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Department of Environment

The People's Republic of Bangladesh

Environmental Impact Assessment (EIA) Report

For

SPL Petrochemical Complex Limited

Moheshkhali Economic Zone-3

Dhalghata, Moheshkhali, Cox's Bazar

June, 2019

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Abbreviation and Acronym

ADB	Asian Development Bank
APHA	American Public Health Association
AIDS	Acquired Immunue Defficiency Syndrome
AAQM	Ambient Air Quality Monitoring
As	Arsenic
API	American Petroleum Institute
BBS	Bangladesh Bureau of Statistics
BARC	Bangladesh Agriculture Research Council
BIWTA	Bangladesh Inland Water Transport Authority
BERC	Bangladesh Energy Regulatory Commission
BFD	Bangladesh Forest Department
BPDB	Bangladesh Power Development Board
BEZA	Bangladesh Economic Zone Authority
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
BOI	Board of Investment
BDT	Bangladeshi Taka
BOD	Biochemical Oxygen Demand
CAA	Civil Aviation Authority
C_6H_5OH	Phenolic Compounds
CO	Carbon Monoxide
Cn	Cyanide
CP	Contracting Party
CRC	Convention on the Rights of the Child
CETP	Central Effluent Treatment Plant)
CFCs	Chlorofluorocarbons
CD	Cadmium
Cr	Chromium
Cu	Copper
CSR	Corporate and Social Responsibilities
CESR	Corporate Environmental and Social Responsibilities
CFU	Colony Forming Unit
CNG	Compressed Natural Gas
CO_2	Carbon
COD	Chemical Oxygen Demand
^0C	Degree Celsius
DO	Dissolved Oxygen
DMB	Disaster Management Bureau
DDM	Department of Disaster Management
DAE	Department of Agriculture Extension
DPHE	Department of Public Health and Engineering
DOE	Department of Environment
DoF	Department of Fisheries
ECNWRC	Executive Committee of the National Water Resources Council
EZs	Economic Zones
EIA	Environment Impact Assessment
ECA	Environment Conservation Act
ECR	Environmental Conservation Rules
ECC	Environmental Clearance Certificate
EIA	Environmental and Social Impact Assessment
EHS	Environment, Health and Safety

ETP	Effluent Treatment Plant
EA	Environmental Assessment
ESMP	Environmental and Social Management Plan
EMMP	Environmental Monitoring and Management Plan
EMP	Environmental Management Plan
EPFIS	Equator Principle Financial Institutions
ESMS	Environmental and Social Management System
ERP	Emergency Response Plan
ERT	Emergency Response Team
ECA	Ecologically Critical Areas
EC	Electrical Conductivity
FC	Fecal Coliform
FCPS	Fellow of the College of Physicians and Surgeons
FGDs	Focused Group Discussions
Ft.	Feet
FY	Fiscal Year
F	Fluoride
Fe	Iron
FAO	Bangladesh Food & Agriculture Department
GoB	The Government of Bangladesh
GSB	Geological Survey of Bangladesh
HIV	Human Immune deficiency Virus
HHs	Households
Hg	Mercury
ILO	International Labor Organization
IFC	International Finance Cooperation
IUCN	International Union for Conservation of Nature
Km	Kilometer
kg	Kilograms
LGED	Local Government and Engineering Department
LCC	Location Clearance Certificate
MEZ-3	Moheshkhali Economic Zone-3
MoEF	Ministry of Environment and Forests
MOS	Ministry of Shipping
MOLE	Ministry of Labour and Employment
MoFL	Ministry of Fisheries and Livestock
MSDS	Compilation of Material Safety Data Sheets
MEAs	Multilateral Environmental Agreements
MBBS	Bachelor of Medicine Bachelor of Surgery
mm	Mili Meter
mg	Miligram
mg/L	Miligram per litre
µg	Micor gram
MT	Metric Ton
Mn	Manganese
NOx	Nitrogen Oxides
NWMP	National Water Management Plan
NWRD	National Water Resources Database
NWRC	National Water Resources Council
NOC	No Objection Certificate
N	Nitrogen
Ni	Nickel
N	Nitrate
OPs	Operating Procedures

O_3	Ozone
OHS	Occupational Health Safety
PMO	Prime Minister's Office
PM	Particulate Matter
PS	Policy Statement
PCMs	Public Consultation Meetings
PDMs	Public Disclosure Meetings
PSMP	Power System Master Plan
PGCB	Power Grid Company of Bangladesh
Pb	Lead
PCP	Public Communications Policy
P	Phosphorus
PPE	Personal Protective Equipment
PM_{10}	$(Particulate\ Matter)_{10}$
$PM_{2.5}$	$(Particulate\ Matter)_{2.5}$
PCM	Public Consultation Meeting
PD	Public Disclosure
PDM_s	Public Disclosure Meetings
PRA	Participatory Rapid Assessment
PAPs	Project Affected Persons
SC	Shahidul Consultant
Se	Selenium
SO2	Sulfur Dioxide
SMS	Safety Management System
SPM	Suspended Particulate Matter
SPS	Safeguard Policy Statement
SPS	Social Protection Strategy
S	Sulfide
SW	Solid waste
SS	Suspended Solids
SO_x	Oxides of Sulfur
STP	Sewage treatment plant
SWM	Solid Waste Management
SRDI	Soil Research Development Institutes
SS	Suspended Solids
SPM	Suspended Particulate Matter
TDS	Total Dissolved Solids
TC	Total Coliform
TSS	Total Suspended Solids
ToR	Terms of Reference
UNEP	United Nations Environment Programme
UP	Union Parishad
VOCs	volatile organic compounds
WB	World Bank
WARPO	Water Resources and Planning Organization
WTP	wastewater treatment plant
WTP	Water treatment plant
Zn	Zinc
%	Percentages

Executive Summary

Introduction

The oil and petroleum industry of Bangladesh is mostly under the control of Government. The production, processing, refining and marketing of petroleum and petrochemical products in the country is vested exclusively with the Government of Bangladesh as per Bangladesh Petroleum Corporation Act, 2016. Bangladesh Economic Zone Act, 2010, has been introduced by the Government of Bangladesh to facilitate development of Economic Zones (EZs) in the potential regions of the country, aiming to boost up the country's economic development and ensure standard, eco-friendly industrial zone that would encourage more foreign investment. Under this Act, the Bangladesh Economic Zone Authority (BEZA) has been established under the Prime Minister's Office (PMO) and governed by a Board chaired by the Prime Minister. The law provides legal coverage for attracting and leveraging private investment in the development of zones as zone developers or operators, and in the provision of tailored infrastructure services, such as private provision of power, effluent treatment, etc. As the government vision to established Moheshkhali as the economic and industrial hub, BEZA took the initiative to developed Moheshkhali Economic Zone-3 ('Hereinafter MEZ-3) at the Dhalghata Union of Moheshkhali Upazila of Cox's Bazar District.

Super Petrochemical Limited is the first petrochemical industry in the private sector and is the pioneer of its kind since July, 2013. Recently, considering the site location, available infrastructure, existing industries, infrastructure and logistic requirement, they are interested to establish a petrochemical production facility in Moheshkhali Economic Zone-3 (MEZ-3) namely SPL Petrochemical Complex Limited (SPCL) to meet the growing market demand of petroleum and petrochemical products.

Project Background

In considering the demand of petrochemical products in Bangladesh, Super Petrochemical Limited has decided to develop olefin production facilities with the aim of producing import substitute polyolefin products like LLDPE/HDPE and Polypropylene (PP).

Naphtha will be used as main raw material for olefin production and a crude oil refinery will be integrated for recovering naphtha which will also increase efficiency & value. Hence, SPL Petrochemical Complex Limited comprises two major units:

i. Crude Oil Refinery and
ii. Cracker & Polymer Production Unit.

For preparing the Environment Impact Assessment (EIA) report, a Terms of Reference (ToR) on the proposed SPL Petrochemical Complex Limited project was applied to DoE. Afterward, the ToR was granted by DoE Memo No. 22.02.0000.18.72.41.19.141 dated 27thFebruary, 2019.

Policy, Legal and Administrative Framework

This chapter provides a description of the regulatory framework applicable to the proposed project. It highlights environmental, health & safety and social regulations with applicable permits and standards in association with the project. It broadly focuses on the:

- Legal Enforcement Agencies at National Level;
- Applicable national and local Environmental and Social Laws, Regulations and Policies;

- World Bank Environmental Safeguard Policies and expected trigger ability;
- World Bank (WB) Environmental Impact Assessment Guidelines;
- International & National Environment Standards/ Guidelines; and
- Applicable International Conventions/Protocols.

Project Description

Proposed project will be located at Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh to meet the growing market demand of petrochemical products. Basic information of proposed petrochemical project is represented in Table below.

Table I: Description of the Project at a Glance

Name of Project	SPL Petrochemical Complex Limited
Project Proponent	Super Petrochemical Limited
Project Location	Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh
Head Office Address	TK Bhaban (5th Floor), 13 Kawran Bazar, Dhaka, Bangladesh
Major units	i) Crude oil refinery ii) Cracker & polymer production unit
Final Product	LLDPE/HDPE, Polypropylene(PP), Jet A1/ Kerosene, Ultra Low Sulfur Diesel (ULSD), Base oil/White Oil, Furnace Oil, Benzene, Toluene, Xylene, LPG
Plant Capacity	i) Crude Oil Refinery: Design Capacity- 140,000 bpd Target Production- 100,000 bpd ii) Cracker & Polymer Production Unit: a. Cracker Design Capacity: 1,400,000 Metric ton naphtha per year b. Polyolefin Capacity, LLDPE/HDPE : 550,000 & PP: 350,000 Metric ton per year
Raw Material	Crude Oil,Butene-1,Hexene-1, Methane (Natural Gas)
Required Quantity (ton per year)	Crude Oil: 4,488,809 Butene-1: 26,730 Hexene-1:13,900 Methane (Natural Gas): 341,865 Total: 4,871,304
Source of Raw Material	Imported
No. of Employees	1000 (Proposed)
Total Area of Land	386 acres
Project Cost	2 (Two) billion USD

Project Location and Area

The proposed project will be established in Moheshkhali Economic Zone-3 which is located at Dhalghata Union of Moheshkhali Upazila, Cox's Bazar District under Chattogram Division. Total project area is about 386 acres. The land is connected with sea at west side and river at east side. It has deep sea water connectivity and a set up of single point mooring jetty for unloading crude oil & exporting finished petrochemical products. River front will be used for developing jetty in order to export products and import different materials. North side of land is connected with existing Dhalghata road. This road will be developed for connecting Matarbari Port to National Highway and thereafter this project can get access to National Highway through this road.

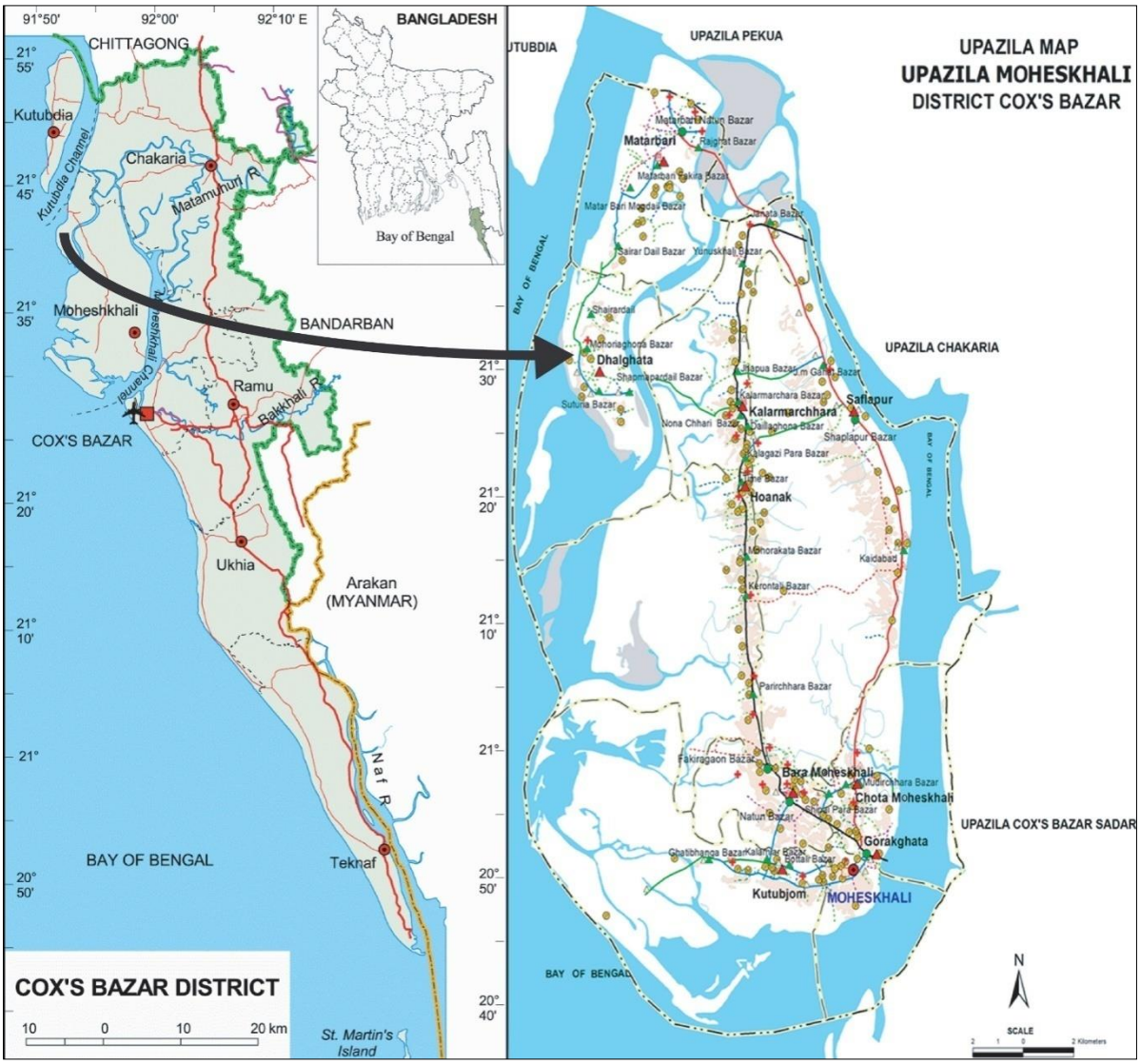

Figure I: Location of MEZ-3

Source: Banglapedia

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Architect, engineer and environment

Figure II: Location of the project site at Moheshkhali Economic Zone-3

Source: Google Earth

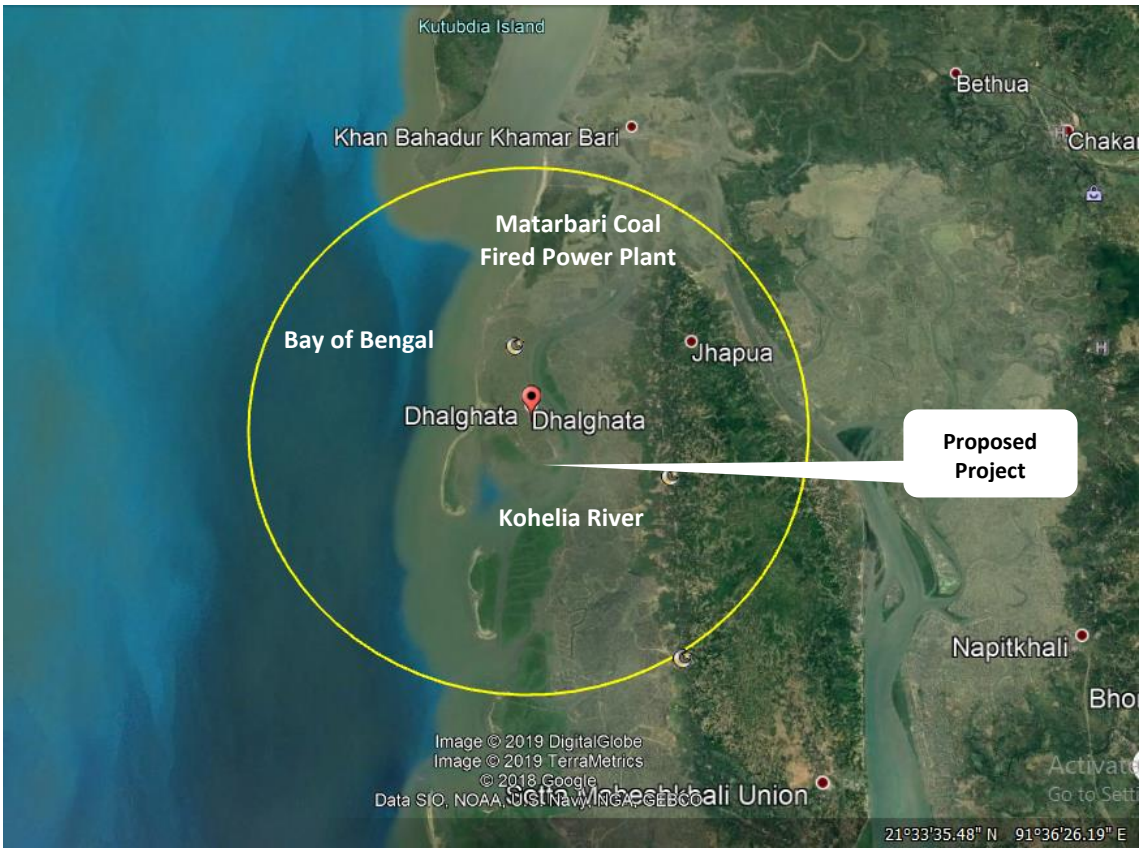


Figure III: 10 km radius from proposed project

Source: Google Earth

Land Use Plan

The proponent will develop the project layout plan. As per the current planning, land use pattern of the project site is given below:

- Total area: 386 acre
- Area occupied by crude oil refinery and cracker & polymer production unit: 241.18 acre
- Area occupied by tank farm/storage: 106 acre
- Green area: 38.82 acre (10% of total land)

Project Schedule

In considering the complexity of the project and the investment required there in it will be implemented in two stages. At first, crude oil refinery will be set up and thereafter cracker &polymer production unit will be set up.

- Target production date of Crude Oil Refinery: July, 2023
- Target production date of Cracker & Polymer Production Unit: July, 2025

Estimated Project Cost

Crude oil refinery and Cracker & polymer production plant set up is a matter of cost and this project total investment is 2 (two) billion USD. Major cost elements are land procurement and development, factory construction, mechanical and electrical works, transport including ocean freight and land vehicle, machineries, raw materials, catalyst cost, insurance, consultant fees, employee salary, etc.

Utilities Requirement

Water, fuel, instrument air, nitrogen and electricity are necessary for this project both at construction and operational phase. The utility requirements during operation phase are given below-

Table II: Types and demand of utility during project activities

Utility	Quantity		Source	Use
Crude Oil Refinery				
Raw Water	400	m^3/hr	Underground	DM plant and Fire pond makeup
DM Water	230	m^3/hr	DM Plant	Boiler feed water and Cooling water makeup
Cooling Water	14500	m^3/hr	Cooling Tower	Process cooling
Nitrogen	4000	Nm^3/hr	Air (Nitrogen generator)	Purging
Air	8000	Nm^3/hr	Air compressor	instrument Air, Nitrogen
HP Steam	300	TPH	Boiler	Process Requirement and Power generation
Natural Gas	700000	scf/h	Petrobangla	300 TPH steam production & heaters
Electricity	35	MW	National Grid & Captive Power Plant	
Cracker & Polymer Production Unit				
Raw Water	1000	m^3/hr	Underground	DM plant and Fire pond makeup
DM Water	750	m^3/hr	DM Plant	Boiler feed water and Cooling water makeup
Cooling Water	48000	m^3/hr	Cooling Tower	Process cooling
Nitrogen	5000	Nm^3/hr	Air (Nitrogen generator)	Purging
Air	6000	Nm^3/hr	Air compressor	Instrument Air, Nitrogen
HP Steam	400	TPH	Boiler	Process Requirement and Power generation
Natural Gas	800000	scf/h	Petrobangla	400 TPH steam production & heaters

Electricity	86	MW	National Grid & Captive Power Plant	

Environmental and Social Baseline

The following table represents the summary of various environmental settings considering 10 km radius around project area.

Table III: Existing environmental settings of the project area

Particulars	Details
Location	Proposed project is located at Moheshkhali Economic Zone - 3 at Moheshkhali Upazila of Cox's Bazar District under Chattogram Division.
Total Area	386 Acres.
Site Elevation	0.2-1.02m from MSL.
Inundation Land Type	Medium high land 2 (land normally inundated 30-90cm depth).
Agro ecological Zone	The proposed area is located in Chattogram Coastal Plain.
Soil Types	According to soil test report Soil layers are of soft to very stiff cohesive clayey silt and silty clay with irregularly very loose to medium dense non-cohesive silty fine sand, very loose to dense non-cohesive silty fine sand with irregularly soil layers are soft to very stiff cohesive clayey silt, stiff to hard cohesive clayey silt with irregularly, medium dense to very dense non-cohesive silty fine sand, stiff to hard cohesive clayey silt and silty clay with irregularly dense to very dense non-cohesive silty fine sand up to 45m.
Major Agricultural Activity	Salt farming and shrimp culture.
Flooding	The proposed project area falls under coastal tidal flood prone area.
Nearest Airport	Cox's Bazar International Airport is about 25.81 km away from the site.
Nearest Railway Station	Chattogram Railway Station is about 70.73 km away from the site.
Nearest Port	Chattogram Sea Port is about 70.34 km and Payra Sea Port is about 167.30 km away from the site.
Climatic Condition	Project is situated at south-eastern climatic sub region of Bangladesh. Annual average temperature and rainfall varies from maximum 34.8°C to minimum 16.1°C. The annual average rainfall is 4285 mm. The district having been a coastal region often fall victim to tidal surge and cyclone.
Seismic Zone	Zone II (Seismic co-efficient is 0.05g)
Forests / National Parks	Some mangrove plantation and reserved forest is found surrounding the project area.
Archaeological Site	None within 10 km. Adinath temple is nearest (17.20 km) and the most of famous historical place of this Island.
Water Bodies	Matamuhuri, Uzantia, Kohelia, Moheshkhali channel and Kutubdia channel are main rivers and channels of the study area.
Ecologically Critical Area	No ecologically critical areas were found within the study area. Kutubdia island is around 12.70 km and Sonadia island is 17.89 km away from the project site.
Environmental and Social Hotspots	Sea, river, homestead forests and vegetation, mangrove vegetation, school, madrasha, mosque, temple etc.

Source: Topographic Survey report, Soil test repot, BBS Report (2011) & Google Earth

Identification and Analysis of Key Environmental Issues

The potential Environmental and Social Impacts Matrix of proposed project have been given in the following Tables. The negative impacts predicted in this manner were the 'unmitigated' impacts. Appropriate mitigation measures were recommended as part of this EIA, thus reducing the occurrence possibility and severity of the potentially adverse impacts.

Table IV: Environmental impact identification matrix (construction phase)

Parameter	Physical Environment					Ecological Environment			Social Environment				
	Topography	Hydrology	Water Quality	Air Quality	Noise	Vegetation	Fauna	Aquatic Environment	Displacement	Employment	Service	Health	Culture
Possession of Land							**P**						
Site development	**P**			**T**		**P**				**T**		**T**	
Civil and Structural Work			**T**	**T**	**T**					**T**		**T**	
Mechanical and Electrical Work				**T**	**T**					**T**			
Water Requirement		**T**	**T**										
Transport				**T**	**T**								
Employment			**T**							**T**	**T**		**T**

Here, P= Permanent, T= Temporary

Table V: Environmental impact identification matrix (operation phase)

Parameter	Physical Environment					Ecological Environment			Social Environment				
	Topography	Hydrology	Water Quality	Air Quality	Noise	Vegetation	Fauna	Aquatic Environment	Displacement	Employment	Service	Health	Culture
Water requirement		**P**											
Liquid effluent			**T**					**T**				**T**	
Gaseous effluent				**T**		**T**						**T**	
Solid waste												**T**	
Hazardous waste			**T**									**T**	
Transport				**T**	**T**								
Operational noise					**P**							**P**	
Immigration			**T**							**P**	**P**		**P**
Employment										**P**			

Here, P= Permanent, T= Temporary

Table VI: Checklist of potential environmental impacts

Project phase	Actions affecting environmental resources	SEI_s without mitigation measures				Type		Comments
		None	Minor	Medium	Major	Adverse	Beneficial	
Construction phase	Land value depreciation	×					×	Land value change: Positive impact
	Loss of and displacement from homestead land	×						No displacement: No impact
	Loss of and displacement from agricultural land	×						No impact
	Damage to nearby operation	×						No impact
	Disruption of drainage pattern	×				×		Combined with economic zone drainage system
	Encroachment into precious ecology	×						No precious ecological issues: no impact
	Runoff Erosion		×					Take care of local drainage pattern
	Worker accident		×			×		Take care by good housekeeping
	Sanitation diseases hazard		×			×		Concentration of labourers may cause unhygienic environment
	Noise/ Vibration hazard			×		×		Pilling/equipment installation may cause noise
	Traffic congestion				×	×		Regular monitoring by designated security
	Employment				×		×	Good employment opportunity
Operation phase	Encroachment into precious ecology	×						No precious ecological issues: No impact
	Depreciation of environmental aesthetics		×					Local community prefer employment generation activities
	Erosion/Silt runoff	×						Having boundary wall: no impact
	Pollution from liquid discharge			×				Preventive measure will be undertaken
	Pollution from solid wastes		×			×		No significant impact
	Air quality			×				No major impact
	Occupational health hazard			×		×		Reduce by good management practice
	Odour hazard		×					Minor impact
	Traffic congestion	×						No carrying of product
	Noise hazard		×					Moderate impact
	Employment			×			×	Good employment opportunity

Environmental and Social Impacts

Impact on Air Quality

Pre-construction Phase: In pre-Construction Phase, no significant impact will be anticipated regarding air emission.

Construction Phase: Gaseous emissions containing PM_{10}, $PM_{2.5}$, SPM, CO, HC, NO_x, SO_2 and lead will be released from the vehicular and construction equipment exhaust.

Post-Construction Phase: It is envisaged that particulate matter, sulfur dioxide, metals, VOCs, fugitive emissions and other criteria pollutants like ozone, oxides of nitrogen and carbon monoxide will be generated during industrial operations.

Impact due to Noise and Vibration

Pre-construction Phase: In pre-Construction Phase, no significant noise and vibration will be generated.

Construction Phase: Operation of different machineries and equipment for construction activities, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise and vibration during construction period.

Post-Construction Phase: During operation phase the noise levels may rise due to vehicular movement and industrial activities. The operation of industrial units can create vibration, but this will be limited to the adjoining area.

Impacts on Water Resources

Pre-Construction Phase: The major water body of the project area is Bay of Bengal and beside Kohelia River. The project will develop in an economic zone. So prior to start the project, only economic zone development activities have impact on water resources.

Construction Phase: Significant quantity of water will be required for various construction activities & domestic purpose. Excess withdrawal of ground water may lead to depletion of aquifers. There is a potential for contamination of groundwater resources resulting from improper management of sewage. The major source of wastewater generation during construction phase is from the labour camp, which will be established for project construction activity. There is a potential for contamination of surface water.

Post Construction Phase: Use of onsite machinery will affect groundwater quality through incidental leakage of fuel and/or lubricants. Impact to the groundwater may occur through leaching of harmful pollutants after rainfall and land washing. Inadequate management of fuel/oils/lubricants could lead to spillages that may reach the groundwater reducing its quality.

In addition, concrete wastewater generated from industrial operation and from the sewage to have effects. Sewerage Treatment Plant (STP) and Effluent Treatment Plant (ETP) shall be installed in operations phase of the project to reduce wastewater pollution in the nearby water bodies. In order to reduce the pressure on ground water project proponent should install rain water harvesting system for potable water.

Impacts on Land Resources

Pre-construction Phase: no major impact will observe due to start the project.

Construction Phase: The soil characteristics of the native soil may also be changed due to import of soil for filling and leveling purpose. It is envisaged that the filling activity may impact the native soil due to spillages during transportation of soil and run-off during filling and compaction.

Post Construction Phase: After development of project, disposal of industrial domestic and process waste may contaminate land and soil quality of the area. The impact can be significant and long term in case of uncontrolled discharges. Improper disposal of waste (hazardous and non-hazardous waste) may degrade soil, water, air quality and ecology of the area. Industries generate significant waste both hazardous and non-hazardous in nature, which can pollute the environment if not managed properly.

Impacts on Agriculture Resources

Pre-construction Phase: The area outside the economic zone is used only for salt cultivation. Because of the area is already an economic zone area, anticipated impact on agriculture is not so critical during pre-construction.

Construction Phase: The Construction activities will require different amount of temporary construction labor and will absorb from different sectors. It can create seasonal scarcity of such labor. Due to development of project, the agricultural activity will not impact.

Post-Construction Phase: The Proposed project will establish in an economic zone. So, operation activities of this project will not affected surrounding salt farming. Beside these, employment opportunity will be created for local people.

Impacts on Fisheries

Pre-construction Phase: The EZ area is mainly saltpan. The local residents earn their livelihood by cultivating salt. Moreover, significant number of them also does fishing six months in a year in the project area. Development of economic zone may destruct natural habitat of fisheries. But, the proposed project will not individually affect fisheries.

Construction Phase: During construction period construction materials may be released to the nearby river or sea from the construction site. This may damage the fisheries ecosystem of the respective water body. Construction materials, oil and chemical materials of heavy machines, vehicles, etc. will be stored in an appropriate storage site to prevent any release into the water body. These measures will minimize the impact of fisheries.

Post-Construction phase: During construction period construction materials may be released to the nearby river or sea from the construction site. This may damage the fisheries ecosystem of the respective water body. Construction materials, oil and chemical materials of heavy machines, vehicles, etc. will be stored in an appropriate storage site to prevent any release into the water body. These measures will minimize the impact of fisheries.

Impacts on Ecosystem

Pre-construction Phase: The site is considered as ‘no trees area’, so, there is no vegetation within the zone except some herbs. Some fauna lived and depended on food from the area will lose the habitat and source of sustenance. Plantation will provide them new home and source of sustenance by the project. The impact on flora and fauna will not be significant for this reason. Although, some scattered mangrove species are located in the west bank of Kohelia River.

Construction Phase: Waste generated from the construction work will include waste plastic, waste glass and waste oil. Furthermore, household waste discarded from the camping ground of the workers will include cans, bottles and garbage. If such waste is no adequately handled, flora and fauna can be affected. Olive Ridley's Turtle (*Lepidochelys olivacea*) is as vulnerable by IUCN. Olive Ridley turtles have been reported nesting in the Coast of Moheshkhali Island. Besides, *Caretta caretta* (Logger head turtle), *Chelonia mydas* (Green turtle), *Eretmochelys Imbricate* (*Hawksbill turtle*) are also found in the Moheshkhali Island. These species are likely to get impacted due to various construction activities of the project. The surface runoff from construction site, generation of suspended solid during piling, spillage & leakage of oil and lubricate, etc., may cause perceptible changes in water quality and also can affect the aquatic habitat and fauna.

Post-Construction Phase: The main impact on terrestrial ecology and biodiversity during the operation phase will result from gaseous and particulate emissions and similar impacts are expected to occur during the testing and start-up stage of the plant. This will include NO_X, SO_X, Methane, CO_2, CO and other gaseous emissions. These emissions are expected to impact the health of any existing fauna in close proximity to the proposed industry site or damage flora existing in the surrounding project area and inhibit its growth, if any. The major impacts sources of aquatic ecology and biodiversity during operation phase of the project include spillage & leakage of fuel & lubricant.

Socio-Economic Impact

Pre-construction Phase: No land acquisition is required for the development of the Project. Since no displacement of settlement occurred resettlement and rehabilitation is not relevant. Material, equipment and worker transportation may disturb existing road traffic including public transport using the highway and commercial vessels of nearby industries. No conflicts will occur with local residence as the land was procured from residents on a willing buyer–willing seller basis.

Construction Phase: Construction activities lead to generation of dust which may impact workers health. The influx of skilled workers might put pressure on the existing resources like water supply, supply of fuel, provision of basic facilities, waste handling and sewage disposal which might create frictions between them and the resident population of the area. The construction phase will throw open a varied set of job opportunities for the population belonging to the study area.

Post-Construction Phase: Due to development activity resource demand will be increased for both industrial work and migrant population. Vast employment opportunities potentially created by the project which will reduce poverty via increased income through various livelihood options.

Impact on Traffic

Pre-construction and Construction Phase: Delivery of construction material and equipment to the construction sites will be by road transport. Also during pipeline construction, works will lead to use alternative routes especially when crossing the highways. The transportation of material and equipment to the construction sites will cause temporary increase in traffic along the roads.

Post-Construction Phase: Impacts on traffic during operation phase are expected to occur due to transportation of products and materials/use of trucks and vehicles; this will lead to increase of frequencies of road operation.

Community Health and Safety

Pre-construction and construction Phase: Improper health and safety (H&S) policy maintained at the site may lead to outbreak of different diseases to the surrounding communities through the sick construction workers.

Post-Construction Phase: Due to project activity some possibility of third party accidents with residents near the construction site will be arise. With the inflow of migrant workers and their interaction with the local population, health issues among the local community might emerge. If proper waste management and effluent discharge system does not maintain, local people will be affected. Beside these, excessive air emission or noise generation will be also affected local community.

Impacts on Occupational Health and Safety

Pre-construction and construction Phase: The lack of adequate mitigation measures on the health and safety of the workers will result in accidents and injuries leading to loss of life or property. It is proposed to implement the following mitigation measures to ensure safe work place for the construction labor.

Post-Construction Phase: The workers who work inside the factory, face occupational health hazard due to different operational processes. Safe and good occupational health status of the employees and workers is important for not only the persons working in the plant, but also for the better plant operation and maintenance.

Emergency Response

Any emergency situation may be arising due to manmade activity (e.g. chemical spillage, fire etc.) or natural cause (e.g. earthquake, land slide, cyclone etc.).

Impacts due to Climate Change

Carbon dioxide is a greenhouse gas (GHG) and emissions of carbon dioxide while not directly harmful to human health, contributes to global warming and climate change. Carbon dioxide will be generated and emitted both directly and indirectly during the proposed complex different phases (e.g. testing and operation). The magnitude of the proposed complex impact on global climate is classified as very Low. However, due to the High duration of the impact and high sensitivity of the VR (Global Climate), the impact on climate change caused by the increase in GHG emissions is considered of Moderate significance.

Public Consultation and Disclosure

Consultation Outcomes

The stakeholders expressed that the development of the project bring social and economic development in the region providing permanent source of income for the PAPs and also to other nearby residential settlements. The stakeholders expressed their desire to hold consultations across the project lifecycle and not just at the initiation phase.

Further, the analysis of the key positive impacts, apprehensions and perceived negative impacts and the suggestions/recommendations as documented during stakeholder consultations are detailed in below table.

Table VII: Impacts perceived by the stakeholders

Positive impacts perceived by the stakeholders	Negative impacts
• Increase in direct and indirect employment opportunities for both the genders.	• Loss of primary source of livelihood.
• Provision of enhanced basic amenities.	• Impact on fishing.
• Facilitate improved access to market centers, educational institutions, healthcare facilities, and offices etc.	• The stakeholders expressed their apprehensions regarding the degradation of the water qualities due to development of industrial activities.
• The cumulative positive impacts of the project will result in increased mobility, employment generation, and above all better economic integration of the area with the major market and trade centers within and outside the districts.	

Environmental Management Plan and Monitoring Indicators

The establishment and execution of proposed project is believed to have a positive impact for sustainable economic growth of the country as well as provision of employment to the local people. However, the project may also have some impacts on the existing local environment, eco-system and socio-cultural activities including land use, soil quality, pollution of water, air, noise, etc. Therefore, a mitigation mechanism has to be established to the affected communities regarding various harmful impacts including the effects on livelihoods, environment, agriculture, water bodies, and surrounding social infrastructures. A detail EMP including health & safety measures has been described in the following table. The Project proponent will be responsible for accomplishing the proposed safety measures mentioned in the proposed EMP.

Following are the main advantages of the environmental mitigation plan:

- Ensure plan for the fulfillment of basic environmental standards essentially required to meet during design, construction, and operation period of the project;
- Provide plan for the development of compensatory actions especially in the form of compensatory forestation, green zone development and landscaping for minimizing the negative ecological impacts due to the project;
- Reduce the potential environmental impacts, causing the biophysical environment in the area to deteriorate and indirectly slow down the economy of local communities by the project.

The EMP for SPL Petrochemical Complex Limited has been prepared based upon optimum and reasonable costs that are needed for mitigation measures on a “least-cost” basis. Activities that needs to be carried out for the environmental management and monitoring of the proposed plan could be divided into two phases: during construction phase, and during operation phase.

Detail Environmental Management Plan, Environmental Monitoring Plan and Budget for Environmental Monitoring is mentioned in Chapter 6, 8 and 9 respectively.

Recommendations

The recommendations made for the project development on the basis of EIA study are given below:

- A set of baseline criteria (existing quality of different environmental parameters including air, water, noise and metal in the area at different time points) has been developed in this report.

It should be used in order to compare and monitor the parameters during pre-construction and construction phases of the project;

- Proposed EMP and EMoP should be implemented strictly during construction and operation phase of the project.
- Project proponent should install and maintain ETP and STP or connected to CETP and CSTP of Economic Zone for the treatment of waste water and maintain `zero' discharge provision for minimizing water pollution.
- Fuel Treatment Plant should be used for the treatment of oil and spillage before discharge;
- National 3R Strategy for Waste Management (Reduce, Reuse, Recycle) should be followed for the management of solid waste.
- Development of a green area surrounding the area should be considered with due importance.
- Rain water harvesting should be carried out to reduce the pressure on surface and ground water resources.
- Roof top of all infrastructures should be managed for the purpose of harvesting rain water, photovoltaic solar energy and gardening.
- All infrastructures should be built based on the seismic design consideration to avoid potential hazard risk.
- To avoid hazard due to any disaster, warning system, emergency evacuation system, construction of ground flood at an elevated level, provision of emergency equipment should be considered.
- Safety Management Guideline for workers should be strictly followed to minimize occupational health hazards.
- Proper training of environmental management, health and safety should be given to project management unit in both construction and operation phase.
- Eligible local people should be considered on priority basis that will be helpful for minimizing the socio-economic disruption.

CHAPTER 1
Introduction

1.1 Prelude

The oil and petroleum industry of Bangladesh is mostly under the control of Government. With a view to providing petroleum and petrochemical products to all consumers at equal price irrespective of transportation cost, the government established Bangladesh Petroleum Corporation (BPC) by a presidential Ordinance in 1976.

The production, processing, refining and marketing of petroleum and petrochemical products in the country is vested exclusively with the Government of Bangladesh as per Bangladesh Petroleum Corporation Act, 2016. The Petroleum Act also specifies the authorities, functions and responsibilities of BPC including establishment of plants & infrastructure, building necessary facilities and their extensions for marketing of petroleum and petrochemical products; monitoring coordination of the subsidiary companies of BPC and any other functions and responsibilities as directed by the government.

Bangladesh Economic Zone Act, 2010, has been introduced by the Government of Bangladesh to facilitate development of Economic Zones (EZs) in the potential regions of the country, aiming to boost up the country's economic development and ensure standard, eco-friendly industrial zone that would encourage more foreign investment. Under this Act, the Bangladesh Economic Zone Authority (BEZA) has been established under the Prime Minister's Office (PMO) and governed by a Board chaired by the Prime Minister. The law provides legal coverage for attracting and leveraging private investment in the development of zones as zone developers or operators, and in the provision of tailored infrastructure services, such as private provision of power, effluent treatment, etc. As the government vision to established Moheshkhali as the economic and industrial hub, BEZA took the initiative to developed Moheshkhali Economic Zone-3 ('Hereinafter MEZ-3) at the Dhalghata Union of Moheshkhali Upazila of Cox's Bazar District.

Super Petrochemical Limited is the first petrochemical industry in the private sector and is the pioneer of its kind since July, 2013. They are an associate concern of T.K Group. SPPL has been contributing in the national economy by producing import substitute petroleum and petrochemical products from local feedstock (Natural Gas Condensate and Naphtha). Recently, considering the site location, available infrastructure, existing industries, infrastructure and logistic requirement, they are interested to establish a petrochemical production facility in Moheshkhali Economic Zone-3 (MEZ-3) namely SPL Petrochemical Complex Limited to meet the growing market demand of petroleum and petrochemical products.

1.2 Project Background

SPL Petrochemical Complex Limited is a 100 % subsidiary of Super Petrochemical Limited and has been constituted for expanding petrochemical production facilities at Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh.

Super Petrochemical Limited is an associated concern of T. K. Group of Industries, one of the largest business conglomerates in Bangladesh. It controls 43 manufacturing units spread over a wide

spectrum of product profile such as vegetable oil & consumer products, steel, leather, textiles, chemicals & petrochemical, paper, cement, tea, particle board, etc.

Super Petrochemical Limited is controlling the petroleum & petrochemical business of the group and is now producing i) Xylene, ii) Toluene, iii) Hexane, iv) Hydrocarbon Solvent, v) Mineral Turpentine (MTT), vi) Gasoline Premium (RON 95), vii) Diesel & viii) LPG.

In considering the demand of polyolefin products in Bangladesh, Super Petrochemical Limited has decided to develop olefin production facilities with the aim of producing import substitute polyolefin products like LLDPE/HDPE and Polypropylene (PP).

Naphtha will be used as main raw material for olefin production and a crude oil refinery will be integrated for recovering naphtha which will also increase efficiency & value. Hence, SPL Petrochemical Complex Limited comprises two major units:

iii. Crude Oil Refinery and
iv. Cracker & Polymer Production Unit.

Super Petrochemical Limited has appointed Shahidul Consultant, a fastest growing research based environmental and management consultancy firm, to provide transaction advisory services for this project including Environment and Social Impact Assessment study.

For preparing the Environment Impact Assessment (EIA) report, a Terms of Reference (ToR) on the proposed SPL Petrochemical Complex Limited project was applied to DoE. Afterward, the ToR was granted by DoE Memo No. 22.02.0000.18.72.41.19.141 dated 27thFebruary, 2019. A copy of the approved ToR by DoE Bangladesh is attached in Annex-7.

1.3 Project Description

Proposed project will be located at Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh to meet the growing market demand of petroleum and petrochemical products. Basic information of proposed power plant project is represented in Table below.

Table 1: Description of the Project at a Glance

Name of Project	SPL Petrochemical Complex Limited
Project Proponent	Super Petrochemical Limited
Project Location	Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh
Head Office Address	TK Bhaban (5th Floor), 13 Kawran Bazar, Dhaka, Bangladesh
Major units	iii) Crude oil refinery iv) Cracker & polymer production unit
Final Product	LLDPE/HDPE, Polypropylene(PP), Jet A1/ Kerosene, Ultra Low Sulfur Diesel (ULSD), Base oil/White Oil, Furnace Oil, Benzene, Toluene, Xylene, LPG
Plant Capacity	iii) Crude Oil Refinery: Design Capacity- 140,000 bpd Target Production- 100,000 bpd iv) Cracker & Polymer Production Unit: a. Cracker Design Capacity: 1,400,000 Metric ton naphtha per year b. Polyolefin Capacity, LLDPE/HDPE : 550,000 & PP: 350,000 M. ton per year

Raw Material	Crude Oil,Butene-1,Hexene-1, Methane (Natural Gas)
Required Quantity (ton per year)	4,871,304 (Crude Oil:4,488,809; Butene-1: 26,730; Hexene-1:13,900; Methane (Natural Gas): 341,865)
Source of Raw Material	Imported
No. of Employees	1000 (Proposed)
Total Area of Land	386 acres
Project Cost	2 (Two) billion USD

All legal documents of the project is attached in Annex-1

1.4 Description of the Project Site

The location of this complex has been carefully selected in considering the area of land to be required for establishing huge processing unit and handling raw material & finished products as well.

In considering above it will be set up at Moheshkhali Economic Zone-3, Dhalghata, Moheshkhali, Cox's Bazar, Bangladesh. Bangladesh Economic Zone Authority (BEZA) has allocated and handed over land to SPL Petrochemical Complex Limited authority for establishing this project.

The land is connected with sea at west side and river at east side. It has deep sea water connectivity and SPM will be developed for unloading crude oil & exporting finished petroleum and petrochemical products. River front will be used for developing jetty in order to export products and import different materials. North side of land is connected with existing Dhalghata road. This road will be developed for connecting Matarbari Port to National Highway and thereafter this project can get access to National Highway through this road.

Figure 1: Location of the project site at Moheshkhali Economic Zone-3

Connectivity

The proposed EZ is well connected in terms of Sea/River transportation facilities. Chattogram Sea Port is about 70km and Payra Sea Port is about 167 km from the site. Kohelia River is very adjacent to the project which can also be used as transportation of raw materials and finished products. However, BEZA would facilitate necessary access road and other off-site infrastructures for the EZ.

1.5 Rationale for the Proposed Project

Petroleum sector is considered the most sensitive sector of economy. Macro-economic indicators are highly sensitive to the price of petroleum and petrochemical products. The three oil distribution companies namely Padma Oil Company Limited, Jamuna Oil Company Limited, and Meghna Petroleum Limited procure, store, and market petroleum and petrochemical products all over the country from their main installations. The price and margin of the petroleum and petrochemical products is fixed by the Government on the basis of quantity sold. According to BPC, the demand of petroleum and petrochemical products in our country stood at 5.26 million MT in year 2015-16.

The oil and petroleum industry of Bangladesh is mostly under the control of Government. With a view to providing petroleum and petrochemical products to all consumers at equal price irrespective of transportation cost, the government established Bangladesh Petroleum Corporation (BPC) by a presidential Ordinance in 1976. Presently BPC is composed of three oil marketing companies, two blending plants, one LPG bottling company and a refinery as its subsidiaries.

The production, processing, refining and marketing of petroleum and petrochemical products in the country is vested exclusively with the Government of Bangladesh as per the Bangladesh Petroleum Act, 1974. The Petroleum Act also specifies the authorities, functions and responsibilities of BPC including establishment of plants & infrastructure, building necessary facilities and their extensions for marketing of petroleum and petrochemical products; monitoring coordination of the subsidiary companies of BPC and any other functions and responsibilities as directed by the government. Intense competition has been prevailing in the lubricant market due to the presence of more than 50 market players along with the brands marketed by three state owned oil marketing companies. Marketing of petroleum and petrochemical products is responsibility of three oil marketing companies namely Padma Oil Company Limited (POCL), Jamuna Oil Company Limited (JOCL), and Meghna Petroleum Limited (MPL).

At present only about 30% of the market demand of the lubricant products are served by the three oil marketing companies. It is notable here that BPC has no price control on the lubricants products. The pricing structure is settled by the Government at ex-refinery level, depots level, and also at consumer level in different distances. The commission at each level of suppliers namely oil marketing companies, agents, dealers are also fixed by the Government. As per the requirement of the state, the Government of Bangladesh imports crude oil and refined oil, then the crude oil is refined through Eastern Refinery Ltd. (ERL), another subsidiary of BPC and distributed through its oil marketing companies. There exists some special arrangement among the three oil marketing companies with a few direct customers. Among the direct customer groups, there are some Government organizations (PDB, Bangladesh Railway, and Defense Service), autonomous body (Chattogram Port Authority, BIWTA, Bangladesh Ordnance Factory) and nationalized industries etc. The oil marketing companies are engaged in marketing of oil products and the income it earns is termed as 'Margin' that is fixed by and determined by the Government. Sales net of cost of goods sold (net earnings

from petroleum and petrochemical products) is recorded in the financial statements as a form of net revenue rather than gross revenue.

Fuel demand in Bangladesh

Petroleum is considered as the energy driver of an economy. It has great influence directly or indirectly in all economic sectors. It is the fundamental input of production and constitutes a significant portion of production cost in every sector of the economy. Fuel is used intensively in every sector including irrigation of agriculture sector, transportation sector and power production. The use of petroleum and petrochemical products in the country is varied. Petrol and diesel are the major fuels for transportation. Diesel is also widely used by farmers for irrigation, while kerosene is mostly used for lighting, especially by rural households without electricity. As a result an increase in petroleum price directly influences the inflation and GDP of the economy. Transportation, power and agriculture sectors are the main fuel-demand driver of Bangladesh. According to BPC, the demand of petroleum and petrochemical products in our country stood at 5.26 million MT in year 2015-16. High Speed Diesel (HSD) and Furnace Oil (FOSH) drive 82.2% of total petroleum demand. A whole import dependency of fuel requires huge foreign exchanges that have a major impact on country's macro economy.

Table 2: Sale of petroleum and petrochemical products during last five years (quantity in million MT)

PRODUCT	2012-13	2013-14	2014-15	2015-16	% of Total	July 16-Dec 16	% of Total
JET A-1 (Jet Fuel)	318,423	323,327	338,829	347,323	6.6%	190,065	6.8%
HOBC (High Octane Blending Component)	110,850	117,452	126,114	147,557	2.8%	86,381	3.1%
MS (Motor Spirit)	169,710	178,674	166,823	137,360	2.6%	95,673	3.4%
SKO (Superior Kerosene Oil)	314,876	289,871	263,029	213,685	4.1%	87,472	3.1%
HSD (High Speed Diesel)	2,964,604	3,242,554	3,396,061	3,396,061	68.6%	1,842,824	66.0%
LDO (Light Diesel Oil)	1,092	1,064	2,666	2,758	0.1%	538	0.0%
JBO(Jute Batching Oil)	25,841	23,538	18,729	16,859	0.3%	7,904	0.3%
FOHS (Furnace oil)	1,076,423	1,202,505	906,771	711,889	13.5%	443,118	15.9%
LUBE (Lube oil)	15,908	17,823	17,869	17,445	0.3%	9,396	0.3%
SBP (Special Boiling Point)	800	368	234	207	0.0%	89	0.0%
MTT (Mineral Turpentine)	9,875	7,821	7,038	2,037	0.0%	2,147	0.1%
LPG (Liquid Petroleum Gas)	19,671	17,529	17,424	16,050	0.3%	8,027	0.3%
BITUMEN	58,396	62,440	59,836	36,446	0.7%	18,056	0.6%
TOTAL	5,086,469	5,484,966	5,321,423	5,256,020	100.0%	2,791,690	100.0%
INC/(DEC)	-127,177	398,497	-163,543	-65,403	-	-	-
% of INC/DEC from Previous Year	-2.44	7.83	-2.98	-1.23	-	-	-

Source: Bangladesh Petroleum Corporation (BPC)

Government supplies almost all of the petroleum demand through import from various countries to support the energy need in transportation, power generation, agricultural activities and others.

Import of petroleum has been increased in year 2016. Improvement in generation has a big impact on diesel consumption by the irrigation pump. Now, a huge number of pumps operate with electricity which earlier used to consume diesel. In upcoming year we can expect increase in petroleum import as government has issued permission for setting up power plants where most of them will be furnace oil based.

Table 3: Imported petroleum and petrochemical products (quantity in MT)

YEAR	GAS OIL	JET A-1	MOGAS	SKO	HSFO	LUBE	ALC	MURBAN	TOTAL
2009	2,243,758	256,576	98,064	141,103	-	7,248	612,913	425,614	3,785,276
2010	2,186,597	339,998	90,197	107,758	-	4,745	620,238	654,832	4,004,365
2011	2,955,798	318,202	95,824	153,598	665,260	4,980	627,535	583,960	5,405,365
2012	2,618,685	339,699	95,824	20,380	670,899	4,852	682,039	583,494	5,015,872
2013	2,608,746	310,884	97,641	28,376	1,005,104	-	592,054	591,091	5,233,896
2014	2,903,928	334,079	35,596	-	869,124	-	592,865	714,746	5,450,338
2015	2,974,749	338,315	33,842	-	414,451	-	697,667	395,006	4,854,030
2016	3,130,052	354,430	150,601	-	481,673	-	728,307	579,848	5,424,911
2017 (Up to June)	1,854,103	178,124	16,463	-	176,802	-	289,736	380,839	670,575

Source: Bangladesh Petroleum Corporation (BPC)

The major portion of imported petroleum is crude oil. Crude oil is refined through Eastern Refinery Ltd. (ERL), another subsidiary of BPC and distributed through its oil marketing companies namely Meghna Petroleum Ltd. (MPL), Padma Oil Company Ltd. (POCL) and Jamuna Oil Company Ltd. (JOCL). Right now total industry storage capacity is 1,189,172 MT. ERL has the highest storage capacity (42.5% of total) as crude oil is refined through it followed by three distribution companies POCL (20.6%), MPL (18.1%) and JOCL (15.5%).

Table 4:Product-wise storage capacity (quantity in MT)

Product/Location	ERL	POCL	JOCL	MPL	LPGL	SAOCL	ELBL	TOTAL
CRUDE OIL	225,800							225,800
LPGL	1,200				540			1,740
NAPTHA	27,300							27,300
MS	4,500	6,865	8,077	7,510				26,952
HOBC	23,800	5,215	6,199	6,236				41,450
SKO	6,000	14,616	14,087	20,065				54,768
HSD	75,750	138,761	129,984	163,090		10,845		518,430
FOHS	63,900	19,934	23,009	16,957		9,260		133,060
JET A-1	1,500	56,785						56,251
SBP		191						191
MTT		1,831						1,831
LDO		110						110
JBO	1,600	2,729	3,001	1,855				9,185
LUBE OIL						8,990	9,464	18,454
BITUMEN	3,500							3,500
RCO (ABP+VB)	44,000							44,000
CONDENSET	19,000							19,000
OTHERS	7,150							7,150
Total	505,000	247,033	184,357	215,713	540	29,095	9,464	1,191,206
As % of BPC's Total	42.4%	20.7%	15.5%	18.1%	0.0%	2.4%	0.8%	100.0%

Source: Bangladesh Petroleum Corporation (BPC)

Capacity

In terms of Capacity, Padma Oil Company Limited holds the highest position with a total capacity of 247,033 MT whereas Meghna Petroleum Limited has a total capacity of 215,713 MT and Jamuna Oil Company Limited has the highest capacity of 184,357 MT. The three oil marketing companies have the highest capacity for High Speed Diesel since demand for High Speed Diesel is the highest among all the petroleum and petrochemical products.

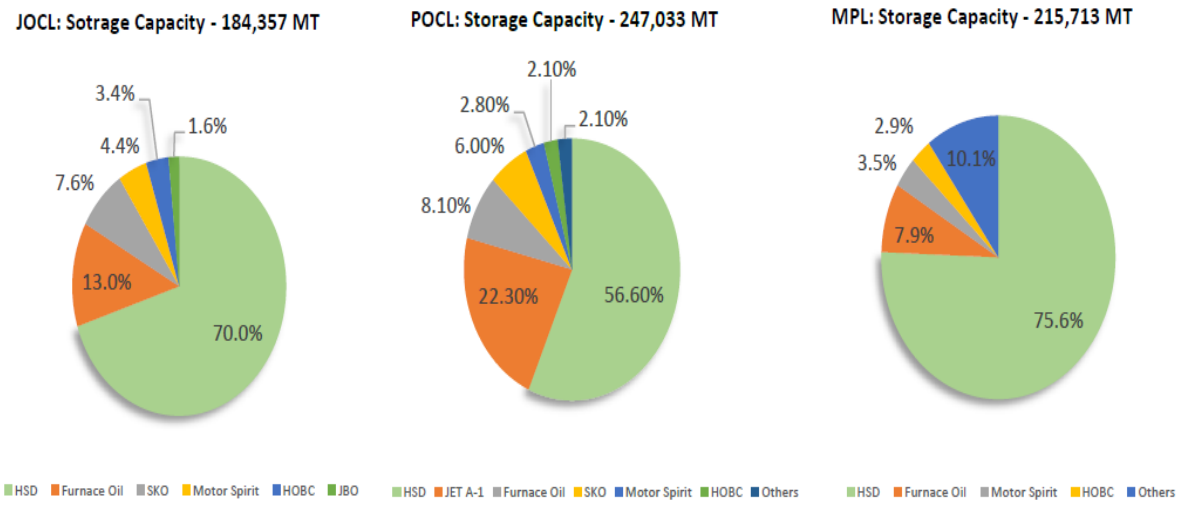


Figure 2: Storage capacity of three oil marketing companies in Bangladesh

Imported Petroleum and petrochemical Products in Bangladesh

Table 5: Crude Oil imported from 2001-02 to 2017-18

Financial Year	Quantity (M.Ton)	FOB Value/USD Million	Taka Crore
2001-02	12,24,707	220.19	1,277.78
2002-03	13,31,003	289.30	1,693.03
2003-04	12,52,424	314.12	1,848.43
2004-05	10,63,208	364.01	2,261.98
2005-06	12,53,285	573.65	3,901.16
2006-07	12,11,037	604.73	4,196.85
2007-08	10,40,084	762.08	5,288.85
2008-09	8,60,877	494.44	3,431.40
2009-10	11,36,567	646.21	4,491.41
2010-11	14,09,302	978.81	7,037.00
2011-12	10,83,467	919.26	7,053.51
2012-13	12,92,102	1060.30	8,536.70
2013-14	11,76,693	968.55	7,957.29
2014-15	13,03,194	734.00	5,739.35
2015-16	10,93,120	336.49	3,225.92
2016-17	13,87,966	514.10	4,132.35
2017-18	11,72,175	565.99	4,603.81

Source: Bangladesh Petroleum Corporation

Table 6: Refined Oil import from 2001-02 to 2017-18

Financial Year	Jet-A-1, SKO, Mogas & HSD		Lubricating Base Oil		Furnace Oil	
	Quantity (M.Ton)	Value (Crore Tk.)	Quantity (M.Ton)	Value (Crore Tk.)	Quantity (M.Ton)	Value (Crore Tk.)
2001-02	2072300	2535.62	15316	30.59	0	0.00
2002-03	2213899	3319.36	1911	5.10	0	0.00
2003-04	2262348	4015.81	6516	18.38	0	0.00
2004-05	2691750	7213.88	10189	38.14	39935	61.53
2005-06	2380582	9382.77	5137	35.53	0	0.00
2006-07	2536535	10443.20	4277	25.13	0	0.00
2007-08	2227753	14343.04	5006	29.94	0	0.00
2008-09	2507819	10945.24	4828	23.63	29959	60.38
2009-10	2634212	12024.18	7262	52.03	0	0.00
2010-11	2488456	21403.69	4749	43.75	230524	1123.17
2011-12	3409935	27111.24	4980	53.11	680982	3819.07
2012-13	2827160	21949.10	4853	38.56	803603	4367.26
2013-14	3158343	23485.56	0	0.00	1016101	5144.68
2014-15	3403889	18569.62	0	0.00	691705	2714.30
2015-16	3337427	11110.31	0	0.00	335150	660.52
2016-17	38,71,432	14,433.91	0	0.00	5,21,199	1,240.66
2017-18	48,92,089	23,300.67	0	0.00	6,50,540	2,091.52

Source: Bangladesh Petroleum Corporation, 2019

Bangladesh is the nineteenth-largest producer of natural gas in Asia. Gas supplies meet 56% of domestic energy demand. However, the country faces an acute energy crisis in meeting the demands of its vast and growing population. Bangladesh is a net importer of crude oil and petroleum and petrochemical products. The energy sector is dominated by state-owned companies, including Petrobangla and the Bangladesh Petroleum Corporation. Chevron, ConocoPhilips, Statoil, Gazprom and ONGC are major international companies engaged in Bangladesh's hydrocarbon industry, with Chevron's gas fields accounting for 50% of natural gas production. (Source: Wikipedia, July 2018)

Seasonal Variations

- March, April, May – irrigation seasons hence demand for power also goes up during drought season.
- LPG & CNG – No seasonal variations
- Seasonal variations do not have an impact on Aviation Fuel, Gasoline and Petrol.
- However it does have an impact on Diesel. Hence Bangladesh Petroleum Corporation makes necessary arrangements to import more quantities of Diesel during the irrigation season lasting from November to April to meet these increased demands.
- Local production in case of LPG & CNG and import of Aviation Fuel, Diesel, Gasoline and Kerosene are enough to meet the country requirements.
- Bangladesh has not experienced a lack of fuel in for the last twenty years due to an effective order processing mechanism in place for import of fuel even during flood and emergency situations.

Fuel Transportation

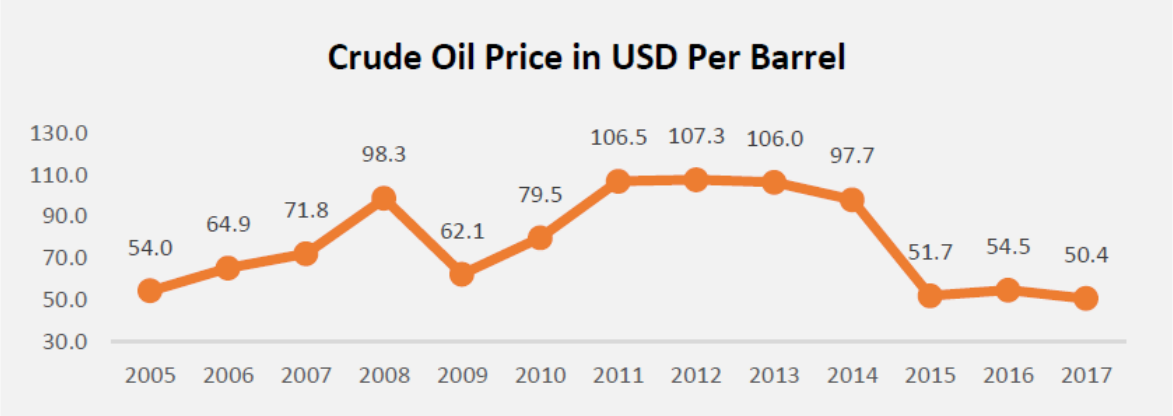
- Shipped to Chattogram, then transferred by coastal and river boats / barges to the regional depots, then trucked to the distribution points.
- LPG & CNG – Through pipelines
- All major fuel depots as well as one refinery are located in the port city of Chattogram:
    - 88% of fuel Transportation is undertaken by river mode of transport

- 7% by railways
- 5% by roads

- Fuel is transported in Tankers by roads, special wagons by trains, shallow draft tankers where depth of water is between 6 to 7 feet and by coastal tanker where depth of water is between 12 to 13 feet.
- Capacity of a Shallow Draft is 500 MT maximum whereas that of a coastal Tanker is 1.000 to 1.500 MT.
- The transportation infrastructure and fleet are not sufficient to handle current domestic needs as well as increased demand from the humanitarian community

Oil price in Bangladesh

The oil industry, with its history of booms and busts, has been in its deepest downturn in year 2015. Many of the companies have gone through bankruptcy as price of the oil came down more than 52.5% of 2013-14's price within a short period of time. As Bangladesh is a net oil import country, decrease in oil price helped to control inflation and made a positive impact on overall economy. The price of the oil was USD 107.3 per barrel in 2012 which came down to USD 97.7 per barrel in 2014. In 2015 it sharply fell down to USD 51.7 per barrel because of oversupply (one of the reasons) in world market by most of the oil producing countries. Bangladesh has taken this low price benefit and prices of diesel and kerosene have been brought down by BDT 3.0 a liter, octane and petrol by BDT 10.0 and furnace oil by BDT 18.0. In the year 2016 it was increased USD 54.5 and USD 50.4 in the year 2017.



Source: Investment Mine, 2018

Government directly controls the fuel-oil distribution companies that are contributing significantly to the total economy of the country by carrying out uninterrupted supply of petroleum and petrochemical products in all remote areas of the country. So their performance depends on the petroleum demands in the economy. Increase in petroleum demand can boost up their market performance in upcoming future.

1.6 Need of the Study

The proposed project comprises of development of crude oil refinery and cracker & polymer production unit which approximate area is about 386 acre. This development work will required filling and leveling works, construction of industry buildings within site, boundary wall, internal road network development etc.

The project attracts the applicability of Environment Conservation Act (ECA), 1995 & Environmental Conservation Rules, 1997. The proposed project is classified under red category as per Environmental Conservation Rules, 1997. Thus, it is required to carry out EIA study for the proposed Project as per ECA, 1995 & Environmental Conservation Rules (ECR), 1997 and obtain approval of DoE before taking up any construction activity at the proposed site.

1.7 Scope of the Study

This EIA for the project identifies the potential environmental impacts/issues due to the industrial project and also provides outline of suggestions of effective measures to mitigate the adverse impact and enhance the positive environmental potential. Specific scope of the EIA report covers to:

- Present a description of the project, the process and activities under the program and evaluate the practices from environmental point of view;
- Present a discussion of environmental, biological, social, legal policy and institutional requirement and arrangement;
- Describe and evaluate the project and adjacent area from environmental, biodiversity health and social point of view;
- Suggestion recommended abatement/mitigation/management measures to ensure environmental, biological, health and social compatibilities and also to comply with the national environmental legal requirements and national environmental quality standards.

1.8 Methodology of the Study

A wide range of environmental issues including physical, chemical, biological, socioeconomic, cultural, landscape values are considered in the EIA processes using methods and techniques to quantify or to qualify those changes to identify the problems, assess negative impacts and recommending integrated environmental management plan for anticipation and mitigation of the potentially harmful or adverse changes and finally ensuring the proposed measures through monitoring and evaluation of the whole EIA process by auditing.

Since identification of the probable adverse impact on surrounding socio-cultural and environmental situation including its magnitude, geographical extension of that impact, duration and frequency, the degree of reversibility, auditing probability of occurrence are critical for, all the issues were addressed in the current EIA study. Assessment of the probability of occurrence of a significant impact was also carried out.

The objectives of methodologies were as follows:

- To understand the nature and location of the project and possible alternatives;
- To identify factors of analysis and assessment objectives;
- Preliminary identification of impacts and scoping;
- Baseline studies and evolution in the absence of Projects;
- Prediction and assessment of impacts and alternatives;
- Comparison of mitigation monitoring and impacts management.

Following steps and methodology have been adopted for the EIA study:

- Review previous studies;
- Harmonization of environmental safeguard requirements of the government and co-financiers;
- Scoping, baseline environmental quality monitoring survey and development of the terms of reference for the EIA study;
- Screening of environmental impacts including soil, water, atmosphere, flora & fauna as well as social impacts including resources, recreation, cultural and prioritization;
- Expert consultations with scientific and professional community;
- Public consultation with affected population, local Government bodies, public representatives, NGOs and business communities to introduce the project components and anticipated impacts;
- Focus group discussions in project area;
- Prediction of impacts and prepare mitigation measures by field investigation, data analysis, and mathematical modeling;
- Integration of environment with engineer's planning and social concerns;
- Preparation of Draft and Updated EIA Reports, Environmental Management and Monitoring plan;
- Present Draft EIA Report in Stakeholder and Public Consultation Meetings for Public Disclosure;
- Submit Final EIA Report and EMMP incorporating comments of DoE for Approval;
- Implement EMMP during construction and operation and maintenance (O/M) stages;
- Environmental auditing by assessing EIA process and feedback to future EIA Study.

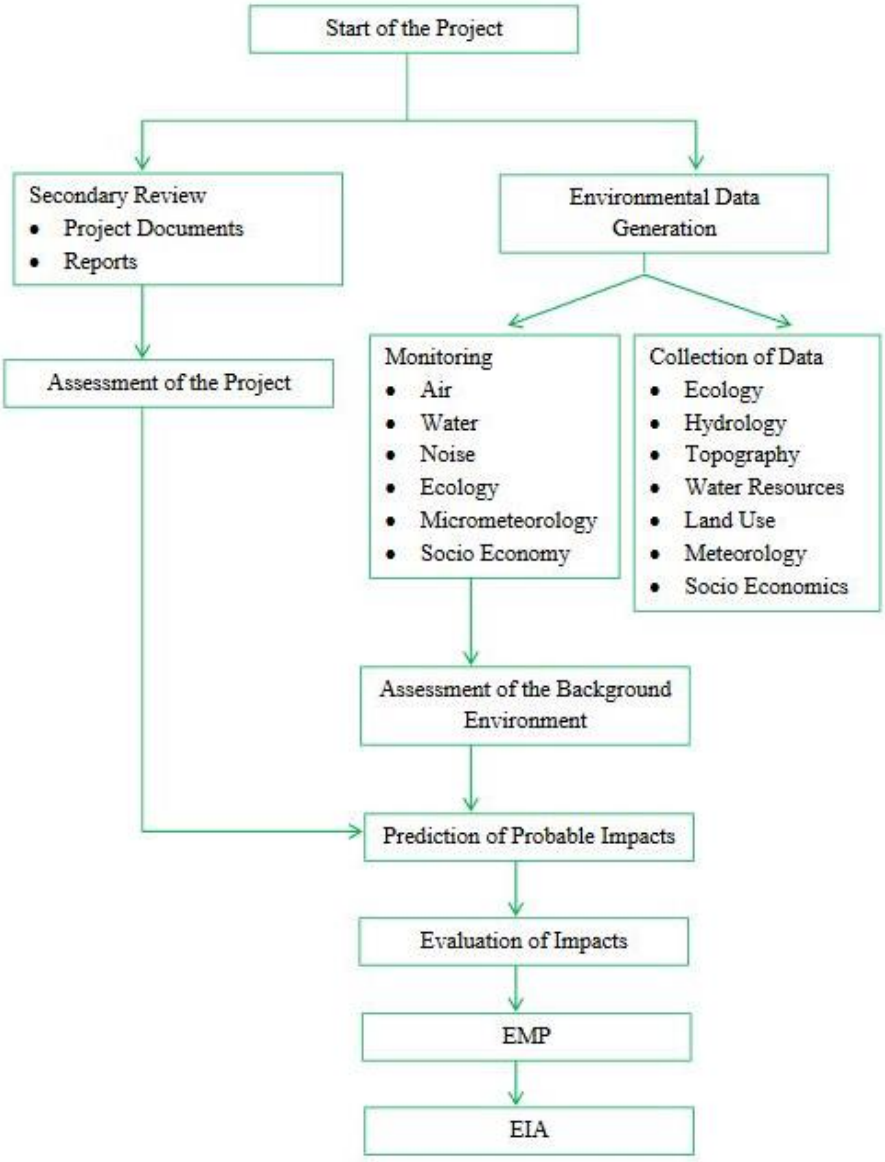


Figure 3: Process of Environmental Impact Assessment (EIA)

1.9 Limitation of the Study

The present EIA Report has been prepared based on the field investigations/assessment, and secondary data from data collected from Department of Public Health and Engineering (DPHE), Department of Environment (DoE), Department of disaster management (DDM), Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), and published journals, and books, public consultation and site observations. The environmental and social assessment is based on the information collected from the various agencies, community consultations and observations. Professional judgment and subjective interpretation of facts and observations has been applied for the preparation of the EIA Report. Since offsite facilities are proposed to be developed by BEZA, required information essential for EA are available.

1.10 ToR Compliance Matrix

The EIA study has been conducted in accordance with the ToR approved by DoE. The approved TOR is presented in Annex-7. Table below presents the point-wise compliance of the approved ToR.

Table 7: Compliance of TOR points

S. No.	ToR Point	Compliance
I.	The project authority shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said project in accordance with the ToR submitted to the Department of DoE and additional suggestions provided herein.	EIA study has been carried out in line with the ToR Approved by DoE and WB guidelines
II.	The EIA Report should be prepared in accordance with following indicative outlines:	Agreed
a.	Executive Summary	Provided in the report
b.	Introduction: (background, brief description, rationale of the project, scope of study, methodology, limitations, EIA Team and references)	Refer Chapter 1
c.	Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)	Refer Chapter 2
d.	Project Activities	Refer Chapter 3
e.	Project schedule: The phase and timing for development of the project	Section 3.4
f.	Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project	Section 3.5
g.	Map and survey information: Location map, cadastral map showing land plots (project and adjacent area), geological map showing geological units, fault zone, and other natural features	Section 1.4, 3.6&Chapter 4
h.	Baseline Environmental Condition (Physical Environment, Biological Environment, Environmental Quality)	Refer Chapter 4
i.	Socio Economic Environment	Refer Chapter 4
j.	Identification, Prediction and Evaluation of Potential Impacts(identification, prediction and assessment of positive and negative impacts likely to result from the proposed project	Refer Chapter 5& 6
k.	Management Plan/ Procedure	Refer Chapter 8 & 9
7	Consultation with Stakeholders/Public Consultation	Refer Chapter 7
10	Emergency Response Plan & Disaster Impact Assessment	Refer Chapter 10
11.	Conclusions and Recommendations	Refer Chapter 11
III	Without obtaining approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favour of important machineries	Agreed
IV	This approval of the Terms of Reference (ToR) would not mean any acceptance or site clearance of the project.	Agreed
VI.	Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.	Agreed
VII.	The project authority shall submit the EIA along with a filled in application for Environmental Clearance in prescribed form, the applicable fee in treasury Challan, the applicable VAT on Clearance fee in a separate treasury Challan, the No Objection Certificates (NOC) from local authority, NOC from forest department (if it is required in case of cutting any forested plant, public or private) and NOC from other relevant agencies for operational activity etc. to the Cox's Bazar District Office of DoE at Cox's Bazar with a copy to the Head Office of DoE in Dhaka.	Agreed

1.11 EIA Team

A multidisciplinary team of professionals having experience of conducting Environment & Social Impact Assessment studies for Industrial parks, Industrial cluster, Special Economic Zones, DTA, Economic Zones, Area development, Industrial Corridors etc. were involved in carrying out EIA study for this project. Details of the professionals are given in the Table below:

Table 8: EIA team

SN	Name of the Professionals	Area of Expertise	Position Assigned
1.	AKM Mizanur Rahaman	Environment and Social Impact Assessment & Environment Management Plan	Team Leader-cum-Environmental Expert
2.	Enggr. Md. Shahidul Karim	Land Use, Planning and Architecture	Urban Planner
3.	Md. Shofiul Islam	Environmental and Social Management Framework	Environmental Expert
4.	Md. Mahbub Kabir	Geo-spatial & Remote Sensing, Water, soil/sediment and air quality.	GIS and Laboratory Expert
5.	Sultana Afrose	Social Impact Assessment (SIA)	SIA expert
6.	Sadia Afrin	Ecology, Biodiversity and Environment	Biodiversity Expert

1.12 Structure of the Report

This EIA report has been prepared strictly following the report structure as per TOR. The EIA report contains project features, baseline environmental conditions, assessment of environmental impacts, and formulation of mitigation measures along with environmental management and monitoring plan.

The report includes the following chapters:

Executive Summary
The chapter provides the brief summary of the EIA report.

Chapter 1: Introduction
This chapter provides background information of the project background, rationale for the proposed project, scope and methodology adopted for EIA study, limitations of the study, TOR compliance matrix, details of the EIA team, structure of the report and references.

Chapter 2: Legislative, Regulation and Policy Consideration
This chapter deals with the details of the potential legal, administrative, planning and policy framework which have been used in the preparation of the EIA Report.

Chapter 3: Project Description
This chapter presents the details of the project, project objectives and options, interventions under selected options and activities, project area of influence, project activities, existing infrastructure in and around the site, project schedule and resources and utilities demand.

Chapter 4: Environmental and Social Baseline
This Chapter describes the baseline environmental conditions around the project site for various environmental attributes, in the project area of influence which is termed as the study area. Topography, soil, water, meteorology, air, noise, land constitute the physical environment, whereas flora and fauna constitute the biological environment.

Chapter 5: Identification and Analysis of Key Environmental Issues
This chapter identifies and details the key environmental issues related to the project.

Chapter 6: Environmental and Social Impact

This chapter details the impacts due to the project activities and suggestive mitigation measures

Chapter 7: Public Consultations and Disclosure

This Chapter provides details for the public consultation meetings in study area and the outcomes of public consultations

Chapter 8: Environmental Management Plan and Monitoring indicators

This Chapter provides mitigation and control measures to attenuate and/or eliminate environmental impacts, which are likely to be caused by the proposed project. An Environmental Management Plan (EMP) has been developed to mitigate the potential adverse impacts and to strengthen the beneficial impacts. This chapter also provides the environmental monitoring plan proposed for the project.

Chapter 9: Cost of EMP

This chapter provides the tentative cost for the implementation of EMP

Chapter 10: Emergency Response Plan & Disaster Impact assessment

This chapter concludes details disaster management plan for various emergency situations and responsibilities to manage them.

Chapter 11: Conclusions and Recommendations

This chapter concludes on the findings that emerged from the environmental assessment study and summarizes the key points to be addressed to ensure the environmental sustainability of the project during the construction and operation phases.

1.13 References

List of secondary data used for carrying out EIA study and preparation of EIA report is given at the following table.

Table 9: Reference used for EIA study

SN	Reference
Government Departments	
1.	Bangladesh Economic Zones Authority (BEZA)
2.	Department of Environment (DoE)
3.	Bangladesh Agriculture Research Council (BARC)
4.	Bangladesh Water Development Board (BWDB)
5.	Bangladesh Meteorological Department (BMD)
6.	Bangladesh Forest Department (DoF)
7.	Bangladesh Bureau of Statistics (BBS)
8.	Bangladesh Petroleum Corporation
9.	Bangladesh Food & Agriculture Department (FAO, Bangladesh)
10.	Geological Survey of Bangladesh (GSB)
11.	Disaster Management Bureau (DMB)
12.	Department of Disaster Management (DDM)
13.	Department of Agriculture Extension (DAE)
14.	Department of Fisheries (DOF)
15.	Power Grid Company of Bangladesh (PGCB)
16.	Land & Revenue Department
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Chapter 2
Legislative, Regulation and Policy Considerations

2.1 Policy, Legal and Administrative Framework

This chapter provides a description of the regulatory framework applicable to the proposed project. It highlights environmental, health & safety and social regulations with applicable permits and standards in association with the project. It broadly focuses on the:

- Legal Enforcement Agencies at National Level;
- Applicable national and local Environmental and Social Laws, Regulations and Policies;
- International & National Environment Standards/ Guidelines; and
- Applicable International Conventions/Protocols.

2.2 Legal Enforcement Agencies

The responsibility of formulation, implementation and modification of national level environmental laws in Bangladesh lies with the Ministry of Environment and Forests (MoEF). The Department of Environment (DoE) established under the Environmental Pollution Control Ordinance, 1977 which functions under the MoEF. It is responsible for carrying out the purposes and provisions of the Environment Conservation Act, 1995 as amended till 2010 (hereinafter referred as ECA) which is the umbrella legislation regulating environmental issues in the country. A brief description of the relevant legal enforcement agencies has been described in the Table below.

Table 10: Relevant legal enforcement agencies and their functions

SN	Agency	Functions
1	Ministry of Environment & Forests (MoEF)	The MoEF is the nodal agency in the administrative structure of the Central Government, for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programs. It oversees all environmental matters in the country and is a permanent member of the Executive Committee of the National Economic Council. It plays a pivotal role as a participant of the United Nations Environment Programs (UNEP). Its principal activities include: • Conservation & survey of flora, fauna, forests and wildlife; • Prevention and control of pollution; and • Forestation & regeneration of degraded areas and protection of environment in the frame work of legislations.
2	Department of Environment (DoE)	An Environment Pollution Control Board was setup under the Environment Pollution Control Ordinance, 1977. It underwent a series of subsequent restructuring and was finally renamed as Department of Environment in 1989. It is headed by a Director General appointed by the Government. The DoE through its head, divisional and district level offices conducts the following principal activities: • Advising the Government to avoid such manufacturing processes, commodities and substances which are likely to cause environmental pollution; • Advisory and issuing directions to the concerned person regarding the environmentally sound use, storage, transportation, import and export of a hazardous substance or its components; • Conducting inquiries and research activities on conservation, improvement and pollution of the environment and rendering assistance to any other authority/organization regarding the same; • Collection and publication of information about environmental pollution; • Conducting programs for observation of drinking water quality and issuing directives if necessary for adherence to drinking water quality standards; • Formulation of environmental guidelines;

SN	Agency	Functions
		• Prescribing and modifying environmental quality standards pertaining to air, water, noise, vehicular emissions etc.; • Issuing Location Clearance and Environmental Clearance Certificates to projects; and • Implementation of provisions of ECA and rules made there under.
3	Bangladesh Forest Department (BFD)	It was established under the MoEF and is responsible for identifying and declaring of certain areas as reserved or protected or private forest lands. It implements the provisions of Forest Act, 1927 and National Forestry Policy, 1994. It's also responsible for wildlife preservation and protection through implementation of Wildlife (Preservation & Security) Act, 2012.
4	Bangladesh Economic Zones Authority (BEZA)	Bangladesh Economic Zones Authority (BEZA) has been emerged by the Bangladesh Economic Zones Act, 2010, the Bangladesh Economic Zones Authority (BEZA) was officially instituted by the government on 9 November 2010. BEZA aims to establish economic zones in all potential areas in Bangladesh including backward and underdeveloped regions with a view to encouraging rapid economic development through increase and diversification of industry, employment, production and export.
5	Water Resources and Planning Organization (WARPO)	It was established under the Water Resources Planning Act, 1992. Its core functions include: • Monitoring the implementation of National Water Management Plan (NWMP); • Upkeep of water resource assessments; • Maintenance, updating and dissemination of the National Water Resources Database (NWRD) and MIS; • Secretariat to the National Water Resources Council (NWRC) and the Executive Committee of the National Water Resources Council (ECNWRC); • Responding to the NWRC/ECNWRC requests for information and advice; • Periodic update of the NWMP; • Assisting other agencies in planning, monitoring, studies and investigations; • Adhoc advice on policy, strategy, institutional and legal issues; • Laying down effluent discharge standards into river in consultation with DoE; and • Special studies and research as required.
6	Ministry of Shipping (MoS)	The Ministry of Shipping encompasses within its fold shipping and port sectors which also oversee the safety and environmental matters and the regulatory aspects of maritime shipping. It is responsible for: • Development and maintenance of waterways, inland water transport, ports, ocean shipping, development and expansion of physical infrastructural facilities, etc. • Managing and maintaining inland, island and inter island ferry-boat and shipping services; • Formulation and implementation of act, rules and policies regarding the aforementioned issues.
7	Bangladesh Inland Water Transport Authority (BIWTA)	It was setup in 1958 under the provisions of East Pakistan Inland Water Transport Authority Ordinance 1958. Its specific functions include: • Carry out river conservancy works; • Disseminate navigational and meteorological information including publication of river charts; • Draw up programmers of dredging requirements and priorities for efficient maintenance of existing navigable waterways and for resuscitation of dead or dying rivers, channels, or canals, including development of new channels and canals for navigation; and • Develop, maintain and operate inland river ports, landing/ferry Ghats and terminal facilities in such ports or Ghats.
8	Ministry of Fisheries and Livestock (MoFL)	The main functions of the MoFL include: • Preservation of fisheries resources; • Fulfilling the requirement of animal protein through proper management and planned development; • Increasing socio-economic conditions of fishermen; • Creating employment opportunities for rural unemployed and landless people; • Expanding foreign exchange earnings by exporting fish and fishery products; • Developing innovative technologies through research for fisheries development and preservation; and

SN	Agency	Functions
		• Protection of fishes through implementation of Protection and Conservation of Fish Act, 1950 as amended till date.
9	Bangladesh Power Development Board (BPDB)	It is a statutory body created in May 1, 1972 and is responsible for major portion of generation and distribution of electricity mainly in urban areas except Dhaka and West Zone of the country. It has undertaken a massive capacity expansion plan to add about 10500 MW generation capacities in next 5 years to achieve 24000 MW Capacity according to Power System Master Plan (PSMP) 2021.
10	Bangladesh Energy Regulatory Commission (BERC)	It was established under the Bangladesh Energy Regulatory Commission Act, 2003. Some of its key functions include: • Issue, cancel, amend and determine conditions of licenses, exemption of licenses and determine the conditions to be followed by such exempted persons; • Regulation of generation, storage, supply, and transmission of energy; • Determine tariff for electricity distribution etc.; • Ensure control of environmental standard of energy under existing laws; • Extend co-operation and advice to the Government, if necessary, regarding electricity generation, transmission, marketing, supply, distribution and storage of energy.
11	Ministry of Labor and Employment (MoLE)	It was established with following objectives: • Creation of employment opportunity; • Creation of semi-skilled and skilled manpower; • Enhancement of productivity of factories by creating friendly working environment between workers & employers; • Ensuring welfare of workers in different industrial areas; • Implementation of labor laws; • Fixing up minimum wages of labor; and • Ensuring justice through Labor Court. It has been divided into four departments, viz: • Directorate of Labor • Chief Inspector of Factory and Establishment • Minimum Wages Board • Labor Appeal Tribunal
12	Ministry of Law and Parliamentary Affairs	This ministry is divided in to the Law and Justice Division and the Parliamentary Affairs Division for functional purposes. The Law and Justice Division of the Ministry of Law, Justice and Parliamentary Affairs has the responsibility of providing legal advisory services to other ministries, divisions, departments, and organizations of the Government. The parliamentary affairs division is assisted by the law commission and the human rights commission and its main function lies in formulating, scrutinizing and preparing legislations. When needed, it provides legal opinions and translations for other ministries.
13	Ministry of Land	The ministry of land is in charge of land administration, management and development for the overall growth of the nation. The Ministry manages Government owned lands, vested properties and abandoned properties. It is responsible for the collection of land development tax, land surveying and record keeping and updating. Land Acquisition and requisition fall under the responsibilities of this ministry.
14	Board of Investment (BOI), Bangladesh	The Board of Investment was established in 1989 by the Investment Board Act. The specific functions of board are: • Implementation of all provisions as lay down under The Investment Board Act, 1989. • To promote domestic and foreign investment as well to enhance international competitiveness of Bangladesh; • To identify the hindrance of investment and provide necessary facilities and assistance in the establishment of industries.
15	Civil Aviation Authority (CAA), Bangladesh	The Government of the People's Republic of Bangladesh formed Civil Aviation Authority, Bangladesh in the year of 1985. The main functions of CAA are: • It is responsible for registration of aircrafts and issues license to each personnel responsible for flight operations; • To regulate air traffic and provides facilities and services for aeronautical telecommunications and air navigation;

SN	Agency	Functions
		• The authority is responsible for construction, maintenance and development of airports and aerodromes.
16	Union Parishad	Union Parishad (UP) currently is the only elected statutory local government body for the rural Bangladesh. A UP consists of a chairman and twelve members. They are elected on the basis of adult franchise. Each UP has a full-time Secretary, appointed by the Deputy Commissioner (DC). The functions of UP are: • Maintenance of law and order and conduction of censuses of all kinds. • Registration of births, deaths, blind people, beggars and destitute. • Planning and implementation of development schemes in the field of agriculture, forestry, fisheries, livestock, education, health, small and micro enterprises, communications, irrigation and flood control. • Protection and maintenance of public property such as roads, bridges, canals, embankments, markets, telephones and electricity lines.

2.3 Applicable Environmental and Social Laws, Regulations and Policies

The relevant Acts and Rules pertaining to the project have been summarized in the Table below.

Table 11: Applicable environmental, health and safety and social laws, regulations and policies

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
National Environment Policy, 1992 and Action Plan It sets out the framework for establishment of legislations related to 15 sectors including environment, water, agriculture, water resources development, forest & wildlife, fisheries etc. The key provisions of the policy are: • Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) of all new public and private sector industrial projects are mandatory. • Adoption of corrective measures by polluting industries in phases. • Prevention of land erosion, and environmentally sound management of newly accreted land. • Conservation of wildlife, bio-diversity, forest, fisheries and livestock.	Ministry of Environment and Forests, Bangladesh Department of Environment, Bangladesh	Project proponent should ensure that project activities comply with the provisions made under the policy and the legislations made there under for implementing the same.
National Environmental Policy, 2018 According to the fifth amended of the constitution of the people's Republic of Bangladesh environment, biodiversity conservation and development has been taken as the main principles to govern the state. For this purpose it has included in article 18 (a) that state will conserve and developed the environment for the present and future citizen and will also ensure the security of the national resources, biodiversity, wetland, forest and conserve the wildlife.	Ministry of Environment and Forests, Bangladesh Department of Environment, Bangladesh	SPCL should ensure that project activities comply with the provisions made under the policy and the legislations made there under for implementing the same.
National Environmental Management Action Plan (NEMAP), 1995 The National Environmental Management Action Plan (NEMAP, 1995) identifies the main national environmental issues, including those related to the water sector. The main water related national concerns include flood damage, riverbank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion, various specific regional concerns are also identified.	-	Project proponentshould ensure that project activities comply with the provisions made under this action plan.
The Environment Conservation Act, 1995as amended till October 5, 2010 (hereinafter referred as ECA)	Ministry of Environment	The proposed project being a petrochemical plant which falls under

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
The Environment Conservation Rules, 1997(amended in 2017) (hereinafter referred as ECR) The salient features of the Act are as follows: • A Department of Environment (DoE) to be established subsidiary to the MoEF to exercise the provisions of the Act. • The Government of Bangladesh (GoB) will declare Ecologically Critical Areas (ECA) and specify the activities or processes that cannot be initiated or continued in an ECA. • An industrial unit/Project cannot be established without obtaining an Environmental Clearance Certificate (ECC) from the Director General of DoE. • Publication of environmental guidelines related to environmental pollution control and mitigation, conservation and improvement of the environment. • Prescription of rules for implementing the provisions of the Act. The provisions under the ECR are summarized as follows: The industries for the purpose of obtaining ECC have been classified into the following 4 categories based on their site and impact on the environment: • Green • Orange –A • Orange – B • Red The list of industries falling under each category has been annexed in the Schedule–I to the ECR. • For proposed industries falling under the Orange-A & B and Red categories, a Location Clearance Certificate (LCC) needs to be obtained from DoE prior to the issuance of ECC. • The project entrepreneur shall apply for ECC in prescribed form along with prescribed documents and application fees. • ECC (for Red category) will be valid for 1 year from the issuance date and shall be renewed at least 30 days prior to expiry. • Various environmental quality standards pertaining to air, water, sound, odor etc. have been laid down in the schedules attached to the Act. • Emissions and waste discharge standards have been laid down in Schedules 9-11. The person in charge of facility/unit shall notify the Director General, DoE in case of pollutant emission/discharge in excess of prescribed standards or where there is a possibility of the same.	and Forests, Bangladesh Department of Environment, Bangladesh	the Red category as classified under Schedule-I of the ECR. Project proponentshall ensure compliance with the applicable provisions of the Act and the Rules made there under. Project proponent shall ensure that Location Clearance Certificate (LCC) for the proposed project site is obtained. Furthermore, project proponent shall apply for the Environmental Clearance Certificate (ECC) in the requisite manner along with prescribed documents. The EIA to be submitted along with ECC application shall be as per the ToR provided by the DoE. Project proponentshall ensure that pollutant emissions/discharges from various sources etc. during project activities are well within the standards prescribed in the Schedules 2-12 of the ECR 1997. Some of the standards have been revised by the DoE viz. • Ambient Air Quality standard • Vehicular Emission standards • Ambient Noise Standards ***The various applicable standards have been provided in subsequent sections. Compliance to such standards shall be* ensured by project proponent.**
The Bangladesh Economic Zones Act, 2010 This act is make provisions for the establishment of economic zones in all potential areas including backward and underdeveloped regions and development, operation, management and control thereof including the matters ancillary thereto with a view to encouraging rapid economic development through increase and diversification of industry, employment, production and export.	Bangladesh Economic Zones Authority	Project proponent should ensure that project activities comply with the provisions made under this act.
Bangladesh Petroleum Corporation Act, 2016	Energy and Mineral Resources	Project proponent should ensure that project activities comply with the provisions made under this act.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
An Act to provide for the exploration, development, exploitation, production, processing, refining and marketing of petroleum.	Division of Bangladesh	
National Industrial Policy, 2010 The policy aims to ensure the industrialization process is compliant with internationally agreed environment, health, and safety and labor standards. The government will ensure assistance for creating alternative employment, keeping the socio-economic backdrop in mind, for any privatization proposal.	Ministries of Industries	Project proponentshall ensure that the proposed project is registered as prescribed by the Act.
Investment Board Act (1989) Board of Investment, established under this act, is the principal private investment promotion and facilitation agency of Bangladesh which is responsible for implementation of provisions of above said policy. Under the provision of this act as per Schedule 11, All industries established in non-governmental sectors licensed by the Board shall be registered in the prescribed manner. As per Schedule 15 of this act, any industrial undertaking licensed transgresses any provision of this Act or of any rule made there under or breaks any condition relating to the license, the Board may, in such manner as may be prescribed, cancel the license of the industrial undertaking.	Board of Investment (BOI), Bangladesh	Project proponentshall ensure that the proposed project is registered as prescribed by the Act.
National Water Policy, 1999 Endorsed by the GoB in 1999, the National Water Policy (NWP) aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. According to the policy, all agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks. The policy has several clauses related to water resource development projects for ensuring environmental protection. Some of the relevant clauses are: • Clause 4.5b: Planning and feasibility studies of all projects will follow the Guidelines for project Assessment, the Guidelines for People's Participation (GPP), the Guidelines for Environmental Impact Assessment, and all other instructions that may be issued from time to time by the Government. • Clause 4.9b: Measures will be taken to minimize disruption to the natural aquatic environment in streams and water channels. • Clause 4.9e: Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding. • Clause 4.10a: Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken. • Clause 4.12a: Give full consideration to environmental protection, restoration and enhancement measures consistent with National	Bangladesh Water Development Board (BWDB)	Project proponentshall ensure compliance with this policy.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP). • Clause 4.12b: Adhere to a formal environment impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects, in each water resources development project or rehabilitation program of size and scope specified by the Government from time to time. • Clause 4.12c: Ensure adequate upland flow in water channels to preserve the coastal estuary ecosystem threatened by intrusion of salinity from the sea. • Clause 4.13b: Only those water related projects will be taken up for execution that will not interfere with aquatic characteristics of those water bodies.		
National Water Management Plan, 2001 (Approved in 2004) • The objectives of the Plan are listed below: • To operationalize directives given in National Water Policy and to do in accordance with the Government approved Development Strategy. • To address issues related to harnessing and development of all forms of surface and ground water and management of these resources in an efficient and equitable manner. • Consultation and participation with the direct beneficiaries in the hand over and development of water schemes.	Water Resource Planning Organization (WARPO)	Project proponent shall ensure compliance with this policy.
Water Resource Planning Act, 1992 This act has been enacted to develop water resource and to ensure efficient use of this resource. This act focuses on establishing an institution named as Water Resource Planning Institution, the location of its office, Scheduled work, Organogram of the director bodies etc.	Water Resource Planning Organization (WARPO)	Project proponent shall ensure compliance with this policy.
Bangladesh Water Act, 2013 The key features of the Act are: • A National Water Resources Council (NWRC) to be established for implementing the provisions of the Act • A National Water Policy shall be adopted by the Council addressing the following issues: a) Purpose and sectors of water use b) Affordability of water users c) Actual cost of water abstraction and distribution d) Financial ability and backwardness of water users of any group thereof e) Water demand and supply f) Any other issues considered relevant by GoB. • An Executive Committee of the Council shall be established or ensuring efficient performance of the Council. • The GoB can declare certain areas as Water Stress Areas for the protection of water sources or aquifers. • Water zone demarcation (industrial, agricultural, brackish water aquaculture and hatchery water zones) through gazette notification and issuance of protection order for efficient water management in such zones. • Declaration of flood control zone and its management.	Water Resource Planning Organization (WARPO)	This Act was implemented in 2013 and the NWRC and Executive Committee are yet to be formulated. Upon formation of the aforementioned bodies, water stress areas and related provisions may be prescribed. ***Project proponent shall ensure compliance with legal requirements under such provisions if applicable.***

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
• Restriction on abstraction of total water from any water source.		
Bangladesh Water Rules, 2018 Under the article 45 of Bangladesh Water Act, 2013 this rules have been implemented. In this rules the right of safe drinking water and the water necessary for the cleanliness purpose have mentioned. Also international and national assistance, national water policy has been implemented.	Water Resource Planning Organization (WARPO)	Project proponent shall ensure compliance with this policy.
Ground Water Management Ordinance, 1985 As per the provisions as per schedule 5 of this act, no tube well shall be installed in any place without a license granted by the Union Parishad. Also, no application shall be entertained by the Union Parishad unless it is accompanied by such fee as may be prescribed under the requirements of this ordinance.	Ministry of Environment and Forests, Bangladesh	Project proponent should ensure that no tube-well shall be installed in any place without a license granted by the Union Parishad. Project proponent should furnish the following information: • The aquifer condition of the soil where the tube-well is to be installed; • The distance of the nearest existing tube-well; • The area likely to be benefited by the tube-well; • The likely effect on the existing tube-wells including tube wells used for domestic purpose; • The suitability of the site for installation of the tube-well; and • The conditions on which a license, if any, may be granted.
The National Fisheries Policy, 1999 The objectives of the fisheries policy are: • Enhancement of the fisheries production; • Poverty alleviation through creation of self-employment and improvement of socio-economic conditions of the fishermen; • Fulfilling the demand for animal protein; • Achieve economic growth through earning foreign currency by exporting fish and fisheries products; and • Maintain ecological balance, conserve biodiversity, ensure public health and provide recreational facilities The policy broadly aims at fisheries development, regulation of aquaculture, biodiversity conservation and formulation of laws to ban the disposal of any untreated industrial effluents into the water bodies.	Ministry of Fisheries and Livestock (MoFL) Department of Fisheries (DoF)	Project proponent shall ensure that during project operation, no untreated effluent is disposed into the river. The treated effluent shall also meet the standards stipulated under the ECR.
Protection and Conservation of Fish Act, 1950 as amended through February 16, 1995 This Act was promulgated for conservation of fish in Bangladesh and their protection against indiscriminate fishing, poisoning due to industrial effluent disposal into the water, oil spills, etc.	Ministry of Environment and Forests, Bangladesh Department of Fisheries	Project proponent shall ensure compliance with provisions mandated under this Act.
Protection and Conservation of Fish Rules, 1985 The Rules were prescribed under the provisions of Protection and Conservation of Fish Act. It provides the regulations for prohibition of fishing during certain periods, licenses for catching fishes, prevention of fish destruction due to explosives and industrial effluent disposal etc.	Ministry of Environment and Forests, Bangladesh Department of Fisheries	Project proponentshall ensure that untreated effluent is not disposed into the river. The treated effluent shall comply with the discharge standards stipulated under the ECR.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
National Agriculture Policy, 1999 The overall objective of the National Agriculture Policy is to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable food security system for all. Although the policy does not emphasize the coastal zone separately, all specific objectives are applicable to the development of coastal zone agriculture. The policy particularly stressed on minor irrigation capturing tidal water in reservoirs in coastal areas and research on the development of improved varieties and technologies for cultivation in coastal, hilly, water-logged and salinity affected areas. The policy also recognizes that adequate measures should be taken to reduce water-logging, salinity and provide irrigation facilities for crop production.	-	The proposed project is expected to contribute to achieve the objectives of the agriculture policy.
National Land Use Policy (MoL, 2001) The National Land Use Policy (NLUP), enacted in 2001, aims at managing land use effectively to support trends in accelerated urbanization, industrialization and diversification of development activities. The NLUP urges that increasing the land area of the country may be not possible through artificial land reclamation process, which is cost-effective only in the long run. Therefore, land use planning should be based on the existing and available land resources. The policy suggests establishing land data banks where, among others, information on accreted riverine and coastal chars will be maintained. Among the 28 policy statements of NLUP, the following are relevant to coastal area: • Forests declared by the Ministry of Environment and Forests will remain as forest lands; • Reclassification of forest lands will be prevented; and • Effective green belts will be created all along the coast.	–	The proposed project will be designed in accordance with this strategy and will comply with the mentioned requirements.
National Livestock Development Policy, 2007 The National Livestock Development Policy (NLDP) has been prepared to address the key challenges and opportunity for a comprehensive sustainable development of the livestock sub-sector by creating an enabling policy framework. Among 60 or more policy statements, the following two policy statements address the coastal zone: • Specific areas will be identified to implement programs for fattening of cattle and livestock. For this purpose, the Chattogram Hill Tracts, the coastal areas and the islands will be included under the fattening of livestock and cattle program. • Special programs will be taken up for the production of grass in the Chattogram Hill-tracts and the coastal areas.	-	As livestock is one of the key assets in livelihoods, and protection of livestock from cyclones should be emphasized along with security of human life. The proposed project interventions will contribute to the safety of livestock and thus increase livestock productivity.
Standing Orders on Disaster, 2010 The Standing Orders on Disaster is designed to enhance capacity at all tiers of government administrative and social structures for coping with and recovering from disasters. The document contains guidelines for construction, management, maintenance and use of cyclone shelter center. Accordingly, to the guideline, geographical information system (GIS) technology will be	-	Project proponent will provide better communication facilities, which is crucial for emergency response to disasters.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
applied at the planning stage to select the location of cyclone shelter considering habitation, communication facilities, and distance from the nearest cyclone center. The advice of the concerned District Committee is to be obtained before final decision. The cyclone shelters should have easier communication facilities so that in times of distress delay does not occur to go there. For this reason, the road communication from the cyclone shelters should not only link up with city or main road but also with neighboring village areas. Provision of emergency water, food and sanitation and shelter space for livestock during period should also be kept in view for future construction of shelters.		
National Adaptation Program of Action (NAPA) In 2005, the Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh has prepared the National Adaptation Program of Action (NAPA) for Bangladesh, as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized the necessity of addressing climate change and environmental issue and natural resource management. The NAPA is the beginning of a long journey to address adverse impacts of climate change including variability and extreme events and to promote sustainable development of the country. There are 15 adaptation strategies suggested to address adverse effects of climate change. Among the 15 adaptation strategies the following strategies address the coastal region for reducing climate change induced vulnerability. • Reduction of climate change hazards through coastal afforestation with community participation. • Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise. • Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains • Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future. • Promoting adaptation to coastal crop agriculture to combat increased salinity. • Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh.	-	The proposed project will broadly contribute toward achieving the aims and objectives of the climate change adaptation strategies.
Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009 The Government of Bangladesh has prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009. The BCCSAP is built on six pillars: (i) food security, social safety and health; (ii) comprehensive disaster management; (iii) infrastructure; (iv) research and knowledge management; (v) mitigation and low carbon development; and (vi) capacity building. Five programs have been suggested related to improvement of the water management infrastructures in coastal areas	-	The proposed project with compliance within action plan.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
of Bangladesh under pillar 3 (Infrastructure) of BCCSAP, including: • Repair and maintenance of existing flood embankments • Repair and maintenance of existing coastal polders • Improvement of urban drainage • Planning, design and construction of river training works • Planning, design and implementation of resuscitation of the network of rivers and khals through dredging and de-siltation work.		
The Building and Construction Act, 1952 • As per Section 3A of this act, no owner or occupier of a building shall, without obtaining previous permission from the Authorized Officer or the Committee uses the building for the purpose other than that mentioned in the sanction. • All the construction, re-construction works to be undertaken as per terms or conditions prescribed.	Authorized Officer or Committee	Project proponent shall ensure that no building or tank shall be constructed without prior permission from the Authorized Officer or Committee of the area.
The Vehicle Act, 1927 • As per section 4 of this act, no owner or person in charge of a vehicle shall allow any person under the age of eighteen years to drive the same in any public place. • As per section 7, no person shall drive a vehicle in a public place unless he is licensed in the prescribed manner. • Every vehicle must possess a valid registration certificate as per section 11 of this act.	Bangladesh Road Transport Authority	Project proponent shall ensure that every vehicle possess a certification of registration as required under this act.
The Motor Vehicle Ordinance Act, 1983 (as modified on November, 1990) • As per section 3 of the ordinance, no person shall drive a motor vehicle in any public place unless he holds an effective driving license. • No person under the age of eighteen years shall drive a motor vehicle in any public place.	Bangladesh Road Transport Authority	Project proponent shall ensure that no person shall drive a motor vehicle in any public place unless he holds an effective driving license issued to him authorizing him to drive the vehicle.
Fatal Accidents Act, 1855 This Act was promulgated to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. The company will be liable to pay compensation in case of death of any worker/employee or damages in case death has not ensued but such circumstances could have resulted in death.	Ministry of Labor and Employment	Project shall ensure compliance to the Act.
Bangladesh Labor Act, 2006 (as amended through July 22, 2013). The provisions prescribed under chapters pertaining to occupational health and safety, and compensations due to accidents are entailed below. **Chapter V: Health and Hygiene** The chapter deals with provisions regarding cleanliness of the any facility, drinking water supply, ventilation, lighting, dust bean and spittoons, etc. **Chapter VI: Safety** This chapter addresses the issues regarding safety of building and machinery, precautions in case of fire, fencing of machinery, works on or near machinery in motion, hoists and lifts protection of eyes, explosive or inflammable dust/gas, etc.	Ministry of Labor and Employment	Project proponent shall ensure that all conditions provided in chapters V, VI, VII and VIII of the Act, pertaining to Health, hygiene safety and welfare are met in accordance with the amended act. During the construction and operation phases of the proposed project, SPL Petrochemical Complex Limited shall ensure the facilitation of the following provisions: • Management of workers under service rules as approved by the Chief Inspector.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
Chapter VII: Special Provisions related to Health, Hygiene and Safety This chapter deals with provisions to be taken in case of hazardous operations, notice to be given in accidents, notice of certain dangerous occurrences and diseases etc. **Chapter VIII: Welfare** This chapter prescribes the provisions to be facilitated in the facility regarding first-aid appliances, safety record books, washing facilities, canteens, shelters, rooms for children, etc. This Act consolidates and amends the laws relating to employment of labor, relations between workers and employers, determination of minimum wages, payment of wages and compensation for injuries to workers, formation of trade unions, raising and settlement of industrial disputes, health, safety, welfare and working conditions of workers, apprenticeship and matters connected therewith. The provisions prescribed under chapters pertaining to labor benefits and entitlements are as follows: • Conditions of Service and Employment • Employment of Adolescent • Maternity Benefit • Working Hours and Leave • Wages and Payment • Workmen's Compensation for Injury by Accidents • Trade Unions and Industrial Relations		• Provision of Letter of Appointment and ID card (with photograph) for each and every worker. • Maintenance of Service Book with the requisite details. • Retrenchment Policy and conditions of re-employment of retrenched workers, termination of employment etc. • Provisions regarding gratuity, provident fund and other payments at the time of retirement of workers. • Any adolescent employed in any dangerous operation shall be in possession of Certificate of Fitness issued by a registered medical practitioner. • Maternity benefits shall be paid as stipulated in the Act. • Cleanliness of the facility through washing, painting and varnishing etc. for ensuring hygiene. • Ventilation and removal dusts and fumes through adequate number of exhaust systems. • Adequate number of drinking water facilities equipped with cooling systems at convenient places in the unit. All such places shall be legibly marked 'Drinking water' in Bangla. • Separate and adequate number of latrines and urinals for men and women. They shall be maintained in a clean and sanitary condition at all times with suitable detergents and disinfectants. • Leave policy stating the working hours and the number of leaves the workers are entitled to under the provisions of the Act. • Compensation/wages shall be stated in the Letter of Appointment given to the workers/employees. • SPL Petrochemical Complex Limited shall ensure that there is no policy restricting the association of workers'/trade unions. • Workmen's Compensation Policy stating the compensation to be meted out in case of injury due to accidents. Safety of workers engaged in loading and unloading of industries as per prescribed provisions.
Bangladesh Factories Act, 1965 As per section 6 of the Act, the occupier shall furnish some information to Chief Inspector at least fifteen days before he begins to occupy or use any premises as a factory. As per Section 8, the plans and specifications must be approved by Chief Inspector.	Chief Inspector of the Area	Project proponent shall ensure that approval for plan and specifications has been procured from Chief Inspector of area.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
Provisions for cleanliness, disposal of effluents, ventilation, lightning, latrines and urinals have been described in Chapter II of the Act. Chapter IV and V prescribe provisions for safety and welfare of the workers.		Project proponentensures that provisions as prescribed in chapters II, III and IV are complied with.
Environmental Court Act, 2000 **Environmental Court Act, 2010 (amendment)** The law is related to the establishment of a court of justice for the environmental pollution crime and the crime related to it.	_	SPCL should ensure that project activities comply with the provisions made under this act.
National Child Labor Elimination Policy, 2010 The National Child Labor Elimination Policy 2010 has been adopted to provide a framework towards eradicating all forms of child labor by 2015. The policy defines and lays guidelines for underage workers, regulation of their working hours, wages, nutrition needs, mental health, education and overall work environment. As per the policy, a child is a person under the age of 14. A person between the ages of 14 and 18 is an adolescent, and should be granted special amendments, if compelled to work due to poor economic status. The policy also entails that a child may not be employed as a regular employee, not be made to work in hazardous settings, provided breaks more frequent than those for regular employees and have enough time left for study.	Ministry of Labor and Employment Ministry of Women and Child Welfare	During all stages concerning employment of labor, project proponent should take the policy as a guidance document for following ethical practices at workplace, in dealing with adolescent workers, if at all.
Children's Act, 2013 (Act No. 24 of 2013). The Act implements the Nation's ratification to the UN Convention on the Rights of the Child (CRC), and replaces The Children's Act of 1974. The main components of the act are as follows: • The Act changes the legal definition of a child from being a person under the age of 14 to one under the age of 18. • It enforces the national authorities to establish Child Welfare Boards in each district, besides one at the national level. • It criminalizes any kind of cruelty inflicted on children while they are working in both the formal and informal sectors. • The Act further prescribes stricter punishments for using or exploiting children in begging, in brothels, and in carrying drugs, arms, or other illegal commodities.	Ministry of Law, Justice and Parliamentary Affairs. District commissioner's Office.	Project proponentmust ensure that at through all stages of construction and operation, no juvenile (children between ages 14 and 18) are engaged on site.
The Acquisition and Requisition of Immovable Property Ordinance, 1982 The ordinance consolidates and amends the laws relating to acquisition and requisition of immovable property by the government. It lays down the procedures and conditions for acquisition of land and other immovable properties such as common property resources (wells, places of worship, burial grounds, etc.). As per Section 8 of this ordinance, the amount of compensation to be determined taking into consideration market value and decision of Deputy Commissioner.	Ministry of Land, Bangladesh	There is total 386 acres of land comprising private land. Project proponent shall ensure the compliance with provisions of this ordinance relating to compensation.
The Bangladesh Inland Water Transport Corporation Order, 1972 (President's Order) This ordinance has been established for the provision of a Corporation for the purpose of operation, promotion and development of coastal and inland shipping and water transport services.	Bangladesh Inland Water Transportation Authority (BITWA)	Project proponent should ensure the compliance with provisions of the orders.

Summary of Applicable legislation/ Policy	Agency Responsible	Applicable Permit and Requirements
The Civil Aviation Authority Ordinance, 1985 As per section 11 of the ordinance, only Civil Aviation Authority have control over: • All the civil airports and aerodromes in Bangladesh including their planning, construction, operation and maintenance; • All air routes in Bangladesh; • Air space management of civil airports and aerodromes.	Civil Aviation Authority, Bangladesh	Project proponent shall ensure compliance with rules made under this ordinance.
Bangladesh Biodiversity Act, 2017 To ensure biodiversity conservation and sustainable utilization of its components, to distribute benefits and fair share obtained from the livestock and related information this act has been composed.	Department of Environment, Bangladesh	SPCL shall ensure the compliance with provisions of this ordinance
Bangladesh Biological Protection Rules, 2012 According to the conferred power of the government in Article 20 of Bangladesh Environment Conservation Act, 1995 this rules have been formulated	Department of Environment, Bangladesh	SPCL should ensure the compliance with provisions of the orders.
Biosafety Guidelines of Bangladesh (2007) This guideline is intended to be source of information, guidelines, policies and procedures that will enable and encourage those working in the field of biological environment, so that they can work safely and reduce or eliminate the potential for exposure to biological hazard.	Ministry of Environment and Forests, Bangladesh	SPCL should ensure the compliance with provisions of this guideline.
Biologically Critical Area Management Rules, 2016 A national committee will be formed to fill up the purpose of these rules. Responsibilities and activities of national committee, union committee, and village protected committee have also discussed under these rules. Declaration method of announcing ecologically critical area, prohibited activities in the critical area, development planning in the critical area have also considered in this rules.	Ministry of Environment and Forests, Bangladesh Department of Environment, Bangladesh	Project proponent shall ensure compliance with rules made under this ordinance
Rules for Corrosive Material (Control) responsible for Ozone Layer Depletion, 2004 Prohibition of producing, imports, exports, exchange, purchases sell of corrosive materials responsible for ozone layer depletion.	Ministry of Environment and Forests, Bangladesh	SPCL should ensure the compliance with provisions of this guideline.
Sound pollution (control) Rules, 2006 Determine the area of sound pollution; determine the sound pollution standard, prohibition to excess use of sound, provide information about sound pollution etc. are included in these rules.	Traffic control department. Department of Environment, Bangladesh	SPCL should ensure the compliance with provisions of this guideline.

The key permits required to be obtained by project for the construction and operations are set out in the Table below.

Table 12: Key permits required to be obtained by project

Permit	Permitting Authority	Relevant Legislation	Role of Permit
Permission for construction of a Building (construction of buildings)	Authorized Officer or Committee	The Building and Construction Act, 1952	Authorization to construct the proposed project
Location Clearance Certificate (for establishing the project)	Director General, DoE	Environment Conservation Rules, 1997	Authorization to construct the proposed project
Environmental Clearance Certificate	DoE, Bangladesh	Environment	Authorization to set up the plant with limited

Permit	Permitting Authority	Relevant Legislation	Role of Permit
		Conservation Rules, 1997	environmental effects of development and operation of the proposed project.
Permit for establishment of Economic Zone	Bangladesh Economic Zones Authority (BEZA)	Bangladesh Economic Zones Act, 2010	Permit from BEZA itself to be procured for erection of Zone
Installation of a tube -well	Ministry of Environment and Forests, Bangladesh Union/Upazila Parishad	Ground Water Management Ordinance, 1985	Installation of tube in any place
No Objection Certificate from Union Parishad	Union/ Upazila Parishad	Environment Conservation Rules, 1997	A consent in form of NOC from respective Union Parishad
Approval of Plans and registration of the proposed project	Chief Inspector	The Factories Act, 1965	Approval of plans and specifications of the project

2.4 World Bank's Operational Policies and Guidelines

The World Bank follows an operational policy statement (updated in February, 2011), which stipulates that all operations are carried out in an environmentally responsible manner and that projects must comply with all local environment legal obligations and appropriate World Bank guidelines . The World Bank sets out its procedures and policies with regard to conducting environmental assessments on Operational Policy 4.1: Environmental Assessment (October, 1991) and its updates and other pertinent guidelines.

2.5 Applicability

World Bank Environmental and Social Safeguard Policies provide ten (10) potential issues that may need to be considered in an EIA, depending on the specific characteristics of each project. Table below summarizes the expected applicability of the potential Safeguard Policies for the project.

Table 13: Potential World Bank environmental safeguard policies and applicability to project

Safeguard Policy	Requirement	Policy Triggered	Applicability/ Compliance
Environment Assessment (OP 4.1)	The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	This policy applies to all projects requiring a Category (A) Environmental Assessment under OP 4.1. All environmental and social aspects included in the proposed project are adequately examined. The project is likely to have significant potential adverse environmental risks & impacts in its area of influence regarding the natural environment, water, land, human health and safety.
Natural Habitats (OP 4.4)	The Bank requires borrowers to incorporate into their development and environmental strategies analyses of any major natural habitat issues, including identification of important natural habitat sites, the ecological	Yes	Ecological study including floral and faunal diversity has been conducted.

Safeguard Policy	Requirement	Policy Triggered	Applicability/ Compliance
	functions they perform, the degree of threat to the sites, priorities for conservation, and associated recurrent-funding and capacity-building needs.		
Pest Management (OP 4.9)	In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity.	No	Project proponent will ensure that the requirements of the operational policy will be adhered to during procurement of pesticides for the project.
Involuntary Resettlement (OP 4.12)	World Bank recognizes that Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out.	No	The land required for the project has been purchased through negotiated settlements on 'willing buyer-willing seller' through compensation for land acquisition basis between landowners and BEZA. As the land purchase was registered with the land registrar of the locality and the sale deed requires a witness of a local person from the area, the land purchase process has reportedly been transparent.
Indigenous People (OP 4.10)	The Bank recognizes that the identities and cultures of indigenous peoples are inextricably linked to the lands on which they live and the natural resources on which they depend. Hence, A project proposed for Bank financing must be screened for presence of indigenous people.	No	Census records and public consultations indicate that there are no indigenous populations in the study area.
Forests (OP 4.36)	If a project involves significant conversion or degradation of natural forests or related natural habitats that the Bank determines are not critical, and the Bank determines that there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially Outweigh the environmental costs; the Bank may finance the project provided that it incorporates appropriate mitigation measures.	No	The proposed project does not comprise any kind of forest land. But have few mangrove forest on the bank of char.
Physical Cultural Resources (OP 4.11)	The borrower needs to addresses impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of	No	No such tangible forms of cultural heritage or objects were found within the project area.

Safeguard Policy	Requirement	Policy Triggered	Applicability/ Compliance
	the environmental assessment (EA) process.		
Safety of Dams (OP 4.37)	When the Bank finances a project that includes the construction of a new dam, it requires that the dam be designed and its construction supervised by experienced and competent professionals.	No	The project involves the construction and repair of embankment.
Project in Disputed Areas (OP 7.60)	Projects in disputed areas may affect the relations between the Bank and its borrowers, and between the claimants to the disputed area. Therefore, the Bank will only finance projects in disputed areas when either there is no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection.	No	The proposed project is not situated in a disputed area. Any component likely to be financed as part of the project is not situated in a disputed area.
Projects on International Waterways (OP 7.50)	The Bank recognizes that the cooperation and goodwill of riparian is essential for the efficient use and protection of the waterway. Therefore, it attaches great importance to riparian's making appropriate agreements or arrangements for these purposes for the entire waterway or any part thereof.	No	The adjacent Kohelia River is not recognized as a national and/or international waterway. Also, there is no water abstraction issue in this project. However, west part of the zone (sea side) can be considered as waterways for navigation of large vessels.

2.5.1 Categorization of Projects

The Bank screens the private sector activity in order to determine the nature and extent of the environmental and social assessment needed, based on the type, location, sensitivity, and scale of the activity, as well as the nature and magnitude of its potential impacts. This screening also identifies any additional information required to complete the Bank's environmental and social review and determine whether to support the activity. The private sector activity is categorized by the Bank as Category A, B, C, depending on the nature of the activity and financing mechanism, as follows:

Table 14: World Bank's categorization for projects

Category	Justification
Category A	Business activities with potential significant adverse environmental or social risks and/or impacts those are diverse, irreversible, or unprecedented.
Category B	Business activities with potential limited adverse environmental or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures.
Category C	Business activities with minimal or no adverse environmental or social risks and/or impacts.
Category FI	Business activities that involve investment of Bank funds through a financial intermediary, in sub projects that may result in adverse environmental impacts.

Box 1: Applicability for World Bank Project Categorization

The project is classified as a Category A project as per the Bank's categorization system. As per the information requirements, the applicant i.e., the project is required to submit the following documents along with the financing application:

- *EIA report is to be prepared which will examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.*
- *Public consultations with project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects is to be undertaken at least twice; once during preparation of the Terms of Reference (ToR) for the EIA (Scoping), and also after the draft EIA has been prepared.*
- *The draft EA report is to be made available at a public place accessible to project-affected groups and local NGOs.*
- *EMP and/or Action Plans demonstrating the set of mitigation, monitoring, and institutional measures to be taken during implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels.*

2.5.2 Applicability of IFC Performance Standards

The IFC Performance Standards stipulates that any proposed project shall meet the following requirements throughout the life of an investment by IFC or other relevant financial institution:

- *Performance Standard 1:* Assessment and Management of Environmental and Social Risks and Impacts;
- *Performance Standard 2:* Labour and Working Conditions;
- *Performance Standard 3:* Resource Efficiency and Pollution Prevention;
- *Performance Standard 4:* Community Health, Safety, and Security;
- *Performance Standard 5:* Land Acquisition and Involuntary Resettlement;
- *Performance Standard 6:* Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- *Performance Standard 7:* Indigenous Peoples; and
- *Performance Standard 8:* Cultural Heritage

These performance standards and guidelines provide ways and means to identify impacts and affected stakeholders and lay down processes for management and mitigation of adverse impacts.

Performance Standard (PS) 1: Assessment and Management of Environmental and Social Risks and Impacts

PS 1 establishes the importance of:

- Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The project proponent's management of environmental and social performance throughout the life of the project;
- PS 1 is applicable to all projects and associated facilities having environmental and/or social risks and/or impacts. Some of the key environmental and social impacts that the proposed project can be associated with:
- Disposal of dredged material (particularly if the sediments are contaminated and accumulation of hazardous materials;
- Air emissions in terms of ship's propulsion, engines, fuel storage and transfer (release of SO_2, NO_x and Volatile Organic Compounds);
- Emission of dust from dry bulk material storage and handling facilities;

- Discharge of various type of effluents into river-sewage from ship operations, bilge water, vessel cleaning water.
- Management of solid waste generating from ship activities and hazardous material;
- Land acquisition and possible resettlement of local population; and
- Loss of livelihood of local population due to project operations etc.

Box 2: Applicability to PS1

PS 1 is applicable for the project and an Environmental and Social Impact Assessment (EIA) study needs to be conducted prior to the commencement of the project. Proposed project also needs to develop and implement an Environmental and Social Management System (ESMS) to manage the identified risks associated with its operations during construction and operation phase of the project.

Performance Standard 2: Labour and Working Conditions

PS 2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. The objectives of the PS 2 are:

- To promote the fair treatment, non-discrimination, and equal opportunity of workers;
- To establish, maintain, and improve the worker-management relationship;
- To promote compliance with national employment and labor laws;
- To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain;
- To promote safe and healthy working conditions, and the health of workers; and
- To avoid the use of forced labor.

The applicability of PS 2 will be more important during the construction phase as operation phase will have lesser number of staff. This PS covers not only the main plant employees, but all employees/workers, even indirect workers working through contractors. Migrant workers will be engaged for the project and they will be provided accommodation in labour camps. Hence, standards pertaining to campsites will be applicable.

Box 3: Applicability to PS2

PS 2 are applicable to the project and proponent shall ensure provision of adequate facilities such as access to clean water, sanitary facilities and other necessary facilities at the construction sites. Project proponent shall ensure measures to prevent child labor, forced labor, and discrimination is strictly implemented. Freedom of association and collective bargaining shall be provided. Wages, work hours and other benefits shall be regulated as per the national labor and employment laws.

Performance Standard 3: Resource Efficiency and Pollution Prevention

The PS 3 outlines approach to pollution prevention and abatement in line with internationally disseminated technologies and practices with the following objectives:

- Avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from activities; and
- Promote the reduction of emissions that contribute to climate change.

Box 4: Applicability to PS3

The impacts and risks associated with the generation, use, storage, release, and/or disposal of pollutants has been assessed as part of this EIA. Project proponent shall ensure implementation of the mitigation measures provided in the ESMP. Project proponent shall also ensure that pollution control measures are planned and implemented right from the project conception stage. Practices like minimal release of waste/emissions, safe disposal of waste, waste water management etc. shall be considered prior to each project phase. PS 3 is therefore applicable for the proposed project.

Performance Standard 4: Community Health, Safety and Security

PS 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. Its main stress is to ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected communities.

Box 5: Applicability to PS4

The Applicability of this PS has been extended to construction as well as operational phases of the project. It will be associated with unloading and loading activities, movement of vehicles, noise generation, etc. Community health and safety consideration related to the project has been addressed while assessing the environmental and social risks and impacts. Security staff will be engaged form local community whereas labor engaged will be both local as well as migrant.
A stakeholder engagement process has been formulated as a part of community engagement requirements consistent with the requirements of PS 1 including the informed consultation and participation process of affected communities. It will also include dissemination of information pertaining to security arrangements to workers and community. Also, Project proponent will construct and operate the structural elements of the project in accordance with GIIP taking into consideration safety risks to the affected community.

Performance Standard 5: Land Acquisition and Involuntary Resettlement

PS 5 recognizes that project related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Its main aim is to anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by providing compensation for loss of assets at replacement cost and ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of affected persons and community.

Box 6: Applicability to PS5

The land procurement has not resulted in loss of livelihood of the landowners since the land was not being used for any economic activities by the villagers prior to sale (as the land was treated as less agricultural land considering single season crop). There has also not been any physical displacement or resettlement as none of the procured lands were inhabited. Thus PS5 will not be applicable.

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. This standard is aimed to promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

Box 7: Applicability to PS6

The proposed project will involve discharge of various type of wastewater generating from the production activities of different industries like sewage, effluent chemical water etc. Project proponent shall ensure that the discharge of waste water will be undertaken only after suitable treatment of the waste and the limit of the parameters have to be within the standards prescribed by applicable national laws and international guidelines whichever of the two is more stringent. It shall ensure that indiscriminate fishing is prohibited in the project area as mandated by the national laws. PS 6 will be applicable in addressing the aforementioned issues and managing the risks posed by such project operations.
The details of this PS have been detailed out in the EIA study, while implementation of the actions necessary to meet the requirements of this PS shall be managed through the suggested mitigation measures. The operation phase of the proposed project shall ensure protection of fauna and flora of the site and surroundings.

Performance Standard 7: Indigenous Peoples

PS 7 recognizes Indigenous Peoples as social groups with identities that are distinct from mainstream groups in national societies and are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development.

Box 8: Applicability to PS7

Census records and public consultations indicate that there are no indigenous populations in the study area. Thus, PS 7 shall not be applicable to this project.

Performance Standard 8: Cultural Heritage

PS 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention concerning the protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the convention on biological diversity.

Box 9: Applicability to PS8

This PS is applicable when tangible forms of cultural heritage, unique natural features or tangible objects that embody cultural values and certain instances of intangible forms of culture are impacted or are proposed to be used for commercial purposes. No such tangible forms of cultural heritage or objects were found in the project area. Hence this PS is not applicable to the proposed project.

2.6 Applicable World Bank Group EHS Guidelines

The Equator Principle III requires follow up of the environmental, health and safety requirements as per the following guidelines released by International Finance Cooperation (IFC) on 30thApril, 2007. These guidelines ensure that the projects are developed in a manner that is socially responsible and reflects sound environmental management practices. EHS considerations into the site selection and plant design processes should be considered in order to maximize the range of options available to prevent and control potential negative impacts.

1. Environmental, Health, and Safety General Guidelines;
2. Environmental, Health, and Safety Guidelines for Ports, Harbors and Terminals;
3. Environmental, Health, and Safety Guidelines for Shipping.

The key requirements stated in the EHS guidelines have been discussed in the Table below.

Table 15: Key requirements as per EHS guidelines of IFC

SN	Relevant Requirements as Stated in EHS Guidelines
1.	**Air Emissions**
A.	***Combustion Sources***
a)	Combustion sources are characterized by the release of air pollutants typically associated with the combustion of fossil fuels, such as nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matter (PM), as well as other air pollutants including certain volatile organic compounds (VOCs) and metals that may also be associated with a wide range of industrial activities.
b)	The stack height for all point sources of emissions, whether 'significant' or not, should be designed according to GIIP to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects and to ensure reasonable diffusion to minimize impacts.
c)	Avoiding installation of firefighting or refrigeration systems contain chlorofluorocarbons (CFCs), in accordance with applicable phase-out requirements.
B.	***Volatile Organic Compounds***

SN	Relevant Requirements as Stated in EHS Guidelines
a)	Substitution of less volatile substances, such as aqueous solvents.
b)	Collection of vapors through air extractors and subsequent treatment of gas stream by removing VOCs with control devices such as condensers or activated carbon absorption.
c)	Collection of vapors through air extractors and subsequent treatment with destructive control devices such as: • Catalytic Incinerators: Used to reduce VOCs from process exhaust gases exiting paint spray booths, ovens, and other process operations. • Thermal Incinerators: Used to control VOC levels in a gas stream by passing the stream through a combustion chamber where the VOCs are burned in air at temperatures between 700^0 C to $1,300^0$ C. • Enclosed Oxidizing Flares: Used to convert VOCs into CO_2 and H_2O by way of direct combustion.
d)	Use of floating roofs on storage tanks to reduce the opportunity for volatilization by eliminating the headspace present in conventional storage tanks.
C.	***Dust***
a)	Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles, or controls, including air extraction and treatment through a baghouse or cyclone for material handling sources, such as conveyors and bins.
b)	Use of water suppression for control of loose materials on paved or unpaved road surfaces. Oil and oil by-products is not a recommended method to control road dust. Examples of additional control options for unpaved roads.
2.	**Wastewater**
A.	***Discharge to Surface Water***
a)	Process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines. Projects for which there are no industry-specific guidelines should reference the effluent quality guidelines of an industry sector with suitably analogous processes and effluents.
b)	Compliance with national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges.
c)	Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.
B.	***Discharge to Sanitary Sewer Systems***
a)	Meet the pre-treatment and monitoring requirements of the sewer treatment system into which it discharges.
b)	Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact characteristics of residuals from wastewater treatment operations.
c)	Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pre-treatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.
C.	***Septic Systems***
a)	Properly designed and installed in accordance with local regulations and guidance to prevent any hazard to public health or contamination of land, surface or groundwater.
b)	Well maintained to allow effective operation.
c)	Installed in areas with sufficient soil percolation for the design wastewater loading rate.
d)	Installed in areas of stable soils that are nearly level, well drained, and permeable, with enough separation between the drain field and the groundwater table or other receiving waters.
3.	**Wastewater Management**
A.	***Industrial Wastewater***
a)	The design and operation of the selected wastewater treatment technologies should avoid uncontrolled air emissions of volatile chemicals from wastewaters. Residuals from industrial wastewater treatment operations should be disposed in compliance with local regulatory

SN	Relevant Requirements as Stated in EHS Guidelines
	requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.
B.	***Wastewater from Utilities Operations***
a)	Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations.
b)	Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations.
c)	Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.
C.	***Storm water Management***
a)	Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.
b)	Surface runoff from process areas or potential sources of contamination should be prevented.
c)	Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff.
d)	Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds).
e)	Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present.
f)	When water quality criteria allow, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
g)	Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
h)	Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.
D.	***Sanitary Wastewater***
a)	Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage).
b)	Segregation and pre-treatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems.
c)	If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges.
d)	If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required.
e)	Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.
4.	**Water Conservation**
A.	***Process Water Reuse and Recycling***
a)	*Washing Machines:* Many washing machines use large quantities of hot water. Use can increase as nozzles become enlarged due to repeated cleaning and/or wear. Monitor machine water use, compare with specification, and replace nozzles when water and heat use reach levels warranting such work.

SN	Relevant Requirements as Stated in EHS Guidelines
b)	*Water reuse:* Common water reuse applications include counter current rinsing, for example in multi-stage washing and rinsing processes, or reusing waste water from one process for another with less exacting water requirements. For example, using bleaching rinse water for textile washing, or bottle-washer rinse water for bottle crate washing, or even washing the floor. More sophisticated reuse projects requiring treatment of water before reuse are also sometimes practical.
c)	*Water jets/sprays:* If processes use water jets or sprays (e.g. to keep conveyors clean or to cool product) review the accuracy of the spray pattern to prevent unnecessary water loss.
d)	*Flow control optimization:* Industrial processes sometimes require the use of tanks, which are refilled to control losses. It is often possible to reduce the rate of water supply to such tanks, and sometimes to reduce tank levels to reduce spillage. If the process uses water cooling sprays, it may be possible to reduce flow while maintaining cooling performance. Testing can determine the optimum balance. If hoses are used in cleaning, use flow controls to restrict wasteful water flow. Consider the use of high pressure, low volume cleaning systems rather than using large volumes of water sprayed from hosepipes. Using flow timers and limit switches to control water use. Using 'clean-up' practices rather than hosing down.
B.	***Water Cooling Systems***
a)	Use of closed circuit cooling systems with cooling towers rather than once-through cooling systems.
b)	Limiting condenser or cooling tower blow down to the minimum required to prevent unacceptable accumulation of dissolved solids.
c)	Use of air cooling rather than evaporative cooling, although this may increase electricity use in the cooling system.
d)	Use of treated waste water for cooling towers.
e)	Reusing/recycling cooling tower blow down.
B.	***Water Heating Systems***
a)	Repair of steam and condensate leaks, and repair of all failed steam traps.
b)	Return of condensate to the boiler house, and use of heat exchangers (with condensate return) rather than direct steam injection where process permits.
c)	Flash steam recovery.
d)	Minimizing boiler blow down consistent with maintaining acceptably low dissolved solids in boiler water. Use of reverse osmosis boiler feed water treatment substantially reduces the need for boiler blow down.
e)	Minimizing desecrator heating.
5.	**Hazardous Materials Management**
A.	***General Hazardous Materials Management***
a)	Use of dedicated fittings, pipes, and hoses specific to materials in tanks (e.g., all acids use one type of connection, all caustics use another), and maintaining procedures to prevent addition of hazardous materials to incorrect tanks.
b)	Use of transfer equipment that is compatible and suitable for the characteristics of the materials transferred and designed to ensure safe transfer.
c)	Regular inspection, maintenance and repair of fittings, pipes and hoses.
d)	Provision of secondary containment, drip trays or other overflow and drip containment measures, for hazardous materials containers at connection points or other possible overflow points.
B.	***Management of Major Hazards***
a)	Process Safety Information: Procedures should be prepared for each hazardous material and include: – Compilation of Material Safety Data Sheets (MSDS) – Identification of maximum intended inventories and safe upper/lower parameters – Documentation of equipment specifications and of codes and standards used to design, build and operate the process
b)	Operating Procedures: SOPs should be prepared for each step of all processes or operations within the project (e.g., initial startup, normal operations, temporary operations, emergency shutdown, emergency operations, normal shutdown, and start-up following a normal or emergency shutdown or major change). These SOPs should include special considerations for Mazmats used in the process or operations (e.g. temperature control to prevent emissions of a volatile hazardous chemical; diversion

SN	Relevant Requirements as Stated in EHS Guidelines
	of gaseous discharges of hazardous pollutants from the process to a temporary storage tank in case of emergency).
6.	**Noise**
a.	Sitting facilities with consideration of distances from the noise sources to the receptors (e.g., residential receptors, schools, hospitals, religious places) to the extent possible.
b.	Use of noise control techniques such as: using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound-absorptive materials in walls and ceilings; using vibration isolators and flexible connections (e.g., helical steel springs and rubber elements).
c.	Identify and mark high noise areas and require that personal noise protecting gear is used all the time when working in such high noise areas (typically areas with noise levels >85 dBA).
d.	Noise monitoring may be carried out for the purposes of establishing the existing ambient noise levels in the area of the proposed or existing facility, or for verifying operational phase noise levels.
7.	**Biodiversity**
a.	Special consideration for areas of high biodiversity value or those required for the survival of critically endangered or endangered flora and fauna is to be given.
c.	Cleaning or repair of ballast tanks should be equipped with adequate reception facilities able to prevent the introduction of invasive species.
8.	**Occupational Health and Safety**
i.	***Physical Hazards***
a.	Separation of people from vehicles and making vehicle passageways one-way, to the extent practical.
b.	Constructing the areas to be: of adequate strength to support the heaviest expected loads; level, or with only a slight slope; free from holes, cracks, depressions, unnecessary curbs, or other raised objects; continuous; and skid resistant.
d.	Avoiding placing cargo on, or allowing passage of vehicles over, any hatch cover that is not of adequate strength for that purpose.
e.	Clearly marking (indicating its own weight) all lifting beams and frames, vacuum lifting, or magnetic lifting device and every other item of loose gear weighing more than 100 kilograms (kg).
f.	Inspecting disposable pallets and similar disposable devices before use and avoiding re-use of such disposable devices.
g.	Equipping lifting appliances with means of emergency escape from the driver's cabin and a safe means for the removal of an injured or ill driver.
h.	Risk of free fall of materials should be minimized by installing telescoping arm loaders and conveyors.
i.	Materials handling operations should follow a simple, linear layout to reduce the need for multiple transfer points.
j.	Ensuring all seafarers is trained to manage the types of hazards applicable to their assigned responsibilities.
k.	Regular inspection and maintenance of decks areas, including railings, catwalks, stairs, and other walking areas to prevent the existence of cracks, worn or missing parts, and other falling and tripping hazards.
l.	Decks and gratings should be kept clear of grease, garbage, and ice to avoid risk of slipping, and any spillage should be cleaned up immediately.
m.	Installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area.
n.	Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area.
ii.	***Chemical Hazards***
a.	Consider generation of ammonia on site from urea or use of aqueous ammonia in place of pure liquefied ammonia;
b.	Consider use of sodium hypochlorite in place of gaseous chlorine.
c.	Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits.

SN	Relevant Requirements as Stated in EHS Guidelines
d.	Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards.
e.	Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.
f.	Implementation of smoking and naked light regulations during materials transfers activities and hot work permits during ship maintenance.
g.	Proper tank cleaning and venting, and operation, maintenance and inspection of inert gas systems
h.	Be equipped with fire extinguishing devices and self-closing doors and constructed of materials made to withstand flame impingement for a moderate period of time.
i.	Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, etc.).
iii.	***Confined Spaces***
a.	Engineering measures should be implemented to eliminate, to the degree feasible, the existence and adverse character of confined spaces.
b.	Permit-required confined spaces should be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible.
c.	Access hatches should accommodate 90% of the worker population with adjustments for tools and protective clothing.
d.	Mechanical equipment in the space should be disconnected, de-energized, locked-out, and braced, as appropriate.
e.	Appropriate training in confined space hazard control, atmospheric testing, use of the necessary PPE, as well as the serviceability and integrity of the PPE should be verified.
iv.	***Community Health and Safety***
a.	Operators should implement a Safety Management System (SMS) able to effectively identify and correct unsafe conditions.
c.	The Safety Management System should include comprehensive emergency preparedness and response plans that provide a coordinated response based on the port and community resources required to manage the nature and severity of the emergency event.
d.	Visual impacts, including excessive background illumination, should be prevented during the port planning process or managed during operations through the installation of natural visual barriers such as vegetation or light shades, as applicable.
e.	Fire suppression and control includes all automatic and manual fire protection installations.

Applicable World Bank Group EHS Guidelines for Crude Oil and Petroleum Product Terminals

The EHS Guidelines for Crude Oil and Petroleum Product Terminals include information relevant to land and shore-based petroleum storage terminals receiving and dispatching bulk shipments of crude oil, gasoline, middle distillates, aviation gas, lube oil, residual fuel oil, compressed natural gas (CNG), liquid petroleum gas (LPG), and specialty products from pipelines, tankers, railcars, and trucks for subsequent commercial distribution.

2.7 Asian Development Bank (ADB) Safeguard Principles and Policies

2.7.1 Safeguard Policy Statement (SPS), 2009

Built upon the three previous safeguard policies on the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998) and the Environment Policy (2002), the Safeguard Policy Statement was approved in 2009. The safeguard policies are operational policies that seek to avoid, minimize or mitigate adverse environmental and social impacts including protecting the rights of those likely to be affected or marginalized by the developmental process. ADB's safeguard policy framework consists of three operational policies on the environment, indigenous peoples and involuntary resettlement. A brief detail of all three operational policies have been mentioned below:

Environmental Safeguard: This safeguard is meant to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision making process.

Box 10: Applicability to Environmental Safeguards

The proposed project is an establishment with an area of 386 acres and is likely to have significant environmental impacts during construction and operation phase. The impacts and risks associated with the generation, use, storage, release, and/or disposal of pollutants has been assessed as part ofthis EIA and appropriate mitigation measures have been proposed. Practices like minimal release of waste/emissions, safe disposal of waste, waste water management etc. shall be considered prior to each project phase. The Environmental Safeguard is thus applicable to the proposed project.

Involuntary Resettlement Safeguard: This safeguard has been placed in order to avoid involuntary resettlement whenever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

Box 11: Applicability to Involuntary Resettlement Safeguards

The land required for the proposed project is falls under Moheshkhali Economic Zone-3.The sale of land has been undertaken directly on a 'willing buyer-willing seller' basis by project*. Hence, as no physical and economic displacement in terms of involuntary acquisition of land and involuntary restrictions on land use is triggered, the Involuntary Resettlement Safeguard is not applicable for the proposed project.*

Indigenous Peoples Safeguard: This safeguard looks at designing and implementing projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems and cultural uniqueness as defined by the Indigenous Peoples themselves so that they receive culturally appropriate social and economic benefits; do not suffer adverse impacts as a result of projects; and participate actively in projects that affect them.

Box 12: Applicability to Indigenous Peoples Safeguards

The proposed project area does not report any indigenous tribes, minorities or aboriginals. Hence the Indigenous Peoples Safeguard and the requirements there under are not applicable for this project.

Information, Consultation and Disclosure: Consultation and participation are essential in achieving the safeguard policy objectives. This implies that there is a need for prior and informed consultation with affected persons and communities in the context of safeguard planning and for continued consultation during project implementation to identify and help address safeguard issues that may arise. The consultation process begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle. It provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people and is undertaken in an atmosphere free of intimidation or coercion. In addition, it is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups and enables the incorporation of all relevant views of affected people and other stakeholders into decision making.

ADB requires the borrowers/clients to engage with communities, groups or people affected by proposed projects and with civil society through information disclosure, consultation and informed participation in a manner commensurate with the risks to and impacts on affected communities. For projects with significant adverse environmental, involuntary resettlement or Indigenous Peoples impacts, ADB project teams will participate in consultation activities to understand the concerns of affected people and ensure that such concerns are addressed in project design and safeguard plans.

A series of consultations were carried out with the land sellers, community and other (direct and indirect) stakeholders involved in the proposed project by proponent and consultants. Details pertaining to the consultation process are provided in relevant section of this report.

2.7.2 Social Protection Strategy, 2001

ADB has designed a set of policies and programs for social protection in 2001, that is, to reduce poverty and vulnerability by promoting efficient labor markets, diminishing people's exposure to risks, and enhancing their capacity to protect themselves against hazards and interruption/loss of income. The basic aim of the Social Protection Strategy (SPS) is to assist individuals to break the cycle of poverty and enhance the quality of growth through adequate and developed social protection systems in the member countries of ADB. The type of risks covered through the SPS may be economic, environment or social/governance related.

The proposed project shall ensure that the requirements of the ADB's SPS are complied with. Priority shall be given to any identified vulnerable groups. Based on the gender analysis and status of women in the project area, measures for ensuring their overall development shall be taken up by the project proponent. Project proponent shall comply with applicable labor laws in relation to the project. Project proponent shall also take the following measures to comply with the core labor standards[1] for the ADB financed portion of the project;

a) Carry out its activities consistent with the intent of ensuring legally permissible equal opportunity, fair treatment and non-discrimination in relation to recruitment and hiring, compensation, working conditions and terms of employment for its workers (including prohibiting any form of discrimination against women during hiring and providing equal work for equal pay for men and women engaged by the borrower);
b) Not restrict its workers from developing a legally permissible means of expressing their grievances and protecting their rights regarding working conditions and terms of employment;
c) Engage contractors and other providers of goods and services:
    i. Who do not employ child labor[2] or forced labor[3] ;
    ii. Who have appropriate management systems that will allow them to operate in a manner which is consistent with the intent of (A) ensuring legally permissible equal opportunity and fair treatment and non-discrimination for their workers, and (B) not restricting their workers from developing a legally permissible means of expressing their grievances and protecting their rights regarding working conditions and terms of employment; and
    iii. Whose subcontracts contain provisions which are consistent with above paragraphs (I & ii).

[1]The core labor standards are the elimination of all forms of forced or compulsory labor; the abolition of child labor; elimination of discrimination in respect of employment and occupation; and freedom of association and the effective recognition of the right to collective bargaining, as per the relevant conventions of the International Labor Organization.

[2]Child labor means the employment of children whose age is below the statutory minimum age of employment in the relevant country, or employment of children in contravention of International Labor Organization Convention No. 138 'Minimum Age Convention" (www.ilo.org)

[3]Forced labor means all work or services not voluntarily performed, that is, extracted from individuals under threat of force or penalty

2.7.3 Public Communications Policy 2011

The Public Communications Policy (PCP) of ADB, originally formulated in 2005 and revised in 2011, is aimed at promoting improved access to information about ADB's operations related to fund projects. It endorses greater transparency and accountability to stakeholders involved in a project. The PCP establishes the disclosure requirements for documents and information related to projects. It mandates project related documents normally produced during the project cycle to be posted on the web.

2.7.4 Categorization of Projects

As part of its review of a project's expected social and environmental impacts, ADB uses a classification system. This classification is used to reflect the significance of potential environmental impacts understood as a result of the client's impact assessment and to establish ADB's safeguard requirements. The categories used by ADB are:

- Category A Projects: Projects which are likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented.
- Category B Projects: Projects with potential adverse environmental impacts that are less in number, generally site-specific, mostly reversible and readily addressed through mitigation measures.
- Category C Projects: Projects with minimal or no adverse environmental impacts.
- Category FI Projects: Projects which involve investment of ADB funds to or through a financial investment.

Box 13: Applicability for ADB Project Categorization

Since the proposed project is an establishment with an area of 386 acres which will have impacts both in its construction and operation phase, the project is classified as a 'Category A' project as per the Bank's categorization system based on Environmental Safeguards. Categorization of the project as per Involuntary Resettlement and Indigenous Peoples is 'Category C'.

2.8 Equator Principle Financial Institutions (EPFIS) Guidelines

Equator Principles are a set of principles aiming towards promotion of responsible environmental stewardship and socially responsible development, including fulfilling responsibility to respect human rights by undertaking due diligence.

Principle 1: Review and Categorization

Using categorization, the EPFI's environmental and social due diligence is commensurate with the nature, scale and stage of the project, and with the level of environmental and social risks and impacts. The categories are:

Category A – Projects with potential significant adverse environmental and social risks and/or impacts those are diverse, irreversible or unprecedented;

Category B – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and

Category C – Projects with minimal or no adverse environmental and social risks and/or impacts.

Principle 2: Environmental and Social Assessment

For all Category A and Category B projects, the EPFI will require the client to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental impacts of the proposed project. The Assessment Documentation should propose measures to minimize, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed project.

Principle 3: Applicable Environmental and Social Standards

The Assessment process should, in the first instance, address compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. Bangladesh being a Non-Designated Country, the Assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines).

Principle 4: Environmental and Social Management System and Equator Principles Action Plan

For all Category A and Category B projects, the EPFI will require the client to develop or maintain an Environmental and Social Management System (ESMS). Further, an Environmental and Social Management Plan (ESMP) will be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards.

Principle 5: Stakeholder Engagement

The EPFI will require the client to demonstrate effective Stakeholder Engagement as an on-going process in a structured and culturally appropriate manner for all Category A and Category B projects. The client will conduct an informed consultation and participation process. The consultation process will be tailored to the risks and impacts of the project; the project's phase of development; the language preferences of the Affected Communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups.

To facilitate Stakeholder Engagement, the client will, commensurate to the project's risks and impacts, make the appropriate Assessment Documentation readily available to the Affected Communities, and where relevant Other Stakeholders, in the local language and in a culturally appropriate manner.

Principle 6: Grievance Mechanism

For all Category A and, as appropriate, Category B projects, the EPFI will require the client, as part of the ESMS, to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance.

Principle 7: Independent Review

For all Category A and, as appropriate, Category B projects, an Independent Environmental and Social Consultant, not directly associated with the client, will carry out an Independent Review of the Assessment Documentation including the ESMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance.

Principle 8: Covenants

For all Category A and Category B projects, the client will covenant the financial documentation:

- To comply with all the relevant host country social and environmental laws, regulations and permits in all material respects;
- To comply with Action Plan (where applicable) during construction and operation of the project in all material aspects;
- To provide periodic reports in a format agreed with EPFIs (frequency to be agreed, but not less than annually) that documents compliance against APs, as well as against local laws and permits; and
- To decommission the facilities in accordance with an agreed decommissioning plan.

Principle 9: Independent Monitoring and Reporting

To ensure ongoing monitoring and reporting over the life of the project, the EPFIs will, for all A Category projects and where appropriate Category B, require appointment of an independent environmental and/or social expert, or require that the borrower retain qualified and experienced external experts to verify its monitoring information, to be shared with the EPFIs.

Principle 10: Reporting and Transparency

Each EPFI is committed to issuing periodic public reports about project implementation processes and experience with due regard for appropriate project confidentiality.

2.9 International and National Environment Standards/ Guidelines

Bangladesh and World Bank environmental standards and guidelines relevant to the construction and operation of the project cover the following issues[1]:

- Atmospheric emissions and ambient air quality;
- Water quality;
- Liquid effluent discharges to the marine environment;
- Noise emissions and ambient noise levels.

2.9.1 Ambient Air Quality Standards

As per IFC EHS Guidelines, "the ambient air quality standards are ambient air quality levels established and published through national legislative and regulatory processes and ambient quality guidelines refer to ambient quality levels primarily developed through clinical, toxicological, and epidemiological evidence (such as those published by the World Health Organization)". The current air quality guidelines are:

Table 16: Ambient air quality guidelines as per IFC EHS Guidelines

Parameter	Averaging Period	Guideline value in µg/m³
Sulfur Dioxide (SO_2)	24-hour	125 (Interim target-1)
		50 (Interim target-2)
		20 (guideline)
	10 minutes	500 (guideline)
Nitrogen dioxide (NO_2)	1-year	40 (guideline)
	1-hour	200 (guideline)
Particulate Matter PM_{10}	1-year	70 (Interim target-1)
		50 (Interim target-2)

[1]*When host country regulations differ from the levels and measures presented in the EHS Guidelines, project is expected to achieve whichever is more stringent.*

Parameter	Averaging Period	Guideline value in µg/m³
		30 (Interim target-3)
		20 (guideline)
	24-hour	150 (Interim target-1)
		100 (Interim target-2)
		75 (Interim target-3)
		50 (guideline)
Particulate Matter $PM_{2.5}$	1-year	35 (Interim target-1)
		25 (Interim target-2)
		15 (Interim target-3)
		10 (guideline)
	24-hour	75 (Interim target-1)
		50 (Interim target-2)
		37.5 (Interim target-3)
		25 (guideline)
Ozone	8-hour daily	160 (Interim target-1)
	maximum	100 (guideline)

* *Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines*

As per the provisions of Rules 12 and 13 of the ECR 1997, the MoEF is responsible for laying down environmental quality standards (pertaining to air, water, sound, odour and other components) and standards for discharge and emission of waste. Ambient air quality standards have been stipulated in Schedule 2 (Standards for Air) of the Rules. However, these standards were revised by MoEF in 2017. The revised standards have been illustrated in the Table below.

Table 17: Ambient air quality standards of Bangladesh

Pollutant	Averaging Time	Concentration
Carbon Monoxide (CO)(mg/m³)	8 hours	10 (9 ppm)
	-	40 (35 ppm)
Lead (Pb)(µg/m³)	1 hour	0.5
Oxides of Nitrogen(NO_x)(µg/m³)	Annual	100 (0.053 ppm)
Sulfur dioxide (SO_2)(µg/m³)	Annual	80 (0.03 ppm)
	24 hours	365 (0.14 ppm)
Suspended Particulate Matter (SPM)(µg/m³)	8 hours	200
Coarse Particulates(PM_{10})(µg/m³)	Annual	50
	24 hours	150
Fine Particulates($PM_{2.5}$)(µg/m³)	Annual	15
	24 hours	65
Ozone (O_3)(µg/m³)	8 hours	157 (0.08 ppm)
	1 hour	235 (0.12 ppm)

Source: *ECR,97(revised, 2017)*

Air emission standards for Crude Oil Refinery have been stipulated in Schedule 12 (K) of the Rules-

Table 18: Air emission standards for crude oil refinery of Bangladesh

Parameter	Source	Standards for maximum presence	Unit
Sulfur dioxide	Distillation	0.25	kg/ton
	Catalytic Cracker	2.5	kg/ton

2.9.2 Water Quality Standards

As per Schedule 12 of the ECR 1997, designated best use classification has been prescribed for inland surface water as given in the following Table.

Table 19: Standards for inland surface water

SN	Best Practice based classification	Parameter			
		pH	BOD (mg/l)	DO (mg/l)	Total Coliform (number/100 ml)
a.	Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b.	Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
c.	Source of drinking water for supply after conventional treatment	6.5-8.5	3 of less	6 or more	5000 or less
d.	Water usable by fisheries	6.5-8.5	6 of less	5 or more	5000 or less
e.	Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	-
f.	Water usable for irrigation	6.5-8.5	10 or less	5 or more	1000 or less

Notes:

1. *In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.*
2. *Electrical conductivity for irrigation water – 2250 µ mhoms/cm (at a temperature of 25 ° C); Sodium less than 26%; boron less than 0.2%.*

The standards for drinking water have been presented in the Table below as per Schedule 3 of ECR-1997.

Table 20: Standards for drinking water

SN	Parameters	DoE Standards (Drinking Water Standards)
1.	Aluminium (in mg/l)	0.2
2.	Ammonia (in mg/l)	0.5 mg/l
3.	Arsenic (in mg/l)	0.05 mg/l
4.	Balium (in mg/l)	0.01 mg/l
5.	Benzene (in mg/l)	0.01 mg/l
6.	BOD (in mg/l)	0.2 mg/l
7.	Boron (in mg/l)	1 mg/l
8.	Cadmium (in mg/l)	0.005 mg/l
9.	Calcium (in mg/l)	75 mg/l
10.	Chlorides (in mg/l)	150-600 mg/l (1000 mg/l in coastal area)
11.	Chlorinated alkanes Carbontetrachloride(in mg/l) 1,1dichloroethylene(in mg/l) 1,2 dichloroethylene(in mg/l) Tetrachloroethylene(in mg/l) Trichloroethylene(in mg/l)	 0.01 mg/l 0.001 mg/l 0.03 mg/l 0.03 mg/l 0.09 mg/l
12.	Chlorinated phenols pentachlorophenol (in mg/l) trichlorophenol (in mg/l)	 0.03 mg/l 0.03 mg/l
13.	Chlorine (residual) (in mg/l)	0.2 mg/l
14.	Chloroform	0.09 mg/l
15.	Hexavalent Chromium (in mg/l)	0.05 mg/l
16.	Total Chromium (in mg/l)	0.05 mg/l
17.	COD (in mg/l)	4 mg/l
18.	Color	15 Hazen
19.	Copper (in mg/l)	1 mg/l
20.	Cyanide	0.1 mg/l
21.	Detergents	0.2 mg/l
22.	DO	6 mg/l
23.	Faecal Coliform (in n/100 ml)	0
24.	Total Coliform (in n/100 ml)	0

SN	Parameters	DoE Standards (Drinking Water Standards)
25.	Alkalinity (in mg/l)	200-500
26.	Fluorides (in mg/l)	1.0 mg/l
27.	Iron (in mg/l)	0.3-1.0 mg/l
28.	Kjeldhl Nitrogen (total)	1 mg/l
29.	Lead (in mg/l)	0.05 mg/l
30.	Magnesium (in mg/l)	30-35 mg/l
31.	Manganese (in mg/l)	0.1 mg/l
32.	Mercury (in mg/l)	0.001 mg/l
33.	Nickel	0.1 mg/l
34.	Nitrate (in mg/l)	10 mg/l
35.	Nitrite	<1 mg/l
36.	Odor	Odorless
37.	Oil and Grease (in mg/l)	0.01 mg/l
38.	pH	6.5 – 8.5
39.	Phenolic Compounds	0.002 mg/l
40.	Phosphate (in mg/l)	6 mg/l
41.	Phosphorous (in mg/l)	0mg/l
42.	Potassium	12 mg/l
43.	Radioactive materials (gross alpha activity)	0.01 Bq/l
44.	Radioactive materials (gross beta activity)	0.1 Bq/l
45.	Selenium	0.01 mg/l
46.	Silver	0.02 mg/l
47.	Sodium	200 mg/l
48.	Sulfide	0 mg/l
49.	Sulphate (in mg/l)	400 mg/l
50.	Suspended particulate matters	10 mg/l
51.	TDS (in mg/l)	1000 mg/l
52.	Temperature (in ° C)	20-30° C
53.	Tin	2 mg/l
54.	Turbidity (in NTU)	10
55.	Zinc (in mg/l)	5 mg/l

2.9.3 Liquid Effluent Discharges

As per Schedule 10 of ECR 1997, standards for waste from industrial units or project waste have been described. The same has been detailed in the Table below:

Table 21: Standards for liquid effluent discharge

SN	Parameter	Unit	Places for determination of standards		
			Inland Surface Water	Public Sewerage System connected to treatment at second stage	Irrigated Land
1.	Ammonical Nitrogen(as elementary N)	mg/l	50	75	75
2.	Ammonia (as free ammonia)	mg/l	5	5	15
3.	Arsenic (as)	mg/l	0.2	0.05	0.2
4.	BOD 5 at 20°C	mg/l	50	250	100
5.	Boron	mg/l	2	2	2
6.	Cadmium (as Cd)	mg/l	0.05	0.5	0.5
7.	Chloride	mg/l	600	600	600
8.	Chromium (as totalCr)	mg/l	0.5	1.0	1.0
9.	COD	mg/l	200	400	400
10.	Chromium (as hexavalentCr)	mg/l	0.1	1.0	1.0
11.	Copper (as Cu)	mg/l	0.5	3.0	3.0
12.	Dissolved Oxygen(DO)	mg/l	4.5-8	4.5-8	4.5

SN	Parameter	Unit	Places for determination of standards		
			Inland Surface Water	Public Sewerage System connected to treatment at second stage	Irrigated Land
13.	Electro-conductivity(EC)	Micro mho/ cm	1200	1200	1200
14.	Total Dissolved Solids	mg/l	2100	2100	2100
15.	Fluoride (as F)	mg/l	2	15	10
16.	Sulfide (as S)	mg/l	1	2	2
17.	Iron (as Fe)	mg/l	2	2	2
18.	Total Kjeldahl Nitrogen (as N)	mg/l	100	100	100
19.	Lead (as Pb)	mg/l	0.1	1.0	0.1
20.	Manganese (as Mn)	mg/l	5	5	5
21.	Mercury (as Hg)	mg/l	0.01	0.01	0.01
22.	Nickel (as Ni)	mg/l	1.0	2.0	1.0
23.	Nitrate (Aselementary N)	mg/l	10	Not yet Fixed	10
24.	Oil and Grease	mg/l	10	20	10
25.	Phenolic Compounds(as C_6H_5OH)	mg/l	1.0	5	1.0
26.	Dissolved Phosphorus (as P)	mg/l	8	8	15
27.	Radioactive substance	To be specified by Bangladesh Atomic Energy Commission			
28.	pH	-	6-9	6-9	6-9
29.	Selenium (as Se)	mg/l	0.05	0.05	0.05
30.	Zinc (as Zn)	mg/l	5	10	10
31.	Total Dissolved Solids	mg/l	2100	2100	2100
32.	Temperature	° C	40	40	40-Summer
			45	45	45-Winter
33.	Suspended Solids (SS)	mg/l	150	500	200
34.	Cyanide (as Cn)	mg/l	0.1	2.0	0.2

Notes:

(1) These standards shall be applicable to all industries or projects other than those specified under the heading "Standards for sector-wise industrial effluent or emission."

(2) Compliance with these standards shall be ensured from the moment an industrial unit starts trial production, and in other cases, from the moment a project starts operation.

(3) These standards shall be inviolable even in case of any sample collected instantly at any point of time. These standards may be enforced in a more stringent manner if considered necessary in view of the environmental conditions of a particular situation.

(4) Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries.

(5) Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.

(6) Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

(7) Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes 5 and 6 above.

As per Schedule 12 of ECR 1997, standards for liquid waste from crude oil refinery have been described. The same has been detailed in the Table below:

Parameters	Standards for maximumpresence	Unit
Suspended solids (SS)	100	mg/l
Oil and Grease	10	,,
BOD5 20oC	30	,,
Phenol	1	,,
Sulfide (as S)	1	,,
Wastewater flow	700	Cubic Meter/1000 Ton of treated crude oil

As per Schedule 9 of ECR 1997, standards for sewage discharge has been given in the Table below:

Parameter	Unit	Standard Limit
BOD	miligram/l	40
Nitrate	,,	250
Phosphate	,,	35
Suspended Solids (SS)	,,	100

Parameter	Unit	Standard Limit
Temperature	Degree Centigrade	30
Coliform	number per 100 ml	1000

As per the IFC EHS guidelines, the treated sanitary sewage discharge is required to meet the following values.

Table 22: Treated sewage discharge guideline values of IFC

SN	Parameters	Guideline Value
1.	pH	6 – 9
2.	BOD	30mg/l
3.	COD	125mg/l
4.	Total Nitrogen	125mg/l
5.	Oil and Grease	10 mg/l
6.	Total Suspended Solids	50 mg/l
7.	Total coliform bacteria	400 MPN/100 ml

IFC Wastewater and Water Quality Monitoring Programme

A wastewater and water quality monitoring program with adequate resources and management oversight should be developed. The following elements to be considered while setting up the programme:

- *Parameters*: The parameters selected for monitoring should be indicative of the pollutants of concern from the process and should include parameters that are regulated under compliance requirements.
- *Monitoring type and frequency*: Wastewater monitoring should take into consideration the discharge characteristics from the process over time. Effluents from highly variable processes may need to be sampled more frequently or through composite methods. Grab samples or, if automated equipment permits, composite samples may offer more insight on average concentrations of pollutants over a 24-hour period.
- *Monitoring locations*: Effluent sampling stations may be located at the final discharge, as well as at strategic upstream points prior to merging of different discharges.
- *Data Quality*: Sampling should be conducted by or under the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. QA/QC documentation should be included in monitoring reports.

2.9.4 Ambient Noise Standards

As per IFC EHS Guidelines, noise impacts should not exceed the levels presented in the Table below or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 23: Noise level guidelines as per IFC

Receptor	One Hour L_{eq} (dBA)	
	Daytime 07:00 - 22:00	Night time 22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The MoEF under the provisions of ECR, 1997 is responsible for laying down ambient noise standards. Ambient noise standards have been furnished in the Table below:

Table 24: Ambient noise standards as per DoE

SN	Type of Area	Limits in dB(A)L_{eq}	
		Day	Night
1.	Silent Zone	45	35
2.	Residential area	50	40
3.	Mixed area	60	50
4.	Commercial area	70	60
5.	Industrial area	75	70

Note:

1. dB(A) L_{eq} represents time-weighted average noise level on the Decibel-A scale
2. Day time is from 6am to 9pm, Night time is form 9pm to 6 am
3. Mixed area is mainly residential area, and also simultaneously used for commercial and industrial purposes
4. Area up to a radius of 100 m around hospitals/educational institutions/special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

2.9.5 Guidelines of United States Environmental Protection Agency (USEPA)

The USEPA guidelines of Environmental protection in petrochemical complex are summarized as follows.

Oil and Natural Gas Production Facilities: National Emission Standards for Hazardous Air Pollutants (NESHAP)

Section-112: Hazardous air pollutants

The project authority should find out the sources (major, area and stationary) of hazardous air pollutant and make the list of pollutants. The Administrator shall list of each category or subcategory of sources which the Administrator finds presents a threat of adverse effects to human health or the environment (by such sources individually or in the aggregate) warranting regulation.

Test methods

The Administrator may establish, by rule, test measures and other analytic procedures for monitoring and measuring emissions, ambient concentrations, deposition, and bioaccumulation of hazardous air pollutants.

Research facilities

Administrator of the project will establish a separate category covering research or laboratory facilities, as necessary to assure the equitable treatment of such facilities. For purposes of this section, ‘‘research or laboratory facility’’ means any stationary source whose primary purpose is to conduct research and development into new processes and products, where such source is operated under the close supervision of technically trained personnel and is not engaged in the manufacture of products for commercial sale in commerce, except in a de-minimize manner.

Review and revision

The Administrator of project shall review, and revise as necessary (taking into account developments in practices, processes, and control technologies), emission standards promulgated under this section no less often than every 8 years.

Emission Standards

The standards must require the maximum degree of emission reduction that the EPA determines to be achievable by each particular source category. Different criteria for maximum achievable control technology (MACT) apply for new and existing sources. Less stringent standards, known as generally available control technology (GACT) standards, are allowed at the Administrator's discretion for area sources.

Standards and methods

Emissions standards applicable to new or existing sources of hazardous air pollutants shall require the maximum degree of reduction in emissions of the hazardous air pollutants subject to this section (including a prohibition on such emissions, where achievable) that the Administrator, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable for new or existing sources in the category or subcategory to which such emission standard applies, through application of measures, processes, methods, systems or techniques including, but not limited to, measures which—

- Reduce the volume of, or eliminate emissions of, such pollutants through process changes, substitution of materials or other modifications,
- Enclose systems or processes to eliminate emissions,
- Collect, capture or treat such pollutants when released from a process, stack, storage or fugitive emissions point.
- Are designs, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided, or are combinations of the above.

Greenhouse Gas Reporting Program (GHGRP)

The Greenhouse Gas Reporting Program (GHGRP) collects Greenhouse Gas (GHG) data from large emitting facilities, suppliers of fossil fuels and industrial gases that result in GHG emissions when used. The project authority will collect emissions data is to provide a better understanding of the sources of GHGs and to guide development of policies and programs to reduce emissions.

General Stationary Fuel Combustion Sources

Stationary fuel combustion sources are devices that combust solid, liquid, or gaseous fuel, generally for the purposes of producing electricity, generating steam, or providing useful heat or energy for industrial, commercial, or institutional use, or reducing the volume of waste by removing combustible matter. Stationary fuel combustion sources include, but are not limited to, boilers, simple and combined cycle combustion turbines, engines, incinerators, and process heaters.

Reporting threshold

The project authority must report GHGs emissions under this subpart if the existing facility contains one or more stationary fuel combustion sources and the facility meets the applicability requirements.

GHGs to report

The project authority must report CO_2, CH_4, and N_2O mass emissions from each stationary fuel combustion unit.

Calculating GHG emission

The project authority must calculate CO_2, CH_4 and N_2O emissions. The CO_2 mass emissions data for stationary fuel combustion sources shall be monitored.

Data reporting requirements

In addition to the facility-level information required the annual GHG emissions report shall contain the unit-level or process-level emissions (as applicable) and the emissions verification data.

Industrial Waste: Crude Oil and Natural Gas Waste

Identification and Listing of Hazardous Waste

Sets out those criteria, identifies a set of characteristics of hazardous waste, and establishes a list of particular hazardous wastes.

Hazardous waste control program

The project authority shall establish a comprehensive system designed to safely dispose-of, treat, and store or reuse hazardous waste. The basic idea is that the public health and environment will be protected If there is careful monitoring of transportation of hazardous waste, and assurance that such waste is treated or disposed of either at the site where it is generated or after it is carried from that site to a special- facility (both on-site and off-site facilities would require permits) in accordance with certain standards, The Act requires to define hazardous waste, and to publish standards that generators of such waste must follow so that if the substance is not disposed of where it is generated, every person coming in contact with. The waste will know exactly what the waste is, and the quantity. Waste which is defined as hazardous can be disposed of, treated or stored at the place of generation or at an off-site facility.

Water

Protection of underground sources of drinking water

The administrator of project shall publish proposed regulations for State underground injection/Leak control programs.

Enforcement of program

In any case in which the Administrator is authorized to bring a civil action under this section with respect to any regulation or other requirement of this part other than those relating to—the underground injection of brine or other fluids which are brought to the surface in connection with oil or natural gas production.

Comprehensive plan

The objective of a comprehensive management plan shall maintain the quality of the ground water in the critical protection area in a manner reasonably expected to protect human health, the environment and ground water resources. In order to achieve such objective, the plan may be designed to maintain, to the maximum extent possible, the natural vegetative and hydro-geological conditions. Specific actions and management practice to be implemented in the critical protection area to prevent adverse impacts on ground water quality.

2.9.6 Applicable International Conventions

Environmental problems which migrate beyond the jurisdiction (Trans-boundary) require power to control such issues through international co-operation by becoming a Contracting Party (CP) i.e., ratifying treaties or as Signatory by officially signing the treaties and agreeing to carry out provisions of various treaties on environment and social safeguards. Bangladesh has signed and ratified various Multilateral Environmental Agreements (MEAs), International Labor Organization (ILO) Conventions, and International Maritime Conventions. The relevant international conventions have been summarized in the in the Table below.

Table 25: Applicable international conventions

Treaty or Convention & holding year	Brief Description
Convention on Protection of birds, Paris, 1950	Protection of birds in wild state
Convention on oil pollution damage (Brussels), 1969	Civil liability on oil pollution damage from ships
Ramsar Convention, 1971	Protection of wetlands
World Cultural and Natural Heritage (Paris), 1972	Protection of major cultural and natural monuments
CITES Convention (Washington), 1973	Ban and restrictions on international trade in endangered species of wild fauna and flora
Bonn Convention, 1979	Convention of migratory species of wild animal
Prevention and Control of Occupational Hazards (Geneva) 1974	Protect workers against occupational exposure to carcinogenic substances and agents
Occupational hazards due to air pollution, noise and vibration (Geneva) 1977	Protect workers against occupational hazards in the working environment
Occupational safety and health in working environment (Geneva) 1981	Prevent accidents and injury to health by minimizing hazards in the working environment
Occupational Health Services (Geneva) 1985	To promote a safe and healthy working environment
Vienna convention, 1985	Protection of ozone layer
Civil liability on transport of dangerous goods (Geneva), 1989	Safe methods for transport of dangerous goods by road, railway and inland vessels
Convention on oil pollution (London), 1990	Legal framework and preparedness for control of oil pollution
London Protocol, 1990	Control of global emissions that deplete ozone layer
UN Framework convention on climate change (Rio de Janeiro), 1992	Regulation of greenhouse gases emissions
Convention on Biological Diversity (Rio de Janeiro), 1992	Conservation of bio-diversity, sustainable use of its components and access to genetic resources
International Convention on Climate Changes (Kyoto Protocol), 1997	International treaty on climate change and emission of greenhouse gases
Protocol on biological safety (Cartagena Protocol), 2000	Biological safety in transport and use of bio-products

Chapter 3
Project Description

3.1 Introduction

The aim of this project is to produce import substitute polyolefin products like Linear Low-Density Polyethylene (LLDPE)/ High Density Polyethylene (HDPE) & Polypropylene (PP); and Naphtha will be used as main raw material for olefin production. A crude oil refinery will be integrated for recovering the required naphtha. Therefore, the production facilities are being described here as two major units:

- Crude Oil Refinery: In this Unit, Naphtha/ Jet A1/ Ultra Low Sulfur Diesel (ULSD)/ Base Oil/ Furnace Oil/ LPG will be produced from Crude Oil.
- Cracker and Polymer Production Unit: In this unit, LLDPE/ HDPE/ PP/ Benzene/ Toluene/Xylene/ Furnace Oil/ Diesel will be produced from Naphtha.

3.2 Project Objective

The objectives of the project are as follows:

- To establish a petrochemical plant to meet the demand of local market;
- To generate employment opportunities;
- To create a new business window;
- To contribute for the ultimate development of the country.

3.3 Project Activities

3.3.1 Raw Materials

Major raw materials to be needed for the both units are given below:

SL No.	Name of Raw Materials	Quantity (ton per year)
1.	Crude oil	4,488,809
2.	Butene-1	26,730
3.	Hexene-1	13,900
4.	Methane (natural gas)	341,865
	Total	4,871,304

A details list of raw materials and chemicals are attached in annex-8.

3.3.2 Finish Products

The following products will be produced from both Crude Oil Refinery and Cracker & Polymer Production Units.

SL No.	Name of Finish Products	Quantity (ton per year)
1.	LLDPE/HDPE	511,447
2.	Polypropylene	330,755
3.	Benzene	60,557
4.	Toluene	46,292
5.	Xylene	58,459
6.	Base Oil/White Oil	198,574
7.	Jet A-1	78,668

SL No.	Name of Finish Products	Quantity (ton per year)
8.	Ultra-Low Sulfur Diesel	2538,916
9.	Furnace Oil	193,249
10.	LPG	74,237
	Total	4,091,154

3.3.3 Process Description

Feed and Product:

A. Crude Oil Refinery:

i. Feeds: Raw Crude Oil and Natural Gas

ii. Products: LPG, Naphtha, Jet A1, Ultra-Low Sulfur Diesel (ULSD), Base Oil/ White Oil and Furnace Oil.

B. Cracker and Polymer Production Plant:

i. Feeds: Naphtha, Hexene -1, Butene - 1 and Natural Gas.

iii. Products: Linear Low-Density Polyethylene (LLDPE)/ High Density Polyethylene (HDPE), Polypropylene, Benzene, Toluene, Xylene, Pyrolysis Diesel Oil and Pyrolysis Furnace Oil.

The brief descriptions of the processing schemes of different processing units are presented below.

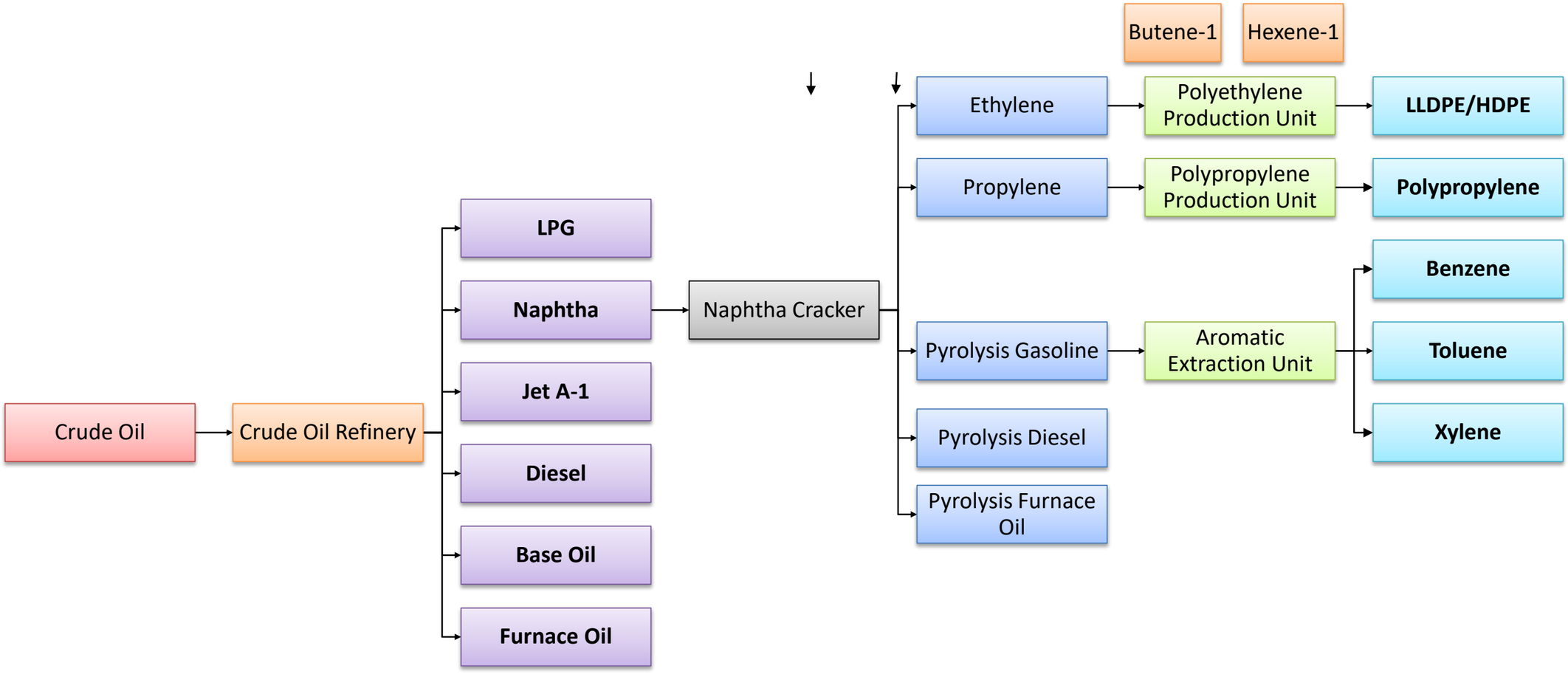


Figure 4: Simplified process flow scheme for proposed project

a) Crude Oil Refinery

Crude Oil Refinery Unit is configured to recover maximum naphtha and diesel. The Crude Oil Refinery comprises of following units:

i. Atmospheric Distillation Unit (ADU) — Design capacity 140,000 BPD
ii. Naphtha Fractionation Unit - Design capacity 60,000 BPD
iii. Vacuum Distillation Unit (VDU) - Design capacity 90,000 BPD
iv. Vacuum Residue Hydrocracker (VRHC) - Design capacity 36,000 BPD
v. Kerosene/Diesel Hydrotreater (KDHT) - Design capacity 35,000 BPD
vi. Diesel Hydrotreater (DHT) - Design capacity 17,000 BPD
vii. VGO Hydrocracker Unit (VGO HC) - Design capacity 46,000 BPD

Following auxiliary units will be set up for above operations:

a) Amine Treating Unit (ATU) — Sour gas treating capacity 100 MMSCFD
b) Acid Gas Removal Unit (AGR) - Acid gas treating capacity 72 MMSCFD
c) Sulfur Recovery Unit (SRU) — Sulfur production capacity 1200 LTID
d) Tail Gas Treating Unit (TGTU) — Tail gas treating Capacity 2440 KSCFH
e) Sulfur Degassing Unit (SDU) — Design capacity 600 MTID
f) Flare Gas Recovery Unit (FGRU) — Gas recovering capacity 18 MMSCFD
g) Hydrogen Production Unit — Production capacity 148 MMSCFD
h) Hydrogen Compression Unit — Compression capacity 160 MMSCFD
i) Sour Water Treatment Unit — Treating capacity 340 GPM
j) Foul Water Treatment Unit — Treating capacity 350 GPM
k) Ammonical Water Treatment Unit — Treating capacity 140 GPM
l) Flare – I
m) Instrument Air & Plant Air System
n) Nitrogen Generation System
o) DM Water Plant
p) Cooling Tower System
q) Boiler & Steam System

i) Atmospheric Distillation Unit (ADU) (U-01)

Atmospheric Distillation Unit is the primary crude fractionation unit which processes Crude oil and produces distillates such as unstabilized Naphtha, Kerosene, Diesel (I), Diesel (II) and Reduced Crude for further processing in downstream processing units.

Process Description:

The crude oil received from storage tank is heated by exchanging heat with different distillate & reduced crude to increase the temperature up to desired level prior to entering the desalter. A small quantity of water and demulsifier chemical are added before preheating. The hot crude is mixed with wash water and fed to the Desalters to reduce its salt content by electric desalting process. A water phase containing most of the salts is separated out and sent to the Effluent Treatment Unit.

The desalted crude is pumped and further heated through parallel trains of heat exchangers and fed to Pre-flash Tower. The Pre-flash Tower Overhead vapors are cooled and routed to overhead accumulator. The Naphtha vapors and liquid from Accumulator are routed to Naphtha Fractionation

Unit (U-02). The preflashed crude from the bottom of Preflash Tower is pumped, preheated in train of exchangers and sent to the Atmospheric Fired Heaters.

Pre-flashed crude is heated and partially vaporized in the fired heaters before entering the Atmospheric Tower. The atmospheric tower overhead vapors are cooled, partially condensed and routed to overhead product drum. Overhead gases are recovered as top product of overhead product drum, compressed and routed to Naphtha Fractionation Unit. Unstabilized liquid Naphtha with Kerosene is recovered as bottom product of overhead product drum and routed to Naphtha Fractionation Unit.

Diesel (I) and Diesel (II) cuts are taken as side streams from the Atmospheric tower and steam stripped in side strippers. These Diesel (I) & Diesel (II) product streams are exchanged heat with exchangers, cooled in Coolers and routed to intermediate storage. During normal operation, Diesel (I) is directly routed to the Kerosene/Diesel Hydrotreater (U-05) as feed and Diesel (II) is directly routed to the Diesel Hydrotreater (U-06) as feed for further processing. Atmospheric tower bottoms (Hot reduced crude) are directly sent to the Vacuum charge heaters as VDU (U-03) feed.

ii) Naphtha Fractionation Unit (U-02)

Naphtha fractionation unit is designed to produce Naphtha as a feed of Cracker unit (U¬101) by fractionation of full range unstabilized Naphtha from ADU (U-01), Kerosene/Diesel Hydrotreater (U-05) and Vacuum Residue Hydrocracker (U-04). Kerosene, LPG & light hydrocarbon are also recovered in this unit.

Process Description:

Unstabilized naphtha liquid from ADU, Kerosene/Diesel Hydrotreater & VRHC unit and naphtha gases (LP Gases) from ADU, VDU, Kerosene/Diesel Hydrotreater, VRHC, Diesel Hydrotreater & VGO Hydrocracker unit are all combined, cooled and sent to LP gas feed drum. The separated vapor from LP gas feed drum is joined with LP flash gas streams from different cracker units, and is fed to LP absorber where heavy hydrocarbons are recovered by absorption with lean kerosene.

The liquid stream from LP gas feed drum is joined with rich kerosene stream from LP absorber, heated and routed to the Debutanizer. This combined stream is stabilized by recovering of LPG (butane) and lighter gas in debutanizer. Recovered LPG is sent to the storage. The overhead gas from debutanizer is joined with the lean low-pressure gas from LP absorber and routed to Amine Treating Unit (U-08).

The debutanizer bottom stabilized product is fed to splitter, where Naphtha is recovered as top product and sent to storage. Kerosene is recovered as bottom product of splitter, cooled and routed to Kerosene/Diesel Hydrotreater (U-05).

iii)Vacuum Distillation Unit (U-03)

Vacuum distillation unit (VDU) processes reduced crude from ADU (U-01) & recycled bottoms of Fractionator/Stripper from VRHC (U-04); and produces distillates such as Light Vacuum Gas Oil (LVGO), Heavy Vacuum Gas Oil (HVGO) & Vacuum Residue for further processing in downstream processing units.

Process Description:

Hot reduced crude is fed directly from the ADU to the vacuum charge heaters along with bottoms recycled of Fractionator/Stripper from Vacuum Residue Hydrocracker Unit (U-04). The reduced crude from vacuum charge heaters enters the flash zone of Vacuum Distillation Tower. The column operates under vacuum by means of steam-jet ejectors & condenser system to achieve required separation between heavy components at lower temperature. From overhead, the un-condensed sour gas is compressed using sour gas compressors and sent to Amine Treating Unit (U-08). Condensed water is routed to Desalter feed water surge drum.

The Light Vacuum Gas Oil (LVGO) product, drawn as upper side stream of vacuum tower, exchanged heat with crude preheat train, cooled in coolers and routed to the VGO Hydrocracker Unit (U-07) for further processing.

The Heavy Vacuum Gas Oil (HVGO) product, drawn as lower side stream of vacuum tower, is steam stripped in stripper, exchanged heat with crude preheats train, cooled in coolers and routed to the VGO Hydrocracker Unit (U-07) for further processing. A part of the vacuum gas oil (VGO) is recycled back to vacuum tower as wash oil.

Vacuum Residue is recovered as bottom product of vacuum tower, exchanged heat with different preheat train and routed to Vacuum Residue Hydrocracker Unit (VRHC) (U¬04). Some portion of vacuum residue product is directly sent to the storage as Furnace Oil blending stock.

iv)Vacuum Residue Hydrocracker Unit (VRHC) (U-04)

The purpose of this Unit is to upgrade the vacuum residual stocks (bottoms of vacuum distillation unit) by catalytic hydrocracking process in the presence of hydrogen and obtain valuable distillate products.

These distillate products are separated as side streams from the Fractionation Tower as Cracked Naphtha, Kerosene and Diesel (I). And these three products are sent to the different treatment unit for further processing to meet the standard product quality.

The Stripper bottom and Fractionator Bottom of VRHC unit are mixed and recycle back to the VDU (U-03) along with reduced crude from ADU (U-01).

Process Description:

The hot vacuum residue is pumped to Residue Feed Heater and then mixed with high pressure recycle hydrogen gas (Preheated in recycle gas heater) in a Mixer. Fresh hydrogen is injected in the suction of hydrogen recycle gas compressor. Mixer outlet is fed to VRHC reactor. Within the reactor, the charge oil is cracked at elevated temperature and high hydrogen pressure in the presence of catalyst.

The Vacuum Residue reaction takes place in an ebullated bed of catalyst. Pump suction form reactor top level maintains a circulation to keep the catalyst particles in continuous ebullition and near isothermal reaction conditions. Some spent catalyst is withdrawn at regular intervals (daily) and replenished by loading fresh catalyst to maintain required catalyst activity.

The reactor effluent flows as a vapor-liquid mixture into hot separator. The flash vapor leaving from the separator is cooled by exchanging heat with different preheat train. Cooled vapor effluent is then fed to Primary Distillate Knockout Drum for removal of condensed liquid. Vapor from primary

distillate knockout drum is further cooled in an air cooler and enters Distillate Separator Drum. The hydrogen rich gases which upon leaving the separator, splits into two streams. The larger of the two streams is compressed in Recycle Gas Compressor and returned to VRHC reactor, as recycle hydrogen. The smaller purge gas stream is sent to the Hydrotreaters (U-05 & U-06) as make-up hydrogen.

Water wash is injected upstream of aero coolers to avoid ammonium bisulfide deposits. The ammonical water is routed to Ammonical Water Treating Unit (Unit-18). Condensed liquid from primary distillate knockout drum joins with reactor effluent liquid from hot separator and flashed to remove hydrogen & low molecular weight hydrocarbons in three successive stages. The resulting vapor is cooled through preheat train exchangers and then in cooler, before it is fed to Low Pressure Flash Drum. The low-pressure flash gas is routed to Amin Treating Unit. The light distillate from Low pressure flash drum is pumped through exchangers, preheated and fed to the Fractionation Tower.

The hot flashed reactor liquid flows in to the Stripper, where it is steam stripped to remove the middle distillates. The stripper overhead streams are fed to Fractionation Tower, along with the preheated light distillates from low pressure flash drum. The stripper bottom product (hot) is pumped and recycles to VDU (U-03) for mixing with reduced crude as VDU feed.

Fractionator overhead vapor is cooled and condensed in Air Cooler before going in Naphtha Accumulator Drum. The vapor from accumulator drum is routed to the Amine Treating Unit. The unstablized liquid naphtha from accumulator is pumped to Naphtha Fractionation Unit (U-02). The separated water, withdrawn from accumulator is sent to the Oily Water Condensate System.

From the fractionator a kerosene cut is drawn to kerosene side stripper and light components removed by steam stripping. The raw kerosene stream is pumped, cooled in cooler, and routed to Kero/Diesel Hydrotreater (U-05).

A diesel cut is fed to diesel side stripper, for removal of light ends by steam stripping. The raw diesel (II) stream is pumped, cooled and routed to Diesel Hydrotreater (U-06).

The fractionator bottom product (hot) is pumped and recycled to VDU (U-03) for mixing with reduced crude as VDU feed.

v) Kerosene/Diesel Hydrotreater (U-05)

The objective of this unit is to upgrade raw kerosene from Naphtha Fractionation Unit and raw diesel (I) from ADU along with cracked kerosene of VRHC (U-04) by catalytic hydrotreating process and obtain valuable distillate products such as Jet Al fuel & Ultra Low Sulfur Diesel (ULSD).

Kerosene/Diesel hydro treatment is carried out by using hydrogen in the presence of a catalyst in reactor, whereby nitrogen & sulfur compounds are converted to ammonia & hydrogen sulfide. Simultaneously, undesirable aromatic hydrocarbons are converted to saturate.

Process Description:

Kerosene/Diesel (I) feed is preheated in the effluent/feed exchangers followed by final heating in the Feed Fired Heater, mixed with preheated hydrogen recycle Gas (Fresh hydrogen is injected in the suction of hydrogen recycle gas compressor) and flows through reactor, which is loaded with hydro desulfurized catalyst. The reactor effluent is cooled by exchanging heat with preheat train exchangers and air-coolers before flowing into the Separator.

The hydrogen rich gas from the separator, combined with fresh hydrogen is recycled to the reactor section by a recycle gas compressor. Recycle gas is preheated in preheat train exchanger. It is further heated in a recycle gas fired heater and joins with preheated hydrocarbon feed to the reactors. Part of the recycle gas is used as quench hydrogen in the reactor.

The hydrocarbon liquid from the separator is depressed into a Flash Drum. The flash gas containing H_2S is sent to Amine Treating Unit (U-08).

The liquid from the flash drum is fed into the Stabilizer, after preheating in exchangers. The stabilizer overhead vapors are partially condensed in an air cooler and flow into Accumulator. Naphtha gas from overhead accumulator is routed to Naphtha Fractionation Unit (U-02). The accumulator liquid naphtha is returned to stabilizer as reflux and the excess naphtha is routed to Naphtha Fractionation Unit (U-02).

Stabilizer bottoms flow to the fractionator, where another naphtha cut is taken as overhead product and routed to Naphtha Fractionation Unit (U-02). Kerosene base stock is drawn from the fractionator as a side stream. It passes through a kerosene side stripper for flash point control and sent to the storage as Jet Al fuel. The bottoms product stream of fractionator is pumped, cooled and routed to storage as Ultra Low Sulfur Diesel (ULSD) product.

vi) Diesel Hydrotreater (U-06)

The objective of this Unit is to upgrade raw diesel (II) from ADU (U-01) along with cracked diesel (II) from VRHC (U-04) by catalytic hydrotreating process and obtain valuable distillate products such as Jet Al fuel & Ultra Low Sulfur Diesel (ULSD).

Diesel hydro treatment is carried out by using hydrogen in the presence of a catalyst in reactors whereby nitrogen and sulfur compounds are converted to ammonia and hydrogen sulfide. Simultaneously undesirable aromatic hydrocarbons are converted to saturate.

Process Description:

Diesel (II) feed is pumped through the effluent/feed exchanger into the reactor which is loaded with hydrodesulfurised catalyst. The recycle gas from compressors discharge is heated through effluent heat exchanger and subsequently recycle gas heater and then mixed with the liquid feed going to the reactor. The reactor effluent is cooled by exchanging heat with preheat train exchangers & air coolers and then flows into the separator.

The hydrogen rich gas phase in the separator, along with fresh hydrogen is recycled to the reactor by a recycle gas compressor. Part of the recycle is used as quench hydrogen in the reactor. The hydrocarbon bottoms from the separator are routed into the Flash Drum. The flash drum off gas is sent to the Amine Treating Unit (U-08). The bottoms from the flash drum are preheated by preheat train exchangers and routed to Stabilizer

The stabilizer overhead vapors flow through an air cooler into the overhead drum. The overhead liquid (unstabilized naphtha) is used as reflux and the excess Naphtha is pumped to the storage as product. Vapors from the overhead drum are sent to Naphtha Fractionation Unit (U-02).

Stabilizer bottoms are pumped to the splitter and the incremental heat is supplied to splitter by a fired heater. Overhead vapors from the splitter are condensed in air cooler and flow into an accumulator. The accumulator liquid is used as reflux, and the excess after cooling is pumped to

storage as Jet Al fuel stock. Splitter bottoms stream is drawn off at the pump discharge, cooled and sent to storage as Ultra Low Sulfur Diesel (ULSD).

vii) VGO Hydrocracker Unit (U-07)

VGO Hydrocracker Unit converts a blend of Light Vacuum Gas Oil (LVGO) and Heavy Vacuum Gas Oil (HVGO) to lighter and high-value distillate products like Naphtha, Jet A 1 and Ultra Low Sulfur Diesel (ULSD) by hydrocracking process. Hydrocracking reactions occur at high temperature and pressure in the presence of hydrogen on a fixed bed catalytic reactor.

Process Description:

Vacuum Gas Oil from VDU (U-03) is passed thru filters and is pumped by high pressure feed pump. It is mixed with recycle gas and the mixture is preheated thru feed/reactor effluent exchanger and further in the reactor feed heater. The mixture then enters top of the reactor. Make-up hydrogen is preheated with reactor effluent, entered at the bottom annulus of the reactor and combined with the feed at top of the reactor.

The reactor consists of several catalyst beds with hydrocracking catalyst with provision of inter-bed recycle gas quenches to control catalyst bed temperatures. The reactor effluent is cooled by series of heat exchangers & coolers and entered in the high-pressure separator, where water, gases and liquid hydrocarbons are separated. A small quantity of water injected just upstream of the final cooler in order to combat corrosion due to hydrogen sulfide and ammonia. Water separated in high pressure separator and routed to the Ammonical Water Treatment Unit (U-18).

Gas stream from high pressure separator enters the H_2S absorber where H_2S is removed by circulating DEA solution. H_2S free gas is then compressed by the recycle gas compressor and recycled back to the reactor feed & inter-bed quench. In order to maintain system pressure and hydrogen purity, a small portion of the recycle gas is bled to Hydro treaters (U-05 & U-06).

Hydrocarbon liquid stream from the high-pressure separator is let down to the LP separator. LP separator gas is routed to Amine Treating Unit (U-08) while the liquid stream is let down to the Flash Drum. The separated gas from this flash drum also goes to Amine Treating Unit. The liquid stream from the flash drum, is routed to the H_2S stripper after preheated in train exchanger. Gas from Overhead Drum of H_2S stripper goes to Amine Treating Unit (U-08). The bottom stream from H_2S stripper is heated through a series of heat exchangers and fractionator feed heater, before entering the fractionator.

The fractionator overhead vapors are cooled in coolers and flow to the overhead drum. Naphtha is recovered as top product of fractionator and routed to the storage. Jet A 1 & Ultra Low Sulfur Diesel (ULSD) are recovered as side stream products, thru side cut strippers, cooled and sent to finished product storage tanks.

The bottoms product is recycled back and mixed with VGO feed to increase the conversion rate & products recovery. Under alternate mode of operation, the fractionation bottom can be partially recycled back to VGO Hydrocracker feed or routed to storage as Base Oil/White Oil products.

Rich DEA from H_2S absorber, goes to DEA flash drum and to the DEA regenerator. H_2S is stripped out of rich DEA in the regenerator and sent to Sulfur Recovery Units (U-10 A/B). From regenerator bottom, the DEA solution free of H_2S, is cooled and back to the H_2S Absorber.

Auxiliary Units:

The auxiliary units will be set-up considering the following aims-

- To produce and ensure fresh-high pressure hydrogen for refinery Hydrotreating & Hydrocracking Units
- To recover valuable sulfur product
- To ensure plant safety
- To ensure utilities requirements for operating the plants
- To ensure environmental regulation and thus setting up a greenfield Petrochemical Complex

a.Amine Treating Unit (ATU) (U-08)

Amine treating unit treats gas streams from refinery and petrochemical units for removing H_2S & CO_2 components. This helps to prepare feed gas for Hydrogen Units & fuel gas for furnaces. Simultaneously, this unit also recovers acid gas as Sulfur Recovery Unit (U-10 A/B) feed.

Process Description:

Unit has three amine contactors. Each of the amine contactors has a gas feed at the bottom and circulating Mono ethanolamine solution from the top. The contactors are equipped with knockout drum. Overhead treated LPG rich gas is routed to the Acid Gas Removal Unit (U-09).

LP gases from refinery & petrochemical units and recovered flare gas from FGRU are mixed and fed to Low Press Contactor. The treated low H2S gas is routed to the Fuel mixing drum as furnaces fuel.

Compressed LP gas is fed to Medium Press Contactor. The treated gas from top of the contactor is routed to the second stage of the compressor for further increase in pressure to be used as Hydrogen Production Unit feed.

HP Bleed/Flash gases form Hydrocrackers and Hydrotreaters is mixed and fed to Second Low Press Contactor. The treated H_2S free gas from top of the contactor is routed to the hydrotreating units as supplementary make-up hydrogen.

Rich amine is recovered from the contactors bottom and routed to amine regenerators. Rich amine is stripped of H_2S with steam reboilers. Lean Amine is recovered from the regenerator's bottom, cooled and recycled back to the three Amine Contactors.

Acid gas is recovered from the amine regenerators overhead and routed to the Sulfur Recovery Unit (U-10 A/B) for sulfur recovery.

b. Acid Gas Removal Unit (AGRU) (U-09)

Acid gas removal unit treats refinery acid gases from different units' by using Benfield solution to produce sweet LP gas and fuel gas product, by removing hydrogen sulfide and carbon dioxide.

Process Description:

The refinery acid gases compressed in a compressor and enter the feed surge drum along with LPG rich gas from Amine Treating Unit (U-08). Feeds are recombined, preheated with exchangers and then fed to the acid gas absorber. Lean Benfield solution is fed to the absorber at its top cold circulation section and middle hot circulation section. The rich solution reaching the bottom of the absorber is routed to the regenerator.

The sweet gas from the absorber overhead is cooled and collected in the separator, where condensate is separated from hydrocarbon. The sweet hydrocarbon product is pumped out from the separator and routed to the storage as LPG or used as fuel.

In the regenerator, the rich Benfield solution is regenerated. The lean solution is collected at the bottom of the regenerator and returned to the absorber.

The regenerator overhead gases are cooled in coolers, collected as acid gas and routed to the Sulfur Recovery Units.

c. Sulfur Recovery Unit (SR U) (U-10 A/B)

Sulfur Recovery Units are designed to recover elemental sulfur from acid gases containing H_2S generated in upstream treating units. The process adopted in these units is called Modified Claus Process. It is consisting of two separate sulfur recovery units.

Process Description:

Acid gas from upstream treating units is mixed with air and burned in the reaction furnace. The gas product is appeared from the furnace and passed through a Waste Heat Boiler, producing steam. After leaving the boiler, the sulfur laden gas is entered the first condenser where sulfur is condensed and routed to a sulfur sump.

The gas leaving the first condenser is reheated in the first reheater by burning a slip of acid gas feed to reactor. Then, reheater effluent gas passes through the first catalytic reactor where additional sulfur is formed. The Sulfur formed in the reactor is removed on the second condenser and routed to sulfur sump. The gas is again reheated in the second reheater and passed through a second catalytic reactor for further conversion to elemental sulfur which is removed in the third condenser. The overall sulfur recovery is ranging from 92% to 96%. After leaving the third condenser, the tail gas containing traces of H_2S and other sulfur species is sent to Tail Gas Treating Unit (U-11) for further recovery of sulfur. In case of emergency or U-11 Shutdown, the tail gas is then routed to the incinerator.

The sulfur from waste heat boiler and all condensers is routed to the sulfur sump where it is kept molten by steam coils. The molten sulfur is then transferred to SDU where dissolved H_2S is removed from the sulfur before transferring it to liquid Sulfur storage.

d. Tail Gas Treating Unit (TGTU) (U-11)

Tail Gas Treating Unit is designed to convert the remaining sulfur compounds of tail gas from SRU, into liquid sulfur; thus, increasing the recovery of sulfur up to 99.5%.

Process Description:

The unit uses Clauspol process which is based on the continuation of Claus reaction between residual H_2S and SO_2 in a proprietary solvent. The tail gas also contains organic sulfur compounds (COS and CS_2) that is being hydrolyzed in the TGTU reactor. The produced H_2S from the hydrolysis is used in the Claus reaction to produce liquid sulfur.

The liquid sulfur, is left the reactor to a sulfur separator drum. In the sulfur separator, any entrained solvent is separated. Then, the sulfur is pumped to Sulfur Degassing Unit. The treated tail gas is routed to the incinerator from the reactor top.

Incinerator Section

The objective of the thermal incineration system is to convert the remaining trace amount of sulfur species in the off gas to SO_2 before it is disposed to atmosphere at safe location. The incinerator system is provided with Waste Heat Boiler to recover heat from flue gas for intermediate superheated steam production.

e. Sulfur Degassing Unit (SD U) (U-12)

SDU unit is designed to reduce H_2S content in the liquid sulfur which is produced in the existing Sulfur Recovery Units and Tail Gas Treating Unit.

The principle is to release the free H_2S and accelerate the decomposition of the polysulfides to free H_2S. The H_2S dissolved in liquid phase (free H_2S) passes into the gaseous phase by physical desorption. The SDU consist of sulfur pit, Flasher and other relative equipment.

The raw sulfur is passed through the sulfur pit to flasher, where free H_2S in liquid sulfur is evolved with steam by flashing and refined sulfur is pumped to storage tank. The separated off gas from flasher top is routed to incinerator.

f. Flare Gas Recovery Unit (FGRU) (U-13)

FGRU is installed to control the pollution and energy conservation measure. FGRU is used to recover flared gases and reusing the same as fuel gas after necessary treatment in Amine Treating Unit (U-08) while releasing a minimum amount of residual flare gas for burning at the stacks. The emission of sulfur dioxides gases to atmosphere is reduced to minimum level and healthy environment is achieved.

g. Hydrogen Production Unit (U-14 AB)

The objective of the Hydrogen Production Units is to generate and supply high purity hydrogen to be needed in VRHC (U-04), Kerosene/Diesel Hydrotreater, Diesel Hydrotreater and VGO Hydrocracker of refinery.

The imported Natural Gas and treated H_2 rich gas is the feed of hydrogen production unit. The design product hydrogen purity is 99.9 % and the maximum Carbon Oxides specification is 10 PPMV.

Process Description:

The Feed Gases are preheated in hydrogen reformer convection section and the last traces of organic & inorganic sulfur compounds are removed in Zinc Oxide beds.

High pressure steam is mixed with the treated feed gas and further heated up in the reformer convection coils before it is introduced into the reformer catalyst tubes, filled with catalyst. Steam and feed gas hydrocarbons react in the presence of catalyst to form hydrogen, carbon dioxide & carbon monoxide. This steam reforming reaction is highly endothermic, requiring heat energy for reaction.

Waste heat is recovered from the reformer effluent to produce high pressure steam and partly for heating Methanator inlet gas. The carbon monoxide (with excess steam) in the reformer effluent is further converted into hydrogen & carbon dioxide in the high temperature and low temperature shift convertors. Shift conversion reaction is exothermic, producing heat energy.

The shift convertors effluent is cooled by exchanging heat with different exchangers & coolers before and routed to MEA absorber. A Monoethanolamine (MEA) solution is used to absorb carbon dioxide. The rich solution is regenerated by heating and flashing at low pressure. The regenerated lean MEA solution is cooled and pumped back to CO_2 absorber after cooling.

The MEA absorber effluent gas is heated and routed to Methanator, where the remaining small quantities of carbon monoxides & carbon dioxide are converted to methane in order to meet the carbon dioxide specification in product hydrogen.

The product hydrogen is cooled by exchanging heat with different exchangers & coolers and routed to Hydrogen Compression Unit for compression.

h. Hydrogen Compression Unit (U-15)

Hydrogen compression unit compress and supply high-pressure hydrogen to be needed in VRHC (U-04), Kerosene/Diesel Hydrotreater, DHT (U-06) and VGO Hydrocracker.

Process Description

There are five reciprocating compressors for Hydrogen. Two of them are driven by motors and the rest with internal combustion engines using refinery engine fuel gas. The hydrogen is compressed in three stages with intermediate coolers and separators. The compressed hydrogen is distributed by a header to different hydro-processing units as per requirements.

i. Sour Water Treatment Unit (U-16)

Sour water streams from various units of refinery and petrochemical are divided into two quality one is high concentration sour water, another one is low concentration sour water. High concentration sour water is heated in exchangers before entering concentrator columns. Concentrator column top NH_3/H_2S gases are routed to SRU (U-10 A/B) and the concentrator bottom water is routed to Effluent Treatment Unit (ETP).

Low concentration sour water is heated in exchangers before entering degasser columns. Degasser column top gases are sent to FGRU (U-13) and the bottom of the degasser the foul water is routed to Foul Water Treatment Unit (U-17).

j.Foul Water Treatment Unit (U-17)

All the foul water streams of refinery are combined, cooled in coolers and pumped to the foul water stripper through heat exchanger. Superheated steam is introduced at the bottom of Tower for stripping gases from the foul water.

The overhead gases of the stripper are condensed. Non-condensable gases are routed to the flare header through overhead Accumulator. Condensed oily water is routed to slop tank through API separator.

The hot stripped water from the column bottom is cooled, pumped and routed to the API separator. A part of this water is reused in ADU (U-01) desalter water system.

k. Ammonical Water Treatment Unit (U-18)

This unit serves to strip out ammonia and H_2S from concentrated ammonical water produced in ADU (U-01) and concentrated foul water from refinery other section.

Unit has two strippers. Most of the feed H_2S is stripped in H_2S stripper, operating under higher pressure. In the subsequent lower pressure NH_3 stripper all the remaining H_2S and complete NH_3 is stripped off.

In the feed system, the concentrated ammonical water from ADU and the foul water from Sour Water Treatment unit are mixed and degassed to flare. The Degasser liquid is pumped to Stripper tower.

The feed to H_2S stripper is heated in exchangers before it is fed to the column. The H_2S gas is recovered from stripper overhead, cooled and routed to SRU.

The H_2S stripper bottom is routed to the NH_3 stripper for stripping H_2S/NH_3 in the column. The stripped gas is sent to SRU or Flare. NH_3 stripper bottom liquid is almost free of NH_3& H_2S and is routed to Effluent Treatment Plant (ETP).

l. Flare - 01

The flare system is designed to provide safe disposal of combustible, toxic gases and vapors released from Process equipment during normal operations and/or upset conditions. The released gases are first routed to flare knock-out drum where heavy end and condensable are separated out and residual gases are burnt at elevated stack.

m. Instrument Air & Plant Air System

Instrument air production system is developed to produce clean & dry (moisture free) air that is supplied to all pneumatic control valves in the refinery. The instrument air is also used as atomizing air. The plant air is only used in general service as like cleaning, purging and air floatation, where dry air is not essential.

n. Nitrogen Generation System

Nitrogen generation system is developed to produce clean & dry (moisture free) Nitrogen (purity 99.9%) and this product nitrogen is used for following purpose-

- Purging the equipment
- For ensuring safe maintenance work
- Pressurize the equipment to maintain positive pressure
- Catalyst regeneration

o. DM Water Plant

Demineralized Water Plant produces distilled water from raw water (deep tube-well water) to prepare high purity water for the Boilers and cooling tower makeup in the Refinery. This is accomplished by Ion exchange process.

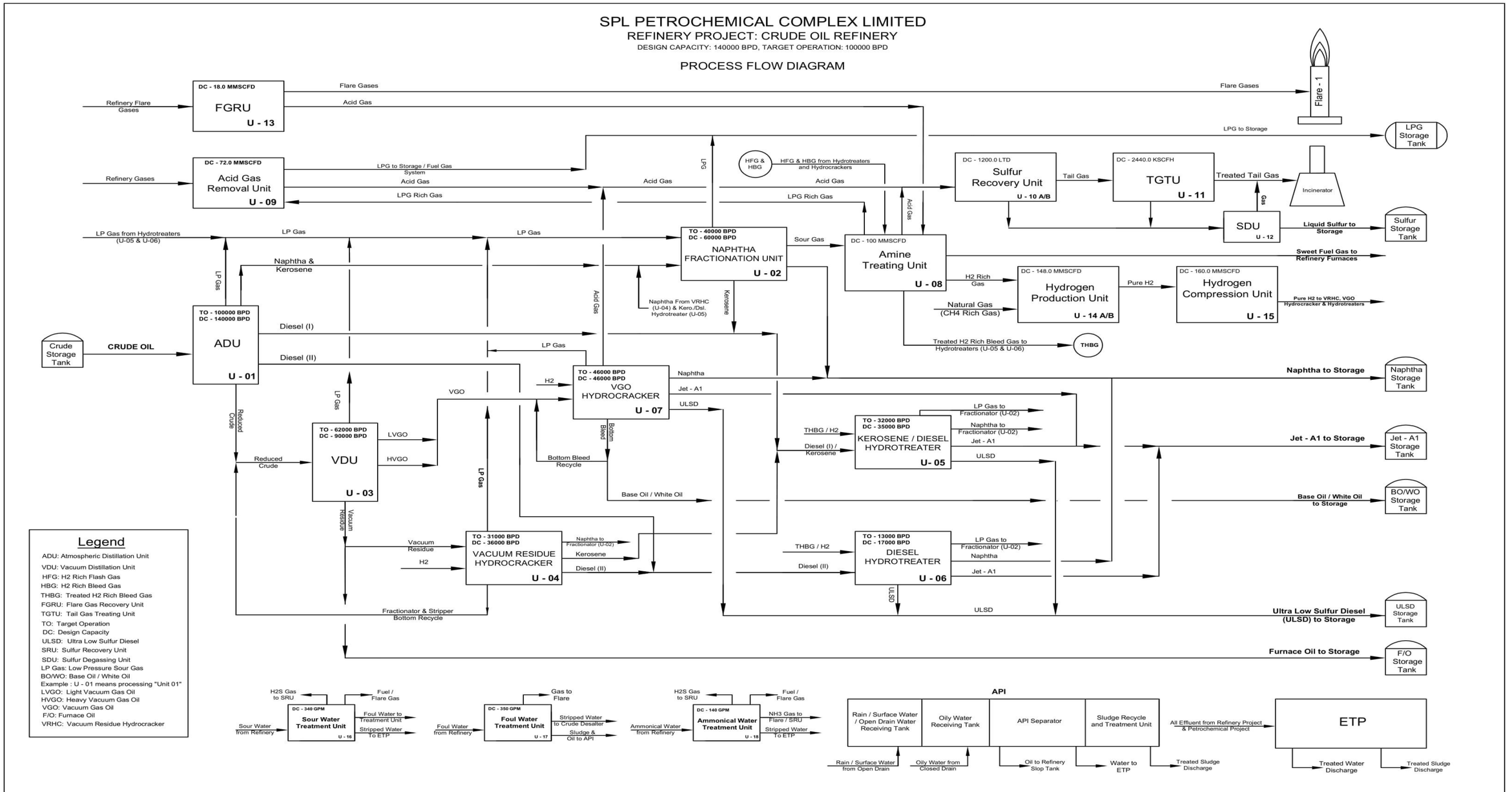
P. Cooling Water System

Cooling Water System consists of a cooling tower and pumps and distribution network to ensure refinery cooling water requirement. The primary source of cooling water make-up is treated demineralized water which is required to maintain level in the Cooling Tower basins. Cooling tower system has chemical treatment facility to control corrosion, scaling and biological growth which will otherwise seriously affect in operations.

q. Boiler and Steam System

Steam System consists of steam generator (boilers) and distribution network at different pressure levels for process and utility requirements. It also distributes BFW for various uses in refinery.

Maximum required steam is produced from boilers; besides this some additional steam is produced from following refinery section: Waste Heat Boilers, Hydrogen Units, SRU Units and Incinerator.



Date	Revision	Drawn By	Checked By	Approved By	SPL PETROCHEMICAL COMPLEX LIMITED MOHESHKHALI EZ - 03, DHALGHATA, MOHESHKHALI, COX'S BAZAR
16-04-2019	Rev. 00	**Saidul Hasan** **B. Sc. (Chemical Engineering)** **MIEB # 32582**	**Avijit Dasgupta** **B. Sc. (Mechanical Engineering)** **MIEB # 33407**	**Pranab Kumar Saha** **Chief Executive Officer**	NAME OF UNIT: CRUDE OIL REFINERY
					TITLE OF DRAWING: PROCESS FLOW DIAGRAM

Figure 5: Process flow diagram for crude oil refinery

SHAHIDUL CONSULTANT
Architect, engineer and environment

b) Cracker and Polymer Production Unit

The purpose of this Cracker and Polymer Production Unit is to process 1400 KTPA Naphtha for producing Linear Low-Density Polyethylene (LLDPE) / High Density Polyethylene (HDPE) and Polypropylene (PP).

The following units are envisaged in this project: -

i. Cracker (U-101) — Design capacity 1400 KTPA
ii. C4/C5 Hydrogenation Unit (U-102)
iii. Pyrolysis Gasoline Hydrogenation Unit (U-103) — Design capacity 300 KTPA
iv. LLDPE/HDPE Swing Unit (U-104) — Design capacity 550 KTPA
v. Polypropylene Unit (U-105) — Design capacity 350 KTPA
vi. Aromatic Extraction Unit (U-106) — Design capacity 250 KTPA

Following auxiliary units will be set-up for above operations:

a. Flare Gas Recovery Unit (U-107)
b. Spent Caustic Treatment Unit (U-108)
c. Flare - 2
d. Instrument Air & Plant Air System
e. Nitrogen Generation System
f. DM Water Plant
g. Cooling Tower System
h. Boiler & Steam System

The Cracker and Polymer Production Unit is designed to produce following valuable products:

i. LLDPE/ HDPE
ii. Polypropylene
iii. Benzene
iv. Toluene
v. Xylene
vi. Pyrolysis Diesel Oil
vii. Pyrolysis Fuel Oil

Process Description:

The followings are the brief descriptions of the processing schemes of different processing units of Cracker and Polymer Production Unit.

i. Cracker (U-101):

Cracker unit is the heart of the total complex, which gives feed to all the downstream end product units. The Cracking furnace are often known as brain behind the steam cracker unit and it is the most important and complex section of the plant.

Process Description:

The Naphtha feed pumped from the storage and firstly preheated with quench water and LP steam. The preheated feed stock is getting mixed with process steam and then sent to convection coils for further heating against flue gases generated in radiant zone of the furnace. Feed stock is then sent

to radiant section coil where main reaction takes place and is cracked to the desired product specification. Heat of furnace effluents is recovered in the transfer line exchangers in which very high-pressure steam is getting produced and being utilized for running the various purposes along with running the compressors & pumps turbine. The transfer line exchangers' effluents are further cooled by direct injection of quench fuel oil from the primary fractionator.

The quench effluents are further cooled and flow to the Primary Fractionator. Fuel oil which is present in cracked gas is separated as a bottom product of Fractionator and sent to storage as Pyrolysis Fuel Oil (PFO) product. Uncondensed cracked gas of primary fractionator is left form the tower top to Quench Water Column. In quench water column, process water and gasoline fraction is separated from cracked gas. Process water is again utilized for generating process steam for steam cracking and the gasoline fraction is sent to the Pyrolysis Gasoline Hydrogenation Unit (U-103). Final Cracked gas leaving from the quench water column top, cooled and sent to the Cracked Gas Compression and Drying Unit

Cracked Gas Compression and Drying:

This is often referred as heart of the steam cracker unit. Cooled cracked gas is now compressed in several stages by cracked gas compressor. After the 2^{nd} /3^{rd}stage of the compressor, the cracked gas is passed through a caustic scrubbing section, which is used to removes CO_2 and H_2S from the cracked gas.

After every stage of compressor, compressed cracked gas is sent to the liquid knockout drum. Cracked gas is leaving from the knockout drums top and cracked gas condensate is leaving from the knockout drums bottom.

Cracked gas and Cracked gas condensate which being generated in liquid knockout drums are sent to cracked gas dryer and cracked gas condensate dryer respectively. Dryers are using to remove moisture from the cracked gas and condensate.

The cracked gas from the dryer enters the chilling system where it is chilled down to -161°C. The chilled cracked gas is finally sent to the crude hydrogen flash drum. Hydrogen stream is produced at the final low temperature flash in the crude hydrogen flash drum. After reheat in the core exchangers, all of the hydrogen is methanated to eliminate CO. Most of this high purity hydrogen is used to hydrogenation purposes in the MAPD converter, C4/C5 hydrogenation unit and the pyrolysis gasoline hydrotreater. The remaining little amount of hydrogen is sent to the fuel gas system for ensuring sufficient fuel gas of furnaces.

The liquid methane condensed in the crude hydrogen flash drum, is flashed back through the core exchangers at low pressure to recover maximum refrigeration. Methane then compressed in a two-stage compressor and sent to the fuel gas system.

The liquid dryer effluent and the condensed liquid from the demethanizer first feed flash drum, flow to the demethanizer prestripper. The demethanizer prestripper removes hydrogen and methane makes a crude ethane separation. And the crude ethane is sent to the deethanizer. The overhead from the demethanizer prestripper flows to the demethanizer.

The demethanizer separate the hydrogen and methane from C2's and heavier, which leaves from the bottom of the demethanizer tower to deethanizer.

The demethanizer bottoms and demethanizer prestripper bottoms are flashed to the deethanizer tower, where the C2's is separated from C3's to a degree which will meet the specification of C2's in the propylene product. The net overhead vapor product, containing all the acetylene, C2's and the small amount of propylene, passes through the ethylene guard drier and then to the acetylene convertor. Acetylene convertor is provided for converting acetylene in to ethylene.

After the acetylene convertor, the C2's stream flow to the ethylene fractionator, where Polymer Grade Ethylene is recovered and ethane is recycled back to furnaces.

The deethanizer bottoms C3's product flows to the depropanizer. The overhead products from the depropanizer enter the methylacetylene-propadiene (MAPD) converters, where acetylene or diolefins are hydrogenated to produce propane and propylene. The effluent from the MAPD converters flows to the C3 Rerun tower, where oligomers formed in the MAPD converters are removed. Then C3's is sent to the pasteurization section to remove light impurities from C3 products. After that C3 products is sent to the Propylene Fractionator, where polymer grade propylene is recovered and propane is recycled back to furnaces.

The depropanizer bottoms is recovered as C4's/C5's product, cooled and routed to the C4/C5 hydrogenation unit.

ii. C4/C5 Hydrogenation Unit (U-102):

C4/C5 hydrogenation unit (U-102) is used to saturate the C4's & C5's by using hydrogen. After the hydrogenation of C4's & C5's, it is recycled back to Cracker.

Refrigeration system:

Several levels of propylene refrigeration are used in a closed system. The discharge from the propylene refrigeration compressor, is de-superheated and condensed by water cooling and flashed into the propylene refrigeration accumulator. Refrigeration is recovered by condensing propylene vapours against the demethanizer reboiler, the C2 splitter reboilers at two levels, and the ethylene product vaporizers.

Ethylene refrigeration is compressed in refrigeration compressor, de-superheated against cooling water, propylene refrigeration and vaporizing low pressure ethylene product, and finally condensed with low level propylene refrigeration. Three levels of ethylene refrigeration are used in closed system.

iii. Pyrolysis Gasoline hydrogenation unit (PGHU) (U-103):

The purpose of this unit is to stabilize and desulfurize the raw pyrolysis gasoline, in order to produce a suitable feed for Aromatic Extraction Unit (U-106).

Process Description:

Feed to the pyrolysis gasoline hydrogenation unit is coming from the cracker unit, which is C5+ gasoline fraction. The C5+ gasoline fraction first enters the hydro desulfurized reaction section where gasoline is desulfurized with olefins saturation by using hydrogen in a catalytic reactor. Then the desulfurized C5+ gasoline goes to the gasoline hydrogenation section, as dienes and styrene's present in the feed are selectively hydrogenated and converted to saturate and ethyl benzene. Hydrogenated feed is sent to the fractionator where C5 is recovered as top product and recycled back to cracker furnaces, C6 to C8 cut is recovered as side streams and routed to Aromatic Extraction

Unit (U-106), C9+ is recovered as bottom products from the fractionator and routed to the storage as Pyrolysis Diesel Oil products.

iv. LLDPE/HDPE Unit (U-104):

The objective of this unit is to produce Linear Low-Density Polyethylene (LLDPE) / High Density Polyethylene (HDPE) from polymer grade Ethylene.

Ziegler-Natta Catalyst: High activity Ziegler-Natta catalyst is used for the production of narrow molecular weight distribution products.

Process Description:

The Polymerization reactor is designed to ensure good mixing and a uniform temperature within the fluidized bed. Polymer particles grow within the fluidized bed over a residence time of several hours. Operating conditions within the reactor are mild. The reactor is divided in three major sections.

A bottom sections with a gas distributor to ensure homogeneous fluidization. A cylindrical section containing the fluidized bed and equipped with catalyst injection and polymer withdrawal facilities.

The polyethylene gas leaving the reactor contains unreacted monomer, co monomers, hydrogen and inert (primarily nitrogen and ethane). Conversion of monomers per pass is proximately 3%. Any fine particles leaving the reactor with the exit gas are collected by cyclones and recycled to the reactor.

The gas then enters the first heat exchanger where the heat of polymerization is removed before passing to the enhanced high productivity separator. This specially designed vessel separates the condensed liquid from the loop gas, which is fed to the main fluidization gas compressor. The separated liquid is then pumped into the reactor via proprietary liquid injection nozzles into the heat of the fluidized bed.

In the reactor, pressure and gas composition are controlled continuously by varying the flow of feedstock into the reaction loop. The relative proportions of the feedstock are adjusted to meet the specification of the required polymer product.

Polymer Withdrawal and Degassing:

The polymer powder is withdrawn from the reactor by simple, robust proprietary lateral discharge system and passed on to the primary degasser, where a part of the gas is flashed off, filtered and recycled to the main loop via the recycle compressor.

The polymer powder is transferred to the secondary degasser, where most part of the residual hydrocarbon is removed and separated in the cryogenic Vent Recovery Unit. The degassed powder collected in the secondary degasser passes to a purge column, where trace hydrocarbons are removed and any residual catalyst activity is killed. Powder is then transferred to the extruder via an intermediate surge bin, mounted directly above the extruder, which allows for routine extruder maintenance.

Grade Changes: On-line DCS transition control ensures consistently rapid and reliable grade changes. Changes of grade are made quickly and easily, with the minimum loss of throughput and the minimum generation of wide-specification product.

Finishing: Product Blending and Extrusion (Pelletizing)-Polyethylene powder is transferred pneumatically to the product powder silo. Powder master batch incorporating additives is prepared

in mixers. Virgin powder and additives are weigh-fed into the extruder. Pellets are extruded under water and are then dried before being conveyed by air to storage. The pellets conveyed from the pelletizing section are homogenized in static homogenization silos. After homogenization, the pellets are transferred to storage silos.

v. Poly Propylene Unit (U-105):

The objective of this unit is to produce Polypropylene from polymer grade propylene.

Process Description:

Fresh PG propylene from OSBL is fed through propylene dryer to the reactor along with the required catalyst, co-catalyst, hydrogen and stereo-modifier. For production of special grades with small ethylene content, ethylene vapor is also fed to the reactor.

The polymerization reactors each have a stirrer and drive systems. Polymerization itself is carried out in a gas phase stirred reaction. Heat removal is managed by evaporative cooling. Liquid propylene entering the reactor vaporizes and thereby removes the exothermic reaction energy. Reaction gas is continuously removed from the top of the reactor and filtered. Reactor overhead vapor ("Recycle Gas") is condensed and pumped back to the reactor as coolant. Non-condensable gases (mainly H_2 and N_2) in the recycle gas are compressed and also returned to the reactor.

The polypropylene product powder is blown out of the reactor under reactor operation pressure. The carrier gas and powder pass into the powder discharge vessel where powder and gas are separated. The carrier gas is routed through a cyclone and filter to remove residual powder, then scrubbed with white oil and sent to compression.

Powder from the discharge vessel is routed via rotary feeders to the purge vessels which are operating in parallel. Nitrogen is used to purge the powder off residual monomers. The overhead gas from the purge vessels is sent to a common membrane unit for monomer/nitrogen recovery. As refrigerant for the membrane unit fresh Propylene is used. The recovered nitrogen is sent back to the purge vessels for further use. The condensed monomers from the purge gas are combined with the filtered carrier gas, then sent to scrubbing and subsequently to carrier gas compression.

The PP powder from the purge vessels is pneumatically conveyed by a closed loop nitrogen system to the powder silos. The powder product from these silos is fed to the extruder where polymer powder and additives are mixed, melted, homogenized and extruded through a die plate, which is heated by hot oil.

Pelletizing of the final product is carried out in an underwater pelletizer where the extruded polymers - after passing the die plate - are cut by a set of rotating knives. The polymer/ water slurry is transported to a centrifugal dryer where polymer and water are separated. Water is recycled to a pellet water tank, for which demineralized water is used as make-up. The cooled pellets are pneumatically conveyed to the pellet blending silos by an air conveying system. After homogenization in the blending silos the pellets are conveyed to the bagging and palletizing system.

vi. Aromatic Extraction Unit (U-106):

The purpose of this unit is to recover Benzene, Toluene and Xylene from the hydrogenated Py. gasoline (C6 to C8 products) by using extractive distillation process.

Process Description:

The feed of this unit is "C6 to C8 gasoline" which is come from the Pyrolysis Gasoline Hydrogenation Unit. The feed first enters the Light End Column. C5 & lighter hydrocarbons are recovered as top product of LEC column, cooled and sent back to cracker unit. The bottom of LEC is pumped, cooled and sent to Extractive Distillation Column bottom. A proprietary solvent is used here to extract aromatics from gasoline.

The non-aromatic raffinate is recovered as top product of EDC column and sent back to Cracker, the aromatic with solvent is recovered as bottom. The bottoms of EDC are sent to the solvent recovery column. The aromatics are recovered from the top of SRC column and solvent from the bottom. Solvent is sent back to EDC column.

Aromatics are sent to the raffinate wash column. After the raffinate wash column aromatics is sent to the benzene column. And the washed raffinate is sent back to SRC column. Benzene is recovered as top products of Benzene recovery column and sent to the storage. Toluene plus Xylene stream is recovered as bottom product of Benzene column and sent to Toluene recovery column, where toluene is recovered as top product and sent to storage. C8+ product is recovered as bottom product of Toluene column and sent to the Xylene column, where Xylene is recovered as top product and sent to the storage. C8+ product is recovered as bottom product of Xylene tower and sent back to cracker as recycle feed.

Auxiliary Units:

The auxiliary units will be set-up considering the following aims-

- To ensure plant safety
- To ensure utilities requirements for operating the plants
- To recover caustic from spent caustic and recycle back it for reusing
- To ensure environmental regulation and thus setting up a greenfield Petrochemical Complex

a. Spent Caustic Oxidation Unit (U-107):

Spent caustic from the spent caustic degassing drum of cracked gas caustic treatment section, is sent to surge tanks. The stream is then oxidized with air in the spent caustic oxidizers, where sulfides in the spent caustic stream are oxidized to thio-sulfates. The Oxidized caustic is recovered from the oxidizer top accumulator and send back to recycle. Waste water is recovered from the bottom of oxidizer and routed to ETP. Off gas is recovered from the oxidizer top and routed to fuel gas system.

Besides, this unit SPCL will send all other sour gases and waste water to crude oil refinery treating units for further treatment and use.

b. Flare Gas Recovery Unit (U-108):

Flare Gas Recovery Unit is installed as a pollution control and Energy Conservation measure. FGRU is used to recover flared gases and reusing the same as fuel gas after necessary treatment in Amine Treating Unit (U-08) while releasing a minimum amount of residual flare gas for burning at the stacks. The emission of sulfur dioxides gases to atmosphere is reduced to minimum level and healthy environment is achieved.

c. Flare - 02

The flare system is designed to provide safe disposal of combustible, toxic gases and vapors released from process equipment during normal operations and/or upset conditions. The released gases are first routed to flare knock-out drum where heavy end and condensable are separated out and residual gases are burnt at elevated stack.

d. Instrument Air & Plant Air System

Instrument air production system is developed to produce clean & dry (moisture free) air that is supplied to all pneumatic control valves of the processing units. The instrument air is also used as atomizing air. The plant air is only used in general service as like cleaning, purging and air floatation, where dry air is not essential.

e. Nitrogen Generation System

Nitrogen generation system is developed to produce clean & dry (moisture free) Nitrogen (purity 99.9%) and this product nitrogen is used for following purpose-

- Purging the equipment
- For ensuring safe maintenance work
- Pressurize the equipment to maintain positive pressure
- Catalyst regeneration

f. DM Water Plant

Demineralized Water Plant produces distilled water from raw water (deep tube-well water) to prepare high purity water for the Boilers and cooling tower makeup in the Refinery. This is accomplished by Ion exchange.

g. Cooling Water System

Cooling Water System consists of a cooling tower and pumps and distribution network to ensure petrochemical cooling water requirement. The primary source of cooling water make-up is treated demineralized water which is required to maintain level in the Cooling Tower basins. Cooling tower system has chemical treatment facility to control corrosion, scaling and biological growth which will otherwise seriously affect in operations.

h. Boiler and Steam System

Steam System consists of steam generator (boilers) and distribution network at different pressure levels for process and utility requirements. It also distributes BFW for various uses in petrochemical units. Maximum required steam is produced from boilers; besides this some additional steam is produced from Waste Heat Boilers section.

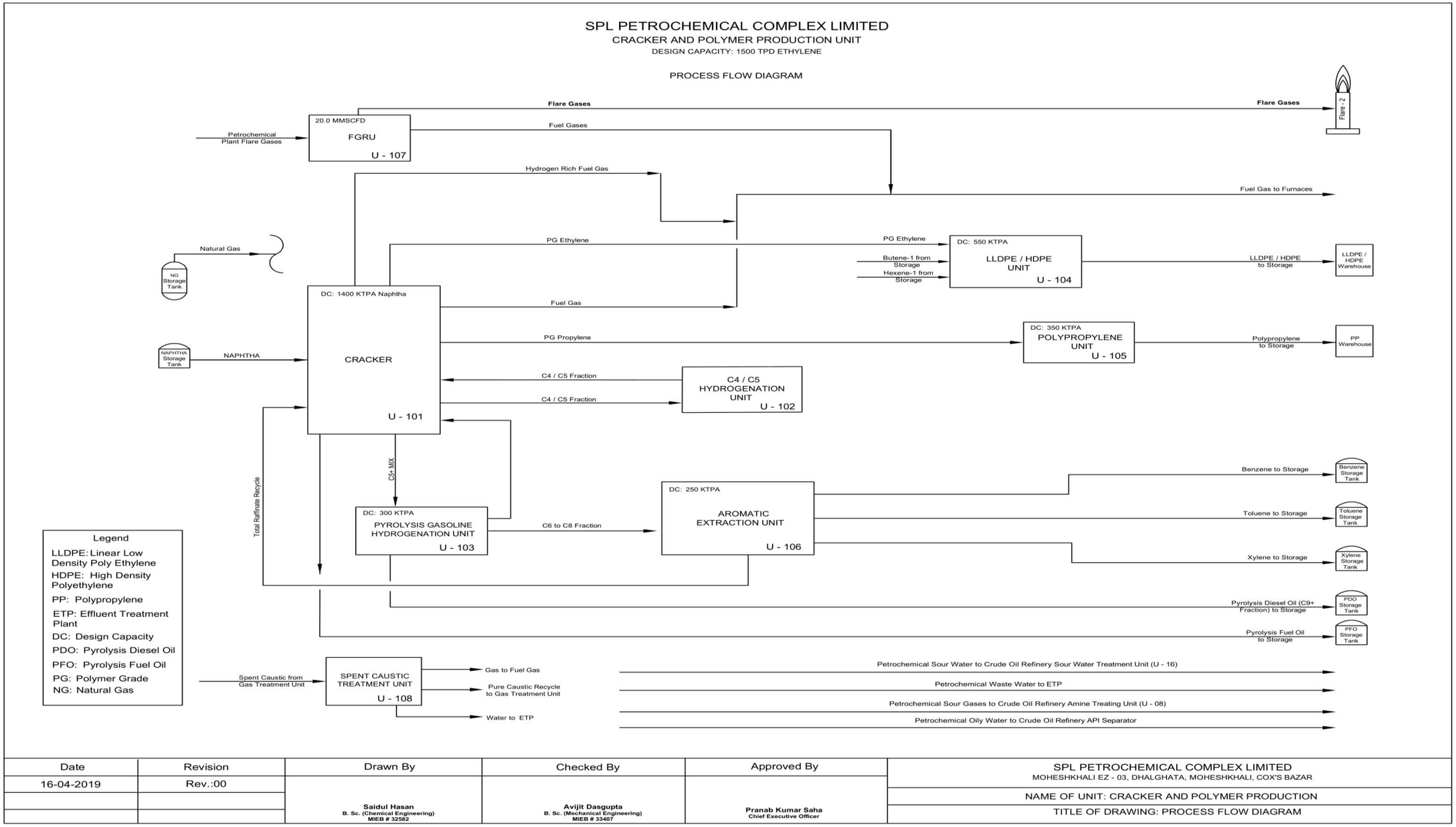


Figure 6: Process flow diagram for cracker and polymer production unit

3.3.4 Common Auxiliaries for both units

The common auxiliary units will be set-up considering the following aims-

- To ensure plant safety
- To save the energy
- To minimize the use of fresh water by recycling the treated water
- To ensure loading & unloading of raw materials and products
- To ensure environmental regulation and thus setting up a greenfield Petrochemical Complex

The Crude Oil Refinery and Cracker & Polymer Production Unit comprise of following common auxiliary units:

a) Fire and Safety System
b) Power Generation System
c) Jetty Facilities for loading and unloading
d) API separator
e) Effluent Treatment Unit (ETP)

3.3.5 Fire and Safety System

The best protection against fire is to prevent the conditions that may lead to fire. The three components of any fire are:

a) Combustible material
b) Air (Oxygen)
c) Ignition source

Combustible gases and liquids normally must not be present in the atmosphere or on the ground in the process area. In case of any combination of these three components happens accidently, SPCL has made a plan to established well organized firefighting system with following equipment's-

1. Fire Pumps: Engine driven fire pumps is used to supply the adequate fire water to All Fire Hydrants/Monitor of the plant area along with tank farm and Jetty.

2. Fire Fighting Monitors: SPCL will be integrated with latest technology and well-designed firefighting monitors to provide adequate fire water. These monitors are capable of rotating 360-degree angle and covered the maximum distance to mitigate and control the fire.

3. Fire Extinguishers: SPCL will be equipped with different types of fire extinguisher, like- Foam extinguisher, CO_2 Extinguisher, Dry powder extinguishers and Water mist Extinguishers to extinguish solid fire, flammable liquid fire, flammable gas fire and electric fire.

4. Truck Mounted Foam Skid: SPCL will be equipped truck mounted foam skid which is capable of quick quench foam to fire area.

5. Fire Hydrant: It is a component of SPCL active fire protection system.

Besides, these fire network system, SPCL will also ensure safety reliving system to flare, explosive limit monitoring system and fire alarm system. SPCL will also design the processing units with standard equipment and technology. The intrinsically safe and explosion proof electrical equipment & instruments will be used in this project to ensure the plant and equipment safety.

3.3.6 Power Generation System

SPL Petrochemical Complex Limited will be connected to national grid from the Matarbari Coal based Power Plant. Reliability of the power is one of the main issues of this project. That's why, SPCL will also establish their own electric power generation system for supplying to the plant during emergency and in any maintenance.

3.3.7 Jetty Facilities for Loading and Unloading

SPCL will use the latest technology to develop the Jetty facilities. Two types of Jetty facilities will be developed for receiving the crude oil and delivering the petrochemical products. Single point mooring (SPM) jetty will be built at sea to receive the crude oil and deliver the liquid petrochemical products. Another Jetty will be established at Kohelia River site to deliver the LLDPE, HDPE, PP and aromatic products. Construction materials will also be loaded and unloaded through this Jetty.

3.3.8 API Separator

API Separator will be developed considering following issues:

- To collect the valuable liquid hydrocarbon product from waste water
- To clean industry effluent and recycle it for further use
- To treat the sludge

Description:

API Separator-It is work-horse of Refinery Wastewater Treatment Systems.

API Separator is a device to separate oil and suspended solids from the wastewater effluents of refineries and petrochemical plants. It was developed 70 years ago by a joint effort of American Petroleum Institute (API) and Siemens Water Technologies. It is a gravity separation device that works on the principles of Stokes Law.

All sump waters, close drain oily water, & surface/storm water drains from refinery units and tankage areas which contain oil are routed to API Separator.

In the API Separator most of the suspended solids will settle to the bottom of the separator as a sediment layer (sludge), the oil will rise to the top of the separator, and the wastewater will be in the middle layer between the oil on the top and the solids on the bottom. Once the oil and suspended solids are removed from the wastewater, the middle phase, wastewater will be oil and suspended solid free.

The separated oil from API separator are collected in an intermediate vessel and routed to the slop oil tank for further processing. The water separated is diverted to the ETP for further treating, where pollutant level falls below the limit stipulated by Department of Environment, Bangladesh (DoE). The remaining sludge of API separator is routed to the sludge treatment unit and after treating it's discharged & buried.

3.3.9 ETP (Effluent Treatment Plant):

ETP is a process, designed for treating the Refinery/Petrochemical effluent for its reuse or safe disposal to the environment. ETP will be developed considering following issues:

- To clean industry effluent and recycle it for further use.

- To reduce the usage of fresh/potable water in Industries.
- To cut expenditure on water procurement.
- To meet the standards for emission or discharge of environmental pollutants from various Industries set by the DoE (Department of environment).
- To safeguard environment against pollution and contribute in sustainable development.

After all treatment, treated effluent water samples are tested in laboratory. The parameter results obtained from lab are strictly compared with the DoE standard limit and corrected up to standard limit by treating. Besides this, SPCL has installed modern gas detectors to detect hydrocarbon, H_2S, CO and CO_2 to ensure the clean environment in project premises.

3.4 Project Schedule

In considering the complexity of the project and the investment required there in it will be implemented in two stages. At first, crude oil refinery will be set up and thereafter cracker & polymer production unit will be set up.

- Target production date of Crude Oil Refinery: July, 2023
- Target production date of Cracker & Polymer Production Unit: July, 2025

3.5 Utilities Demand

Water, fuel and electricity are necessary for this project both at construction and operational phase. The utility requirements during operation phase are given below-

Table 26: Types and demand of utility during project activities

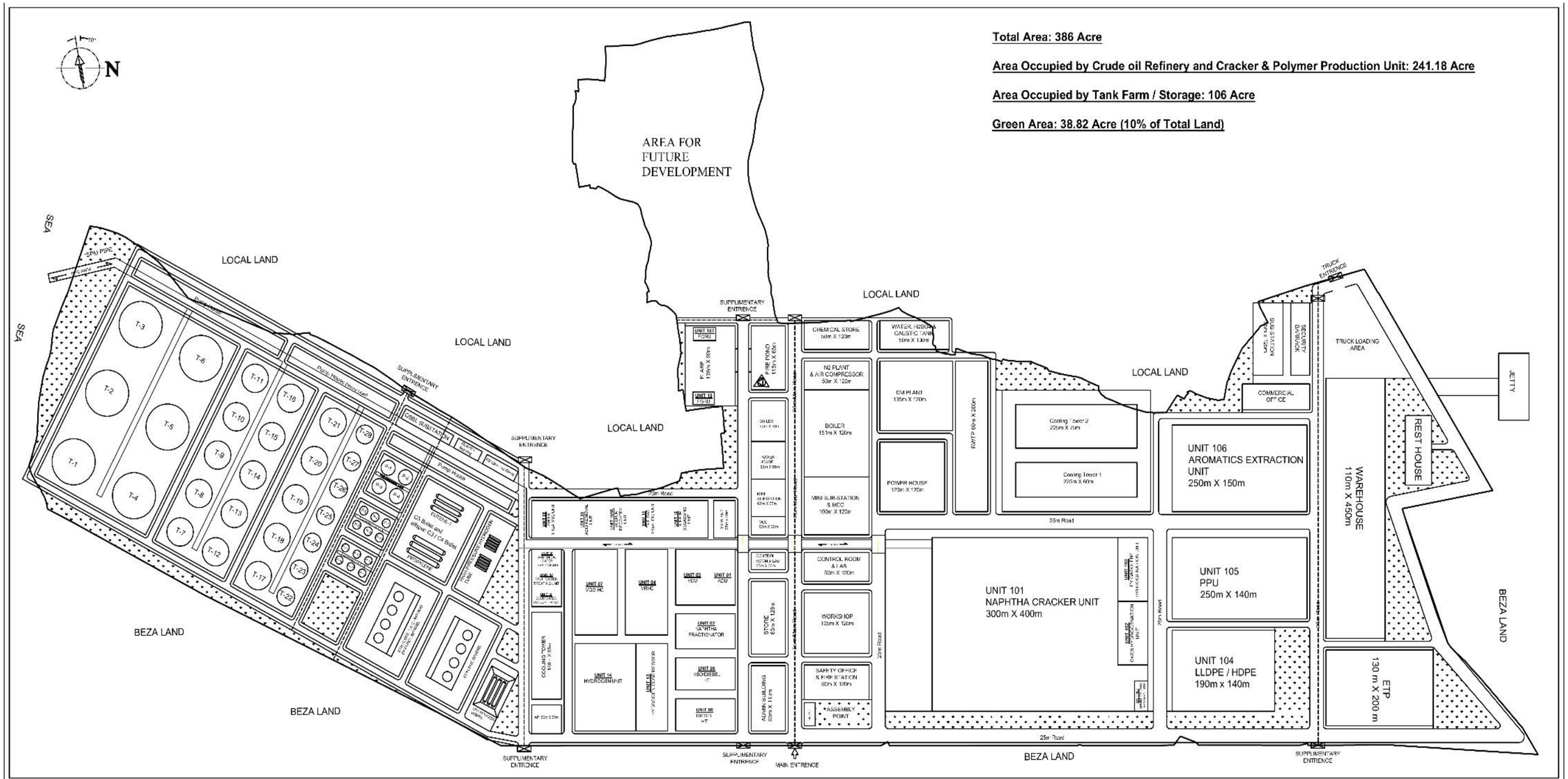
Utility	Quantity		Source	Use
Crude Oil Refinery				
Raw Water	400	m^3/hr	Underground	DM plant and Fire pond makeup
DM Water	230	m^3/hr	DM Plant	Boiler feed water and Cooling water makeup
Cooling Water	14500	m^3/hr	Cooling Tower	Process cooling
Nitrogen	4000	Nm^3/hr	Air (Nitrogen generator)	Purging
Air	8000	Nm^3/hr	Air compressor	instrument Air, Nitrogen
HP Steam	300	TPH	Boiler	Process Requirement and Power generation
Natural Gas	700000	scf/h	Petrobangla	300 TPH steam production & heaters
Electricity	35	MW	National Grid & Captive Power Plant	
Cracker & Polymer Production Unit				
Raw Water	1000	m^3/hr	Underground	DM plant and Fire pond makeup
DM Water	750	m^3/hr	DM Plant	Boiler feed water and Cooling water makeup
Cooling Water	48000	m^3/hr	Cooling Tower	Process cooling
Nitrogen	5000	Nm^3/hr	Air (Nitrogen generator)	Purging
Air	6000	Nm^3/hr	Air compressor	Instrument Air, Nitrogen
HP Steam	400	TPH	Boiler	Process Requirement and Power generation
Natural Gas	800000	scf/h	Petrobangla	400 TPH steam production & heaters
Electricity	86	MW	National Grid & Captive Power Plant	

3.6 Planning for Proposed Project

The proponent will develop the project layout plan. As per the current planning, land use pattern of the project site is given below:

- Total area: 386 acre
- Area occupied by crude oil refinery and cracker & polymer production unit: 241.18 acre
- Area occupied by tank farm/storage: 106 acre
- Green area: 38.82 acre (10% of total land)

Layout plan of the project is given below:



LEGENDS		Drawn By	Checked By	Approved By	SPL PETROCHEMICAL COMPLEX LIMITED	
PROPERTY AS PER COORDINATE	GATE				LOCATION	MOHESHKHALI EZ-03, DHALGHATA, MOHESHKHALI, COX'SBAZAR, BANGLADESH
ROAD	GREEN LAND				DRAWING	GENERAL LAYOUT PLAN
PLOT AREA LINE	FIRE PUMP	Rajib Chowdhury B.Sc. (Mechanical Eng.)	Avijit Dasgupta B.Sc. (Mechanical Eng.) MIEB #33407	Pranab Kumar Saha Chief Executive Officer	REVISION	01
					DATE	22 May 2019

Figure 7: Layout plan for proposed project

3.7 Project Cost

Crude oil refinery and Cracker & polymer production plant set up is a matter of cost and this project total investment is 2 (two) billion USD. Major cost elements are land procurement and development, factory construction, mechanical and electrical works, transport including ocean freight and land vehicle, machineries, raw materials, catalyst cost, insurance, consultant fees, employee salary, etc.

Chapter 4
Environmental and Social Baseline

4.1 Introduction

The environmental and social baseline is the existing status of environment and society around the proposed project site. It has been analyzed through assessment of environmental components like air, water, land, noise, soil, etc. and environmental characteristics like physical, biological and socio-economic status of the study area, within the 10 km radial zone of the project site. Physical environment includes topography, land, soil, meteorology, air, water, noise, etc. and the biological environment includes flora and fauna. Socio-economic environment of the study area includes demography, ethnicity, religion, education and employment opportunity, occupation, income, poverty, social relations, etc. Baseline environmental conditions are based on the data collected from various related agencies and the secondary documents from published sources and websites. The baseline provides the basis for assessment of impact (potential changes in the baseline conditions) due to the development of proposed SPL Petrochemical Complex Limited. The following Figure and table illustrate the summary of various environmental settings considering 10 km radius zone and location map of the project area, respectively.

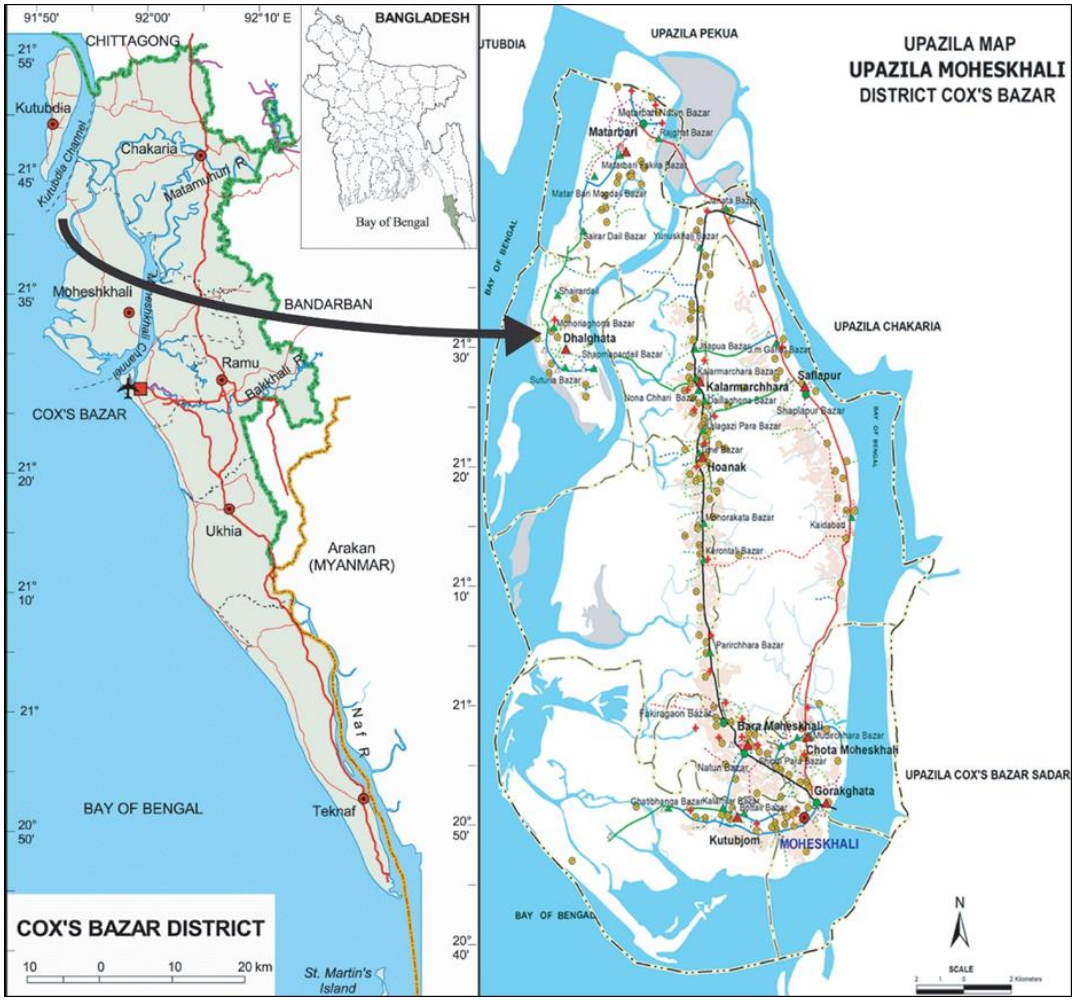


Figure 8: Location of MEZ-3

Figure 9: Location of the project site at Moheshkhali Economic Zone-3

Table 27: Existing environmental settings of project area

Particulars	Details
Location	Proposed project is located at Moheshkhali Economic Zone - 3 at Moheshkhali Upazila of Cox's Bazar District under Chattogram Division.
Total Area	386 Acres.
Site Elevation	0.2-1.02m from MSL.
Inundation Land Type	Medium high land 2 (land normally inundated 30-90cm depth).
Agro ecological Zone	The proposed area is located in Chattogram Coastal Plain.
Soil Types	According to soil test report soil layers are of soft to very stiff cohesive clayey silt and silty clay with irregularly very loose to medium dense non-cohesive silty fine sand, very loose to dense non-cohesive silty fine sand with irregularly soil layers are soft to very stiff cohesive clayey silt, stiff to hard cohesive clayey silt with irregularly, medium dense to very dense non-cohesive silty fine sand, stiff to hard cohesive clayey silt and silty clay with irregularly dense to very dense non-cohesive silty fine sand up to 45m.
Major Agricultural Activity	Salt farming and shrimp culture.
Flooding	The proposed project area falls under coastal tidal flood prone area.
Nearest Airport	Cox's Bazar International Airport is about 25.81 km away from the site.
Nearest Railway Station	Chattogram Railway Station is about 70.73 km away from the site.
Nearest Port	Chattogram Sea Port is about 70.34 km and Payra Sea Port is about 167.30 km away from the site.
Climatic Condition	Project is situated at south-eastern climatic sub region of Bangladesh. Annual average temperature and rainfall varies from maximum 34.8°C to minimum 16.1°C. The annual average rainfall is 4285 mm. The district having been a coastal region often fall victim to tidal surge and cyclone.
Seismic Zone	Zone II (Seismic co-efficient is 0.05g)

Particulars	Details
Forests / National Parks	Some mangrove plantation and reserved forest is found surrounding the project area.
Archaeological Site	None within 10 km. Adinath temple is nearest (17.20 km) and the most of famous historical place of this Island.
Water Bodies	Matamuhuri, Uzantia, Kohelia, Moheshkhali channel and Kutubdia channel are main rivers and channels of the study area.
Ecologically Critical Area	No ecologically critical areas were found within the study area. Kutubdia island is around 12.70 km and Sonadia island is 17.89 km away from the project site.
Environmental and Social Hotspots	Sea, river, homestead forests and vegetation, mangrove vegetation, high school, primary school, madrasha, mosque, temple etc.

Source: Topographic Survey report, Soil test repot, BBS Report (2011) & Google Earth

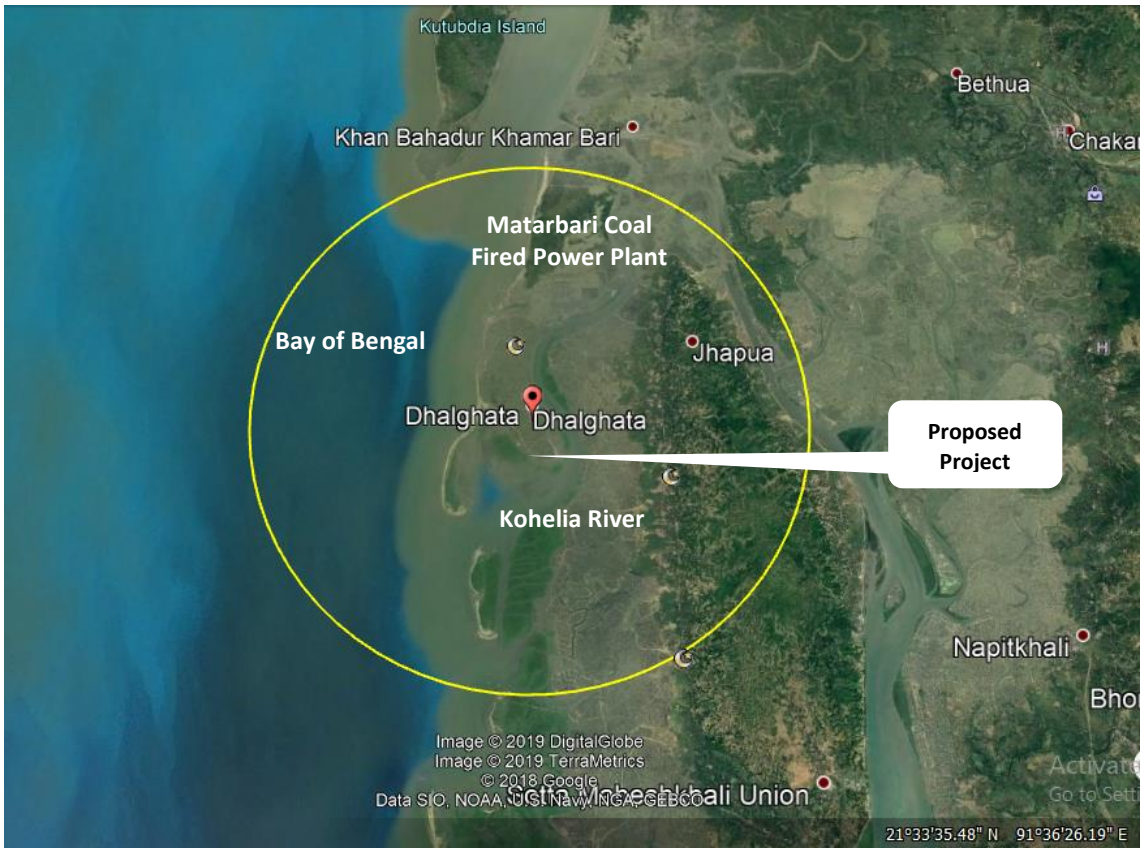


Figure 10: 10 km radius from proposed project

Source: Google Earth

4.2 Meteorology

Bangladesh is located in the tropical monsoon region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity and fairly marked seasonal variations. From the climatic point of view, three distinct seasons can be recognized in Bangladesh- the cool dry season from November to February, the pre-monsoon hot season from March to May and the rainy monsoon season which lasts from June to September. January is the coolest month with temperature averaging near 26°C and April is the warmest with temperatures from 33 to 36°C. Most places receive more than 1525 mm rainfall in a year and areas near the hills receive 5080 mm. Most rain occurs during the monsoon (June-September) and little in winter (November-February). Moderate rains are also reported in months of March, April and October.

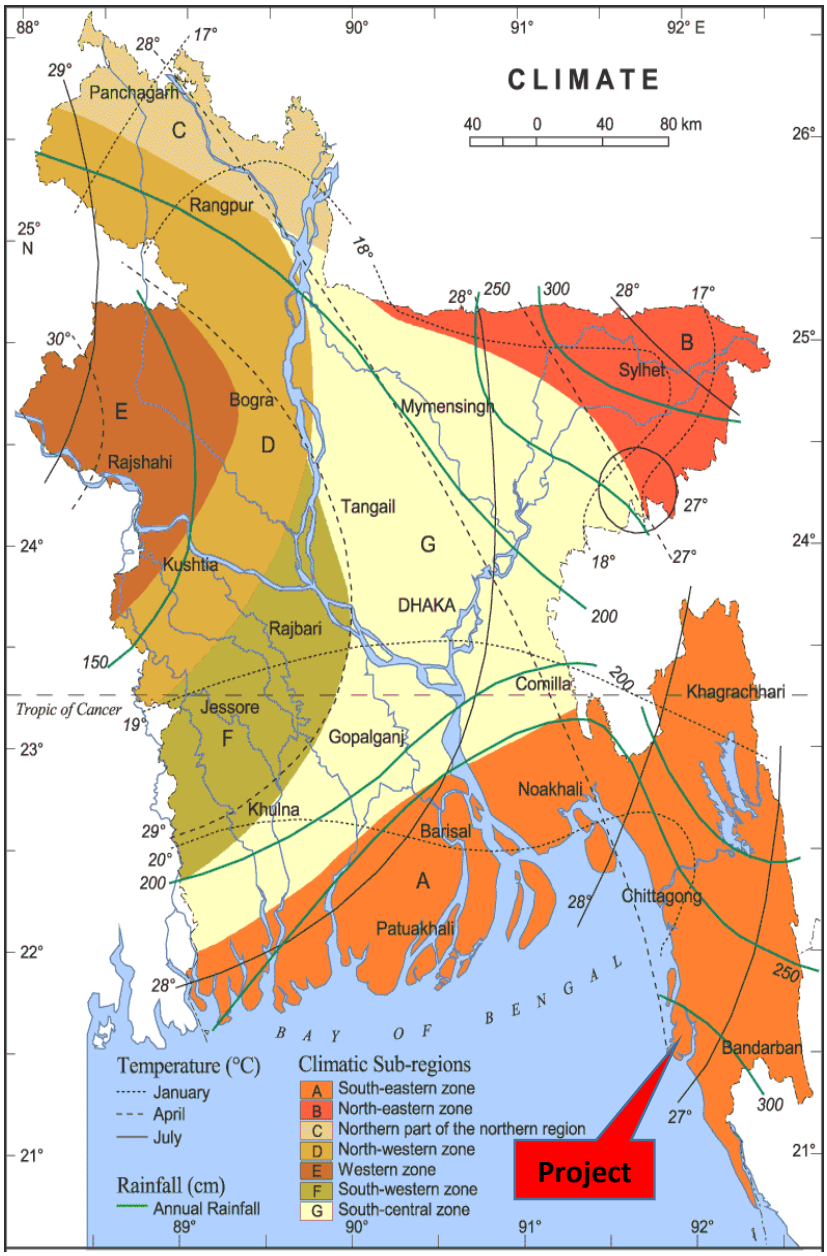


Figure 11: Climatic sub-regions of Bangladesh

Source: *www.thebangladesh.net*

The climatic sub-regions of Bangladesh are presented in the following **Figure 11** and as per that, the Moheshkhali Upazila falls in climatic sub-region namely South-Eastern Zone. The nearest meteorological station of Bangladesh Meteorological Department (BMD) is at Cox's Bazar and Kutubdia. The climatic conditions as recorded at Cox's Bazar and Kutubdia are therefore considered applicable for the proposed project. To assess the climatic conditions of the area, climatology data has been collected from BMD.

4.2.1 Temperature

The period from February to March is marked by continuous increase in the temperatures. April is the hottest month of the year. The annual average temperature varies from maximum to 34.8 °C and minimum 16.1°C, respectively. With the onset of monsoon by mid-May, the temperatures descend slightly. January is the coolest month of the year. The monthly variation of normal maximum and minimum temperatures of the project area from two stations has been given in the Table **28** and Figure 12 & Figure 13**.**

Table 28: Average minimum and maximum temperature of two stations for last five years

Year	Stations	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average minimum temperature													
2018	Cox's Bazar	12.4	17.2	21.4	24.5	-	-	-	-	-	-	-	-
	Kutubdia	15.1	18.4	22.0	24.2	-	-	-	-	-	-	-	-
2017	Cox's Bazar	15.0	19.7	22.8	26.2	25.7	26.3	25.8	25.9	26.0	25.2	20.6	18.3
	Kutubdia	15.7	17.9	20.7	24.0	26.4	26.0	25.8	25.8	25.7	24.9	21.7	17.7
2016	Cox's Bazar	15.3	20.3	23.1	23.1	26.7	25.8	25.9	25.4	25.5	25.8	25.0	18.9
	Kutubdia	15.0	19.7	22.8	26.2	25.7	26.3	25.8	25.9	26.0	25.2	20.6	18.3
2015	Cox's Bazar	17.1	17.7	21.6	24.6	26.3	25.8	25.4	25.7	25.7	24.5	21.1	17.6
	Kutubdia	16.5	17.4	21.0	24.1	26.4	26.2	25.6	25.9	26.1	24.6	20.5	17.3
2014	Cox's Bazar	15.7	17.8	21.3	25.8	27.0	26.6	26.1	25.6	25.4	24.8	21.2	17.0
	Kutubdia	15.7	17.8	21.3	25.8	27.0	26.6	26.1	25.6	25.4	24.8	21.2	17.0
Average maximum temperature													
2018	Cox's Bazar	26.0	29.0	32.3	33.5	-	-	-	-	-	-	-	-
	Kutubdia	25.1	29.8	32.1	32.7	-	-	-	-	-	-	-	-
2017	Cox's Bazar	22.3	24.5	25.5	27.9	30.0	28.7	27.8	28.3	28.4	28.3	26.8	23.8
	Kutubdia	21.2	23.5	25.2	27.8	29.8	29.1	28.3	28.8	28.7	28.3	26.2	22.8
2016	Cox's Bazar	26.2	30.2	32.9	32.6	32.9	32.0	30.1	31.0	31.7	31.9	30.3	29.3
	Kutubdia	25.5	29.2	32.5	32.8	32.9	31.8	30.5	31.4	32.0	31.9	29.1	28.0
2015	Cox's Bazar	27.4	29.4	32.7	32.9	33.6	30.8	29.6	30.9	31.9	31.6	30.2	26.8
	Kutubdia	25.7	27.7	30.8	31.4	32.7	31.3	30.0	31.3	31.8	31.2	29.8	26.5
2014	Cox's Bazar	27.7	29.3	32.3	34.9	34.6	32.6	31.5	30.8	31.9	33.1	31.5	28.5
	Kutubdia	25.5	27.2	30.3	33.5	33.8	32.1	31.6	30.6	31.6	32.4	30.5	27.0

Source: *BBS Yearbook of Agricultural Statistics and Statistical Bulletin*

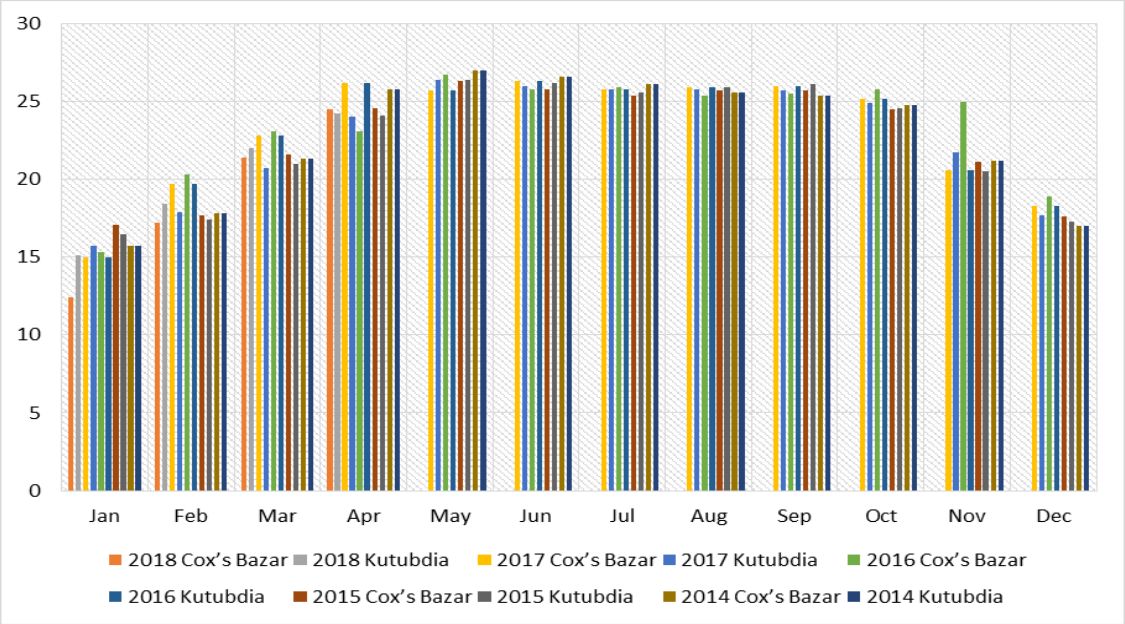


Figure 12: Average minimum temperature of two stations for last five years

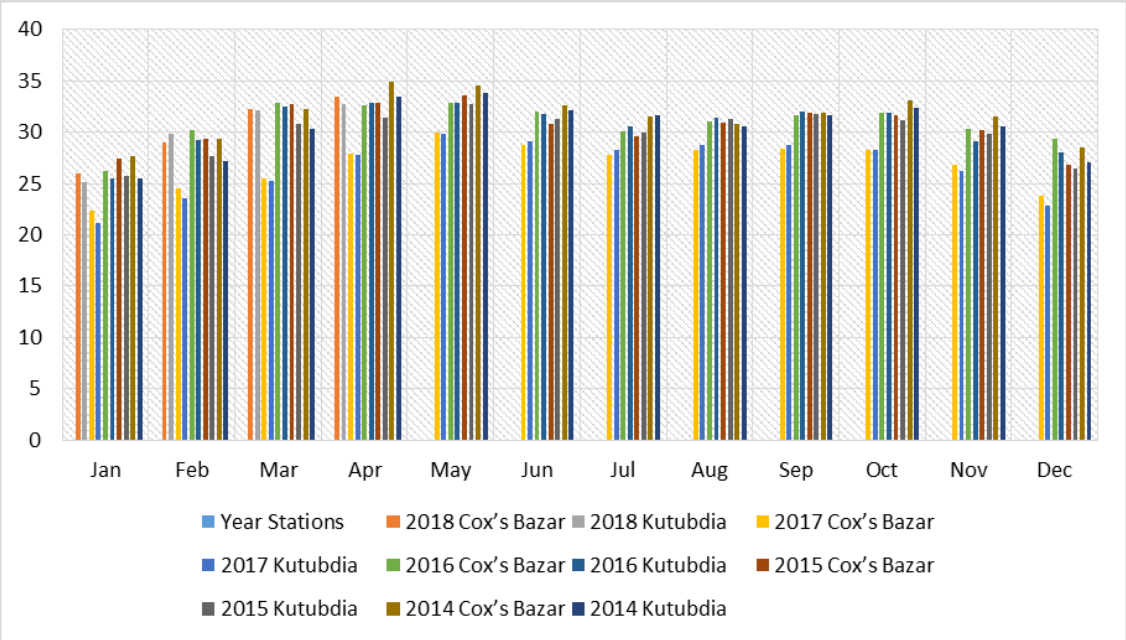


Figure 13: Average maximum temperature of two stations for last five years

Source: *BMD*

4.2.2 Humidity

Due to heavy rainfall and proximity to Bay of Bengal, the humidity levels in Bangladesh remains high. Annual average relative humidity in the project area is around 80%. Humidity fluctuations are stable every year in both areas in view of seasonal humidity change. The difference in the average humidity between respective months is rather small, in a range of 65 - 90%, while the average is 75 - 90% in the rainy season of May to October and 65 - 85% from November to April where little rain falls. The monthly variation of humidity patterns from Cox's bazar and Kutubdia station has been given in Table **29**.

Table 29: Monthly variation of relative humidity of two stations for last five years

Year	Month / Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	Cox's Bazar	84	81	76	69	-	-	-	-	-	-	-	-
	Kutubdia	68	71	72	71	-	-	-	-	-	-	-	-
2017	Cox's Bazar	68	67	76	81	78	85	89	87	87	83	76	76
	Kutubdia	71	71	76	80	78	82	84	85	82	82	77	78
2016	Cox's Bazar	74	76	75	77	79	82	89	86	84	82	78	77
	Kutubdia	78	79	79	79	79	81	86	84	83	82	79	78
2015	Cox's Bazar	76	71	69	80	78	88	91	87	86	84	79	77
	Kutubdia	77	71	69	79	77	85	88	84	83	82	77	76
2014	Cox's Bazar	73	71	73	76	79	86	85	88	84	79	77	76
	Kutubdia	78	76	74	79	78	82	83	87	88	84	76	74

Source: *BBS Yearbook of Agricultural Statistics and Statistical Bulletin*

4.2.3 Rainfall

About 80% of the precipitation occurs during five monsoon months (May to September). Minimum precipitations are recorded during the month of November to February whereas aveage showering does occur in March, April and October. The monthly total rainfall variation and annual rainfall variation in different years has been given in Table **30** &Table **31**.

Table 30: Monthly total rainfall in Cox's Bazar and Kutubdia station

Year	Stations	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	Cox's Bazar	26	0	0	59	-	-	-	-	-	-	-	-
	Kutubdia	11	0	0	108	-	-	-	-	-	-	-	-
2017	Cox's Bazar	0	0	216	361	143	541	1437	531	524	149	13	36
	Kutubdia	0	0	169	270	187	639	1188	444	615	170	9	30
2016	Cox's Bazar	0	0	25	22	359	538	1113	472	309	418	41	0
	Kutubdia	9	4	65	14	318	329	872	573	377	262	102	0
2015	Cox's Bazar	10	0	16	72	96	1573	1400	657	618	207	40	27
	Kutubdia	16	0	4	188	81	1034	1517	666	452	220	40	35
2014	Cox's Bazar	-	29	1	4	139	677	717	611	264	41	-	-
	Kutubdia	-	48	4	55	103	1055	620	545	449	80	1	-

Source: *BBS Yearbook of Agricultural Statistics and Statistical Bulletin*

Table 31: Annual rainfall for Cox's Bazar and Kutubdia station (2008-2017)

Year / Stations	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cox's Bazar	4603	3283	3438	4440	4123	4059	2483	4716	3297	3951
Kutubdia	3171	2658	2702	3894	4677	4203	2960	4253	2939	3721

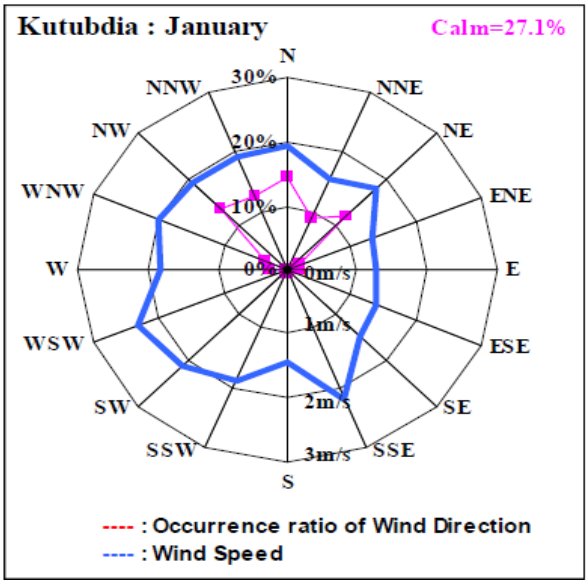
Source: *BBS Yearbook of Agricultural Statistics and Statistical Bulletin*

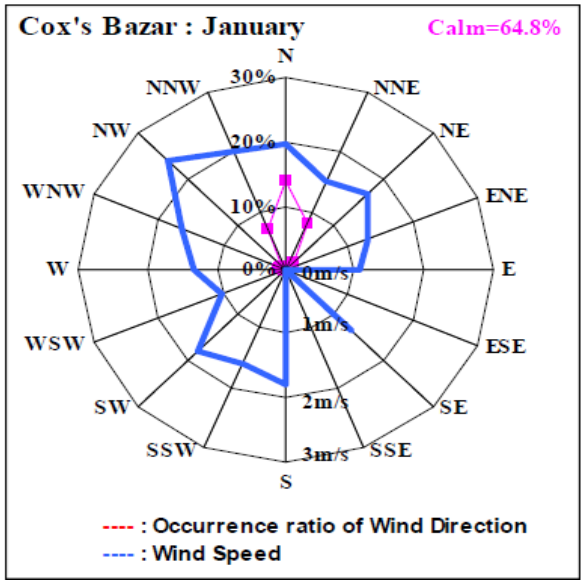
4.2.4 Evaporation

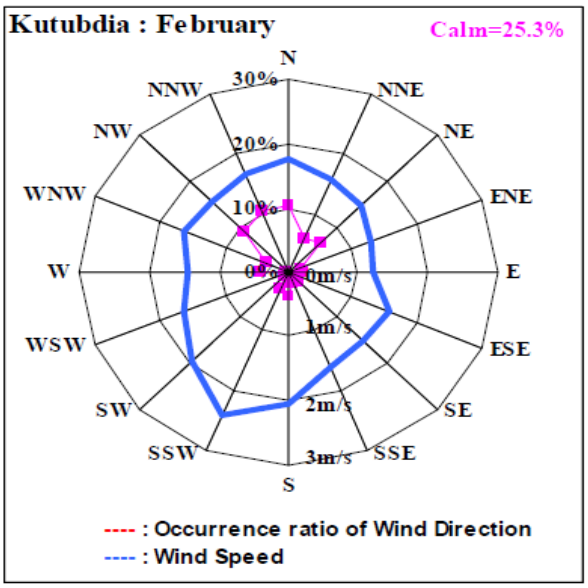
Evaporation is the process by which water changes from a liquid to a gas or vapor and back into water cycle as atmospheric water vapor. The atmosphere of coastal zone always enriches with humidity because of high evaporation over the sea surface. Solar radiation and evaporation are maximum during the pre-monsoon periods compared to the rest of the year. During high temperature in March-April, the evaporation from the soil also become high which further increase the soil salinity. A significant rainfall during this period could help mitigate the salinity problem.

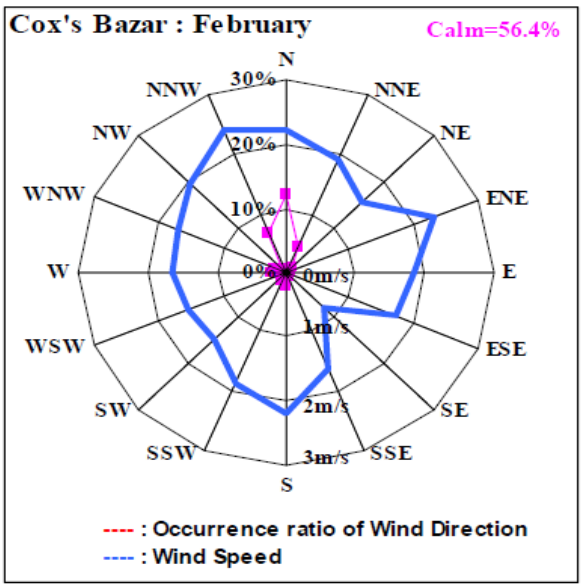
4.2.5 Wind Speeds

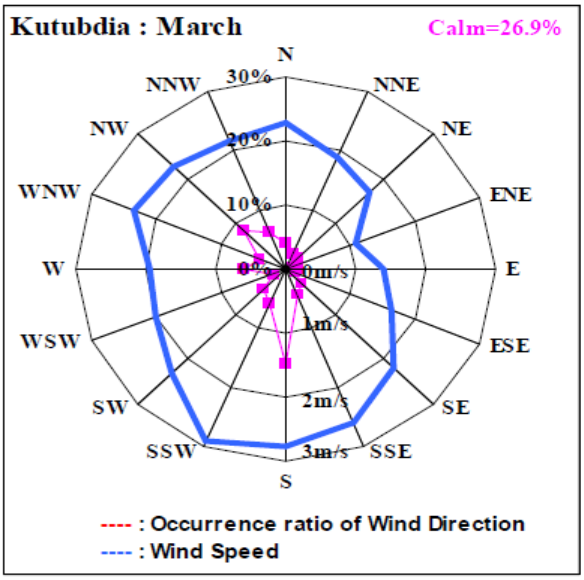
The Figure given below indicates the monthly frequency ratio of wind direction and the average wind speed for each wind direction in Kutubdia and Cox's Bazar. The data was missing in Kutubdia for 2006. In Cox's Bazar, "Calm (wind speed 0.5m/sec and lower)" occurs most frequently, accounting for more than 50% from September to March. Except for this difference, the wind directions in both areas show similar tendencies. Northerly winds are dominant in January and February, and no significant high wind speed was observed in specific wind direction. Southerly winds become dominant from March, especially from April to September. In July and August, there is a tendency of slightly higher wind speed in southwesterly winds, otherwise no significant high wind speed was observed in any specific wind direction. Wind direction shifts from southerly winds to northerly winds in October, and there is a tendency of high wind speed of southwesterly winds. Northerly winds are dominant in November and December, but high wind speed tends to occur in southwesterly winds.

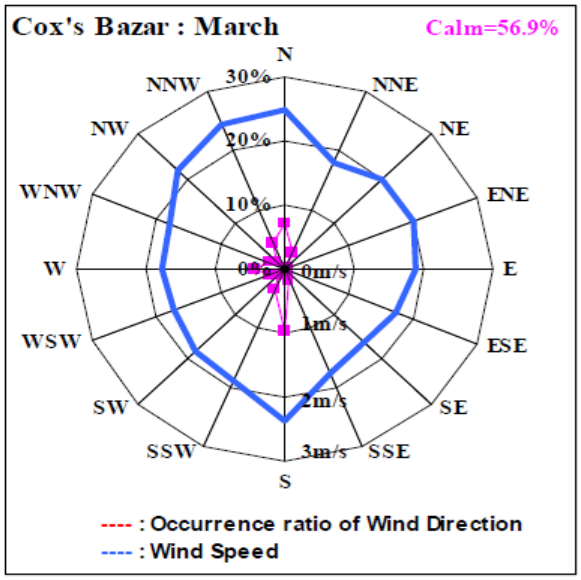


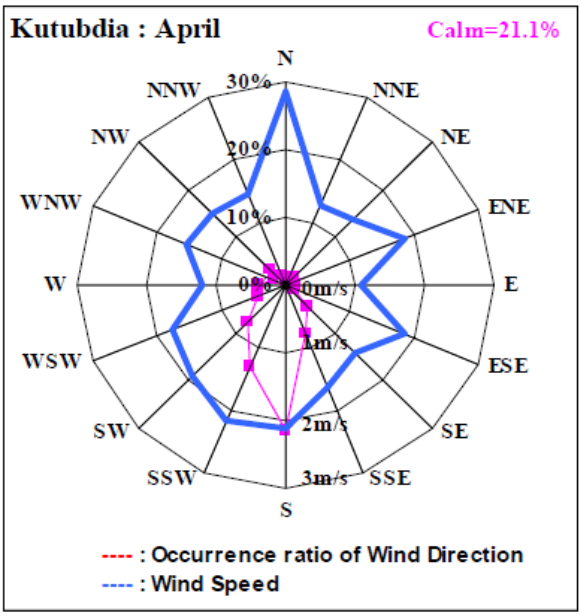


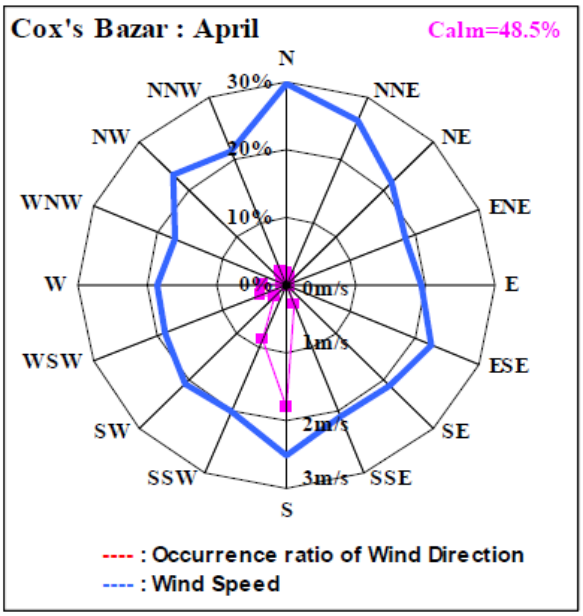


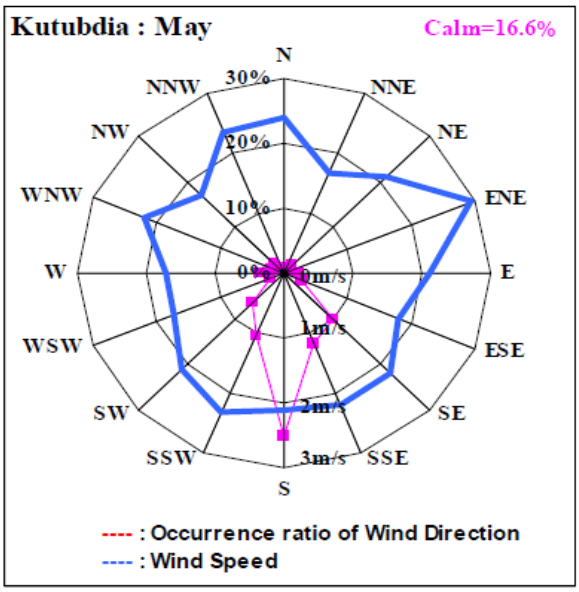


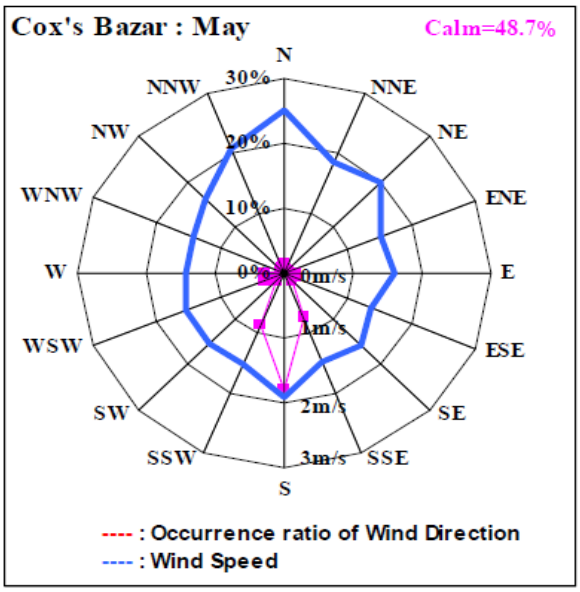

Kutubdia : March
Calm=26.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

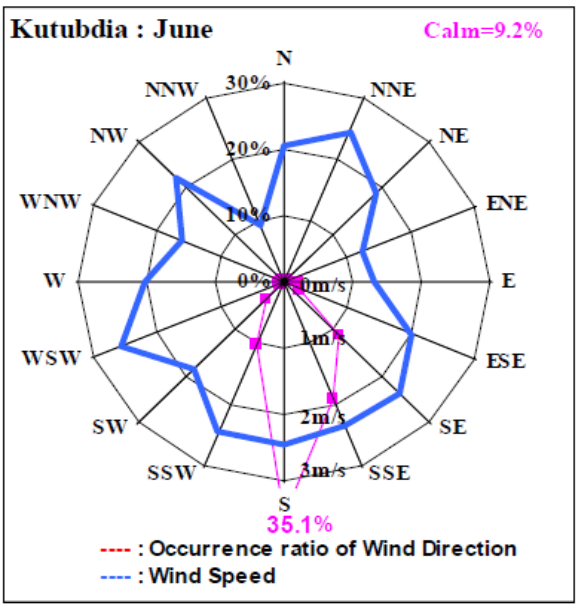

Cox's Bazar : March
Calm=56.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

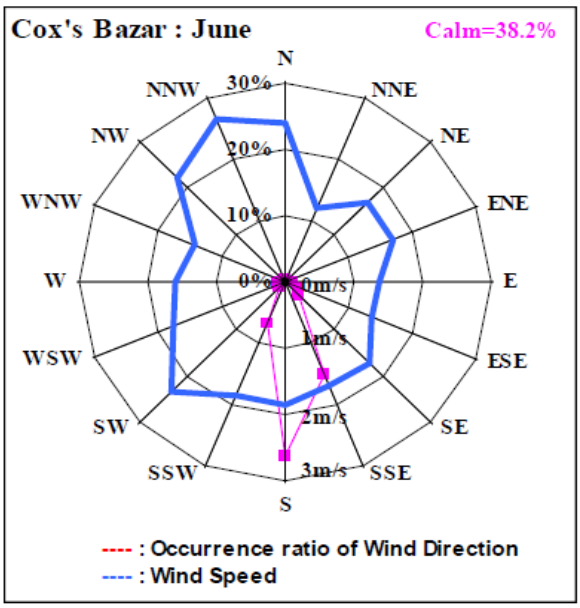

Kutubdia : April
Calm=21.1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

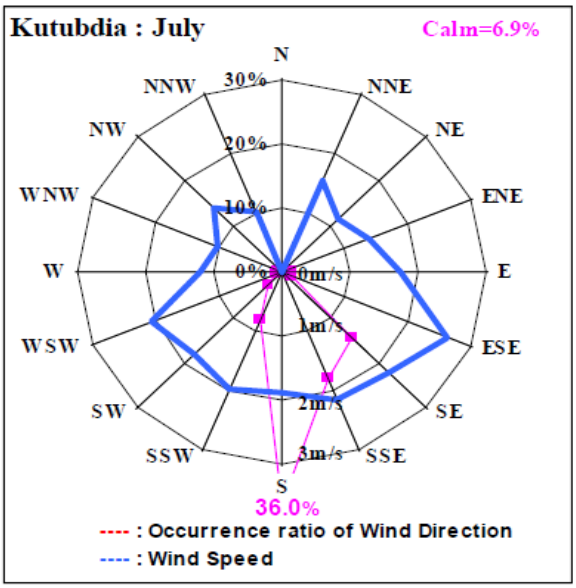

Cox's Bazar : April
Calm=48.5%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

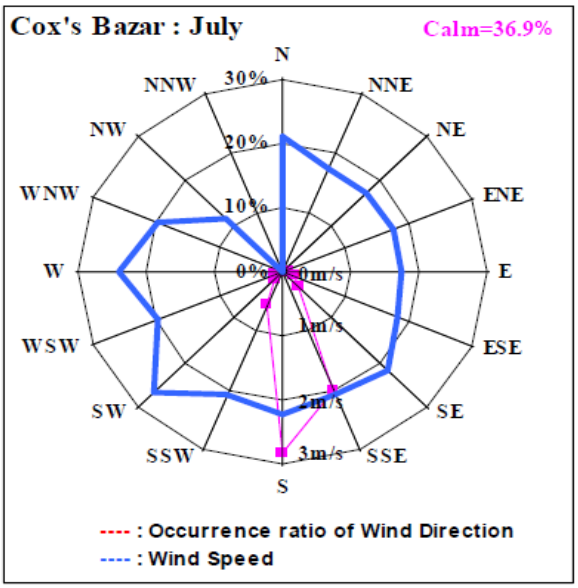

Kutubdia : May
Calm=16.6%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

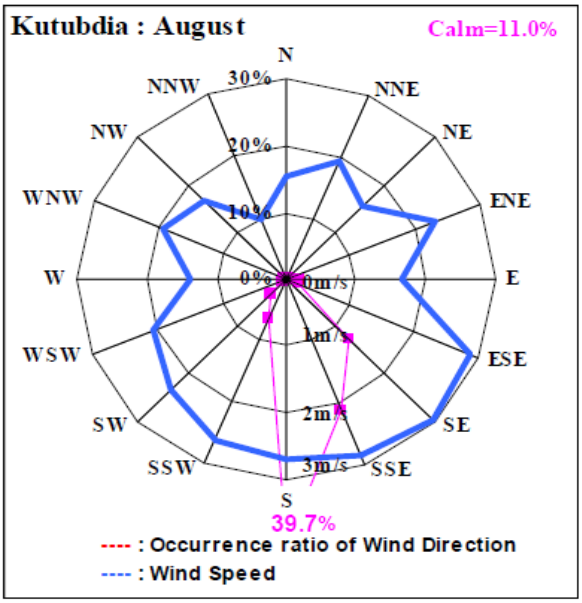

Cox's Bazar : May
Calm=48.7%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

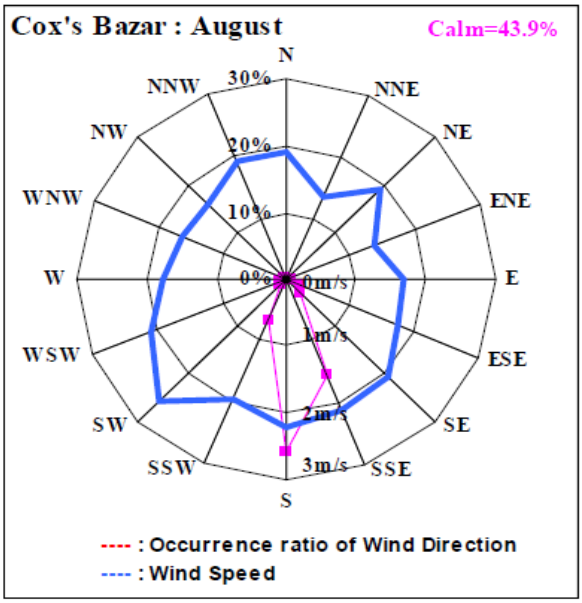




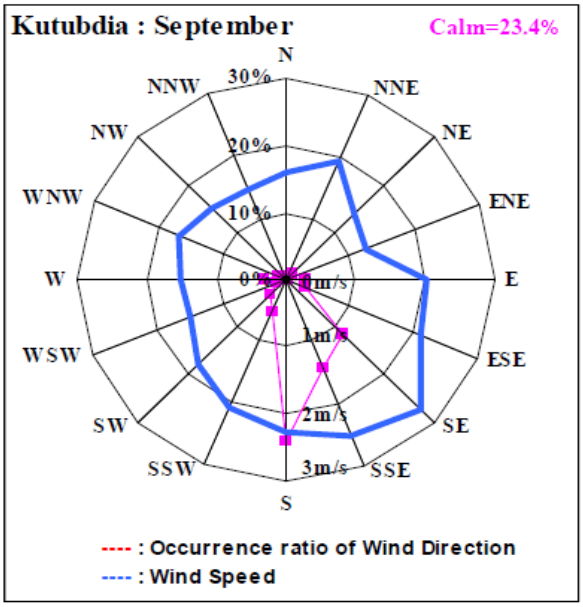


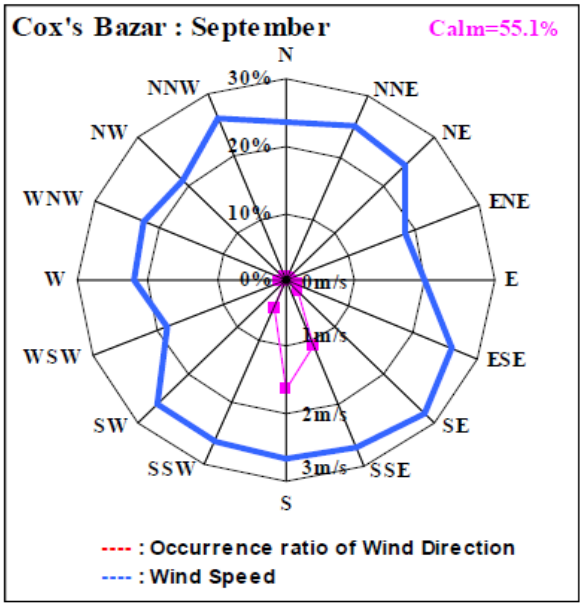


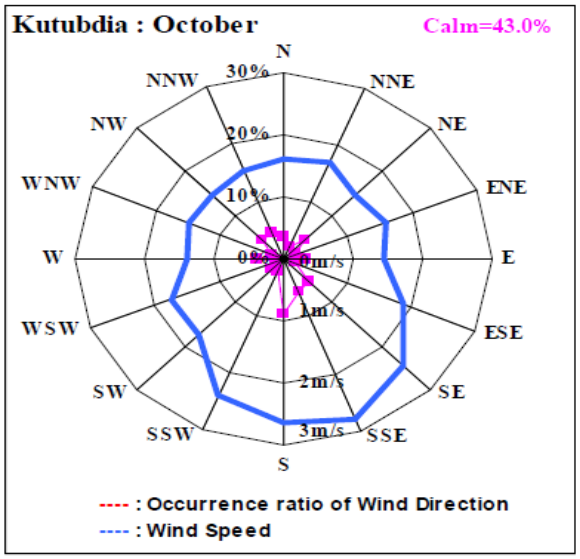


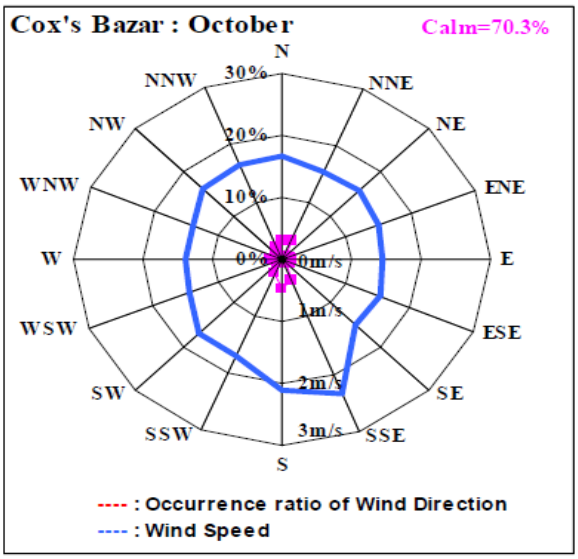


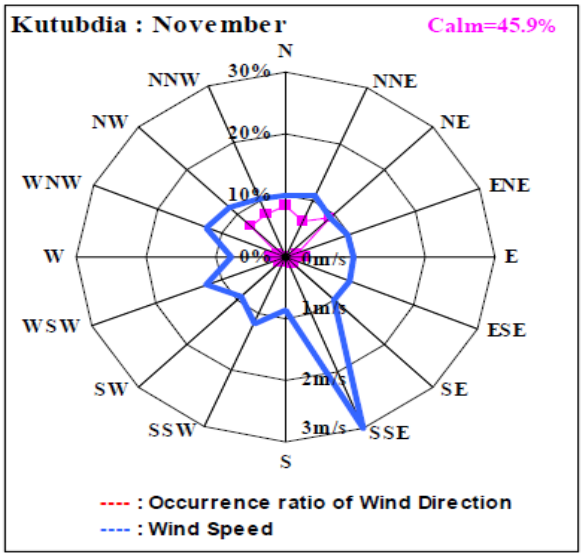
SHAHIDUL CONSULTANT
Architect, engineer and environment

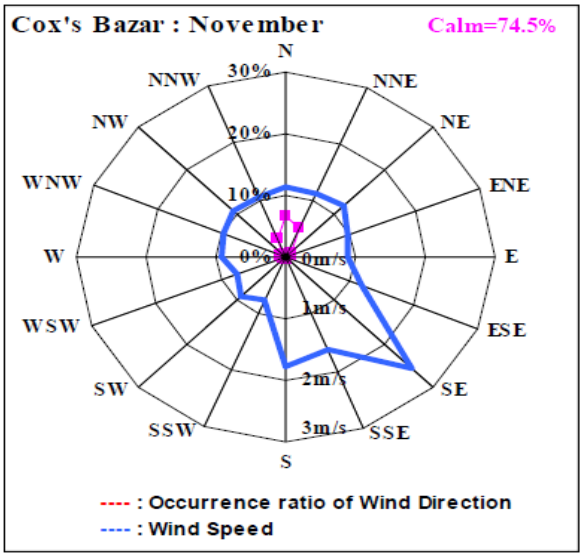

Kutubdia : September
Calm=23.4%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Cox's Bazar : September
Calm=55.1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Kutubdia : October
Calm=43.0%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Cox's Bazar : October
Calm=70.3%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Kutubdia : November
Calm=45.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Cox's Bazar : November
Calm=74.5%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

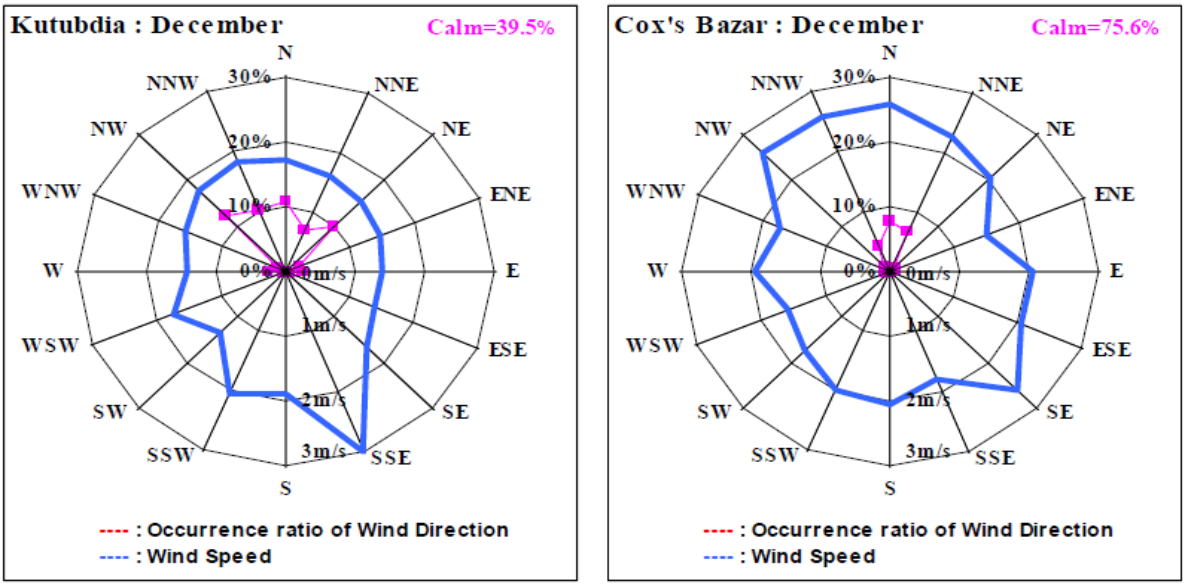


Figure 14: Monthly wind rose

Source: *EIA of Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities*

4.2.6 Sun Shine Hours

Sunshine duration or sunshine hours is a climatological indicator, measuring duration of sunshine in a given period (usually, a day or a year) for a given location on Earth; typically expressed as an averaged value over several years. It is a general indicator of cloudiness of a location, and thus differs from insolation, which measures the total energy delivered by sunlight over a given period. Sunshine duration is usually expressed in hours per year, or in (average) hours per day. In the project area, December is the sunniest, followed by January and November. July and August has the lowest amount of sunshine. The average monthly sunshine hours at the project has been given in Figure **15**.

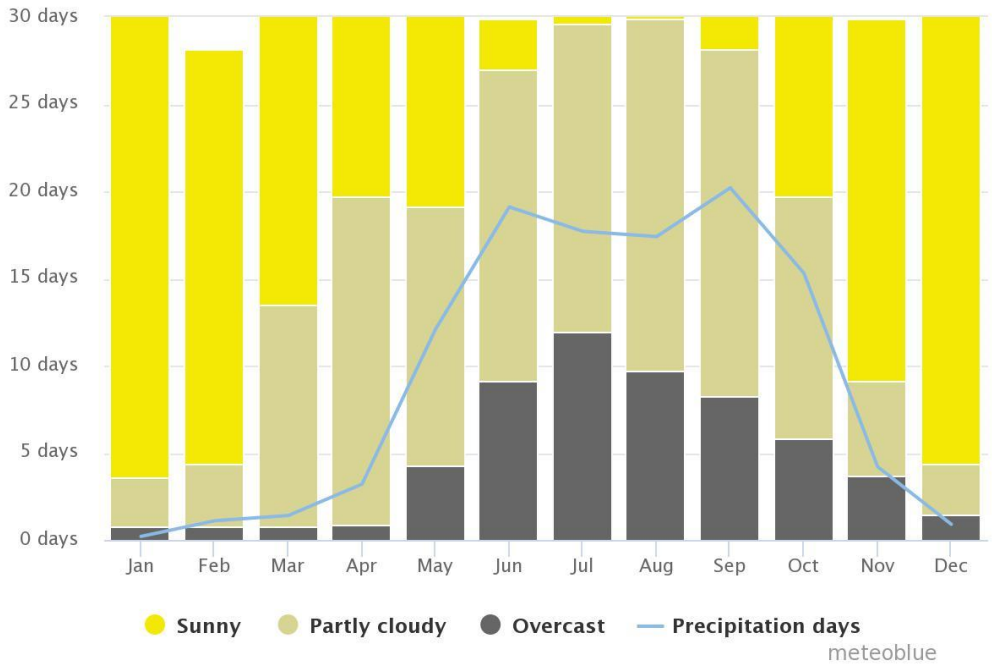


Figure 15: Average monthly sunshine hours in the project area

Source: *meteoblue*

4.3 Air Quality and Noise

4.3.1 Ambient Air Quality of the project site with respect to Standard of ECR, 1997

Moheshkhali Upazila is not industrialized. The present ambient air quality of the concerned area, as a result, is not much contaminated. To assess the present air quality of the area, one Ambient Air Quality Monitoring (AAQM) Stations were setup. The locations of the monitoring stations for air quality study were selected on the basis of meteorological data, topography, sensitive locations etc. Predominant wind direction during the season is from south and south west. Monitoring was conducted in respect of the following parameters:

a. Total Suspended Particulate Matter (SPM)
b. Oxides of Sulfur (SO_X)
c. Nitrogen Oxides (NO_X)

All the above mentioned pollutants were monitored at the station. The equipment was placed at a height of 3 to 7 meters above ground level at the monitoring stations, thus negating the effects of windblown ground dust and free from vertical obstructions within a cone of 120° from the actual position of the sampler, to avoid any impedance to the pollutants. The equipment was always placed at open space free from trees and vegetation which otherwise act as a sink of pollutants resulting in lower levels in monitoring results. The results were compared with respect to Standard of ECR, 1997 for industrial and mixed area. Summary of the monitored air quality results are given below in the following Table. All the air quality parameters were within the acceptable range prescribed by Environmental Conservation Rules (ECR), 1997 (amended 2017)

Table 32: Determination of air quality of the project area

Air quality parameters	SPM (µg/m³)	SO_x (µg/m³)	NO_x (µg/m³)
Average concentration	56	4.4	7.5
Standard Limit (ECR, 1997)	Below 200 (8 hrs)	Below 80 (yearly) 365 (24 hrs)	Below 100 (yearly

Source: *Bangladesh Environmental Engineering Training & Lab Services Ltd.*

4.3.2 Ambient Noise Level of the Project Site

Data indicates that the existing noise levels in proposed area are within the range of Bangladesh Environmental Quality Standard as well as WB General EHS Guidelines, 2007 for residential zone. This report uses the primary data as baseline data of noise environment.

Table 33: Noise level in the project area

Location	Noise level dB(A)	Noise Standard dB(A) according to ECR 97 (amended 2017)	
	Day	Day	Night
South-West Corner	57	75	70
North-West Corner	51		
South-East Corner	48		
North-East Corner	45		

Source: *Bangladesh environmental engineering training & lab services ltd.*

The baseline noise environment in the project area was within the range accepted by Bangladesh Environmental Quality Standard (Noise Pollution (Control) Rules, 2006).

4.3.3 Air Pollution and Noise Sources from existing and known sources

Existing and Known Sources of Noise

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. Natural factors such as topography, vegetation, and temperature can further reduce noise over distance. The two most common types of noise are point source and line source. Point source noise is associated with noise that remains in one place for extended periods of time, such as with construction activities. Line source noise is generated by moving objects along a linear corridor. Highway traffic is the best example of line source noise. The standard reduction for point source noise is 6 dB per doubling of distance from the source while for a line source it is 3 dB per doubling of distance from the source.

Construction Noise: One of the easiest things to identify and one of the hardest things to quantify is noise associated with the actual construction of the project. How much noise construction activities will generate, how often will it occur, and how long will it last are all questions that should be answered in the assessment. Construction is usually performed in a series of steps or phases, and noise associated with different phases can vary greatly. However, similarities in noise sources allow typical construction equipment to be placed into one of three categories: heavy equipment, stationary equipment, or impact equipment.

Heavy equipment: Heavy equipment can be defined as earth-moving equipment, such as excavating machinery like excavators, backhoes, and front loaders, as well as handling equipment like graders, pavers, rollers, and dump trucks. Noise levels at 50 feet from heavy equipment range from about 72 to 97 dB. During the phase of construction using heavy equipment, noise is generated more or less at a constant level. Therefore, noise levels can be equated to an average hourly level.

Stationary Equipment: Stationary equipment such as pumps, power generators, and air compressors, effluent treatment plant (ETP) etc., generally run continuously at relatively constant power and speed. Noise levels at 50 feet from stationary equipment can range from 68 to 88 dB, with pumps typically in the quieter range. An averaged noise level may be assumed for stationary equipment because of its fixed location and constant noise pattern.

Existing and known sources of Air pollutants

There are several sources of air pollutants like stake emissions, emissions from different processing units, emissions from vehicles, emissions from landfill discharge, emissions from natural gas use, emissions from electricity consumption etc.

4.4 Water Resources

4.4.1 Surface Water System

The rivers of Bangladesh mark both the physiography of the nation and the life of the people. About 700 in number, these rivers generally flow south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but

overworked soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and its greatest hazard. The profusion of rivers can be divided into five major networks.

- The Jamuna-Brahmaputra
- The second system is the Padma-Ganges
- The third network is the Surma-Meghna system
- The fourth river system--the Padma-Meghna
- A fifth river system, unconnected to the other four, is the Karnafuly.

The project area falls in the fifth river system of Bangladesh. The project area covers Kohelia River. **Figure 16** shows the existing river network map of the project area.

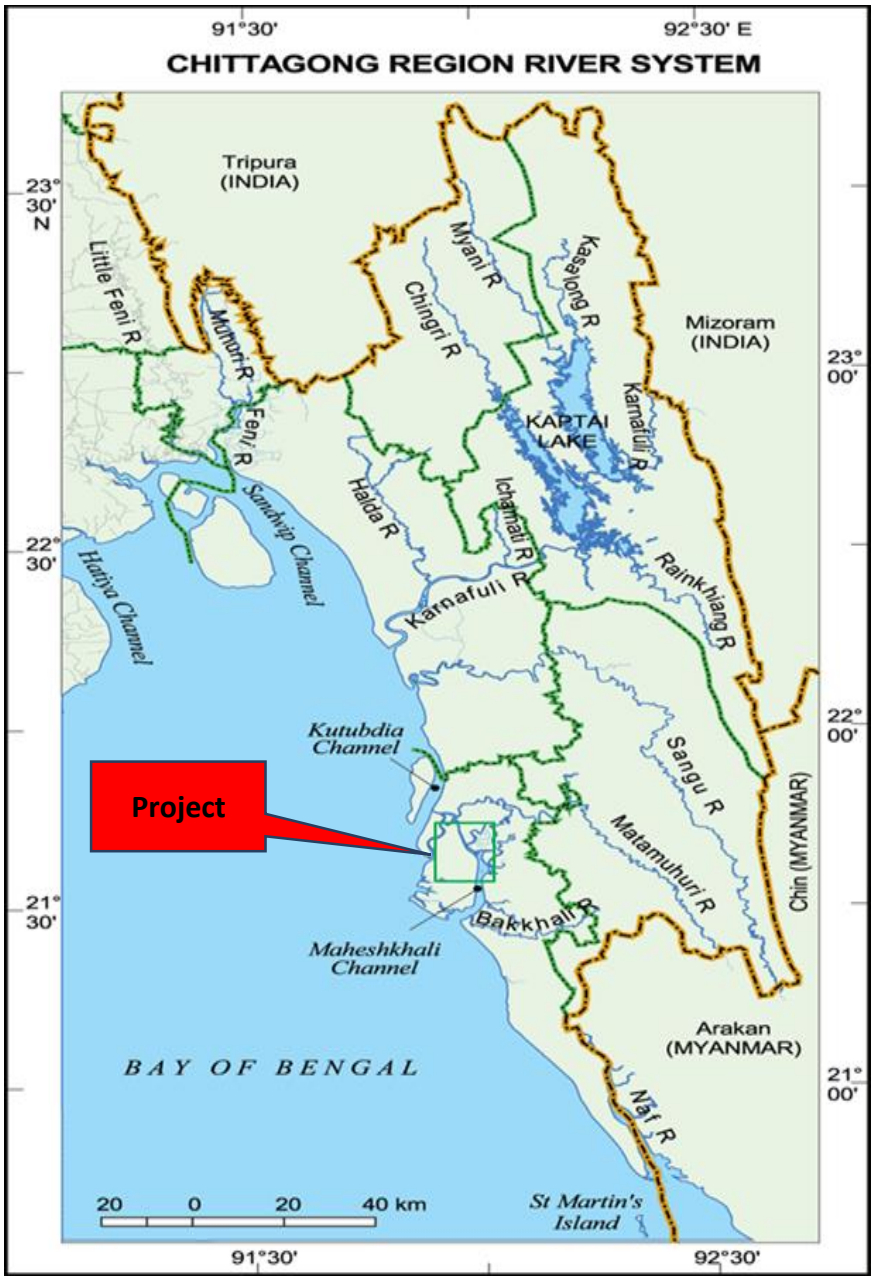


Figure 16: River system map

Source: *National Encyclopedia of Bangladesh, Banglapedia*

Water quality Analysis

Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface and groundwater in the project area. The surface water sampling was based on the identification of the major surface water body and its interaction with the project. Ground water sampling locations were selected to obtain representative water samples from various zones within the project area. The samples were collected from existing tube well (Hand pump being used by the villagers). A total of five (5) samples, three (3) surface water samples and two (2) ground water samples were collected from the studied area. The samples were analyzed for parameters covering physical, chemical and bacteriological characteristics as mentioned in the scope of works. Water samples were collected randomly in pre-washed sterile glass bottles. The surface water quality was compared with the Bangladesh ECR standard for best practice classification criteria and has been given in the following Table.

The local people use surface water for domestic and a little bit drinking purposes. The project will use the surface water during different phases i.e., pre-construction and construction. For operational activities, the project will use ground water through deep tube-well system and if the project uses surface water during operation phase, it will treat through water treatment plant (WTP) before use. Since adjacent to the project site, there is a likelihood of polluting the river and sea due to wastewater discharge and runoff during rainy season. To mitigate this, the project has a provision of using CETP to treat wastewater before discharge, if produced. No effluent (solid or liquid) will be discharged into the river without being treated. The possibility of leakage of oil and other pollutants can make the rainwater within the project site polluted. So, the rain water (susceptible of containing pollutant) will not be discharged into the river without treatment. Appropriate boundary wall will be built to prevent runoff and raw material (including toxic substances) will be transported by covering and stored with protection.

Table 34: Surface water quality near the project site

Water quality parameters	Unit	Concentration	Bangladeshi Standard for Inland Surface Water (ECR, 1997,amended 2017)	Methods of Analysis
P^H	-	7.80	6.5 - 8.5	P^H meter
DO	mg/L	5.7	5 or more then 5	DO Meter
BOD_5(20°C)	mg/L	5.8	less then10	DO Meter
Total coliform (TC)	CFU/100ml	> 200	-	Membrane Filter method

**CFU= Colony Forming Unit*

Source: *Bangladesh environmental engineering training & lab services ltd.*

4.4.2 Tropical Cyclones and Tidal Flooding

Natural hazards can be categorized into three broad categories in Bangladesh, like exogenic hazards caused by the earth surface processes (flood, riverbank erosion, coastal erosion, landslide, soil erosion and groundwater contamination); endogenic hazards caused by internal earth processes (earthquake and volcanic eruption); and, atmospheric hazards caused by atmospheric processes (storm, cyclone, northwester, tornado, hurricane, drought, etc.). On many occasions there are overlaps between these different events. Natural hazards can be profiled against seven basic criteria such as event magnitude, frequency of occurring, duration and areal extent, speed of onset, spatial dispersion and temporal spacing.

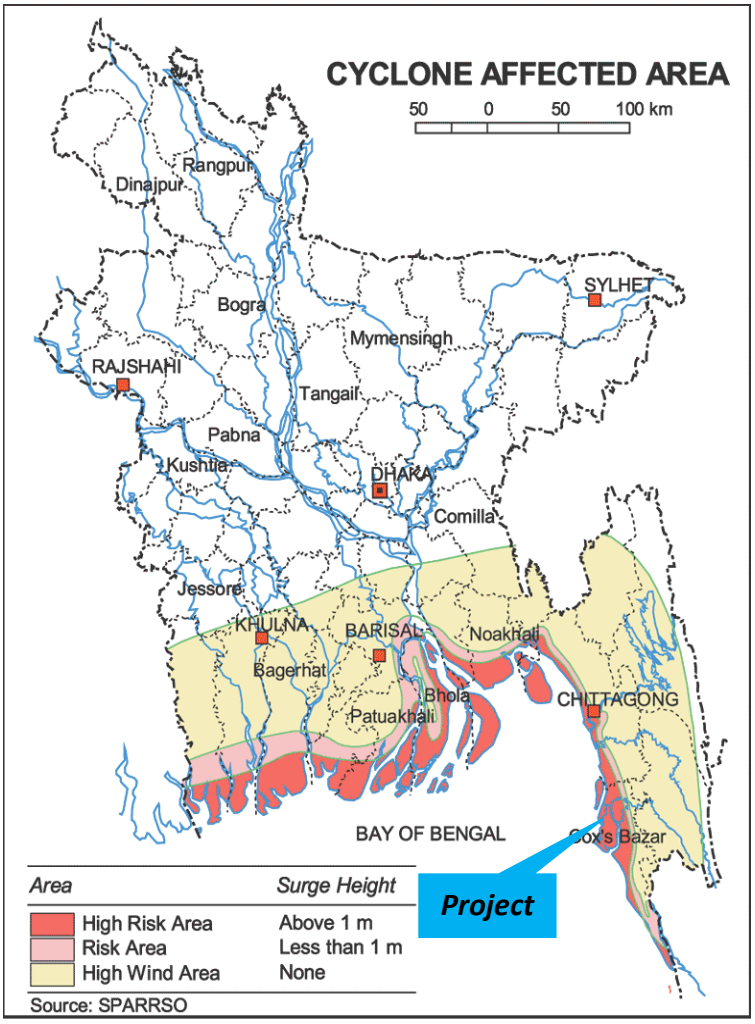


Figure 17: Position of project at cyclone affected areas of Bangladesh

Source: *SPARRSO*

During the years 1960 to 2015, Bangladesh was hit by 55 severe cyclones, 33 of which were accompanied by storm surges. List of major cyclones recorded in Chattogram-Cox's Bazar area in last 30 years is presented in Table **35**.

Table 35: List of major cyclonic storms in project area

Date of Occurrence	Nature of Phenomenon	Landfill Area	Maximum Wind Speed in Km/hr.	Direction of the Max Wind Speed	Tidal Surge Height in ft.	Central Pressure (mbs)
1	2	3	4	5	6	7
11.10.60	Severe Cyclonic Storm	Chittagong	160	South-East	15	-
31.10.60	Severe Cyclonic Storm	Chittagong	193	South-East	20	-
09.05.61	Severe Cyclonic Storm	Chittagong	160	South-East	8-10	-
30.05.61	Severe Cyclonic Storm	Chittagong (Near Feni)	160	South-South-East	6-15	-
28.05.63	Severe Cyclonic Storm	Chittagong-Cox's Bazar	209	South-East	8-12	-

Date of Occurrence	Nature of Phenomenon	Landfill Area	Maximum Wind Speed in Km/hr.	Direction of the Max Wind Speed	Tidal Surge Height in ft.	Central Pressure (mbs)
11.05.65	Severe Cyclonic Storm	Chittagong-Barisal Coast	160	South-South-East	12	-
05.11.65	Severe Cyclonic Storm	Chittagong	160	South-East	8-12	-
15.12.65	Severe Cyclonic Storm	Cox's Bazar	210	South-East	8-10	-
01.11.66	Severe Cyclonic Storm	Chittagong	120	South-East	20-22	-
23.10.70	Severe Cyclonic Storm of Hurricane intensity	Khulna-Barisal	163	South-West	-	-
12.11.70	Severe Cyclonic Storm of Hurricane wind	Chittagong	224	South-East	10-33	-
28.11.74	Severe Cyclonic Storm	Cox's Bazar	163	South-East	9-17	-
10.12.81	Cyclonic Storm	Khulna	120	South-West	7-15	989
15.10.83	Cyclonic Storm	Chittagong	93	South-East	-	995
09.11.83	Severe Cyclonic Storm	Cox's Bazar	136	South-East	5	986
24.05.85	Severe Cyclonic Storm	Chittagong	154	South-East	15	982
29.11.88	Severe Cyclonic Storm with a core of hurricane wind	Khulna	160	South-West	2-14.5	983
18.12.90	Cyclonic Storm (crossed as a depression)	Cox's Bazar Coast	115	South-East	5-7	995
29.04.91	Severe Cyclonic Storm with a core of hurricane wind	Chittagong	225	South- East	12-22	940
02.05.94	Severe Cyclonic Storm with a core of hurricane wind	Cox's Bazar-Teknaf Coast	220	South-East	5-6	948
25.11.95	Severe Cyclonic Storm	Cox's Bazar	140	South-East	10	998
19.05.97	Severe Cyclonic Storm with a core of hurricane wind	Sitakundu	232	South-East	15	965
27.09.97	Severe Cyclonic Storm with a core of hurricane wind	Sitakundu	150	South-South-East	10-15	-
20.05.98	Severe Cyclonic Storm with a core of hurricane wind	Chittagong Coast near Sitakunda	173	South-South-East	3	
28.10.00	Cyclonic Storm	Sundarban Coast near Mongla	83	South-South-West	-	-
12.11.02	Cyclonic Storm	Sundarban Coast near	65-85	South-South-West	5-7	998

Date of Occurrence	Nature of Phenomenon	Landfill Area	Maximum Wind Speed in Km/hr.	Direction of the Max Wind Speed	Tidal Surge Height in ft.	Central Pressure (mbs)
		Raimangal River				
19.05.04	Cyclonic Storm	Teknaf-Akyab Coast	65-90	South-East	2-4	990
15.11.07	Severe Cyclonic Storm with a core of hurricane wind (SIDR)	Khulna-Barisal Coast near Baleshwar river	223	South-West	15-20	942
25.05.09	Cyclonic Storm (AILA)	West Bengal-Khulna Coast near Sagar Island	70-90	South-South-West	4-6	987
16.05.13	Cyclonic Storm (MAHASEN)	Noakhali-Chittagong Coast	100	South-South-East	-	-
30.07.15	Cyclonic Storm (KOMEN)	Chittagong-Cox's Bazar Coast	65	South-East	5-7	988
21.05.16	Cyclonic Storm (ROANU)	Barisal-Chittagong Coast near Patenga	128	West-South-West	4-5	992
30.05.17	Severe Cyclonic Storm (MORA)	Chittagong-Cox's Bazar Coast near Kutubdia	146	South-East	-	-

Source: *BMD*

The project area experiencing two types of flood like tidal and storm surge flood. Tidal flooding experienced in project areas in tow times in a day. During this flooding river water level is higher than normal level. Storm surges is a type of flood in which the project site is located, mostly occurred along the coastal areas of Bangladesh which has a coast line of about 800 km along the southern part of Bay. This coastal area is shallow and the coastal line in the eastern portion is conical in shape. Therefore, storm surges are likely to occur due to flood tides of cyclones and southwestern monsoon winds.

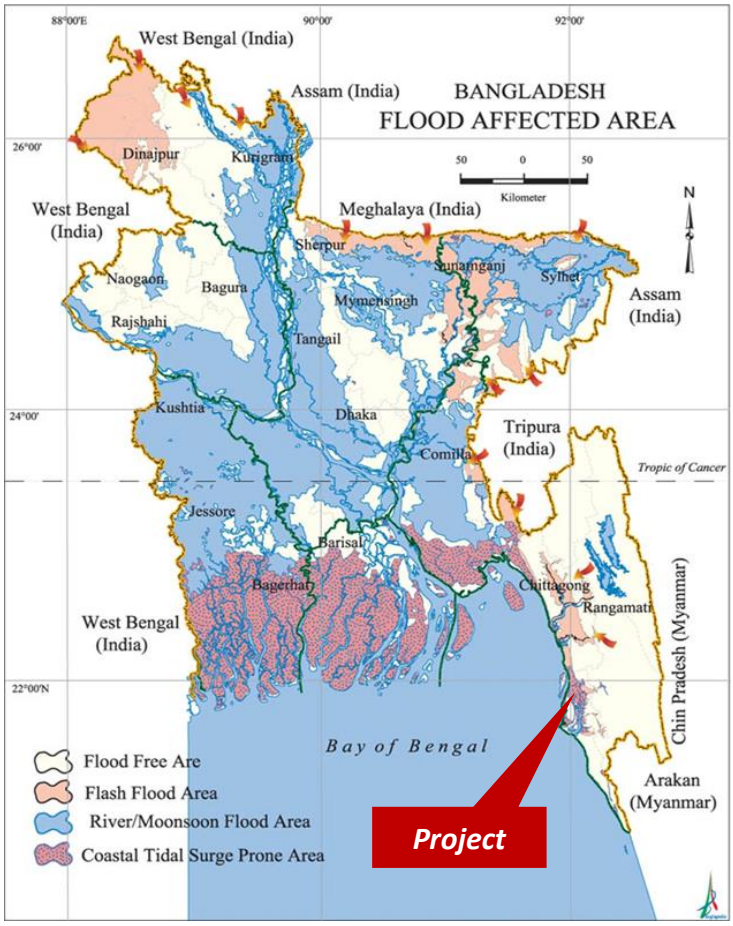


Figure 18: Position of project at flood prone areas of Bangladesh

Source: *www.thebangladesh.net*

The Kohelia River itself is ungauged. So, there is no measured water level and discharge data of the river. However, there are a few surrounding rivers/channels for which water level data is available. These data were collected from the Bangladesh Water Development Board (BWDB) and Water Resources Planning Organization. The details of the data collected are given in Table **36**.

Table 36: Water level data near the project site

Water bodies/ River/ Channel	Highest flood in m PWD(Year)	Water bodies/ River/ Channel	Highest flood in m PWD(Year)
Moheshkhali Channel	4.36 (1985)	Kutubdia Channel	5.46 (1971)
	4.21 (1983)		4.90 (1972)
	4.20 (1987)		4.20 (1997)
	4.20 (1988)		2.23 (2005)
	4.20 (1989)		-

Source: *BWDB, WARPO*

A study conducted by CPGCBL, showed that considering the above gauge stations with respect to Kohelia River at Moheshkhali, the 50-year flood level was estimated to be about bout 4.63 m PWD and the 50-year mean tidal water level about 2.74 m PWD.

4.4.3 Salinity

Saline water intrusion is highly seasonal in Bangladesh. Salinity and its seasonal variation are dominant factors for the coastal eco-system, fisheries and agriculture. Therefore, any change in the

present spatial and temporal variation of salinity will affect the biophysical system of the coastal area. The changes in salinity in the coastal area of Bangladesh have been assessed by IWM & CEGIS, 2007 on Coastal Communities and their Livelihoods in Bangladesh. Based on the study results, the iso-saline lines of 1 & 5 ppt for base condition and 1, 5 &15 ppt have been drawn for 2050s conditions (given in the Figures below). These figures indicate that in base condition about 10% areas are under 1 ppt salinity and 16% under 5 ppt salinity and this area will increase to 17.5% (1 ppt) and 24% (5 ppt) by 2050s. From the figures, it is clear that the proposed project is very adjacent to the salinity wave front.

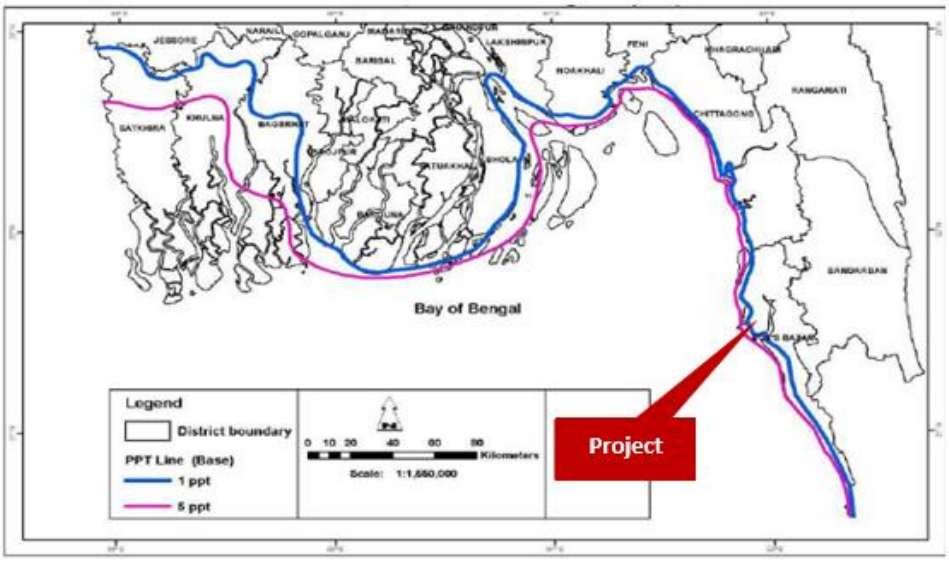


Figure 19: Salinity condition in coastal area (for base condition)

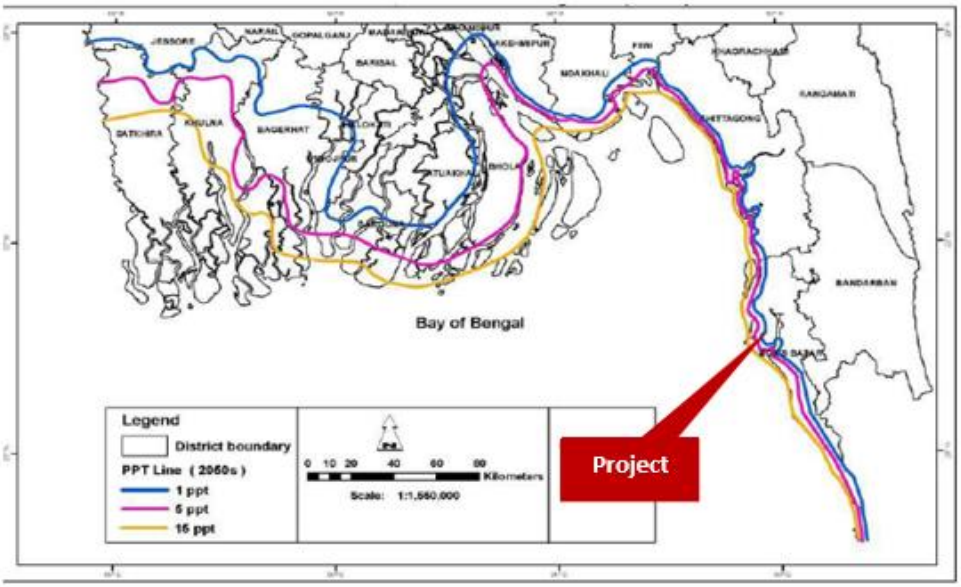


Figure 20: Salinity condition in coastal area (for 2050)

Source: *EIA on proposed 6.5 km long embankment cum road construction from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata under Matarbari 2x600 MW USC Coal-Fired Power Project*

4.4.4 Drainage Congestion and Water Logging

Drainage congestion and water logging are not prominent in the study area. The project area has already been bounded by water development board embankment on Kohelia River. Few part of the embankment was breached. During high tide, water frequently enter to the project area through Kohelia River breaching embankment and Bara Matamuhuri khal and other connecting khals meanwhile it inundates the lowland. Accordingly, during ebb tide, water drain out properly so drainage congestion is not found the study area. During monsoon period, most of the low land becomes full of water. From the study it is observed there would not be any significant impact of the proposed project. This is mainly due to the fact that the BWDB polder already exists and it will only be improved.

4.4.5 Erosion and sedimentation

Millions of people of the country are affected by riverbank erosion every year that damages standing crops, farmland and homestead land. The site is vulnerable for bank erosion. The erosion activity is being lower down the river bed of Kohelia through sedimentation of materials. The proposed embankment cum road along the west of Kohelia River of the island shall be made very strong and permanent to save the island from cyclone, tidal waves aid erosion along with Sedimentation.

Table 37: Occurrence of river erosion in various Upazilas of Cox' Bazar district (2008-2011)

Upazilas	2008	2009	2010	2011
Chakaria	**Yes**	**Yes**	**Yes**	**Yes**
Cox's Bazar Sadar	No	No	No	No
Kutubdia	No	No	No	No
Moheshkhali	No	No	No	No
Pekua	No	No	No	No
Ramu	No	No	No	No
Teknaf	No	No	No	No
Ukhia	No	No	No	No

Source: *BBS, 2011*

MEZ-3 authority will build protective embankment and boundary wall to prevent both riverbank and soil erosion through surface runoff of the project.

4.4.6 River Morphology

The terms river morphology used to describe the shapes of river channels and how they change over time. The morphology of a river channel is a function of a number of processes and environmental conditions, including the composition and erodibility of the bed and banks (e.g., sand, clay, bedrock); vegetation and the rate of plant growth; the availability of sediment; the size and composition of the sediment moving through the channel; the rate of sediment transport through the channel and the rate of deposition on the floodplain, banks, bars, and bed; and regional aggradation or degradation due to subsidence or uplift.

The Delft 3D model can be used for morphological change prediction purpose. The Flow Module of the model with the sediment and morphology components enabled was used to predict morphological changes in the Kohelia River. As the embankment-cum-road is already in place and its alignment would be more or less the same under the proposed condition, the model was run a number of times with the grid and bathymetry setup earlier for base condition. The information on sediment characteristics was derived based on the data provided in JICA et al. (2013). In the given

Figure, shows the cumulative erosion/sedimentation scenarios for both base condition and three future time horizons (5, 10 and 20 years later). The overall results indicate that the morphological changes may be more in the lower reaches of the river than that in the upper reaches. These lower reaches may show both erosion and deposition in the future. The main channel between the downstream end and the middle reach may become deeper in future due to bed erosion. Both sides of the deeper channel show a pattern of siltation due to low velocity in the short to medium terms (5-10 years). In the long term (10-20 years), the banks of the river show a tendency of erosion. Thus, erosion protection measures would be needed throughout the river.

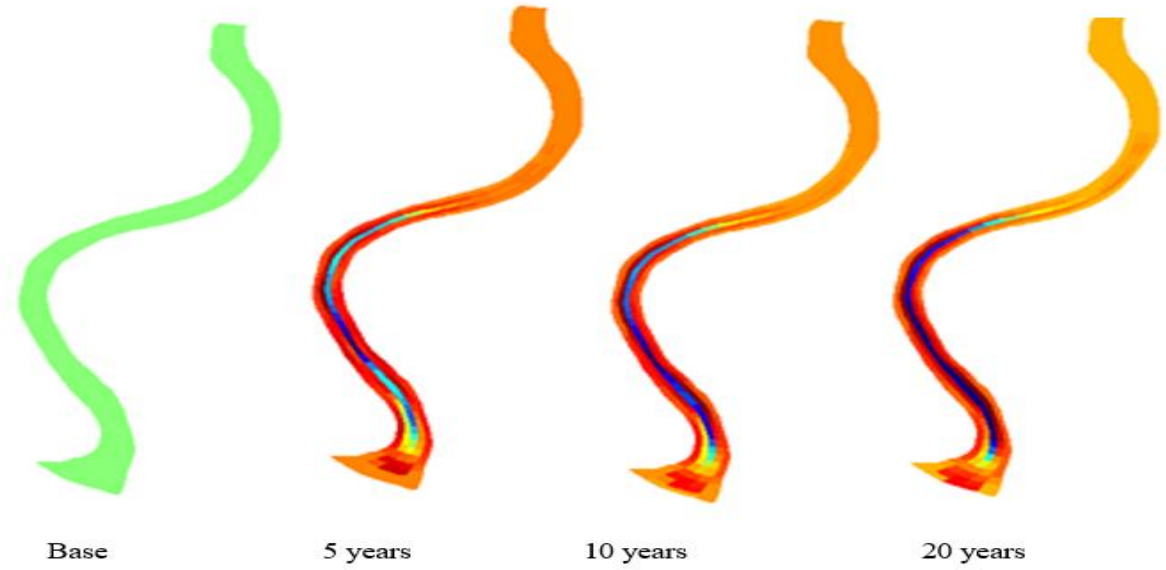


Figure 21: Simulated time series maps of erosion-sedimentation in the Kohelia River

Note: The deep blue color indicates erosion, the deep red sedimentation and others indicate more or less no change

Source: *EIA on proposed 6.5 km long embankment cum road construction from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata under Matarbari 2x600 MW USC Coal-Fired Power Project*

4.4.7 Navigation

Major rivers include Matamuhuri River, Uzantia, Kohelia, Masgona rivers and Moheshkhali channel are adjacent to the project area which would be utilized for transportation of construction materials of the infrastructure of the project. This river is enough depth of navigability for river transportation especially cargo, steamer etc. The water of the Kohelia River is used mainly for the transportation of cash crops like (salt and shrimp) and fishing by non-engine and engine driven country boats. The erosion material is being deposited in the river bed leading to somewhat low navigable depth. But navigation of the rivers is now still active.

4.4.8 Ground Water System

Bangladesh is located over a subsiding basin of tectonic origin with a great thickness of sedimentary strata. This is an unconsolidated alluvial deposit of recent to sub-recent age overlying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface quaternary alluvium contains good aquifer characteristics (transmission and storage coefficients). The groundwater storage reservoir has three divisions; upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand.

Groundwater table fluctuations indicate the recharge and discharge to the groundwater reservoir. The highest groundwater table occurs in the study area during the month of August-September when the aquifer recharges fully and the lowest is during February-March due to natural discharge and groundwater use for domestic and irrigation purposes.

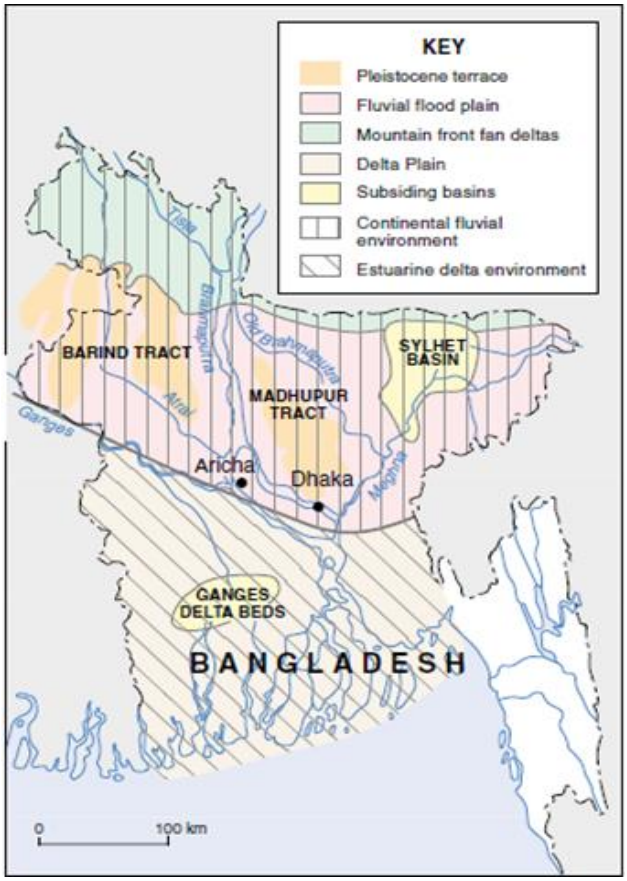


Figure 22: Simplified geology and geomorphology of Bangladesh

Source: *British Geological Survey, NERC, 2001*

Groundwater is abundant in Bangladesh and the aquifers are highly productive. The sediments are predominantly non-indurated and easy to drill by hand, at least to shallow levels. Water tables vary across the country but are typically shallow at around 1–10 m below the ground surface. These factors have made groundwater an attractive and easily accessible resource and have led to a rapid proliferation in the use of groundwater over the last few decades. Today, 97% of the population relies on groundwater for potable supplies and groundwater is also an important source for irrigation and industry. Groundwater levels across Bangladesh become depressed during the dry season, but the aquifers replenish fully during the monsoon. Exceptions occur beneath the major cities, especially Dhaka, where large-scale abstraction has led to long-term drawdown of the water table.

The number of tube wells in Bangladesh is not known but estimates put the number at around 6–11 million. The vast majority of these are private tube wells, which penetrate the shallow alluvial aquifers to depths typically of 10–60 m. Irrigation boreholes typically tap deeper aquifers in the region of 70–100 m depth. In some areas, notably the south and the Sylhet Basin of north-east Bangladesh, deep tube wells abstract groundwater from depths of 150 m or more. In the south, the deep tube wells have been installed to avoid high salinity at shallower levels (BGS and DPHE, 2001).

Shallow hand-dug wells occur in some areas, though they are much less common than tube-wells. In the project area more than 90% people use ground water as a source of drinking water.

It is observed from the ground water analysis that Arsenic, Iron, Manganese and Total Dissolve Solids content in the ground water of the project area exceeded the Bangladesh Standard and Testing Institutes (BSTI) standard. Around 89.5% water is used from the ground in the project area (BBS, 2011).

Table 38: Ground water quality data of the project site

SL. No.	Parameter	Unit	Concentration present	Bangladesh Standard for Drinking water (ECR, 1997)	Analysis Method
1.	Temperature	^0C	27	20-30	Digital thermometer
2.	P^H		7.15	6.5-8.5	P^H meter
3.	TDS	mg/L	723	1000	Conductivity meter
4.	Turbidity	mg/L	2.1	10	Turbidity meter
5.	Chloride	mg/L	156	150-600 (1000 for coastal area)	APHA, 1998
6.	DO	mg/L	2.27	6	DO meter
7.	Total coliform (TC)	CFU/100ml	0	0	Membrane Filter method
8.	Fecal Coliform	CFU/100ml	Nil	0	Membrane Filter method
9.	Arsenic	mg/L	0.01	0.05	AAS
10.	NH_3	mg/L	0.04	0.5	AAS

**CFU= Colony Forming Unit; *BDL= Below Detection Limit*

Source: Bangladesh environmental engineering training & lab services ltd.

4.5 Land Resources

4.5.1 Agro-ecological regions

Agro-ecological Zones are land areas categorized on the basis of four elements such as physiography, soils, land levels in relation to flooding and agro-climatology. Physiography forms the primary element in defining and delineating the agro ecological regions in Bangladesh. Soils form the second element in defining and differentiating agro ecological zones as soil conditions determine important properties for plant growth, moisture supply, root aeration and nutrient supply. The third factor is land level in relation to flooding. The last one is related to different agricultural products for different climatic conditions of the regions (Banglapedia, 2019). It is considered in identifying agro ecological zones in Bangladesh comprises the four climatic zones of the country. Agro-ecological zone indicates an area characterized by homogeneous agricultural and ecological characteristics. This homogeneity is more prominent in the sub-region and unit levels.

The agro-ecological zones of Bangladesh have been divided in 30 regions. The proposed project falls under the Chattogram Coastal Plain. This region occupies the plain land in greater Chattogram and the eastern part of Feni. It is a compound unit of piedmont, river, tidal and estuarine floodplain landscapes. The major problem in these soils is high salinity during dry season (October to May). Grey silt loams and silty clay loam soils are predominant. Acid Sulphate soils which are potentially extremely acidic occur in mangrove tidal floodplains. Non-calcareous Grey Floodplain soils, Non-calcareous Alluvium and Acid Sulphate soils are the major components of the general soil types of

the area. General fertility level of the soils is medium, and N and K are limiting. Status of S is high. Organic matter content is low to moderate and the status of Zn and B is medium.

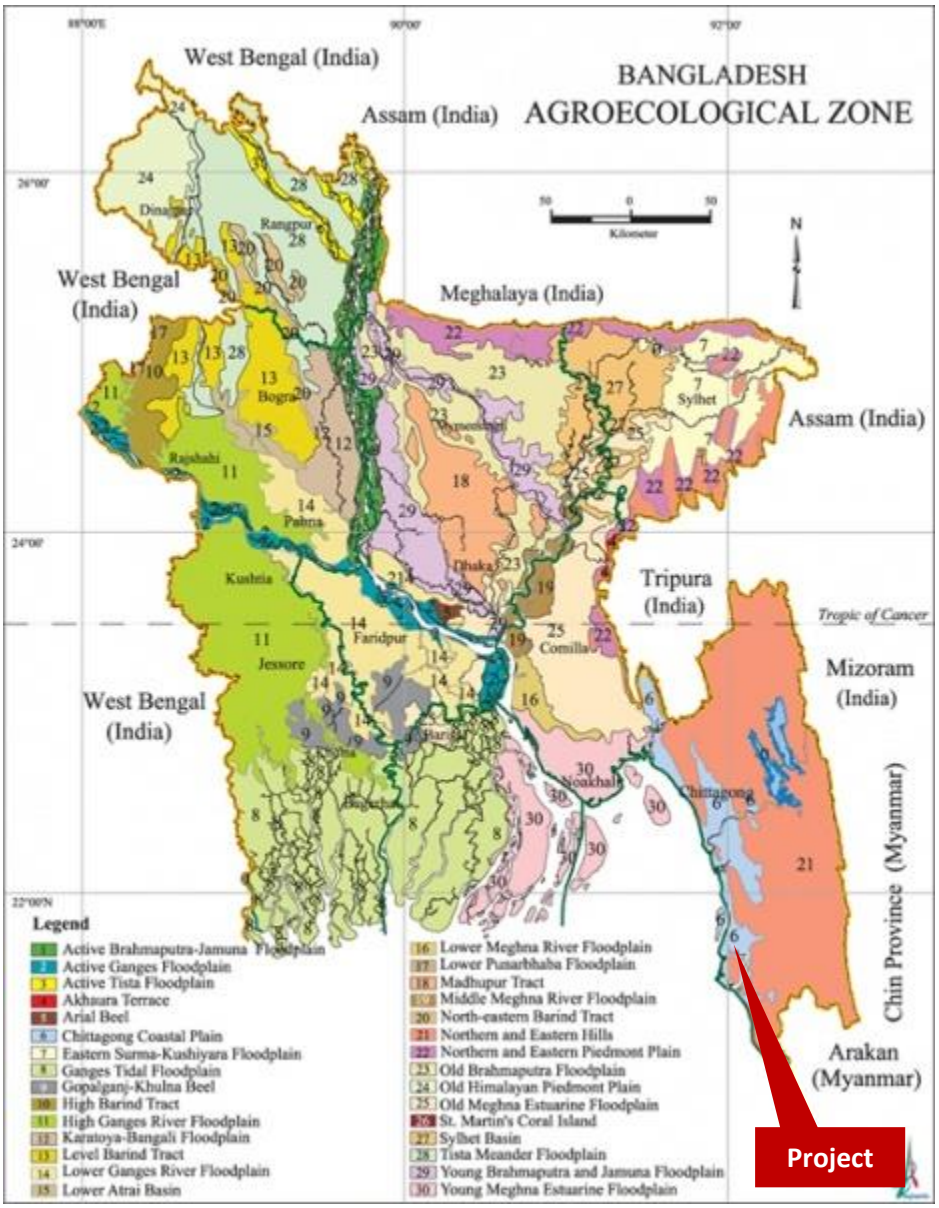


Figure 23: Agro-ecological regions of Bangladesh

Source:*Banglapedia*

4.5.2 Land Types

The land type characteristics are not uniform within the study area. Out of total 26456 acres of land, 24% (6340 acres) low land, 59% (15500 acres) medium land and 17% (4616 acres) are high land in Moheshkhali Upazila (BBS, 2011). The inundation land type of proposed project is medium high land 2 (land normally inundated 30-90cm depth). Figure 24 show the land types of proposed project.

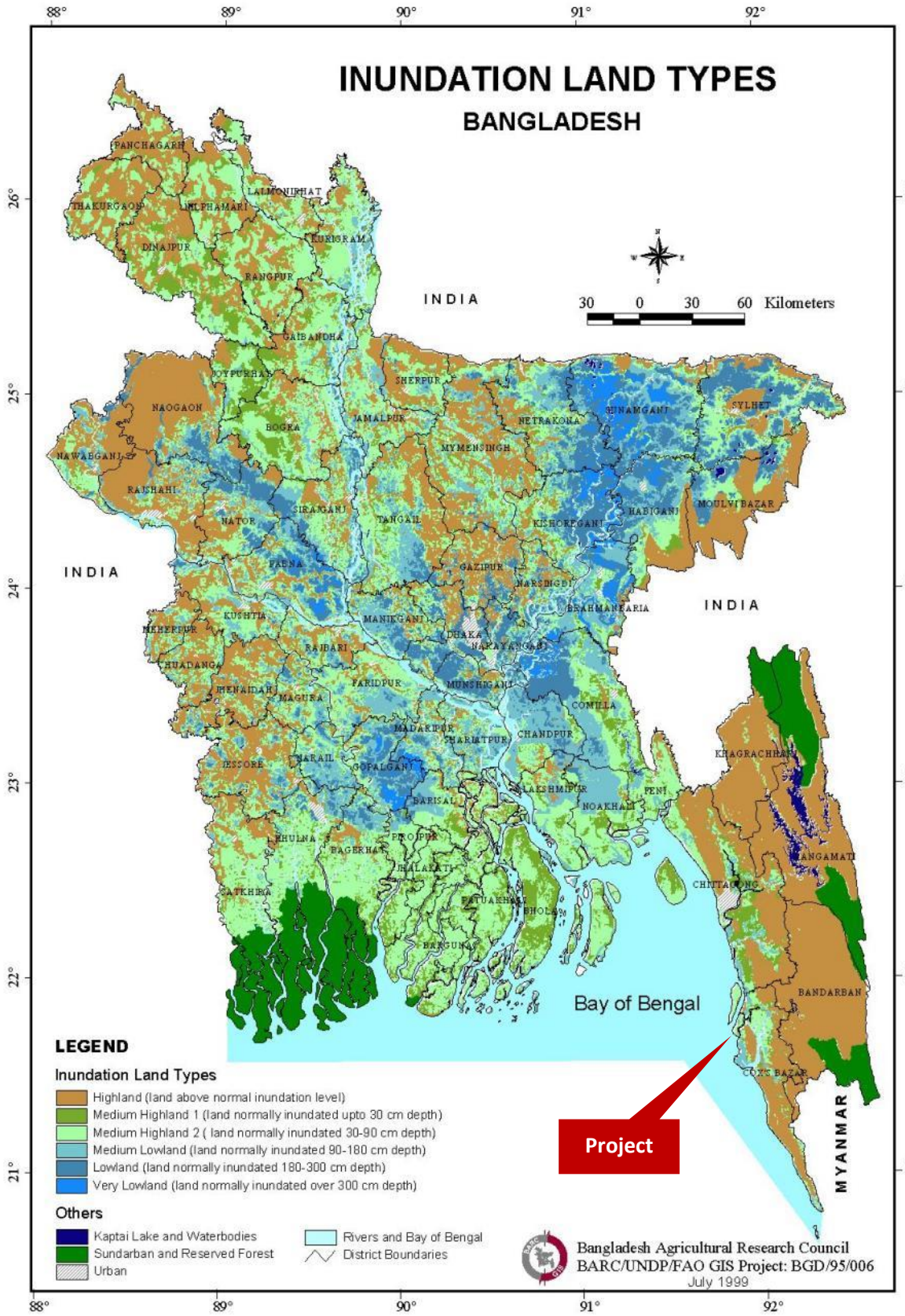


Figure 24: Land types map of Bangladesh indicating the project site

Source: *BARC*

4.5.3 Soil Texture

Soils of the project area are mainly formed from recent alluvial sediments. The area has a wide variation in geology and landforms due to variation of sediment deposits or deposited in different times from Karnaphuli, Sangu, Matamuhuri, Banshkhali and Naf Rivers. On the basis of broader characteristics of the alluvia, the whole area is mainly divided into two physiography i.e. tidal floodplains and sandy beaches.

Tidal flood plains are tidally flooded, very poorly drained, finely stratified now silty to clayey alluvium. They are occurring on tidal mud flats, regularly tidally flooded and remain wet throughout the year. The alluvium is mostly moderately to strongly saline. Mangrove tidal floodplains are grey colored, silty clay loam to clayey non-saline soils are occurring in high to medium highlands. Some medium lowlands are seasonally moderately deeply flooded. Soils in this type of lands are grey colored, moderately fine textured and strongly saline (often used for salt bed). This type of soils is mainly occurring in in the Moheshkhali area especially in the Kohelia river bank side. Beach sands soils are mainly grey in colour and sandy in texture. They are tidally flooded and strongly saline.

Food and Agricultural Organization (FAO) conducted a number of surveys classification presents a series of 28 general soil classes of Bangladesh (shows in the figure below). The project survey area falls in the soil tract group 3, 10, 17a & 17b which are acid Sulphate soil; Grey Piedmont Soils; Mainly Deep, Brown (some red), Soils on low hills and Deep and Shallow Brown soils on very steep, high hill ranges respectively.

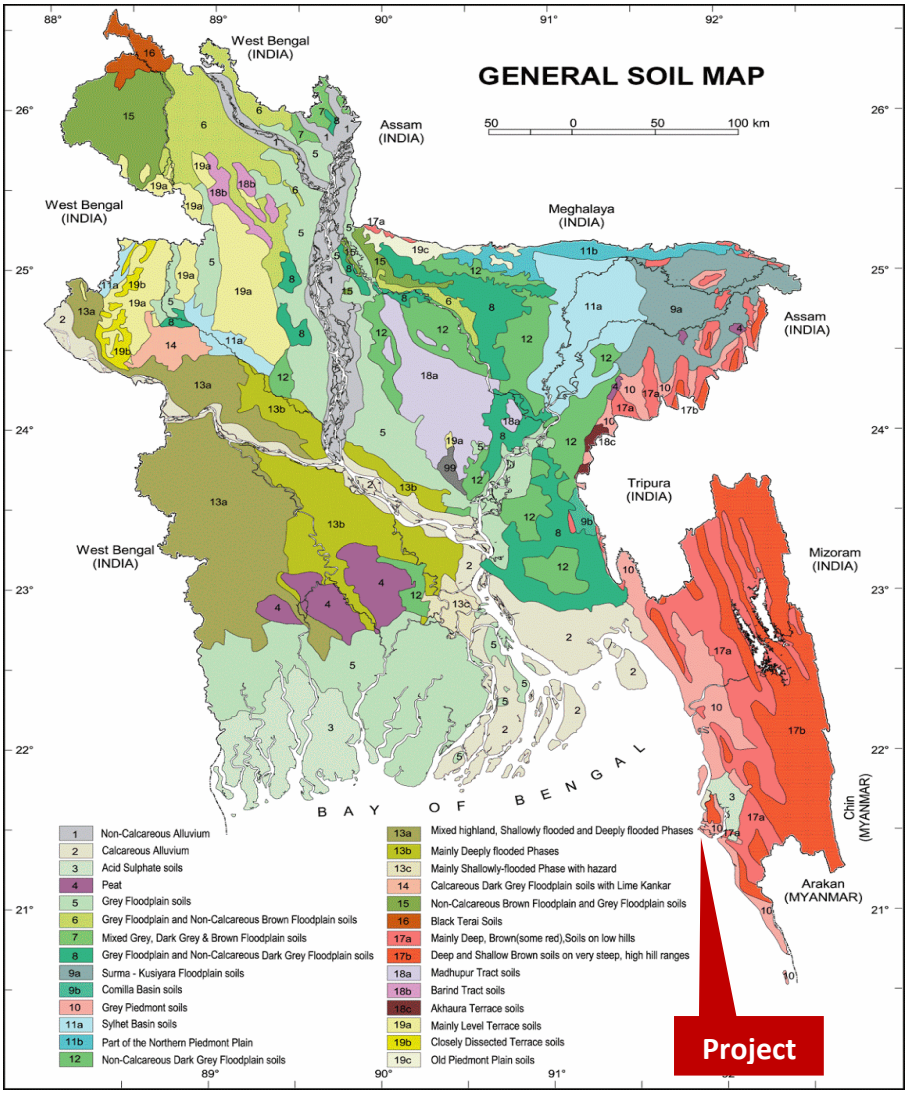


Figure 25: Soil classification map of Bangladesh

Source: *Banglapedia*

4.5.4 Land Use

Within the project area there are no substantial variations in land types and land use patterns. Land types of the project area are mostly medium high land. There are agricultural and industrial area, water bodies (Rivers, canals, small canals, Ponds, etc.), and fallow land, etc. are covered major land use. Total area of Moheshkhali Upazila is 362.18 sq km (BBS, 2011). There is no reserve forest within the project area. The Bangladesh Bureau of Statistics, 2011, provided the land area based on utilization of Moheshkhali Upazila.

Land use in Moheshkhali Upazila are mainly depends on the surface water availability, quality etc. In the Moheshkhali Upazila 2073.4 hectares of land are used for salt production. In Moheshkhali Upazila total cultivable land 5275.36 hectares, salt production 2073.4 hectares, shrimp cultivation 2105.69 hectares, fallow land 1715.21 hectares. Only 23% land is used for agricultural use[5]. The total

[5]Source:EIA on proposed 6.5 km long embankment cum road construction from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata under Matarbari 2x600 MW USC Coal-Fired Power Project.

operated land area of Moheshkhali Upazilla is 35168 acres, among them 1194acres, 15535 acres, 153 acres and 9574 acres are permanent cropped area, temporary cropped area, permanent fallow area and others, respectively. Out of 15535 acres of temporary cropped area, 170 acres, 11505 acres, 2990 acres, and 1040 acres are current fallow, single, double and triple cropped area, respectively (BBS, 2011). Figure **26** shows the agricultural land use map of Bangladesh.

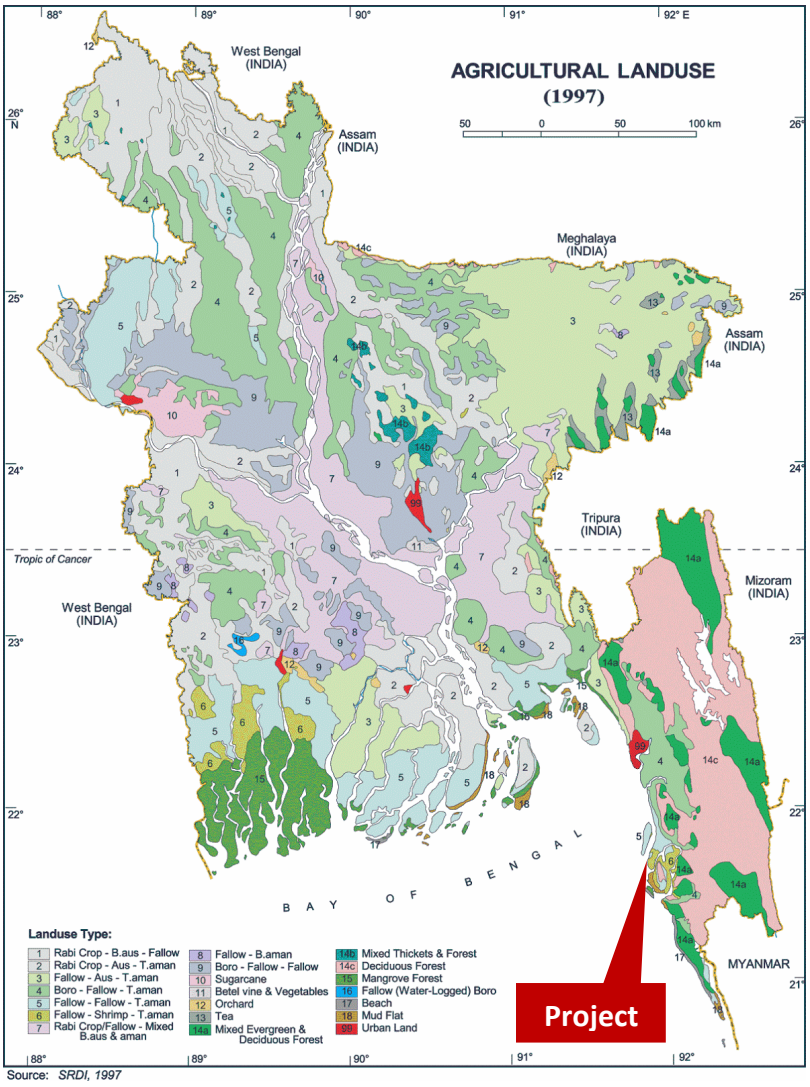


Figure 26: Agricultural land use map of Bangladesh

Source: *SRDI*

4.6 Agricultural Resources

4.6.1 Farming Practice and Cropping Pattern

People are mainly farmers and fishers. Some are also involved with trade and commerce. Many people are having business in the Cox's Bazar. No industry or other major economic enterprises were set up in the project area.

Local level employment is mainly in the agriculture sector. Land ownership pattern also shows that more than 60% are landless or marginal famers who work either as land labour, salt labour or boat man. Among the rest only 10% are rich farmers and rest are small, middle or substantial farmers. Most of them are being own small plots of land.

Various types of farming practices occurred in the proposed project area are prominent as namely salt and shrimp farming which is run by individually or combined or mixed. Farmers cultivate small scale homestead vegetable, fruits such as been, tomato, raids, brinjal, green chili, coconut, mango, jackfruit, lemon, guava, olive etc. (field visit, 2018).

4.6.2 Cropped Area in Moheshkhali Upazila

The total operated land area is 26456 acres, permanent cropped is 1194 acres, temporary cropped area is 15535 acres, permanent fallow area is 153 acres and other is 9574 acres in Moheshkhali Upazila of Cox's Bazar District. Figure **27** shows the cropped area of Moheshkhali Upazila.

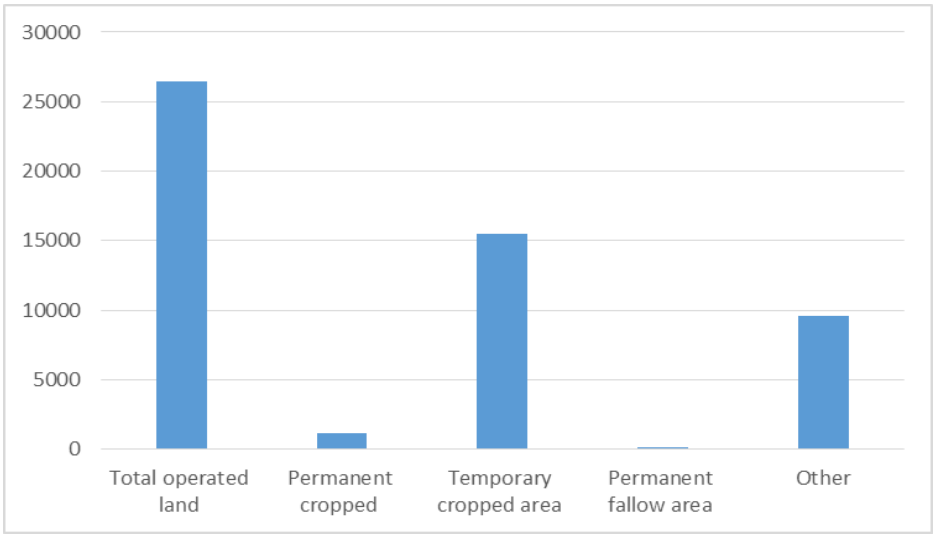


Figure 27: Cropped area in Moheshkhali Upazila

Source: *BBS, 2011*

The project will not hamper the agricultural practices and development; rather the farmers could be benefited indirectly by promotion of economic growth of the area by the project.

4.6.3 Crop Production in Moheshkhali Upazila

The main crop of the project area is shrimp and salt. Most of the people are earning money by cultivation and working of salt and shrimp field. Other crops are Paddy, wheat, potato, mustard, pepper, maize, groundnut, betel, tobacco, watermelon, vegetables etc. in Moheshkhali Upazila. Crop production especially for Paddy, wheat and potato in Moheshkhali Upazila is not a full satisfactory trend. Table **39** shows the rice production in Moheshkhali Upazila.

Table 39: Production of Rice in Moheshkhali Upazila (Area in acre and production in metric ton)

Year	Types of rice					
	Aus		Aman		Boro	
	Area	Production	Area	Production	Area	Production
2009-2010	238	229	20982	27590	17432	26626
2010-2011	162	157	21050	24863	17745	27542

Source: *BBS, 2011*

4.6.4 Crop Damage

Crop production is damaged by different climatic threats like food, drought, heavy rainfall, untimely rainfall, tornado, cyclone, river bank erosion etc. Within the threats, flood and cyclone are main objects that can damage the crops seriously. Every year, almost one-third of Bangladesh is flooded.

However, because of topographical characteristics, the regions of the country experience the degree of flooding; some parts may be under deep flood water, others unaffected. Flooding is beneficial only within certain limits of timing, duration and magnitude. In the project area, mostly flood and cyclone with tidal surge are main responsible to damage the crops. So, the project should have scope to do required management in the project area.

4.6.5 Main Constraints of Crop Damage

Economic, environmental and other factors can constrain crop production in different ways. Economic demotivation and financial problem can cause initial pessimism in production decision. Environmental hostile factors like disasters and unwanted conditions can cause harms in latter stage of production. Main constraints of crop production in the project area are-

- Irregular irrigation facilities during winter season
- Flood water submerged the land during rainy season
- Lack of training for suitable cultivation and overcoming the loss of crop to the farmers
- Non-introducing the new high yielding varieties and new technologies;
- Low fertility of land
- Lack of open market sell of seeds and fertilizer, quality seed and other inputs as demanded by farmers
- Unavailability of credits
- Lack of agricultural loans of flood-affected farmers

4.7 Livestock and Poultry

Livestock and poultry has been playing significant role in the economy of the study area, as in the agricultural share of economy of Bangladesh. Along with agriculture, it is an essential part of integrated farming system. Livestock provides supports for cultivation like threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for household consumption. Agricultural by-products can be used as fodder and feed of Livestock and poultry. There are 233261 Cow and buffalo, 61179 goat and 11005 sheep in the project area. Moreover, there are also 398588 hen and cock, 63676 duck in the project site (BBS, 2011).

Table 40: Status of livestock and poultry at the project area

Particulars	Number
Cow & buffalo	29826
Goat	16149
Sheep	1836
Hen and Cock	290874
Duck	33535

Source: *BBS, 2011*

Most of the households in the project area have poultry and livestock, a practice that helps to reduces poverty through generating alternative income and employment. The common livestock and Poultry found in the project area are cow, buffalo, goat, sheep, duck, chicken etc.

4.7.1 Feed and Fodder Shortage

Fodders and feed is the most important input of livestock rearing. Crop residues and naturally grown grasses alongside roads, river bank, char lands, etc. are the main feed for the cattle in Bangladesh. Shortage of fodder and high price of feed ingredients are affecting the small holders significantly. Dairy units are running off due to shortage of fodder or grazing land/ high price of feed ingredients.

The pasture land has reduced significantly all over the country due to cultivation of High Yielding Varieties (HYV) of rice to meet the demand of growing population. Climate change is causing unusual behavior in temperature, rainfall, flooding pattern etc., and affecting either in natural growth or damaging the pasture grasses. Besides, adulteration of commercial feed by the miller; Inadequate or no quality control system of commercial feed is traceable.

A potential threat to natural growth of grasses in the char lands for grazing of animals. Fodder cultivation is not generally practiced by the smallholders, because of land constraints belonging to them. However, Private dairy farmers grow the fodder for their cows either in their own land or leased out lands from others. Most of the poor families do not have their adequate land to grow fodders. They are to depend on naturally grown grasses in alongside roads, embankments and polders, and also on aquatic plants. The smallholders suffer from shortage of fodder during cropping seasons. Seasonal variation is experienced by the farmers in availability of forages. Crop residues and a very little amount of green forages are given to their animals throughout the year. The dairy farmers cultivate maize as fodders and fodders of exotic and high yielding varieties for their animals. Some of these are perennial type, such as: Napier, Para, German, Sudan grass, Jumbo, etc. However, fodder cultivation in cultivable land depends on opportunity costs with other crop (Bangladesh Delta Plan, 2010). Constraints of feeds and fodder availability in the project site for cattle can be summarized as follows:

1. Scarcity of grazing land;
2. Scarcity of land for fodder cultivation.
3. Low quality and adulterated feed in the market
4. Use of crop residues as household cooking fuel and other purposes.
5. Change in cropping pattern
6. Lack of standards and quality control system
7. Lack of knowledge of feeding system
8. Lack of coordinated effort.

4.7.2 Livestock/Poultry Diseases

Parasites and diseases cause serious losses in the livestock and poultry production. Compounding factors make the control of health problems difficult and they include:

- General low level of nutrition
- Large livestock population
- Warm humid climate
- Congestion of animals during annual flooding
- Difficult communications impede implementing control programs.

The government has estimated that losses due to internal parasites are far greater than losses caused by diseases but both are serious. Mainly, adequate levels of nutrition would significantly reduce production losses caused by parasites. The most frequently reported diseases among cattle and buffaloes are anthrax, black quarter and foot and mouth disease. Newcastle disease, fowl pox, fowl cholera and duck plague are common among poultry (BARC, 1985).

The most crucial period is between July and October (rainy season) for outbreak of livestock and poultry diseases. The duck plague generally occurs in summer. However, some diseases prevail throughout the year. During monsoon season, the wet condition of the animal shelter promotes

various kinds of diseases to the bullocks and cows. The unhygienic condition of the courtyards during this season may also spread the diseases to the poultry birds.

4.8 Fisheries

4.8.1 Introduction

Fish of different varieties abound in this district which enjoys the advantages of marine fishing. Moreover, varieties of fish are caught from rivers, tributary channels and creeks and even from paddy field during rainy season. Prawn is abundantly available in the district. Prawn farming and salt production in the coastal area of the district are the most important economic activities of the area. Dry fish is an important source of income to the fishermen especially in the islands.

Fish resources of the Project area are diversified with different fresh and brackish water habitats. Open water fish habitat of the Project area including surrounding rivers and khal, acting as major arteries of fish migration into and within the project area. These water bodies play a vital role in maintaining fish productivity of internal open water. Bulk of the commercial fish production is coming from culture fish habitats while the main catch of capture/open water habitats comes from different seasonal and perennial khals particularly during wet season. The numbers of fish area is decreasing due to shrinkage of open water fish habitat, loss of khal-river connectivity, presence of water regulatory structures on the khals and their improper operations, and the corresponding decrease of fish catch. On the other hand, aquaculture is developing in suitable ponds of congestion free highland area within the Polder. The information regarding fisheries in Moheshkhali Upazila is given in the Table **41**.

Table 41: Fish production in Moheshkhali Upazila of Cox's Bazar district

Sources	2010-2011	2009-2010
Number of pond	570	-
Number of Dighee	1	-
Number of fisherman	40000	35000
Production of fish	15000	14000

Source: *BBS, 2011*

4.8.2 Problems and Issues

Fish biodiversity is affected by morphological changes of River, disruption of ecology, intensive agriculture, indiscriminate fishing, and loss of River-khal connectivity for filling wetlands and water regulatory structures on khals on the project area. The key fisheries problems and issues identified during baseline survey are as follows:

- Unplanned and indiscriminate fishing using monofilament gill net, and overexploitation of fishes by using huge number of narrow meshed estuarine set bag nets for fishing;
- Interrupting fish migration and movement due to improper management and mal-functioning of the water regulatory structures along with encroachment and barriers;
- Siltation of internal khals, causing loss to the year-round river-khal connectivity;
- Lack of quality fish seed and feed for the improved aquaculture practices;
- Insufficient loan facilities for aquaculture practices;
- Lacking of extension services and updated information;
- Poor market facility;
- Prevalence of fish diseases;
- Lack of technical knowledge on pond management; and

- Insufficiently trained farmers in the project area

4.8.3 Habitat Description

On the basis of habitat of fisheries of the study area are classified under two broad categories: capture fisheries and culture fisheries. Rivers and Internal khals are considered under capture fish habitat; whereas the ponds: homestead ponds and commercial ponds are classified under culture fisheries. Fish habitat in Rivers and internal khals is generally the open source of fisheries for local people like non-commercial professional and household level fishermen. It also enriches the inland closed water commercial and private culture of fisheries like ponds, leased beels, etc. especially during rainy season.

4.8.4 Fish Production and Effort

The estimated total fish production of the Project area is about 99 percent comes from culture fisheries while the rest comes from capture fisheries habitats. The annual fish production of Moheshkhali Upazila in the fiscal year of 2009-10 and 2010-11 were 14000 and 15000 metric ton, respectively (BBS, 2011). Fish production trend from capture/open water fisheries are declining in the project area. The production is declining mostly due to obstacles to fish migration and shrinkage of fish habitat. Aquaculture is expanding gradually in the area by converting the cultivated land, as well as the medium low lands of the area.

It is reported during the field investigation and consultations with the local people very few households are engaged in commercial fishing while about few households are involved in part time fishing activity in and around the area. Fishermen are usually catch fish in the nearby tidal floodplain, rivers and khals. The available fisheries occupations of the area are mainly fishermen, fish traders, and fish farmers. Women of the traditional fishermen families are also involved in collection of post larvae shrimp in the area.

Fishing in the project area, fishermen is mostly carried out with the help of push nets, beach seine nets, shrimp nets, estuary set bag nets, marine setbag nets and long lines. The structures of the three net types, i.e., shrimp nets, estuary set bag nets and marine set bag nets, are basically the same, although the water depths for those nets to be set up are different. The push net is used to target shrimp fly for shrimp cultivation; therefore, push nets are not used during the dry season, which is when salt cultivation is conducted instead of shrimp cultivation. Most of the fishing gear is used throughout the year.

4.8.5 Fish Migration

Many types of fish migrate on a regular basis, on time scales ranging from daily to annually or longer, and over distances ranging from a few meters to thousands of kilometers. Fish usually migrate to feed or to reproduce, but in other cases the reasons are unclear. Migrations involve the fish moving from one part of a water body to another on a regular basis.

The open water fish species migrate for spawning and feeding to open and regulated khals as they use these khals for feeding and shelter ground. Most of the open water fishes choose still water during that time and the migration is very crucial for reproduction of fishes. Some fish species migrate horizontally to these water bodies as part of their life cycle. Due to sedimentation channel bed and water control structures hamper the migration of fish and other aquatic biota. Fish species such as Tengra, Phaisa, Gulsha, Khorsula, etc. migrate horizontally to these water bodies as part of

their life cycle. A difference can be made between main channel migratory species, such as the major carps and the floodplain resident species that are often small and have accessory respiratory systems and prolific reproduction.

4.8.6 Fish Biodiversity

The Project area is moderate in fish biodiversity though biodiversity of fishes has been declining over the years. Obstruction in fish migration routes, morphological changes of internal khals, siltation of fish habitats, squeezing of spawning and feeding grounds and further expansion of both culture fishery are some of the causes of gradual declining of fish abundance and biodiversity. The Project area is rich in fish biodiversity. There are about more than 100 species of fish and shrimp. A list of fisheries species in the propose project site is given in the Table **42**.

Table 42: List of aquatic species recorded in river and sea

SL.No.	Local (Bangladeshi) Name	English Name	Scientific Name
1.	Aila	Black banded trevally	*Seriolina nigrofasciata*
2.	Koral bata	Flathead grey mullet	*Mugil cephalus*
3.	Chowkha	Big-eye ilish	*Ilish filligera*
4.	Pan mach	Spotted sickle fish	*Drepane punctata*
5.	Poysha mach	Deep pugnose pony fish	*Scutor ruconius*
6.	Futki chapa	Talang quenfish	*Scomberoides commersonianus*
7.	Faissa/dati faissa	Long jaw thryssa	*Thryssa setirostris*
8.	Sada datina	Silver grunter	*Pomadasys hasta*
9.	Ram chowkkhya	Elongati ilish	*Ilisha elongate*
10.	Chowkkhya faissa	Jewelled shad	*Ilisha megaloptera*
11.	Kata gogut	Catfish	*Arius nenga*
12.	Hatir kan	Spade fish	*Ephippus orbis*
13.	Toli	Tolishad	*Hilsa toli*
14.	Ilish	Hilsha	*Tenualosa ilisha*
15.	Kamila	Indian Pike conger	*Congresox talabonoides*
16.	Ram kata	Catfish	*Arius maculates*
17.	Kaua mach	Hard tail scad	*Megalaspis cordyla*
18.	Khoilla	Grey mullet	*Mugil corsula*
19.	Gang koi	Triple tailed fish	*Lobotes surinamensis*
20.	Koral	Giant seaperch	*Lates calcarifer*
21.	Korati chela	Tenpounders	*Elops machnate*
22.	Kuichcha	White spotted moray	*Gymnothorax punctatus*
23.	Laukka	Indian salmon	*Polynemus indicus*
24.	Olua	Neglected grenadier anchovy	*Coilia neglecta*
25.	Mur baila	Flathead fish	*Platycephalus indicus*
26.	Mouri	Shrimp scad	*Alepes djeddaba*
27.	Pekhom mouri	Indian thread fin	*Alectis indicus*
28.	Malabar mouri	Malabar cavalla	*Carangoides malabaricus*
29.	Chowkhkha	Yellow strie scad	*Selaroides leptoplepis*
30.	Samudrik pangas	Fatty catfish	*Pangasisus pangasius*
31.	Hail chanda	Black pomfret	*Parastromateus niger*
32.	Tobolchi	Ox-eyed scad	*Selar boops*
33.	Takia	Fringe scale sardine	*Sardinella fimbriata*
34.	Ram gojar/shol	Cobia	*Rachycentron canadus*
35.	Nilambori	Short fin scad	*Decapterus macrosoma*
36.	Sada datina	Silver grunter	*Pomadasys hasta*
37.	Taila faisa	Hair fin anchovy	*Setipinna taty*
38.	Tailla	Fourfinger threadfin	*Eleutheronema tetradactylum*

SL.No.	Local (Bangladeshi) Name	English Name	Scientific Name
39.	Roissa	Paradise threadfin	*Polynemus paradiseus*
40.	Tek chanda	Jacks	*Atropus atropus*
41.	Tengra	Bagrid catfish	*Mystus gulio*
42.	Thuitta	Red cornet fish	*Fistularia villosa*
43.	Hichchiri	White sardine	*Escualosa thoracata*
44.	Rupali Chanda	Silver pomfret	*Pampus argentius*
45.	Undora	Lady fish	*Sillago domina*
46.	Lal poa	Silver jew	*Johnius argentius*
47.	Churi	Ribbon fish	*Trichiurus savala*
48.	Cheowa	Torpedo trevally	*Taenoides anguillaris*
49.	Loitta	Bombay duck	*Harpodon nehereus*
50.	Maitya	Jack and pompanos	*Cybium guttatum*
51.	Pata mach	Sole	*Cynoglossus mactostomus*
52.	Bom maitya	Tuna	*Euthynnus affinis*
53.	Bata	Bata	*Mugil cephalus*
54.	Potka	Potka	*Chelonodon patoca*
55.	Chiring	Gobi	*Apocryptes bato*
56.	Sada chingri	White shrimp	*Penaeus indicus*
57.	Horina chingri	Brown shrimp	*Metapenaeus monoceros*
58.	Chali chingri	Yellow shrimp	*Metapenaeus brevicornis*
59.	Bhetki	Barramundi	*Lates calcarifer*
60.	-	Cuttlefish	*Sepia sp.*
61.	-	Squid	*Loligo sp.*
62.	Kachu chingri	Bird shrimp	*Metapenaeus lysianassa*
63.	Baghatara chingri	Rainbow Shrimp	*Parapenaeopsis sculptilis*
64.	Chingri	Small shrimp	*Acetes sp.*
65.	Kakra	Moon crab	*Matuta planipes*
66.	Kakra	Ridged swimming crab	*Charybdis natator*
67.	Kakra	Giant mud crab	*Scylla sp.*
68.	-	Bengal's snake-eel	*Pisodonophis boro*
69.	Phasa	Hairfin anchovies	*Setipinna phasa*
70.	-	Speigler's mullet	*Valamugil speigleri*
71.	-	Spottail needlefish	*Strongylura strongylura*
72.	-	Commerson's glassy	*Ambassis sp.*
73.	Gurjāli	Fourfinger threadfin	*Eleutheronema tetradactylum*
74.	-	Tank goby	*Glossogobius giuris*
75.	Bhetki	Barramundi	*Lates calcarifer*
76.	-	Small-head hairtail	*Lepturacanthus savala*
77.	-	John's snapper/golden snapper	*Lutjanus johnii*
78.	-	Eel goby	*Odontamblyopus rubicundus*
79.	-	Burrowing goby	*Trypauchen vagina*
80.	Chewa	Lanceolate goby	*Pseudapocryptes elongates*
81.	Borguni	Target Fish	*Terapon jarbua*
82.	Shamuk	Shells	*Gasteropods*
83.	-	Maine borers	*Teredo*
84.	Jhinuk	Oysters	*Pelecypods*
85.	Octopas	Octopuses	*Phylum echinydermata*
86.	-	Sponges	*Porifera*
87.	Jely mach	Jelly fish	*Medusozoa*
88.	Probal	Corals	*Disambiguation*
89.	-	Sea- anemone	*Actiniaria*
90.	Tara mach	Star fish	*Asteroidea*
91.	-	Sea-urchin	*Echinoidea*

SL.No.	Local (Bangladeshi) Name	English Name	Scientific Name
92.	Shomoudro shosha	Sea- cucumber	*Holothuroidea*

Source: *BBS, 2011 & field visit*

4.8.7 Fisheries Management

There is no fishery based community association found in the study area. Fishing right on existing fish habitats is limited. Enforcement of fisheries regulation is also weak. No fish sanctuary is found in the study area.

4.9 Ecological Resources

4.9.1 Bio-ecological Zones

IUCN, The World Conservation Union, has divided Bangladesh into 25 Bio-ecological Zones (Nishat et al, 2002) in the context of physiographic and biological diversity. The study area has fallen under two bio-ecological zones of coastal plain and coastal marine water. The area (both directly and indirectly impacted area) occupies terrestrial as well as aquatic ecosystems. Each of the bio-ecological zones represents the overall ecological situation of an area of the country. A map of the Bio-ecological zone is presented in the figure below.

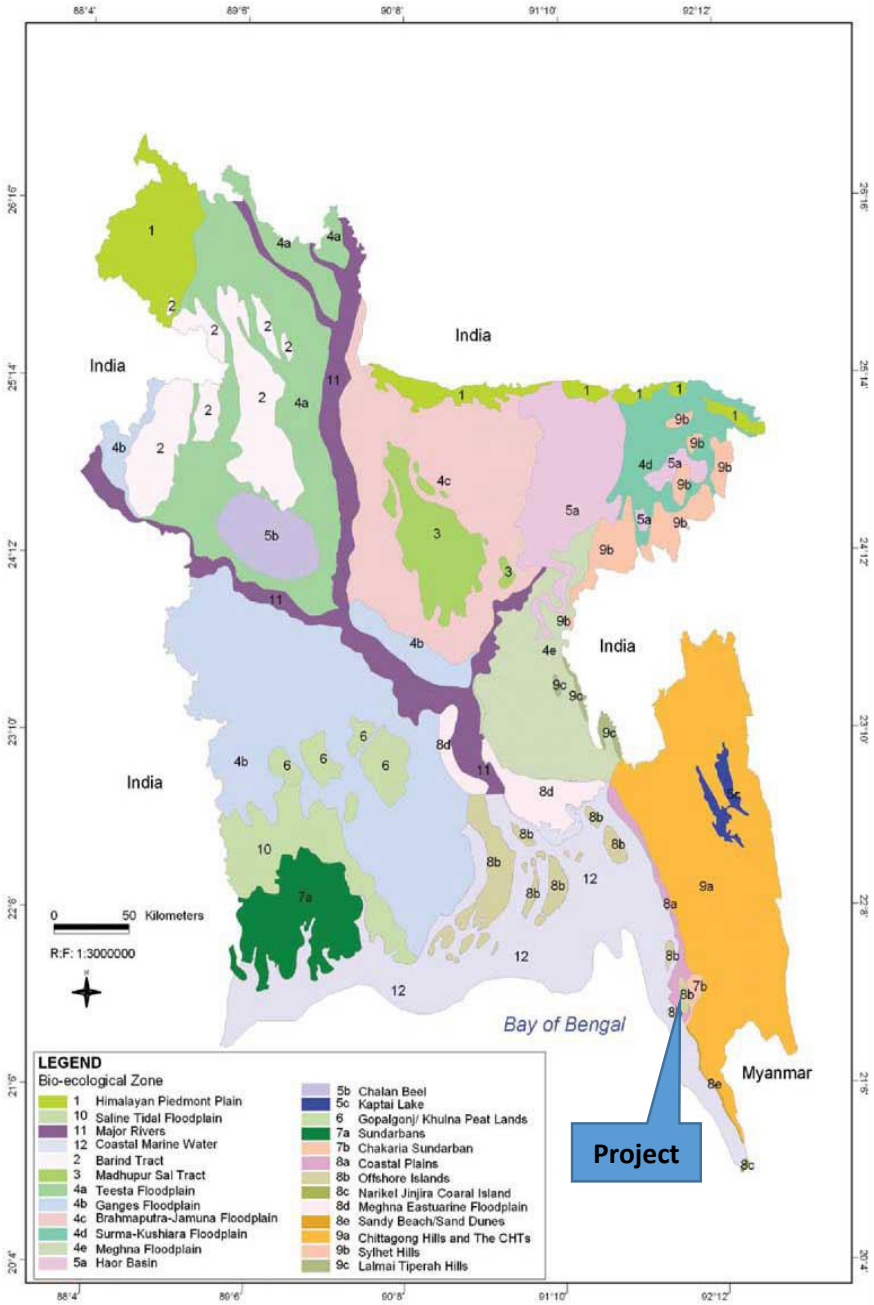


Figure 28: Bio-ecological zones of Bangladesh

Source: *www.thebangladesh.net*

4.9.2 Ecologically valuable habitats

Ecologically Critical Areas (ECA's)

In the proposed project influence zone surrounding, there is no ECA area or even any protected area. Sonadia ECA is about 12.70 km far from the project site.

Coral reef

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, there is no coral reef habitat around the project site, and the closest coral reef to the project site is St. Martins Island located approximately 126 km from the project site.

Seaweed

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, seaweed does not grow around the project site because the transparency of the sea water is low.

Mangrove forest

There are no mangrove forests around the proposed site. They are only scattered at the riverside of the Kohelia River. There is a mangrove forest, which is large scale and artificially established, at the south side of Matarbari Island and its opposite bank of Moheshkhali Island.

Mudflats

Mudflats or mud flats, also known as tidal flats, are coastal wetlands that form when mud is deposited by tides or rivers. Very wide mud flats appear along Kohelia River at low tide level where water fowls such as herons and egrets were found being feed on benthos. Occurring on tidal mud flats, they are tidally flooded on a regular basis and remain wet throughout the year.

4.9.3 Common Flora and Fauna

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 rural area. Appropriate mitigation program should be undertaken to protect the existing ecosystem from gaseous emissions and water discharge from the proposed project.

The project site consists of land used for salt farms and other purposes, and not primeval forests or tropical rain forests. The area is the presumed habitat of birds, dolphins, and sea turtles on the IUCN Red list (endangered species, etc.), and construction work may have a possible impact on the rare species and ecosystem.

Terrestrial Flora

The forests of Cox's Bazar broadly represent five categories of natural vegetation. These are: Tropical wet evergreen, Tropical moist semi-evergreen, Tropical moist deciduous, bamboo brakes and grassland. Terrestrial plants found during survey in and around the project area, on homesteads, roadside and agricultural lands have been listed. Most of the species found in this area are

angiosperms. No threatened species, as designated by IUCN status declaration of 2012, were recorded. Three species (*Calamus guruba Buch-Ham, Trihosanthes cordata Roxb, and Lepisanthes rubiginosa)* which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chattogram University).

Large area close to Kohelia River is used as salt fields which are turned into shrimp farms during rainy season. On the bank along the Kohelia River, there were some patches of mangrove trees. 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.

Table 43: List of some terrestrial flora around the project site

SL. No.	Local name	English name	Scientific Name
1.	Jali bet	Cane	*Calamus guruba Buch-Ham.*
2.	Noyte shaakh	Snake guard	*Trichosanthes cordata Roxb.*
3.	Bara harina/Chagalnadi	Rusty sapindus	*Lepisanthes rubiginosa*
4.	Pain gach	Australian pine tree	*Casuarina equisetifolia*
5.	Akashmoni	Earleaf acacia	*Acacia auriculiformis*
6.	-	Api-api	*Avicennia alba*
7.	Bina	Indian Mangrove	*Avicennia officinalis Sonneratia*
8.	-	Herbaceous seepweed	*Suaeda maritima*
9.	Kas	Polymorphic grass	*Saccharum spontaneum*
10.	Jadu palang	Sea purslane	*Sesuvium portulacastrum*
11.	Chhagalkhuri	Beach morning glory	*Ipomea pes-carpae*
12.	Muragphul	Plumed cockscomb	*Celosia argentea*
13.	Durba	Bermuda grass	*Cynodon dactylon*
14.	Biliti siris	Raintree	*Samanea saman*
15.	Kalo jam	Java Plum	*Syzygium cumini*
16.	Shisu	Indian rosewood	*Dalbergia sissoo*
17.	Chotra	West Indian Lantana	*Lantana camara*
18.	Reri	Castor bean	*Ricinus communis*
19.	Sachishak	Ponnanganni	*Alternanthera sessilis*
20.	Kabonapi	Alligator weed	*Alternantheraphiloxeroides*
21.	Garjan	Garjan	*Dipterocarpus turbinatus*
22.	Boilam	-	*Anisoptera scaphula*
23.	Narikel	Coconut	*Cocos nucifers*
24.	Bonshimul	Silk cotton tree	*Bombax insiginis*
25.	Chundul	Cheeni	*Tettameles nudiflora*
26.	Telsur	Rock Dammar	*Hopea odorata*
27.	Segun	Teak	*Tectona grandis*
28.	Chapalish	Chapalish	*Artocarpus chapalish*
29.	Dhup	Black dhup	*Canarium resiniferum*
30.	Gamar	Beechwood	*Gumelina arborea*
31.	Jarul	Giant crape-myrtle	*Lagerstroemia speciosa*
32.	Hartaki	Chebulic myrobalan	*Terminalia chebula*
33.	Bahera	Bastard myrobalan	*Terminalia bellirica*
34.	Hargaza	Okshi	*Dillenia pentagyna*
35.	Pitraj	Pithraj tree	*Aphanamixls polystachia*
36.	Chalmoogra	Chaulmoogra	*Hydnocarpus kurjii*
37.	Jalpai	-	*Elaeocarpus tectorius*

SL. No.	Local name	English name	Scientific Name
38.	Rudrakia	-	*E ganitrues*
39.	Tatua	Mimosa	*Albizia odoratissima*
40.	Deohal	False Mangosteen	*Garciria xanthochymus*
41.	Bon sonalu	Apple blossom tree	*Cassia nodosa*
42.	Dumur	Fig tree	*Ficus sp.*
43.	Bazna	-	*Zanthophylium flavescens*
44.	Harphata	-	*Baccaurca sapida*
45.	Barela	Long-Leaf Varnish Tree	*Holigarna caustica*
46.	Nageswar	Sri Lankan ironwood	*Mesua nagassarium*
47.	Kiabon	-	*Carallia lucida*
48.	Kasturi	Indian cassia	*Cinnamomum cecidodaphne*
49.	Ashok	Ashoka	*Saraca indica*
50.	Jam	Blackberry	*Eugenia jambolana vav*
51.	Mooli	Muli Bamboo	*Melocanna bambusoides*
52.	Lola bans	Bamboo	*Melocanna compactiflorus*
53.	Bandori	-	*Calamus tenuis*
54.	Chalta	Elephant Apple	*Dillenia indica*
55.	Pitali	-	*Trewia nudiflora*
56.	Sheora	Sand Paper Tree	*Streblus asper*
57.	Akh	Cane	*Calamus viminalis*
58.	Am	Mango	*Mangifera indica*

Sources: *BBS, 2011 & Field visit*

Terrestrial Fauna

As for precious species of animals designated by IUCN, the Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*) and Hawksbill turtle (*Eretmochelys imbricate*) classified as Critically Endangered, three turtles species (*Geoclemys hamiltonii, Chelonia mydas, Caretta caretta*) classified as Endangered and one turtle species *(Lepidochelys olivacea*) classified as Vulnerable were observed within the project site and the front beach. There were no other precious species of insects, amphibians, reptiles, mammals or birds that were designated by IUCN.

Five species of reptiles (*Calotes versicolor, Mabuya mabuya, Gekko gecko, Panghura tentoria, Naja naja*) which are considered by Bangladesh researchers as threatened species, and 2 species of birds (*Arachnothera magna, Ketupa zeylonensis*) considered as threatened species were observed, however they are commonly seen over broad areas and the impact of the project on these species is expected to be insignificant.

Rivers, channels, creeks, ponds, puddles and some swamps create open surface of fresh water which local residents use as water resource as well as cattle and birds. Very wide mud flats appear along Kohelia River at low tide level where water fowls such as herons and egrets were found being feed on benthos.

Spawning takes place at nighttime when human activity is low, however the light and noise of any nighttime construction may have adverse effects on these species. Consequently, night construction activity in the spawning season should be avoided as much as possible and should be conducted under minimum light. Lighting colors that do not affect the spawning (e.g., red or yellow) should be selected. The careful monitoring of spawning status is necessary.

The terrestrial fauna including mammals, birds, reptiles and amphibians around the project site area presented in the following Table **44**.

Table 44: List of some terrestrial fauna around the project site

SL. No.	Local name	English name	*Scientific Name*
		Mammals	
1.	Chamchika	Indian Pipistrelle	*Pipistrellus coromandra*
2.	Kola Badur	Leschenault's Rousette	*Rousettus leschenaulti*
3.	Baro badur	Indian Flying Fox	*Pteropus giganteus*
4.	Kathbirali	Hoary-bellied Himalayan Squirrel	*Callosciurus pygerythrus*
5.	Indur	House rat	*Rattus rattus*
6.	Indur	Indian Mole rat	*Bandicota indica*
7.	Chika	House shrew	*Suncus murinus*
8.	Baghdas	Large Indian Civet	*Viverra zibetha*
9.	Ud biral	Common otter	*Lutra lutra*
10.	Bejji	Indian grey mongoose	*Herpestes edwardsii*
11.	Mecho biral	Fishing cat	*Felis viverrina*
12.	Bon biral	Jungle cats	*Felis chaus*
13.	Khek shial	Foxes	*Vulpes bengalensis*
14.	Banor	Rhesus macaque	*Macaca mulatta*
15.	Kukur	Dog	*Cannis Familiaris*
16.	Chagol	Goat	*Capra Hircus*
17.	Bhera	Sheep	*Bovidae : Ovis*
18.	Goru	Cow	*Bos taurus*
19.	Mohesh	Buffalo	*Bubalus bubalis*
20.	Biral	Cat	*Felis : Catus*
		Birds	
1.	-	Spoon-billed sandpiper	*Eurynorhynchus pygmeus*
2.	-	Arachnothera magna	*Streaked Spiderhunter*
3.	-	Brown Fish Owl	*Ketupa zeylonensis*
4.	-	River Lapwing	*Vanellus duvaucelii*
5.	Kalamatha Kastechora	Black-headed Ibis	*Threskiornis melanocephalus*
6.	Heugliner Gangchil	Brown headed Gull	*Chroicocephalus brunnicephalus*
7.	Kalaghar Panchil	Black-naped Tern	*Sterna sumatrana*
8.	Palasi Gangchil	Great Black-headed Gull	*Larus ichthyaetus*
9.	Khoiramatha Gangchil	Brown-headed Gull	*Larus brunnicephalus*
10.	Choto Dhuljiria	Little Sand Plover	*Charadrius mongolus*
11.	Boro Dhuljiria	Greater Sand Plover	*Charadrius leschenaultii*
12.	Kentish Jiria	Kentish Plover	*Charadrius alexandrinus*
13.	Proshanto Shonajiria	Pacific Golden Plover	*Pluvialis fulva*
14.	Timinker Chaha	Timminck's Stint	*Calidris temminckii*
15.	Sanderlin	Sanderlin	*Calidris alba*
16.	Lal Nuribatan	Ruddy Turnstone	*Arenaria interpres*
17.	Pati Batan	Common Sandpiper	*Actitis hypoleucos*
18.	Bon Batan	Wood Sandpiper	*Tringa glareola*
19.	Choto Gulinda	Whimbrel	*Numenius phaeopus*
20.	Eureshio Gulinda	Eurasian Curlew	*Numenius arquata*
21.	Lenja Chega	Pin-tailed Snipe	*Gallinago stenura*
22.	Dholaghar Machranga	Collared Kingfisher	*Todiramplus chloris*
23.	Khoira Chokachoki	Ruddy Shelduck	*Tadorna ferruginea*
24.	Machmural	Osprey	*Pandion haliaetus*
25.	Kalamatha Nishibok	Black-crowned Night Heron	*Nycticorax nycticorax*

SL. No.	Local name	English name	*Scientific Name*
26.	Choto Panchil	Little Tern	*Sterna albifrons*
27.	Dhupni Bok	Grey Heron	*Ardea cinerea*
28.	China Kanibok	Chinese Pond Heron	*Ardeola bacchus*
29.	Deshi Kanibok	Indian Pond Heron	*Ardeola grayii*
30.	Go Boga	Cattle Egret	*Bubulcus ibis*
31.	Boro Boga	Great Egret	*Casmerodias albus*
32.	Majhla Boga	Intermediate Egret	*Egretta intermedia*
33.	Choto Boga	Little Egret	*Egretta garzetta*
34.	Choto Pankouri	Little Cormorant	*Phalacrocorax niger*
35.	Lenja Ratchora	Large-tailed Nightjar	*Caprimulgus macrurus*
36.	Khuruley Pencha	Spotted Owlet	*Athene brama*
37.	Khoira mechupacha	Broun Fish Owl	*Ketupa zeylonensis*
38.	Asio Talbatashi	Asian Palm Swift	*Cypsiurus balasiensis*
39.	Shobuj Tia	Rose-ringed Parakeet	*Psittacula krameri*
40.	Modna Tia	Red-breasted Parakeet	*Psittacula alexandri*
41.	Neel-lej Shuichora	Blue-tailed Bee-eater	*Merops philippinus*
42.	Khoiramatha Shuichora	Chestnut-headed Bee-eater	*Merops leschenaulti*
43.	Bangla kaththokra	Lesser goldenback	*Dinopium benghalense*
44.	Pati Hoodhood	Eurasian Hoopoe	*Upupa epops*
45.	Pakra Machranga	Pied Kingfisher	*Ceryle rudis*
46.	Dholagoloa Machranga	White-throated Kingfisher	*Halcyon smyrnensis*
47.	Pati Machranga	Common Kingfisher	*Alcedo atthis*
48.	Dholagola Chatighurani	White-throated Fantail	*Rhipidura albicollis*
49.	Fingey	Bronzed Drongo	*Dicrurus aeneus*
50.	Boro Recket-Fingey	Greater Racket-tailed Drongo	*Dicrurus paradiseus*
51.	Kalaghar Rajon	Black-naped Monarch	*Hypothymis azurea*
52.	Fatik Jal	Common Iora	*Aegithina tiphia*
53.	Taiga Chutki	Taiga Flycatcher	*Ficedula albicilla*
54.	Nirol Prina	Plain Prinia	*Prinia inornata*
55.	Udoi Dholachokh	Oriental White-eye	*Zosterops palpebrosus*
56.	Golafola Satarey	Puff-throated Babler	*Pellorneum ruficeps*
57.	Dhani Tulika	Paddyfield Pipit	*Anthus rufulus*
58.	Dholakomor Munia	White-rumped Munia	*Lonchura striata*
59.	Tila Munia	Scaly-breasred Munia	*Lonchura punctulata*
60.	Kalamatha Munia	Tricoloured Munia	*Lonchura malacca*
61.	Deshi Chandithot	Indian Silverbill	*Lonchura malabarica*
62.	Deshi Babui/Baoi	Baya Weaver	*Ploceus philippinus*
63.	Dahi Makarmar	Streaked Spiderhunter	*Arachnothera magna*
64.	Shidure Moutushi	Crimson Sunbird	*Aethopyga siparaja*
65.	Beguni Moutushi	Purple Sunbird	*Cinnyris asiaticus*
66.	Begunikomor Moutushi	Purple-rumped Sunbird	*Leptocoma zeylonica*
67.	Chunimukhi Moutushi	Ruby-cheeked Sunbird	*Chalcoparia singalensis*
68.	Komlapet Fuljhur	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*
69.	Metethot Fuljhuri	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*
70.	Lalpith Fuljhuri	Scarlet-backet Flowerpecker	*Dicaeum cruentatum*
71.	KhoiraHarichacha	Rufous Treepie	*Dendrocitta vagabunda*
72.	Metey Bonababil	Ashy Woodswallow	*Artamus fuscus*
73.	Holdey Pakhi	Black-hooded Oriole	*Oriolus xanthornus*
74.	Dar Kak	Jungle Crow	*Corvus macrorhynchos*
75.	Pati Kak	House Crow	*Corvus splendens*
76.	Bangla Bulbul	Red-vented Bulbul	*Pycnonotus cafer*
77.	Holdepa Horial	Yellow-footed Green Pigeon	*Treron phoenicopterus*

SL. No.	Local name	English name	*Scientific Name*
78.	Tila Ghughu	Spotted Dove	*Streptopelia chinensis*
79.	Raj Ghughu	Eurasian Collared Dove	*Streptopelia decaocto*
80.	Horikol	Orange-breasted Green Pigeon	*Treron bicintus*
81.	Jalali Kabutor	Common Pigeon	*Columba livia*
82.	Pati Tuntuni	Common Tailorbird	*Orthotomus sutorius*
83.	Udoi Doel	Oriental Magpie-Robin	*Copsychus saularis*
84.	Jhuti Sahlik	Jungle Myna	*Acridotheres fuscus*
85.	Bhat Shalik	Common Myna	*Acridotheres tristis*
86.	Dholatola Shalik	Pale-bellied Myna	*Acridotheres cinereus*
87.	Khoiralej Kathshalik	Chestnut-tailed Starling	*Sturnus malabaricus*
88.	Pakra Shalik	Pied Myna	*Sturnus contra*
89.	Kala Fingey	Black Drongo	*Dicrurus macrocercus*
90.	Pati Chorui	House Sparrow	*Passer domesticus*
91.	Kalamatha Kastechora	Black-headed Ibis	*Threskiornis melanocephalus*
92.	Chhoto Chaha	Little Stint	*Calidris minuta*
93.	Terek Batash	Terek Sandpiper	*Xenus cinereus*
94.	Chhoto Dhuljiria	Lesser Sand Plover	*Charadrius mongolus*
		Reptiles	
1.	Kalo Kasim	Spotted Pond Turtle	*Geoclemys hamiltonii*
2.	-	Olive Ridley Turtle	*Lepidochelys olivacea*
3.	-	Logger head turtle	*Caretta caretta*
4.	Kachim	Green turtle	*Chelonia mydas*
5.	-	Hawksbill turtle	*Eretmochelys Imbricate*
6.	Kalo Kossop	Indian Black Turtle	*Melanochelys trijuga*
7.	Majhari Kaitta	Median Roofed Turtle	*Pangshura tentoria*
8.	Roktochusha	Garden lizard	*Calotes versicolor*
9.	Achil	Skink	*Mabuya mabuya*
10.	Tokkhak	Tokay Gecko	*Gekko gecko*
11.		Pangshura tentoria	*Median Roofed Turtle*
12.	Kono bang	Southeast Asian toad	*Duttaphrynus melanostictus*
13.	Kotkoti bang	Green Frog	*Euphlyctis hexadactylus*
14.	-	Cricket frog	*Fejervarya limnocharis*
15.	Kola bang	Bull frog	*Hoplobatrachus tigerinus*
16.	Koper Ashami Bang	Cope's Assam Frog	*Sylvirana leptoglossa*
17.	Gaso Bang	Bronzed Frog	*Rana temporalis*
18.	Gokhra	Cobra	*Naja naja*
19.	Python	Python	*Molunrus tivittatus*
20.	Tiktiki	Lizards	*Hemidactrlus prooki*
21.	Gokhra shap	Monocellate cobra/Bengal cobra	*Naja kaouthia Lesson*
22.	Dhora sap	Checkered keel back	*Xenochrophis piscator*
23.	Jati Sap	Monocled Cobra	*Naja kaouthia*
24.	Sibolder Joloj Shap	Siebold's Smooth Water Snake	*Enhydris sieboldi*

Sources: *BBS, 2011 & Field visit*

4.9.4 Ecosystem Services and Function

The Millennium Ecosystem Assessment (MA) defined ecosystem services are "the benefits people obtain from ecosystems." The MA also delineated the four categories of ecosystem services—supporting, provisioning, regulating and cultural. The national economy and the people of Bangladesh are inseparably linked to the productivity and sustainability of Bangladesh's ecosystem, including vast and differentiated terrestrial ecosystem that are seasonally variable in their

characteristics as well. The population of the project area usually gets all types of ecosystem services as discussed below.

Supporting services

Ecosystem services "those are necessary for the production of all other ecosystem services". These include services such as nutrient recycling, primary production and soil formation. These services make it possible for the ecosystems to provide services such as food supply, flood regulation, and water purification.

Products obtained from ecosystems

- Food (including sea food and game), crops, wild foods, and spices
- Raw materials (including lumber, skins, fuel wood, organic matter, fodder, and fertilizer)
- Genetic resources (including crop improvement genes, and health care)
- Water
- Biogenic minerals
- Medicinal resources (including pharmaceuticals, chemical models, and test and assay organisms)
- Energy (hydropower, biomass fuels)
- Ornamental resources (including fashion, handicraft, jewelry, pets, worship, decoration and souvenirs like furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)

Regulating services

"Benefits obtained from the regulation of ecosystem processes"

- Carbon sequestration and climate regulation
- Waste decomposition and detoxification
- Purification of water and air
- Pest and disease control

Cultural services

"Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences"

- Cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.)
- Spiritual and historical (including use of nature for religious or heritage value or natural)
- Recreational experiences (including ecotourism, outdoor sports, and recreation)
- Science and education (including use of natural systems for school excursions, and scientific discovery)
- Therapeutic (including Eco therapy, social forestry and animal assisted therapy)

4.10 Socio-Economic Condition

4.10.1 Socio-Economic Condition

The total population of Moheshkhali Upazila is 321218 with a population density of 887 per square km. Among the total population, 215019 are male and 155525 are female; the sex ratio (male/female) is 107. There are 122140 HHs with average size of a HH is 5.5. Based on religious identity, 301858 are Muslim, 16647 are Hindu, 2682 are Buddhist, 6 are Christian and 25 are others. The economy of Moheshkhali is mainly agro-based. The demographic profile of the project area has been illustrated in the following Table **45**.

Table 45: Demographic conditions of the project area

Demographic indicators		Moheshkhali Upazila	
Total Population	Male	3,21,218	2,15,019
	Female		1,55,525
Population density (per sq. km.		887	
Number of Households		1,22,140	
Average Household sizes		5.5	
Sex ratio		107	
Number of Population by religion identity.	Muslim	3,01,858	
	Hindu	16,647	
	Buddhist	2,682	
	Christian	6	
	Others	25	

***Source**: BBS, 2011*

The area is a disaster prone area as many cyclones and tidal bores affected the area in the past. Farmers do not go for land cultivation as that is not profitable to them. As a result, leasing out of land on annual rent basis is a common practice in the area. For salt cultivation each Kani (40 decimals) is leased out at BDT 12,000 (US$ 1=80) to 18,000 where for shrimp cultivation at BDT 2,000-3,000. Shrimp is less profitable than salt cultivation due to modern technique used for salt production at less cost.

With the modern technique salt production per hectare has gone very high and thereby profit also increased, in return, land lease value has also increased. In the case of homestead land, it is about BDT 30,000-35,000. Some 20% households have migrant members outside the country, who are dependent on remittances. They are mainly working in Saudi Arab, Dubai, Malaysia, Oman, etc. These people have less dependency on farming; as a result, affect to the family income would be less due to land acquisition or other interventions from the project side. Presence of NGOs is there in the locality including all national level NGOs. The area is also known for operation of Muslim NGOs who were rendering services specifically to Rohinga refugees and other local Muslim people. All kinds of welfare activities are done by those NGOs. People in the area are also positive to the NGO activities. Other local level institutions are also there about which more detail to be investigated (EIA study of long embankment cum road construction at Moheshkhali, 2016).

4.10.2 Quality of Life Indicators

Education

The average literacy rate at Moheshkhali Upazila is 30.8%; male 30.5%, female 31.7%. The number and types of different educational institutions are given in the Table **46**.

Table 46: Number and types of different educational institutions in the project area

Name of the educational institutions	Number of educational institutions
Government primary school (class I-V)	47
Registered primary school (class I-V)	16
Private (non-registered) primary school (class I-V),	04
Kindergarten school (pre-schooling),	13
NGO school	10
Government secondary school	01

Name of the educational institutions	Number of educational institutions
Government college	00
Non-Government college	04
Madrasah	20
Kawmi madrasah	20
Ebtedayee madrasah	09
Technical and vocational institution	01
Medical college	00
Agricultural and veterinary college	00

Source: *BBS, 2011*

Health and Recreation

They have to travel to the nearest market to see quack doctors and other sources for medical and health treatment. They often suffer from general fever, respiratory infection (such as cold), diarrhoea and stomach-ache. The health and social welfare data of Moheshkhali Upazila has been given below. The population of the project area usually gets limited access of recreation facilities. Not many of them collect information from TV or radio as they do not have these items at home. They often listen to radio or watch TV at tea stands or in the local markets for collecting information, apart from which they hear news from neighbors and friends.

Table 47: The health and social welfare situation of the project area

Health related facilities	Number						
Government health complex	No.	No. of bed	No. of doctor	No. of Nurse	No. of technician		No. of other staff
	1	50	4	2	2		66
Private hospital/clinic	0	0	0	0	0		0
Diagnostic center	2	3	0	-	2		5
Physician/ Practitioner	No. physician	MBBS/FCPS / Over	L.M.F	Unani/ Ayurvedic	Homeopathy		-
	10	0		0	0		0
Number of health center providing health and family planning services	No. of union health centre	Health services	Sterilization	MR	Injection / Copper-T	Oral pill/Condom	No. of immunization center
	6	40394	0	0	81101	15040	66
Number of existing family planning personnel	TFPO	MO	FPI	TFPA	FWV	FWA	Midwife or SBA
	1	0	1	2	4	27	15

Source: *BBS, 2011*

Water and Sanitation and Housing

All of the local people depended on tube wells for water. Local residents used alum (phitkari) for purifying water instead of boiling water. Almost 98% of households of Moheshkhali Upazila have

access to safe drinking water. On the other hand, only 60% of the households are under access to sanitary latrines (Health Bulletin, 2014). The housing status of the project area is combination pucca, semi-pucca, katcha and terraces. However, Katcha houses are more common in Moheshkhali Upazila.

4.10.3 Income and Poverty

The highest average monthly household nominal income was recorded BDT.14092 for Chattogram Division. The estimates of HCR in 2010 using the lower poverty line show that Chattogram division has the lowest incidence of poverty of 13.1 percent. In 2010, using the lower poverty line, per capita income of the poor is Chattogram division at Tk. 648.71 and using the upper poverty line, per capita income of the poor is Chattogram division at Tk. 1307.27 (HIES 2010). Chattogram Division has recorded the lowest HCR of incidence of poverty at 26.2%. The poverty headcount rate of Chattogram division is 26.1 as well as percentage of poor people is 16.8. Figure **29** shows the project area in the poverty map of Bangladesh.

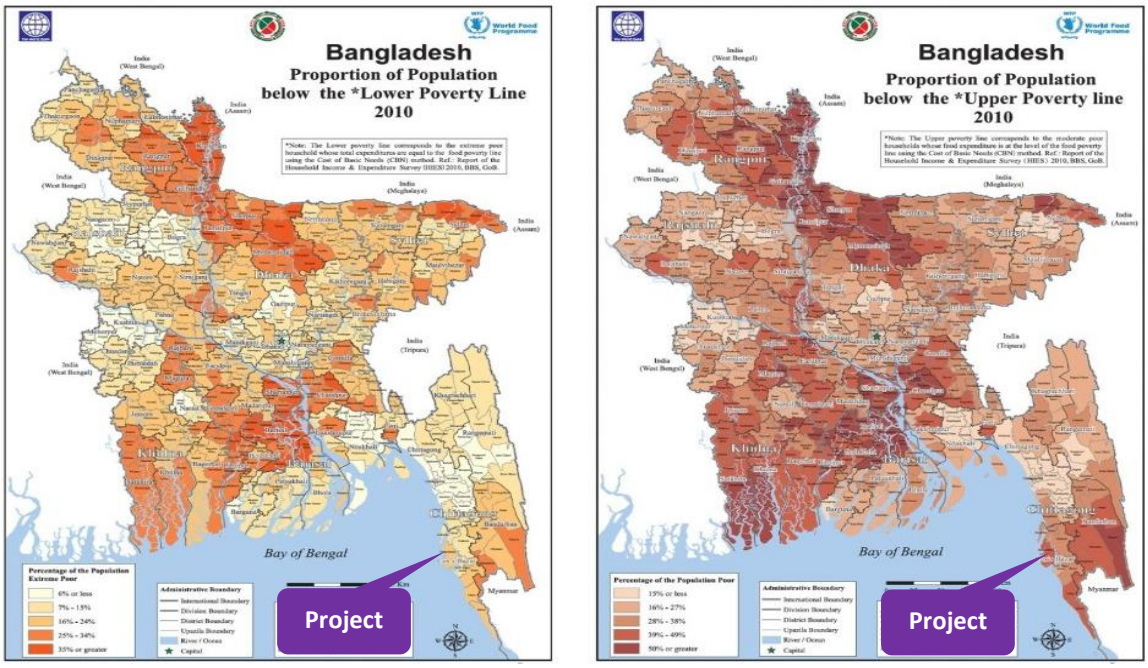


Figure 29: Poverty map of Bangladesh indicating the project site

4.10.4 Gender and Women

Total Female population in Moheshkhali Upazila is 155,525. Sex ratio was 107; the average literacy rate of female is 31.1.7% comparatively higher than the male 30.5 %. (BBS, 2011). Women are usually doing no work in the field very often. Confined to home women are assigned to duties of performing domestic chores, bearing and rearing children and serving to the husband and the elders. Sometimes poor women, widows, divorcees work as day labourer in LGED's road construction projects. Frequently they do not go for shopping or marketing in the local bazaar. Women headed households also share with the neighbors to fulfil their shopping or marketing needs as maximum as possible to avoid teasing or harassment from the male members of the society.

4.10.5 Common Property Resources

Throughout the world there are assets that are neither private nor state property, but common property. The term denotes a class of institutions that govern the ownership and rights-of-access to assets. Common property assets are to be distinguished from "public goods," in that, unlike the latter, use by someone of a unit of a common property asset typically reduces the amount available to others by one unit (in economic terminology, such an asset is rivalrous in use). The institution of common property creates and harbors reciprocal externalities. As some of the most interesting examples of common property assets are natural resources, this entry is restricted to them. Social Institutions, Khals, Playgrounds can be referred as common property resources. Hats, bazars and fairs are social institution or at least the mechanism of not only trade but also social interaction. The common property resources of the project are having been given in the Table **48**.

Table 48: Common property resources of the project area

Common property resources	Number of common property resources
Daily bazar	20
Weekly hat	125
Public library	20
Mosque	430
Eid-Gah	10
Temple	25
Church	0
Pagoda	7
Stadium/ Playground	6
Park/ Amusement Park	0
Bridge	160
Baily bridge	0
Culvert	200

Source: *BBS, 2011*

4.10.6 Conflict of Interest and Law and Order Situation

Local conflicts may occur between local residents who may feel that they have received unfair compensation and other local residents or conflict with staff of the Deputy Commissioner's Office. Conflict may occur between local residents and external workers because of any changes to local customs if external workers cannot understand local customs.

A number of consultations with local residents will be required to conduct in preparing the LARAP during implementation. Regulations in Bangladesh stipulate the need to conduct public consultations in land acquiring processes.

Local people should be employed for the construction works to the maximum extent possible, and any workers from other countries should be taught to respect local customs in order to facilitate good relationships with local people. The lodgings of the project workers should be equipped with sufficient living facilities to keep workers at the project site as much as possible.

The existing law and order situation is improved. Because people of the project area are getting compensation form the authority on regular basis. It will continue up to finish the compensation of affected person.

4.10.7 Historical, Cultural and Archaeological Sites

There are no historical, cultural and archaeological properties or heritage sites in or around the site. The Adinath temple is nearest and the most of famous historical place of this Island.

Chapter 5
Identification and Analysis of Key Environmental Issues

5.1 Environmental Sensitivity Investigation

The proposed project area is environmentally sensitive due to the geographical location. All the environmentally sensitive issues were investigated by a selected consultants group through carry out primary and secondary data analysis. The main hindrances of the proposed project sustainability are natural calamity like cyclones, earthquake etc. Design consultants should consider this sensitive issue in the design structure to make project environmentally sound and sustainable. The structure should be maintained adequate height to protect from cyclones, earthquake, landslide etc. Disaster management plan has to be developed by the project proponent to protect from natural calamities.

5.1.1 Natural Hazard

A vulnerability map gives the precise location of sites where people, the natural environment or property are at risk due to a potentially catastrophic event, often induced by climate change, which could result in death, injury, pollution or other destruction. Such maps are made in conjunction with information about different types of risks. It could delineate the commercial, tourist, and residential zones that would be damaged in case of natural disaster.

Vulnerability mapping can allow for improved communication about risks and what is threatened. It allows for better visual presentations and understanding of the risks and vulnerabilities so that decision-makers can see where resources are needed for protection of these areas. The vulnerability maps will allow them to decide on mitigating measures to prevent or reduce loss of life, injury and environmental consequences before a disaster occurs. Those preparing the maps can overlap flood inundation and slope stability zones with property maps in order to determine which properties and buildings are at risk. They can then notify the landowners and inform them of government subsidies or other support available for undertaking a measure that would protect their homes from potential damage by, for example, water inundation or slope failure.

The following figure shows the vulnerability map of different hazards of Bangladesh. Form the figure it is understood that the study area is fall in storm surge affected area. Strom surge generally cause due to cyclone. So, any infrastructure development in this area should be follow precaution to resist this events. It would help the decision maker to take decisions during design period.

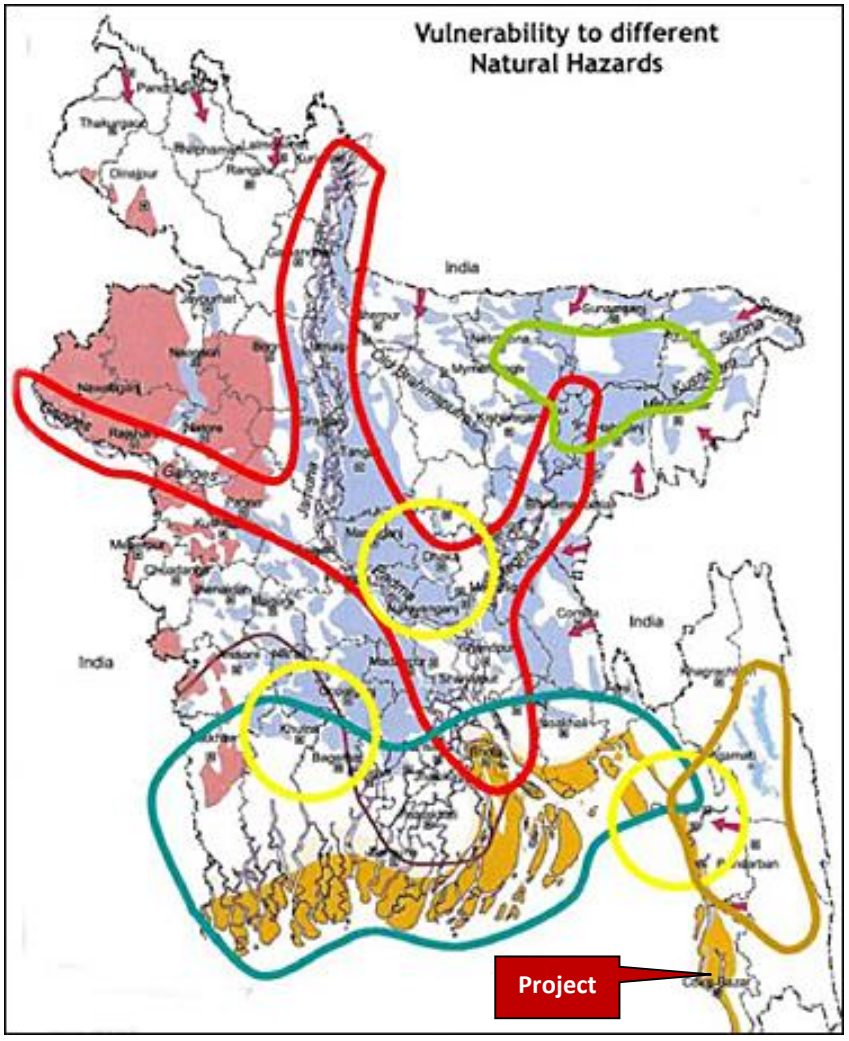


Figure 30: Inventory of different hazard areas

Source: CEGIS

Note:
Inventory of the vulnerable areas for droughts –pink; floods-light blue; surges-yellow ochre;
Hot spots related to large rivers -in red; coast-blue; urban centres-yellow; haor/wetlands-green; hill tracts/soil erosion-yellow ochre. [1]

5.1.2 Seismicity

Seismic structural strength assessment of existing buildings, strengthening of existing proposed foundation system and superstructures of critical structures, incorporation of liquefaction potential criteria in the structural design process for structures are few of the considerations to be in mind. A preventive measure can be coordinated by ensuring anti-seismic design (end bearing pile foundation including bored or driven piles and use reinforced concrete raft for shallow foundation), quality control (selection of adequate material and appropriate workmanship) under expert supervision. Project site lies in the seismic zone II which is also called moderate intensity seismic zone with basic seismic coefficient of 0.15g. Having location in Zone-II the land buildings and land-based structures for this Project should be designed to withstand maximum lateral load of 50% of gravity load.

[1]https://www.dutchwatersector.com/news-events/news/11347-bangladesh-government-takes-up-100-year-delta-plan-to-reduce-climate-risks.html

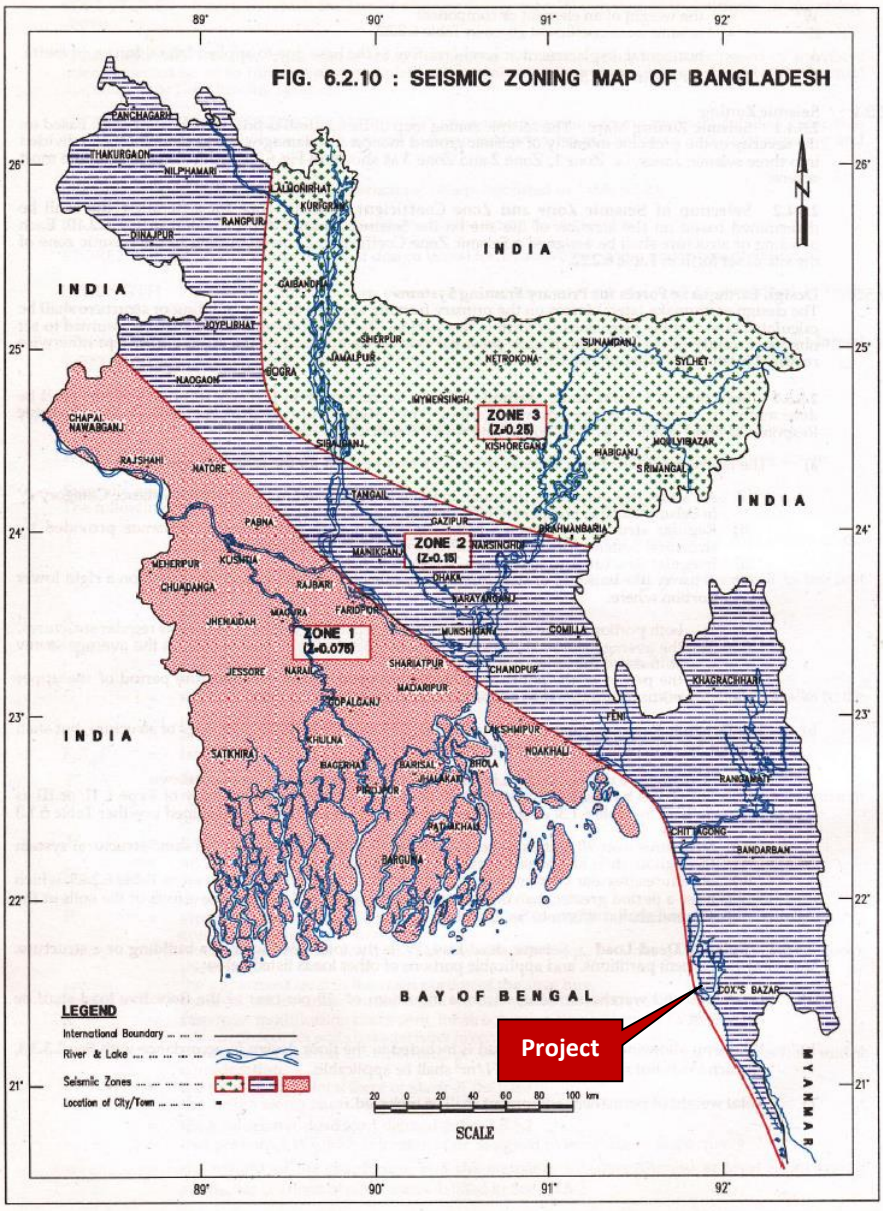


Figure 31: Seismic zones of Bangladesh

Source: BNBC

5.1.3 Flood, Cyclone and River Bank Erosion

The cyclonic map of Bangladesh shows that the proposed project area falls under high cyclonic risk area with surge height above 1m and subsequently tidal flood occurs in the project area. The proposed project has no possibility of erosion/river bank erosion according to the morphological history of Kohelia River. Despite of the river along the EZ has possibility of erosion. However, the proponent will construct retaining wall along the river bank in order to protect from erosion.

5.1.4 Change of Meteorology

Temperature, rainfall, humidity, etc. components of weather may not change much for the development of project, if the effluents are treated properly. So, the species distribution including flora and fauna will not be disturbed in this region.

5.2 Environmental Asset

Environmental assets are the naturally occurring living and non-living components of the Earth, together constituting the bio-physical environment, which may provide benefits to humanity. The environmental assets can be grouped into two categories: Individual approach and Ecosystem approach. In the project area environmental assets/resources include water, soil and fish, forests, lakes and agricultural/salt farms areas.

Environmental assets identified in the study area are listed below:

1. Air quality of the area
2. Water quality of the area
3. Noise level of the area
4. Transportation system of the area
5. Ecosystem of study area

Identified Environmental assets of the project are likely to be impacted due to development of the different facilities during the pre-construction, construction and operation stages of the project along with the project activities which may have an impact on the Environmental assets and the associated impacts are listed below. The detailed impact identification and mitigation measures are given at Chapter 8.

Table 49: Environmental assets of the project area

S.N	Environmental Assets	Impact	Related Project Activity
Pre-Construction & Construction Phase			
1.	Air quality of study area	Degradation	Site clearance/preparation, construction activities, excavation, exhaust from construction vehicles/machinery.
2.	Water quality of study area	Degradation	Solid and liquid waste discharge.
3.	Noise level of study area	Increase in noise levels	Construction activities, movement of construction vehicles/machinery.
4.	Transportation system	Traffic congestion	Increased nos. of vehicles carrying construction raw material and construction debris
5.	Eco-system of project area	Impact on flora and fauna	Cutting of trees, littering activities, disposal of waste, construction activities and fugitive emissions.
Operation Phase			
1	Air quality of study area	Degradation	Exhaust from vehicles and machinery.
2	Water quality of study area	Degradation	Solid and liquid waste discharge.
3	Noise level of study area	Increase in Noise levels	Increased traffic movement and industrial activities.
4	Transportation system	Traffic congestion	Increased nos. of vehicles due to industrial activities.
5	Eco-system of study area	Impact on flora and fauna	Disposal of untreated solid and liquid waste, impact on fisheries.

5.3 Environmental Hotspot

No significant environmental hot spots existed in the project area. The project area is very close to the sea. Sea, itself is an environmental hot spot for multiple resources diversity. The project authority will take appropriate protective measures to save these natural resources. Another important hot

spot named Sonadia Island designated as an Ecologically Critical Areas (ECAs) by DoE. The area is approximately15 km from the project site. Neither of the hot spots area is affected by the project activities. Another environmentally sensitive are is Kutubdia Island which is 18 km away from the project site.

5.4 Likely Beneficial Impacts

The project will bring in much direct and indirect positive impact on the environmental and social wellbeing of the locality. The likely benefits from the proposed development are listed as below:

5.4.1 Socio-Economic-Environmental Benefits

Many people are having business in the Cox's Bazar. No industry or other major economic enterprises were set up in the project area. People will get benefit through set up new industry, increase in employment and business opportunities.

5.4.2 Industrial Decentralization

Most importantly proposed project will come with the promise of employment of thousands of skilled and unskilled people of the locality. Inevitably, standard of living is projected to improve significantly.

5.5 Community Recommendations

The following recommendations were made during public consultation -

- As positive externalities, proposed project should improve and create livelihood to the local people;
- Local people should be employed by the contractor during construction work;
- Adequate safety measures should be taken during construction work;
- Concerns were also raised on possible traffic and population pressure caused by external employed personnel;
- Water treatment system should be installed to prevent water pollution.
- Finally, local people have appreciated the EZ Project and employment generation; and have promised that they will cooperate with the executing agency during project implementation.

5.6 Alternative Analysis

Project alternative is required, if the impacts of the project design are significant to the environment and social components. Different sites were analyzed on the basis of location, accessibility, potential for industrial growth, availability of raw material, infrastructural development, availability of man-power, vulnerability to natural and manmade disasters, availability of the basic amenities and utilities for industrial development, etc.

Scope of Alternative Location

The Project is not adjacent to or in any environmentally sensitive, reserve or protected areas, and does not cause an impact on terrestrial biodiversity as well as aquatic fisheries values if appropriate mitigation measures will take. The proposed project location is inside an economic zone. So, these factors leave no scope for considering a more feasible site other than the current one.

Alternative Technology and Raw Materials

The existing offsite infrastructures shall facilitate extra benefit to project developer which makes the project cost effective to the client. Most of the technologies proposed in the project are labor intensive. Minimum mechanical equipment will be used during construction work. All these works will be done by labor force with minimum mechanical equipment except in the case of piling. This action will produce minimal environmental impacts. During piling period sound pollution may occur which will adversely affect the workers and operator exposed to machine. Care should be taken and adequate protective measures should be applied for the working persons at and nearby the drilling site.

5.7 Environmental and Social Impacts Assessment Methodologies

The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of project activities and will be largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial), and the methodology defined below will be applied to define both beneficial and adverse potential impacts. The criteria for determining significance are generally specific for each environmental and social aspect but generally the magnitude of each potential impact is defined along with the sensitivity of the receptor. Generic criteria for defining magnitude and sensitivity used for the project are summarized below.

5.8 Magnitude

The assessment of magnitude has been undertaken in two steps. Firstly, the key issues associated with the project are categorized as beneficial or adverse. Secondly, potential impacts have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as:

- Duration of the potential impact;
- Spatial extent of the potential impact;
- Reversibility;
- Likelihood; and
- Legal standards and established professional criteria.

The magnitude of potential impacts of the project has generally been identified according to the categories outlined in the Table below.

Table 50: Parameters for determining magnitude of impacts

Parameters	Major	Moderate	Minor	Negligible/Nil
Duration of potential impacts	Long term (more than 25 years)	Medium Term Lifespan of the project (15 to 20 years)	Less than project lifespan	Temporary with no detectable potential impact
Spatial extent of the potential impacts	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact

Parameters	Major	Moderate	Minor	Negligible/Nil
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable

5.9 Sensitivity/Rating

The sensitivity of a receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of features on the site or the surrounding area. Criteria for determining receptor sensitivity of the project's potential impacts are outlined in the Table below.

Table 51: Criteria for determining sensitivity of receptors

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Low / Negligible	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation.

5.10 Assigning Significance

Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the potential impact significance matrix shown in the Table below.

Table 52: Assessment of potential impact significance

Magnitude of Potential impact	Sensitivity of Receptors			
	Very High	High	Medium	Low / Negligible
Major	Critical	Major	Moderate	Negligible
Moderate	Major	Major	Moderate	Negligible
Minor	Moderate	Moderate	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

5.11 Mitigation Measures

Subsequent to the impact assessment discussed above, appropriate mitigation measures have been proposed to avoid, offset, mitigate/reduce, or compensate for the identified impacts. Generally, impacts having moderate to critical consequence require appropriate avoidance/ mitigation/compensatory measures to reduce the significance. Impacts having low to negligible significance can be left alone not needing any mitigation measures.

Generally, preference is given to the avoidance of the impact with the help of options available for nature, siting, timing, method/procedure, or scale of any project activity. If avoidance is not possible, appropriate mitigation and control measures are proposed to reduce the consequence significance of the predicted impact. Finally, if impact reduction is not possible, compensatory measures are proposed.

5.12 Assessment of Residual Impacts

The final step in the impact assessment process is determining the significance of the residual impacts, which essentially are the impacts which would be experienced even after implementing the mitigation/compensatory measures. Ideally, all of the residual impacts should be of negligible to low significance. For any residual impacts having moderate significance, monitoring mechanism is necessary to ensure that their significance does not increase. No residual impacts having major or critical significance are generally acceptable.

5.13 Impact Screening

As part of the environmental impact assessment process, a screening matrix was used tailored specifically to the proposed project, focusing the potential environmental impacts during the design, construction and operation phases. The matrix examined the interaction of project activities with various components of the environment. The impacts were broadly classified as physical, biological and social, and then each of these broad categories further divided into different aspects. The potential impacts thus predicted were characterized as follows:

- High negative (adverse) impact
- Low negative impact
- Insignificant impact
- High positive (beneficial) impact
- Low positive impact
- No impact

The potential Environmental and Social Impacts Matrix of the project have been given in the following Tables. The negative impacts predicted in this manner were the 'unmitigated' impacts. Appropriate mitigation measures were recommended as part of this EIA, thus reducing the occurrence possibility and severity of the potentially adverse impacts.

Table 53: Environmental impact identification matrix (construction phase)

Parameter	Physical Environment					Ecological Environment			Social Environment				
	Topography	Hydrology	Water Quality	Air Quality	Noise	Vegetation	Fauna	Aquatic Environment	Displacement	Employment	Service	Health	Culture
Possession of Land													
Site development	**P**			**T**		**P**				**T**		**T**	
Civil and Structural Work			**T**	**T**	**T**					**T**		**T**	
Mechanical and Electrical Work				**T**	**T**					**T**			
Water Requirement		**T**	**T**										
Transport				**T**	**T**								
Employment			**T**							**T**	**T**		**T**

Here, P= Permanent, T= Temporary

Table 54: Environmental impact identification matrix (operation phase)

Parameter	Physical Environment					Ecological Environment			Social Environment				
	Topography	Hydrology	Water Quality	Air Quality	Noise	Vegetation	Fauna	Aquatic Environment	Displacement	Employment	Service	Health	Culture
Water requirement		**P**											
Liquid effluent			**T**					**T**				**T**	
Gaseous effluent				**T**		**T**						**T**	
Solid waste												**T**	
Hazardous waste			**T**									**T**	
Transport				**T**	**T**								
Operational noise					**P**							**P**	
Immigration			**T**							**P**	**P**		**P**
Employment										**P**			

Here, P= Permanent, T= Temporary

Table 55: Checklist of potential environmental impacts

Project phase	Actions affecting environmental resources	SEI_s without mitigation measures				Type		Comments
		None	Minor	Medium	Major	Adverse	Beneficial	
Construction phase	Land value depreciation	×					×	Land value change: Positive impact
	Loss of and displacement from homestead land	×						No displacement: No impact
	Loss of and displacement from agricultural land	×						No impact
	Damage to nearby operation	×						No impact
	Disruption of drainage pattern	×				×		Combined with economic zone drainage system
	Encroachment into precious ecology	×						No precious ecological issues: no impact
	Runoff Erosion		×					Take care of local drainage pattern
	Worker accident		×			×		Take care by good housekeeping
	Sanitation diseases hazard		×			×		Concentration of labourers may cause unhygienic environment
	Noise/ Vibration hazard			×		×		Pilling/equipment installation may cause noise
	Traffic congestion				×	×		Regular monitoring by designated security
	Employment				×		×	Good employment opportunity
Operation phase	Encroachment into precious ecology	×						No precious ecological issues: No impact
	Depreciation of environmental aesthetics		×					Local community prefer employment generation activities
	Erosion/Silt runoff	×						Having boundary wall: no impact
	Pollution from liquid discharge			×				Preventive measure will be undertaken
	Pollution from solid wastes		×			×		No significant impact
	Air quality			×				No major impact
	Occupational health hazard			×		×		Reduce by good management practice
	Odour hazard		×					Minor impact
	Traffic congestion	×						No carrying of product
	Noise hazard		×					Moderate impact
	Employment			×			×	Good employment opportunity

Chapter 6
Environmental and Social Impacts

6.1 Introduction

Petrochemicals industry has various impacts during construction phase, operation phase and at end of project life on environmental parameters like land environment, water quality, air quality of surrounding area and due to generation of solid and hazardous wastes. Environmental impact identification is based on stage of project and the type, scale and location of proposed project activity. Potential environmental impacts associated with the proposed project activities are classified as: i) impacts during site preparation or pre-construction phase, ii) construction phase, and ii) operation or post construction phase.

Some of the important impacts associated with the proposed project will be linked with land use, land stability (soil erosion), soil contamination, water availability, surface and ground water quality, water pollution, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change, socio-economic, places of social/cultural importance (religious structures, community structures), construction and raw material sourcing and storing, and OHS. Adequate mitigation measures are needed to mitigate/minimize all likely environmental impacts and those have been discussed along with the impacts.

6.2 Impact on Air Quality

6.2.1 Pre-construction Phase

In pre-Construction Phase, no significant impact will be anticipated regarding air emission.

Mitigation Measures: N/A

6.2.2 Construction Phase

The proposed project involves construction activities which include- site development (leveling, earth work), civil construction, construction material handling and stockpiling; and transportation of construction material, equipment and labours. Air quality will be impacted from the following sources during the construction phase:

- Fugitive dust emissions from site clearing, excavation work, cutting and leveling work at sites and access roads, stacking of soils, handling of construction material, transportation of material, emission due to movements of vehicles, plying of heavy construction machinery etc.;
- Vehicular emissions due to traffic movement on site and on the connecting roads;
- Exhaust emissions from construction machineries, other heavy equipment as bull dozers, excavators, compactors; and
- Emissions from diesel generator required for emergency power during construction period.

Gaseous emissions containing PM_{10}, $PM_{2.5}$, SPM, CO, HC, NO_X, SO_2 and petrochemical etc. will be released from the vehicular and construction equipment exhaust. The vehicular movement on the unpaved roads will also result in the fugitive dust emissions. The movement of trucks carrying

construction material to the site will lead to fugitive and exhaust emissions which would impact the people in the project area of influence. The movement of heavy trucks also increases the potential for road accidents.

Mitigation Measures:

To mitigate the construction impacts, project proponent should have contract agreements with contractors as well as sub-contractors to implement the measures provided in EMP.

- Sprinkling of water at construction site;
- Provision of face mask to workers to minimize inhalation of dust particles;
- Construction of barricades surrounding the plot;
- Minimizing stockpiling by coordinating excavations, spreading, re-grading, compaction and importation activities;
- Cease or phase-down work if excess fugitive dust is observed, investigate source and take suppression measures such as water spray;
- Adequate parking space should be provided for the construction vehicles so as to prevent idling of the vehicles and the emissions generating from them;
- Vehicles carrying construction material and debris should be covered with tarpaulin cover;
- Raw materials, excavated soil and other debris should be stored under covered sheds or cover with tarpaulin;
- Tree plantation along with the project boundary to mitigate the fugitive dust emissions;
- Construction vehicles and machinery should be regularly serviced and check for pollution control;
- Low sulfur diesel used for running construction equipment and vehicles.

6.2.3 Post-Construction Phase

Volatile Organic Compounds (VOCs), nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2) and particulate matter (PM_{10}) were identified as Contaminants of Potential Concern (COPC).

Particulate matter will be generated during operation of the proposed project and similarly during the testing and start-up stage. The values of particulate matter (PM) expected to be emitted during normal operation from each of the different sources (e.g. furnaces and turbines). These emissions of particulate matter will persist long time and the duration of impacts during the testing and start-up stage will be limited (less than one year).

Air quality will also be reduced by gaseous emissions from operation of the proposed petrochemical industry and similarly during the testing and start-up stage as well as docking activities and product and material transport by trucks. There will be a reduction in air quality as a result of emissions from process furnaces, flares, boilers and turbines. The main gaseous emissions of concern will include: nitrogen oxides (NOx), carbon monoxide (CO) and sulfur dioxide (SO_2). The gaseous emissions impacts due to the proposed complex normal operations will persist as long as the plant is under operation while the duration of impacts during the testing and start-up stage will be limited (less than one year). Impacts are therefore expected to reduce the air quality.

The amount of SO_2 in exhaust gases is directly dependent on the sulfur content of the used fuel. NOx are a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is an odorous, brown, acidic, highly corrosive gas that can affect human health and the environment. In particular, high levels of NO_2 can

damage the human respiratory system and increase a person's susceptibility to, and severity of, respiratory infections and asthma. Long-term exposure can cause chronic lung disease. NO_2 is also harmful to vegetation, damaging foliage and inhibiting growth. NO_2 reacts with oxygen (O_2) to form NO and Ozone (O_3). As with NO, O_3 when found in the lower atmosphere is harmful to human health producing similar effects on the respiratory system. Carbon monoxide (CO) is emitted as a result of incomplete combustion of fuel in engines. The emission rates of the contaminants of potential concern during the normal operation of the proposed complex. It is worth noting that all the air emissions sources are complying with the most stringent industry specific applicable limit.

Considering the expected life span of the proposed project the duration of the impact is classified as high, the impacts expected on the air quality due to plant operation are of Moderate significance. The rates of emission during the testing and start-up stage are expected to be higher than those expected during normal operation. However, the impacts during testing, start-up and decoking will persist for a short and limited time only (very low duration), while impacts during the operation of the plant are expected to persist during the lifetime of the project. As such, impacts during the testing, start-up and decoking are expected to be Moderate. Beside these, there are possibilities to accidental release of any petrochemical product. Moreover, vehicle exhaust emissions due to raw material transport through trucks and vehicles will contribute to the reduction of air quality. Gaseous emissions from trucks and vehicles will lead to a reduction in air quality inside the workplace as well as outside the boundaries of the project. Given the expected high frequency of vehicle trips, the impact over the life time of the project would be of Moderate significance.

Mitigation Measures

- Provision should be made for peripheral green belt all along the project boundary;
- Power generators should be provided with stacks of adequate height (higher than nearest building) to allow enough dispersion of emission;
- Process emission if any should be controlled with the installation of adequate air pollution control systems;
- Air pollution monitoring should be carried out quarterly to check the air pollution level;
- The latest technology and equipments should be used for control of air pollution;
- Fully automated machines should be installed in operation processes;
- Installation of sour gas treatment system and sulfur recovery plant;
- Installation vapour of recovery system in loading area for aromatics /benzene containing steams;
- The fired heaters and utility boilers are mostly being fired with fuel gas to keep emissions under control;
- Preference of usage of clean fuel like LPG, low sulfur diesel should be explored;
- Energy conservation should be adopted by opting the alternate energy options like solar power;
- Odour should be managed at the site using odour suppressant and planting fragrance flowering trees;
- Periodic checkups should be conducted for the workers;
- To reduce exposure levels, rotate the shifts of the workers;
- Appropriate PPEs such as half face respirator, dust mask etc. should be used for;
- Chemicals should be stored and transferred in close conveyors in all the industries.

6.3 Impact due to Noise and Vibration

6.3.1 Pre-construction Phase

In pre-Construction Phase, no significant noise and vibration will be generated.

Mitigation Measures: N/A

6.3.2 Construction Phase

Operation of different machineries and equipment for construction activities, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise during construction period. The heavy equipment, machineries, transportation and earthworks used for the construction activities are the major sources of noise. Noise levels will have compounding effect when multiple equipment and trucks operate at the same time. However, due to the linear shape of site the large-scale concentration of construction equipment may not happen. Thus, compounding effect may not be very high.

Vibration in buildings can arise from internal and external sources. The internal sources originated from machines (elevators, fans, pumps, drop hammers, trolleys, punching presses) and from the activities of people (walking, jumping, dancing, running etc.). External sources arise from road and traffic, construction activities (Pile driving, blasting, excavation and compacting of soil), sonic booms, strong winds and earthquakes. Most vibrations are generated inside the buildings. The resulting vibrations may cause impaired function of instruments and rare but possible structural damage. The primary concern is that the vibration can be intrusive and annoying to building occupants.

Most vibration problems can be described in terms of the sources, transmission path, and the receiver. The receiver in this current context will be the adjacent buildings. The nature of the soil between the source and receiver has a great influence on the intensity of the vibration received. Soft soil results severe amplitude vibrations than hard or rock like materials but soft soils attenuate the vibrations somewhat more rapidly with distance. Vibrations activities will happen throughout the construction phase. The magnitude, spatial extent and duration of this impact are Low, very low and very low, respectively and as a result the overall impact of this valued receptor is Minor.

Mitigation Measures

The following mitigation measures will be implemented to minimize potential impacts during the construction phase:

- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machinery and construction equipment that may be in intermittent use should be shut down or throttled down during idle time;
- Acoustic enclosure will be provided for the DG set;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby sensitive receptors as far as practicable;
- Honking should be avoided;
- Construction work should be carried out only during day time (from 8.00 am to 6 pm); and
- Machinery to be used should comply with the noise standards prescribed by DoE;

- At individual worker level, the construction contractor should be insisted to provide earmuffs to the workers exposed to high noise levels.

To deal with noise exposure by construction workers in construction site, pocket guide by OSHA is helpful. The following noise reduction measures are suggested in the pocket guide.

Reduce It: Reduce the noise by using the quietest equipment available. For example, choose a smaller, quieter generator.

Move It: Move the equipment farther away with the use of extension cords, additional welding leads, and air hoses. Noise levels go down as we increase our distance from a noisy object. Move the generator (example) farther away or face it in a direction that is away from where most people are working. If you are not required to be in a high noise area, move to a quieter area.

Block It: Block the noise by building temporary barriers of plywood or other on-site materials to keep the noise from reaching workers. Place a five-sided, oversized wooden box over the generator. Add fire-resistant acoustical absorbing material (foam) inside the box. If the generator sits on soil or sand, that will help absorb some of the noise.

6.3.3 Post-Construction Phase

Noise and Vibration

During operation phase the noise levels may rise due to vehicular movement and industrial activities. Noise generation due to operation of pumps & compressors, boilers, cooling tower etc. noise in the operation phase is considered as medium. These activities will happen throughout the operation phase, although the magnitude and extent is low, the impact of noise can be considered as Moderate.

The operation of industrial units can create vibration, but this will be limited to the adjoining area. In the operation of different industries, advanced technologies should be used as much as possible to ensure low vibration. Workers should use safety equipment in noisy work environment.

Mitigation Measures

- All the rotating machineries and flare should be designed to meet the specific limit;
- Green buffer should be developed all along the project boundary;
- Project proponent should install the new machinery of modern make which complies with the noise standards prescribed by DoE;
- Job rotations should be practiced for workers in industry to prevent prolonged exposure to high noise level as it may lead to deafness, fatigue, head ache, nausea and drowsiness;
- Noise regulators must put a strong mandate and fine on vehicle operators which are not properly maintained, produce noise (silencers not proper);
- Proper greasing, periodic checkups for frictionless movements;
- Comprehensive hearing conservation programmes identify noise sources, reduce workplace sound levels, and train workers on the hazards of noise exposure and proper use of hearing-protective devices should be conducted;
- Workers exposed to excessive noise should use appropriate PPE including ear plugs, muffs, or both when engineering or administrative controls are not feasible to reduce exposure;

- Acoustic design with sound proof glass paneling will be provided for critical operator cabins/control rooms of individual modules as well as central control facilities;
- Use engineering methods to reduce sound levels by modifying, enclosing and dampening noise sources;
- The monitoring of noise and medical surveillance (i.e., audiometry) assess worker exposure to noise and their resulting loss of hearing. This helps to identify noise problems and evaluate the adequacy of corrective measures.

6.4 Impacts on Water Resources

6.4.1 Pre-Construction Phase

The major water body of the project area is Bay of Bengal and beside Kohelia River. The project will develop in an economic zone. So prior to start the project, only economic zone development activities have impact on water resources.

Mitigation Measures: N/A

6.4.2 Construction Phase

Ground Water

Significant quantity of water will be required for various construction activities & domestic purpose. Excess withdrawal of ground water may lead to depletion of aquifers. There is a potential for contamination of groundwater resources resulting from improper management of sewage.

Surface Water

The major source of wastewater generation during construction phase is from the labour camp, which will be established for project construction activity. There is a potential for contamination of surface water resources resulting from improper management of sewage. The quality of water bodies could also be affected due to surface runoff from contaminated soil (soil contamination due to oil/ fuel spillage and leakages), particularly during monsoon season. The surface runoff carrying the loose top soil will lead to increased sedimentation in the receiving water bodies. Contamination to water bodies may also result due to oil spilling during construction activities and/or surface runoff from the construction site to the nearby water body.

Mitigation Measures

- Try to avoid excavation activities during monsoon;
- No sewage or waste water should be accumulated in any unlined structure;
- Timely disposal of the construction/chemical/hazardous waste so as to prevent leaching of any pollutant to ground;
- Temporary storm water drains and rain water harvesting ponds should be constructed so as to store rain water for construction activities;
- Regular inspections at site to monitor leakages in water storage tanks;
- Creating awareness among construction workers about the importance of water conservation;
- Covering the water storage tanks at site to prevent evaporation losses;
- Maintaining appropriate flow of water sprinklers at site;
- Construction of adequate nos. of toilets and proper sanitation system;

- Construction of soak pits/septic tanks to dispose-off the domestic waste water generated from labour camps to prevent disposal of sewage in water bodies;
- Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies;
- No debris/construction material should enter in the drainage system;
- Use of licensed contractors for management and disposal of waste and sludge;
- Spill/ leakage clearance plan to be adopted for immediate cleaning of spills and leakages;
- Adequate management of the spent lubricant collection and disposal through contractors who are authorized to recycle or dump in Government approved landfills.

6.4.3 Post Construction Phase

Use of onsite machinery will affect groundwater quality through incidental leakage of fuel and/or lubricants. Impact to the groundwater may occur through leaching of harmful pollutants after rainfall and land washing. Inadequate management of fuel/oils/lubricants could lead to spillages that may reach the groundwater reducing its quality.

In addition, concrete wastewater generated from industrial operation and from the sewage to have effects. Sewerage Treatment Plant (STP) and Effluent Treatment Plant (ETP) shall be installed in operations phase of the project to reduce wastewater pollution in the nearby water bodies. In order to reduce the pressure on ground water project proponent should install rain water harvesting system for potable water.

Mitigation Measures

- Installation of spent caustic oxidation facilities for caustic recovery and reuse;
- Treatment of contaminated rain water before disposal;
- Usage of water conservation fixtures to minimize water consumption;
- Installation of leakage detection system to minimize the water loss;
- Usage of latest technologies in industries which requires lesser water;
- Provision of dual plumbing system so as STP/ETP treated water can be re-used for various purposes as per suitability of the quality;
- Each industry should obtain consent of DoE before construction and operation and should comply to the conditions laid by them;
- No leachate, waste water, chemicals and waste material should be stored in pervious unlined area/pond;
- ETP, STP and API should be designed on the basis of effluent quantity and characteristics;
- Proper management of waste should be done to prevent any contact between the waste and storm water;
- Storm water drains should be lined to separate from effluent drains and inspected & cleaned before monsoon every year;
- Sludge should be dried into cakes and used as manure for green belt;
- Do not discharge leachate directly into the ground without treatment;
- Surface and ground water quality shall be monitored periodically.

6.5 Impacts on Land resources

6.5.1 Pre-construction Phase

The land will be primarily developed by the proponent of Moheshkhali Economic Zone-3. So, no major impact will observe due to start the project. Filling materials' quality must be tested before using as filling materials. At the proposed site where the project will be developed, no households will be directly affected by the project implementation who own land within the proposed alignment site. So, replacement and resettlement is not necessary. Land filling can disrupt the natural drainage pattern and cause drainage congestion which can affect the land resource.

Mitigation Measures

- Protecting national storm water drainage network and/or creating more drainage network could be a solution of water logging.

6.5.2 Construction Phase

Construction work may affect the topography and geology of the area around the proposed site. Solid waste generated will include rubble, substratum removed during foundation, broken concrete, glass, bricks etc. and scrap iron pieces, insulation, packaging materials, plastic drums etc. Hazardous waste generated includes paint drums, glass wool insulation, asbestos pieces etc. Improper waste disposal will lead to unhygienic conditions. Construction material (concrete, iron sheets, plant and machinery etc.) transport will lead to increase in number of vehicles on local roads.

The soil characteristics of the native soil may also be changed due to import of soil for filling and leveling purpose. It is envisaged that the filling activity may impact the native soil due to spillages during transportation of soil and run-off during filling and compaction.

Mitigation Measures

- Stripping of topsoil should be scheduled (maintain vegetation cover for as long as possible) in order to prevent the erosion (wind and water) of soil;
- Vegetation should be planned and maintained for slope stabilization and to prevent soil erosion after construction period;
- The disturbed areas and soil stock piles should be maintained moist to avoid wind erosion of soil;
- The routes for movement of heavy machinery should be designated to avoid the soil compaction in other areas;
- A register of Materials Safety Data Sheets (MSDS) relating to all hazardous will be maintained;
- Transport vehicles and equipment should undergo regular maintenance to avoid any oil leakages; designate routes for bringing construction material and outside soil;
- Construction contractor should designate the sites to be used for disposal of hazardous wastes including waste oils, solvents, paint and batteries;
- Contractor should ensure that no unauthorized dumping of hazardous waste is undertaken from the site;
- Fuel and other hazardous substances should be stored in areas provided with roof, impervious flooring and bund/containment wall.

6.5.3 Post Construction Phase

After development of project, disposal of industrial domestic and process waste may contaminate land and soil quality of the area. The impact can be significant and long term in case of uncontrolled discharges. Improper disposal of waste (hazardous and non-hazardous waste) may degrade soil, water, air quality and ecology of the area. Industries generate significant waste both hazardous and non-hazardous in nature, which can pollute the environment if not managed properly.

Contamination of soils from the processes is generally a less significant problem when compared to contamination of air and water. Natural bacteria that may use the petroleum and petrochemical products as food are often effective at cleaning up petroleum spills and leaks compared to many other pollutants. Many residuals are produced during the operation processes. Soil contamination including some hazardous wastes, spent catalysts or coke dust, tank bottoms, and sludge from the treatment processes can occur from leaks as well as accidents or spills on or off site during the transport process.

Mitigation Measures

- Provision shall be made for proper storage and disposal of industrial waste and industrial domestic waste;
- Spent catalyst will be sent to dispose or recover metals;
- Establishment of solid waste treatment unit with sewerage line, self-septic tank, soak oil tank, intermediate solid oil disposal tank, garbage storage tank and a scrap storage area;
- Waste should be segregated at source into hazardous and non-hazardous waste. Further the waste should be segregated into recyclable and rejected waste. Recyclable waste should be sent to authorize vendors for recycling and rejected waste should be disposed off as per the norms specified by DoE for the particular waste;
- Industrial waste generated should be stored on sealed surfaces and should be disposed off as per guidelines of DoE;
- No chemical/hazardous raw material should be allowed to spill over the land and should be operated in covered systems;
- Excessive packaging should be reduced and recyclable products such as aluminum, glass, and high-density polyethylene (HDPE) are being used where applicable;
- Organic waste should be resold to value addition industries or can be feeder to live stock;
- Use of advanced techniques to control specific portions of the manufacturing process to reduce wastes and increase productivity;
- All chemicals, imported petroleum and petrochemical products should be handled carefully and trained persons;
- Sludge generated in effluent treatment plant should be sold to authorized recyclers.

6.6 Impacts on Agriculture resources

6.6.1 Pre-construction Phase

The area outside the economic zone is used only for salt cultivation. Because of the area is already an economic zone area, anticipated impact on agriculture is not so critical during pre-construction.

Mitigation Measures: N/A

6.6.2 Construction Phase

Construction activities will require different amount of temporary construction labor and will absorb from different sectors. It can create seasonal scarcity of such labor. Due to development of project, the agricultural activity will not impacted.

Mitigation Measures: N/A

6.6.3 Post-Construction Phase

Proposed project will established in an economic zone. So, operation activities of this project will not affected surrounding salt farming. Beside these, employment opportunity will be created for local people.

Mitigation Measures

- Care must be taken to ensure that any solid and liquid industrial wastes shall not be discharged in the local land;
- Any conflict with local farmers should be avoided and complain from farmers should be managed with priority.

6.7 Impacts on Fisheries

6.7.1 Pre-construction Phase

The EZ area is mainly saltpan. The local residents earn their livelihood by cultivating salt. Moreover, significant number of them also does fishing six months in a year in the project area. Development of economic zone may destruct natural habitat of fisheries. But, the proposed project will not individually affect fisheries.

Mitigation Measures: N/A

6.7.2 Construction Phase

During construction period construction materials may be released to the nearby River or Sea from the construction site. This may damage the fisheries ecosystem of the respective water body. Construction materials, oil and chemical materials of heavy machines, vehicles, etc. will be stored in an appropriate storage site to prevent any release into the water body. These measures will minimize the impact of fisheries.

Mitigation Measures

- Proper disposal and management of construction waste;
- No waste should be dumped in water bodies during construction;
- Wastewater from labour camp and construction site should not be disposed off in the waterbodies;
- Septic tank/soak pits should be provided to dispose off the wastewater from construction camp;
- Site should be kept clean so as no pollutant from site should enter the water bodies along with run-off;
- Excavation activities should not be undertaken during monsoon season;
- Piling of raw material at construction site should be avoided;
- Raw material, debris and fuel should be stored on paved surfaces under covered areas.

6.7.3 Post-Construction phase

Fish demand will be increase in project area due to migrated population. During operation, runoff of exposed soil surfaces and drainage of waste water from industrial operation and sewage drainage into rivers is expected which can lead to the contamination of the water body from unexpected substances and it can destroy fisheries ecosystem. Appropriate protection measure from waste water contamination (if any) to the river by functioning ETP and STP will be established to control the pollution, save the fisheries and other aquatic resources of the Project area. Appropriate monitoring system will be devised for desired standard of ETP outlet parameters.

Mitigation Measures

- Adoption of adequate wastewater and industrial effluent management technology, so no untreated sewage is discharged into surface water body;
- Industrial, municipal and hazardous waste should be managed in such a way that no waste is dumped or disposed in surface water body;
- Direct discharge of any effluent or waste should be avoided;
- Over extraction of fishery resources by project related people need to be restricted.

6.8 Impacts on Ecosystem

6.8.1 Pre-construction Phase

The site is considered as 'no trees area', so, there is no vegetation within the zone except some herbs. Some fauna lived and depended on food from the area will lose the habitat and source of sustenance. Plantation will provide them new home and source of sustenance by the project. The impact on flora and fauna will not be significant for this reason. Although, some scattered mangrove species are located in the west bank of Kohelia River.

6.8.2 Construction Phase

Waste generated from the construction work will include waste plastic, waste glass and waste oil. Furthermore, household waste discarded from the camping ground of the workers will include cans, bottles and garbage. If such waste is no adequately handled, flora and fauna can be affected. Segregating waste at collection, recycling and reusing waste will be promoted and non-recyclable waste will be disposed at appropriate sites according to related regulations. Hazardous waste will also be treated accordingly. To reduce the amount of solid waste discharged from the workers during the construction work, efforts will be taken to employ local workers wherever possible, so that the amount of household waste at the workers camp will be minimized. These measures will be taken to ensure protection of aquatic and terrestrial ecosystem.

Olive Ridley's Turtle (*Lepidochelys olivacea*) is as vulnerable by IUCN. Olive Ridley turtles have been reported nesting in the Coast of Moheshkhali Island. Besides, *Caretta caretta* (Logger head turtle), *Chelonia mydas* (Green turtle), *Eretmochelys Imbricate* (Hawksbill turtle) are also found in the Moheshkhali Island. These species are likely to get impacted due to various construction activities of the project. The surface runoff from construction site, generation of suspended solid during piling, spillage & leakage of oil and lubricate, etc., may cause perceptible changes in water quality and also can affect the aquatic habitat and fauna.

Mitigation Measures

- Plantation of trees surrounding the project area;
- No waste shall be discharged into the river or sea.

6.8.3 Post-Construction Phase

Terrestrial ecology and biodiversity surrounding the project site may be affected during the operation phase of the plant. Impacts could result from the following environmental aspects:

- Proposed plant equipment testing and start-up stage;
- Operation of the main plant; and
- Material transport/use of trucks and vehicles

The main impact on terrestrial ecology and biodiversity during the operation phase will result from gaseous and particulate emissions and similar impacts are expected to occur during the testing and start-up stage of the plant. This will include NO_x, SO_x, Methane, CO_2, CO and other gaseous emissions. These emissions are expected to impact the health of any existing fauna in close proximity to the proposed industry site or damage flora existing in the surrounding project area and inhibit its growth, if any. Most floras have defense mechanisms against periodic exposure to air pollutants. They have protection against short duration, high exposure to air pollutants. Also, the operation of the proposed industry will generate noise that is expected to disturb the neighboring fauna. Generally, fauna will move away from the source of noise if a suitable habitat is found elsewhere. However, no significant habitat loss is expected to occur as the proposed project site is located within an economic zone.

The major impacts sources of aquatic ecology and biodiversity during operation phase of the project include spillage & leakage of fuel & lubricant.

Mitigation Measures

- Periodic monitoring shall be carried out as per as the monitoring plan for air, water, noise and soil and ensure that no impact;
- No waste shall be discharged into water bodies;
- Tree survival rate shall be monitored;
- Regular monitoring should be carried out for terrestrial and aquatic ecological and any unexpected effect should be investigated.

6.9 Socio-Economic Impact

6.9.1 Pre-construction Phase

Land Acquisition

No land acquisition is required for the development of the Project. Since no displacement of settlement occurred resettlement and rehabilitation is not relevant.

Disturbance to Existing Social Infrastructure and Services

Material, equipment and worker transportation may disturb existing road traffic including public transport using the highway and commercial vessels of nearby industries. For movement of vehicles, traffic management system should be developed.

Local Conflicts of Interest

No conflicts will occur with local residence as the land was procured from residents on a willing buyer–willing seller basis. Moreover, consultations with local residents have been conducted in preparing the EIA Report. Local people should be employed for the construction works to the maximum extent possible, and any workers from other places/countries should be taught to respect local customs in order to facilitate good relationships with local people. The lodgings of the project workers should be equipped with sufficient living facilities to keep workers at the project site as much as possible.

Mitigation Measures: N/A

6.9.2 Construction Phase

Impact on Health and Hygiene

Construction activities lead to generation of dust which may impact workers health. Adequate waste management plan, air, soil, noise and water pollution controls are required to be adopted to prevent any impact on health.

Impact on existing resources

The influx of skilled workers might put pressure on the existing resources like water supply, supply of fuel, provision of basic facilities, waste handling and sewage disposal which might create frictions between them and the resident population of the area.

Employment Opportunities

The construction phase will throw open a varied set of job opportunities for the population belonging to the study area. Direct and indirect job opportunity will be increased especially for unskilled work. Once, the proposed works commences in the construction phase, the land contributors of the project affected area should be given priority in employment (both, skilled and unskilled) opportunities that will arise. This step will help in the required capacity building of the local population as well.

Mitigation Measures

- Provision of proper training to all workers for handling the construction equipment;
- Provision of cautionary and guiding signage in Local and English language indicating the hazard associated with the site;
- Employment should be provided to local people;
- Entry to the fuel storage area and construction equipment rooms should be restricted and should be only allowed for trained personnel;
- Wastewater from the toilet should be disposed off in septic tanks and soak pits and should not be allowed to accumulate at labour camp site or construction site;
- Dustbins should be provided at labour camps for collection of waste and waste should be regularly disposed off through the concerned agency;
- Temporary storm water drainage system should also be provided at camp site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies;

- Arrangement of fire-fighting should be made at site and workers should be trained to use the system in case of fire;
- Provision of personal protective equipment like safety jackets, helmets, gumboots, gloves, face mask, ear buds, goggles, safety shoes etc. as per requirement and nature of job in which they are involved;
- Job rotation should be carried out for workers exposed to high noise and dust areas;
- Provision of first aid facility at the site and the labour camp;
- Labour camps should be located at neat and clean location with no water logging issues;
- Proper sanitation facility including toilets, bathing facility and washing facility should be provided at site and at labour camps for workers;
- Clean drinking water supply should be provided to labour;
- Regular inspection for hygiene and safety in labour camps should be done.

6.9.3 Post-Construction Phase

Impact on existing resources

Due to development activity resource demand will be increased for both industrial work and migrant population.

Employment Opportunities

Vast employment opportunities potentially created by the project which will reduce poverty via increased income through various livelihood options.

Mitigation Measures

- Extending reach of Corporate Social and Environmental Responsibilities (CSER) Program;
- Communication with local community though community relation department;
- Compliance with the relevant regulations;
- Employ local residents as much as possible;
- Promote communication between workers and local people (e.g., join in local events);
- Training should be provided to the local people for their skill enhancement;
- Prior to engagement of migrant labour, medical check-up should be carried out and copy of the medical certificate should be collected by project proponent, through sub-contractors, and maintained as part of their records;
- Regular medical camps should be conducted amongst the labourers and the local population to make them aware about diseases like typhoid, malaria, tuberculosis, STD's, HIV Aids etc.

6.10 Impact on Traffic

6.10.1 Pre-construction and Construction Phase

Delivery of construction material and equipment to the construction sites will be by road transport. Also during pipeline construction, works will lead to use alternative routes especially when crossing the highways. The transportation of material and equipment to the construction sites will cause temporary increase in traffic along the roads.

Mitigation Measures

- Time traffic flows to avoid periods of heavy traffic along main roads;

- Safe driving training will be mandatory to all drivers;
- Periodic servicing of vehicles will be carried out in accordance with the manufacturer's instructions;
- Avoid vehicle movements during rush hours;
- Adopt a traffic plan to cover all transport arrangements during the construction phase;
- Drivers will undergo medical surveillance;
- Adequate planning of activities to ensure and avoid unnecessary transportation trips. This may include ensuring full loading of trucks for the transport of required building materials to the site where possible;
- A traffic management plan has to be prepared;
- Vehicle speed restrictions should be applied;
- Minimize night time vehicle movement.

6.10.2 Post-Construction Phase

Impacts on traffic during operation phase are expected to occur due to transportation of products and materials/use of trucks and vehicles; this will lead to increase of frequencies of road operation.

Mitigation Measures

- Provide a dedicated parking area for private vehicles of project personnel;
- Safe driving training will be mandatory to all drivers;
- Basic maintenance for vehicles will be carried out by the driver/operator;
- Defects found will be repaired before the vehicle is back to service;
- Periodic servicing of vehicles will be carried out in accordance with the manufacturer's instructions;
- Avoid vehicle movements during rush hours;
- Drivers will undergo medical surveillance;
- Avoid unnecessary journeys;
- Vehicle speed restrictions should be applied;
- Minimize night time vehicle movement;
- Marine vessels should have oil/spill removal facilities.

6.11 Community Health and Safety

6.11.1 Pre-construction and construction Phase

Improper health and safety (H&S) policy maintained at the site may lead to outbreak of different diseases to the surrounding communities through the sick construction workers.

Mitigation measures

- Excavated trenches/ditches and freshly cut steep side slopes should be clearly marked and fenced for the safety of passersby and workers alike;
- Project or construction vehicles should be briefed on speed limit within sensitive areas such as schools, commercial and residential areas;
- The community must be informed of the type of activities being undertaken for the project and the health and safety measures that can be undertaken by them as a precautionary

measure. Additionally, the emergency response plan must also be communicated to the villages in the vicinity;

- Proper health and safety plan should be prepared during design and take action accordingly during construction to avoid road accidents and health hazards of the surrounding project community;
- Linkage of Communication, Disclosure and Grievance Redressal Mechanism should also cover labourers so that any concerns on working conditions or contractor mal-practices can be managed.

6.11.2 Post-Construction Phase

Due to project activity some possibility of third party accidents with residents near the construction site will be arise. With the inflow of migrant workers and their interaction with the local population, health issues among the local community might emerge. If proper waste management and effluent discharge system does not maintain, local people will be affected. Beside these, excessive air emission or noise generation will be also affected local community.

Mitigation measures

- Safety barrier and warning sign surrounding the construction site;
- Monitor any effect due to operation work on local community;
- Provide security and health facility to local people if any health issue or accident arises due to project activity;
- Establish the plan of site safety and security measures to communities and its implementation;
- Education and instruction to the project personnel and workers on local culture;
- Restricting access to the site with a focus on high risk structures or areas depending on site-specific situations including fencing, signage and communication of risks to the local community;
- Emphasizing safety aspects among drivers;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;
- Arrangement of worker's accommodation, if necessary.

6.12 Impacts on Occupational Health and Safety

6.12.1 Pre-construction and construction Phase

The lack of adequate mitigation measures on the health and safety of the workers will result in accidents and injuries leading to loss of life or property. It is proposed to implement the following mitigation measures to ensure safe work place for the construction labor.

Mitigation measures

- The project owner should ensure that the contractor (make part of contractors contract) have and occupational health and safety plan. Contractor should provide accidental and medical insurance for all the workers;
- The contractor should conduct daily tool box meeting for all workers to discuss potential work related hazards and other safety aspects;

- The contractor should conduct training for all workers on safety and environmental hygiene at no cost to the employees;
- The contractor should maintain first aid facilities for the workers and will instruct and induct all workers in health and safety matters (induction course) including construction camp rules and site agents/foremen will follow up with toolbox talks on a weekly basis. Workforce training for all workers starting on site will include safety and environmental hygiene;
- Fencing on all areas of excavation;;
- Workers should be provided with appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, dust mask, goggles, and ear protection at no cost to the workers;
- Contractor should keep the first aid kit at the construction sites at all time;
- To provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed;
- Contractor should be responsible for evacuation injured person to the nearest medical center;
- H&S trainings should be provided to all the workers with respect to hazards linked to the activities;
- Monitoring of the PPE usage can be strengthened, in that, a mechanism can be adopted whereby defaulters receive a warning on non-usage and stringent actions can be taken on subsequent offences;
- Maintain H&S records of occupational H&S incidents, accidents, diseases and dangerous occurrences;
- Ensure that PPE is available at all times at site;
- In event of accidents, the contractor will be responsible for immediate evacuation of injured person to the nearest medical center. The contractor should bear medical and other expenses of the injured person;
- Undertake daily tool box talk and proper training of the workers regarding health and safety procedures related to PPE usage, and regulatory provisions;
- The contractors should ensure H&S standards of labour camps and conduct random spot checks to determine any issues related to improper waste disposal or the living conditions in these camps (i.e. presence of secure shelter and flooring, number of persons per room, number of toilets for the manpower, water availability etc.);
- Strong protocols should be built as part of contractual obligations around zero tolerance of child labour or harassment of women workers and even health and safety aspects. These should also be monitored by supervision and monitoring team; and
- A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board will be maintained.

6.12.2 Post-Construction Phase

The workers who work inside the factory, face occupational health hazard due to different operational processes. Safe and good occupational health status of the employees and workers is important for not only the persons working in the plant, but also for the better plant operation and maintenance.

Mitigation measures

- To provide OHS training program and information on basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure;
- To provide adequate supplies and easy access of drinking water with a sanitary system;
- To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary;
- Adequate preventive measures from negative factors such as fire, lighting, safe access, work environment temperature, area signage, labelling of equipment, communicate hazard codes, electrical connections;
- To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction;
- To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers and occasional visitors;
- Proper maintenance of PPE and the instruction of proper use;
- Monitoring of the PPE usage can be strengthened, in that, a mechanism can be adopted whereby defaulters receive a warning on non-usage and stringent actions can be taken on subsequent offences;
- Maintain H&S records of occupational H&S incidents, accidents, diseases and dangerous occurrences;
- Ensure that PPE is available at all times at site;
- Additionally a Code of Conduct can be instituted for the operational phase that takes into account (a) health & safety aspects; (b) restrictions on activities – Dos and Don'ts; (c) labour camp regulations; (d) zero tolerance of illegal activities including: unlicensed prostitution; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting which will be shared with all contractors for induction of their employees/supervisors/workers;
- Strong protocols should be built as part of contractual obligations around zero tolerance of child labour or harassment of women workers and even health and safety aspects. These should also be monitored by supervision and monitoring team; and
- A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained.

6.13 Emergency response

Any emergency situation may be arising due to manmade activity (e.g. chemical spillage, fire etc.) or natural cause (e.g. earthquake, land slide, cyclone etc.).

Mitigation measures

- Formulation of chemical management plan as necessary;
- Training of safety usage and preparation of the emergency response plans;
- Implementation of the proper storage and record of usage;
- Applying for the acquisition of the license with management plan in accordance with the relevant law, and compliance with the law;
- Provision of protective equipment and clothes to workers as necessary;
- Preparation of the disaster prevention equipment and management manual;

- Installation of adequate number of fire hydrants in important places;
- Provide emergency drill and training;
- Compliance with the National Standard Operational Procedure for building construction to make earthquake resistant;
- Preparation of the disaster prevention plan such as emergency contact list;
- Implementation of suggested Disaster Management Plan (DMP).

6.14 Impacts on Climate Change

Carbon dioxide is a greenhouse gas (GHG) and emissions of carbon dioxide while not directly harmful to human health, contributes to global warming and climate change. Carbon dioxide will be generated and emitted both directly and indirectly during the proposed complex different phases (e.g. testing and operation). The magnitude of the proposed complex impact on global climate is classified as very Low. However, due to the High duration of the impact and high sensitivity of the VR (Global Climate), the impact on climate change caused by the increase in GHG emissions is considered of Moderate significance.

Mitigation measures

- All the possible energy convention and high efficiency machines will be used for minimizing greenhouse gas generation.

Chapter 7
Public Consultation and Disclosure

7.1 Introduction

Community participation always plays a key role for sustainable development. According to the guidelines of the DoE and the development partners, people's participation in planning and implementation phases of category A & B projects (usually red category) is essential to take necessary actions for minimizing any undue socio-cultural, political or any other conflicts and to address environmental issues. People have the right to know about what is going to happen in their surroundings. They must be informed about the positive and negative impacts for obtaining their perceptions, views and feedbacks on the probable changes likely to happen within the study area. Therefore, a series of public consultation meetings (PCMs) and public disclosure (PD) were undertaken with community stakeholders in accordance with the World Bank's Environmental Guidelines.

7.2 Objectives of Public Consultation and Disclosure Meeting

The primary objective of the PCMs and PD is to incorporate the opinions and suggestions of the public and all other stakeholders at the project planning stage to ensure wider acceptability of the project. The key objectives are as follows:

- To provide information on the economic, environmental, and social benefits as well as potential negative impacts from the project;
- To ensure that the potential project affected persons (PAPs), stakeholders, and local communities are engaged in a meaningful dialogue and are well informed prior to the decision of the project proponent as to the nature and extent of social and environmental impacts attributable to the proposed project with respect to planning;
- To ensure that the concerns of, and issues raised by the PAPs, stakeholders, and local communities are incorporated and adequately addressed in the EIA study;
- To engage in a participative exercise with PAPs, stakeholders, and local communities and obtain expertise and local, traditional wisdom and knowledge from them in order to plan the mitigation measures; and
- To facilitate periodic opportunities to the principal stakeholders to offer their inputs on all key components of the project.

7.3 Approach and Methodology of Public Consultation and Disclosure Meeting

7.3.1 Approach of PCM and PD for EIA

PCM and PD offer an opportunity for people to participate in the decision making process for design, development, and implementation of the project. It provides a platform for project affected persons and different stakeholders to express their views on possible impacts of the proposed intervention on environmental and social parameters. PCM and PD for EIA are planned at two different stages (EIA scoping stage and draft EIA report stage) in order to collect opinions and feedback of the public and to disseminate information on the project and EIA Study.

a) EIA Scoping Stage

The first stage of the PCM and PD for EIA is conducted at the time of environmental scoping in the initial stage of the EIA study. Information on the Project and scope of the EIA study is disseminated to the public and then comments and opinions are collected to incorporate into the report.

b) Draft EIA Report Stage

The second stage of the PCM and PD for EIA is conducted at the time of preparation of draft EIA report. Information about findings of draft environmental and social impact assessment study and proposed mitigation measures are disseminated to the general public that are directly or indirectly affected by the project. In addition, their feedback and opinions are obtained which are reflected in the EIA report together with their comments and request on the environmental and social mitigation measures, environmental management plan (EMP) and environmental monitoring plan (EMoP).

7.3.2 Methodology of PCM and PD for EIA

The consultant team prepared a checklist for the consultation meetings. The issues on the overall study, planning as well as project interventions and probable impacts of project on the environment, socio-economic condition and institution were incorporated in the checklist. The issues of discussion were also shared with the implementing authority for obtaining their responses and suggestions. The probable places of meeting were selected in consultation with the project officials and local knowledgeable persons of the study area.

A Socio-environmentalist from the multi-disciplinary EIA consultant team facilitated the consultation process with instantly available local people separately to collect/record opinions and views from their own perspectives. The other members of the EIA team also attended and assisted as necessary. The team used maps of the study area during discussion to share about the interventions for the participants of the consultation meetings. The facilitators explained all relevant points and issues in order to enable the participants to comprehend the proposed interventions/ activities properly and to respond accordingly. The team took utmost care in recording opinions and views of the participants relevant to the EIA study.

7.3.3 Stakeholder Engagement Plan

In order to ensure effective engagement and open, frequent and honest dialogue with local communities and other key stakeholders, a stakeholder engagement plan is designed throughout the life of the project. This plan is to be developed and implemented in order to identify stakeholder and their issues of concern, establishes the methods for consultation, and provides a specific action plan for stakeholder engagement throughout the life of the project.

Table 56: Stakeholder engagement plan

Key Stakeholders		
Project proponent	:	SPL Petrochemical Complex Limited
Related organizations/ Local government	:	Union Parishad (UP member-male and female)
Local people	:	Land owners, businessmen, fishermen, day labor, teacher, religious people, women etc.
Private business	:	Private companies/ factories around the zone
Non-Governmental Organizations	:	Community Based Organizations (CBOs)
Engagement methods		
EIA phase	:	Organizing consultation meetings inviting key

		stakeholders above at draft scoping report and draft EIA report
Pre-construction/ Construction phase/ Regular operation Phase	:	– Regular communication with local community through personal contact; – Meeting with the representative of village on the quarterly basis; – Participatory meeting with villagers; – Interview survey with villagers.
Information disclosure		
EIA phase: Pre-construction/ Construction phase/ Regular operation Phase	:	Disclosures of draft scoping report and draft EIA report.
Grievance mechanism process and complaints register		
All phase	:	– Receiving complaints and opinions from the public on regular basis through the engagement method; – Meeting with the representative of villages; – Participatory meeting with villagers.

7.4 Public Consultation Meetings (PCMs)

Participatory Rapid Assessment (PRA) and Focused Group Discussions (FGDs) were held in major settlement areas of the Project site to inform people about the objectives of the Project. In each of the consultation, participants were encouraged to share their observations, suggestions, and experiences on various environmental and safety issues and suitable mitigation and enhancement measures. Issues discussed were:

1. Awareness and extent of the project and development components;
2. Resettlement and compensation of project affected peoples (PAPs);
3. Benefits of the project for the economic and social advancement of the community;
4. Labor availability in the project area or requirement of outside labor involvement;
5. Local disturbances due to dust, noise generation during construction activities;
6. Necessity of cutting trees and the degree of clearing vegetation at project sites;
7. Impact on fisheries and salt cultivation;
8. Water logging and drainage problem, if any;
9. Discharge of polluted water into the River;
10. Earth filling to develop the area;
11. Possible negative environmental consequences of the project like air quality, water pollution, and human health impacts etc.

The meetings were aimed to:

1. Ensure that the public was provided with opportunities to participate in the decision making process and to influence decisions that would affect them;
2. Identify the widest range of potential issues about the project as early as possible and in some cases, have those resolved;
3. Ensure that government departments were notified and consulted early in the process; and
4. Ensure a broad range of perspectives were considered in any decision.

7.4.1 Proceedings of Public Consultation

The public hearing for the development of proposed project was conducted in the premises of Dhalghata Union at Moheshkhali Upazilla of Cox's Bazar District. The public hearing was attended by

Chairman, the Union Parishad (UP) members of Dhalghata Union, project relevant stakeholders and representatives of Shahidul Consultant.

Chairman of Dhalghata Union Parishad initiated the proceedings and welcomed the gathering. He narrated the procedure to be followed for obtaining Environmental Clearance (EC) and explained purpose and usefulness of this public hearing.

Representative of Shahidul Consultant, explained the proposed project and the environmental assessment of the region which included project background; introduction of the project proponent; institutional and legal framework for the project specifying role of Shahidul Consultant; project description with brief of project location, its connectivity, land use plan, and other aspects like sources and consumption of water, management of wastewater, source and consumption of electricity, solid waste generation and disposal, development of green belt, and other social and economic development that would emanate from this industrial area. Potential impacts of the development, suggested mitigation measures to mitigate them, environmental and social monitoring program was also explained to the public. Thereafter the UP members requested the attending public to convey their suggestions/ comments/ concerns about the proposed project.

7.5 Public Disclosure Meetings (PDMs)

For the implementation of PD at the draft EIA stage, the additional arrangement was made to implement at the draft EIA stage taking into account the opinion received at the scoping stage as follows:

a) Preparation and disclosure of the main part in local language in addition to the documents which are officially required in accordance with EIA procedure;
b) Arrangement of PD before the day of holding PCM;
c) Arrangement for changing PD period i.e., 1 month to 2 weeks; and
d) Distribution of the reports to more places.

7.6 Consultation Outcomes

The stakeholders expressed that the development of the project bring social and economic development in the region providing permanent source of income for the PAPs and also to other nearby residential settlements. The stakeholders expressed their desire to hold consultations across the project lifecycle and not just at the initiation phase.

Further, the analysis of the key positive impacts, apprehensions and perceived negative impacts and the suggestions/recommendations as documented during stakeholder consultations are detailed in below table.

Table 57: Impacts perceived by the stakeholders

Positive impacts perceived by the stakeholders	Negative impacts
• The proposed project will create employment opportunity for the adjacent local community during construction and operation phases; • Land value around the project will be increased; • Education, health, bazaar, telecom, hotel & restaurant facilities will be available and established; • New business will be introduced.	• Pollution of river and sea water; • Reduction of aquatic species; • Increase the possibility of accident; • Increase traffic congestion; • Pollution of air environment.

Chapter 8
Environmental Management Plan and Monitoring Indicators

8.1 Introduction

Environmental Management Plan (EMP) is a site-specific plan developed to ensure that all necessary measures including mitigation and monitoring activities are identified and implemented in order to preserve and protect the environment and to avoid and manage the negative impacts of the project and comply with environmental legislation. The primary objective of the EMP is to provide a guideline for proper management and monitoring of the identified environmental and other impacts due to the project and to offer document to the implementers for accomplishing the institutional requirements of the authority. It will identify the residual impacts and unavoidable impact and its management. As GoB is committed to ensure sound environmental condition, preparation and execution of EMP is mandatory for preparation, implementation and monitoring of environmental protection measures during and after commissioning of the project. EMP indicates how various measures are proposed to be undertaken during different phases of the project including cost components. To develop a proper Environmental Management System (EMS) following steps are important:

Figure 32: Different steps of EMS

The present study clarifies the following proposed EMP:

- The mitigation measures that needs to be taken during construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce to acceptable limits;
- The actions needed to implement these measures; and
- A monitoring plan consists of concrete monitoring indicator require to assess the effectiveness of the mitigation measures employed.

Similarly, integrated EMP is a necessary requirement for implementation of the project, which will be a guide for the environmental protection activities. A comprehensive measure for mitigation and monitoring of possible environmental hazards has been enlisted for ensuring safety measures and minimizing the risks and hazards due to implementation of the project in the study.

8.2 Mitigation Plan

The establishment and execution of proposed project is believed to have a positive impact for sustainable economic growth of the country as well as provision of employment to the local people. However, the project may also have some impacts on the existing local environment, eco-system and socio-cultural activities including land use, soil quality, pollution of water, air, noise, etc. Therefore, a mitigation mechanism has to be established to the affected communities regarding various harmful impacts including the effects on livelihoods, environment, agriculture, water bodies, and surrounding social infrastructures. A detail EMP including health & safety measures has been described in the following table. The Project proponent will be responsible for accomplishing the proposed safety measures mentioned in the proposed EMP.

Following are the main advantages of the environmental mitigation plan:

- Ensure plan for the fulfillment of basic environmental standards essentially required to meet during design, construction, and operation period of the project;
- Provide plan for the development of compensatory actions especially in the form of compensatory forestation, green zone development and landscaping for minimizing the negative ecological impacts due to the project;
- Reduce the potential environmental impacts, causing the biophysical environment in the area to deteriorate and indirectly slow down the economy of local communities by the project.

The EMP for SPL Petrochemical Complex Limited has been prepared based upon optimum and reasonable costs that are needed for mitigation measures on a “least-cost” basis. Activities that needs to be carried out for the environmental management and monitoring of the proposed plan could be divided into two phases: during construction phase, and during operation phase.

Table 58: Environmental and social mitigation and management plan

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
Pre-construction phase				
Social and traditional	Loss of livelihood	• Aim of petrochemical industry establishment is to provide and create employment.	Project proponent	BEZA/DOE
	Vulnerable group	• Not applicable.	Project proponent	BEZA/DOE
	Local Conflict of Interests	• Not applicable.	Project proponent	BEZA/DOE
	Water Sources	• Provision of alternative water sources.	Project proponent	BEZA/DOE
	Cultural Heritage/ Asset	• Not applicable	Project proponent	BEZA/DOE
	Quality of life for local communities	• Quality of life of the local communities will be improved if everything can be maintained properly.	Project proponent	BEZA/DOE
	Displacement of settlements	• Petrochemical industry will be set up inside the economic zone. So, no local settlement will be affected.	Project proponent	BEZA/DOE
Construction phase				
Air Pollution	Emission of dust, volatile organic compounds, PM ($PM_{2.5}$, PM_{10}), gaseous emission like SO_X, NO_X, CO, CO_2 etc. from construction activities and vehicular activities.	• Continuous monitoring air quality by using air quality measuring devices; • Monitoring of wind speed and direction to manage dust-generating activities during undesirable conditions; • Spraying water where dust suppression is severe; • Using barrier so that dust can't go outside; • Limited the speed of vehicle; • Cover up the construction site to minimize waste production; • Use low sulfur content fuel for machinery and equipment to reduce SO_2 emissions from engines whenever possible; • Modify machinery to reduce NO_X emissions; • All energy consuming and CO_2 generating activities should be done as efficiently as possible to minimize CO_2 emissions; • Adopt a policy of switching off machinery and equipment when not in use; • Use or establish hard-covered roadways for vehicle movement; • Vehicle speed restrictions should be applied across the project site to avoid excessive dust generation;	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Trucks transporting excavated soil and other construction raw material to and from the site to be covered to minimize fugitive dust emission; • Appropriate maintenance, engine tuning and servicing of construction equipment to minimize exhaust emissions; • Minimize unnecessary journeys or equipment use.		
Noise, nuisance and Vibration	Noise, nuisance and vibration from machineries, construction work can affect.	• Protective measures (ear muffs, ear plugs) will be distributed to the workers; • Low noise generating equipments should be set up; • Active and passive noise controller mechanism have to be set up; • Installation of sound-proofing sheet; • Avoidance of construction at night time; • Avoidance of intensive operation of construction machineries; • Speed limit for drivers; • Preventive maintenance of equipment and vehicles; • Introducing barriers to the vibration waves in the transmission path can reduce vibrations that reach a building; • Unnecessary engine operations to be minimized (e.g. equipment with intermitted use switched off when not working); • Piles in properly selected patterns also reduce noise and vibration	Contractor	Project proponent
Water Pollution	Because of the presence of polycyclic and aromatic hydrocarbons, phenols etc. Impact on ground water and surface water quality, ground water depletion, drainage cognation	**Surface water** • No disposal of any wastewater directly without being treated into water bodies; • Handling oil in a container to minimize oil spillage; • Treat waste water by using activated sludge model; • Waste disposal to water body are prohibited; • Treat accidental spills of any floating unit with spill containment and clean up (dispersant) materials; and • Prevent discharge of contaminants and wastewater streams to ground water; • Provide proper drainage facilities. **Ground water**	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Minimum extraction of ground water; • Control all onsite wastewater streams and ensure appropriate collection, treatment and discharge; • Prevent discharge of contaminants and wastewater streams to ground water; • Apply high quality control standards to the construction of wastewater storage trenches/tanks to avoid leakage and arrange for frequent discharge to prevent sewage spillage/overflow; • Good housekeeping to prevent leaks and incidental spills; • Minimize onsite storage of potentially contaminating materials; • Adequate management and proper handling and storage of construction materials, oils and fuel to avoid spillages. • Properly managed and disposed wastes; • Implementation of a continuous and regular site inspection system; • Restrict the earth work activities during monsoon season; • Channelize all surface runoff from the construction site through storm water drainage system and provide adequate size double chambered sedimentation tank; • Prevent & mitigate spill of paint/fuel within the construction site.		
Soil Pollution	Disruption of earth surface due to construction work and solid waste generation.	• Reduce toxic waste production • Recycle and reuse the waste as much as possible • Improve technology to treat soil like solidification advanced oxidative process etc. • Control all onsite wastewater streams and ensure appropriate collection, treatment and discharge; • Good housekeeping to minimize spills/leaks; • Minimize onsite storage of potentially contaminating materials; • Proper handling and management of wastes; • Waste water should not be dumped directly to the soil	Contractor	Project proponent
Ecosystems	• Disturbance of land ecosystem at the time of	• Clear marking of boundary of the project site to prevent the contractor from clearing the vegetation outside of the Project site • Prevent unnecessary clearing or disturbance of native vegetation.	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
	drilling and construction work. • Construction of jetty will affect aquatic ecosystem • Disturbance to threatened marine resources (Olive Ridley's Turtle, Green turtle, Hawksbill turtle)	• Vehicle tracks and roads should be used to decrease habitat destruction. • Minimizing areas of excavation and active work sites as far as possible. • All work will be undertaken during the day, as much as reasonably practical, to ensure lighting does not impact birds and noise will be reduced as much as reasonably practical to avoid fauna disturbance. • If protected/sensitive species are discovered or suspected, then work will be ceased and inform the relevant authority; contractor will seek expert advice and/or consult the client in order to develop and agree on an appropriate management strategy; • No litter or plastic bags/containers will fly off the site boundaries. • Water sprinkling for dust suppression; and • Provision of dust curtains to reduce the dust emission; • Taking Measures for protecting Sea Turtles.		
Production of sludge's and waste	Sludge contains toxic substances. Generation of solid waste will degrade soil and surface water quality.	• Waste management plan should be prepared and maintain; • Plastics, cans etc. will be sent for recycle; • No waste will be stored under the open area; • Quantities of construction materials to be accurately estimated to minimize the potential for excess generation of waste; • Construction activities to be appropriately scheduled to minimize the potential for rework; • Waste bins will be installed clearly marked wherever required. Such places include eating/rest areas, next to operational areas and next to any worker assembly areas; • Adequate waste management, awareness and communication through training, tool box talks and posters placed across the site.	Contractor	Project proponent
Agriculture	There is no agricultural land surrounding the proposed project. Only salt farm was found in that area.	• To avoid the discharge of any waste materials to surrounding land.	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
Fisheries	Reduce fishery resources, disturbances to fishery habitat etc.	• Prevention of leakage of hazardous chemicals and oils into the water bodies. • The Project will try and avoid disrupting peak fishing activities to the extent feasible. • Vessels to minimize unnecessary vessel movements, such as propeller thrusting, to avoid sediment disturbance • Care must be taken during construction of jetty.	Contractor	Project proponent
Impacts on Socio-Economy	Impact on health, aesthetics and hygiene, existing resources, create employment opportunities, local conflicts of interest.	• Various environment awareness programmes shall be organized by management committee on regular basis to bring forth the beneficial aspects of the project at local level; • A management committee shall take keen interest in public participation and expectations of the local people for improving quality of life during planning of welfare activities under CESR plan; • The committee shall identify eligible people for jobs in construction and lower level administrative jobs by noting their literacy level, extent of need, availability of means, etc. or the committee should confirm the employment of local people by sub-contractors. • Unskilled labor during the project construction phase should be sourced from the local community; • The initiatives of the project proponents are likely to be focused on livelihood restoration, income generation, education and provision of health facilities which can further improve the quality of life of the community in the vicinity.	Contractor	Project proponent
Impact on Traffic flow	Increase of traffic volume and possibility of accidents.	• Safe driving training will be mandatory to all drivers; • Periodic servicing of vehicles will be carried out in accordance with the manufacturer's instructions; • Avoid vehicle movements during rush hours; • Adopt a traffic plan to cover all transport arrangements during the construction phase; • Training and licensing industrial vehicle operators of specialized vehicles such as forklifts, including safe loading/unloading, load limits;	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Vehicle speed restrictions should be applied; • Minimize night time vehicle movement.		
Community Health and Safety	Third party accidents with residents near the construction site or accidents with local people by the traffic of construction vehicles, disputes among local people and migrated workers. Community people can be affected by contaminated water, soil and water if not treated properly.	• Safety barrier and warning sign surrounding the construction site; • Monitor any effect due to operation work on local community; • Provide security and health facility to local people if any health issue or accident arises due to project activity; • Establish the plan of site safety and security measures to communities and its implementation; • Education and instruction to the project personnel and workers on local culture; • Restricting access to the site with a focus on high risk structures or areas depending on site-specific situations including fencing, signage, and communication of risks to the local community; • Construction activities should be timed, and provision for pedestrians should be made; • Excavated trenches/ditches and freshly cut steep side slopes should be clearly marked and fenced for the safety of passers and workers alike; • Community must be informed of the type of activities being undertaken for the project and the health and safety measures that can be undertaken by them as a precautionary measure. Additionally, the emergency response plan must also be communicated to the villages in the vicinity; • Proper health and safety plan should be prepared during design and take action accordingly during construction to avoid road accidents and health hazards of the surrounding project community; • Linkage of Communication, Disclosure and Grievance Redressed Mechanism should also cover laborers so that any concerns on working conditions and contractor mal-practices can be managed; • Dispute settlement among stakeholders in case incidences occur; • Arrangement of worker's accommodation if necessary.	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
Occupational Health and Safety	Accidents and incidents during the work.	• To provide adequate health care facilities and first aid within construction sites; • Establish easily accessible eye wash fountain near to the work place; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; • To provide adequate supplies and easy access of drinking water with a sanitary facilities; • To provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; • To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; • To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors; • Proper maintenance of PPE and the instruction of proper use. • Give them protective uniforms while doing sensitive works.	Contractor	Project proponent
Emergency Situation	Chemical spillage, fire, earthquake, flood, river bank erosion etc.	• Formulation of chemical management plan as necessary; • Training on safety usage and preparation of the emergency response plans; • Implementation of the proper storage and record of usage; • Applying for the acquisition of the license with management plan in accordance with the relevant law, and compliance with the law; • Provision of protective equipment and clothes to workers as necessary;	Contractor	Project proponent

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Preparation of the disaster prevention equipment and management manual; • Installation of the fire hydrants; • Implementation of emergency drill; • Compliance with the National Standard Operational Procedure for building construction; • Preparation of the disaster prevention plan such as emergency contact list; • Implementation of suggested Disaster Management Plan (DMP). • Ensure the use of emergency stairs.		
Climate Change	Impact in the increase of GHGs by vehicle traffic operation of tenants in the construction phase.	• Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible; • Provision of commuter bus.	Contractor	Project proponent
Post-construction phase				
Air Pollution	Emission of dust, PM, gaseous emission like SO_x, NO_x, CO, CO_2, sulfur, benzene, Volatile Organic Compounds (VOCs) like xylene, toluene, polyclic aromatic hydrocarbons, hazardous Air Pollutants (HAPs) etc.	• Scrubber at bagging section can minimize the emission of pollutant; • Installation of sour gas treatment system and sulfur recovery plant; • Installation vapour of recovery system in loading area for aromatics /benzene containing steams; • The fired heaters and utility boilers are mostly being fired with fuel gas to keep emissions under control; • Regular monitoring and maintenance of all equipment, generators etc.; • Installation of flare gas recovery unit to recover the fuel gas and use it. It will also reduce the gaseous emission; • Installation of flare by using latest technology equipment should be set up; • Set up local exhaust ventilation to reduce the inhalation of the hazards; • Providing full face organic respirator or full face mask to the worker to minimize the hazardous inhalation;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Separate eating and smoking areas from the workplace to prevent ingestion; • Regularly monitor airborne concentration; • Use of cyclones (tertiary cyclones, multi cyclones) to abate particulate emissions. Besides, electrostatic precipitators, wet flue gas scrubber etc. should be used to control PM emission from each industry; • Ensure that air emissions from point sources will meet all relevant national and international standards; • Besides point source monitoring, air quality monitoring should be carried out in specific locations; • Use low sulfur content fuel for machinery/equipment, modify machinery, and switch off machinery/equipment when not in use; • Use portable leak detection equipment to identify and prevent fugitive emissions; • Any leak once detected will be immediately reported; • Bag filters shall be applied to control PM emissions and scrubbers can be used to control gaseous emissions; • In order to reduce SO_X concentrations, De-SOx catalyst additive, feed desulfurization and flue gas desulfurization methods must be followed; • Minimize unnecessary journeys and equipment use and adopt a policy of switching off machinery and equipment when not in use; • Use best available technologies for emissions reduction of NO_X like Fuel De-nitrification, FCC NO_X control, Diluent injection, Flue Gas recirculation, Steam or water injection, Low NO_X burners, Selective non-catalytic reduction and selective catalytic reduction etc. • Provision for covering/Pressurizing of API separators with or without vapor recovery for controlling VOCs. • Preparation of feasible mitigation measures, such as, energy use efficiency, process modification, selection of fuels or other		

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		materials, the processing of which may result in less polluting emission, application of emission control techniques, if necessary. • Reducing the emission of volatile organic compounds.		
Noise, nuisance and Vibration	Noise and vibration from machineries will cause negative health impacts to the human and faunal diversity of that area and reduce machineries and equipment's efficiency.	• Provision measures (ear muffs, ear plugs) will be distributed to the workers; • Low noise generating latest technology equipments should be set up; • Avoiding continuous (more than 8 hrs.) exposure of workers to high noise areas; • Avoidance of construction at night time; • Hazard sign of the noise can be displayed in different strategic part of the strategic to pass the caution and warning among the workers; • Active and passive noise controller mechanism have to be set up; • Avoidance of intensive operation of construction machineries; • Speed limit for drivers; • Ensuring preventive maintenance of equipment; • Unnecessary engine operations to be minimized (e.g. equipment with intermitted use switched off when not working); • Provision of use noise reducing technology and noise barriers; • Provide hearing checkup regularly to workers; • During operational phase, it is recommended that routine maintenance procedures will put in place to ensure that vibration is minimized. This measure includes inspection and maintenance of mountings to isolate machinery that is prone to vibrations and the balancing or reciprocating and rotating machinery.	EHS officer/Project proponent	BEZA/DOE
Water Pollution	Deterioration of water quality due to wastewater discharge, chemical/oil spillage (like; polycyclic and aromatic hydrocarbons, phenols, metals derivatives, sulphides, naphthylenic acids	**Ground Water** • Proper maintenance and management of plant during operation to minimize the risk of spillage and leakage; • Regular inspection of pipes and other potential sources of leaks for the early detection of possible seepage; • Store and manage potentially contaminating materials according to best environmental practices;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
	etc.) solid waste dumping etc. into nearby water bodies.	• Implement a comprehensive Waste Management Policy which ensures the safe storage and timely treatment and removal of waste; • Install groundwater monitoring wells and implement a continuous monitoring and sampling program, as part of the environmental monitoring plan, to detect any impacts to groundwater quality; • Formulate a spill contingency plan; • Wastewater can be treated by aeration, oil and grease separation, reserve osmosis, ion exchange process; **Surface water** • Keeping liquid effluents to minimum as applicable; • Installation of spent caustic oxidation facilities for caustic recovery and reuse; • Sour water, ammonical water and foul water treatment unit will be installed; • Temperature, salinity and other qualities will be regularly monitored and documented at the outfall; • Avoid taking or disposing water at known sensitive, breeding or nesting areas; • Treatment of contaminated rain water before disposal; • Establish filtration, liquid water treatment, waste water sludge treatment technology; • Avoiding swimming and fishing from navigation routes; • Provision of an Effluent Treatment Plant (ETP) and API with good cushion to meet the hydraulic and pollution load during operating the plants. The project authorities should ascertain at planning stage and further evaluate at commissioning stage so that the treated effluent would have characteristics of prescribed limits of National and International standards. The performance of ETP should be continuously monitored and any deviation in performance should be corrected on priority basis;		

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Regular monitoring of effluent from different treatment units and also combined final discharge of treated wastewater is recommended. Performance evaluation of effluent treatment plant as well as sewage treatment plant should be undertaken at regular intervals for all relevant parameters covered under this study • The project authority should establish a Sewerage Treatment Plant (STP) in order to treat and proper management of Sewages produced during operation phases. • Establish more technically improved methodology like thermal hydrolysis, wet oxidation, ion exchange, combustion etc;		
Land Resources and Soil Pollution	Contamination of Soil from hazardous waste, coke dust, tank bottoms and sludge from the treatment	• Store and manage potentially contaminating materials according to best environmental practices to avoid spills and leaks; • Regular monitoring, maintenance and using best available techniques; • Adopt good handling and transportation practices to avoid loss of material and soil contamination; • Formulate a spill contingency plan and have appropriate response equipment available onsite; • Implement a comprehensive Waste Management Policy which ensures the safe storage and timely treatment and removal of waste. Wastes should be properly managed and disposed of in accordance to the waste management plan. • Proper maintenance of sewage system;	Project proponent	BEZA/DOE
Wastes Generation	Impact of petroleum contaminants waste, hazardous material and solids generated from offices works.	• Spent catalyst will be sent back to catalyst supplier to recover precious metals or disposed off as per recommendation complying with all regulatory issue; • Maximize the opportunities for reuse and recycling of materials to minimize solid waste generation; • Waste bins will be installed wherever required; • Different types of wastes shall not be mixed into one container; • Provide proper disposal methods for each waste stream;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Maintain a record of waste leaving the site (description and volume) e.g. use of waste manifests; • Technologies for preventing oil spillage at the time of crude loading; • Light bulbs and fluorescent light fittings to be treated at an approved hazardous waste treatment facility. • Re-engineering of byproducts. • Establishment of solid waste treatment unit.		
Odor	Odor from wastes and different manufacturing process. Unloading of crude oil, Loading of phenols, burning of gases from sour water stripping, sulfur compounds, nitrogen compounds (ammonia), hydrocarbons (aromatics) can create odor at the workplace.	• Regularly collect waste from bens and dispose of into selected place; • Maximize the opportunities for reuse and recycling of materials to minimize solid waste generation; • Use nitrate based products in the septic tank areas; • Control the use of fugitive emissions; • Develop scrubbing system and incineration system for controlling odorous gasses; • Waste bins will be installed wherever required; • Different types of wastes shall not be mixed into one container; • Provide proper disposal methods for each waste stream; • Maintain a record of waste leaving the site (description and volume) e.g. use of waste manifests; • Unused catalysts will be returned to the manufacturer. • Provide mask to workers who work in the odour producing area; • Marked the odour producing area; • Regular checkup for workers who work in those areas; • Waste and sludge should be manage and handled carefully before disposal; • Provide waste bins; • Regularly checking machineries which use odour producing chemicals. • Provide adequate ventilation system in odour generating areas.	EHS officer/Project proponent	BEZA/DOE
Agriculture	The impact will not so high since the location of the	• Care must be taken to ensure that any solid and liquid industrial wastes shall not be discharged in the local land;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
	industry inside an economic zone and surrounding area is only used for salt farming.	• Any conflict with local farmers should be avoided and complain from farmers should be manage with priority.		
Fisheries	Impacts on fish production. pH balance of the ocean water can be changed which can effects fish species of the ocean.	• Minimize unnecessary vessel movements, such as propeller thrusting, to avoid sediment disturbance; • Avoiding swimming and fishing from navigation routes as much as possible; • Vessels will never be overloaded; • Necessary caution should be taken to minimize accidental spillage of oil; • Fishermen will be informed about the project and their feedback to be taken on seasonality and routes. • Adoption of adequate wastewater and industrial effluent management technology so no untreated sewage is discharged into surface water body; • Industrial, municipal and hazardous waste should be managed such that no waste is dumped or disposed in surface water body; • Direct discharge of any effluent or waste should be avoided; • Over extraction of fishery resources need to be protected; • The project authority should make a specific route for River transportation near the project site by consulting with the Department of Fisheries (DoF), Bangladesh in order to minimize the negative impacts on fishery resources.	EHS officer/Project proponent	BEZA/DOE
Ecosystem	Impact on terrestrial and aquatic ecosystem due to odour, dispersion of air pollutants and untreated liquid.	• Use acoustic insulation, where appropriate; • Fitting vehicles with effective exhaust silencers, where available; • Take caution to reduce accidental chemical spillage; • Minimize machinery operation and vehicle movements, particularly during the night hours; • Recommended measures to avoid inappropriate waste disposal include the implementation of a comprehensive Waste Management Policy which ensures the safe storage and timely treatment and removal of waste;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Use improved technology to reduce air emission; • Development of green belt throughout the periphery of the area; • Inspection will be undertaken to identify the potential of leak/spills in the different offshore components, including pipelines, and to implement corrective action if necessary; and regular monitoring to ensure water discharged complies with national limits; • Proper spill control plan to be adopted on site; • Oily water separator to be installed at the point of surface run-off discharge ; • Suggestions from Spill Contingency Plan to be strictly implemented in case of spillage; • Regular monitoring should be carried out for terrestrial and aquatic ecological and any unexpected effect should be investigated.		
Natural Resources	Impacts on natural resource availability.	• Optimize and reduce the use and consumption of fossil fuels and diesel; • Water consumption will be optimized by identifying and implementing water conservation; re-use measures, rainwater harvesting; • Optimize and reduce the use of electrical sources; • Provide training to all employees on resource conservation methods; • Use resource conserving technology.	Project proponent	BEZA/DOE
Impacts on Socio-Economy	Nuisance and disturbance to the nearby population, employment opportunities, development of infrastructure etc.	• Extending reach of Corporate Social and Environmental Responsibilities (CSER) Program; • Communication with local community though community relation department; • Compliance with the relevant regulations of child labor; • Employ local residents as much as possible; • Promote communication between workers and local people (e.g., join in local events);	Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• As a mitigation measure the land owner, share croppers, lessee farmers and the salt pan workers will be appropriately compensated as per Government Rules; • Training should be provided to the local people for their skill enhancement; • Project proponent should be responsible in giving an orientation to the migrant laborers on the local custom and tradition followed by the local population; • Prior to engagement of migrant labor, medical check-up should be carried out and copy of the medical certificate should be collected by project proponent, through sub-contractors, and maintained as part of their records; • Regular medical camps should be conducted amongst the laborers and the local population to make them aware about diseases like Typhoid, malaria, tuberculosis, STD's, HIV Aids etc.; • The positive impact can be further enhanced by committing an assured engagement level for the local community and by ensuring that priority is given those who contributed the land for project.		
Impact on Traffic	Nuisance and disturbance to the nearby population, accidents, disturbance to ecology.	• Provide a dedicated parking area for private vehicles of project personnel; • Safe driving training will be mandatory to all drivers; • Basic maintenance for vehicles will be carried out by the driver/operator; • Defects will be repaired before the vehicle is back to service; • Periodic servicing of vehicles will be carried out in accordance with the manufacturer's instructions; • Avoid vehicle movements for supply and product distribution during rush hours; • Drivers will undergo medical surveillance; • Training and licensing industrial vehicle operators of specialized vehicles such as forklifts, including safe loading/unloading, load limits;	Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Adequate planning of activities to ensure and avoid unnecessary transportation trips; • Provide driver safety training; • Prepare a traffic management plan; • Provision of a specific sea/river transportation route for vehicles including marine vessels; • Minimize night time vehicle movement.		
Community Health and Safety	Accidents with local people by the traffic of construction vehicles and any operation activities, disputes among local people and migrated workers, possibilities of disease outbreak. Community people can be affected by contaminated water, soil and water if not treated properly.	• Safety barrier and warning sign surrounding the construction site; • Monitor any effect due to operation work on local community; • Provide security and health facility to local people if any health issue or accident arises due to project activity; • Establish the plan of site safety and security measures to communities and its implementation; • Education and instruction to the project personnel and workers on local culture; • Restricting access to the site with a focus on high risk structures or areas depending on site-specific situations including fencing, signage, and communication of risks to the local community; • Emphasizing safety aspects among drivers; • Avoiding dangerous routes and times of day to reduce the risk of accidents; • Dispute settlement among stakeholders in case incidences occur; • Arrangement of worker's accommodation as necessary.	EHS officer/Project proponent	BEZA/DOE
Occupational Health and Safety	Accidents and incidents during the operation phase.	• To provide adequate health care facilities and first aid in the facility; • Washing hands and to remove outer protective cloths before going to the clean place; • Providing impervious dresses to the worker at the work place like viton gloves; • Provide eye shields or goggle shields to the worker to protect the eyes. • Provide respiratory mask especially for odour generating area; • Establish easily accessible eye wash fountain near to the work place;	EHS officer/Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
		• Arrange regular supply and laundering of work clothing. • Provide suitable washing and changing facilities. • provide post hazards information and safety resumes to the worker; • Not to take contaminated cloths to home; • Avoid direct eye and skin contact and inhalation of vapors. • Provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; • Provide adequate lavatory facilities for the number of people expected to work in the facility; • Provide adequate supplies and easy access of drinking water with a sanitary means; • Arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; • Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labeling of equipment, communicate hazard codes, electrical line etc. • To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors; • Proper maintenance of PPE and the instruction of proper use.		

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
Emergency Situation	Chemical spillage, fire, earthquake, flood, river bank erosion etc.	• Formulation of chemical management plan as necessary; • Stop discharge of the chemical if possible do it with safety. • Use foam containing fire extinguisher, dry chemicals and carbon di oxide. • Close all ignition sources. • Labeling the chemicals with the information of the chemical nature of the hazards. • Packing of the chemicals should be suitable for transportation, storage and use. • Training of safety usage and preparation of the emergency response plans; • Implementation of the proper storage and record of usage; • Applying for the acquisition of the license with management plan in accordance with the relevant law, and compliance with the law; • Provision of protective equipment and clothes to workers as necessary; • Preparation of the disaster prevention equipment and management manual; • Installation of the fire hydrants; • Implementation of emergency drill; • Compliance with the National Standard Operational Procedure for building construction; • Preparation of the disaster prevention plan such as emergency contact list; • Implementation of suggested Disaster Management Plan (DMP). • Routine maintenance of the equipment to ensure its stable condition.	Emergency response team/Project proponent	BEZA/DOE
Climate Change	Impact in the increase of GHGs by vehicle traffic and emission from operation work.	• Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible; • Provision of commuter bus.	Project proponent	BEZA/DOE

Issues	Expected Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Responsibility	
			Implementing	Supervision
	Effects on ozone layer depletion. Combustion of petrochemical is responsible for excessive amount of acid rain. Chemical use like ammonia can acidify the ground and water bodies.	• Using waste heat boiler by excess heat recovered production steam; • Using flare gas recovered system to recover flare gas; • Using energy conservation measures and high efficiency machines to minimize greenhouse gas generation; • Using heat boiler to recover excess heat by producing steam.		

8.2.1 Green Belt Development

Development of a greenbelt/tree plantation along the boundary and internal roads will be beneficial. The tree plantation will have the following objectives:

- Restoration of green cover lost due to tree felling and shrub cutting during land clearance activities;
- Restoration/preservation of genetic diversity;
- Attenuation of noise pollution from the industry to surroundings;
- Creation of aesthetic environment.
- Project proponent has a plan of tree plantation for developing green environment in order to minimize greenhouse gas. Above 10 % of total land are kept for plantation.

At least three rows of trees may be retained along the boundary. New trees can be planted to make up the gaps devoid of trees. The selection of trees and plants for greenbelt/tree plantation should be those which could grow in the existing agro climatic conditions. They should be able to survive in the local soil conditions.

Based on the above considerations and also due to loss of trees on the site, the plant species should be native (especially those which are cut from the site and for road widening) in nature. The selected plant species would need minimum level of maintenance including fertilization and other soil amelioration.

Apart from trees, the shrubs removed from the site, and other herbaceous species may also be planted in between the trees along the boundary wall. This will act as green cover, prevent soil erosion by increasing the binding capacity of the soil, and importantly act as noise barrier together with trees. Tree plantation also needs to be taken up along the roads.

8.2.2 Plan for Energy Efficiency

To ensure the energy efficiency and build up the green development, SPCL will exercise following action plan:

- Excess heat is recovered by producing steam with using waste heat boiler. It's saved the energy, environment and fuel gas.
- Flare gases is recovered by using Flare gas recovery system. Recovered fuel gas will be used as fuel for furnaces, which will save the energy and environment.
- Water will be recycled to minimize the use of fresh water and discharge to environment.
- Sulfur is recovered by using Sulfur recovery system, which will save the environment from releasing sulfur containing gases. Recovered Sulfur, itself a valuable product.
- Steam condensate will be return to the deaerator, which will minimize the water loss and energy loss.
- Sour gases and waste water treatment facilities will be set-up to control the environmental emission and effluent discharge quality as per Bangladesh standard declared by Department of Environment (DoE).

8.2.3 Corporate Social and Environmental Responsibility (CSER)

The concept of corporate social responsibility is based on the idea that not only public policy but companies, too, should take responsibility for social issues. In more recent approaches, CSER is seen as a concept in which companies voluntarily integrate social and environmental concerns into their business operations and into the interaction with their stakeholders. The idea of being a socially responsible company means doing more than comply with the law when investing in human resources and the environment.

Under the CSER framework, proposed action plans have the benefit and welfare of the society as well as environmental sustainability of the project which is given below:

Proposed Action Plans

- At policy level, the CSER trust needs to allocate a considerable resource on alternative livelihoods. The CSER trust guidelines of proposed project if any shall clearly define project role and participation in the alternative livelihoods implementation plan. The project may contribute to the alternate livelihoods plan under their CSER networks.
- The CSER trust shall engage an external agency to conduct a market study to identify livelihood options. A phased alternative livelihood plan along with financial feasibility shall be developed for all the affected villages. If required, an external agency shall be contacted to implement the livelihood plan.
- A monitoring committee shall be formulated to ensure proper implementation and documentation of the alternative livelihood plan.
- A sustainable environment friendly green belt may be proposed under the CSER fund throughout the periphery of the project area and all the unpaved open spaces if present.

Environmental and Social Management Plans to be Prepared

This Section of the EIA report provides recommendations for environmental and social management measures based on the available information at this stage of the project. However, it is planned that at a later stage, namely detailed design phase, Project proponent will prepare detailed management plans and procedures to address potential social and environmental impacts identified within this EIA and ensure implementation of the measures contained therein. Recommended management plans and/or procedures are presented in the following table. These individual plans or procedures may be stand-alone documents or combined into a larger environmental management plan addressing a range of environmental aspects, according to project needs. They may be prepared by or in collaboration with project contractors. Each management plan will document applicable legal requirements (if existing), criteria, standards, and mitigation and management commitments for the project. Monitoring and reporting requirements will be included to (1) increase baseline information, (2) confirm predicted impacts and (3) identify unforeseen impacts, thus enabling continuous improvement and adaptive management where required.

Table 59: Recommended management plans

Plan	Content/Objectives
Emergency Response Plan	Includes safe working procedures for staff, designation of safety zones and measures to protect sensitive receptors.
Waste Management Plan	Provides detailed descriptions and quantities of wastes expected to be produced by the project, direct waste flows and outline project waste collection and disposal frequencies.
Traffic Management Plan	Includes a baseline transport study and impact assessment, expected traffic movements throughout construction and operations, assessment of optimum traffic routing, recommendations for upgrading local infrastructure, recommendations for road safety education, and other procedures to mitigate and manage traffic impacts.
Noise, Dust and Light Management Plan	Includes an inventory of all noise, dust, particulate matter and light generating activities, and details control methods to be used during construction and operations.
Chemicals and Hazardous Materials Handling Plan	Outlines procedures for storage and use of chemicals and hazardous materials, including access and security, provision of PPE and distribution of MSDS information.
Decommissioning Plan	Outlines procedures for decommissioning project facilities.

8.3 Enhancement Plan

A detailed EMP with possible mitigation measures during pre-construction, construction and operational phases have been proposed in the present study. So, as a part of enhancement plan, some following measures are proposed to carry out for reducing the potential risks:

i. As the Bay of Bengal is besides the proposed project, there is high risk of tropical cyclones. So, the project authority should make protective measures against all types of natural calamities;
ii. Development of green belt by tree plantation of native flora within and around the entire location of the project;
iii. Development of rainwater harvesting system and proper drainage system;
iv. To prevent the pollution of water, air and soil, discharging industrial gaseous effluent, solid wastes, waste water before releasing out;
v. Maintain national and international environmental, social, health & safety standard;
vi. All the unpaved open places throughout the zone premises, if have, can be made greener by planting trees in order to enhance the aesthetic view of sites as well as long term environmental sustainability with the aid of CESR fund.

8.4 Contingency Plan

A contingency plan is an essential guideline for undertaking the immediate need-based response in a well-designed, organized and coordinated manner for facing any adverse incident during an emergency. Contingency plan will guide to identify the victims at risk (who, what extent, when), responsible authority and the materialistic & natural disruptions (what extent). Nature of emergency & hazardous situations may be of any or all of the following categories:

a. Emergency

- Fire, burn injury
- Accidental injury
- Electric shock

- Explosion
- Chemical spillage
- Any Medical emergency

b. Natural Disasters

- Flood
- Earthquake
- Storm/tornados/cyclone

c. Other External Factors: manmade disaster, sabotage, war etc.

The Contingency Plan will have the following minimal components:

- Accidents preventions procedures/ measures
- Fire prevention planning and measures
- Fire water storage and foam system
- Accident/emergency response planning procedure
- Communication system
- Emergency control center
- Emergency information system with role & responsibility and command structure
- Recovery procedure
- Assessment of damages and rectification
- Evaluation of functioning of disaster management plan
- Accident investigation
- Clean-up and restoration

The objectives of having an Emergency Response Plan (ERP) are to:

- Guide the authority/emergency response team (ERT) in determining the appropriate response to emergencies;
- Provide respondents/ERT with planned strategy and recognized measures;
- Guide to notify the appropriate ERT personnel and regulatory authorities;
- Manage public and media relations;
- Notify the next-to-kin of accident victims;
- Promote inter-section communications to coordinate emergency response to minimize the effects of troublesome events;
- Reducing recovery time and costs;
- Respond to immediate requirements to safeguard the environment and the community.

Generally following steps of responses can be followed to combat any emergency:

Step-1: Risk determination& immediate measures

(i) Identification of potential hazards associated with the emergency episode due to the natural events or regular activities.
(ii) Taking appropriate measures by the ERT/authority for determining the type, quality, extent of involvement.

Step-2: Local investigation: Determination of the source/reason of the event resulting to the emergency and prevent further losses.

Step-3: Detail assessment: Conduct an assessment of the incident site for any further information on hazards and taking necessary actions for remedies.

Step-4: Rehabilitation: Initiating restoration/rehabilitation measures.

Step-5: Reporting: Reporting of the occurrence of the incidence with all the details including the measures undertaken to the appropriate authority taking initiative for further steps including financial assistance etc. to the appropriate authority.

Step-6: Risk Communication: Taking steps for mass communication with addressing public and media regarding concerns and issues including human lives, property and the environment and responses to resolute the stress of the community and the country.

Functioning of following units can be helpful to combat any emergency in the industrial area. Emergency Response Cell with an:

a. Well trained emergency response team (ERT)
b. Emergency preparedness plan
c. Provision of periodic drill of emergency rescue operations; e.g. Firefighting services;
d. Emergency medical services
e. Provision of emergency transfer of patients

Health, Safety and Safe Work Environment

In accordance with the requirement of DoE, project proponent must have a plan to take adequate measures against accidents and to meet the emergency. A contingency plan should be in place to deal with any emergency or natural calamities. There should be trained emergency response teams, specific contingency plans and incidence specific equipment packages in place to deal with these types of emergencies. In case of an emergency incident occur, immediate action must be taken to mitigate the impacts. In order to minimize the possibility of injury to the responders and others it is important that emergency responders follow the steps of emergency response plan to avoid missing of any events.

The Health and Safety Management Plan is attached in Annex-5.

Work plays a central role in people's lives, since most workers spend at least eight hours a day in the workplace, whether it is on a plantation, in an office, factory, etc. Therefore, work environments should be safe and healthy. Yet this is not the case for many workers. Every day workers all over the world are faced with a multitude of health hazards, such as:

- Dusts;
- Gases;
- Noise;
- Vibration;
- Extreme temperatures.

Unfortunately, some employers assume little responsibility for the protection of workers' health and safety. In fact, some employers do not even know that they have the moral and often legal responsibility to protect workers. As a result of the hazards and a lack of attention given to health and safety, work-related accidents and diseases are common in all parts of the world.

Costs of Occupational Injury/Disease

Work-related accidents or diseases are very costly and can have many serious direct and indirect effects on the lives of workers and their families. For workers some of the direct costs of an injury or illness are:

- The pain and suffering of the injury or illness;

- The loss of income;
- The possible loss of a job;
- Health-care costs.

It has been estimated that the indirect costs of an accident or illness can be four to ten times greater than the direct costs, or even more. An occupational illness or accident can have so many indirect costs to workers that it is often difficult to measure them. One of the most obvious indirect costs is the human suffering caused to workers' families, which cannot be compensated with money.

The costs to employers of occupational accidents or illnesses are also estimated to be enormous. For a small business, the cost of even one accident can be a financial disaster. For employers, some of the direct costs are:

- Payment for work not performed;
- Medical and compensation payments;
- Repair or replacement of damaged machinery and equipment;
- Reduction or a temporary halt in production;
- Increased training expenses and administration costs;
- Possible reduction in the quality of work;
- Negative effect on other workers.

Some of the indirect costs for employers are:

- The injured/ill worker has to be replaced;
- A new worker has to be trained and given time to adjust;
- It takes time before the new worker is producing at the rate of the original worker;
- Time must be devoted to obligatory investigations, to the writing of reports and filling out of forms;
- Accidents often arouse the concern of fellow workers and influence labor relations in a negative way;
- Poor health and safety conditions in the workplace can also result in poor public relations.

Overall, the costs of most work-related accidents or illnesses are very high to the workers and their families and to the employers as well. On a national scale, the estimated costs of occupational accidents and illnesses can be as high as three to four per cent of a country's gross national product. In reality, no one really knows the total costs of work-related accidents or diseases because there are a multitude of indirect costs which are difficult to measure beside the more obvious direct costs. Project proponent will ensure health, safety and safe work environment for the officials and workers.

8.5 Compensation Plan

Workers who develop any disease/injury during construction or operational phase of the proposed project should be treated accordingly with ensuring necessary compensation by the responsible authority.

8.6 Monitoring Plan

The main purpose of a monitoring plan for the potential environmental parameters during the construction and operation phases in this project is:

- To provide a standard guideline for comparing the baseline environmental conditions (data observed/collected during the study period) and other factors with that of the construction and operational phases.

- To evaluate the effectiveness of the mitigation measures for preservation of the natural environment.
- To detect any disruption of environment according to national standards.

Several environmental components can be affected during the construction and operation of the project. Following plan has been formulated for monitoring and evaluation of environmental components with potential risk of disruption.

Table 60: Monitoring plan for proposed project

Category	Issues Monitoring Methods and Parameters	Location	Frequency	Executing Agency	Enforcement Agency
Pre-construction and construction phase					
Air Quality	NOx, SOx, CO, $PM_{2.5}$, PM_{10} etc.	3 points in the construction site	1 week/3 months	Contractor	Project proponent
Water Quality	Water, temperature, pH, SS, TDS, EC, DO, BOD_5, COD, Total coliforms, Total nitrogen, Total Phosphorus, Chromium, As, Fe, other metals etc.	Outflow of construction (at least 3 sampling points/mixing point. Well near the construction site (1 point)	Once/2 months	Contractor	Project proponent
Wastes	Amount and kind of solid wastes.	Construction site	Once/3 months	Contractor	Project proponent
Noise and Vibration	Noise and vibration level, Traffic count	Preservation area such as residence around the proposed construction site (at least 1 point)	Once (24 hours)/3 months	Contractor	Project proponent
Ecosystem	Species number	1 point in the construction area	Twice a year in dry and rainy seasons	Contractor	Project proponent
Hydrology	Groundwater level, Ground elevation level, consumption of groundwater amount	Well near the construction site	Once/ months	Contractor	Project proponent
Socio-economic Condition	The implementation status for CSR activities such as community support program	Around project Site	Once /year	Contractor	Project proponent
Occupational Health and Safety	Record of accidents and infectious diseases	Construction site	Once/month	Contractor	Project proponent
Community Health and Safety	Record of accidents and infectious diseases related to the community	Around construction site	Once/month	Contractor	Project proponent
Operation phase					
Air Quality	NO_X, SO_X, CO, CO_2, sour gas, H_2S, Volatile Organic Compounds (VOCs), aromatic hydrocarbons, HAPs etc.	Representative location inside the project area	1 week each in the dry and rainy seasons (first 3 years after starting of the operation stage)	EHS officer/Project proponent	BEZA/DOE

Category	Issues Monitoring Methods and Parameters	Location	Frequency	Executing Agency	Enforcement Agency
Water Quality	Temperature, pH, SS, DO, BOD5, COD, color, odor, Total Nitrogen, Total Phosphorus, Sulphide, polycyclic and aromatic hydrocarbons, phenols, metals derivatives, salt, naphthylenic acids etc.	At least 3 sampling points/mixing point: discharge water, upstream water, and downstream water)	Every month: Water temperature, pH, SS, DO, BOD_5, COD, color and odor, Every 3 months: all parameters	EHS officer/Project proponent	BEZA/DOE
Wastes	Amount of hazardous and non-hazardous wastes in the project site.	Project site	Twice/year	EHS officer/Project proponent	BEZA/DOE
Soil Contamination	Status of control of solid and liquid waste which causes soil contamination.	Project site	Twice/year	EHS officer/Project proponent	BEZA/DOE
Noise and Vibration	Source noise emissions (Noise level monitoring in db (A) near noise generating equipment's	Project site	Every 3 months	EHS officer/Project proponent	BEZA/DOE
Odor	Offensive odor control by the proponent	Project site	Twice/year	EHS officer/Project proponent	BEZA/DOE
Ecosystem	Species number	1 point in the project area	Twice a year in dry and rainy seasons	Project proponent	BEZA/DOE
Socio-economic Condition	The implementation status for CSER activities such as community support program.	Around Project Site	Once /year	Project proponent	BEZA/DOE
Occupational Health and Safety	Record of accidents and infectious diseases	Work sites and offices	Twice/year	EHS officer/Doctor/ Project proponent	BEZA/DOE
Community Health and Safety	Record of accidents and infectious diseases related to the community	Around the Project site	Twice/year	EHS officer/Doctor/ Project proponent	BEZA/DOE
Usage of Chemicals	Record of the type and quantity of chemicals and implementation status of control measures through self-inspection	Project Site	Biannually	Store keeper/Project proponent	BEZA/DOE

Note: *Air quality monitoring site in the construction area should be selected in consideration of keeping the same location during construction phase.

** Water quality monitoring location should be selected at least three points for one discharge point to confirm the impact of the effluent water from the project site to the existing canals/Rivers/water bodies.

8.7 Monitoring Indicators

Due to establishment of the proposed project several environmental components have potential risk of disruption either during construction or operational phases that needs to be monitored for detection and management of any damage of the environment. Following are the plausible indicators with major significance that should be monitored and evaluated for the potential risks that could be beneficial for carried out proper mitigation measures:

a) Health & safety issues of workers
b) Air quality
c) Water quality (ground water and surface water)
d) Noise level
e) River water level
f) Soil erosion
g) Waste management
h) Existence of terrestrial and marine flora & fauna (compared to the baseline scenario)

8.8 Environment Management Cell

The company will formulate the environment management cell with vision to operate the EMP requirements as suggested in the chapter. Environmental Management Cell has to be formulated for efficient & easy operation of environment management system & operations. The illustrative presentation of the EMC is presented below in the figure.

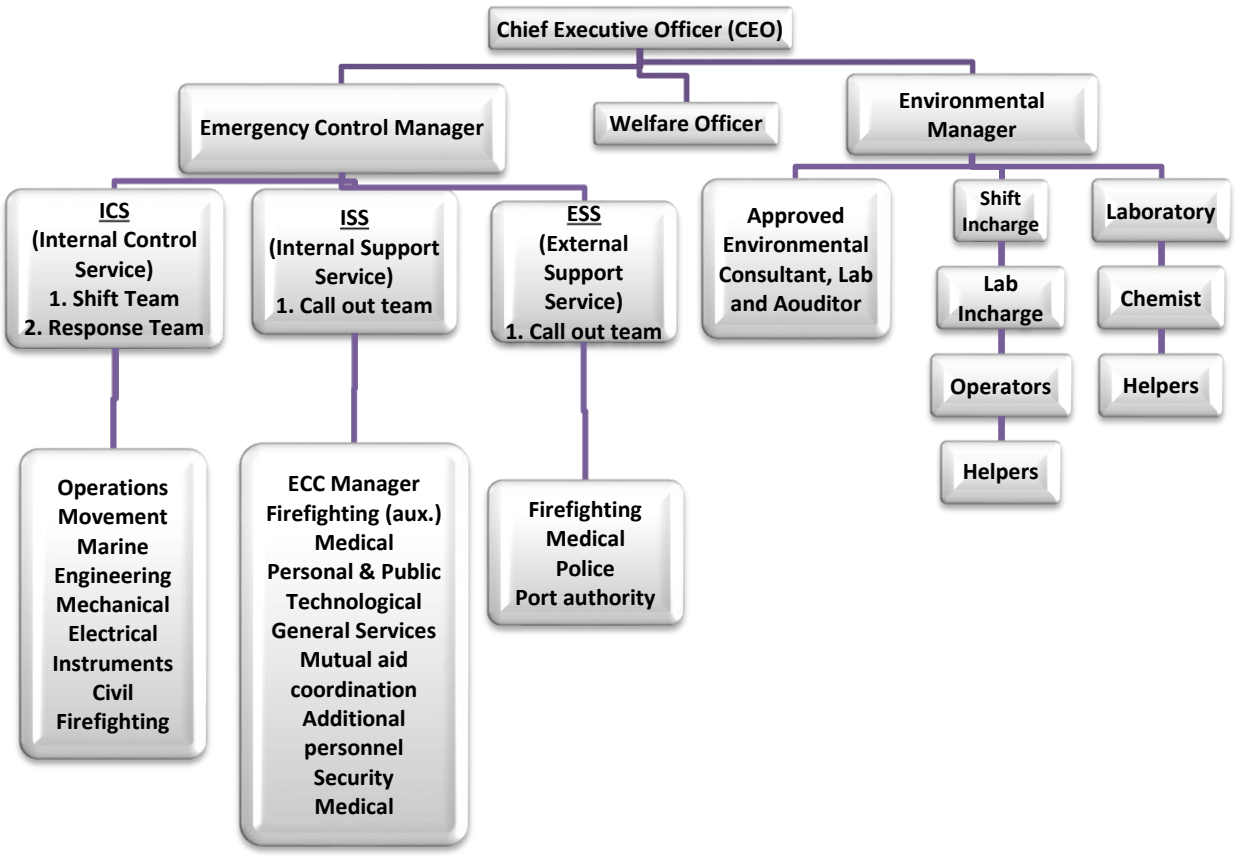


Figure 33: Typical Environment Management Cell

As indicated in Organogram, Chief Executive Officer (CEO) of the company will lead the EMS as head of the Environmental Management Cell. CEO will be assisted by Emergency Control Officer (ECO), Welfare Officer/ Pro and Environmental Manager for day to day activities of EMC. CEO will guide the subordinate staff members- Emergency Control Manager (ECM), Environmental Manager, Welfare officer for necessary action plan & activities of environmental management plan. Welfare officer will look after the operation related with government offices, public and other stakeholders for necessary operation including statutory proceedings. The technical operations including environmental monitoring and efficient operations & maintenance of pollution control equipment/machineries etc. The Lab in-charge will look after the operations of in-house monitoring & analysis of environmental samples. Approved environmental laboratory/consultant will also be appointed for the operations related with third party environmental monitoring, environmental audit (as & when required) and other techno-legal environmental services. The plant & shift in-charge will look after the plant/department level operations including ETP operation, air pollution control devices operation, process and utility operations to ensure that all instructions & action plans issued by superior authorities are efficiently followed & implemented to prevent environmental pollution & operational hazards. Primarily the Environment manager will be responsible for all technical nonconformities of EMS and he/she is responsible to prepare necessary documents & report for day to day compliance to stipulated EMS, CC&A Conditions as well as other statutory & voluntary requirements.

All necessary standard operating procedures for technical matters of EMS will be prepared by Environment Manager whereas the standard operating procedures administrative operation will be prepared by PRO. The standard operating procedures will be prepared well before the inception of operation phase of the project and the CEO will check these Necessary cleanup procedures (SOPs). After necessary corrections, CEO will forward these SOP to MD for approval and approved SOP will be controlled by responsible personnel. The approved copy of these SOP will be issued to concern personnel for day to day operations.

Up on citation of any non-conformities/non-compliance in EMS and related operations, he/she will immediately report to the CEO with necessary report/document. The ECO then will call up a meeting on urgent basis and will issue an action plan to close the noncompliance/ non-conformity. If the issue of non-conformities/non-compliance is cited to be serious or major ECO will consult CEO of the company and according to the instruction of CEO further action plan will be issued by ECO to all members of EMC. The environment manager by help of other personnel of EMC and company will start operation to resolve the issue of non-conformities/non-compliance and he/she will regularly update the CEO for the current status. Similarly CEO will give instruction to Welfare office for necessary actions required to be initiated at administrative level including necessary proceeding with other organization, govt. offices & public etc. All official declaration about the non-conformities will be made by CEO. Such declaration can also be made by Environmental Manager after authorization by CEO. Whenever required information or report of nonconformities will be submitted or issued to govt. offices or public by Welfare officer in line with the necessary instructions given by CEO.

Authorities Responsible for EMP Implementation

Structural measures (such as installation of ETP, upgradation, tanks, preventive and protective equipment etc.): Directors, Project manager, accounting head/manager, Site Officer & engineers, Contractors.

Non-Structural (SOP's, studies, implementing systems etc.): Directors, production manager, accounting head/manager, plant in-charge, safety& environment officer &engineers, contractors & operators.

8.9 Training

Training is of much importance in environmental management. Environmental science is a developing subject and the people implementing environmental strategies should remain up to date with the environmental control processes. The person in charge of the environmental monitoring team should attend suitable training courses. Besides, there shall be training programme for the general employees on environmental issues at different level.

Initial safety training is one of the most important aspects of any safety program. All employees and contractors must receive some level of basic training, specific to the facility and nature of the job. It must be ensured that appropriate orientation is given to:

- Employees
- Contactors
- Sub-contractors
- Visitors

The orientation shall also include a review of the following:

- Company safety policy and procedures;

- Specific job hazards safety precautions job responsibilities;
- Regulatory requirements;
- Company enforcement policy, and
- Worker right-to-know and authority to refuse unsafe work.

8.10 Statutory Requirements and Implementation

Both statutory requirements and regulatory requirements are those requirements that are required by law. These requirements are non-negotiable and must be complied with. Failure to comply a legal requirement may result in a fine or penalty and possibly a custodial sentence for the person or persons responsible or organization for such failure. Proposed project will also commitment to meet relevant laws and guidelines. Project proponent shall ensure that these entire statutory requirements are met in time.

8.11 Documentation

Documentation is an important step in implementing Environmental Management Plan. All statutory norms should be kept at one place for quick references. All monitoring results should be kept at selected folders which can be easily accessed. The presentation of the results should also be planned. Graphs and diagrams can be used to show the trend in environmental quality or achievement. Documents should be kept at a declared position.

All accidents and near-miss incidents shall be investigated to determine what caused the problem and what action is required to prevent a recurrence. Employees required to perform investigations shall be trained in accident investigation techniques. The incident/accident investigation should be a fact-finding exercise rather than faultfinding. The investigations will focus on collection of evidence to find out the “root cause” of the incident. The recommendations of the investigation report would be implemented in phases.

Pipeline construction and operation facilities have been and will continue to be designed to comply with the legal elements of both national and international standards, legislation, codes of practice and design specifications, and best practices. As a part of this process, measures to minimize the probability of releases and reduce potential impacts through selection of alternative processes to be considered as an integral part of the development.

Mitigation should reflect the intent and regulatory framework outlined in the GoB environmental policy and in applicable World Bank operational Directives. The purpose of impact mitigation and counter measures is to avoid creating negative impacts wherever possible, to minimize impacts where they may be unavoidable, and to generate opportunities for improvements or positive impacts where appropriate. Documentation will include:

- Major technical information in operation;
- Organizational Charts;
- Environmental Monitoring Standards, environmental and related legislation, operational procedure;
- Monitoring Records;
- Quality Assurance Plan for Monitoring;
- Emergency plans.

Chapter 9
Cost Estimation for Environmental Mitigation Measures and Monitoring

This section describes the budget plans for the environmental management and environmental monitoring by the project proponent. Proponent will take necessary environmental mitigation measures and its expenses for the environmental management not only at the construction and operation phases but also at the closing, termination, and after termination phases in accordance with their EIA study. The costs are approximate and need calibration at the time of detailed design and estimation stage.

9.1 Budget Plan for Environmental Management

Most of the mitigation measures such as, construction of ETP, waste management, trainings etc. are already included in the project cost. Main costs for mitigation measures are shown in the Table below. Detailed costs for each mitigation measure are to be calculated at the detailed design stage.

Table 61: Cost for main mitigation measures

SN	Items	Budget (per year)	
		Before/During Construction Phase	Operation Phase
1.	Construction of ETP, STP, WTP, API separator, Sour gas treatment unit, Flare gas recovery units etc.	Will be included in the Project cost	Will be included in the Project cost
2.	Greening area		
3.	Others (waste disposal, training and education)		

9.2 Budget Plan for Environmental Monitoring

In terms of budget for environmental monitoring before/during construction and operation phases, main monitoring cost related with field measurements such as air, water, and noise quality. Annual costs for field measurements in the construction phase by contractor and in the operation phase by the proponent are estimated, respectively, as shown in the Table below.

Table 62: Estimated annual costs for monitoring in the construction and operation phases

SN	Parameters	No. of Samples/Sites (per year)	Unit cost (BDT)	Total cost (BDT)/year
1.	Ambient Air Quality (SPM, $PM_{2.5}$, PM_{10}, SOx, NOx, CO_2, CO)	07	40,000	280,000
2.	Surface Water Quality: BOD, COD, DO, pH, TDS, TSS, Ammonia, Nitrate, TC, FC, heavy metals and other pollutants	07	30,000	210,000
3.	Ground water quality (Arsenic, Iron, etc.)	05	50,000	250,000
4.	Noise Quality	10	50,000	500,000
5.	Wastewater (ETP, STP)	05	45,000	225,000
6.	API separator	10	300,000	3,000,000
7.	Environment, health and safety training for staff development and ESMP evaluation	01	1,000,000	1,000,000
			Total Cost Per Year	**5,465,000**

Table 63: Estimated annual cost for manpower environmental management and monitoring

SN	Designation	Number	Cost BDT. (per month)	Cost BDT. (per year, including two full bonuses)
1.	Environmental Specialist	1	150,000	2,100,000.00
2.	Occupational health and safety Inspector	1	100,000	1,400,000.00
3.	ETP/STP In charge	18	50,000	12,600,000.00
4.	Support staff	20	20,000	5,600,000.00
			Total	**21,700,000.00**

*Cost per Year = Salary per month X 12 Months + Bonus (equal to one month salary) X 2

Chapter 10
Emergency Response Plan & Disaster Impact Assessment

10.1 Introduction

Accidental risk involves the occurrence or potential occurrence of some accident consisting of an event or sequence of events resulting into fire, natural calamities like flood and cyclone, explosion or toxic hazards to human health and environment. Risk Assessment (RA) provides a numerical measure of the risk that a particular facility poses to the public. It begins with the identification of probable potential hazardous events at an industry and categorization as per the predetermined criteria. The consequences of major credible events are calculated for different combinations of weather conditions to simulate worst possible scenario. These consequence predictions are combined to provide numerical measures of the risk for the entire facility. MCA stands for Maximum Credible Accident or in other words, an accident with maximum damage distance, which is believed to be probable. MCA analysis does not include quantification of the probability of occurrence of an accident. In practice the selection of accident scenarios for MCA analysis is carried out on the basis of engineering judgement and expertise in the field of risk analysis especially in accident analysis. Detailed study helps in plotting the damage contours on the detailed plot plan in order to assess the magnitude of a particular event. A disastrous situation is the outcome of fire, natural calamities and explosion or toxic hazards in addition to other natural causes that eventually lead to loss of life, property and ecological imbalances.

10.1.1 Methodology of MCA Analysis

The MCA analysis involves ordering and ranking of various sections in terms of potential vulnerability. The data requirements for MCA analysis are:

- Operating manual
- Flow diagram and P&I diagrams
- Detailed design parameters
- Physical and chemical properties of all the chemicals
- Detailed plant layout
- Detailed area layout
- Past accident data

Following steps are involved in the MCA analysis:

- Identification of potential hazardous sections and representative failure cases.
- Visualization of release scenarios considering type and the quantity of the hazardous material.
- Damage distance computations for the released cases at different wind velocities and atmospheric stability classes for heat radiations and pressure waves.
- Drawing of damage contours on plot plan to show the effect due to the accidental release of chemicals.

10.1.2 Past Accident Data Analysis

Analysis of events arising out of the unsafe conditions is one of the basic requirements for ensuring safety in any facility. The data required for such an analysis has either to be generated by monitoring

and/or collected from the records of the past occurrences. This data, when analysed, helps in formulation of the steps towards mitigation of hazards faced commonly. Trends in safety of various activities can be evaluated and actions can be planned accordingly, to improve the safety.

10.1.3 Hazard Identification

Identification of hazards is an important step in Risk Assessment as it leads to the generation of accidental scenarios. The merits of including the hazard for further investigation are subsequently determined by its significance, normally using a cut-off or threshold quantity. Once a hazard has been identified, it is necessary to evaluate it in terms of the risk it presents to the employees and the neighboring community. In principle, both probability and consequences should be considered, but there are occasions where it either the probability or the consequence can show to be sufficiently low or sufficiently high, decisions can be made on just one factor. During the hazard identification component, the following considerations are taken into account.

- Chemical identities;
- Location of process unit facilities for hazardous materials;
- The types and design of process units;
- The quantity of material that could be involved in an airborne release;
- The nature of the hazard (e.g. airborne toxic vapours or mists, fire, explosion, large quantities stored or processed handling conditions) most likely to accompany hazardous materials spills or releases.

10.1.4 Fire and Explosion Index (FEI)

Fire and Explosion Index (FEI) is useful in identification of areas in which the potential risk reaches a certain level. It estimates the global risk associated with a process unit and classifies the units according to their general level of risk. FEI covers aspects related to the intrinsic hazard of materials, the quantities handled and operating conditions. This factor gives index value for the area which could be affected by an accident, the damage to property within the area and the working days lost due to accidents.

10.1.5 MCA Analysis

MCA analysis encompasses defined techniques to identify the hazards and compute the consequent effects in terms of damage distances due to heat radiation, toxic releases, vapour cloud explosion etc. A list of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. Hazardous substance, on release can cause damage on a large scale. The extent of the damage is dependent upon the nature of the release and the physical state of the material. In the present report the consequences for flammable hazards are considered and the damages caused due to such releases are assessed with recourse to MCA analysis.

Flammable substances on release may cause Jet fire and less likely unconfined vapour cloud explosion causing possible damage to the surrounding area. The extent of damage depends upon the nature of the release. The release of flammable materials and subsequent ignition result in heat radiation wave or vapour cloud depending upon the flammability and its physical state. Damage distances due to release of hazardous materials depend on atmospheric stability and wind speed. It

is important to visualize the consequence of the release of such substances and the damage caused to the surrounding areas.

10.1.6 Fire and Explosion Scenarios

Combustible materials within their flammable limits may ignite and burn if exposed to an ignition source of sufficient energy. On process plants, this normally occurs as a result of a leakage or spillage. Depending on the physical properties of the material and the operating parameters, the combustion of material in a plant may take on a number of forms like jet fire, flash fire and pool fire.

10.1.7 Flash Fire

A flash fire is the non-explosive combustion of a vapour cloud resulting from a release of flammable material into the open air, which after mixing with air, ignites. A flash fire results from the ignition of a released flammable cloud in which there is essentially no increase in combustion rate. The ignition source could be electric spark, a hot surface, and friction between moving parts of a machine or an open fire. Flash fire may occur due to its less vapour temperature than ambient temperature. Hence, as a result of a spill, they are dispersed initially by the negative buoyancy of cold vapours and subsequently by the atmospheric turbulence. After the release and dispersion of the flammable fuel the resulting vapour cloud is ignited and when the fuel vapour is not mixed with sufficient air prior to ignition, it results in diffusion fire burning. Therefore the rate at which the fuel vapour and air are mixed together during combustion determines the rate of burning in the flash fire.

The main dangers of flash fire are radiation and direct flame contact. The size of the flammable cloud determines the area of possible direct flame contact effects. Radiation effects on a target depend on several factors including its distance from the flames, flame height, flame emissive power, local atmospheric transitivity and cloud size. Most of the time, flash combustion lasts for no more than a few seconds.

10.1.8 Natural Calamities

Natural calamities like river bank erosion, flood, earthquakes etc. can occur within the area. The project site falls under the earthquake zone II which indicate medium intensity of earthquake.

10.2 Disaster Management Plan (DMP)

10.2.1 Approach to Disaster Management Plan

Onsite Emergency or disaster is an unpleasant sudden event of such a magnitude which may cause extensive damage to life and property, due to in-plant emergencies resulting from deficiencies in operation, maintenance, design and human error; natural calamities like flood, cyclone and earthquake; and deliberate and other acts of man like sabotage, riot, war etc. It is important for every industry to have a well-documented Emergency Plan to meet any major untoward incident or disaster. In view of this, an approach to Disaster Management Plan (DMP) to tackle the emergencies, SPL Petrochemical Complex Limited has been delineated in the following sections. Roles and responsibilities of key personnel have also been defined in the plan.

10.2.2 Formulation of DMP and Emergency Services

SPL Petrochemical Complex Limited will formulate a Disaster Management Plan for better and safe management of their plants. The DMP is related to the final assessment and it is the responsibility of the plant management document including the following elements.

- Assessment of the size and nature of the events foreseen and the probability of their occurrence;
- Formulation of the plan and liaison with authorities, including the emergency services;
- Procedures for raising the alarm and communications both within and outside the works;
- Appointment of key personnel and their duties and responsibilities, especially for works incident controller and works main controller;
- Emergency control centre;
- Action on-site;
- Action off-site.

The plan is prepared to set out the way in which designated people at the site of the incident can initiate supplementary action both inside and outside the works at an appropriate time. An essential element of the plan must be the provision for attempting to make safe the affected unit, for example by shutting it down. On a complex site, the plan includes the full sequence of key personnel to be called in from other sections or from off site.

10.2.3 Need for Disaster Management Plan

Different types of industries will produce a lot of toxic, highly reactive, explosive or inflammable chemicals which are potentially hazardous not only to the human beings, flora and fauna but also to all forms of property and our environment as a whole. Thus, extreme care is essential in handling such chemicals in any form and at all stages of manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion or sale. Several agencies of the Government are entrusted with the responsibility of ensuring safe handling and management of hazardous chemicals under acts and rules made for the purpose. In spite of these measures, the possibility of accidents cannot be ruled out. Human errors and mechanical, electrical, instrumental or system failures have, on occasions, led to severe disasters. Accidents occurred at Bhopal, Mexico and other parts of the world have made people concerned with the dangers of chemical accidents. Occurrence of such accidents makes it essential that the Governments as well as the local authorities are fully prepared to mitigate the sufferings and meet the eventualities resulting from any unfortunate occurrence of chemical accidents in our country.

Following are the general types of Emergency /Disaster which lead to preparation of disaster management plan:

- Fire in tank farm area
- Large oil spillage which may escape outside the plant boundary
- Major fire / explosion in unit area
- Toxic gas release
- Major Earthquake above 7 Richter Scale
- Flood or river bank erosion.

10.2.4 Objectives of Disaster Management Plan

The purpose of DMP is to give an approach to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies associated to production and operations in the site. The overall objectives of DMP are to:

- Ensure safety of people, protect the environment and safeguard commercial considerations;
- Immediate response to emergency scene with effective communication network and organized procedures;

- Obtain early warning of emergency conditions so as to prevent impact on personnel, assets and environment;
- Safeguard personnel to prevent injuries or loss of life by protecting personnel from the hazard and evacuating personnel from an installation when necessary;
- Minimize the impact of the event on the installation and the environment, by:
    - Minimizing the hazard as far as possible
    - Minimizing the potential for escalation
    - Containing any release
- To provide guidance to help stack holders take appropriate action to prevent accidents involving hazardous substances and to mitigate adverse effects of accidents that do nevertheless occur.

10.2.5 Different Phases of Disaster

Warning Phase

Emergencies/disasters are generally preceded by warnings during which preventive measures may be initiated. For example release of light hydrocarbons, uncontrollable build-up of pressure in process equipment, weather forecast give warning about formation of vapour cloud, cyclones, equipment failure etc. This is the phase when emergency/disaster actually strikes and preventive measures may hardly be taken. However, control measures to minimize the effects may be taken through a well-planned and ready-to-act disaster management plan. The duration may be from seconds to days.

Rescue Phase

This is the phase when impact is almost over and efforts are concentrated on rescue and relief measures.

Relief Phase

In this phase, apart from organization and relief measures internally, depending on severity of the disaster, external help should also be summoned to provide relief measures (like evacuations to a safe place and providing medical help, food clothing etc.). This phase will continue till normalcy is restored.

Rehabilitation Phase

This is the final and longest phase. During which measures required to put the situation back to normal as far as possible are taken. Checking the systems, estimating the damages, repair of equipment's and putting them again into service are taken up. Help from revenue/insurance authorities need to be obtained to assess the damage, quantum of compensation to be paid etc.

Key Elements

Following are the key elements of Disaster Management Plan:

- Basis of the plan
- Accident/emergency response planning procedures
- On-site Disaster Management Plan
- Off-site Disaster Management Plan.

10.2.6 Basis of the Plan

Identification and assessment of hazards is crucial for on-site emergency planning and it is therefore necessary to identify what emergencies could arise in production of various products and their storage. Hazard analysis or consequence analysis gives the following results.

- Hazards from spread of fire or release of flammable and toxic chemicals from storage and production units.
- Hazards due to formation of pressure waves due to vapour cloud explosion of flammable gases and oil spill hazards.

10.2.7 Emergency Planning and Response Procedures

Emergency rarely occurs; therefore activities during emergencies require coordination of higher order than for planned activities carried out according to fixed time schedule or on a routine day-to-day basis. To effectively coordinate emergency response activities, an organizational approach to planning is required. The important areas of emergency planning are organization and responsibilities, procedures, communication, transport, resource requirements and control centre. Offsite emergency requires additional planning over and above those considered under onsite plans, which should be properly integrated to ensure better coordination.

The emergency planning includes anticipatory action for emergency, maintenance and streamlining of emergency preparedness and ability for sudden mobilization of all forces to meet any calamity.

10.2.8 On-site Disaster Management Plan

Onsite emergency/disaster is an unpleasant event of such magnitude which may cause extensive damage to life and property due to plant emergencies resulting from deficiencies in operation, maintenance, design and human error, natural calamities like flood, cyclone and earthquake; and deliberate and other acts of man like sabotage, riot and war etc. an onsite disaster may occur all of a sudden or proceeded by a major fire. Purpose for the on-site disaster management plan is-

- To protect persons and property of processing equipment's in case of all kinds of accidents, emergencies and disasters;
- To inform people and surroundings about emergency if it is likely to adversely affect them;
- To inform authorities including helping agencies (doctors, hospitals, fire, police transport etc.) in advance, and also at the time of actual happening;
- To identify, assess, foresee and work out various kinds of possible hazards, their places, potential and damaging capacity and area in case of above happenings. Review, revise, redesign, replace or reconstruct the process, plant, vessels and control measures if so assessed.

In order to handle disaster/emergency situations, an organizational chart entrusting responsibility to various personnel of the plant and showing their specific roles should be available. Following fire protection facilities are available to combat the emergencies and depending upon the type of emergencies any one or combination of the facilities are applied.

- Fire Water System
- Carbon Dioxide System
- Foam System
- First Aid Fire Fighting Equipment
- Mobile Fire Fighting Equipment
- Gas / Fire Detection and Alarm System.

Before Crisis

- Prepare a plan of the storage, handling and pumping stations premises and surroundings showing therein the areas of various hazards like fire, explosion, toxic releases and also location of assembly points, fire station or equipment's room, telephone room, first aid or

ambulance room, emergency control room, main gate, emergency gates, normal wind direction, outside fire station, hospital and other services. Mention their distances from proposed activities.

- The fire protection equipment shall be kept in good operating condition at all the time and fire-fighting system should be periodically tested for people functioning logged for record and corrective action.
- The fire-fighting training shall be provided to all officers, truck drivers and other employees who are likely to be present in installation.
- There should be regular mock fire drills once a month record of such drills shall be maintained.
- Every employee or authorized person working in the production shall be familiarized with the fire alarm signal and shall know the location of fire alarm point nearest to place of work.
- Assign key personnel and alternate responsible for site safety.
- Describe risk associated with each operation conducted.

During Crisis

- Monitor the behaviour of entrant for any effects that suggests they should be evacuated;
- Evacuate the space if any hazard that could danger the entrant is detected;
- Perform no other duties that may interfere with their primary responsibilities;
- Notify the attendant if they experience any warning signs or symptoms of exposures or detect a dangerous condition;
- Exit the permit space when instructed by attendant;
- Reporting Procedure.

In the event of fire from accidental release of flammable gas or liquid, a person seeing the incident will follow the laid down procedure in the plant and report as follows:

- Will dial the nearest telephone;
- Will state his name and exact location of emergency;
- Will contact affected officers on duty;
- People reporting the accident will remain near the location to guide emergency crew arriving at the scene.

In case fire emergency person should activate the nearest available push button type instrument which will automatically sound an alarm in fire control room indicating the location of fire.

After Crisis

- Report injuries or blood or body fluid exposures to the appropriate supervisor immediately.

Assembly points:

Assembly points shall be set up farthest from the location of likely hazardous events, where pre-designed persons from the works, contractors and visitors would assemble in case of emergency. Up-to date list of pre-designed employees shift wise must be available at these points so that roll call could be taken. Pre-designated persons would take charge of these points and mark presence as the people come into it.

- Wash wounds and skin sites that have been affected with soap & water;
- Workers should be seen as soon as possible by a health professional;

- Provide information to the relevant public authority and community including other closely located facilities regarding the nature of hazard and emergency procedure in event of major accident;
- Record and discuss the lessons learned and the analysis of major accidents and misses with employees and employee representative.

10.2.9 Emergency Organization Structure

Following are the key personnel and the units in the plant which are responsible to take appropriate actions during emergencies.

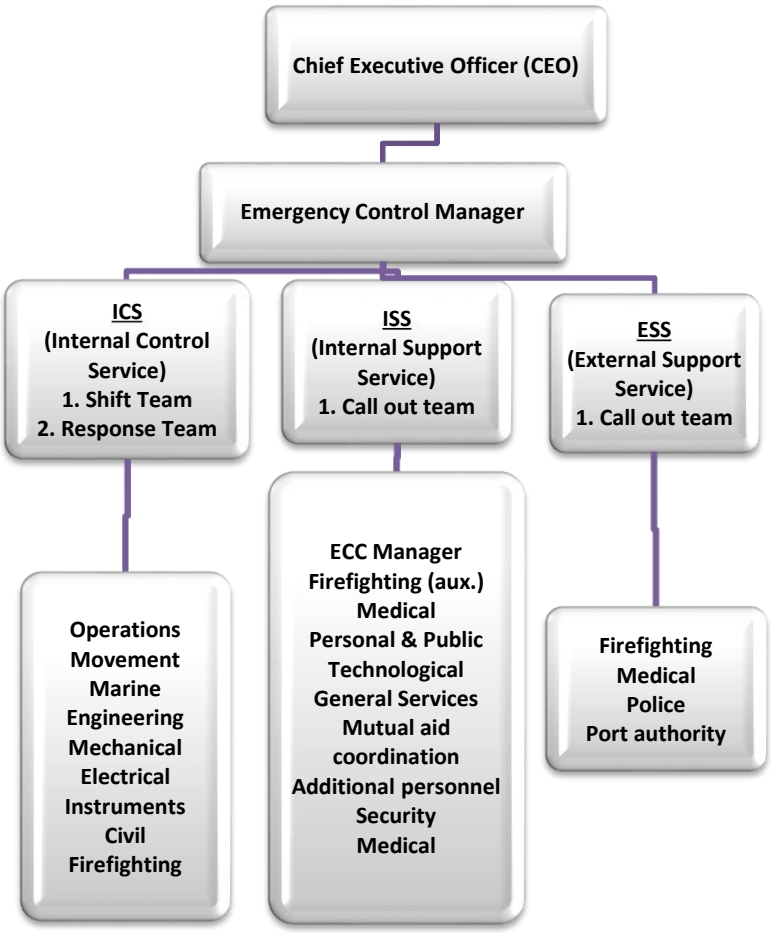


Figure 34: The incident command organogram for emergency situation

Here,
Head of Emergency Control/ Leader/ Plant Chief= Chief executive Officer
ECC Manager = Emergency Control Center Manager/ Safety In-Charge
ICS= Internal Control Service
ISS= Internal Support Service
ESS= External Support Service
Responder = SPCL employees who's are involved in EMP
Firefighter = In Emergency situation all trained employee of SPCL will work as a firefighter
EMP = Emergency Management Plan

The first action is that the following Response Teams move to their predetermined reporting locations:

(1) Fire service on shift.
(2) Security force on shift
(3) Medical service on shift.
(4) Emergency/ Safety Manager
(5) Department heads or duty officer for:

i. Emergency/Safety services
ii. Operations
iii. Movements
iv. Engineering
v. Firefighting

These Response Teams, together with shift personnel of all departments, form the Internal Control Services. As necessary, the Emergency Manager will then call upon the Internal Support Services consisting of the following Call-out Teams:

i. Deputy emergency manager
ii. Auxiliary firefighters
iii. Auxiliary first aiders - personnel and public relations
iv. Technological services
v. General services
vi. Mutual Aid coordinator
vii. Medical
viii. Security
ix. Additional personnel via telephone call lists

Outside normal working hours, or in the absence of key personnel, the responsibilities are delegated to persons on "duty rosters". Additionally, depending on local circumstances, the Head of Emergency Control may call upon External Support Services via special arrangements or in compliance with legal requirements. External Call-out Teams could come from the local Police, local Port Authority, local Fire Brigade and local Medical Agencies or Health Authority.

It should be borne in mind that at the outbreak of an emergency there may be limited manpower immediately available on site, normally restricted to the operations shift crew only. The delay in arrival of nominated key personnel in the emergency organization will vary greatly with the time of the start of the incident. During daytime on week-days staff is readily available from offices and the works.

Shift In-charge should be able to execute these extended responsibilities in the initial phase of the emergency; the precise emergency task of each shift team member must be clearly defined.

10.2.10 Incident Command System (ICS)

Major incident can create special problems can result in the need for a larger organizational framework to effectively manage the incident. The following flowchart identifies the steps that should be followed once notification of serious incident has been reported to the Control Room.

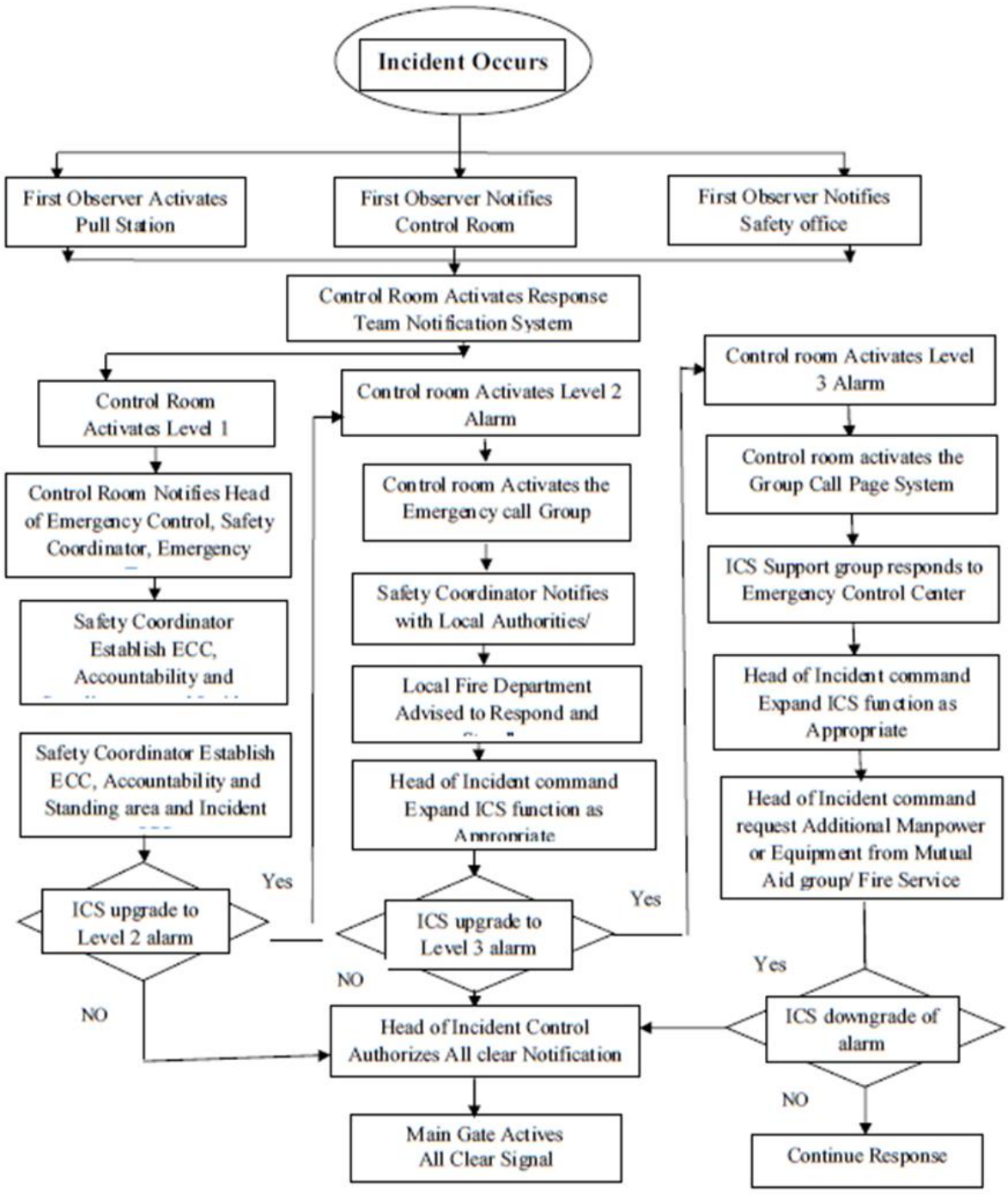


Figure 35: Incident commanding system

10.2.11 Role and Responsibilities

The duties & responsibilities of different personnel of Emergency Response Team in the emergency situation are described as follows:

Head of Emergency Control

Chief Executive Officer of SPCL is the core person during any emergency situation happen. As a Head of Emergency Control he provides strategic guidance and resource supports as needed for overall coordination and control. He is the chief decision making person in any emergency situation.

- Assess the situation and/or obtain a briefing from the prior Incident personnel.
- Determine incident objectives and strategy.
- Establish the immediate priority.
- Ensure Planning meetings are scheduled as required.
- Ensure the adequate safety measures are in place.
- Approve and authorize the implementation of an Incident Action plan.
- ECC Manager, Operation & Maintenance team leaders, Incident Controller follows and executes his command and instruction during emergency.
- Give instruction about operational containment actions, e.g. "isolation of source of the problem, emergency shutdown/depressurizing, pump-out, movements/marine action;
- Puts the relevant Emergency Call-Out Plan into effect;
- Sets up office in the Central Emergency Control Centre;
- Arrange required external support service.
- Ensures coordination of mutual aid supports
- Agrees the content of statements to the news media via the personnel and public affairs officer or by himself.
- Confirms that the relevant firefighting/emergency tactics and actions are in progress, in consultation with those in direct charge of these activities; controls, via the security force, the traffic in the area, arranges for road blocks in consultation with his key officers; arranges for the relief of key personnel when the emergency situation is prolonged; ensures that general support services are provided, e.g. catering, correspondence/telexes, weather reports etc. liaises with the External Support Services and the authorities;
- Oversee rescue of injured and trapped personnel;
- Instruct SPCL responsible personnel about the post-emergency rehabilitation of the area;
- Makes arrangements to investigate the incident and the response operation, and to prepare a report to management.
- Authorize release of information to the news media
- Order the demobilization of the incident when appropriate.

Emergency Control Manager (ECM)

The ECC Manager is responsible for assessing the emergency category, co-coordinating between different on-site and off-site responding group, rescue injured people and arrange their proper treatment. He therefore:

- Conducts the On-site appraisal and defines or confirms the emergency category
- Considers the need to activate a Forward Control Centre as the situation so warrants
- Inform to Head of Emergency Control about external support services requirement
- Ensures that the Medical Emergency Plan is executed e.g. first aid stations operational, casualties receiving adequate treatment, transport of the injured to clinics/hospitals, arranging for additional medical expertise or help as required
- Makes arrangements for search and counting of people
- Ensures that the operational containment actions are progressing, e g" isolation of source of the problem, emergency shutdown/depressurizing, pump-out, movements/marine actions
- Ensure that the fire-water pumps are performing satisfactorily and are continuously monitored

- Confirms that the relevant firefighting/emergency tactics and actions are in progress, in consultation with those in direct charge of these activities; controls, via the security force, the traffic in the area, arranges for road blocks in consultation with his key officers; arranges for the relief of key personnel when the emergency situation is prolonged; ensures that general support services are provided, e.g. catering, correspondence/telexes, weather reports etc. liaises with the External Support Services and the authorities
- Take action to rescue of injured and trapped personnel
- Arranges for personal information/support for relatives of those injured
- Liaise with local authorities and company fire officers
- Liaise with other officers (medical, safety) to ensure the transfer of advice and information;
- Makes arrangements for an emergency log
- Ensures that steps are taken to preserve evidence and records, which is important for the subsequent investigation into the causes of the incident
- Initiates the post-emergency rehabilitation of the area
- Investigate the incident and the response operation, and to prepare a report to management.

Incident Controller (IC)

The Incident Controller may be Operation Head or the Shift In-Charge. He reports to the Head of Emergency Control, is in direct charge of the operational containment action sand has overall responsibility for the integrated emergency actions in the field of fire-fighting and operations. The Incident Controller will:

- Ensure that all necessary operational actions are initiated such as isolation of source of leakage, emergency shutdown, decommissioning of facilities in distress or endangered, depressurizing, and other emergency actions as required;
- Oversee the overall direction of the fire-fighting tactics;
- Coordinate initial personnel evacuation;
- Ensure that personnel make use of appropriate life-supporting and protective equipment;
- Ensure that the installed plant protection facilities have been activated and are functioning;
- Inform the Head of Emergency Control/ ECC Manager of any existing or potential hazards which may have a bearing on the incident control tactics e.g. gas release, overflowing drains, structural collapse, or other escalation of the incident;
- Coordinate essential processing and emergency arrangements with other processing/movements sections, e g. product and process materials rundown/supplies, utilities;
- Arrange engineering services for e.g. spading, blinding flanges
- Ensure that appropriate marine emergency actions are taken in coordination with the appropriate harbor authorities. (e.g. In-Charge of tankers)
- Ensure that the area has been made safe (e g. no ignition sources, road blocks, no open bleeders or vents);
- Supervise post-emergency activities in the problem area;
- Keep the Head of Emergency Control fully informed on the progress of the emergency actions and requirements.

10.2.12 Off-site Disaster Management Plan

Emergency is a sudden unexpected event, which can cause serious damage to personnel life, property and environment outside the boundary wall of the refinery as a whole, which necessitate evolving Off-site Emergency Plan to combat any such eventuality. In Offsite disaster management plan, many agencies like Revenue, Public Health, Fire Services, Police, Civil Defense, Home Guards, Medical Services and other Voluntary organization are involved. Thus, handling of such emergencies requires an organized multidisciplinary approach.

Evacuation of people, if required, can be done in orderly way. The different agencies involved in evacuation of people are Civil Administration (both state and central), non Govt. organizations, factory Inspectorate and Police authorities.

Fire

Effects of fire on population will be mainly due to thermal radiation. In such cases, houses situated to the proximity of disaster need to be evacuated, although a severe smoke hazard due to fire is to be reviewed periodically.

Explosion

An explosion will give a very little time to warn population and areas affected may be much longer than that in case of fire. The effects of explosion on population will be mainly due to shock waves, flying splinters, collapse of structures and exposure to thermal radiation.

Toxic gas/vapour release

A toxic gas release will generally threat much larger area and population, exposed to the drifting cloud of toxic gases and vapours. The time available for warning population will depend on the point of release, wind direction and velocity.

Huge oil spillage may lead to escape of Oil out-side the factory premises and take the route of our effluent discharge channel. People outside the complex may be warned not to collect oil and provide any source of ignition to create fire in the effluent discharge channel.

The purpose of the off-site disaster management plan is:

- To save lives and injuries and to prevent or reduce property losses;
- To provide for quick resumption of normal situation or operation;
- To make explicit the inter related be suggested if necessary;
- To make explicit inter related set of actions to be undertaken in the event of an industrial accident posing hazards to the community;
- To inform people and surrounding about emergency and disaster if it is likely to adversely affect machinery will be established for this purpose to guide the people in proper way
- To plan for rescue and recuperation of casualties and injuries. To plan for relief and rehabilitation;
- To plan for prevention of harms, total loss and recurrence of disaster. It will be ensured that absolute safety and security is achieved within the shortest time.

Before Crisis

This will include the safety procedure to be followed during an emergency through posters, talks and mass media in different languages including local language. Leaflets containing do's/ don'ts before and during emergency should be circulated to educate the people in vicinity.

- People in vicinity of hazardous installation, and others who are potentially affected in the event of an accident, should be aware of the risks of accidents, know where to obtain information concerning the installation, and understand what to do in the event of an accident.
- Non-governmental Organizations (NGO's) (Such as environmental, humanitarian and consumer group) should motivate their constituents and others, to be involved in risk reduction and accident prevention efforts.
- They should help to identify specific concerns and priorities regarding risk reduction and prevention, preparedness and response activities.
- NGO's should facilitate efforts to inform the public and should provide technical assistance to help the public analyse and understand information that is made available.
- Public authorities (at all levels) and management of hazardous installation should establish emergency planning activities/program's for accidents involving the hazardous substance.
- All parties who will be involved in emergency planning process. In this respect public health authorities, including experts from information centres should be involved in relevant aspects of offsite emergency planning.
- Emergency warning alert system should be in place to warn the potentially affected public, or there is an imminent threat of an accident.
- The system chosen should be effective and provide timely warning. Suitable warning system could include or a combination of for e.g.: sirens, automatic telephone message, and mobile public address system.

During Crisis

Central Control Committee: As the off-site plan is to be prepared by the government a central control committee shall be formed under the chairmanship of area head. Other officers from police, fire, factory, medical, engineering, social welfare, publicity, railway, transport and requisite departments shall be incorporated as members. Some experts will also be included for guidance. The functions of committee should be:

- To work as main co-coordinating body constituted of necessary district heads and other authorities with overall command, coordination, guidance, supervision, policy and doing all necessary things to control disaster in shortest times.
- To prepare, review, alter or cancel this plan and to keep it a complete document with all details.
- To take advice and assistance from experts in fields to make plan more successful.
- To set in motion all machineries to this plan in event of disaster causing or likely to cause severe damage to public, property or environment.
- The incident control committee, traffic control committee and press publicity committee will first be informed, as they are needed first.

Medical Help, Ambulance and Hospital Committee: This committee consisted of doctors for medical help to the injured persons because of disaster. Injuries may be of many types. As such doctors are rarely available we have to mobilize and utilize all available doctors in the area.

Functions and duties of the committee include:

- To give medical help to all injured as early as possible.
- Civil surgeon is the secretary who will organize his team.
- On receiving information to rush to spot he will immediately inform his team and will proceed with all necessary equipment's.
- First aid and possible treatment shall be provided at the spot or at some convenient place and patients may be requested to shift to hospitals for further treatment.
- All efforts shall be made on war basis to save maximum lives and to treat maximum injuries.
- Continuity of the treatment shall be maintained till the disaster is controlled.

Traffic Control, Law and Order: The committee is headed by District Superintendent of Police. Functions and duties of this committee should be:

- To control traffic towards and near disaster, to maintain law and order.
- To evacuate the places badly affected or likely to be affected.
- To shift the evacuated people to safe assembly points.
- To rehabilitate them after disaster is over.
- Necessary vehicles, wireless sets and instruments for quick communications shall be maintained and used as per need.

After Crisis

At the time of disaster, many people may badly be affected. Injured people shall be treated by medical help, ambulance and hospital committee, but those not injured but displaced kept at assembly points, whose relative or property is lost, houses collapsed and in need of any kind of help shall be treated by this welfare and restoration committee. Functions and duties of this committee are:

- To find out persons in need of human help owing to disastrous effect.
- They may give first aid if medical team is not available.
- They will serve the evacuated people kept at assembly points. They will arrange for their food, water, shelter, clothing, sanitation, and guidelines to reach any needful places.
- They will look for removal and disposal of dead bodies, for help of sick, weak, children and needy persons for their essential requirements.
- The team will also work for restoration of detached people, lost articles, essential commodities etc.
- The team will also look after the restoration of government articles.
- The team will also ensure that the original activities, services and systems are resumed again as they were functioning before the disaster.

Police Department

- The police should assist in controlling of the accident site, organizing evacuation and removing of any seriously injured people to hospitals.

- Co-ordination with the transport authorities, civil defense and home guards.
- Co-ordination with army, navy, air force and state fire services.
- Arrange for post mortem of dead bodies.
- Establish communication centre.
- Fire Brigade.
- The fire brigade shall organize to put out fires and provide assistance as required.

Hospitals and Doctors

- Hospitals and doctors must be ready to treat any injuries.
- Co-ordinate the activities of Primary Health Centres and Municipal.
- Dispensaries to ensure required quantities of drugs and equipment's.
- Securing assistance of medical and paramedical personnel from nearby hospitals/institutions.
- Temporary mortuary and identification of dead bodies.

Media

- The media should have ready and continuous access to designated officials with relevant information, as well as to other sources in order to provide essential and accurate information to public throughout the emergency and to help avoid confusion.
- Efforts should be made to check the clarity and reliability of information as it becomes available, and before it is communicated to public.
- Public health authorities should be consulted when issuing statements to the media concerning health aspects of chemical accidents.
- Members of the media should facilitate response efforts by providing means for informing the public with credible information about accidents involving hazardous substances.

Non-governmental organizations (NGOs)

NGO's could provide a valuable source of expertise and information to support emergency response efforts. Members of NGOs could assist response personnel by performing specified tasks, as planned during the emergency planning process. Such tasks could include providing humanitarian, psychological & social assistance to members of community and response personnel.

Duties of NGOs are listed below:

- Evacuation of personnel from the affected area;
- Arrangements at rallying posts and parking yards;
- Rehabilitation of evacuated persons;
- Co-ordination with other agencies such as police, medical, animal husbandry, agriculture, electricity board, fire services, home guards and civil defense;
- Establishing shelters for rescue, medical, fire-fighting personnel.
- Evacuation of personnel from the affected area;
- Arrangements at rallying posts and parking yards;
- Rehabilitation of evacuated persons;
- Co-ordination with other agencies such as police, medical, animal husbandry, agriculture, electricity board, fire services, home guards and civil defense;
- Establishing shelters for rescue, medical, fire-fighting personnel.

10.2.13 Mock Drills

As per the Industrial Major Accident Hazard Rules-

a) The occupier shall ensure that a mock drill of the on-site emergency plan is conducted every six months.
b) A detail report of the mock drill conducted shall be made immediately available to the concerned authority.

Accordingly, Onsite Disaster Mock Drills are conducted once in six months. Also, Major Fire and Minor Fire mock drills are conducted once in three months and one month respectively.

Lessons Learned System for Mock Drills

Performances during the mock drills are reviewed by CEC Co-coordinators and other involved persons including observers. Observations/shortcomings are reviewed and recommendations are made for improvements which are followed by F&S for compliance. The action points from the mock drill observations should be circulated to all concerned for liquidation.

All Clear / Re-entry Procedures

Chief Emergency Controller (CEC) will declare "All Clear" after control of the Incident and arrange measures required for post Disaster control period and ask Fire Station to Blow 2 minutes straight run siren.

After incident normalization, CEC would ask Unit in-charge to visit and check the incident site along with representatives of Inspection and F&S and also Maintenance (Electrical / Mechanical / Civil/ Instrumentation/ Rotary) as needed. Standard Checks particular to a unit will be provided by respective Area Managers. Based on feedback of the team, CEC would allow re-entry / resumption of operations at the incident site.

Evacuation Plan

Purpose

To establish method of systematic, safe and orderly evacuation of all the occupants in case of fire or any emergency, in the least possible time, to a safe assembly point through nearest safe means of escape. Additionally to use available fire appliances provided for controlling or extinguishing fire and safeguarding of human life.

Fire Escape Drill Procedure

- In the event of fire condition or on hearing the fire alarm all the occupants of the building shall immediately leave the work area and proceed towards nearest safe escape route. A care should be taken before leaving the workplace so that the escape route shall not be blocked due to chairs or other similar object.
- Security In-charge will ensure the access control system is defeated for safe evacuation of all the occupants from the affected building.
- The occupants will have to leave the affected area / block / building in a speedy and orderly manner.

- Before leaving the workplace occupants will switch off electrical gadgets such as AC, Computers, Water heaters, etc. The area owner of the building will ensure electric supply cut off to the affected building.
- The emergency exit / normal exit if not affected due to fire and / or smoke shall be used for speedy evacuation.
- All occupants will follow in a row while escaping from the block / building. Unnecessary haste and crowding shall be avoided on the escape route. Panic actions of the occupants will definitely delay the evacuation.
- The occupants having visitors shall ensure the safe evacuation of the visitor along with them to the safe assembly point.
- Efforts shall be made to control or extinguish the fire with the help of available fire extinguishers in that area.
- Building / block in-charge shall ensure the safe escape and orderly evacuation of all the occupants.
- All occupants after being evacuated shall assemble at designate safe assembly point. Block/building in-charge will arrange for head count to ensure that all the occupants have been safely evacuated.
- Security in-charge shall ensure that all the visitors have been evacuated as per visitor entry register/gate pass register. The visitors shall evacuate from the building / block along with the occupants and report to security in charge.
- The missing/suspected trapped occupants will be searched and rescued by the fire crew.
- Upon All-Clear signal from the incident controller, occupants can go back to their work place.

Do's

- Leave your workplace immediately and rush through safe escape route.
- Evacuate in a speedy but orderly manner.
- Help elderly and handicapped persons for evacuation.
- Assemble at safe assembly point and report to your floor coordinator.

Don'ts

- Panic.
- Re-enter in the affected building.

Training

On job training to the engineers on various facets of risk analysis would go a long way in improving their horizon which in turn is expected to reflect in the operation of plant, especially from the safety stand point. In order to combat with emergency situations arising out of accident release of hazardous chemicals, it is necessary for industries to prepare an exhaustive offsite and onsite emergency preparedness plan. The fire crew belonging to the fire-fighting department shall be given intensive training for the use of all equipment and in various fire-fighting methods for handling different types of fires.

10.2.14 Checklist for Capability Assessment

The checklist will help in assessing the preparedness, prevention and response resources capabilities. The points included in the checklist are only indicative and there is a need to closely examine the local requirements while preparing the checklist.

For good control and management of an incident, there are three important requisites.

- Defined organization
- Effective means
- Trained people

The organization has to be properly structured for routine as well as emergency purposes with clear understanding of duties and responsibilities. The structure has to consider an execution and speedy implementation of the response plans; while at the same time, it should be flexible enough to tune itself to the fast changing situations. All plans and procedures for emergency handling should be established. Checklists in the form of Do's and Don'ts of preventive maintenance, strengthening of HSE, manufacturing utility staff are listed in the subsequent subsections. Work permit check list is described below:

Table 64: Work permit check list

Sl. No.	Precaution to be taken	Yes	No
1.	Electrically isolated and fuse removed. Lock out-Tag out (LOTO) followed		
2.	Flow isolated by closing valves		
3.	De-pressurized – vacuum released		
4.	Vessel cooled		
5.	Drained fully and drain kept open		
6.	Vent kept open		
7.	Manhole kept open		
8.	Vessel purged with steam		
9.	Vessel purged with water		
10.	Vessel purged with nitrogen/ air		
11.	Vessel free from toxic gases/vapours/ flammable substances		
12.	Gas test shows > 20% oxygen inside vessel		
13.	Safety tags card placed wherever required		
14.	Personal PPE's provided		
15.	Exhaust / ventilation inside vessel is sufficient		
16.	Caution boards placed		
17.	Tools and tackles checked as per specifications		
18.	Head count of the area known to relevant persons		
19.	Trained Site supervisor nominated		
20.	Safety measures such as hydrant, alarms, sensors checked		

Chapter 11
Conclusion and Recommendation

11.1 Conclusions

BEZA, formed under EZ Act, 2010 is overall agency for implementation of EZ projects for rapid economic development of Bangladesh. BEZA will invest in land and related off-site infrastructure development so as to make zone accessible and resourceful. Thereafter economic zone development will be responsibility of private developers. Proposed project will be established in Moheshkhali Economic Zone-3. The project falls under Red category as per ECA, 1995 and requires prior environment clearance from DoE, Bangladesh.

Petrochemical plants can also be considered as plans and development projects which have the short and long-term environmental effects. The results show that the most significant environmental and exploitation impacts of petrochemical projects are water and soil pollution, air and noise, as well as socioeconomic consequences. Petrochemical industries in the operation will create more significant implications than the construction stage on the environment, some of them in terms of lack of control and environmental management, are irreversible and damaging. Basically, the major environmental problems of these plants, especially in terms of noncompliance with environmental regulations and standards have risky consequences, and impair the organic nature of human societies and also wildlife. However, the impacts from both construction and operation can be reducing through mitigation measures as provided in EMP.

11.2 Recommendations

The recommendations made for the project development on the basis of EIA study are given below:

1. A set of baseline criteria (existing quality of different environmental parameters including air, water, noise and metal in the area at different time points) has been developed in this report. It should be used in order to compare and monitor the parameters during pre-construction and construction phases of the project;
2. Proposed EMP and EMoP should be implemented strictly during construction and operation phase of the project.
3. Project proponent should install and maintain ETP and STP or connected to CETP and CSTP of Economic Zone for the treatment of waste water and maintain `zero' discharge provision for minimizing water pollution.
4. Fuel Treatment Plant should be used for the treatment of oil and spillage before discharge;
5. National 3R Strategy for Waste Management (Reduce, Reuse, Recycle) should be followed for the management of solid waste.
6. Development of a green area surrounding the area should be considered with due importance.
7. Rain water harvesting should be carried out to reduce the pressure on surface and ground water resources.

8. Roof top of all infrastructures should be managed for the purpose of harvesting rain water, photovoltaic solar energy and gardening.
9. All infrastructures should be built based on the seismic, cyclone and storm surge design consideration to avoid potential hazard risk.
10. To avoid hazard due to any disaster, warning system, emergency evacuation system, construction of ground flood at an elevated level, provision of emergency equipment should be considered.
11. Safety Management Guideline for workers should be strictly followed to minimize occupational health hazards.
12. Proper training of environmental management, health and safety should be given to project management unit in both construction and operation phase.
13. Eligible local people should be considered on priority basis that will be helpful for minimizing the socio-economic disruption.

All the activities under SPL Petrochemical Complex Limited should be done according to the Government policies, rules and regulations.