEASURES:

Not required.

11) Accident

IMPACTS:

Inadequate construction work may cause accidents. The percentage of traffic accident may rise by an increase in the number of vehicles movement.

MITIGATION MEASURES:

During the construction work, a safety management program setup regulation will be worked out, and various forms of safety measures will be implemented based on this regulation. To ensure traffic safety, various forms of measures will be taken, as exemplified by inspection of traffic rules, installation of traffic signs and markings, education on safe driving, reduction of the vehicle speed in the school-commuting roads and residential areas, and avoidance of driving during the school commuting time zone.

7.2.2 Operation period

7.2.2.1 Environmental pollution

1) Air pollution

IMPACTS:

Natural gas will be used as the fuel for operation. Initially High Sppeed Diesel (HSD) will be used in the peaking power plant until natural gas is available. When the peaking plant will be converted into combined cycle power plant, natural gas will be used as main fuel and HSD as alternative fuel. However, the exhaust gas due to combustion of gas/HSD from a gas turbine passing through HRSG during the operation may lead to air pollution by SO_x or NO_x.

The amount of exhaust gas from a power plant into the atmosphere is greater than in other industries.

During the operation, there is estimated to be impact on air quality by exhaust from the gas turbine. Initially, HSD will be used as main fuel. The alternative fuel is natural gas if supplied by Petrobangla. DoE standard of ambient air quality is given in the following table.

DoE Standard of Ambient Air Quality

Air Pollutant	Standard	Averaging Time
1	2	3
Carbon Mono-oxide	10mg/cu- m(9ppm) ^(Ka)	8 hours
	40mg/cu-m(35ppm) ^(Ka)	1 hour
Lead	0.5µg/cu-m	annual
Nitrogen Oxide	100µg/cu-m (0.053ppm)	Annual
Suspended Particulate Matter (SPM)	200µg/cu-m	8 hours
Particulate Matter 10 (PM ₁₀)	50µg/cu-m ^(Kha)	Annual
	150µg/cu-m ^(Ga)	24 hours
Particulate Matter 2.5 (PM _{2.5})	15µg/cu-m	Annual
	65µg/cu-m	24 hours
Ozone	235µg/cu-m(0.12ppm) ^(Gha)	1 hour
	157µg/cu-m(0.08ppm)	8 hours
Sulfur Dioxide	80µg/cu-m(0.03ppm)	Annual
	365µg/cu-m(0.14ppm) ^(Ka)	24 hours

Abbreviation:

ppm: Parts Per Million

Notes: * In this schedule Air Quality Standards means Ambient Air Quality Standards

(Ka) Not to be exceeded more that once per year

(Kha) Annual Average value will be less than or equal to 50 microgram/cubic meter

(Ga) Average value of 24 hours will be less or equal to 150 microgram/cubic meter for one day each year.

(Gha) Maximum average value for every one hour each year will be equal or less than 0.12 ppm.

The current air quality is below the limit of the environmental standards of Bangladesh. Appropriate measures must be taken to ensure that the standards will be met in future as well.

MITIGATION MEASURES:

Environment conciliatory measure as a prerequisite for estimation

- Fuels used

The Khulna Peaking Power Plant (hereinafter referred to as "Khulna PPP) adopts the method of using natural gas for combustion of the gas turbine. Basically, this method reduces the load on the environment as follows

- Sulfur content may cause air pollution if HSD fuel is used. But Sulfur content in the natural gas is very negligible. So, special attention must be given to reduce sulfur content if HSD fuel is used. From NREL study, the SO₂ emission rate for combined cycle power plant is **324kg/GWh**. Using this base data, for 225MW CCPP, the SO₂ emission rate will be **73kg/hr**. Using stack height formula, $H=14Q^{0.3}$ (where, H= Stack height in m and Q = SO₂ emission rate in kg/hr), the approximate height of the stack is about **51m**.
- Basically, complete combustion of the fuel occurs in the gas turbine. Almost no CO or SPM is produced.
- A low-NOx burner/ water injection is used to minimize generation of the nitrogen oxides.

The exhaust NOx concentration will be kept below 40 ppm and below the emission standard. This value is sufficiently below the guideline of the World Bank.

Table 7.2.2.1 NOx emission concentration

Item	New installation (natural gas)	Emission standard of Bangladesh	IFC/World Bank guideline (PPAH)
NOx emission concentration	< 40 ppm	40 ppm	165 mg/m ³ (80 ppm)

In order to mitigate the air pollution, based on the above calculation of stack height, it is suggested to install a high smokestack having a height of about **60 meters**. to minimize the impact of the major building within the aforementioned site.. Further, to minimize the chance of the building affecting diffusion, arrangement is so configured that high buildings will not be located to the leeward in the north and south as the main wind direction.

2) **Water pollution**

IMPACTS:

River water will be used in the cooling system and therefore, thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, river water and underground water will be contaminated.

To dispose of the waste water produced by operation of the power plant, waste water treatment facilities capable of precipitation by condensation, neutralization and oil separation and household waste water treatment facilities will be installed. Further, leakage of light oil as a preliminary fuel can be assumed.

MITIGATION MEASURES:

To dispose of the waste water produced by operation of the power plant, waste water treatment facilities capable of precipitation by condensation, neutralization and oil separation and sanitary waste water treatment facilities will be installed. When the aforementioned measures are taken, the waste water level will not exceed the waste water reference level of Bangladesh.

The bottom surface of the tank in the existing power plant is lined with concrete. The newly installed tank is provided with measures to protect underground water against contamination by oil. Furthermore, a concrete wall of about 4m has been constructed around the fuel tank to protect the surrounding from spillage of fuel if any. If any leakage takes place in the fuel tank, oil will be accumulated within concrete wall. This spilled oil may be contaminated. So, the spilled oil will be drained to the oil water separator tank and purified before sending to the main fuel tank.

In order to minimize the effect of discharge of hot water in the river, water will be carried away as far as possible from the source, either through canal or pipe line and water will be discharged over a wide concrete surface near the river bank. These combined actions will cool the hot discharge water. However, the temperature of discharge waste water should not exceed 3°C compared to the temperature of intake water.

3) Solid Waste & Sludge Management:

IMPACTS:

The industrial waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the household solid waste such as cans, bottles and food remnants discarded by employees is also generated.

If such waste is inadequately handled, river water and underground water will be contaminated, and sanitation problems will arise.

MITIGATION MEASURES:

For the waste produced in the process of operation of the power plant, the waste management program including the reduction, reuse and

recycling of the waste will be worked out. To put it more specifically, the measures to be taken includes systematic solid waste collection at the worksite, prohibition of dumping contaminated substances, appropriate classification, and disposal at the disposal site determined for each class of waste.

The sludge will be generated very negligible because of usage of HSD as fuel. However, the sludge will be accumulated in oil water separator tank for separating oil from the sludge and the sludge will be sold out.

4) Noise and vibration

IMPACTS:

The noise generation source during the operation includes workers' commutation, traffic of vehicles for carrying the periodic inspection materials and operation of the power generation facilities.

Noise problem has been taken up by the inhabitants of the surrounding area. Noise of the power generation facilities is produced even during the nighttime, so sufficient consideration must be given to the impact of noise and vibration.

MITIGATION MEASURES:

In the field of more detailed designing for future, efforts must be made to achieve the estimated noise level resulting from the operation of the power generation facility, for example, by introduction of the state-of-the-art low-noise equipment.

5) Odor

IMPACTS:

Facilities or equipment that produce odor are not included in the power generation facilities.

The household solid waste of the employees will be produced. If such waste is inadequately handled, odor may be produced by putrefaction.

MITIGATION MEASURES:

Garbage will be subjected to separate collection, and garbage will be disposed of on a periodic basis to make sure that odor by putrefaction will not be produced.

7.2.2.2 Natural environment

1) Underground water

IMPACTS:

Since no additional underground water will be lifted, there will be no additional impact.

MITIGATION MEASURES:

Since no additional impact is expected, no mitigation measure is necessary.

2) Ground subsidence

IMPACTS:

If there is a considerable reduction of underground water level resulting from underground water intake, ground subsidence may occur.

MITIGATION MEASURES:

It is estimated that there will be no substantial reduction in the underground water level in the surrounding area by the underground water intake.

3) Terrestrial ecosystem

IMPACTS:

The proposed project site and its surrounding areas have already been converted into industrial cum agricultural land and are used for artificial purposes. There is no natural forest in these areas. The plants are restricted to fruit trees and ornamental plants.

The area to be used in the power plant is comparatively small and will have little impact on plants and animals.

MITIGATION MEASURES:

The buffer zone will be planted with fruit trees.

4) River ecosystem

IMPACTS:

Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.

MITIGATION MEASURES:

As discussed with reference to "Water pollution", measures will be taken to prevent water pollution in the river so that the impact on the plants and animals living in the river will be minimized.

5) Precious species

IMPACTS:

For the precious land species having been verified around the proposed project site, the industrial and agricultural area is not their major living place for building nests. Accordingly, impact on these species will be very small.

Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.

MITIGATION MEASURES:

The buffer zone will be planted with trees.

The Bhairab River is inhabited by fishes as precious species of this district. The impact of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

7.2.2.3 Social Environment

1) Employment and livelihood, Land utilization, Burden on vulnerable groups, Uneven distribution of benefit and loss

IMPACTS:

There are a high percentage of day workers around the site. They want to be hired not only during the period of construction work but also during the operation of the power plant.

When large-sized heavy equipment will be transported for maintenance and management by ship, activities of fishery may be interfered.

MITIGATION MEASURES:

It is assumed that the inhabitants around the site are very deficient in high technical level applied to the operation work.

Measures are taken that local people are prioritized at employment opportunity in simple work like cleaning.

In addition to this, prospective indigenous workers can acquire relevant high skills for operation through preliminary education and training program in cooperation with local municipalities from an early stage, so that hiring of as many people as possible is conducted within local area.

Moreover, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure.

After the gas pipeline has been laid, the site will be backfilled, and the transmission line except for stubs will be put back to the current state. There will be no impact on the livelihood of the farmers.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishery activities.

2) Local Economy

IMPACTS:

The potential increase in income of inhabitants and local companies owing to this project may be contributed to local economic revitalization.

MITIGATION MEASURES:

As described with reference to "Employment and livelihood", even in the operational phase, local inhabitants will be prioritized at employment as many as possible.

Cleaning and catering services as well as supply of materials will be provided by the local companies.

In addition, compensation for land acquisition (for gas and transmission lines) will be conducted complying with relevant national laws, in parallel with the mitigation measures so that income levels of local farmers, fishermen will not be declined.

Moreover, it is important to cooperate for the fostering of new local industries through consultation with local municipality.

3) Infrastructure and Service Facilities

IMPACTS:

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

The local inhabitants desire new and increased medical facilities to be built so that the current medical care system will be improved.

MITIGATION MEASURES:

Regarding commuting vehicles, measures will be taken as is shown in '6) Land traffic' described below.

The existing medical facilities will be expanded and improved, so that the construction workers can also be benefited.

5) River traffic

IMPACTS:

Large-sized heavy equipment will be transported for construction as well as maintenance by ship. Transportation will be carried out in the rainy season when a sufficient water depth is ensured.

MITIGATION MEASURES:

In the rainy season, the river width will increase and there will be little impact on the river traffic of the local inhabitants.

6) Land traffic

IMPACTS:

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

MITIGATION MEASURES:

Measures such as use of buses, inspection of the traffic rules, introduction of the traffic signs and markings and education on safe driving will be taken to alleviate the impact.

7) Sanitation

IMPACTS:

About **150 employees** will be engaged in the operation of the power plant. There may be a shortage of sanitary facilities such as toilet facilities.

MITIGATION MEASURES:

These measures include the installation of the septic tank treatment system conforming to the number of employees and an education and training course on sanitation management.

8) Risk of Infectious Disease

IMPACTS:

Workers coming from the outside area may carry infectious diseases.

These workers coming from the outside area will receive health checkup before being employed.

MITIGATION MEASURES:

Further, the following measures will be taken:

- Installation of medical facilities and periodic health checkup
- Education and training of workers on sanitation management.

9) Utilization and Right of water (including groundwater)

IMPACTS:

Since no additional underground water is planned to be used, surrounding wells may not be adversely affected.

As discussed with reference to "Underground water", water for domestic and office use can be supplied sufficiently without the underground water level being substantially reduced.

MITIGATION MEASURES:

No additional mitigation measure is envisaged.

10) Landscape

IMPACTS:

The building of the power plant is higher than the surrounding structures, and this may affect the landscape.

The power generation facility contains a smokestack having a height of 45 meters, a turbine building having a height of 22 meters.

MITIGATION MEASURES:

The area of the proposed project site is limited and there will be little impact on landscape.

11) Accident

IMPACTS:

Possible accidents may include leakage of light oil as a standby fuel or breakage of the gas pipeline in terms of equipment. Further, various forms of operation or maneuvering errors may occur during the operation.

MITIGATION MEASURES:

The following measures are taken against possible accidents:

- Creating and implementing a sanitation and safety education program
- Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities
- Working out a management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program
- Installation of fire prevention equipment and facilities at proper positions inside the power plant.
- Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning facilities and emergency exit.
- Working out safety regulations.

12) Global warming

IMPACTS:

CO₂ as a warming substance will be discharged from the power plant.

MITIGATION MEASURES:

The present project uses a power generation system characterized by high efficiency and a reduced amount of CO₂ produced per unit of electricity produced.

Chapter 8: ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND MONITORING PLAN

8.1 Scope of EMP

The main objective of the Environmental Management Plan (EMP) and Environmental Monitoring Plan is to ensure implementation of the mitigation measures planned to reduce the environmental impact by the implementation of the power plant project, and to verify and record the environmental impact.

The EMP and Monitoring Plan are worked out based on the following:

- To reduce the environmental impact to the permissible level by the mitigation measures during the period of construction and operation, so that a hazardous impact will not occur.
- To configure a responsible organization for the implementation of the mitigation measures.
- To implement the EMP and Monitoring Plan adequately during the period of construction and operation.

The permissible level mentioned above is determined based on the national standard of Bangladesh listed below

(1) Air Quality

a) Ambient Environment

Table 8.1.1 shows the atmospheric environmental standard. In Bangladesh, although strategic area including industrial area and school and hospital are designated, the classification of other lands, either “commercial” or “residential”, is determined by DoE in charge according to the situation.

The project site is classified as “industrial area” by Khulna DOE.

Table 8.1.1 : Ambient Air Quality Standard

Air Pollutant	Standard	Averaging Time
1	2	3
Carbon Mono-oxide	10mg/cu- m(9ppm) ^(Ka)	8 hours
	40mg/cu-m(35ppm) ^(Ka)	1 hour
Lead	0.5µg/cu-m	annual
Nitrogen Oxide	100µg/cu-m (0.053ppm)	Annual
Suspended Particulate Matter (SPM)	200µg/cu-m	8 hours
Particulate Matter 10 (PM ₁₀)	50µg/cu-m ^(Kha)	Annual
	150µg/cu-m ^(Ga)	24 hours
Particulate Matter 2.5 (PM _{2.5})	15µg/cu-m	Annual
	65µg/cu-m	24 hours
Ozone	235µg/cu-m(0.12ppm) ^(Gha)	1 hour
	157µg/cu-m(0.08ppm)	8 hours
Sulfur Dioxide	80µg/cu-m(0.03ppm)	Annual
	365µg/cu-m(0.14ppm) ^(Ka)	24 hours

Abbreviation:

ppm: Parts Per Million

Notes: * In this schedule Air Quality Standards means Ambient Air Quality Standards

(Ka) Not to be exceeded more that once per year

(Kha) Annual Average value will be less than or equal to 50 microgram/cubic meter

(Ga) Average value of 24 hours will be less or equal to 150 microgram/cubic meter for one day each year.

(Gha) Maximum average value for every one hour each year will be equal or less than 0.12 ppm.

b) Gas emissions

The emission standard regarding the operation of the power plant is shown in **Table 8.1.2**. During operation of Khulna 225MW combined cycle power plant, natural gas will be used as fuel in the power plant. So, negligible amount of SOx and particulate matter will emit. NOx is the only concern. The emission standard of NOx for Khulna CCPP is **40ppm**.

Diesel oil will be used in case gas is not available, and the regulation value for dust emission is 150 mg/Nm³. Regarding SOx, regulation for emission amount applies as well as concentration.

Table 8.1.2 : Gas Emission Standard for Industrial Facilities

No.	Parameter	Unit	Standard Limit
1.	Particulates		
	a) Electric Power Station of 200 Megawatts and above	mg/Nm ³	150
	b) Electric Power Station less than 200 Megawatts	mg/Nm ³	350
2.	Chlorine	mg/Nm ³	150
3.	Hydrochloric Acid gas & mist	mg/Nm ³	350
4.	Total Fluoride (F)	mg/Nm ³	25
5.	Sulfuric Acid mist	mg/Nm ³	50
6.	Lead particle	mg/Nm ³	10
7.	Mercury particle	mg/Nm ³	0.2
8.	Sulfur Dioxide		
	a) Sulfuric Acid manufacture (DCDA process)	kg/ton	4
	b) Sulfuric Acid manufacture (SCSA process)	kg/ton	10
	Minimum Stack height for Sulfuric Acid emission		
	Lowest height of stack for dispersion of sulfuric acid	m	
	a) Coal Fired Electric Power Station		
	i) 500 Megawatts & above	m	275
	ii) 200-500 Megawatts	m	220
	iii) Below 200 Megawatts	m	14 (Q) ^{0.3}
	b) Boiler	m	
i) For Steam up to 15 tons/hour	m	11	
For steam above 15 tons/hour	m	14 (Q) ^{0.3}	
9.	Nitrogen Oxides		
	a) Nitric Acid manufacture	kg/ton	3
	b) Gas Fired Electric Power Station		
	i) 500 Megawatts & above	ppm	50
	ii) 200-500 Megawatts	ppm	40
	iii) Less than 200 Megawatts	ppm	30
c) Metal Treatment Furnace	ppm	200	
10.	Soot & Dust Particles		
	a) Air Ventilated Furnace	mg/Nm ³	500
	b) Brick-field		1000
	c) Cooking Furnace		500
	d) Limestone Furnace		250

Note: Q=SO₂ emission in kg/hour

2) Water quality

a) Ambient Water Quality

The classification of water area is determined by the DoE in charge, as in the case of air quality. Bhairab River flowing near the project site is classified as “water used for pisciculture” by Khulna DOE. For other parameters, the water quality standard for drinking water applies.

Table 8.1.3 : Ambient Water Quality Standard (Inland Surface Water)

Sl. No.	Best Practice based classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable Water Source supply after bacteria freeing only	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation purpose	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable Water Source Supply after conventional processing	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisciculture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

Note :1) Maximum amount of ammonia presence in water are 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.

2) For water used in irrigation, Electrical Conductivity-2250 micro mho/cm (at 25°C). Sodium less than 26 mg/l* Boron less than 2 mg/l*

Table 8.1.4 : Environmental Water Quality Standard (Drinking Water)

Sl. No.	Parameter	Unit	Standard limit
1.	Aluminum	mg/l	0.2
2.	Ammonia (NH ₃)	"	0.5
3.	Arsenic	"	0.05
4.	Barium	"	0.01
5.	Benzene	"	0.01
6.	BOD : 5 20°C	"	0.2
7.	Boron	"	1.0
8.	Cadmium	"	0.005
9.	Calcium	"	75
10	Chloride	"	150-600 **
11	Chlorinated Alkanes	"	
	Carbon tetrachloride		0.01
	1.1 Dichloroethylene	"	0.001
	1.2 Dichloroethylene	"	0.03
	Tetrachloroethylene	"	0.03
	Trichloroethylene	"	0.09

Sl. No.	Parameter	Unit	Standard limit
12.	Chlorinated phenols	"	
	Pentachlorophenol		0.03
	2,4,6 Trichlorophenol	"	0.03
13.	Chlorine (residual)	"	0.2
14.	Chloroform	"	0.09
15.	Chromium (hexavalent)	"	
16.	Chromium (total)	"	
17.	COD	"	
18.	Coliform (fecal)	n/100 ml	0
19.	Coliform (total)	"	0
20.	Color	Huyghens	15
21.	Copper	mg/l	1
22.	Cyanide	"	0.1
23.	Detergents	"	0.2
24.	DO	"	6
25.	Fluoride	"	1
26.	Alkalinity (as CaCo ₃)	"	200-500
27.	Iron	"	0.3
28.	Nitrogen (Total)	"	1
29.	Lead	"	0.05
30.	Magnesium	"	30-35
31.	Manganese	"	0.1
32.	Mercury	"	0.001
33.	Nickel	"	0.1
34.	Nitrate	"	10
35.	Nitrite	"	Less than 1
36.	Odor	"	Odorless
37.	Oil & Grease	"	0.01
38.	pH	"	6.5-8.5
39.	Phenolic compounds	"	0.002
40.	Phosphate	"	6
41.	Phosphorus	"	0
42.	Potassium	"	12
43.	Radioactive Materials	Bq/l	0.01
44.	Radioactive Materials	"	0.1
45.	Selenium	mg/l	0.01
46.	Silver	"	0.02
47.	Sodium	"	200
48.	Suspended solid	mg/l	10

Sl. No.	Parameter	Unit	Standard limit
49.	Sulfide	"	0
50.	Sulfate	"	400
51.	Total soluble matter	"	1000
52.	Temperature	0C	20-30
53.	Tin	mg/l	2
54.	Turbidity	J.T.U	10
55.	Zinc	mg/l	5

Note : ** In coastal Aera 1000

b) Waste water

Table 8.1.5 shows waste water discharge standard. As waste water treated within the power plant is discharged into the Bhairab River, the standard value for "Inland Surface Water" applies.

Table 8.1.5 : Water Discharge Standard.

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
1.	Ammoniacal Nitrogen	mg/l	50	75	75
2.	Ammonia (free ammonia)	mg/l	5	5	15
3.	Arsenic (As)	mg/l	0.2	0.05	0.2
4.	BOD5 200C	mg/l	50	250	100
5.	Boron	mg/l	2	2	2
6.	Cadmium (Cd)	mg/l	0.05	0.5	0.5
7.	Chloride	mg/l	600	600	600
8.	Chromium (total Cr)	mg/l	0.5	1.0	1.0
9.	COD	mg/l	200	400	400
10.	Chromium (hexavalent Cr)	mg/l	0.1	1.0	1.0
11.	Copper (Cu)	mg/l	0.5	3.0	3.0
12.	Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13.	Electrical Conductivity	micro	1200	1200	1200
14.	Total Dissolved Solids (TDS)	mg/l	2,100	2,100	2,100
15.	Fluoride (F)	mg/l	7	15	10
16.	Sulfide (S)	mg/l	1	2	2
17.	Iron (Fe)	mg/l	2	2	2
18.	Total Kjeldahl Nitrogen (N)	mg/l	100	100	100
19.	Lead (Pb)	mg/l	0.1	1.0	0.1
20.	Manganese (Mn)	mg/l	5	5	5

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
21.	Mercury (Hg)	mg/l	0.01	0.01	0.01
22.	Nickel (Ni)	mg/l	1.0	2.0	1.0
23.	Nitrate (N molecule)	mg/l	10.00	Undetermined	10.0
24.	Oil & grease	mg/l	10	20	10
25.	Phenol	mg/l	1.0	5	1
26.	Dissolved Phosphorus (P)	mg/l	8	8	10
27.	Radioactive Materials.	As			
28.	pH		6-9	6-9	
29.	Selenium	mg/l	0.05	0.05	0.05
30.	Zn (Zn)	mg/l	5.0	10.0	10.0
31.	Total Dissolved solid	mg/l	2,100	2,100	2,100
32.	Temperature	Centigrade			
	Summer		40	40	40
	Winter		45	45	45
33.	Total Suspended Solid	mg/l	150	500	200
34.	Cyanide (CN)	mg/l	0.1	2.0	0.2

- Note : 1) These standards shall be applicable to industrial units or projects other than those given under Quality Standards for Classified Industries (Schedule 12).
- 2) These quality standards must be ensured at the moment of going into trial production for industrial units and at the moment of going into operation for other projects.
- 3) The value must not exceed the quality standard during spot check at any time ; if required, the quality standards may be more strict to meet the environment terms in certain areas.
- 4) Inland Surface Water shall mean drain, pond, tank, water body or water hole, canal, river, spring and estuary.
- 5) Public sewer shall mean sewer connected with fully combined processing plant including primary and secondary treatment.
- 6) Irrigated land shall mean appropriately irrigated plantation area of specified crops based on quantity and quality of waste water.
- 7) Inland Surface Quality Standards (Schedule 13) shall be applicable for any discharge taking place in public sewer or land not defined in Notes 5

3) Noise level

The applicable category of zone and noise standard for noise level are determined by the DoE in charge. The Khulna DOE determined the noise standard in the surrounding area of the power plant as follows: in the industrial area 75dBA in daytime and 70dBA in nighttime; in the residential area, 55dBA in daytime and 45 dBA in nighttime (**Table 8.1.6**).

Table 8.1.6 : Noise Standard

Sl. No.	Zone Class	Limits in dBA	
		Day	Night
a)	Silent Zone	50	40
b)	Residential Zone	55	45
c)	Mixed Zone (this area is used combinedly as residential, commercial and industrial purposes)	60	50
d)	Commercial Zone	70	60
e)	Industrial Zone	75	70

Note: 1) The day time is considered from 6 a.m. to 9 p.m. The night time is considered from 9 p.m. to 6 a.m

2) From 9 at night to 6 morning is considered night time.

3) Area within 100 meters of hospital or education institution or educational institution or government designated / to be designated / specific institution / establishment are considered Silent Zones. Use of motor vehicle horn or other signals and loudspeaker are forbidden in Silent Zone.

8.2 Work Plans and Schedules

8.2.1 Construction Phase

Before starting the construction work, the Project Director (PD) of NWPGCL is required to give sufficient consideration to the details of the construction work, and to make sure that the required EMP and Monitoring Plans are thoroughly understood by the contractor.

Thus, the Project Director (PD) of NWPGCL is required to form the required organization.

Especially, there is an active inflow of the workers and many construction-related vehicles during the construction. The details of the construction work, schedule and mitigation measures should be sufficiently explained to the communities in the surrounding area. The countermeasures should be altered as appropriate, based on the correct understanding of the views of the residents.

The following are the major environmental impacts during the construction work.

- Inflow of workers and an increase in the number of construction-related vehicles
- Generation of construction wastes
- Generation of dust particles, and gas emission from vehicles and machinery
- Generation of noise from vehicles and machinery
- Occurrence of muddy water in the excavation area

Employing workers from local areas during the construction phase will have a favorable impact on the local economy. Sufficient consideration must be given to the local employment, including implementation of the preliminary education and training program of the workers.

Table 8.2.1 gives the basic information of the EMP during the construction phase, and **Chapter 8.4** describes the Environmental Monitoring Plan.

The EMP and monitoring plan should be worked out by sufficient discussions between the NWPGCL and the contractor. To confirm the implemented plan and to study further measures, a report schedule should be worked out in such a way that the contractor will report the current situation of implementation in the form of a written statement. This report should be submitted to the Khulna DoE for further discussion.

Table 8.2.1 : Major Environmental Impacts and Mitigation Measures During the Construction Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Inflow of workers	<ul style="list-style-type: none"> ▪ Generation of sewage and refuse ▪ Outbreak of diseases ▪ Safety, accident prevention, land traffic ▪ Employment, income, livelihood, vulnerable groups, uneven distribution of benefit ▪ infrastructure 	<ul style="list-style-type: none"> ▪ Installation of sewage treatment facilities ▪ Can and bottle refuse is classified and are supplied to a third party for reuse ▪ Disposal at a predetermined disposal site. ▪ Installation of sewage treatment facilities ▪ Installation of medical facilities and implementation of periodic health checkups ▪ Education and training on health management of the workers ▪ Prevention of epidemics among workers (HIV/AID, dengue fever, malaria, hepatitis A) ▪ Elimination of potential breeding site for harmful insects, provision of preventive medicine as necessary ▪ Use of Bus for worker ▪ Avoidance of the time when students travel between school and home ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon) ▪ Priority of employment for local residents, development of employment standard ▪ Utilization of local service (cleaning, catering, materials) ▪ Implementation of the preliminary education and training programs with local authority ▪ Installation of medical facilities 	Contractor (NWPGL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Installation of construction equipment	<ul style="list-style-type: none"> ▪ Safety, accident prevention, land traffic ▪ Noise ▪ Gas emission, flying sand and dust particles from vehicles ▪ River traffic 	<ul style="list-style-type: none"> ▪ Avoidance of the school commuting time ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon) ▪ No traffic at night ▪ Periodic inspection and maintenance management ▪ Periodic check of the concentration of vehicle emissions based on laws and regulations ▪ Stop the engine when idling ▪ Use of a cover to protect against dust, and periodic washing of vehicles ▪ Periodic cleaning of the surrounding roads ▪ Monitoring of resident areas ▪ BIWTA will be consulted to determine appropriate safety and/or scheduling standards to be followed. 	Contractor (NWPGL)
Excavating work and operation of construction equipment	<ul style="list-style-type: none"> ▪ Emission gas from machinery/sand and dust dispersion ▪ Noise 	<ul style="list-style-type: none"> ▪ Periodic watering of sediment disposition site and such ▪ Monitoring in residential area ▪ Operation in daytime only in principle ▪ Use of low-noise machinery (silencer, muffler) ▪ Construction of temporary fence around Project site ▪ Restriction of worker's prolonged exposure to noise ▪ Use of Personal Protective Equipment (PPE) 	Contractor (NWPGL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	<ul style="list-style-type: none"> ▪ Construction debris ▪ Soil runoff, turbid water, waste water from equipment cleaning ▪ Leakage of harmful substances ▪ Loss of habitat of flora and fauna ▪ Income, livelihood, vulnerable group 	<ul style="list-style-type: none"> ▪ Waste management program consisting of reduction, reuse, and recycling of materials. ▪ Prohibition on dumping of any contaminating material ▪ Appropriate segregation of waste and disposal into designated disposal site ▪ Installation of temporary settling tanks and sediment fencing ▪ Water used for equipment cleaning is collected in the temporary tank and treated before discharge ▪ Monitoring at the water outlet ▪ Mitigation measures to prevent leakage, installation of cleaning facility ▪ Installation of green buffer ▪ The agricultural products growing on the site is compensated according to the Bangladesh regulation. ▪ Explanation of the construction extent and procedure in the early stage. ▪ Preferentially employ local people predicting decrease in income. 	Contractor (NWPGL)
	<ul style="list-style-type: none"> ▪ Safety, accident prevention, land traffic, infrastructure 	<ul style="list-style-type: none"> ▪ Develop a safety management plan and rules ▪ Swift transport to medical facility ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Installation of bypass for farm road and waterway within the site 	
Water intake	<ul style="list-style-type: none"> ▪ Lowering of groundwater level ▪ Ground subsidence 	<ul style="list-style-type: none"> ▪ Monitoring of underground water level in the surrounding wells ▪ Dig deeper wells as necessary ▪ Monitoring of underground water level in the surrounding wells 	Contractor (NWPGL)

8.2.2 Operation Phase

During the operation phase, the NWPGL is responsible to form a required organization for environmental management. This organization is responsible for receiving the complaints from the residents of the surrounding area during the operation phase and to take appropriate measures, so that the complaints of the residents will be correctly understood and necessary measures will be taken.

The basic idea is to establish a relationship with the local communities. It is important to sufficiently explain the environmental management procedures taken at the power plant. It is also important to invite the residents and school children to observe the power plant.

The following describes the major environmental impacts during the operation phase.

- Generation of gas emissions and waste water
- Generation of noise from operating machinery
- Generation of solid waste from operation

The operation workers are required to have specialized knowledge. It will be difficult to hire workers from the local area. However, employing local workers will have a favorable impact on the local economy. For the comparatively easy work, sufficient consideration must be given to local employment, including implementation of the preliminary education and training programs for workers.

Table 8.2.2 gives the basic information on the EMP during the operation phase, and Chapter 9.4 describes the environmental monitoring plan.

NWPGL should prepare a report on the implementation of the EMP and monitoring plan and should submit it to the Khulna DoE and related organizations for further discussion.

Table 8.2.2 : Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Power generation	<ul style="list-style-type: none"> ▪ Generation of gas emissions 	<ul style="list-style-type: none"> ▪ Adoption of a high stack ▪ Installation of a continuous monitoring system for gas emissions ▪ Adoption of pre-mixing method and a low-NOx combustor ▪ Monitoring of atmospheric air ▪ Periodic maintenance and management 	NWPGCL
	<ul style="list-style-type: none"> ▪ Generation of cooling and waste water 	<ul style="list-style-type: none"> ▪ Construction of open channel for a distance for cooling the hot water ▪ Installation of a wastewater treatment system capable of coagulation sedimentation, neutralization, and oil separation ▪ Monitoring of waste water ▪ Monitoring of the river or local water ▪ Blow-off water from cooling tower is cooled by dilution 	
	<ul style="list-style-type: none"> ▪ Generation of noise and vibration 	<ul style="list-style-type: none"> ▪ Planting trees around the power plant ▪ Adoption of low-noise type machinery and installation of soundproofing covers ▪ Installation of low-vibration type machinery and the use of rigid foundations ▪ Periodic maintenance and management ▪ Monitoring around the border of the site and residential area ▪ Distribution of ear protectors to employees 	
Water intake	<ul style="list-style-type: none"> ▪ Lowering of Groundwater level ▪ Ground subsidence 	<ul style="list-style-type: none"> ▪ Monitoring the underground water level in the surrounding wells ▪ Dig wells of appropriate deepness as necessary 	NWPGCL
Generation of waste	<ul style="list-style-type: none"> ▪ Generation of sludge from the 	<ul style="list-style-type: none"> ▪ Waste management program consisting of reduction, reuse, and recycling of materials. 	NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	wastewater treatment system ■ Generation of waste oil ■ Generation of domestic waste	■ Systematic collection and protected-storage on-site ■ Prohibition on dumping of any contaminating material ■ Waste away from the site and their appropriate disposal in a designated municipal dumping site.	
Presence of power plant, inflow of workers	■ Loss of habitat of flora and fauna ■ Employment, livelihood, vulnerable people, uneven distribution	■ Provision of vegetated buffer ■ Preferential employment of local people ■ Utilization of local service (cleaning, catering) and materials ■ Implementation of the preliminary education and training programs with local authority	NWP GCL
	■ Land traffic	■ Use of Bus for worker ■ Observation of traffic regulations, installation of traffic signs, and education on driving safety ■ Speed limit in residential- and school area	
	■ Social foundation ■ Diseases	■ Provision of emergency medical facility ■ Medical facility and periodical health checkup ■ Education and training on health management of the workers	
	■ Accident and safety management	■ Tank storage areas will be equipped with oil spill bank and countermeasure for underground oil seepage and designed as physical containment area. ■ Implement gas leakage prevention procedures and have available on-site all preventive equipment and materials as part of the process of developing emergency plan. ■ Fire protection equipment and facilities shall be made available at suitable locations in power plant including fixed fire protection system, fire hydrants, portable fire fighting equipment, fire vents, alarm system, fire compartments and fire exit signs. Preparation of safety standard.	

8.3 Environmental Implementation and Training

During operation phase, NWPGL is responsible for the system organization of environmental management of the power plant and its implementation. The environmental manager, who should be a senior environmental engineer, should take charge of the management of the system to ensure environmental management and monitoring described hereinafter.

The environmental manager should be responsible for reporting the planning and implementation of environmental management plan and environmental monitoring plan to the manager of the power plant through all the phases of the project, and the director should take the final responsibility.

The environmental manager provides preliminary training on environmental management to the staffs prior to the beginning of the operation. The environmental manager should also provide appropriate updated training all through the operation phase.

The environmental manager is also responsible for reporting about the negotiation with local residents and issues of environmental management and monitoring and training to Khulna DoE and relevant organization.

8.4 Environmental Monitoring Plan

8.4.1 Monitoring Parameters

a) Construction Phase

Table 8.4.1 shows the monitoring condition during the construction phase.

- Air quality monitoring: SPM, SO₂, and NO₂ are used as parameters for the measurement. Air quality will be monitored in the residential areas in principle. If there are any places susceptible to impact such as schools, select those places as the target of the measurement.
- Waste water monitoring: TSS will be used as a parameter for the measurement. Waste water will be monitored at the outlet from the settling tank.
- Noise monitoring: Noise level will be used as the parameter for the measurement. Noise will be monitored in the residential areas in principle. If there are any place susceptible to impact such as schools, those places will be selected as the target of the measurement.
- Underground water monitoring: The underground water level, Water temperature, and precious metals (As, etc) is used as the parameter for the measurement. Underground water will be monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

b) Operation Phase

Table 8.4.2 shows the monitoring condition during the operation phase.

- Gas emission monitoring: SPM, SO₂, and NO₂ will be used as parameters for the measurement. Gas emissions will be monitored in the flue.
- Air quality monitoring: SPM, SO₂, and NO₂ will be used as parameters for the measurement. Air quality will be monitored in the residential areas in principle. If there are any place susceptible to impact such as schools, select those place as the target of measurement.
- Waste water monitoring: Water temperature, DO, SS, oil, BOD, and precious metals will be used as parameters for the measurement. Waste water will be monitored at the outlet where the waste water is discharged from treatment plant.
- Water quality monitoring: Water temperature, DO, SS, oil, BOD, and precious metals are used as parameters for the measurement. Water quality will be monitored at river or local.
- Noise monitoring: Noise level will be used as the parameter for the measurement. Noise will be monitored on the boundary of the site and in the residential areas in principle. If there is any place susceptible to impact such as schools, select those places as the target of the measurement.
- Underground water monitoring: The underground water level, Water temperature, and precious metals (As, etc) will be used as the parameter for the measurement. Underground water will be monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

8.4.2 Monitoring Schedule

Tables 8.4.1 and **8.4.2** show the monitoring schedule during the construction and operation phases.

Table 8.4.1 : Monitoring Schedule during the Construction Phase

Item	Parameter	Place	Frequency
Air quality	SPM, SO ₂ , NO ₂	Residential areas and schools	Monitor SPM every two weeks, and SO ₂ and NO ₂ every two months.
Water quality	TSS	Drain outlet	Every month
Noise	Noise level	Residential areas and schools	Every week when the amount of construction work is maximized
Underground water	Underground water level Water temperature, heavy metals (As, etc)	Residential area	Twice/year (dry season and rainy season)

Table 8.4.2 : Monitoring Schedule during the Operation Phase

Item	Parameter	Place	Frequency
Gas emission	SPM, SO ₂ , NO ₂	Flue	Monitor SO ₂ and NO ₂ on a continuous basis (by a continuous monitoring system), and SPM every month.
Air quality	SPM, SO ₂ , NO ₂	Residential areas and schools	Monitor SO ₂ and NO ₂ every month, and SPM every two months.
Waste water/Effluent	pH, Water temperature, DO, SS, oil, BOD, and heavy metals (Pb, Fe etc)	Drain outlet	Every two months
Water quality	pH, Water temperature, DO, SS, oil, BOD, and precious metals	River	Twice a year (dry and rainy seasons)
Noise	Noise level	On the border of the site and in the residential areas	Twice a year
Underground water	Underground water level Water temperature, heavy metals (As, etc)	Residential area	Twice/year (dry season and rainy season)

8.5 Occupational Health and Safety

8.5.1 General Requirements

In Bangladesh the main law related to occupational health and safety is Labor Law 2006. The law has provisions on occupational hygiene, occupational diseases, industrial accidents, protection of women and young persons in dangerous occupation.

8.5.2 Workplace Environmental Quality

The proposed power plant project has several phases - the construction of infrastructure and installation and commissioning of plant equipment, operation of the plant etc.

The construction phase includes site preparation and plant construction, access road construction etc. The health hazards associated with these activities are mainly due to dust and noise pollution. Excessive noise contributes to loss of hearing and triggers physiological and psychological body changes. Dust pollution can cause eye and respiratory irritation and in some cases allergic reactions. The inhalation of exhaust gases from vehicles and machinery are also harmful for health. Stress can be caused by working in shifts, high work load, poor living condition of workers etc.

Remedial measures

To minimize the hazards arising from the activities at different phases of plant construction and operation, the following measures should be taken:

Employees should be informed of the potential health impacts they are facing. The employer should inform his employees of these potential hazards, arrange proper medical examination prior to and during employment, as well as tests and analyses necessary for the detection of diseases. Works with volatile toxic chemicals should be undertaken in a well ventilated place. Laborers handling offensive toxic chemicals should be provided with and forced to use protective clothing. Workers exposed to an excessive amount of noise should be provided with protective gear and be relieved frequently from their post. Workers exposed to large amounts of dust should be provided with adequate protective gear. Frequent spraying of water should be undertaken to minimize dust pollution. Persons undertaking construction and installation works should have access to amenities for their welfare and personal hygiene needs such as sanitary toilets, potable drinking water, washing facilities, shelter sheds etc. Proper disposal of waste and sludge should be arranged. Health education and information on hygiene should be provided to the workers. Regular checks on food quality should be arranged within the work site.

(a) Safety

Safety implies the reduction of risk of accidents at the work site. Accident prevention is more valuable than any mitigatory or compensatory measures. This may be achieved through strict rules and procedures for the execution of specific tasks, enforcement of the rules, discipline amongst workers,

maintenance of machineries used and by providing all necessary gear or equipment that may enhance the safety of the workers.

The following guidelines should be followed to maintain the safety of the workers:

- Workers have to be informed about the possible damage or hazards related to their respective jobs.
- If pedestrian, traffic or plant movements at or near the site are affected by construction works, the person with control of the construction project must ensure that these movements are safely managed so as to eliminate or otherwise to control any associated health and safety risks.
- Must ensure sufficient lighting in the area where a person performs construction work or may be required to pass through, including access ways and emergency exit or passage without risk to health and safety.
- Construction site needs to provide safe access to and egress from all places where they may be required to work or pass through.
- This includes the provision of emergency access and egress route that must be free from obstructions.
- Adequate perimeter fencing should be installed on the site before construction work commences and that should be maintained during the construction work and signs should be placed which is clearly visible from outside the site including emergency telephone numbers.
- Must ensure that electrical installations materials, equipment and apparatus are designed, installed, used, maintained and tested to eliminate the risk of electrical shock, burns, fire or explosion.
- Construction site should be kept orderly and tidy. Access ways should be kept clear of materials and debris and maintained in a non-slippery condition. Materials should be stored in an orderly manner so that it does not pose any risk to the health or safety of any person.
- Arrangements of first aid facility should be made accessible when construction work is being undertaken.

8.5.3 Work in Confined Spaces

In the operational phase of the plant, the work will mainly be limited in confined spaces.

In this phase, noise pollution may pose risk to health. It has been observed that the measured noise level near the generators and turbines ranged from 90 dBA to 110 dBA.

This level of noise limits the continuous exposure to the workers from 2 to 4 hrs beyond which hearing impairment may be caused. If the installation of

generators and turbines are within a confined space and monitored through glass windows, it will not pose any serious threat. However precautions should be undertaken during routine inspections and maintenance works. Supervisors, inspectors and related personnel should wear noise protectors like ear plugs or ear muffs. Wearer should be given a choice between ear muffs and plugs as muffs are easy to use but may be a nuisance in a confined work space and be uncomfortable in hot environment. Whereas ear plugs don't get in the way in confined spaces but may provide little protection if not used carefully.

As the employees will work in confined spaces, the air pollution may not pose a health risk. However, the ambient temperature may be high due to plant operation and measures should be taken to keep temperature within a comfortable limit. Where damage to plant presents an electrical hazard, the plant should be disconnected from the electricity supply main and should not be used until the damaged part is repaired or replaced.

8.5.4 Hazardous Material Handling and Storage

During construction of the plant, commercially available chemicals (paints, thinners etc) will be used and stored in the construction area. Hence small amount of unused or spent chemicals (used paints, motor oils) will be generated. Hazardous wastes likely to be generated during routine project operations include oily water, spent catalyst, lubricants and cleaning solvents.

Operation and maintenance of the plant also generates some hazardous wastes. These include waste oil, boiler bottom ash, spent solvents, batteries, fluorescent light tubes, lubricating oils etc. The project will also involve the construction and operation of gas pipe line and handling of large amount of natural gas. Natural gas poses some risk of both fire and explosion.

Used lead acid batteries contain lead, sulfuric acid and several kinds of plastics which are hazardous to human health. Therefore the following set of storage guidelines should be adopted:

- the storage place must be sheltered from rain and other water sources and if possible , away from heat sources
- the storage place must have a ground cover
- the storage place must have an exhaust ventilation system in order to avoid gas accumulation
- the storage place must have a restricted access and be identified as a hazardous material storing place
- any other lead materials which may eventually arise, such as plumbing, should be conveniently packaged and stored in accordance with its characteristics

It is recommended that where dangerous goods are stored and handled, that premises should be provided with fire protection and fire fighting equipment. These equipments should be installed, tested and maintained in accordance

with the manufacturer's guidelines. The employer must ensure that a procedure for dealing with emergencies is in place, implemented, maintained and communicated to persons on the premises who may be affected by or respond to an emergency.

Ignition sources in hazardous areas should be eliminated. The facility staff should be trained and equipped with personal protective gear such as rubber gloves, boots, hard hats, apron or splash suit and a face shield with safety glasses or goggles.

8.5.6 Training

Training is an integral part of a preventive strategy. The target groups requiring training should be managers, supervisors, and technicians and related staff who may be exposed to risk at work.

Employee representatives should represent the views of workers to management about occupational health and safety and report to workers about management policy. Persons likely to be exposed to risks should be provided with information and instruction in safety procedures associated with the plant at the work place.

Relevant health and safety information should be provided to persons involved in installation and commissioning, use and testing of the plant.

Information on emergency procedures relating to the plant should be displayed in a manner that can be readily observed by persons who may be affected by the operation of the plant.

Training should be provided to use fire fighting equipment when necessary.

Facility staff needs to be trained in the safety procedures that are to be implemented during unloading, transfer and storage of hazardous materials.

8.5.7 Record Keeping and Reporting

Record keeping and reporting is one of the requirements of any QA/QC system and essentially of a good management tool. Properly maintained records of construction, installation, training, equipment maintenance, operation, fault detection and remedy can help in reducing risks of accidents, legal costs and thereby overall cost of operation of a plant. Records also help in identifying causes of any accident and elimination of the same accident in future. Records may be maintained for the proposed plant as follows.

Construction phase

A person with control of a construction project or control of construction work should retain records for a reasonable period after the completion of the construction project of the occupational health and safety induction training and any other training given to persons directly engaged or trained by them to undertake construction work on the project.

Operation phase

During operation of the plant, arrangements should be made to keep records on any relevant tests, maintenance, inspection, commissioning and alteration of the plant, and make those records available to any employee or relevant health and safety representative.

All other records, including assessment reports not indicating a need for monitoring and/or health surveillance and records of induction and training, shall be maintained for at least five years in a suitable form.

Chapter 9: RISK ASSESSMENT AND MANAGEMENT

9.1 Introduction

The problem of protecting human health and the environment may best be defined as the management of risk. The failure to manage risk effectively and to establish priorities rationally translates ultimately into a failure to protect health, safety, and the environment. Through the use of risk assessment, concerned authorities can estimate the relative level of risks posed by different substances, products and activities and can establish priorities in determining whether, and how, to regulate.

Risk assessment is the technical process for estimating the level of risks posed by operational processes or products, i.e. the probability that a given harm will occur as a result of the processes or products. Risk assessment is applied to a substance, proceeds in four major steps:

Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause

- Dose - response assessment: predicting the degree of adverse effects at a given exposure level
- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

Risk management options are then evaluated in a proposed solution to provide reduction of risk to the exposed population. Specific actions that are identified and selected may include consideration of engineering constraints as well as regulatory, social, political and economic issues related to the exposure. Quantitative assessment of risks associated with hazard identification, dose-response assessment, exposure estimation and risk characterization were beyond the scope of the present study. However, this study takes a qualitative approach to identify common hazards within the power plant and recommends measures for managing these risks with accidents and external threats.

9.2 Power Plant Risks Assessment

The process of electricity generation from oil or gas is by no means risk free because of high temperature and pressure conditions within the plants, rotating machineries and high voltages involved. Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the oil/gas fired power plants put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. It is therefore essential that a risk management plan should be devised in order to both reduce risk of accident and to take the correct action during accidents. Important risks of accidents in thermal power plants leading to disasters or emergency situations may occur during following events:

- Risks during emergency: Fire, Explosion, Oil/acid spillage, Toxic chemical spillage, Electrocutation
- Risks due to natural disasters: Flood, Cyclone, Earthquake, Storm, Lightning,
- Risks due to external threats: Sabotage, War situation, Water/food poisoning

In power plants, accidents can occur at two different levels. First, these may occur due to fires, explosions, oil or chemical spillage and spontaneous ignition of inflammable materials. In such events, operators working inside the plant and at various strategic hazard locations will be affected.

Second, risks are also associated with external threats of sabotage. Failure of automatic control/warning systems, failure of fuel oil storage tanks and chemical release from acid and alkali stores and handling also pose great degree of associated risks.

9.3 Managing the Risks

As mentioned earlier, in order to reduce the risks associated with accidents, internal and external threats, and natural disasters, a risk management program is essential. Risk management planning can be done during design and planning stage of the plant as well as during plant operation. While risk management is mainly preventive in nature during the plant operation stage, the design and planning stage of the plant can incorporate changes in basic engineering to include safety design for all processes, safety margins for equipment, and plant layout. The following steps among others are important in managing the risks mentioned.

- Gas storage is to be designed with adequate precautions in respect of fire hazard control.
- Storage of hazardous substances such as acids and alkalis should be sited in protected areas.
- With respect to plant operation, safe operating procedures should be laid down and followed to ensure safety, optimum operation and economy.
- A fire fighting group with adequate manpower and facilities such as water tank of sufficient capacity, CO₂ tank, foam tank, portable fire extinguishers should be provided and facilities located at strategic locations e.g. generator area, high voltage panel, control rooms, and fuel tank area.
- Regular checks on safe operating practices should be performed.

In order to achieve the objective of minimizing risks at the Khulna PPP, the unit will be trained to act in a very short time in a pre-determined sequence to deal effectively and efficiently with any disaster, emergency or major accident to keep the loss of life, human injury, material, plant machineries, and impacts on the environment to the minimum.

9.4 Emergency Response Plan

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

The primary objective of the plan is to keep the loss of life, material, machinery/equipment damage, and impacts on the environment to minimum.

9.4.1 Emergency Response Cell

It is highly recommended that an Emergency Response Cell (ERC) adequately equipped with highly trained manpower and appropriate gears is established within the power plant in order to effectively implement the emergency response plan. The main functions of the emergency response cell should include the following.

- Identification of various types of emergencies
- Identification of groups, communities, and areas those are vulnerable to different kinds of emergencies
- Preparing service teams for various operations within the organization through extensive training
- Establishment of early detection system for emergencies
- Developing reliable, instant information and communication system
- Mobilizing all units in the plant within a very short time to address any emergency

9.4.2 Emergency Preparedness

The ERC headed by a trained Manager should establish an Emergency Control Room with links to all plant control rooms and all other services.

The team will be responsible for preparing and executing a specific emergency response plan for the power plant . The team should meet at regular intervals to update the plan, based on plant emergency data and changes in support agencies.

The team should undertake some trial runs, e.g. fire drill, in order to be fully prepared and to improve upon the communication links, response time, availability and workability of emergency gears and other critical factors.

Upon receiving information about an accident, the ERC team will assemble in the Emergency Control Room within the shortest possible time and formulate emergency control procedure.

9.4.3 Fire Fighting Services

The Fire Officer will be the commanding officer of the fire fighting services. The FO will head a fire fighting team of trained officers and workers. Adequate fire fighting equipment e.g. fire extinguishers of different types appropriate for different strategic locations must be planned according to requirements of existing and future plants.

Depending on the scale of emergency, the fire fighting team will work in close association with security and maintenance personnel of plant. Additional assistance may also be sought from outside fire stations when required.

Preparedness is extremely important for efficient and effective fire fighting services at the time of emergency. This can be better achieved by organizing fire drills at regular intervals, e.g. once every two weeks during dry summer, months and once every two months during wet months involving all team members, all other service groups, all staff of the power plant, and utilizing all fire fighting gears.

9.4.4 Emergency Medical Services

The Chief Medical Officer will be responsible for providing medical services within the power plant at the time of any emergency. The services should also be rendered to people living in the close vicinity of the plant and affected by any accident within the plant.

The Medical room of the Khulna PPP must be equipped with adequate medical personnel and equipment for providing emergency services in addition to normal Medicare services to population of the plant.

A team of well trained Medical Officers specializing in burn injury, orthopedics, electrocution, chemical toxicity or poisoning, and shock treatment must be available at the power plant Medical room. The number of officers may be determined considering the total number of staff and their family members in the plant. Special attention must be given to child injury treatment.

The following services must be on alert at all times in the plant.

First aid services for attending patients on the spot. The Medical room should provide training on first aid services to some designated staffs of important areas of operation, e.g. boiler area, turbine hall, transformer area, electrical rooms, and chemical storage facilities, for immediate attention to the injured.

Ambulance services should be available for transport of casualties from spot to Medical room of the plant, and from Medical room to outside hospital, as necessary. Facilities for transportation of fatalities to appropriate hospital or to relatives or to the police following prescribed procedure should be available.

All potential areas for emergency¹ accidents in the plant must have an information chart including contact phone numbers of relevant services.

9.4.5 Rescue Services

Without going for additional manpower, the rescue team can be formed with potential staffs of the Power Plant, e.g. from medical services, security services and fire fighting services, for conducting rescue operations following an emergency. A senior member can be designated Rescue Officer who will be responsible for formulating rescue plan and guiding the team.

9.4.6 Security Services

Khulna PPP will have a strong independent security team headed by the Chief Security Officer and will be responsible for the overall security of the plant , its equipment, machineries, buildings, utilities. The security office shall maintain liaison with other emergency services at the time of emergency and during normal hours.

9.4.7 Public Relations Services

The Public Relations Officer (PRO) of the Power Plant will be responsible for communicating emergency related information to concerned officials within the power plant. The PRO however, will consult the Emergency Manager before communication with outside agencies.

The PRO will be responsible for warning people in and around the plant against potential fire hazards, or possible chemical contamination of water.

The PRO will keep close contact with outside local community and provide direction, and participate along with management team in the welfare services for the affected communities.

9.5 Concluding Remarks

Apart from the services mentioned above, the Environmental Management Unit and the Emergency Response Cell must ensure that all staffs working within the Power Plant are oriented, through orientation programs, about the dos and don'ts during emergencies as well as overall environmental aspects and issues related to power plant operations.

It is however, to be emphasized that the emergency response plan (ERP) outlined above is to be used as guide only and that the Environmental Management Unit and the Emergency Response Cell shall develop their own environmental management system (EMS) following ISO 14001 and the emergency response plan (ERP) respectively in consultation with and involving the Khulna PPP and the NWPGL Management.

Chapter 10: PUBLIC CONSULTATIONS

10.1 Introduction

Public consultation forms an important part of the EIA study. The main objective of the consultation process is to apprise the local inhabitants about the proposed project and to seek their opinions regarding the possible impacts of the project. It was recognized that their opinions would be more useful as they are accustomed to construction and operation of a number of power plant units in the locality in last few years.

Public involvement is a fundamental principle of any environmental assessment study. The inclusion of the views of the affected and interested public helps to ensure that the decision making process is equitable and fair and leads to more informed choice and better environmental outcomes. The findings from the public consultations carried out as a part of the EIA study were utilized in the development of the EMP (presented in Chapter 8), especially in identifying the significant impacts of the proposed project and developing the corresponding mitigation measures.

10.2 Approach and Methods

Within the framework of the present study, public consultation process has been initiated with an explicit objective to ensure people's participation. More specifically this was aimed at improving the study, taking into account opinions from the people of the study area.

The consultation sessions included Focused Group Discussions (FGD). one FGD was organized only with men and another with women residents around the project site.

Formal and informal meetings in terms of FGD with different groups and interviews with Key Informants (KIs) of the area were held with the primary objective to understand the people's perceptions regarding relevant issues. Discussion mainly centered on problems of the area relevant to the proposed project and suggested solutions.

Apart from Focus Group Discussion, In-depth interviews were conducted with the different officials of Khalishpur upazila to grasp their views and opinions.

The study also took into consideration the findings of questionnaire survey carried out as part of the EIAs conducted for other power plants, (positive and negative impacts), the socio-economic and political situation and peoples' perception about the project.

Consultation was undertaken at early stages of the EIA study so that potentially affected groups/people could provide meaningful input to the EIA. The dialogue, both formal and informal, was continued throughout the period. All consultations and meetings were documented including responses to the questionnaire.

10.3 Public Consultation

10.3.1 Focused Group Discussion (FGD)

2 FGDs were conducted around the project area; one for male and another for female participants. The number of participants in each FGD varied between **7 and 12**. FGDs for male participants were conducted by one male member of the consultant's team and those for female participants were conducted by a lady member of the team.

FGD-1 (Female Group):

FGD-1 was conducted at 11:00am on April 30, 2013 at Uttar Kashipur, Khalishpur, Khulna. The participants were from Uttar Kashipur, Khalishpur, Khulna. 10 female residents participated in this group discussion. The profile of participants is given in **Table-10.3.1(1)**.

Table-10.3.1(1) : List of Participants of FGD Group-1 (Female)

SL. No.	Name	Hasband Name	Occupation	Age	Education Qualification	Monthly Income	Family Size	Remarks
01	Rakha Akter	Md. Shah Jahan	Student	14	S.S.C	10,000	7	
02	Hasina Begum	Md. Shah Jahan	House Wife	40	Class Five	10,000	7	
03	Lakhi Akter	Md. Kaium	House Wife	21	Class Five	5,000	2	
04	Sabina Begum	Md. Bellal Sheikh	House Wife	23	Class Eight	10,000	4	
05	Farjanan Akter	Md. Mizanur	House Wife	28	Class Ten	7,000	3	
06	Hasina Begum	Md. Sundor Ali Molla	House Wife	42	Class Five	8,000	3	
07	Sema Akter	Md. Sofiq Hossain	House Wife	22	0	15,000	5	
08	Nasrin Akter	Md. Shahadat Hossain	House Wife	30	Class Five	7,000	3	
09	Sahina Akter	Md. Alamgir	House Wife	25	0	10,000	5	
10	Rekha Begum	Md. Masud Miah	House Wife	23	0	10,000	5	

Pictures taken during FGD with female group held on April 30, 2013 are given below:



Focus Group Discussion with Female Group at Uttar Kashipur, Khalishpur, Khulna

FGD-2 (Male Group):

FGD-2 was conducted at 3:30pm on April 30, 2013 at Kashipur Tea Stall, Khalishpur, Khulna. The participants were from Kashipur, Khalishpur, Khulna. 8 male residents participated in this group discussion. The profile of participants is given in **Table-10.3.1(2)**.

Table-10.3.1(2) : List of Participants of FGD Group-2 (Male)

SL. No.	Name	Father's Name	Occupation	Age	Education Qualification	Monthly Income	Family Size	Remarks
01	Md. Mahabub	Md. Anawar	Student	19	Class Ten	10,000	5	
02	Md. Nasir	Md. Malak	Service	38	Class Eight	15,000	6	
03	Md. Imran	Md. Sofiqul	Service	18	Class Seven	8,000	5	
04	Haider Ali	Md. Diraj	Business	52	"	8,000	3	
05	Md. Mahedi Hasan	Md. Moien	Business	32	Class Seven	12,000	5	
06	Md. Aungul Gazi	Md. Hatam	Day Labour	55	"	15,000	7	

SL. No.	Name	Father's Name	Occupation	Age	Education Qualification	Monthly Income	Family Size	Remarks
07	Md. Nannu	Rangha Miah	Day Labour	40	"	10,000	5	
08	Md. Manik	Md. Abdul Hasem	Retired	66	Class Two	6,000	2	

Pictures taken during FGD with male group held on April 30, 2013 are given below:



Focus Group Discussion with Male Group at Kashipur, Khalishpur, Khulna

The findings of the Focus Group Discussions (FGD) are elaborated below:

Findings of FGD-1:

10 female members took part in the conversation. Their average age is 27. Their average monthly income is Tk 8200. All were house wife and only one participant was student. Their average family size per household is 4.4.

Opinions of the participants are given below:

- The price of the land has increased. House rent has also increased. As a result, it is hard for the poor people to live with this increase in rent.
- Noise pollution from the 40MW rental Power Plant is very high.

- Smog emitted from this power plant is causing air pollution, which caused diseases like coughing, breathing difficulties, headache, deafness etc among the people.
- Due to noise pollution, the infants were scared and they could not sleep properly. The houses shake due to the noise. In the beginning, the sound was intolerable, but they hope that the sound will decrease in the upcoming days.
- Due to the old power plant, the water became toxic, and thus the rates of death of fishes have also increased.
- Foxes were seen at the graveyard previously, but nowadays, no people are buried over here and as a result, no foxes are seen.
- In the area of Goalpara, the level of water has decreased due to the presence of the industries and the power plant.
- Due to natural environmental problems, foxes, beji, vultures, owls, squirrels, parrots are seen seldom.
- Due to the establishment of the new power plant, many trees have been cut off.
- Before the establishment of this power plant, the place was free. At present times, for establishing the 150 MW and 75 MW (225MW) CCPP, the works are underway.
- The border boundary walls of the new power plant are always damp due to water. As a result, it is difficult for the local people to move
- Due to the establishment of the power plant, high frequency noises can be heard from the outside and as a result, this causes a lot of problem.

Findings of FGD-2 :

Male members took part in the conversation. Their average age is about 40. Their average monthly income is Tk 10,500. Average family size per household is 4.75. Two participants are service holders, two businessman, one student, two day labourer and one retired person.

Opinions of the participants are given below:

- The price of the land has increased. House rent has also increased. As a result, it is hard for the poor people to live with this increase in rent.
- Noise pollution from the 40MW rental Power Plant is very high.
- Smog emitted from this power plant is causing air pollution, which caused diseases like coughing, breathing difficulties, headache, deafness etc among the people.

- Due to noise pollution, the infants were scared and they could not sleep properly. The houses shake due to the noise. In the beginning, the sound was intolerable, but they hope that the sound will decrease in the upcoming days.
- Due to the old power plant, the water became toxic, and thus the rates of death of fishes have also increased.
- Foxes were seen at the graveyard previously, but nowadays, no people are buried over here and as a result, no foxes are seen.
- In the area of Goalpara, the level of water has decreased due to the presence of the industries and the power plant.
- Due to natural environmental problems, foxes, beji, vultures, owls, squirrels, parrots are seen seldom.
- Due to the establishment of the new power plant, many trees have been cut off.
- Before the establishment of this power plant, the place was free. At present times, for establishing the 150 MW and 75 MW (225MW) CCPP, the works are underway.
- The border boundary walls of the new power plant are always damp due to water. As a result, it is difficult for the local people to move
- Due to the establishment of the power plant, high frequency noises can be heard from the outside and as a result, this causes a lot of problem.
- Everybody want new power plant for the development of the country.

10.3.2 In-Depth Interview:

In-depth interviews were conducted with different officials of Khalishpur upazila. The outcome of the discussions are elaborated below:

1. **Local Fisheries Officer :**

He welcomed and applauded the old power station and the establishment of the new power station. But he obliged that the new power plant that will be established have to be under the normal circumstances that will not be harmful to the society at the same time also quoted that, most importantly, the new power plant have to be environment friendly. So, in order for this to take affect in reality, he wants the Government to play a role in order to achieve this. He wants that, no disposes, chemicals and effluent should not be dropped into the river, by this way, the marine life of the river will be adversely affected and it will affect the human body at the same time. The Fisheries Officer also commented on the fact that, the pressure of the water should not run by the electricity. By this way, the height of the water will decrease, current of the water will decrease as well, and this will cause the production of fishes to decrease. The river will be lead towards drought.

The flow of the water will be decreased. An asrom can be set up by the banks of the Terokhada Bashukholi River..

2. Educational Officer:

Tremendous noise pollution is done by the old power station. This causes difficulties for the students to study properly. Load shedding takes place most of the times. People within this locality are suffering from various kinds of diseases because of the noise and air pollution. People who are suffering from cardiac problems are suffering the most from this noise pollution. He welcomed the establishment of the new power plant. He also mentioned that, most of the foreign countries have acquired the technology of noise free and environmental friendly power plants, so, the new power plant that will be established, should also acquire these technologies for the betterment of the people.

3. Agricultural Officer:

In recent times in Khulna, there are more farming of fishes rather than rice and wheat.

The chemicals from the power plant should not go to the rivers and also to the cultivated lands, according to the Agricultural Officer. But the cultivated lands are well protected and well away from the power plant, so the chance for the cultivated lands to get affected by the power plant is very unlikely. But, the people who live in the locality of the power plant are really suffering from the noise pollution of the power plant. So, the Government and the local people have to take appropriate measures to ensure that the new power plant that will be installed soon, have to be environment friendly. By the establishment of the new and improved power plant, the lack of power supply of our country will decrease and at the same time it will decrease the rate of unemployment of the country and thus the people of Bangladesh will live in eternal peace and harmony.

4. Community Leader:

In an interview with Mr. Sultan Mahmud (Pinto), Ward Commissioner, Ward number: 07, Khalishpur Power Plant Site, Khalishpur, Khulna Mobile Number: 01925316137, Mr. Mahmud appreciated the authority of NWPGL to appoint local workers in the construction of Khulna 150MW Peaking Power Plant and also keeping close contact with him. He gladly accepted the conversion of the peaking power plant into combined cycle power plant as base plant to solve the power crisis and for national development as well. But he was very worried about the environmental pollution by Agreeko 40MW rental power plant, which is causing noise and air pollution. However, he was informed that this rental power plant will be dismantled and some additional equipments will be in that place to convert the peaking power plant into combined cycle power plant, which will be very environmental friendly. In that case, he opined that he has no objection for converting the peaking power plant into combined cycle power plant if no environmental pollution take place.

10.4 Recommendations:

Noise pollution and harmful smog is exhausted in to the environment. If this smog is inhaled then it is really harmful to our body. Tree's and plant's growth rate have decreased dramatically. children are suffering from the most of its effects. Children are having breathing difficulties because of this air pollution. The effect of diseases e.g. problem of heart, ear, head etc are increasing. It was recommended to take immediate measures to reduce harmful noise level caused by the 40MW Rental Power Plant. The proposed power plant should be also constructed in such a way that no harmful noise will be produced from the power station.

Chapter 11: CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

In this study, the effects of the project activities on physico-chemical, ecological and socio-economic (i.e., human interest related) parameters during both construction and operation phases have been assessed. The impacts have been identified, predicted and evaluated, and mitigation measures suggested for both construction and operation phases of the proposed power plant. The important physico-chemical environmental parameters that are likely to be affected by the project activities include air and noise pollution.

The study suggests that most of the adverse impacts on the physico-chemical environment are of low to moderate in nature and therefore, could be offset or minimized if the mitigation measures are adequately implemented. Since the project site is located in a developed area that does not appear to be very sensitive ecologically, the impact of project activities on most ecological parameters (e.g., wet lands, homestead vegetation, forest cover, bushes and trees, wild life, species diversity) are mostly insignificant.

Some adverse impact during the operation phase of the plant will come from NO₂, emission from the power plant. However, modeling study suggests that the effect of increased NO₂, in the ambient air due to emission from the proposed power plants will not be very significant.

Noise level has been identified as significant potential impact of the proposed power plant during both the construction and operation phases. The noise generated from construction activities during the construction phase might become a source of annoyance at the residential Area to the project site.

There is no need for land acquisition. Additionally, there is no settlement in this designated area. Therefore, no population will be displaced and no resettlement will be required for the construction of the power plant.

During operation phase, no significant negative impact is anticipated on socio-economic environmental parameters.

During public consultations carried out as a part of the EIA study, people welcomed the proposed power plant project. However, they recommended installing a plant of good quality, which will be able to provide uninterrupted power and will be able to keep anticipated air and noise pollution to a minimum level.

11.2 Recommendations

The environmental assessment carried out for the proposed power plant at Khulna, suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the EMP. It is therefore recommended that the proposed Khulna 225MW Combined Cycle Power Plant may be installed, provided the suggested mitigation measures are adequately implemented. It is also recommended that

the environmental monitoring plan be effectively implemented in order to identify any changes in the predicted impacts and take appropriate measures to off-set any unexpected adverse effects.

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation activities, the gas/oil fired power plant put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. An emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

Annexure

Annex-1:

**Site Clearance Certificate issued by
Department of Environment (DoE)**



গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
খুলনা বিভাগীয় কার্যালয়
পরিবেশ ভবন, বয়রা, খুলনা।
www.doe-bd.org

স্মারক নং-২২.০২.৪০৪৭.০১৬.৪৪. ৩৩.১৩. ৬১৭

১৬/০৬/১৪২০ বঙ্গাব্দ
তারিখঃ -----
২৭/০৬/২০১৩ খ্রিস্টাব্দ

বিষয়ঃ অবস্থানগত ছাড়পত্র নবায়ন।

আবেদনকারী প্রতিষ্ঠান অপম্প্রেডেশন অব খুলনা ১৫০ মেঃ ওয়াট পিকিং পাওয়ার প্লান্ট টু ২২৫ মেঃ ওয়াট কম্বাইন্ড সাইকেল পাওয়ার প্লান্ট প্রকল্প (নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোং লিঃ, বিদ্যুৎ ভবন (১৩ তলা) ০১ আব্দুল গণি রোড, ঢাকা-১০০০ - এর আবেদনসহ দাখিলকৃত কাগজপত্র পর্যালোচনায় প্রতিষ্ঠানটির অনুকূলে জারিকৃত অবস্থানগত ছাড়পত্র নবায়নযোগ্য বিবেচিত হয়।

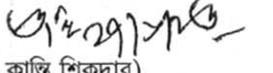
২। অতঃপর প্রতিষ্ঠানটির কার্যক্রমের বিষয়ে পরিবেশ দূষণ সংক্রান্ত কোনরূপ অভিযোগ না থাকায় নিম্নবর্ণিত শর্ত প্রতিপালন সাপেক্ষে ০৩/০৭/২০১৪ পর্যন্ত অবস্থানগত ছাড়পত্র নবায়ন করা হলোঃ

শর্তাবলীঃ

১. অবকাঠামোগত উন্নয়নের আওতায় অন্যান্য বিষয়ের মধ্যে আই ই ই প্রতিবেদনে বর্ণিত সকল মিটিগেশন মেজার্স যথাযথভাবে বাস্তবায়ন করতে হবে।
২. শিল্প ইমারত দ্বারা সাইটের সর্বাধিক ৬৬% স্থান আচ্ছাদিত করা যাবে এবং উহার পশ্চাতে ও দুই পার্শ্বে ন্যূনতম ২.৫০ মিটার স্থান উন্মুক্ত রাখতে হবে।
৩. অনুমোদিত TOR এর ভিত্তিতে ইআইএ প্রতিবেদন প্রণয়ন করতে হবে এবং উক্ত ইআইএ প্রতিবেদন পরিবেশ অধিদপ্তরের অনুমোদনের নিমিত্তে পেশ করতে হবে।
৪. ইআইএ প্রতিবেদনে এ কারখানা সৃষ্ট গ্যাসীয় পদার্থের নিঃসরণ (SOx, NOx, CO) এবং বস্তুকণার (Particulate Matters) নির্গমন পরিবেশ সংরক্ষণ বিধিমালা ১৯৯৭ এ উল্লিখিত মানমাত্রার মধ্যে রাখা, কুলিং ওয়াটার পুনঃব্যবহারের ব্যবস্থা এবং তরল বর্জ্য পরিশোধনের ডিটেইল পরিকল্পনা অসম্পূর্ণ করতে হবে। প্রতিবেদনে অন্যান্যের মধ্যে Spent lubricating oil, oil filter এবং Sludge ব্যবস্থাপনার বিবরণী ও ড্রেনেজ প্লান অন্তর্ভুক্ত থাকতে হবে।
৫. ইআইএ প্রতিবেদনে নিজস্ব লোকবল ও ইকুইপমেন্ট এর সমন্বয়ে ইন-হাউজ এনভায়রনমেন্টাল মনিটরিং সিস্টেম গড়ে তোলার বিষয়ে প্রয়োজনীয় কারিগরী ও আর্থিক প্রস্তাবনা অন্তর্ভুক্ত করতে হবে।
৬. ইআইএ অনুমোদিত না হলে আমদানীতব্য যন্ত্রপাতির অনুকূলে L/C খোলা যাবে না।
৭. সংশ্লিষ্ট বিষয়ে অভিজ্ঞ মাল্টিডিসিপ্লিনারী টীমের মাধ্যমে ই আইএ প্রণয়ন করতে হবে।
৮. স্থানীয় কর্তৃপক্ষের অনাপত্তিপত্র দাখিল করতে হবে।
৯. ১-৮ এর সিদ্ধান্ত বাস্তবায়ন পূর্বক পরিবেশগত ছাড়পত্রের জন্য আবেদনপত্র দাখিল করতে হবে।
১০. পরিবেশগত ছাড়পত্র ব্যতিরেকে গ্যাস সংযোগ গ্রহণ ও বিদ্যুৎ উৎপাদনে যেতে পারবে না।
১১. এই ছাড়পত্রের মেয়াদ শেষ হওয়ার ৩০ (ত্রিশ) দিন পূর্বে ছাড়পত্রের সত্যায়িত ফটোকপি ও নবায়ন ফি প্রদানপূর্বক নবায়নের জন্য আবেদন করতে হবে।
১২. বিধি মোতাবেক প্রতিবৎসর ছাড়পত্র নবায়ন করা না হলে এই ছাড়পত্র বাতিল বলে গণ্য হবে।
১৩. পরিবেশ আইন/বিধিমালা মোতাবেক প্রয়োজনীয় দূষণ নিয়ন্ত্রণমূলক ব্যবস্থা না নিলে আইনানুগ শাস্তিমূলক ব্যবস্থা নেয়া হবে
১৪. প্রতিষ্ঠানের শব্দ এবং তরল/বায়বীয় বর্জ্যের নিঃসরণ/নির্গমন মাত্রা যথাক্রমে শব্দ দূষণ (নিয়ন্ত্রণ) বিধিমালা-২০০৬ এবং পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-এ বর্ণিত মানমাত্রার মধ্যে হতে হবে।
১৫. বাংলাদেশ পরিবেশ সংরক্ষণ আইন, ১৯৯৫(সংশোধিত ২০১০) এবং পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-প্রদত্ত ক্ষমতা বলে উল্লিখিত শর্ত সমূহ Enforce করা হবে।
১৬. কারখানার বিরুদ্ধে কোন অভিযোগ উত্থাপিত হলে এবং অত্র দপ্তর কর্তৃক তার সত্যতা প্রমাণ হলে এই ছাড়পত্র বাতিল বলে গণ্য হবে।
১৭. প্রতিষ্ঠান সংশ্লিষ্ট জায়গা ব্যবহারে কোন মামলা/মোকদমা বা মালিকানা বিষয়ে কোন অভিযোগ উত্থাপিত হলে ছাড়পত্র বাতিল বলে গণ্য হবে
১৮. এই ছাড়পত্র কোন অবস্থাতেই হস্তান্তর করা যাবে না।
১৯. দূষণ নিয়ন্ত্রনের স্বার্থে প্রয়োজ্য অন্য কোন শর্ত প্রতিপালনে কর্তৃপক্ষ বাধ্য থাকবে।

২০. পরিবেশ অধিদপ্তরের পরিদর্শক ও পরিদর্শনের ক্ষমতাপ্রাপ্ত অন্যান্য কর্মকর্তাগণ কারখানা পরিদর্শনকালে ছাড়পত্র/নবায়নপত্র দেখতে চাইলে তা দেখাতে হবে এবং ছাড়পত্র/নবায়নপত্র কারখানার এমন স্থানে ঝুলিয়ে রাখতে হবে যাতে তা সহজে দৃশ্যমান হয়।
২১. এ ছাড়পত্র বিভাগীয় কার্যালয়ের গোল সিল ও Emboss সহযোগে জারি করা হলো।

৩। উল্লিখিত শর্তাবলী যথাযথভাবে প্রতিপালনের ক্ষেত্রে সংশ্লিষ্ট কর্তৃপক্ষের কোনরূপ উদাসীনতা, শিথিলতা বা যে কোন শর্তের লংঘন পরিবেশ দূষণ সংশ্লিষ্টতায় জনস্বাস্থ্যের প্রতি হুমকি বিবেচনায় প্রদত্ত ছাড়পত্র জনস্বার্থে বাতিল বলে গণ্য হবে।


(ড. তরুণ কান্তি শিকদার)
পরিচালক
ফোনঃ ০৪১-৮৬১৫০৭

✓ প্রকল্প পরিচালক
অপগ্রুডেশন অব খুলনা ১৫০ মেঃ ওয়াট পিকিং পাওয়ার প্লান্ট টু
২২৫ মেঃ ওয়াট কম্বাইন্ড সাইকেল পাওয়ার প্লান্ট প্রকল্প
নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোং লিঃ
বিদ্যুৎ ভবন (১৩ তলা) ০১ আব্দুল গণি রোড, ঢাকা-১০০০

অনুলিপি সদয় জ্ঞাতার্থেঃ

- ১। মহাপরিচালক, পরিবেশ অধিদপ্তর, ঢাকা।
২। জেলা প্রশাসক, খুলনা।
৩। অফিস কপি।

Annex-1.1 :
Terms of Reference (TOR) for EIA Study

Terms of Reference (TOR)
for
Environmental Impact Assessment (EIA)
of
Up-gradation of Khulna 150MW Peaking Power Plant into 225 MW Combined Cycle Power Plant Project

1.0 Introduction

In order to meet the peak demand in western part of Bangladesh, North West Power Generation Company Ltd. (NWPGL) has undertaken to construct 150MW Peaking Power Plant at Goalpara, Khulna within Khulna Power Station complex. This power plant will be run by High Speed Diesel primarily followed by Natural Gas when natural gas will be available. The construction of this power plant is now underway. But there is strong need of base load power station in the western part of Bangladesh. So, NWPGL has planned to convert this peaking power plant into combined cycle power plant by adding one HRSG of 75MW capacity to generate 225MW with the financial assistance of Asian Development Bank (ADB).

The environmental legislation in Bangladesh, particularly, the Environmental Conservation Act. 1997. (recently amended - Amendment 2000), states that any development project shall require environmental clearance from the Department of Environment (DOE), Ministry of Environment and Forest. Government of the People's Republic of Bangladesh. The proposed Project falls under the "Red Category" as per the Environmental Conservation Rules of 1997. which requires to submit Initial Environmental Examination (IEE) report prior to Environmental Impact Assessment (EIA) report based on previously approved to obtain environmental clearance from the DoE. Therefore. NWPGL must take clearance from the Department for implementation of the power plant and other ancillary works.

Some of the important issues identified in the IEE report requires further investigation to complete impact assessment and identify possible mitigation measures. EIA will show the path of implementing the project in an environmentally sound manner. In compliance to these requirements, Terms of Reference for EIA study for this project has been prepared to carry out the EIA study.

2.0 Project components

The project includes construction of 75MW Heat Recovery Steam Generator in addition to 150MW Peaking Power Plant in Khulna near Goalpara power station. The activities are civil works, building works, electrical and mechanical works, drainage and sewage works etc.

3.0 Scope of work

Environmental impact assessment (EIA) of Up-gradation of 150MW Peaking Power Plant into 225 MW Combined Cycle Power Plant at Khulna should be carried out. The EIA study should specifically include the following:

- i. Obtain information on the proposed interventions from NWPGL.
- ii. Review of the findings of the IEE study concentrating on the IECs likely to be

- impacted by the project.
- iii. Community profile of the villages adjacent to the proposed location of the power station. This profile will cover the baseline condition of the exiting neighbouring community.
 - iv. Detail air quality assessment should be carried out.
 - v. Ambient noise monitoring. As the project site is located adjacent to several industries, there are numerous contributors to ambient noise levels in the area.
 - vi. Surface water and groundwater laboratory analysis. Consultant will be required to carry out detail analysis of surface and ground water using appropriate methodology.
 - vii. Thermal Plume modelling will be completed considering proposed power plant. The impact of the water discharge by both the power stations and the resulting effect should be studied.
 - viii. Laboratory analysis of dredged river materials.
 - ix. Ecological survey.
 - x. A summary review of Bangladesh's cyclonic storms.
 - xi. Road traffic survey. The result of the study should be analysed and incorporated in the EIA.
 - xii. River traffic survey. A comprehensive river traffic survey will be done to understand the impact of additional traffic during construction.
 - xiii. Detailed land-use survey should be conducted using appropriate method
 - xiv. Establish the environmental baseline conditions of the Project.
 - xv. Assess environmental impacts of the proposed interventions.
 - xvi. Prepare an environmental management plan (EMP), which should include mitigation measures, enhancement measures, compensation measures and an environmental monitoring plan.

4.0 Output

The study should produce an EIA report on construction of upgrading 150 MW Peaking Plant at Khulna into 225MW combined Cycle power Plant containing the following:

- Project description;
- Environmental baseline condition:
- Environmental impacts of the proposed interventions;
- Environmental management plan, which should include:
 - a. Mitigation plan;
 - b. Enhancement plan;
 - c. Compensation plan;
 - d. Contingency plan and
 - e. Monitoring plan.

5.0 Methodology

EIA study of Up-gradation of 150MW Peaking Power Plant into 225 MW Combined Cycle Power Plant at Khulna should be conducted on the basis of the information of the project activities supplied by the project proponent (BPDB). After reviewing the IEE report, the EIA study should be conducted following the DoE Guidelines for selected industries (DoE, 1997), and Environmental Guidelines for selected industrial and water development projects (ADB 1990). The Consultant's multi-disciplinary team of experts should make further reconnaissance and exploratory site visits. Important environmental components (IECs) likely to be impacted by the proposed interventions should be taken from the IEE report. Data on the impact of the interventions should be generated through professional assessment of the multi-disciplinary EIA team members incorporating the information gathered from the stakeholders through public consultation.

At the IEE stage socio-economic data and environmental data were collected from the project area by administering a socioeconomic questionnaire and environmental questionnaire in area having a width of 500 m on all sides of the proposed power plant area. In depth information on these IECs should be collected during the EIA study.

Environmental and socio-economic data from secondary sources (B.B.S., DoE, Department of Meteorology, BWDB: Agro-climatic survey of Bangladesh and other IEE reports) of the proposed project area should be collected to prepare baseline environmental and socio-economic profile of the areas.

6.0 Outline of EIA Report

The EIA report should include the following sections.

- 6.1 **Background of the Project:** This section should include objectives, scope, and size of the project.
- 6.2 **Description of the Project:** This section should describe the project components according to design, fuel, water and chemical uses, gas emission and pollution control system, technical requirements, performance, etc.
- 6.3 **Description of Environmental Baseline:** The environmental baseline condition in the area selected for the proposed Power Plant should be prepared based on literature review, reconnaissance field visits, and consultation with local people. The baseline should include land resources, water resources, agriculture resources, biological resources and socio-economic condition
- 6.4 **Anticipated Environmental Impacts and Mitigation Measures:**

Information on the proposed interventions should be collected from NWPGL. Environmental impacts of the proposed interventions on the IECs should be assessed through several sets of activities. The future-without-project (FWOP) condition should be generated through trend analysis and consultation with the local people. This should reflect conditions of IECs in the absence of any project intervention. Changes expected to be brought about due to project interventions should be assessed to generate the future-with-project (FWIP) condition. The difference between the FWOP and FWIP condition should be presented as the environmental impacts of the project. This should include both

positive and negative impacts which should be considered in the preparation of the environmental management plan.

6.5 Environmental Management Plan

The environmental management plan (EMP) should be prepared suggesting mitigation measures for minimizing the effect of the negative impacts, enhancement plan for increasing the benefit of the positive impacts, compensation plan for compensating the negative impacts that can not be mitigated and an environmental monitoring plan for monitoring changes taking place through implementation of the project.

(a) Mitigation plan

Measures aimed at minimizing the impact of the negative impacts should be suggested in the mitigation plan. The negative impacts of the proposed interventions, assessed at the environmental impact assessment stage, should be picked up for inclusion in the mitigation plan.

(b) Enhancement plan

Measures aimed at increasing the benefit of the positive impacts of the proposed interventions should be suggested in the enhancement plan. The positive impacts, assessed at the environmental and social impact assessment stage, should be picked up for the enhancement plan.

(c) Contingency Plan

Preparation required for avoiding accidental events as well as measures needed for minimizing the damage of accidental events should be presented in the contingency plan.

(d) Compensation plan

Negative impacts for which mitigation measures cannot be suggested should be picked up for the compensation plan that should indicate monetary compensation to be paid.

(e) Monitoring Plan

Monitoring plan should consider the important environmental components likely to be impacted by the project interventions. The monitoring plan should include suggestions on data to be collected, processed, analyzed and interpreted to detect changes taking place in the impacted area. Location and frequency of data collection on each indicator along with institutional arrangement of environmental monitoring should be suggested in the monitoring plan. Also, necessary budget may be included.

6.6 Public Consultation and Information Disclosure Action Plan:

Public consultation should be conducted and information disclosure plan on proposed activities should be prepared.

7.0 Staffing

The EIA of up gradation of 150MW Peaking Power Plant into 225 MW Combined Cycle Power Plant in Khulna should be carried out by a multi-disciplinary team supported by field researchers as given in the table below:

Sl. No.	Position
1.	Environmental Planning Specialist
2.	Power Plant Expert
3.	Water Quality Expert
4.	Air and Noise Quality Expert
5.	Morphologist
6.	Socio-Economist
7.	Soil and Agriculture Specialist
8.	Ecologist/ Fisheries Specialist

Annex-1.2 :

Analysis Report of High Speed Diesel being used in the 150MW PPP

DATE: 10/04/2013

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 28021

Preliminary Report: BC13-02194.001

The results contained in this Analyst Report are for information purposes only, pending issuance of the Certificate of Analysis by an authorized signatory.

CLIENT ORDER NUMBER :	Gasóleo	SGS ORDER NO.:	363314
CLIENT ID :	Gasóleo	PRODUCT DESCRIPTION :	Diesel (Automotive Fuel) - TOP HSD Sample
LOCATION :	-		
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Top		
SAMPLED :	--	RECEIVED	08 avr. 2013
ANALYSED :	08 avr. 2013 - 10 avr. 2013	COMPLETED :	08 avr. 2013 - 10 avr. 2013

Assay Laboratory accredited by ENAC with accreditation N° LE/249. The Laboratory has the estimated uncertainties for all the accredited parameters at the customer's disposal. The test marked with (*) fall outside the scope of accreditation.

PROPERTY	METHOD	RESULT UNITS	UNCERT
Carbon	ASTM D5291-10 (Proc. A)	84,6 % (m/m)	--
Hydrogen	ASTM D5291-10 (Proc. A)	13,8 % (m/m)	--
Nitrogen *	ASTM D4629-02	130 mg/kg	--
Sulphur	IP 336-04	0,13 % (m/m)	--
Gross Calorific Value	ASTM D240-09	10949,0 kcal/kg	--
Net Calorific Value	ASTM D240-09	10249,0 kcal/kg	--
Density at 15°C	ASTM D4052-11	841,3 kg/m ³	± 0.35
Relative Density (SG) at 15/15°C	ASTM D4052-11	0,8421 ---	--
Kinematic Viscosity at 40°C (104°F)	ASTM D445-12	3,570 cSt	--
Cold filter plugging point (CFPP)	UNE EN 116-98/AC-99 (Err.2006) (Automat.)	-4 °C	--
Pour Point *	ASTM D97-11	-6 °C	± 6
Flash Point by PMCC - Proc. A / Automatic Tester	ASTM D93-12 (Automat.) (Proc.A)	79,0 °C	--
Distillation of Petroleum Products at Atmospheric Pressure	ASTM D86-11b (Automat.)		
Initial boiling point (IBP)		194,7 °C	--
10% Recovered at		235,6 °C	--
20% Recovered at		253,6 °C	--
30% Recovered at		267,7 °C	--
40% Recovered at		279,8 °C	--
50% Recovered at		291,4 °C	± 2.1
60% Recovered at		302,3 °C	--

The results shown in this test report specifically refer to the sample(s) tested as received unless otherwise stated. All tests have been performed using the latest revision of the methods indicated, unless specifically marked otherwise on the report. Precision parameters apply in the determination of the above results. Users of the data shown on this report should refer to the latest published revisions of ASTM D-3244; IP 367 and ISO 4259 and when utilising the test data to determine conformance with any specification or process requirement. This Test Report is issued under the Company's General Conditions of Service (copy available upon request or on the company website at www.sgs.com). Attention is drawn to the limitations of liability, indemnification and jurisdictional issues defined therein. This report shall not be reproduced except in full, without the written approval of the laboratory. -The Laboratory will keep the samples for 45 days.

AUTHORISED SIGNATORY

Enric Cura i de Nuix
 Director de Laboratorio



DATE: 10/04/2013

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Preliminary Report: BC13-02194.001

The results contained in this Analyst Report are for information purposes only, pending issuance of the Certificate of Analysis by an authorized signatory.

CLIENT ORDER NUMBER :	Gasóleo	SGS ORDER NO.:	363314
CLIENT ID :	Gasóleo	PRODUCT DESCRIPTION :	Diesel (Automotive Fuel) - TOP HSD Sample
LOCATION :	-		
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Top		
SAMPLED :	--	RECEIVED	08/04/2013
ANALYSED :	08/04/2013 - 10/04/2013	COMPLETED :	08/04/2013 - 10/04/2013

Assay Laboratory accredited by ENAC with accreditation N° LE/249. The Laboratory has the estimated uncertainties for all the accredited parameters at the customer's disposal. The test marked with (*) fall outside the scope of accreditation.

PROPERTY	METHOD	RESULT UNITS	UNCERT
70% Recovered at		315,1 °C	--
80% Recovered at		329,9 °C	--
90% Recovered at		350,7 °C	± 4.4
95% Recovered at		369,1 °C	--
Final boiling point (FBP)		373,1 °C	--
% Recovery		96,9 % (v/v)	--
% Residue		2,5 % (v/v)	--
% Loss		0,6 % (v/v)	--
Ash Content	UNE EN ISO 6245-03	<0,001 % (m/m)	--
Ni, V and Fe in Crude Oils & Residual	ASTM D5708-12 (Method A)		
Fuels by ICP			
Calcium §		<0,1 mg/kg	--
Sodium §		<0,1 mg/kg	--
Lead §		<0,1 mg/kg	--
Zinc §		<0,1 ppm (m/m)	--
Potassium §		<0,1 mg/kg	--
Nickel		<0,1 mg/kg	--
Vanadium		<0,1 mg/kg	--
Carbon Residue (on 10 % Distillation Residue)	ASTM D4530-11	<0,1 % (m/m)	--
Sample Weight *	ASTM D4870-09	10,01 g	--
Total Sediments - Existent *	ASTM D4870-09	<0,01 % (m/m)	--
ASTM Colour	ASTM D1500-07	L2.0 ---	--

§ - Analyte not in published method scope

- Result is outside of test method limits and/or analytical range used in method precision study

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 Director de Laboratoris

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CLIENT ID :	Gasóleo	PRODUCT DESCRIPTION :	Diesel (Automotive Fuel) - TOP HSD Sample
LOCATION :	-		
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Top		
SAMPLED :	--	RECEIVED	08/04/2013
ANALYSED :	08/04/2013 - 10/04/2013	COMPLETED :	08/04/2013 - 10/04/2013

Assay Laboratory accredited by ENAC with accreditation N° LE/249. The Laboratory has the estimated uncertainties for all the accredited parameters at the customer's disposal. The test marked with (*) fall outside the scope of accreditation.

PROPERTY	METHOD	RESULT UNITS	UNCERT
Base Number *	ASTM D974-12 (Procedure B)	<0,02 mg KOH/g	--
Acid Number (Method B) *	ASTM D664-11a	0,05 mg KOH/g	--
Derived Cetane Number *	ASTM D7668-10	53,8 Rating	--
Cetane Index (Procedure A)	ASTM D4737-10	56,4 Rating	--
Copper Strip corrosion (3h / 50°C)	ASTM D130-10	1a Rating	--

- Result is outside of test method limits and/or analytical range used in method precision study

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 08039 Barcelona

ISOLUX INGENIERIA, S.A.
 CL
 CABALLERO ANDANTE, N° 8
 MADRID
 SPAIN
 28021

Preliminary Report: BC13-02194.002

The results contained in this Analyst Report are for information purposes only, pending issuance of the Certificate of Analysis by an authorized signatory.

CLIENT ORDER NUMBER :	Gasóleo	SGS ORDER NO.:	363314
CLIENT ID :	Gasóleo	PRODUCT DESCRIPTION :	Diesel (Automotive Fuel) - Bottom HSD Sample
LOCATION :	-	VESSEL :	-
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Bottom		
SAMPLED :	--	RECEIVED :	08/04/2013
ANALYSED :	08/04/2013 - 10/04/2013	COMPLETED :	08/04/2013 - 10/04/2013

Assay Laboratory accredited by ENAC with accreditation N° LE/249. The Laboratory has the estimated uncertainties for all the accredited parameters at the customer's disposal. The test marked with (*) fall outside the scope of accreditation.

PROPERTY	METHOD	RESULT UNITS	UNCERT
Carbon	ASTM D5291-10 (Proc. A)	85,6 % (m/m)	--
Hydrogen	ASTM D5291-10 (Proc. A)	14,1 % (m/m)	--
Nitrogen *	ASTM D4629-02	130 mg/kg	--
Sulphur	IP 336-04	0,12 % (m/m)	--
Gross Calorific Value	ASTM D240-09	10903,5 kcal/kg	--
Net Calorific Value	ASTM D240-09	10188,5 kcal/kg	--
Density at 15°C	ASTM D4052-11	841,2 kg/m ³	± 0.35
Relative Density (SG) at 15/15°C	ASTM D4052-11	0,8420 ---	--
Kinematic Viscosity at 40°C (104°F)	ASTM D445-12	3,568 cSt	--
Cold filter plugging point (CFPP)	UNE EN 116-98/AC-99 (Err.2006) (Automat.)	-4 °C	--
Pour Point *	ASTM D97-11	-6 °C	± 6
Flash Point by PMCC - Proc. A / Automatic Tester	ASTM D93-12 (Automat.) (Proc.A)	78,0 °C	--
Distillation of Petroleum Products at Atmospheric Pressure	ASTM D86-11b (Automat.)		
Initial boiling point (IBP)		190,5 °C	--
10% Recovered at		235,1 °C	--
20% Recovered at		254,0 °C	--
30% Recovered at		264,4 °C	--
40% Recovered at		282,8 °C	--
50% Recovered at		293,4 °C	± 2.1
60% Recovered at		305,1 °C	--

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 Director de Laboratorio

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PROPERTY	METHOD	RESULT UNITS	UNCERT
70% Recovered at		317,3 °C	--
80% Recovered at		331,6 °C	--
90% Recovered at		350,9 °C	± 4.4
95% Recovered at		367,0 °C	--
Final boiling point (FBP)		374,0 °C	--
% Recovery		97,8 % (v/v)	--
% Residue		1,0 % (v/v)	--
% Loss		1,2 % (v/v)	--
Ash Content	UNE EN ISO 6245-03	<0,001 % (m/m)	--
Ni, V and Fe in Crude Oils & Residual	ASTM D5708-12 (Method A)		
Fuels by ICP			
Calcium §		<0,1 mg/kg	--
Sodium §		<0,1 mg/kg	--
Lead §		<0,1 mg/kg	--
Zinc §		<0,1 ppm (m/m)	--
Potassium §		<0,1 mg/kg	--
Nickel		<0,1 mg/kg	-- #
Vanadium		<0,1 mg/kg	-- #
Carbon Residue (on 10 % Distillation Residue)	ASTM D4530-11	<0,1 % (m/m)	--
Sample Weight *	ASTM D4870-09	10,01 g	--
Total Sediments - Existent *	ASTM D4870-09	<0,01 % (m/m)	--
ASTM Colour	ASTM D1500-07	L2.0 ---	--

§ - Analyte not in published method scope

- Result is outside of test method limits and/or analytical range used in method precision study

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LOCATION :	-	VESSEL :	-
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Bottom		
SAMPLED :	--	RECEIVED	08/04/2013
ANALYSED :	08/04/2013 - 10/04/2013	COMPLETED :	08/04/2013 - 10/04/2013

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PROPERTY	METHOD	RESULT UNITS	UNCERT
Base Number *	ASTM D974-12 (Procedure B)	<0,02 mg KOH/g	--
Acid Number (Method B) *	ASTM D664-11a	0,05 mg KOH/g	--
Derived Cetane Number *	ASTM D7668-10	53,4 Rating	--
Cetane Index (Procedure A)	ASTM D4737-10	56,7 Rating	--
Copper Strip corrosion (3h / 50°C)	ASTM D130-10	1a Rating	--

- Result is outside of test method limits and/or analytical range used in method precision study

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Preliminary Report: BC13-02194.003

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CLIENT ORDER NUMBER :	Gasóleo	SGS ORDER NO.:	363314
CLIENT ID :	Gasóleo	PRODUCT DESCRIPTION :	Diesel (Automotive Fuel) - Middle HSD Sample
LOCATION :	-		
SAMPLE SOURCE :	-		
SAMPLE TYPE :	Middle		
SAMPLED :	--	RECEIVED	08/04/2013
ANALYSED :	08/04/2013 - 10/04/2013	COMPLETED :	08/04/2013 - 10/04/2013

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PROPERTY	METHOD	RESULT UNITS	UNCERT
Carbon	ASTM D5291-10 (Proc. A)	85,3 % (m/m)	--
Hydrogen	ASTM D5291-10 (Proc. A)	13,9 % (m/m)	--
Nitrogen *	ASTM D4629-02	130 mg/kg	--
Sulphur	IP 336-04	0,12 % (m/m)	--
Gross Calorific Value	ASTM D240-09	10955,0 kcal/kg	--
Net Calorific Value	ASTM D240-09	10250,0 kcal/kg	--
Density at 15°C	ASTM D4052-11	841,2 kg/m ³	± 0.35
Relative Density (SG) at 15/15°C	ASTM D4052-11	0,8420 ---	--
Kinematic Viscosity at 40°C (104°F)	ASTM D445-12	3,571 cSt	--
Cold filter plugging point (CFPP)	UNE EN 116-98/AC-99 (Err.2006) (Automat.)	-4 °C	--
Pour Point *	ASTM D97-11	-6 °C	± 6
Flash Point by PMCC - Proc. A / Automatic Tester	ASTM D93-12 (Automat.) (Proc.A)	79,0 °C	--
Distillation of Petroleum Products at Atmospheric Pressure	ASTM D86-11b (Automat.)		
Initial boiling point (IBP)		196,2 °C	--
10% Recovered at		238,9 °C	--
20% Recovered at		255,6 °C	--
30% Recovered at		268,8 °C	--
40% Recovered at		280,9 °C	--
50% Recovered at		292,7 °C	± 2.1
60% Recovered at		304,7 °C	--

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PROPERTY	METHOD	RESULT UNITS	UNCERT
70% Recovered at		316,8 °C	--
80% Recovered at		331,3 °C	--
90% Recovered at		351,5 °C	± 4.4
95% Recovered at		369,5 °C	--
Final boiling point (FBP)		383,5 °C	--
% Recovery		98,5 % (v/v)	--
% Residue		1,3 % (v/v)	--
% Loss		0,2 % (v/v)	--
Ash Content	UNE EN ISO 6245-03	<0,001 % (m/m)	--
Ni, V and Fe in Crude Oils & Residual Fuels by ICP	ASTM D5708-12 (Method A)		
Calcium §		<0,1 mg/kg	--
Sodium §		<0,1 mg/kg	--
Lead §		<0,1 mg/kg	--
Zinc §		<0,1 ppm (m/m)	--
Potassium §		<0,1 mg/kg	--
Nickel		<0,1 mg/kg	--
Vanadium		<0,1 mg/kg	--
Carbon Residue (on 10 % Distillation Residue)	ASTM D4530-11	<0,1 % (m/m)	--
Sample Weight *	ASTM D4870-09	10,47 g	--
Total Sediments - Existent *	ASTM D4870-09	<0,01 % (m/m)	--
ASTM Colour	ASTM D1500-07	L2.0 ---	--

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PROPERTY	METHOD	RESULT UNITS	UNCERT
Base Number *	ASTM D974-12 (Procedure B)	<0,02 mg KOH/g	--
Acid Number (Method B) *	ASTM D664-11a	0,05 mg KOH/g	--
Derived Cetane Number *	ASTM D7668-10	53,1 Rating	--
Cetane Index (Procedure A)	ASTM D4737-10	57,0 Rating	--
Copper Strip corrosion (3h / 50°C)	ASTM D130-10	1a Rating	--

**** End of Analytical Results ****

- Result is outside of test method limits and/or analytical range used in method precision study

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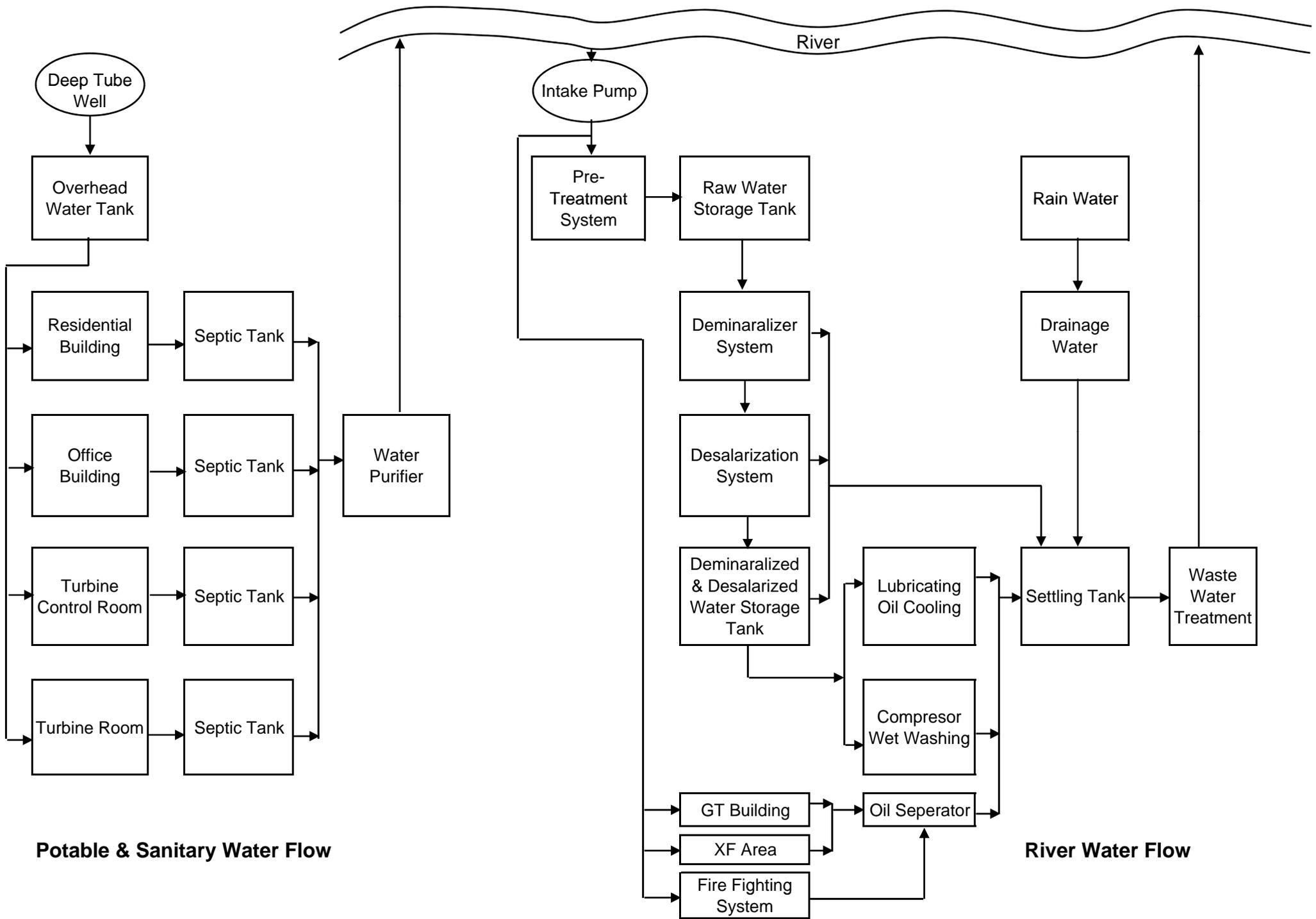
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 Director de Laboratorio

Annex-3.1 :

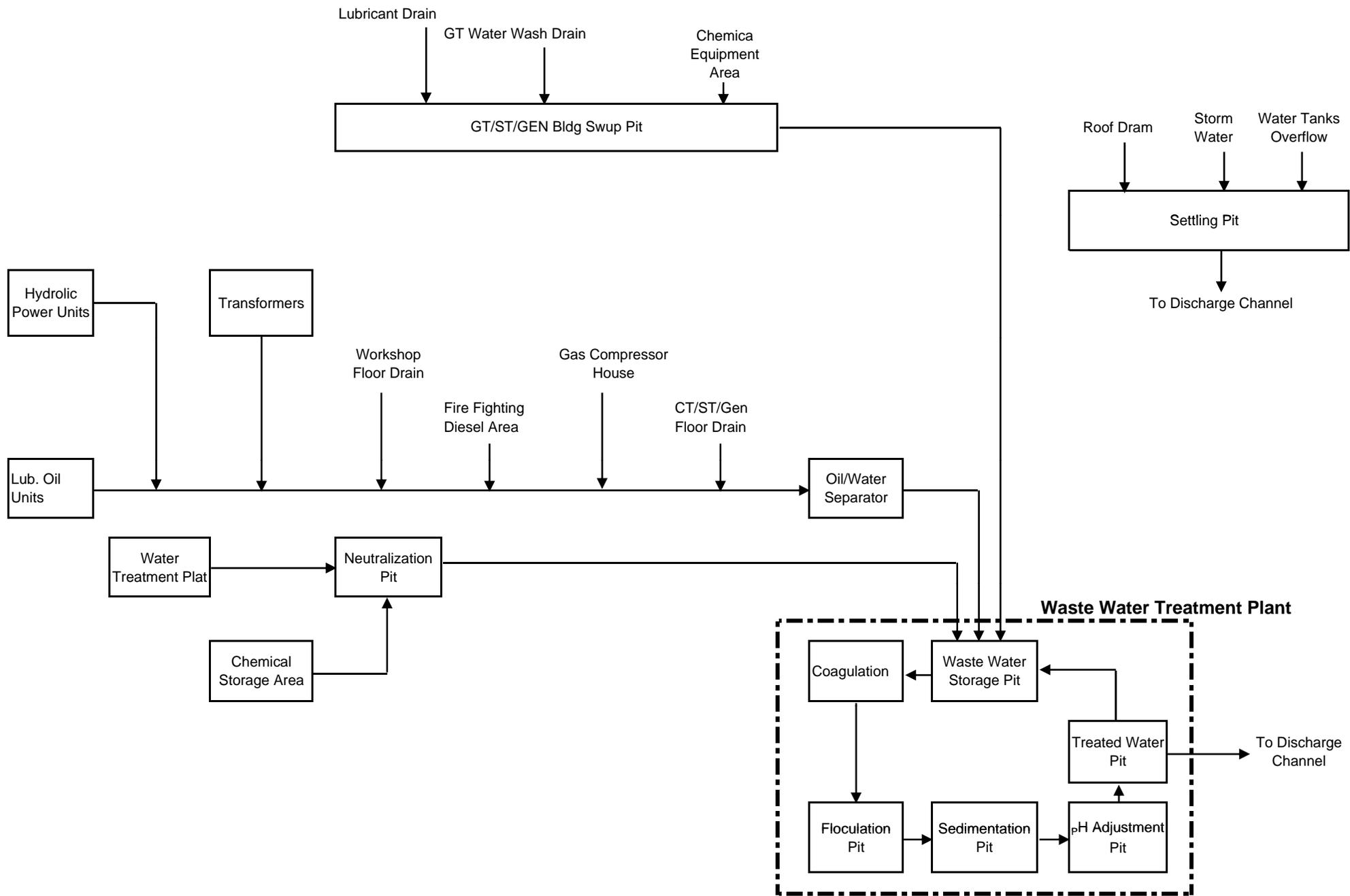
Layout Plan of Upgradation of Khulna 150 MW Peaking Power Plant to 225MW Combined Cycle Power Plant

Annex-3.5(1) :
Conceptual Flow Diagram of Water



Annex-3.5(1) : Conceptual Flow Diagram of Water

Annex-3.5(2) :
Conceptual Waste Water System Diagram



Annex-3.5(2): Conceptual Waste Water System Diagram

Annex-3.5(3) :
Description of Industrial, Sanitary and Oily
Waste Water Treatment Plant installed in
the 150MW PPP.

CLIENT:

NWPGCL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



**INDUSTRIAL, SANITARY AND OILY WASTE
WATERTREATMENT DESCRIPTION**

INDUSTRIAL, SANITARY AND OILY WASTE WATER TREATMENT DESCRIPTION

1	10/01/2013	For information	IMG	JHL	DGB
REV	DATE	DESCRIPTION	EDITED	CHECKED	APPROVED

CLIENT:

NWPGCL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

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CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

1. INTRODUCTION

The Plant Drain System has been designed to separate effluents as a function of their physical and chemical characteristics, to collect them, to homogenize those that require treatment and to discharge them up to the interface point.

The Plant Drain System is organized into a series of subsystems which are differentiated mainly by the source and nature of the effluents collected: oily effluent network, non-oily effluent network and other drains.

Oily Effluent Network

This network consists of:

- West oily drains network coming mainly from gas booster compressors shelter and site services building area. This network is made up of civil piping that leads potentially oily effluents proceeding from mainly areas where oil is present, e.g. gas booster compressors, fire protection diesel pumps, diesel storage tank area, and hosing down and cleaning of these units. This network merges on a pit with the east oily drains network in the south-east area.
- East oily drains network. This network is made up of civil piping that leads potentially oily effluents proceeding from mainly areas where oil is present, e.g. High speed diesel (HSD) tanks area, transformers area and gas turbine equipment, and hosing down and cleaning of these units. A sump pit collects these drains in order to pump them up to Oil separator where the oil is eliminated.

Non-Oily Effluent Network

This network comprises:

- Water tanks area network. This network is made up of civil piping that leads non-oily drains proceeding from water tanks by gravity to the existing rainwater network channel.
- Water treatment plant drains. These drains are gravity driven to a neutralization basin, where chemical drains shall be neutralized, and subsequently driven by gravity to the discharge channel.

Other Drains

- Chemical containment drains and oily drains (battery room, GT pits, diesel and fuel storage, gas turbine stack, etc.) are also collected in the Power Plant. These drains shall be confined in spill containment trays or bunds; oils shall be subsequently removed by an authorised waste handler, while chemical drains shall be neutralised, and removed by an authorised waste handler as well.

CLIENT:

NWPGCL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)

**INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION**

- Sanitary network: the pipes of this network collect the wastewater from the sanitary facilities of the power plant (administration building, control room & switchgear building, canteen and from the workshop and store building). The wastewater is driven by gravity to the Sanitary water treatment plant (10GR_001).

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)

**INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION****2. EFFLUENT TREATMENT PLANT****2.1. GENERAL DESCRIPTION**

The purpose of this Neutralization System is to collect all the drains that are produce in the WTP and neutralize them in order to accomplish with the effluent discharge limits (section 2.2).

The neutralization system comprises a concrete underground basin with 120m³ of useful capacity recirculation and discharge pumps and two blowers for mixing and homogenization

The main drains and effluents of the Water Treatment Plant are as follows:

- Regeneration of the ion exchangers
- Backwash of sand filters
- Activated carbon filters

The design of the plant is made to minimize the chemical consumption in this point by balancing the excess of regenerant of the cation exchanger with the excess of regenerant of the anion exchanger, neutralizing both effluents with the homogenization.

2.2. EFFLUENT LINE - NEUTRALIZATION

This line has a basin that receives all different effluents generated throughout the Plant.

This mixture of effluents will only meet effluent parameters when pH is adjusted and controlled, through the addition of acid or base, to keep it between 6 and 9.

Two air blowers and an air distribution grid (covering the whole bottom of the basin) are installed to help this homogenization occur. The air blowers provides air continuously to the neutralization basin, where the air is divided and distributed through small strainers, duly designed for this purpose. PVC has been installed for this grid, in order to withstand the conditions within the neutralization basin.

In effluents treatment plant it is crucial to do a good homogenization and lamination of the effluents, so as to obtain homogeneous characteristics as possible. This will lead to a reduction in the reagent consumption during operation of the Plant.

The basin volume is 120 m³. To reach that value the following drain volumes have been considered:

- Drain volume per regeneration (w/ recirc.) 51 m³

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

- Drain volume per regeneration (w/o recirc.) 75 m³
- Backwash water volume per filter 5 m³

The treatment process carries on in several steps:

First, once the cationic resin regeneration has been completed and a mid level is arisen, the recirculation pump starts in order to get proper homogenization besides air supply by blower.

Meanwhile, the anionic resin regeneration takes place and its drains discharge to the basin, where they are continuously mixed with the previous drains.

Once the regeneration of both resins has finished, the mixing and recirculation go on for 10 minutes approximately and then the pH analyser reading commands, depending on the value it's the dosification (soda or acid).

Once the correct pH is achieved, then close recirculation automatic valve and open the discharge automatic valve until low level in basin. Continuous monitoring of Turbidity and temperature is done by on line instrumentation.

2.3. CHARACTERISTICS

The effluent discharged by the Neutralization basin shall meet the standard by WORLD BANK GROUP Pollution Prevention and Abatement Handbook.

PARAMETER			VALUE
pH			6-9
Temperature increase (°C) ¹			<3
Oil and greases (mg/l)			10
Suspended (mg/l)	material	TSS	50
Total residual chlorine (mg/l)			0.2
Chromium (total)			0.5
Copper			0.5
Iron			1.0
Zinc			1.0

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

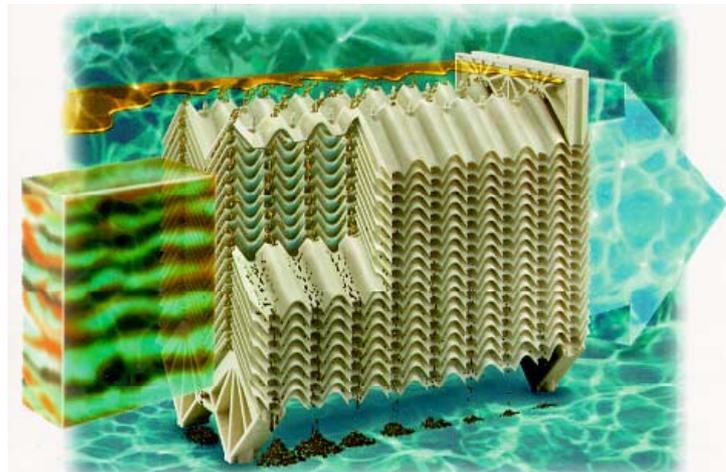
3. OIL SEPARATOR

3.1. GENERAL DESCRIPTION

The Oil-Water Separator is a passive gravity-flow system for the separation of the light products not miscible in water (oils, gasoline, etc.) of their mixtures with water. The design utilizes the difference in specific gravities between the two fluids (for ex. water/oil).

The separator is designed to receive the not emulsified mixtures and to process it on a once-through basis.

From now on it will be designate by "product" the light fluid to separate and by "water" to fluid in continuous phase.



The mixture (for ex. water/oil) passes to the Separator through the inlet elbow. In the Inlet or pre-separation Chamber the separation of the greater droplets of Product and the heaviest solids is produced. The Product flows toward the upper part remaining floating on the surface of the water and the solids decant in the bottom of the Chamber. After, that water, with the smallest droplets of Product and solids, flows through the Plate Pack. As the product / water mixture flows through the plates, the Product droplets tend to rise in the water due to the buoyancy effect. As the droplets rise, they come in contact with the underside of the plates and coalesce, forming a thin film of Product on the plate surface which migrates upward along the surface of the Plates until it reaches the plate peaks. There it accumulates in a thicker product layer. Holes have been provided in the plates at the peaks, so that the Product collected in this manner may "weep" through the holes and eventually come to the top of the separator. The separate Product forms a film that floats in the upper part of the water.

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

The clean water flows by the lower part of the outlet chamber, and abandons the Separator through the outlet pipe. Due to the small space between Plates, through them the solids decantly rush in the lower part. The inferior valleys of the Plates include holes that allow the solids decant in the lower part forming a sludge under the Plate packs that it is necessary to extract intermittently, either manual or automatically.

The separated product film floating on the water surface, leaves through the adjustable skimmers to a Product Collection Chamber located next to the Separator, or away from the same.

Accessory Elements

The Separator is supplied in carbon steel with different accessory equipment to facilitate the operation and maintenance, to know:

- Safety Valve that cuts off the circulation of fluid from the separator when the accumulated product is too high and there is a risk of it passing to the exterior through the clean water outlet.
- Calescent plates for the separation of oil and solids
- Pumping equipment for extraction of mud and separate Product

3.2. CHARACTERISTICS

The characteristics of the Oil Separator are the following:

Parameter	Value
Oil separator capacity	26 m3/h
Treated water oil and greases content (mg/l)	≤10
Treated water suspended solids concentration (mg/l)	≤50
Oil separator efficiency (%)	>80

CLIENT: NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT: KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

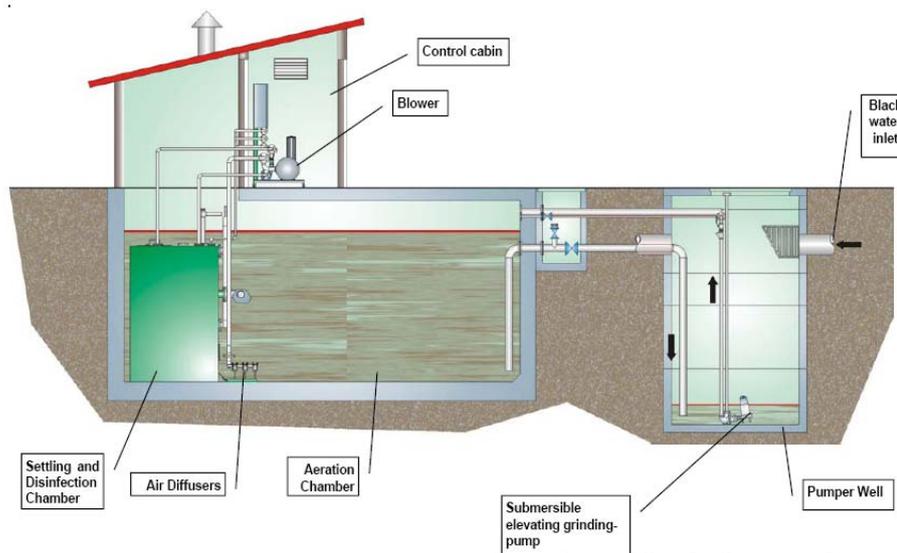
4. SANITARY WATER TREATMENT PLANT

Sewage Treatment Plant carry out the sewage treatment by biological means (with continuous air supply by blower), activated sludge process and extended aeration, with sludge recirculation.

The Sanitary water treatment plant consist of one (1) prefabricated concrete module, ready to be installed aboveground, with feed supply by pump and discharge by gravity.

4.1. GENERAL DESCRIPTION

The Plant consist of a single-built prefabricated steel module (settling and disinfection chamber) inside in a closed concrete pit (aeration chamber) built "in situ". This modular construction allows the increase of the processing capacity by placing more plants in parallel.



The air diffusers responsible for the oxygenation and agitation of the water to be treated are placed within the aeration chamber fixed to the prefabricated steel module. The biological filter and pipes that recirculate sludge and grease towards the aeration hamber are located, also, in the prefabricated steel module. The settling is pressurized in the settling chamber facilitating the deposition of solids.

All the instruments and control elements of the plant are housed on a prefabricated steel frame and located inside a concrete room built "in situ" over the pit. The connections between the instruments which are inside the room and the prefabricated steel module are throughout the pipes of the corresponding section.

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

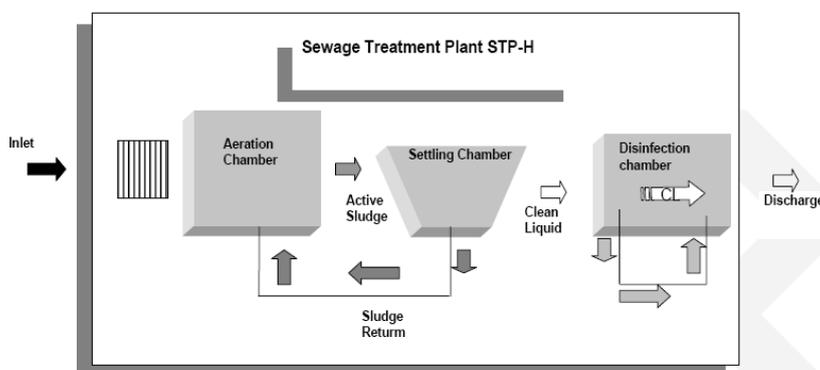
Elements

1. Grinding-pumping system
2. Aeration System
3. Settling Chamber
4. Disinfection system
5. Discharge System
6. Control Panel
7. Control Cabinet

4.2. FUNCTIONAL DESCRIPTION

The sewage treatment plant starts to operate when the sewage coming from the pumping and grinding pit are suctioned and enter the aeration chamber to start the biological reduction process.

The influent containing aerobic bacteria and the organic compounds that serve as food for them, enter a turbulent environment, rich in oxygen. The air under pressure is introduced through stainless steel diffusers located near the bottom of the Aeration Chamber. Small bubbles of air are generated which create the agitation necessary to mechanically reduce solids to small particles, increasing the contact surface between the bacteria and the oxygen incorporated. This way the bio-reduction of solids is produced, loosening carbon dioxide and other simple compounds.



During this process, the bacteria form small loose colonies or flocs around small particles of organic material in suspension and pass the Clarifier Chamber through a baffled transfer port located between the two chambers.

The Clarifier Chamber is completely filled with liquid (having evacuated of all air by the equalizing valve, during the filling operation) and operates under hydrostatic pressure

CLIENT:

NWPGL NORTH-WEST POWER GENERATION COMPANY LTD



PROJECT:

KHULNA 150MW PEAKING POWER PLANT PROJECT (Package 1A)



INDUSTRIAL, SANITARY AND OILY WASTE WATERTREATMENT DESCRIPTION

due to the level difference between the Aeration Chamber and the Clarifier Chamber. This results in a more effective sludge decanting, rich in bacteria concentration, referred to as activated sludge. The liquid in the top part of the clarifier tank passes through a manifold to the Disinfection Chamber, as the last stage.

The activated sludge is periodically re-circulated to the Aeration Chamber, according to the signal sent by an internal timer of the control system to the solenoid valve. The recirculation velocity may be regulated by air valves depending on the variations in load of the unit.

The remaining clear liquid passes through the manifold towards the final disinfection on the Disinfection Chamber. This step also serves to control the liquid level in the Aeration Chamber.

The fluid is forced to circulate through the Chlorine tablet feeder, and passes to the Disinfection Chamber. After the disinfection stage the flow is discharged to the exterior by gravity.

In total, the system is an assembly of pipes, baffles and deposits aimed to obtain a biological reduction of solids, a physical separation and finally, disinfection.

4.3. CHARACTERISTICS

The Sanitary water treatment plant is suitable for the treatment of a flow rate of 3,500 l/day (max.6 eq. h.) of sewage waters.

The outlet effluent complies with the following parameters:

Parameters	Values
Suspended solids	30 mg/l
BOD5	20 mg O2/l
pH	6.5-8.5

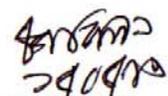
Annex – 4.6

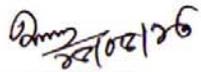
DoE's Air Quality Test Report

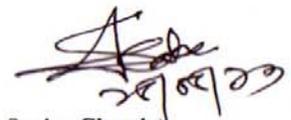
Government of the people's republic of Bangladesh
 Department of Environment
 Khulna Divisional Office
 Boyra, Khulna

Air Quality Analysis Sheet Of 225 MW Combined Cycle power plant at Goalpara, Khulna.

Date	Lab Code	Sample Location	SPM ($\mu\text{g}/\text{m}^3$)	SO _x ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO PPM v/v	Remarks
04/05/13	178	In front of Plant Gate	197.0	20	21	0.9	All the Parameters within Normal Limit
	179	In front of Administrative Building	180.0	18	23	0.9	
Bangladesh Standards-			200($\mu\text{g}/\text{m}^3$)	80 ($\mu\text{g}/\text{m}^3$)	100 ($\mu\text{g}/\text{m}^3$)	9 PPM	


Sample collector


Laboratory Assistant


Senior Chemist

Annex – 4.7.13

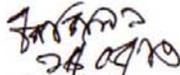
DOE's Test Result of Noise level in the project area

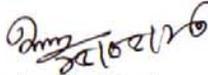
Government of the people's republic of Bangladesh
 Department of Environment
 Khulna Divisional Office
 Boyra, Khulna

Analysis Sheet Of 225 MW Combined Cycle power plant at Goalpara, Khulna.

Date of Sampling	Lab Code	Time	Sample Location	Noise Lebel(dBa)	Remarks
Q4/05/13	180	01:45(PM)	In front of Plant Gate	74	Parameters are within Limit
	181	02:15(PM)	In front of Administrative Building	71	
	182	02.30(PM)	Near East Side Of Boundary	73	
Bangladesh Standards-(day time)				75(dBa)	

Note: দিবাঃ জের ৬ টা হতে রাত ৬টা ও রাতঃ রাত ৬টা হতে জের ০৬টা


 Sample collector


 Laboratory Assistant


 Senior Chemist

Annex – 4.8.1

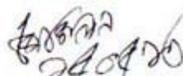
DoE's Bhairab River Water Quality Test Report

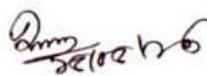
Govt. of the People's Republic of Bangladesh
Department of Environment
Khulna Divisional Office
Boyra, Khulna

Analysis sheet of River water sample

Sample Location	Date	Lab Code	Temp.	PH	EC	Chloride	Turbidity	SS	DO	BOD	COD	Iron	Nitrate	Sulfate	Ammonia	Phenols	Copper	Zinc	Remarks
Bhairab River Near 225 MW Combined Cycle power plant at Goalpara, Khulna	04/05/13	31	34.7	7.65	-	3640	58.0	45	6.4	0.8	68	0.1	20	20	2.0	<0.1	0.1	<0.01	P^{II}, DO and BOD with national Limit. High Conc. of Cl⁻ and SO₄²⁻ may be due to salinity of tidal river water.
Bhairab River 100meter upstream 225 MW Combined Cycle power plant at Goalpara, Khulna	04/05/13	32	33.8	7.65	-	3630	58.0	42	6.8	0.6	64	0.1	20	20	2.0	<0.1	0.1	<0.01	
National Standard				6.5-8.5	-	-	-	-	>5	<10	-	-	-	-	-	-	-	-	

Note: All unit in mg/l, except Tem °C, EC micro-S/cm, Turbidity NTU, T. Coli colonies No/100 ml and salinity-ppt


Sample collector


Laboratory Assistant


Senior Chemist

Annex – 4.8.2

DoE's Ground Water Quality Test Report

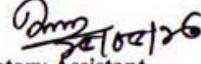
Govt of the People's Republic of Bangladesh
Department of Environment,
Khulna Divisional Office
Boyra, Khulna

Analysis sheet of Ground water sample

Sample Location	Date	Lab Code	Temp.	PH	EC	Turbidity	T S	TDS	SS	DO	BOD	COD	T. Hardness	Iron	N- Nitrate	Sulfate	Phosphate	Chromium	Salinityyy	Coli colonies	Remarks
Tube-well water of near 225 combine cycle power plant at Goalpara, Khulna	04/05/13	T-32	24.5	7.59	.	8.23	.	.	.	5.4	0.1	<20	.	.	.	.	.	.	.	.	All the parameters are within limit
Bangladesh Standards-			20-30	6.5-8.5	.	10	.	.	.	6	0.2	4	200-500	0.1-1.0	.	.	.	.	.	.

Note: All unit in mg/l, except Tem 0C, EC micro S/cm, Turbidity NTU, T. Coli colonies No/100 ml


Sample collector


Laboratory Assistant


Senior Chemist

Annex – 6.13.2

Questionnaire for Social & Environmental Survey

SOCIAL AND ENVIRONMENT IMPACTS STUDY

Name of Centre: **Khulna**

ID No.

Date: Photograph No: Time : Stating :

Ending:

RESPONDENT IDENTIFICATION.

মুজিবগ/আবে | অগ্নি বগ..... | অগ্নিবগK GKWJ

মতল ব মস-ব ত-তK GtmiQ | eZ@vfb অগ্নি v GB Gj vKvq GKWJ Zvc we`yr tKt`f Dci Rwi c KvR cwi Pvj bv

Ki WQ |

Name of Respondents (Dēi `vZvi bvg).....

(we`wii Z wKvbn)t Mohalla/Village:.....Union/Word:.....

Upazilla: Lwj kcj , Location: Disctirct-Khulna.

Check by interviewer.....date.....Signature.....

Check by Supervisordate.....Signature.....

Check by Quality Control.....date.....Signature.....

MIGRATION IN AND OUT

- 14| Avcbv iv GB Gj vKvq KZ w` b..... hver emevm Ki tQb?.....
- 15| Avcbv iv cteKv_vq wQtj b (uefu wj LtZ nte)?.....
- 16| eZgvtb GLvtb Ae`vtbi Kvib Dtj E` Ki`b?.....
- 17| emoi Qv`, t` l qvj Ges tqtSi aib wj wceX Ki`b

	wJb	cvKv	Uwj	gwU	euk	Qb/ tMvj cvZv	cvU Lwo	KvW	Ab`vb`
Qv`	1	2	3		5	6	7	8	
t` l qvj	1	2		4	5	6	7	8	
tqtS		2		4	5			8	

TREATMENT OF THE FAMILY MEMBERS

- 18| Amy` n`j Avcbv ev Avcbv i cwi evti i m` m`iv wPwKrmvi Rb` tKv_vq hvb?
.....
- 19| GLvtb AvcbvtK tKvb UvKv w` tZ ntqQj wK? n`v n`j KvZ UvKv Dtj E`Ki`b.....UvKv|
- 20| Avcbvt` i cwi evti vbæwj wLZ m`ut` i gta` tKvbwU AvtQ?

(mvavi bZ Avcbv wK wK t` tLb l tkvtbb?)

- | | | |
|------------------|----------------------------|------------------|
| K. ti wWl 01 | L. tUwj wfk b 02 | M. evB mvBtKj 03 |
| N. gUi mvBtKj 04 | O. tmj vB tgvkb 05 | P. j`vU` tdvb 06 |
| Q. tgvBj tdvb 07 | R. ti wdrvti Ui 08 | S. Mwo/UtK 09 |
| T. wi Kmvf`vb 10 | U. tbSkv 11 | V. Nwo 12 |
| W. Avj gwi 13 | X. LvU/weQv v 14 | Y. tPqv /teA 15 |
| Z. tgvBj 16 | _. Ab`vb` 17 (wlv` t Ki b) | |

WATER AND SANITATION

21| Avcbv` i cwi ev`i i Lvevi cwbi c`avb Drm wK?

K. evmvi wfZ`i cvBc.....01

L. evmvi evB`i cvBc.....02

M. bj Kc/Mfxi bj Kc.....03

N. Kqv.....04

O. c`Ki /Lvj /n`05

P. b`x.....06

Q. Ab`vb` (wbw` @ Ki b)07

22| Avcbv` i Gj vKv`Z (bj K`ci) Lvevi cwbt`Z Avtm`K Avt`Q wK?

n`u 1 bv 2

23| Avcbvi ewot`Z cvqLvbi aiY wK ?

K. tmdwU U`v`/AvaybK Uq`j U.....01

L. Rj vex/ `we j `wUb.....02

M. wCU j `wUb.....03

N. tLvj v j `wUb.....04

O. Sj š-j `wUb.....05

P. tSvc Svo/tLvj v gw.....06

Q. Ab`vb` (wbw` @ Ki b).....07

Knowledge, Attitude, about the use of electricity

24| Avcbv` i evmvq we`jr Avt`Q wK? n`u 1 bv 2 (31 G hvb)

25| Avcbv` qv K`i ej `eb Avcbv` i Gj vKvq wK wK ai`bi Kv`R we`jr e`envi Kiv nq?

.....

.....

26| Avcbv` i Gj vKvq th we`jr mieivn Kiv n`Q Zvi fvj w`K_{vj} wK wK?

.....

.....

.....

27| hw` Lvivc etj , Lvivc w`K_{vj} wK wK?

.....

.....

28| Avcbv` i Gj vKvq 225 tgmvl qvU (KgevbmvB`Kj) bZb Zvc we`jr tK>`^`vcb Kiv n`qt`Q tm`q`i`i

Avcbvi gZvgZ ej `p? (Probe fvj w`K/ Lvivc w`K_{vj} wbw` @ fv`te Rvbi tP`ov Ki`b)

a) (fvj w`K)

b) (Lvivc w`K).....

c) Avciwb tkb Gifc gtb Ktib?.....
(ueu wj Lp)

29| i vbwi Kvtr Ryj vbx wnmvte wK e'envi Ktib?

- K. Kw.....01 L. kl" AveRov.....02
- M. Meiti i uJ.....03 N. Gj wc/Zij M'vm.....04
- O. Btj KwK wUvi05 P. M'vm.....06
- Q. tKti wmb.....07

30| Ryj vbx eve` gvtm KZ e'q nq.....UvKv

ENVIRONMENT IMPACT OF THE SOCIETY

31. Avciwb nqZ AeMZ AvtQb th, Avcbvt` i AwZ Kvtr GKwU we` jr tk>` ttek wKozwkí cÖZövb AvtQ| G
wel tq Avcbvi gZvgZ wK?

32. GB we` jr tk>` wKí cÖZövb Ae`vtbi Kvi tb (kã `j b/evqy`j b) mvavi bZ Avcbvt` i tKvb Amyeav nq
wK? wK ai tbi Amyeav nq?.....

.....Probe wj Lp|

33. Dtj wZ mgm`v wj Qvov Avi wK wK cwí tek MZ mgm`v AvtQ etj Avciwb gtb Ktib?

.....Probe wj Lp|

34. Avciwb wK gtb Ktib we` jr tk>` wKí cÖZövb `vtbi Kvi tb Avcbvt` i Gj vKvZ AmyL/wemL ewx

tctqtQ? niiv 1 bv 2

wK ai tbi AmyL wemL ewx ctqtQ.....

35. eZ@v b Avcbvi wBR⁻ ^emv fZ/Gj vKv fZ ev ⁻ vbxq f v te (Ab[^] T) mvavi bZ wK wK ai f bi MvQc vj v Av f Q et j Av c w b hv f b b |

35. wK wK MvQ cvj v Awec`vcba(Av f Q)	35. wK wK MvQ cvj v Awec`vcba(Av f Q)	35. wK wK MvQ cvj v Awec`vcba(Av f Q) |	36. wK wK MvQ cvj v wec`vcbae

37. eZ@v t b GB MvQc vj v , wj wec`vcba n l qvi c 0 vb wZb wJ Kvi b D t j \vdash Ki "b?
c 0 g Kvi Y..... wZxq Kvi Y..... ZZxq/tkl Kvi Y.....

38 f Kb Av c t b Gi f c g t b
K t i b?.....
(ueu wj Lp)

39. eZ@v t b Av cbv f ` i Gj vKv f Z wK wK ci ev RxeRŠ' mvavi bZ t ` Lv hvq?
ci RxeRŠ' bvg w b t g r D t j \vdash Ki "bt

39. wK wK Rxe/RŠ- Awec`vcba(Av f Q)	39. wK wK Rxe/RŠ- Awec`vcba(Av f Q)	39. wK wK Rxe/RŠ- Awec`vcba(Av f Q)	40. wK wK Rxe/RŠ- wec`vcbae

41. eZ@v t b GB ci | RxeRŠ-wec`vcba n l qvi c 0 vb wZb wJ Kvi b D t j \vdash Ki "b?
c 0 g Kvi Y..... wZxq Kvi Y..... ZZxq/tkl Kvi Y.....

42. †Kb Avctb Gifc gtb
Ktib?.....

(ûeû wj Lp)

43. eZgvtb Avcbt` i Gj vKvZ wK wK cwL mvavi bZ t` Lv hvq?

cwLi bvg wbtgæDtj E-Ki "bt

43. wK wK cwL Awec` vcbæ (AvtQ)	43. wK wK cwL Awec` vcbæ (AvtQ)	43. wK wK cwL Awec` vcbæ (AvtQ)	44. wK wK cwL wec` vcbæ

45. eZgvtb GB cwL wec` vcbæI qvi c0 vb wZbwJ Kvi b Dtj E-Ki "b?
c0g Kvi Y.....w0Zxq Kvi Y.....ZZxq/tkl Kvi Y.....

46. †Kb Avctb Gifc gtb
Ktib?.....

(ûeû wj Lp)

47. eZgvtb Avcbt` i Gj vKvZ wK wK gvQ mvavi bZ t` Lv hvq?

gvQ, wj i bvg wbtgæDtj E-Ki "bt

47. wK wK gvQ Awec` vcbæ (AvtQ)	47. wK wK gvQ Awec` vcbæ (AvtQ)	47. wK wK gvQ Awec` vcbæ (AvtQ)	48. wK wK gvQ wec` vcbæ

48. eZgvtb GB gvQ, wj i wec` vcbæI qvi c0 vb wZbwJ Kvi b Dtj E-Ki "b?
c0g Kvi Y.....w0Zxq Kvi Y.....ZZxq/tkl Kvi Y.....

49. $\int K b \sin x \cos x \, dx$

Katib?.....

(Üeü wj Lp)

50. $\int \sin x \cos x \, dx$ i $\int \sin x \cos x \, dx$ HwZnwmK $\int \sin x \cos x \, dx$ wv`Rb $\int \sin x \cos x \, dx$ AvtQ wk? n`u bv

(hw` HwZnwmK $\int \sin x \cos x \, dx$ ev wv`Rb $\int \sin x \cos x \, dx$ Zvtj wv` ófvte D`j E-Ki`b)

1.....2.....3.....4.....

51. $\int \sin x \cos x \, dx$ i $\int \sin x \cos x \, dx$ AvtQ..... etj AvtB hv`bb |

Rmbbv/ej $\int \sin x \cos x \, dx$ =

52. wk Kvi $\int \sin x \cos x \, dx$ GB Ae`vi m`ó ntqtQ (A`r cmbi tj qvi wv`P Ae`vtbi Kvi b) m`ó ntqtQ etj

AvtB g`b Katib |

Ae`v m`ó i Kvi Y.....Rmbbv/ej $\int \sin x \cos x \, dx$ =

53. $\int \sin x \cos x \, dx$ c`Zôvb $\int \sin x \cos x \, dx$ AvtB i $\int \sin x \cos x \, dx$ AvtQetj

AvtB hv`bb |

Rmbbv/ej $\int \sin x \cos x \, dx$ =

(D`i`vZvtK ab`ev` Rmbtq $\int \sin x \cos x \, dx$ Kvi tkl Ki`b |)