Environmental Assessment Report

Summary Environmental Impact Assessment
Project Number: 39933
August 2006

Bangladesh: Phulbari Coal Project

Prepared by Asia Energy Corporation (Bangladesh) Pty Ltd for the Asian Development Bank (ADB).

CURRENCY EQUIVALENTS
(August 2006)

Currency Unit	–	Taka (BDT)
BDT 1.00	=	USD 0.015
USD 1.00	=	BDT 68.00

ABBREVIATIONS

AAQS	–	Ambient air quality standards
ADB	–	Asian Development Bank
AIS	–	Automatic Identification System
AMD	–	Acid mine drainage
Asia Energy	–	Asia Energy Corporation Bangladesh Pty Ltd
BCM	–	Bank Cubic Meters
BDT	–	Bangladesh Currency Taka
BES	–	Bangladeshi Environmental Standards
BG	–	Broad gauge (1,676 millimeters between rails)
BIWTA	–	Bangladesh Inland Water Authority
BR	–	Bangladesh Railway
CAR	–	Corrective action report
CBO	–	Community-based organizations
CEMP	–	Construction environment management plan
COLREGS	–	International Regulations for Preventing Collisions at Sea
CHPP	–	Coal handling preparation plant
DG	–	Dual gauge
DNV	–	Det Norske Veritas
EMP	–	Environment management plan
ESC	–	Environmental site clearance
FDI	–	Foreign direct investment
FTV	–	Floating transfer vessel
GDP	–	Gross domestic product
GMDSS	–	Global Maritime Distress & Safety System
GNI	–	Gross national income
GPS	–	Global positioning system
GOB	–	Government of Bangladesh
HSE	–	Health, safety, and environment
IFC	–	International Finance Corporation
IMO	–	International Maritime Organization
IPDP	–	Indigenous people's development plan
IUCN	–	The World Conservation Union
JORC	–	Joint Ore Reserves Committee of the Australasian Institute of Mining & Metallurgy
LOM	–	Life of Mine
MARPOL	–	International Convention for the Prevention of Pollution from Ships
MBCM	–	Millions of Bank Cubic Meters
MPA	–	Mongla Port Authority
NACOM	–	Nature Conservation Management
NGO	–	Non-government organization
PPAH	–	Pollution Prevention Abatement Handbook

SEIA	–	Summary environmental impact assessment
SEPP	–	Soil erosion protection plan
SMEC	–	SMEC International Pty Ltd
SOPEP	–	Shipboard oil pollution plan
SRF	–	Sundarbans Reserved Forest
TBT	–	Tributyltin
UDT	–	Upper Dupi Tila

WEIGHTS AND MEASURES

CH4	–	Methane
CO	–	Carbon monoxide
dB(A)	–	Decibels (measured in audible noise bands)
dwt	–	Deadweight tonnage
g	–	Gram
ha	–	Hectare
kg	–	Kilogram
km	–	Kilometer
L10	–	Noise level exceeded for 10% of the measurement interval time. The LA10 noise level is often used when assessing the impacts of road-traffic noise, as road-traffic noise is characterized by short-term fluctuations caused by passing vehicles.
L90	–	Noise level exceeded for 90% of the measurement interval time.
Ldn	–	Day-night noise level. This is the cumulative noise exposure over a 24-hour period, with an additional 10 dB(A) imposed on noise level during the nighttime period.
Leq	–	Equivalent continuous sound pressure level. This represents the steady sound level which is equal in energy to the fluctuating level of the measurement period.
Lmax	–	Maximum noise level measured during the measurement interval
m	–	Meter
m2	–	Square meter
m3	–	Cubic meter
Mbcm	-	Million bank cubic meters
mm	–	Millimeter
Mt	–	Mega (million) tonnes
NO2	–	Nitrogen dioxide
NOX	–	Oxides of nitrogen
PM10	–	Particulate matter less than 10 microns in equivalent aerodynamic diameter
PM2.5	–	Particulate matter less than 2.5 microns in equivalent aerodynamic diameter (also known as fine particulate matter).
SO2	–	Sulfur dioxide
T t	–	Tonne (metric ton)
TSP	–	Total suspended particulates
yr	–	Year
µg	–	Microgram
µg/m3	–	Micrograms per cubic meter
mg/m3	–	Milligrams per cubic meter

GLOSSARY

Aquifer horizons	–	Layers of permeable material within a geological sequence
Barging	–	Transport of coal and other materials on barges
Bathymetry	–	Measurement of depth in sea
Batter	–	The wall created by open pit mining
Beel	–	A wetland fed by surface water
Bund	–	Man-made earth embankment
Clay horizon	–	A layer of clay
Drawdown measurements	–	The measurement of the groundwater surface
Evapotranspiration	–	Loss of water caused by evaporation
Ex-pit overburden dump	–	The stockpile of non-coal material excavated from the open pit and stored on the surface adjacent to the pit.
Final void	–	The remnant of the open pit mine that is not backfilled
Gravity reclaim method	–	The recovery of material from stockpiles via feeders whereby the material flows under gravity
Hardstand area	–	The man-made pads created by filling and compaction for material storage and buildings
Longwall	–	Method of underground coal mining
Noise bund	–	Man-made earth embankment for noise abatement
One-lane channel	–	A shipping lane that takes one ship at a time
Overburden	–	The non-coal material excavated from the open pit
Passing-loop	–	A section where the rail track is doubled to allow passing
Permian	–	A geological time period dating from around 290 to 250 million years ago. Most of the world's coal dates from this period.
Pyrites	–	Iron sulphide
Quaternary period	–	The Quaternary is a subdivision of geological time (the Quaternary Period), which covers the last two million years up to the present day.
Scouring	–	Erosion
Sidings	–	A section of track where trains can pull off the main track
Sinusoidal	–	Having the shape of a sine wave
Sleeper	–	A wooden or concrete beam on which rail track is laid
Stackers	–	A crane structure from which material is discharged onto stockpiles
Temperature inversion	–	A temperature inversion is a thin layer of the atmosphere where the decrease in temperature with height is much less than normal (or in extreme cases, the temperature increases with height).
Tertiary period	–	The Tertiary is the geological period between 65 million and 2 million years ago.
Trailing suction hopper	–	A trailing suction hopper is a 'hoovering' method of dredging employed by large ocean-going dredging vessels.
Water catchment areas	–	A water catchment is an area of land where rainwater collects and runs off to a natural low point.

CONTENTS

APPENDIXES


BANGLADESH
PHULBARI COAL MINE PROJECT
89°00'E
91°45'E
25°30'N
22°00'N
0 25 50 75
Kilometers
INDIA
MYANMAR
Bay of Bengal
RAJSHAHI
DHAKA
SYLHET
KHULNA
BARISAL
CHITTAGONG
Phulbari Coal Mine
Khulna Coal Terminal
Offshore Reloading Facility
Panchagarh
Thakurgaon
Nilphamari
Lalmonirhat
Saidpur
Kurigram
Rangpur
Dinajpur
Parbatipur
Phulbari
Gaibandha
Bahadurabad
Joypurhat
Sherpur
Bogra
Naogaon
Jamalpur
Netrokona
Sunamganj
Tamabil
Chhatak
Sylhet
Mymensingh
Mohanganj
Nawabganj
Bhuapur
Madhupur
Kishoreganj
Kulaura
Moulvibazar
Habiganj
Sirajganj
Jamuna Bridge
Nalka
Rajshahi
Natore
Bonpara
Tangail
Brahmanbaria
Shahji Bazar
Ashuganj
Gazipur
Hardinge Bridge
Ishurdi
Pabna
Kushtia
Manikganj
DHAKA
Akhaura
Narsingdi
Meherpur
Rajbari
Chuadanga
Faridpur
Narayanganj
Jhenaidah
Darsana
Magura
Daudkandi
Comilla
Jessore
Narail
Shariatpur
Madaripur
Chandpur
Laksham
Gopalganj
Lakshmipur
Feni
Khagrachari
Noakhali
Khulna
Barisal
Bagerhat
Satkhira
Pirojpur
Bhola
Rangamati
Mongla Port
Chittagong
Dohazari
Patuakhali
Patiya
Bandarban
Khepupara
Barguna
Akram Point
Cox's Bazar
Teknaf
Teesta R.
Brahmaputra R.
Jamuna R.
Kushiyara R.
Ganges R.
Padma R.
Madhumati R.
Meghna R.
Pussur R.
Haringhata R.
Sundarban Reserve Forest
Sundarban East
Sunderban South
Sundarban West
National Capital
Divisional Headquarters
District Headquarters
Major Town
Coal Mine
Road
Railway
Railway Corridors
Barging Route
Shipping Route
Mangla Port
Seaport
Inland River Port
River
Divisional Boundary
International Boundary
Boundaries are not necessarily authoritative.
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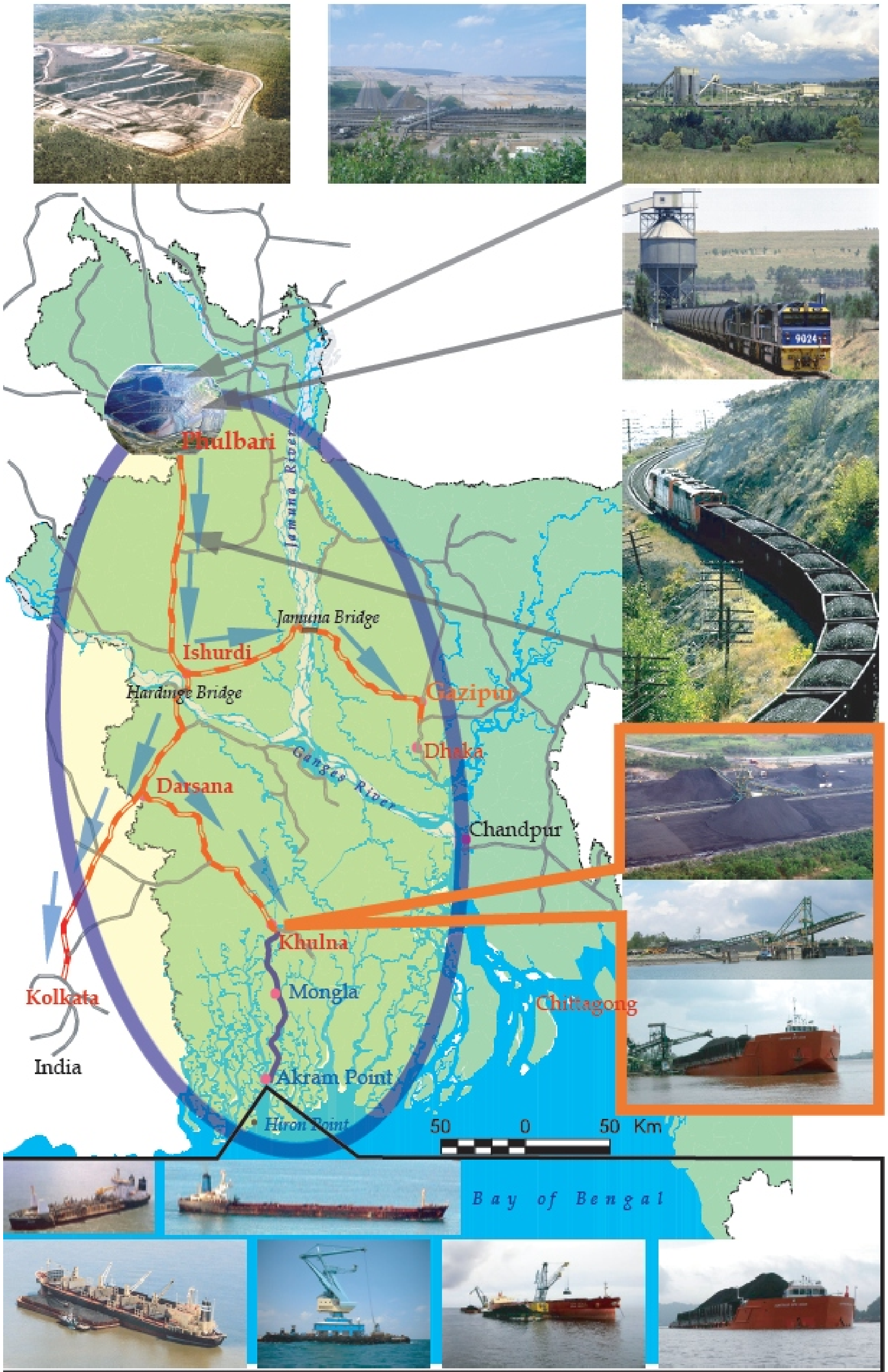
Figure 1: The Various Components of the Project



Note: The Illustrations are from various project in Australia.

Figure 2: Conceptual Mine Land Occupation Plan

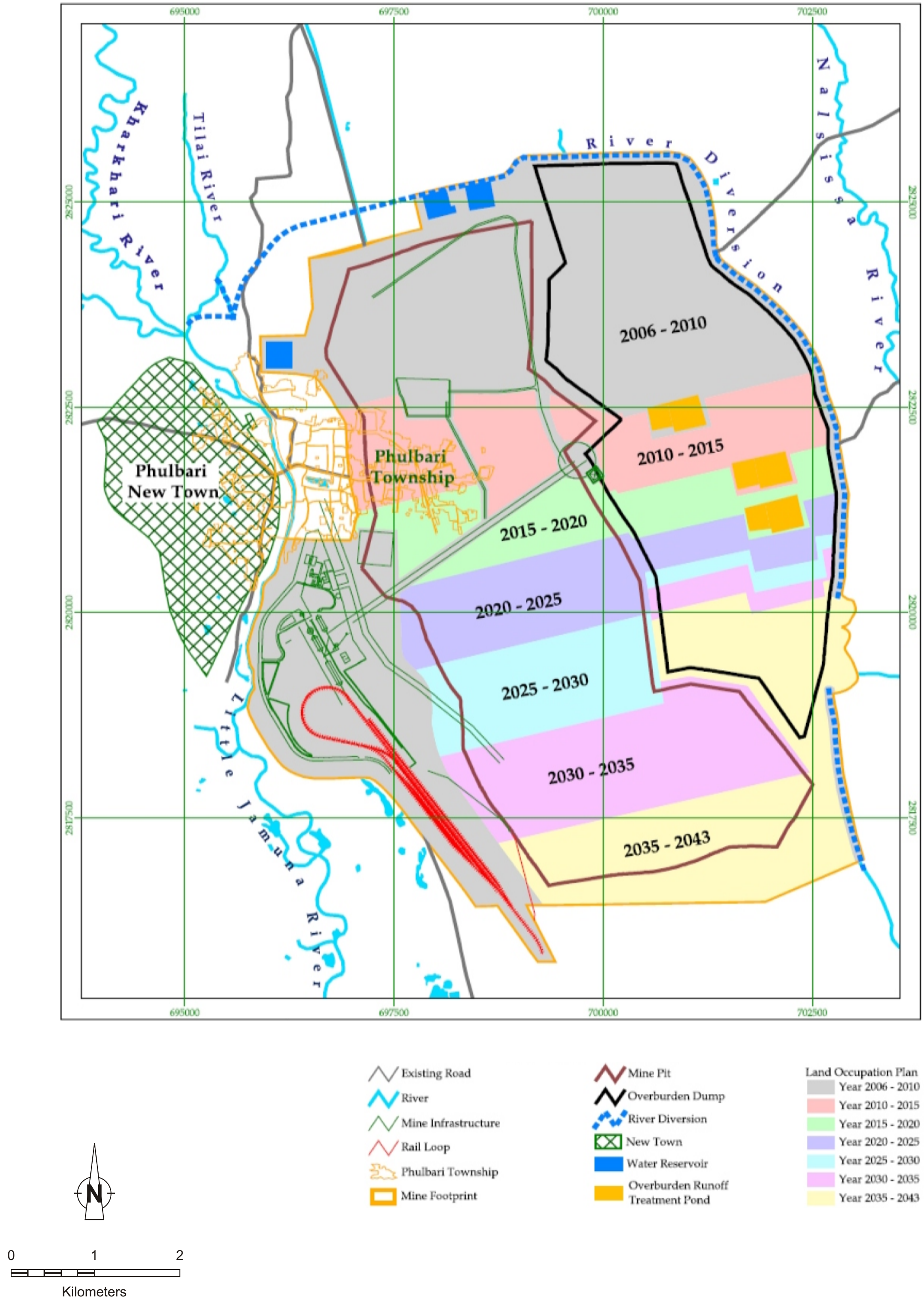


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Figure 3: Concept Design of Coal Terminal at MPA area in Khulna

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Figure 4: Barging and Shipping routes

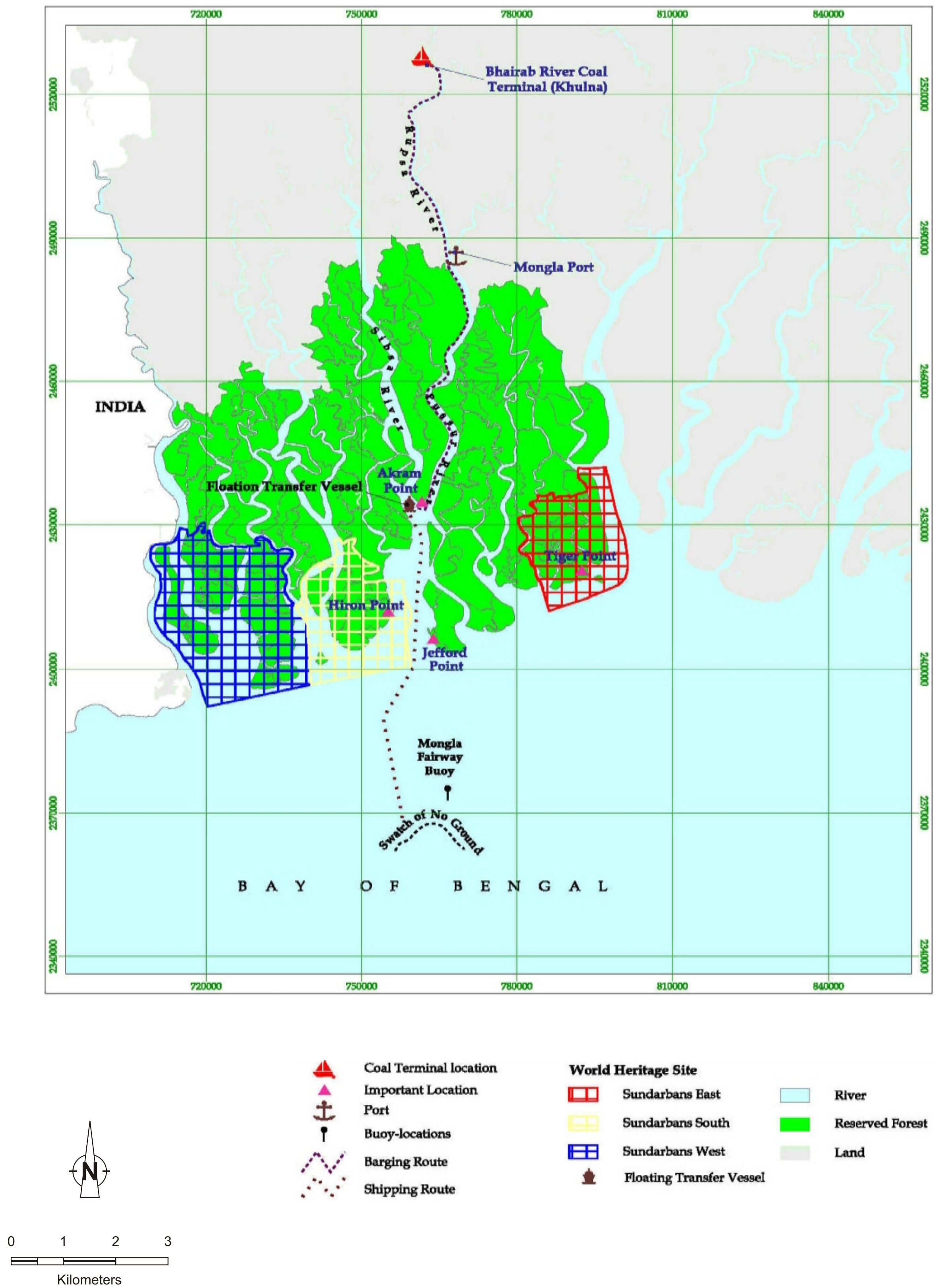


Figure 5: Shipping channel from Akram Point to the Bay of Bengal

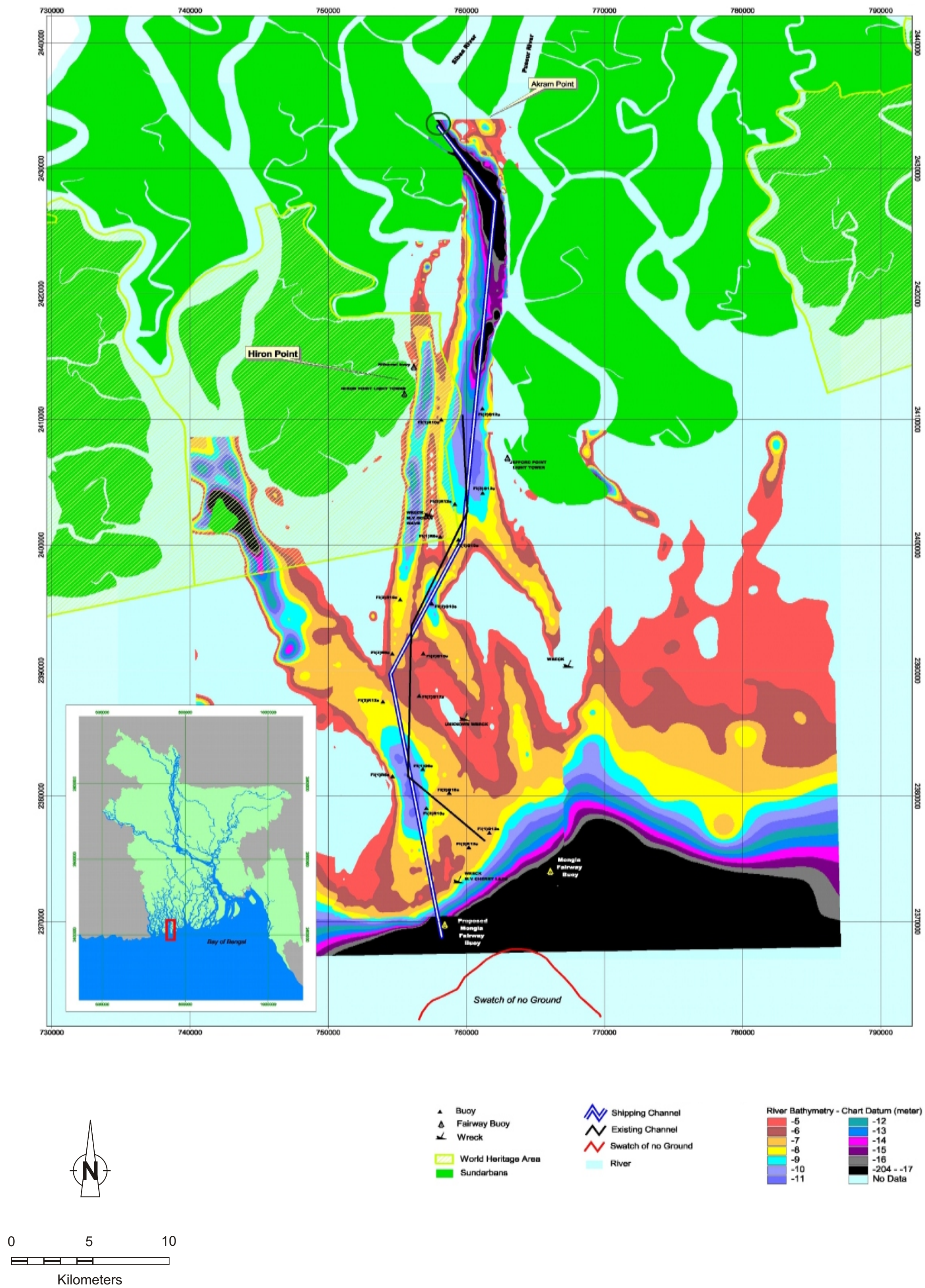
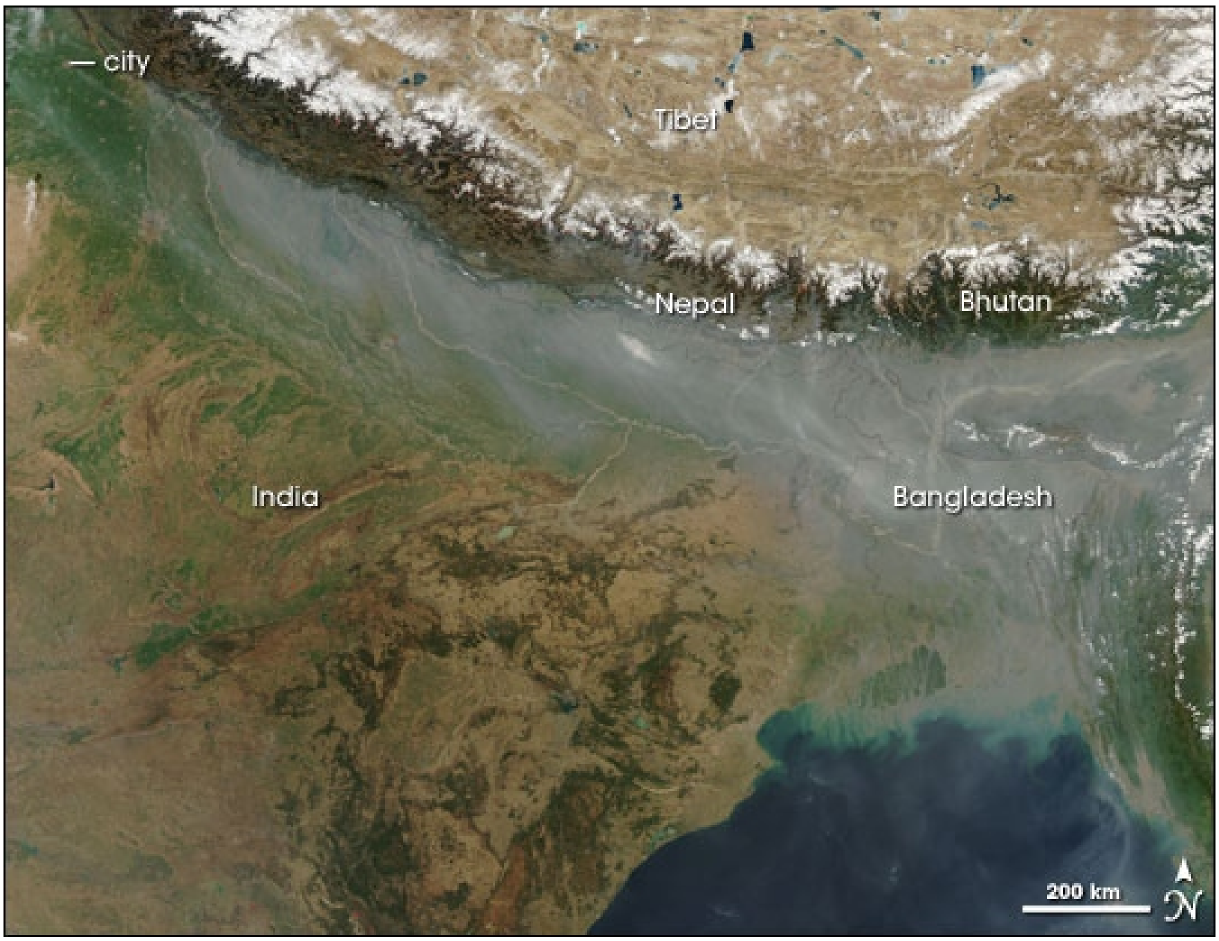


Figure 6: Satellite image showing smog situation over South Asia, 5 February 2006 (NASA)



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I. INTRODUCTION

1. Bangladesh's vast reserves of unexploited coal lie mainly in the northwest of country; its natural gas resources are found in the east. There are an estimated two billion tonnes of coal beneath the ground in northwest Bangladesh. This is broadly equivalent to 53 trillion cubic feet (TCF) of natural gas – more than three times the known gas reserves. Exploiting this coal is going to be critically important for the country's long-term economic growth. Bangladesh's low overall commercial energy consumption is holding back the country's economy. The Phulbari coal basin has a reserve of 572 million tonnes of high quality bituminous thermal and semi-soft coking coal. By mining what is possibly the largest coal reserve in Bangladesh, the Phulbari Coal Project will provide the country with a vital new source of sustainable energy, transform the northwest region's economy from predominantly agricultural to significantly industrial, increase Government earnings and revenues, increase exports, and accelerate the pace of industrial development throughout the country. Overall it is estimated that the Project will add between 0.7% and 1.0% to Bangladesh's annual Gross Domestic Product (GDP) and provide more than 20,000 new direct and indirect jobs.

2. This Summary Environmental Impact Assessment (SEIA) is based on some 110 studies (i) for this Project and its associated infrastructure in Bangladesh. It also specifically addresses (ii) an assessment of railway transportation routes to the Indian border and the Khulna Coal Terminal; and (iii) operations at the Khulna Coal Terminal including barging, and offshore reloading facility for transfer to seafaring vessels. The Project's full Environmental and Social Impact Assessment (ESIA) consists of impact assessments, environmental management plans, a comprehensive resettlement plan, an indigenous people's development plan, and a public consultation and disclosure plan. Table A1.2 contains a full list of the EIA's reports and studies. SMEC International Pty Ltd of North Sydney, Australia (SMEC) prepared most of the EIA, but a large number of other organizations, companies, and individuals were also involved. In order to keep this SEIA as short and informative as possible in light of the vast quantity of documents: (i) this SEIA only goes into detail about important issues involving potentially large impacts to sensitive areas; and (ii) in cases where less impact is foreseen, this SEIA only briefly describes the likely environmental consequences.

3. The proposed Project is classified by the Asian Development Bank (ADB) as category A - a project with significant potential environmental impacts if the appropriate mitigation measures are not properly implemented.

4. The sponsor, Asia Energy PLC, is operating through its wholly owned subsidiary Asia Energy Corporation (Bangladesh) Pty Ltd. To reach positive cash flow, the current estimated investment cost is some USD 1,2 billion and the total investment during project operations is estimated at around USD 2 billion. Asian Development Bank has a mandate with Asia Energy to undertake a due diligence review of the Project with the intention of taking a lead.

5. Asia Energy is committed to developing and operating the mine in a financially, socially, and environmentally responsible manner. In this regard, the overarching design principles are to comply with Government of Bangladesh (GoB) regulatory requirements and to implement mining industry "best practice" procedures with particular reference to:

(i) the Equator Principles;
(ii) International Finance Corporation (IFC) environmental and social safeguard policies (on such issues as involuntary resettlement, indigenous peoples, and cultural property);

(iii) ADB's *Environment Policy* (2002) and ADB's *Environmental Assessment Guidelines* (2003), including the involuntary resettlement plan and indigenous peoples development plan;
(iv) World Bank and IFC guidelines on coal mining; and
(v) proposed new IFC performance standards.

II. DESCRIPTION OF THE PROJECT

6. The Project involves the development and exploitation of a coal mine near the town of Phulbari in northwestern Bangladesh, around 350 kilometers (km) from Dhaka. Farming (mainly rice) is the predominant livelihood. Phulbari itself is a small town of about 30,000 people, which is served by the national highway, north–south railway networks, and an airport at Syedpur 40 km to the north. The railway town of Parbatipur, 18 km north of Phulbari, is a major rail junction with links to India. The area is among the poorest in Bangladesh. The location of the mine is depicted in Map 1.

7. The mine footprint (mine and associated infrastructure) covers approximately 5,192 hectares (ha). The coal mine will be developed as an open-cast mine and at any one stage the open pit will cover an area of about 2,180 ha. The mine is expected to deliver up to 15 million tonnes per year for 30 plus years. At full production, about 8 million tonnes will be exported by rail and barges to an offshore reloading facility at Akram Point for export to international markets, some 4 million tonnes will be exported to India via railway, and the remaining 3 million tonnes will be used for a proposed mine-site 500 MW power plant and sold for domestic use. The development stages of the mine are described in Figure 2. As the mine advances, the excavated area will be progressively backfilled and the land restored to its natural state. Water pumped from the ground in the vicinity of the mine will be injected into the aquifer in the surrounding areas and channelled and piped back to local farms, villages and Phulbari township.

8. Mine-to-market will be accomplished via train from Phulbari to India and to a reloading site in Khulna around 330 km south of Phulbari. Khulna is located along the large Rupsa and Pussur River system, which empties into the Bay of Bengal. The coal will be barged approximately 107 km to a deep water anchorage near Akram Point, where it will be transferred to large seafaring ships (Panamax) via a floating loading terminal.

9. Hence, the overall Project is divided into three main components:

(i) Phulbari coal mine (briefly described above).
(ii) Upgrading of the railway to the Indian border and the Coal Terminal in Khulna. The railway corridor traverses more than 500 km of land between Phulbari, Khulna, and Gazipur. The railway is already fully operational, but needs upgrading in certain areas together with sidings to allow for trains to meet; hence avoiding the construction of double track. The extent of the final upgrade and the number of sidings will be determined during the detailed design phase.
(iii) Construction of the Coal Terminal in Khulna, including barging and offshore reloading facilities for coal transfer to seafaring vessels. Coal laden barges will travel south down the Bhairab, Pussur, and Rupsa rivers to a floating transfer vessel (FTV) located near Akram Point, a distance of 107 km. The FTV will be anchored approximately 2.5 km southwest of Akram Point, in the Sibsa River channel, and will be used to transfer coal onto ocean-going ships. Empty barges will return along the same route. The ships will travel along a 67 km channel,

extending past the Mongla Port Authority's (MPA) pilot station at Hiron Point to the Bay of Bengal. The Project will include dredging a 43 km channel through the Outer Bar between Hiron Point and a relocated Fairway Buoy at the edge of the Swatch of No Ground. The barging and shipping routes are depicted in Figure 4.

10. The railway component is subject to partial financing by ADB's South Asia Department, Transport and Communications Division; hence, currently a basic environmental impact assessment (EIA) has been performed for this component in the overall preparations of EIAs for the Project's three components. A full-scale EIA covering the railway component will be accomplished under the proposed public sector loan.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical and Biological Environment

1. Meteorology and Climate

11. The climate (precipitation), the regular annual variation (monsoon), and other meteorological conditions significantly affect the environmental impact of the Project. For instance, there is frequent flooding in the rainy season and completely opposite conditions in the dry season.

12. Bangladesh's climate is heavily influenced by the Asiatic monsoon, which results in three distinct seasons: (i) the monsoon or wet season (May–October); (ii) the "winter" season (November–February); and (iii) the hot (dry) season (March–April). November–April is also known as the dry season. "Summer" consists of the hot (dry) season and the monsoon season.

13. The mean annual rainfall is approximately 2,000 millimeters (mm). Approximately 70% of total annual rainfall occurs during the monsoon season when tropical depressions originating in the Bay of Bengal bring heavy rains. Potential evapotranspiration rates are of the order of 1,500 mm and exceed rainfall from November to May.

14. January is usually the coldest month in Bangladesh. Average daytime ambient temperatures vary from 17 degrees Celsius (°C) in the northern parts of the country to 21°C in the coastal areas. Minimum temperatures in the northeast and northwestern parts of the country can in January are around 5°C to 9°C. Temperatures reach their annual peak prior to the onset of the monsoon in April. Daytime temperatures during this time average 27°C to 30°C and maximum temperatures can exceed 40°C.

15. During the winter, cool dry winds from the north and northwest prevail across the country. Prior to the onset of the monsoon in March and April, hot conditions and thunderstorms prevail while winds gradually start blowing from the south or southwest - a pattern that continues throughout the monsoon period. Winds are generally stronger in the summer than they are in winter.

16. The direction of prevailing winds is generally consistent during the winter and monsoon seasons, and more variable during the transition periods. The Himalayan mountains influence wind patterns. Recirculation of winds during the monsoon season under the influence of the Himalayas can result in winds circling to the east–southeast in the northern parts of the country.

17. The low topographical variations across central and western Bangladesh result in minimal local variation in climate.

2. Phulbari Coal Mine

18. A portion of eastern Phulbari township is located in the Project area. The Project area has a 10 km radius extending from the center of the deposit (although a larger area was used for hydrological and hydrogeological studies).

19. Key biophysical features of the environment are:

(i) The Project area is on the elevated Barind Tract, where scattered villages and Phulbari township are surrounded by farmland.
(ii) Land use within the Project area is dominated by agriculture. Most plots are harvested two to three times per year (average 2.2); the main crop is rice.
(iii) Flooding is rare, as Phulbari township, nearby villages, and most of the coal deposit are located on elevated ground.
(iv) The area is characterized by low salinity concentrations; very low arsenic concentrations in groundwater in unconsolidated, thinly developed aquifers overlying shallow bedrock.
(v) Most local rivers flow intermittently (drying up in the dry season), have narrow drainage systems, have low salinity, are bacteriologically polluted, and contain trace quantities of some metals.
(vi) Most soils have elevated acidity at the surface, low acidity at depth, and a wide range of water drainage characteristics.

20. The following six macro-ecosystem types are found in the Project area (listed from most prevalent to least prevalent in terms of total area occupied): (i) cultivated land, (ii) roadside vegetation, (iii) exotic-wood plantations, (iv) sal forests, (v) homestead vegetation, and (vi) wetland areas (rivers, canals, beels, floodplains, ponds created by roadside borrow pits dug for during road construction, and natural ponds). Some 512 flora species, 158 terrestrial vertebrate species, and 89 fish species have been recorded within the Project area. This represents a moderate faunal and floral diversity that, in general, is considered similar to that found on Bangladesh's rural floodplains. None of the species recorded are endemic and there are no ecologically critical areas or other designated protected areas located within the Project area. No sal forests or large beels are located within the mine footprint.

3. Railway Transportation

21. The proposed coal transport rail corridor traverses more than 500 km of land between Phulbari, Khulna, and Gazipur. It passes through agricultural land, major towns, and villages, and passes over the Ganges-Padma and Brahmaputra-Jamuna rivers. The rail corridor crosses over land that is flat or slightly undulating, with slopes ranging from less than 1% to 5%. Elevations range from 32 meters (m) above sea level at Phulbari, to 6–10 m above sea level on the fluvial floodplains in the central areas, to less than 2 m above sea level on the deltaic estuarine plains around Khulna. The railway line is generally free from flooding.

22. Land use along the rail corridor reflects the national trend in being primarily agriculture-based. Of the documented land use types between Phulbari and Khulna, 65% of the 37,711 ha fall under this category. Rural settlements and homesteads account for 21.6% of land use along

the rail corridor, making it the second most dominant land use type, followed by urban settlements (9.2%).

23. Domestic biomass burning (such as wood, dung, and straw) is responsible for most air emissions in the Project area. Other contributors to air pollution include vehicular and rail traffic, re-suspended road dust, brick kilns to make bricks, and small industries. The impact of the Asian Brown Cloud - caused by the fine particulate matter - is a regional phenomenon that causes haze problems across northern India and Bangladesh. Figure 6 shows a satellite image of the Asian Brown Cloud.

24. Measured noise levels vary at the given locations according to (i) the number, composition, and speed of trains using the railway; (ii) horn usage by locomotives; and (iii) other sources of ambient noise, including road-traffic noise, industrial noise, general community noise, and noise from birds and insects.

25. The surface water conditions in the Project area are different to most of Bangladesh in that the location is the Barind Tract which is relatively elevated and remote from the major river systems. The groundwater conditions in the Upper Dupi Tila Formation aquifer in the Project area are similar to other parts of the country, however the aquifer thickness and depth are less in the Project area. This regionally important aquifer system runs under the entire length of the proposed coal rail corridor.

4. Coal Terminal in Khulna including Barging and Offshore Reloading

26. The Coal Terminal site in Khulna lies within the city boundaries on the Bhairab River, which is approximately 300 m wide in this region. Brick kilns and small industries line the opposite bank of the river. The coal reloading facility site in Khulna was previously an industrial site under the jurisdiction of MPA. Figure 3 illustrates the site.

27. The site will operate around the clock. However, levels of activity will depend upon train delivery and barge loading requirements. It is estimated that the site will receive five trains per day. Each train will take approximately 3 hours to unload. The total time spent loading barges per day is expected to be about 12 hours.

28. The main rail line to Khulna is located just west of the site. An existing 0.6 km spur line will be rebuilt to enable trains to access a new 2.5 km long loop track around the perimeter of the site. The loop track will allow one empty train just unloaded and one full train waiting to be unloaded to be processed with minimal interruption to traffic off the site. Coal trains will arrive at the site via the main Khulna–Jessore rail line.

29. The proposed port site was cleared earlier for the development of MPA facilities and associated land uses, and thus supports no natural habitat.

30. Rapid urbanization in Khulna has resulted in declining vegetation coverage. Accordingly, the importance of vegetation as a major sink of pollutants in the area has been studied in addition to biodiversity values. Roadsides, riverbanks, and industrial sites have been identified as potential areas for revegetation within the Khulna City Corporation area.

31. Many trees and shrubs — including indigenous and exotic flowering, fruit-bearing, and ornamental species that occur around staff residences and other buildings, along roadsides, and in small plantations — have already been planted across the port site by the MPA.

Groundcover vegetation also occurs in open space areas and in and around rice paddies. Similar vegetation types also occur on adjoining land and throughout the wider Khulna area.

32. The on-site vegetation provides a habitat for common fauna species that are tolerant of disturbances from the extensive human activities across the site and on adjoining land. These species include birds like the house crow, common myna, black kite, Brahminy kite, black drongo, red-vented bulbul, magpie robin, and sparrow—all of which are reportedly common in the Khulna area. Common amphibian species such as the common toad and the bullfrog are also present on the site, particularly in and around rice paddies, ponds, and shrimp farms, as well as along the riverbank. The site also supports common rodents such as rats, mice, and mole shrews, and common reptiles like geckoes, house lizards, and possibly snakes.

33. Threatened species ("vulnerable" or "endangered," as defined by The World Conservation Union) are not present because of the lack of natural habitat and the high degree of human activity at the site.

34. The Bharaib–Rupsa River system near Khulna is subject to water pollution and high sedimentation rates. The water quality of the Pussur River is affected by pollution from industrial and agriculture-related activities, although concentrations of pollutants generally appear to be within permissible limits. The river also appears to contain high suspended solid loads, attributable to the ongoing and increasing sedimentation rates experienced in the Pussur River system. The level of such pollution downstream diminishes with increased distance as it is diluted by tributary streams and tidal flushing.

35. Like many waterways in Bangladesh, river systems in the project area are subject to over-fishing. Although the diversity of aquatic species in southwest Bangladesh is relatively high, the Bharaib–Rupsa river system near Khulna supports a relatively low number of aquatic species. The diversity and abundance of aquatic species is most likely higher in downstream areas, particularly south of Mongla in the Sundarbans area, where the riverbanks and surrounding natural environment are relatively undisturbed and human activities are limited.

36. No detailed aquatic biodiversity surveys of the Rupsa River have been undertaken near the port site. A variety of indigenous and exotic aquatic species are present, including fish, crustaceans, and mollusks. Common fish and crustacean species known to occur in the project area include bighead carp, Thai puti, galda, and bagda. These play an important economic role, providing food and a source of income for many families. Aquatic plants—including phytoplankton species—are also present, as well as planktonic and benthic invertebrates. Aquatic mammals such as the Gangetic dolphin are also present, although it has been noted that the population of the Gangetic dolphin in the Bharaib–Rupsa river system has declined sharply because of a variety of factors, including water pollution and human encroachment on habitat areas. It is likely that populations of other aquatic mammals have also declined.

37. Akram Point is located within the Sundarbans Reserved Forest (SRF) which is the world's largest mangrove area. The Sundarbans area in Bangladesh was declared a reserved forest in 1875. It currently extends over an area of approximately 600,000 ha of land and water that is known as the Sundarbans Reserved Forest. The SRF is managed by the Bangladesh Forest Department, which has jurisdiction over the coastal zone (extending to a distance of 5 nautical miles out to sea from the shore). The mangrove forest of the Sundarbans contains over half of the Bangladesh's remaining natural forest and supports extraordinary biodiversity. In 1992, the entire SRF was designated an internationally significant wetland under the Convention on Wetlands of International Importance (commonly known as the Ramsar

Convention). The three SRF wildlife sanctuaries, the Sundarbans West Wildlife Sanctuary, Sundarbans East Wildlife Sanctuary, and the Sundarbans South Wildlife Sanctuary, are on UNESCO's World Heritage Site List.

38. This area is very sensitive. However, the deep water anchorage at Akram Point will be at least 1.3 km from the nearest shoreline which itself is 16 km north of the Sundarbans World Heritage Area. The shipping channels will pass at least 1.5 km from these protected areas. Figure 5 illustrates the waterways from Akram Point, and how they lead to the Bay of Bengal and avoid the Sundarbans World Heritage Area.

39. The processes of shoreline erosion and accretion within the SRF are highly complex because of the large number of interconnecting waterways. There are reports that net erosion is occurring along the sea face, although new islands are also emerging in some areas.

40. At the Outer Bar, the top layer of sediment to be dredged appears to be subject to movement caused by waves and currents. It is therefore a dynamic environment—one that is unlikely to have been colonized by sea grasses and associated species. Nevertheless, it likely supports a range of benthic invertebrates, which are often important to the productivity of aquatic ecosystems. Benthic sampling undertaken in 2003 recorded a total of 26 varieties of benthic fauna at Hiron Point, including crabs, insect larvae, annelids, and mollusks.

41. Six kilometers to the south is a deep sea area known as the Swatch of No Ground, where water depths fall to more than 200 m below chart datum. There is limited information about the biodiversity of the proposed spoil disposal area over the Swatch of No Ground. However, the Swatch of No Ground is one of three major fishing grounds in the Bay of Bengal, and is known to support numerous pelagic and demersal fish and shrimp species.

42. Water quality sampling in the Sundarbans showed that the area was affected not only by industrial waste discharges containing heavy metals, PCBs, oil runoff, and organic chemicals, but also by agriculture-related pollutants. Concentrations of most heavy metals were generally within the permissible limits in the river water. The relatively high concentrations of oil and grease recorded were attributed to petroleum products released from ships and other vessels. The Project will introduce stricter handling of wastewater and industrial waste in the area, so the water quality is likely to improve slowly.

43. A total of 224 fish, 44 mollusk, and 39 crustacean species, and 72 phytoplankton, 28 zooplankton, and 33 benthic genera were recorded recently in the SRF in limited aquatic surveys. Surveyed sites included two sites on the Pussur River upstream of Akram Point, and one site at Hiron Point near the entrance to the Bay of Bengal. The data obtained indicates that the Pussur River supports high species diversity, particularly in its lower reaches. A fish breeding ground was identified in the river east of Akram Point.

44. The floristic composition of the SRF is rich compared with other mangrove areas of the world; 334 flora species have been recorded in the area. The most commonly occurring species are the mangroves Sundri (*Heretiera fomes*) and Gewa (*Exoeceria agallocha*), but vegetation cover includes a mosaic of mangrove associations developed along east–west and north–south salinity gradients, as well as grassy meadows, mudflats, sand bars, dunes, and beach vegetation. Along the Pussur River, the main mangrove associations are Sundri and Sundri–Gewa types. The river is generally fringed by mudflats and Golpatta (*Nypa fruticans*). From Akram Point to Hiron Point, sand bars, grassy swales, and bare ground fringe the tidal flats along the sea face.

45. The SRF also supports a diverse vertebrate assemblage; 453 species have been recorded in the area, at least 58 of which are categorized as threatened. Of particular note is Bangladesh's last remaining population of the endangered royal Bengal tiger, and other species such as the spotted deer, saltwater crocodile, Gangetic dolphin, and 117 species of waterfowl, including migratory species such as sandpipers, whimbrel, curlew, and other waders. These species forage on inter-tidal flats and roost in mangroves or on sand bars, dunes, and beaches, particularly in the dry season. The most important areas for these species include several sites at or near the Pussur River entrance. Nesting sites for several turtle species have also been recorded in this area.

46. Capital dredging will involve removal of an estimated 30 million cubic meters approximately 72 million tonnes (t) of sediment from a 43 km long section of the Outer Bar in order to improve the navigability of this area. The spoil material will be disposed of in the Swatch of No Ground. Studies show that that 67% of the spoil material will flow directly to the bottom leaving approximately 33% suspended in the water column. Dredging to maintain this channel is expected to remove about 7.5 million tonnes of sediment in the first year, reducing to and leveling out at 3 million tonnes per year by the fifth year. The quantities of sediment being disposed of are considered insignificant compared with the 200–500 million tonnes per year of sediment discharged to the Swatch of No Ground from the Ganges–Brahmaputra–Meghna river systems, especially when the “one-off” nature of capital dredging is considered. The impacts associated with the quantities of material disposed are therefore considered negligible. A monitoring program will be implemented during dredging operations to specifically monitor biodiversity at the spoil dumping location.

B. Socio-cultural Environment

1. Phulbari

47. The population of the four upazilas (subdistricts) (Birampur, Nawabganj, Parbatipur, and Phulbari) in the area was estimated at 832,220 in 2001. This results in an average density of 711 people per square km, which is much less than the national average of 1,023 people per square km. The key features of the social environment are:

(i) 3,600 (18.6%) of the households are located in the built-up (township) area of Phulbari, with the remaining households (81.4%) living in rural villages of various sizes.
(ii) Approximately 9% of the surveyed households are from ethnic minority groups. The Santal is the largest of these ethnic minority groups.
(iii) More than 43% of persons aged 7 years and older are illiterate; nearly 46% had attained some form of primary education; few had a secondary or higher secondary qualification.
(iv) Agriculture (mainly rice production) underpins the local economy and is an important source of livelihood and income for farm, non-farm, and landless households. Agricultural labor is also an important source of income, specifically for ethnic minority households. For many households agriculture is an essential, although no longer a sufficient, factor in their survival, and households have to pursue a diversified range of work and income generation.
(v) Tubewells are the most important source of domestic water. Ponds and rivers are seldom used for domestic water purposes.
(vi) More than 50% of the households have no access to a sanitation facility.

(vii) More than 25 NGOs and 14 community-based organizations (CBOs) participate in a wide range of activities.

2. Railway Transportation

48. Settlements are quite common alongside the railway in Bangladesh, and while the settlers are living on land that is not their own (usually Bangladesh Railway-owned land), most have been living there long enough to have invested in the construction of houses.

49. Along the existing railway route between Phulbari and Khulna, a range of housing types were identified, depending on the location of the track. The settlements alongside the railway corridor vary in their distance from the tracks. There are some houses within the right-of-way as close as 3–5 m away from the rail corridor.

50. Illegal residential and agricultural activities occur within some parts of the rail corridor.

51. Aside from grazing activities, the right-of-way is used as a pedestrian thoroughfare. Pathways closely follow the railway line in places and are used by pedestrians and livestock alike. In areas where there are no pathways alongside the railway track, the tracks themselves are commonly used as a thoroughfare. In addition, communities gather to socialize both alongside the railway tracks and on the tracks.

52. There are a total of 351 level crossings, which equates to about one level crossing per kilometer of railway. Many are currently poorly managed.

3. Coal Terminal in Khulna including Barging and Offshore Reloading

53. Khulna district was created in 1882 by incorporating Khulna and Bagerhat from Jessore district, and Shatkhira, Kaligonj, and Bashantapur from Pargana district. In the 1950s, Mongla Port was established 32 km south of Khulna city. During the late 1950s and early 1960s Khulna district was an important industrial center. However, growth stalled following the decline of the jute industry in the late 1970s and 1980s. In recent years economic activity has increased, most likely because of an improved fishing industry and the establishment of Khulna University. It is expected that the newly opened Rupsa Bridge will help regenerate activities in Mongla Port and bring new businesses to the district.

54. Khulna has a population of about 1 million and is the third largest city in Bangladesh (after Dhaka and Chittagong). An estimated 20% of the city's population lives in slum areas and/or as squatters. An estimated 106,000 squatters live on private land and 66,000 on government land. Approximately 22% of housing is classified as poor quality.

55. Approximately 3,200 people live on the planned reloading facility site in Khulna. Of those people, approximately 1,000 are MPA staff and their families, approximately 700 are sublet tenants, and the remaining 1,500 are squatters. An estimated 3,000 squatters live on adjoining Bangladesh Railways land south of the site. Approximately 580 families live in 157 MPA-owned residences. There are another 360 families (squatters) who live in slum conditions.

56. Facilities on the reloading facility site include:

(i) high school (800 students), secondary school (300 students), and kindergarten;
(ii) Port Health Centre, operated by the Port Health Department; and

(iii) administration buildings and warehouses, shops and tea houses, large playing fields, two clubs (a women's club and the Port Club), mosque and graveyard, and a number of ponds, low-lying areas, and vacant plots that are used for recreation, fishing, and kitchen gardens (a source of additional income and nutrition).

57. The above facilities are used by MPA staff and their families, as well as by people living on and around the site. People living and working on the site have created significant consumer demand. Numerous shops occupy the site, while many restaurants and workshops have been established along Old Jessore Road, which adjoins the western boundary of the site.

58. Most people living on the site work for the MPA, mainly as administrative personnel or laborers who commute daily to the MPA offices and other facilities at Mongla. Some laborers work at the jetty, in warehouses, or at river transport facilities. The two schools, kindergarten, and the Port Health Centre also provide employment. Other sources of employment are household services, shops, and tea houses. Household incomes vary significantly, ranging from BDT 1,500 to BDT 35,000 per year.

IV. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATIONS MEASURES

A. General

59. The Project is complex, with various components and subcomponents. This SEIA covers all significant impacts on the environment. The more complex issues are discussed in detail, and the mitigation measures are explained and listed.

60. Collection of primary environmental data commenced some 3 years ago in the Phulbari area. In order to establish a comprehensive database on biophysical baseline conditions, a large-scale monitoring system was established to measure parameters such as surface and groundwater quality, groundwater depth, river level fluctuations, air quality, meteorology, dust, noise, and seasonal biodiversity. Data from the other two project component areas (the Phulbari–Gazipur railway corridor and the Coal Terminal in Khulna) has been sampled for a shorter period of time. Various studies and other projects have been used to complement the monitored data.

61. Sampling around the three Project component areas has shown no notable levels of contamination in either the ground or groundwater

B. Phulbari Coal Mine

62. The footprint and the gradual development of the mine site are illustrated in Figure 2. The development of the mine is a continuous process, involving progressive excavation and simultaneous backfilling of the mined area.

1. Air Quality

63. Air pollution may result from various activities associated with the Project, including (i) relocation of transport corridors, (ii) construction of infrastructure, (iii) removal of the overburden (the material that overlies the coal); (iv) coal mining activities; and (v) rehabilitation works.

64. Particulate matter less than 10 microns in equivalent aerodynamic diameter (PM10) levels in areas around the coal mine exceed or nearly exceed Bangladeshi Environmental Standards (BES) levels. The results of the baseline sampling program indicate that existing ambient airborne particulate matter concentrations are high, especially in the dry season. This is partly caused by the Asian Brown Cloud (explained earlier and depicted in Figure 6). The existing ambient air quality standards (AAQS) of the Government for PM10 (24-hour) was exceeded at agricultural locations AN01 and AN04 (where the "residential" standard is 200 micrograms per cubic meter (µg/m3)). For location AN07 the BES Guideline is higher (400 µg/m3) since it is "commercial and mixed." All exceedance occurred during the dry winter period. Although there are no Government guidelines for particulate matter less than 2.5 microns in equivalent aerodynamic diameter (PM2.5—also known as fine particulate matter), it was still measured. The data is found in Table A1.8. The AAQS of the Government are found in Table A1.7. The monitoring and receptor locations for point air quality impact predictions are found in Table A1.9.

65. The results of the passive sampling program indicate that nitrogen dioxide (NO2) concentrations are well below the current AAQS for residential areas in Bangladesh. This was expected as there are no major sources of oxides of nitrogen (NOX) emissions in the Project area. Sulfur dioxide (SO2) analysis indicates that ambient SO2 concentrations are also well below the Government standard for residential areas.

66. Modeling for PM10 generally shows minor additional Project-generated pollution levels. Dispersion modeling found that maximum particulate concentrations resulting from the Project emissions will generally be less than the AAQS in the areas surrounding the Project site — except in areas to the west of the Coal Handling Preparation Plant (where the coal will be washed and graded) and in the southern areas of west Phulbari township. The results are found in Table A1.10. For PM2.5 the contribution from the Project varies but generally the average is 4 µg/m3 compared to a cumulative background level of 70 µg/m3.

67. The maximum predicted PM10 (24-hour) concentrations deriving exclusively from Project emissions exceed the residential area standard of the Government only at receptors 4 and 5 during year 5 assessment stage (Table A1.10). Similar impacts can be expected while ex-pit overburden dumping quantities are at peak rates and until mining activities move further south and the ex-pit dump area in the north is rehabilitated.

68. While it has been assumed that emissions from the Project will be constant over the year, meteorological conditions vary significantly. The predicted PM10 (24-hour) concentrations discussed above will be at their maximum under worst-case meteorological conditions (e.g., source-to-receptor winds, no rainfall, and stable atmospheric conditions). These worst case conditions do not occur on a regular basis. Analysis of the dispersion model outputs found that ambient concentrations exclusively from project emissions exceed the residential standard of the Government on approximately 8% of the days during the assessment year at receptor 5. At receptor 4, there was only one exceedance of the residential standard of the Government; predicted concentrations on all other days of the year were below 200 µg/m3. This is reflected in the predicted annual average PM10 (24-hour) concentrations exclusively from project emissions — which are well below the predicted maximum allowable concentrations.

69. At receptor points other than receptors 4 and 5; the predicted maximum PM10 (24-hour) concentrations exclusively from project emissions are below the standards of the Government. However, the predicted cumulative level of project emissions combined with existing background emission levels exceeds the standard of the Government at almost all receptors in

at least one assessment year. Cumulative exceedance includes pollution associated with the Asian Brown Cloud over the region and local emissions.

70. Operations will be reduced when weather conditions prevail that enhance emission generation or reduce emission dispersion. Easterly and southeasterly winds result in increased impacts from the area near the coal handling preparation plant (CHPP) west of the site. In order to fully manage the impacts on ambient air pollution, the project environmental monitoring system will include real-time monitoring of ambient particulate matter concentrations and meteorological parameters. Once suitable relationships between meteorological conditions, operations, and ambient concentrations at the receptor locations are developed (this will take one to two full climatological cycles — i.e., 1–2 years), the system will be used to detect meteorological conditions that are likely to lead to significant impacts. When such conditions are detected, project management will reduce operations accordingly. This type of system has been implemented in open pit coal mines in Australia.

71. "Best practice" control measures will be integrated with the project operations to reduce dust emissions. The use of an overland conveyor to transport coal to the CHPP, installation of automated dust suppression systems linked to meteorological sensors (as a part of the Environment Management Plan [EMP]) to control emissions from the CHPP stockpiles, and the regular watering of working areas in the mine and ex-pit areas will ensure that standards will be met. It is worth noting that Barapukuria Coal Mine (just north of the Project area) has been maintaining coal stockpiles in excess of 100,000 tonnes over the past 2 years without complaint of dust nuisance. Their stockpile management is effective and has included simple water spraying systems.

72. Dust deposition is not normally directly linked to adverse public health impacts. However, increased dust deposition rates can lead to soiling of surfaces and materials and other inconveniences, potentially making it a community nuisance. In Australia, the New South Wales Environment Protection Authority has established a guideline value for deposition of insoluble solids of 4 grams per square meter per month (g/m2/month) (including background deposition rates). The New South Wales Environment Protection Authority also states that the maximum increase in deposition rates from a development should be limited to 2 g/m2/month. A review of other international guidelines (North Ayrshire Council, 2000) indicates a nuisance threshold of 5.6–19.5 g/m2/month.

73. The results of the dust deposition sampling program indicate that dust deposition rates at most locations fluctuate between approximately 3 and 6 g/m2/month. Predicted increases in dust deposition rates are presented in Table A1.11. The deposition rates vary between 0.3 and 2 g/m2/month for most receptor points. The maximum predicted increase is 5.2 g/m2/month (this increase is predicted to occur at receptor point 12 for the modeled scenario that represents year 15). However, the predicted increase is below the nuisance threshold of 5.6–19.5 g/m2/month. Therefore, potential increases in dust deposition rates are unlikely to lead to a significant deterioration in amenity. However, strict management of dust emissions—including regular sampling of dust deposition rates—will be implemented as a part of the EMP.

74. Cumulative impacts resulting from the Barapukuria Power Station and other possible future open cut coal mines and industrial facilities in the Project area are likely to place an increased strain on air quality. Asia Energy is committed to initiating and promoting an active implementation of best available control technologies to mitigate emissions from industrial developments in the Project area. This will also force consideration by the Government in cooperation with the various operators. Asia Energy emission controls will set the standards for

others in the country. The process of continuous monitoring will enhance emission control. Asia Energy will facilitate the establishment of and participate in a Phulbari air quality action committee. Asia Energy has allocated a budget with capital cost of USD 400,000 and operating costs of USD 45,000 annually for this continuous monitoring. Asia Energy has already established two automated meteorological stations and will establish eight ambient air quality monitoring stations as part of the EMP.

2. Noise

75. A literature search found no relevant information on ambient noise levels in the project area. It is understood that ambient noise measurements have been undertaken in association with the Barapukuria Coal Mine and Barapukuria Power Station projects preparation and operations. However, the information is not yet publicly available.

76. Project monitoring data show that noise levels already exceed BES night-time limits at many locations around Phulbari; some locations also exceed night-time limits. A summary of measured baseline noise levels in Phulbari is found in Table A1.14. The Government of Bangladesh and World Bank guidelines for environmental noise are found in Table A1.12. It should be noted that the government guidelines for environmental noise are stricter than the World Bank's guidelines. The receptors for monitoring noise are in the same locations as the receptors for monitoring point air quality, and are listed in Table A1.21.

77. While it is understood that standards of the Government exclude background noise levels, the potential impacts from a noise source are to some extent dependent upon how intrusive the noise from the source is on existing ambient noise. An understanding of existing ambient noise levels in the Project area is thus important. Drill rigs, power generators, construction of transport corridors, construction of mine infrastructure, mine operation equipment, blasting, coal extraction, transport of coal to handling and storage facilities, and earthworks and vehicle movements associated with rehabilitation of the mine site will all potentially generate noise impacts.

78. Several phases of the Project have been examined and six separate stages have been identified for detailed noise impact assessment. The selected stages represent worst-case impacts over the course of the Project. Noise sources during each of the six stages were determined based on guidance provided by the mine planning team.

79. Modeling demonstrates that noise impacts from the Project will satisfy Government standards, except in the case of night-time activities conducted under temperature inversion conditions. Model predictions indicate that there might be modest exceedance of Government standards in the residential areas closest to the mine during very limited periods due to certain weather conditions. In these instances, mining operations will be curtailed or halted altogether. Predicted noise impacts from the Project are found in Table A1.16. The receptor points for the prediction are found in Table A1.15.

80. Geological surveys have indicated that there will be a need to blast Permian material at the base of the pit. An assessment of potential impacts and ground vibration from such blasting has found that significant impacts are unlikely at locations more than 500 m from the blast area. No residences will lie within this zone. However, a series of small trial blasts prior to commencement of mine production blasting will be carried out to verify the impact predictions.

81. The noise and blasting impact assessment has found that impacts from the Project can be controlled by implementing several mitigation measures, some of which are listed below. A strictly enforced noise management plan is required as part of the project EMP in order to ensure that community nuisances are minimized.

82. Some of the principal mitigation strategies that will be adopted for the Project to ensure that all guidelines and environmental requirements are fulfilled are outlined below. Details are found in the EMP.

(i) Earthworks and other noisy activities related to the construction of the CHPP will be restricted to daytime hours only (6am to 9pm). Haulage of overburden from the pit to the CHPP area during the construction period will be limited to daytime hours only.
(ii) A 15-meter high noise bund will be constructed around the CHPP area and will be in place prior to the commencement of normal operations of the CHPP. A 15-meter high noise bund will be progressively developed along part of the western boundary of the mining pit, adjacent to East Phulbari, and will extend around the coal dump point and primary and secondary crushers when they are in their year 15 location.
(iii) Low-noise equipment will be selected for project activities wherever possible and feasible.
(iv) Monitoring of project operations will be undertaken both during the day and at night, and also under adverse meteorological conditions. Operations will be restricted when monitoring indicates that project noise thresholds are exceeded.
(v) Noise monitoring system will be installed with alarm levels for short-term noise. Detailed noise monitoring, a community consultation program, regular assessment of noise impacts from the Project, and a process of continual environmental improvement will be adopted as part of the EMP.
(vi) A series of trial blasts prior to commencement of the mine production blasting will be carried out to verify impact predictions and develop site-specific blast-management procedures.

3. Surface Water

83. Detailed hydraulic and hydrologic analysis of flood flows in the catchments and floodplains of the Little Jamuna River, Khari Pul creek, and Nalsissa creek in the vicinity of the Phulbari mine site have been undertaken. The hydrologic and hydraulic impacts of the release of mine dewatering flow into the Little Jamuna River have also been investigated. It has been concluded that the mine and the township will be protected against even the most extreme flood event if appropriate embankments are constructed using material from the mine overburden.

84. The 100-year flood extent and depth with and without the development of the mine and land settlement has been assessed. Mine development would raise flood depths 0.1–0.3 m in some areas to the northwest and west of Phulbari. Localized land settlement resulting from the consolidation of aquifer horizons associated with the extraction of groundwater (and controlled by aquifer injection) will not significantly reduce water surface elevations in and around the mine site. The net result of this land settlement is that some small areas, especially the area immediately north of the mine site, could be inundated during a 100-year flood to depths of around 0.2–0.5 m. No additional flood impact resulting from land settlement is anticipated for areas west of the Little Jamuna River. Most villages are elevated and set away from the current floodways; some are 0.6–1 m above the agricultural floodplain. Villages immediately north of the

mine footprint are scheduled for early resettlement. Thus flood inundation resulting from land settlement is not anticipated to be a major concern.

85. The effect of the mine dewatering flows on the Little Jamuna River was examined using flow duration curves. As expected, the mine dewatering flows were found to be significant only in the dry season months (October to April). As it is anticipated that much of this low flow release will be extracted by irrigators, it can be concluded that the mine dewatering flows are unlikely to cause any hydrologic or hydraulic problems in the Little Jamuna River.

86. Hydrological and surface water quality characteristics could be affected by the construction of flood protection levees, overburden dumps and noise protection bunds; loss of water catchment areas; diversion of watercourses; and off-site discharge of excess treated "dirty" water from the mine site. Potential impacts relate to discharges containing high sediment loads, low pH, and elevated levels of nutrients; biochemical oxygen demand; chemical oxygen demand; and oils and hydrocarbons. Changes to the physical-chemical environment of water bodies may have impacts on downstream aquatic flora, fauna, and fisheries.

87. The Khari Pul creek (which is actually more of a drainage channel, with water flows of 0.3 m3/sec to 12 m3/sec during extreme rainfall) carries the untreated wastewater from Barapukuria Coal Mine (just north of the Project area). The proposed diversion is indicated in Figure 2. The diversion of the Khari Pul creek is based on detailed hydraulic modeling.

88. Maintaining the drainage line within the Khari Pul catchment will retain the current flow regime into Ashoorar Beel (in terms of timing and seasonality), although volumes might be reduced. The channel design will be sinusoidal to slow flow velocity and match existing riparian and aquatic habitats. Water discharged to any receiving area will meet the GoB guidelines.

89. Set out below are some principal mitigation strategies that will be adopted for the Project to ensure that all guidelines and environmental requirements are fulfilled. Details have been developed in the EMP:

- (i) A combination of flood protection levees, visual mounds, sound bunds, and overburden dump (project bund) will encapsulate the active mining and processing areas.
- (ii) Groundwater discharge from mine dewatering of the Upper Dupi Tila (UDT) aquifer will be used to maintain baseline flow conditions in the nearby watercourses and beels.
- (iii) Erosion controls will be implemented according to a comprehensive erosion and sediment control plan.
- (iv) Runoff from overburden dumps and the mine pit will be collected, treated and preferentially reused on-site. Where water is in excess of mine water requirements, it will be treated to meet Government effluent discharge standards and discharged at designated locations.
- (v) A mine wastewater treatment plant and associated wastewater collection system will be constructed, with effluent to be preferentially used on-site.
- (vi) A number of acid mine drainage mitigation strategies will be instigated.

4. Groundwater

90. The results of a coal exploratory drilling program, stratigraphic drill holes, and groundwater bores have been used to determine the hydrogeological setting of the Phulbari

mine. This information has significantly improved the hydrogeological understanding of the Phulbari coal basin and is the basis of input for the numerical groundwater model. Where local information was unavailable, information from the neighboring Barapukuria Coal Mine project was also reviewed and incorporated into the analysis. The Permian Phulbari coal basin is overlain by up to 150 m of unconsolidated sands and clays that were deposited during the Tertiary and Quaternary periods.

91. In terms of dewatering, the Tertiary sequence (Upper Dupi Tila and Lower Dupi Tila Formations) are of primary interest. The Upper Dupi Tila (UDT) is a regional aquifer. The UDT has been identified across the Phulbari coal basin and is present at Barapukuria as well.

92. Four pumping test investigations were undertaken to obtain characteristic UDT aquifer parameters (and calibration data) for input into a numerical groundwater model. At each of the test sites, the geological profile was consistent and water level drawdown measurements indicated a delayed yield response from the UDT aquifer. The aquifer parameters, transmissivity and specific yield, were used to define the expected long-term groundwater response to pumping.

93. To maintain dry and safe working conditions in the open cut mine, the water table will be lowered to the base of the mine pit. Dewatering activities will have potential impacts on the local and regional hydrogeological regime, with predicted groundwater drawdown of approximately 25 m at a distance of 4 km from the mine pit, and 15 m at a distance 6 km. This may result in (i) reduction in groundwater availability to the local farming community, Phulbari township, and nearby villages; (ii) reduced baseline flow into watercourses and Ashoorar Beel during the dry season; (iii) land settlement; and (iv) a general reduction in groundwater quality. Groundwater injection will compensate for this and additional modeling work, field investigations, and trials will be part of the detailed design phase.

94. Investigations indicate that arsenic is not currently a problem in the Project area, and is unlikely to be released as a result of mine dewatering. Analysis indicates that no groundwater within a 20 km radius of the Project exceeded 5 microgram per liter (µg/L). Bangladesh's standard limit for arsenic is 50 µg/L. WHO (2005) indicated an international standard for arsenic in drinking water at 200 µg/L in 1958, 50 µg/L as a “guideline value” in 1963, and 10 µg/L as a “provisional guideline value” in 1993.

95. The following is a list of some of the principal mitigation strategies that will be adopted for the Project to ensure that all guidelines and environmental requirements are fulfilled. Details are found in the EMP:

- (i) Deep tubewells will be drilled to the base of the UDT aquifer to supply reticulated water to affected villages.
- (ii) Monitoring of shallow tubewells in the eastern part of Phulbari will occur to determine whether access to groundwater has been impacted upon by the dewatering activity. Groundwater from the mine dewatering system will be reticulated to Phulbari township households ahead of any impact on current tubewell water supply.
- (iii) Conceptual water delivery systems for irrigators have been formulated based on the degree of water level decline.
- (iv) Groundwater from the dewatering system will be the primary source of reticulated water supply to the extended Phulbari township.

(v) The area extent of irrigation water demand will vary over time, depending on the location of the mine and associated dewatering system. Water delivery demand and infrastructure systems will be designed for these various contingencies.

(vi) Water quality is currently being monitored within rivers and beels surrounding the mine. Should monitoring indicate that rivers or beels adjacent to the Project — including Ashoorar Beel — are adversely affected by dewatering activities at Phulbari mine, water will be released to the surface water body from the mine dewatering system to maintain current seasonal water levels and quality.

(vii) Surface water carrying organic matter will flow into the lake in the wet season, marginally lowering the salinity and facilitating nutrient delivery to the lake.

5. Water Treatment

96. The mine dewatering systems will initially be installed as a ring of dewatering bores around the box cut footprint. As the box cut expands, additional dewatering bores will be placed on benches within the pit. As the mine expands, some of the initial production bores will be destroyed and replaced by new production bores around the outside. Periodic replacement of sacrificial bores will continue throughout the life of the Project. The groundwater from all production bores will be of low salinity and visually clean. The predicted long-term average dewatering rate is around 6,000 litres per second (L/sec).

97. Water that flows into the pit and accumulates on the floor will be of low salinity but will be turbid. Sump pumps will be located on the pit floor to remove rainfall and groundwater inflow that accumulate in the base of the pit.

98. In the box cut stage in year 3, for example, it is expected that groundwater inflow to the mine will be around 100 L/sec in the dry season and 900 L/sec in the wet season respectively. The rainfall to the pit in the dry and wet seasons may vary from 0 to 300 L/sec. Near the end of mining, groundwater inflow may be similar but rainfall runoff will be much greater — up to 1,800 L/sec.

99. Clean water from the dewatering bores will be pumped into the “ring main” (a large diameter pipeline that will collect water from every pumping bore, both inside and outside the pit). This water arriving directly from the aquifer will not require treatment and will be directed to the irrigation and aquifer injection systems, the water supply for Phulbari, the construction camp, administration, and watercourses. Monitoring of the water is part of the EMP.

100. In the long term, about 2,500 L/sec of water from the dewatering system will be required for irrigation in the dry season, and nothing will be required in the wet season. Around 200 L/sec may be required for aquifer injection in year 2 to restrict ground water drawdown to the mine area; up to 1,700 L/sec will be required for aquifer injection in about year 30. The long-term average of 6,000 L/sec from the dewatering ring main system, eventually around 4,200 L/sec is required for these two activities. These can be covered by clean groundwater from the mine production bores.

101. Water with low salinity will be pumped from the pit floor to the surface, then piped through a separate pipeline to sedimentation treatment basins before reuse on-site or release to watercourses. These sedimentation ponds will be designed for a 1 in 20 year rainfall event and a 24-hour retention period. Some of this water will be preferentially used for such activities as dust suppression, fire fighting, coal washery, and rehabilitation. Excess water will be released into either the Little Jamuna River or the Khari Pul creek. Monitoring of the water will be part of

the EMP and will determine if additional treatment is required. The settlement dams will be cleaned out during the dry season.

102. Surface water runoff, derived from rainfall falling on mine disturbed areas, will be directed into sedimentation ponds. These ponds are separate from those treating the water from the floor of the pit. Runoff from un-rehabilitated sections of the ex-pit overburden dump will be channeled to large basins south of the dump. The retention basins will be sized for 24-hour retention. These basins will move progressively southwards as the mine and ex-pit dump also move southwards. Another separate treatment basin will be located for runoff around the infrastructure area. In addition, separate water treatment facilities will be built to trap oil. Monitoring of the water will be part of the EMP and will determine if additional treatment is required (e.g., acid mine drainage).

103. The Khari Pul creek will be diverted around the east of the mine footprint to deliver water to Ashoorar Beel. The water from the Barapukuria Mine currently flows down Khari Pul. It will continue to flow via the diversion to Ashoorar Beel. Asia Energy acknowledges its responsibility to meet the national water quality standards of the Khari Pul at the discharge from the Project area. To this end Asia Energy is committed to carry out water treatment as required but also work with Government authority (Department of Environment) and Barapukuria Mine to ensure water discharged from the Barapukuria mining lease into the Asia Energy Project area also meets national water standards.

104. The EMP will govern the handling of mine dewatering. The volume and timing of release of water for irrigation will be decided by the Irrigation Committee (including NGOs, farmers, and project staff). The Department of Public Works will take water from the ring main as required. Water release for aquifer injection will be determined by project staff through environmental monitoring. Water release to watercourses will depend on the season and on the mine environmental monitoring program, as outlined in the EMP.

6. Biological Environment

105. The Project could potentially result in the direct loss of some common habitats. No sal forests or major beels will be directly affected by mining activities, but indirect effects may occur as a result of watercourse diversion, discharge of excess mine site-treated “dirty” water, increased sediment load resulting from land clearing and earthworks, mine dewatering activities, and groundwater discharge to watercourses. Other impacts may include weed invasion and elevated noise levels.

106. All conservation significant species recorded within the project area have a wide distribution within Bangladesh; the mine footprint area is not considered vital to the survival of any of these species.

107. Some of the principal mitigation strategies that will be adopted for the Project to ensure that all guidelines and environmental requirements are fulfilled are listed below. Details have been developed in the EMP:

(i) Mining and associated activities will be limited to the mine footprint to ensure that habitat removal is limited.

(ii) To minimize the loss of terrestrial habitats within the mine footprint, homestead vegetation and roadside vegetation will be retained or replanted wherever possible. Beels within the mine footprint will be retained and maintained in existing condition where possible.

(iii) The potential for increased sedimentation resulting from land clearance and excavation will be minimized through appropriate sediment and erosion controls in accordance with the soil management plan (a component of the EMP).

(iv) The Khari Pul creek diversion has been designed to maintain fish passage to Ashoorar Beel and areas further downstream. The Department of Fisheries and the national NGOs involved in the beel at different stages have been consulted in the design of the diversion.

(v) Engineering works will be implemented to minimize or compensate for changes to groundwater levels and flows through aquifer injection, and hence to minimize potential for adverse impacts to terrestrial vegetation and to dry season levels of beels.

(vi) The overburden dump and filled-in areas of the mine pit will be progressively rehabilitated and revegetated. A mix of local and exotic timber, fruit-bearing, medicinal, and fodder species will be used in initial revegetation of the disturbed land within the mine footprint. Local indigenous species will be given long-term priority where feasible. In particular, sal (*Shorea Robusta*) and associated canopy and understory species, including medicinal plants, will be planted where practicable.

(vii) The margins of the Khari Pul creek will be revegetated south of the overburden dump to the edge of the mine lease to create a wildlife corridor with possible extensions outside the mine footprint to Ashoorar Beel.

(viii) To reduce human pressure on remaining biodiversity resources, an extensive awareness campaign for biodiversity conservation aimed at local communities within and around the project area will be implemented.

7. Visual Effects

108. The mine's impact on the visual landscape will change over time as the mine is developed and operated over its 30-plus year lifespan. The most prominent landform change will be the ex-pit overburden dump, which will effectively obscure views from near the mine's eastern boundary. However, in the long term, the rehabilitated mine will form a contrasting feature in a flat landscape and will establish a 10 km native forest visual link from northeast of Phulbari to Ashoorar Beel. It should be noted that open pit mines in other countries have become significant sightseeing attractions for the local community and tourists. The opportunity to establish a mine lookout will be considered during the project implementation phase. Experience suggests that such an initiative would be both a community business development and a community relations opportunity.

109. Views from the west around Phulbari will be subject to the highest impacts, mainly because of the relatively high population density in that area. The Project is also expected to have a high visual impact on views from the northeast to southeast sector. The Project will have minimal visual impact on the area south of the mine, which is further from the mine site.

110. Some of the principal mitigation strategies that will be adopted for the Project to minimize visual impacts are listed below. Details have been developed in the Construction Environment Management Plan (CEMP), the coal handling preparation plan, and the EMP:

(i) During initial mine development, visual mounds will be constructed around the western and northern perimeters of the mine. These mounds will be vegetated.

(ii) Lighting will be carefully designed so that lights are fixed as low as possible and directed to the ground or away from possible view locations. Temporary lighting systems for mining operations will be focused on immediate work areas and away from off-site viewing points.
(iii) The overburden ex-pit dump will be rehabilitated and a native forest established. The forest will form a biodiversity corridor with the final void and Ashoorar Beel.
(iv) Most of the pit and infrastructure areas will be rehabilitated and converted back into agricultural land; the final void lake will be integrated with the biodiversity corridor and used for irrigation, for recreation, and to benefit biodiversity.

8. Sociocultural Environment

111. The Project must acquire a large area of land for mine-related activities. This will require displacement of the population currently residing in the mine area. The mine footprint is located mainly on agricultural and settled land. Current estimates are that about 9,000 households (some 40,000 people), including some residents at the extreme eastern end of the Phulbari township, will have to be relocated. Population displacement will occur in all four upazilas, with Phulbari being the most affected. In addition, up to 160 households may have to be relocated for the realignment of rail and road corridors. The extension of the western portion of Phulbari town and the establishment of relocation villages is set to occur mostly on open (cultivation) land. Population displacement is therefore generally not anticipated at the village relocation sites.

112. A significant reduction in land acquisition and population displacement is not possible without compromising the economic and technical viability of the Project.

113. The following related plans have been finalized as part of the project documentation and actions will be taken accordingly:

(i) resettlement plan, including a project entitlement matrix that details resettlement and compensation entitlements;
(ii) livelihood restoration plan;
(iii) an indigenous people's development plan;
(iv) land acquisition plan as required under the legislation;
(v) conceptual land use plan for the extended Phulbari township and surrounding villages; and
(vi) public consultation and disclosure plan.

9. Mine Rehabilitation

114. A detailed mine rehabilitation plan has been developed. It includes establishing 1,946 ha of native forests on the ex-pit overburden dump, with a wildlife corridor bordering the mine lake (which will have a surface area of 696 ha) and connecting with the forest and wetlands of Ashoorar Beel. High-value agriculture will be established in the filled-in pit area and rehabilitated infrastructure over an area totaling 2,550 ha. Asia Energy is committed to ensuring that funds are available for all these rehabilitation works.

C. Railway Transportation, River, and Barging

1. Railway Corridor

115. The railway component is subject to partial financing by ADB's public sector; hence at this stage only a basic environmental impact assessment (EIA) has been carried out for this component. A full-scale environmental assessment will be carried out under the proposed public sector loan.

116. Approximately 1.5 million tonnes of coal is scheduled to be mined and transported in 2008. This will increase to 10 millon tonnes per year (Mtpa) by 2011 and to 15 Mtpa at peak mine production in 2013. The distribution between the various markets and transportation means is found in Table A1.30.

117. Coal will be transported via various types of wagon and locomotive, depending on the destination. Trains will have up to 100 wagons with a capacity of 4,000 tonnes and an approximate length of 1,100 m.

118. As many as 11 trains per day will transport coal from the Phulbari coal mine to domestic markets throughout Bangladesh, Indian markets via Darsana, and international markets via a coal loading terminal at Khulna.

119. An extensive rail network exists in Bangladesh and neighboring India. The network consists predominantly of broad gauge (1,676 mm between rails), with some meter gauge (1,000 mm between rails) and dual gauge. Bangladesh Rail moves approximately 3.5 million tonnes of freight per year over its entire network. Freight consists of containers, petroleum products, and a variety of mixed freight.

120. There is sufficient capacity in the existing system to accommodate the proposed coal freight movements. Some parts of the network have been recently upgraded and other sections will be upgraded in the near future. However, to safely accommodate coal trains at required speeds, a number of improvements will be required, mainly related to rail, sleeper, and ballast rehabilitation, and passing-loop upgrades. Rail upgrading works will take approximately 2 years.

121. Various sections of the rail network will require rehabilitation, including ballast, sleeper, rail, and passing-loop upgrades. New rail sidings will be required at Gazipur and also at other locations yet to be determined. The segments of the rail corridor are listed in Table A1.18. The existing conditions and proposed upgrades are found in Table A1.17.

122. Monitoring of noise along the railway indicate that at a distance of 12–20 m from the railway, Day–night noise levels (Ldn) vary from 70 decibels measured in audible noise bands [dB(A)] to 62 dB(A). (The day-night noise level is the cumulative noise exposure over a 24-hour period, with an additional 10 dB(A) imposed on noise level during the nighttime period.) At a distance of 50 m, Ldn noise levels vary between 64 and 70 dB(A). At a distance of 100 m from the railway, Ldn noise levels vary between 62 and 70 dB(A). At a distance of 150 m from the railway, Ldn noise levels vary between 56 dB(A) and 64 dB(A). Variations in the measured Ldn noise levels are a result of the number, composition, and speed of trains using the railway at the given locations; whether the locomotive horn is used regularly at the location; and the influence of other sources of ambient noise. The attended noise monitoring at each location found that there were a number of noise sources other than railway noise that influenced ambient noise levels. These included road-traffic noise, industrial noise, general community noise, and noise

from birds and insects. The measured noise levels are found in Table A1.19. They exceed the Government guidelines, which are found in Table A1.12.

123. The rail corridor operations are unlikely to cause gross groundwater contamination because of the low porosity of the overlying clay materials present throughout most of Bangladesh. The railway line is generally free from flooding. By design the existing railway line is located on built-up embankments to facilitate rail movements during the wet season and in flood conditions, and to facilitate continued drainage through existing waterways.

124. Biodiversity values are relatively low in the extensive agricultural areas along the length of the rail corridor. Nevertheless, because the railway corridor includes nonagricultural vegetation and is surrounded by landscapes modified for agriculture, it has the capacity to function as an ecological link facilitating the movement of birds and wildlife, as well as providing a habitat for a limited number of species. For this reason, in areas heavily modified for agriculture, the existing railway corridor also performs the important ecological function of a "seed bank" for regeneration and distribution of plant species. In extreme or prolonged flooding conditions, the raised portions of the existing railway corridor (i.e., embankments) may also act as a habitat refuge for fauna and flora species.

125. Railway surveys were undertaken as part of this study in order to define the number of level crossings, their frequency, location, and type. The results of the surveys are found in Table A1.20.

126. Many level crossings in Khulna city that will be used by coal trains traveling between Phulbari and Khulna were found to be surrounded by shops and/or markets. Rickshaw and pedestrian traffic was especially frequent in these areas. Safety features such as traffic barriers and warning signs at most of the level crossings inspected appeared to be old, damaged, or absent. Where barriers were present, they appeared to be manually operated, but attendants were absent in most cases. The railway, including the crossings, will be upgraded under the proposed public sector loan.

127. The majority of rail rehabilitation works will be undertaken within the existing rail corridor. The exact location of works has yet to be identified; their location will be dependent on the final arrangements regarding the development of this component.

2. Coal Terminal in Khulna

128. The rail marshalling yard at Khulna will be utilized for marshalling of trains to or from the Coal Terminal site. The rail marshalling yard is an existing operation located directly to the west of the Coal Terminal site in Khulna. The existing rail marshalling yard will be upgraded, if necessary, to accommodate the proposed coal trains. It is anticipated that upgrading works will not require expansion of the marshalling yard outside its existing footprint.

129. Detailed design of the rail loop will carefully consider noise mitigation measures, such as incorporating the rail loop on a slight uphill gradient to reduce wagon bunching and noise. Other mitigation measures that will be considered include the use of slack-reduced couplings.

130. Trains will be brought to the terminal by main line locomotives. Subject to the detailed design phase, the type of locomotives to position trains during unloading will be decided. Wagons will be fitted with gates that will discharge the coal into a steel receiving hopper in the

ground. Conveyors will be constructed within a concrete dumper pit and tunnel to deliver coal to the receiving system.

131. Detailed geotechnical investigations will be required to determine foundation requirements and to ensure that the pit is designed to prevent uplift. Dewatering will also be required during construction and operations. Equipment within the dumper pit will be suitable for occasional immersion in the event of local flooding.

132. The dumper will be covered by a concrete and masonry enclosure. Misting sprayers will be installed to contain dust within the enclosure and water sprayers will be used to wash down wagons as they leave the enclosure. Water will be collected and pumped to a settlement pond. The receiving conveyors will have removable dust covers and all transfers will be fully enclosed and equipped with water sprayers to minimize fugitive dust.

133. Coal stockpiles will be located on the west side of the site. This will allow for easy expansion to the east with a fourth conveyor if necessary in the future. It also allows stockpiles to act as noise barriers. To minimize dust generation, water cannons will be installed along both sides of each stockpile to spray the coal to keep it moist. The stockpile spray control system will be linked with wind measurements to maximize its effectiveness.

134. As a part of the EMP, a CEMP will detail environmental protection and monitoring measures to be incorporated throughout construction. These will include water, air quality, noise, traffic, and barge controls.

3. River and Barging

135. A fleet of barges will transport coal from the proposed Coal Terminal in Khulna, down the Bhairab, Rupsa and Pussur rivers to a deep anchorage near Akram Point, a distance of approximately 58 nautical miles (107 km). The barges will be leased from world-class operators to ensure state-of-the-art design and safety conditions throughout the duration of the Project. This anchorage is approximately 32 nautical miles (59 km) north of the Mongla Fairway Buoy in the Bay of Bengal. Ships will access the terminal via a designated shipping lane extending to the Bay of Bengal. The MPA has an existing pilot and administration facility at Hiron Point.

136. The shipping channel is comprehensively assessed and charted in as straight a line as possible to keep it at a maximum distance from the shore line of the Sundarbans. The routing of the channel is illustrated in Figures 4 and 5.

137. An estimated total of eight barges would be required to accommodate the maximum throughput of 8 million tonnes per year. Each barge will take approximately 33 hours to complete the cycle. Barges will be progressively phased in to meet demand as coal production rates increase. Barge design specifications are found in Table A1.31.

138. The floating transfer vessel (FTV) will be located at a natural deep trough at the southwestern side of Akram Point, 32 nautical miles (59 km) north of the Mongla Fairway Buoy in the Bay of Bengal. The water depth at this point is approximately 18 m. This location is approximately 1.5 km from the southwest shoreline, and is therefore partly protected from prevailing southwest winds.

139. Barges will moor alongside the FTV where coal will be transferred to large ships. Empty barges will then return to Khulna via the same route. Two larger coal storage barges will be anchored near the FTV, which will allow flexibility in ship arrival and loading operations.

140. Cargo mats will be used to capture any spillage between the ship and barge, and redirect the spillage back to the barge for later recovery and placement on board the vessel.

141. The maximum possible draft for the vessels is 13 m, however the draft that any vessel transporting coal will load to will be restricted to 12 m. For Handymax vessels, the 12 m draft will not create a loss of cargo space. Typical ship dimensions are found in Table A1.32.

142. Pilotage from the Mongla Fairway Buoy is compulsory for all large vessels. MPA currently has a pilot station at Hiron Point, located south of Akram Point on the western side of the bay. The pilot station will be upgraded as a part of the Project. Ships will arrive at the Mongla Fairway Buoy and with the assistance of MPA pilots will be brought up river to the FTV at the Akram Point anchorage. The anchorage has a long and wide deep-water area where several vessels — up to Panamax size — (Table A1.32) can safely anchor at a depth of more than 17 m. This area is not used by trading ships and should therefore not be congested when coal transfer operations commence.

143. The channel will be a "one lane" channel design for use by deep draft vessels that can only move on high water. As such, all other vessels (with the exception of those with drafts of less than 8 m) that want to enter the river must wait for the channel to be cleared before they can proceed. Radio communication with the MPA traffic center will be used to control the movement of all vessels once the channel is operational.

144. The proposed barging and shipping operations are considered unlikely to have any significant adverse impacts on river hydrology, sedimentation rates, or turbidity.

145. To minimize the potential for accidents and consequent environmental impacts resulting from adverse weather conditions, a comprehensive safety and emergency response plan—a component of the overall EMP—has been developed and will be incorporated into the proposed barging and shipping operations. The plan will comply with all international shipping conventions and will include provisions that relate to following:

(i) All shipping and loading operations will cease in the event of a tropical cyclone or other adverse weather conditions;
(ii) Vessels will proceed to sea for safety or seek shelter in protected inlets where possible during a cyclone or other adverse weather conditions.
(iii) All barges and ships will be fitted with global positioning system (GPS), radar, and/or other electronic navigation systems to minimize the potential for grounding or collisions.
(iv) Existing navigation marks and aids on the river, particularly “leading marks,” will be reviewed and improved to help barge and ship masters navigate the river under all conditions. Lighted navigation marks will be installed or upgraded to ensure safe 24-hour operation.
(v) All vessels will carry appropriate spill containment and treatment equipment, including booms and skimmers, absorbent mats and rolls, absorbent material in bulk (Drysorb), and detergents. In sensitive areas, ships will be required to run on diesel.

(vi) Dispensing of fuel to vessels other than the floating terminal at Akram Point will be strictly prohibited.

(vii) Ballast water will be exchanged at sea in the Indian Ocean or the Bay of Bengal prior to arrival in Bangladeshi waters. Upon arrival at Akram Point, ships will be subject to inspection by quarantine officers to ensure that ballast water has been exchanged properly.

(viii) The pumping of other water from ships while in port will be prohibited.

(ix) Waste generated onboard all vessels, including the floating loading terminal, will be contained in tightly sealed containers and disposed of on a regular basis by barge to designated onshore facilities. Disposal of waste overboard will be prohibited and crew members of all vessels will be given training in appropriate waste containment and disposal practices.

(x) All vessels will be subject to a regular maintenance program to ensure proper functioning of steering and navigation systems, and to preserve the structural integrity of the hull, fuel tanks, etc. Proper maintenance will reduce the potential for grounding, collisions, and fuel and oil leaks.

4. Dredging

146. Currently, the entrance to the Pussur River from the Bay of Bengal is insufficiently deep to allow access to large vessels. This shallow area is known as the Outer Bar and extends for approximately 40 km from the Bay of Bengal (Mongla Fairway Buoy) to Hiron Point. The Outer Bar currently allows vessels with a maximum draft of 8 m. This is insufficient for Panamax vessels, which operate with a draft of 12 m. It is therefore proposed to undertake capital dredging (initial) and maintenance dredging (ongoing) across the Outer Bar.

147. The Outer Bar lies at the approach to the Pussur River from the Bay of Bengal and extends 40 km south to Hiron Point. Six kilometers to the south is a deep sea area known as the Swatch of No Ground, where water depths fall to more than 200 m below chart datum.

148. Dredging requirements have been identified using bathymetry data and survey charts provided by the MPA and Institute of Water Modelling. A proposed channel design was developed with the objective of minimizing dredging requirements without compromising safe navigation and the integrity of the Sundarbans World Heritage Area. The proposed alignment follows existing deeper channels, avoids shoals and wrecks, and is outside the Sundarbans World Heritage Area boundary.

149. The channel requiring dredging commences approximately 17 km south of the proposed loading terminal at Akram Point, and extends to a point 4 km south of the MPA's jurisdiction. This channel will be approximately 40 km long, to a level approximately 11.7 m below chart datum. This depth allows for variations in ship drafts and ongoing siltation.

150. Based on the above design, the improvements of the channel will require the dredging of approximately 30 million m3 of sediment in the first year. Most of the dredging will occur around the Outer Bar, with no dredging required from the proposed FTV near Akram Point to Hiron Point.

151. High rates of siltation in the Pussur River mean that maintenance of the channel will be required at regular intervals. Based on current understanding of sediment transport processes, it is expected that sedimentation will be greatest during the first year and will reduce and stabilize

by about the fifth year. Estimated dredging quantities are approximately 7.5 million m3 in the first year, reducing to and stabilizing at approximately 3.0 million m3 in the fifth year.

152. A review of disposal locations has revealed that there are no areas deep enough for the disposal of dredged sediment along the extent of the Outer Bar. In addition, disposal of sediment from the river system upstream of the dredging works was not considered because of the probable return of the disposed material to the river system, leading to an increase in maintenance dredging requirements. The potential for sediment to re-suspend is reduced when dumped onto a slope instead of a flat sea bed. Dredge loads will therefore be dumped within a restricted area on the slope of the Swatch of No Ground, rather than over its flat bed.

153. It is therefore proposed that the spoil will be disposed over the Swatch of No Ground at a depth of 60 m below chart datum. This will effectively permanently remove the sediment from the river system. The quantities of sediment being disposed of are considered insignificant compared with the 200–500 million tonnes per year of sediment discharged to the Swatch of No Ground from the Ganges–Brahmaputra–Meghna river systems. The impacts associated with the quantities of material disposed of are therefore considered negligible.

154. In order to minimize the proposed dredging's impact on water quality, the following will be undertaken:

(i) Water quality controls for shipping operations will also be implemented in dredging operations.
(ii) Sampling will be undertaken to determine background suspended solid loads and turbidity levels.
(iii) Suspended solid loads and turbidity levels will be monitored during dredging and disposal operations to quantify any resultant increases, and to identify the need for specific mitigation measures.
(iv) Monitoring results will be integrated with biodiversity monitoring results to determine the level of impact to aquatic species as a result of increased suspended sediment and/or turbidity.
(v) Detailed sampling and testing for contaminants will be undertaken on the sediment along the proposed dredging route to ensure suitability for deep sea disposal.

D. Coal Terminal in Khulna Including Barging and Offshore Reloading

1. Khulna Port Facility

155. The Khulna Port facility is an already existing site that was used previously as an industrial site with an active port. Because most of the industrial activities in the region have closed, the site has not been fully utilized for several decades. The design of the site as a part of the Project is illustrated in Figure 3.

156. Coal stockpiles will dominate views from most directions and will be seen in a relatively flat and homogenous landscape. Stackers and conveyors will be prominent when viewed from north, south, and east. Ongoing activities at the site will include train, bulldozer, stacker, and barge movements. Although the Coal Terminal in Khulna will dominate the landscape, it is in keeping with the general ambience of the port activities immediately to the south. The terminal's impact on the landscape will be minimal in light of the development of this part of the river front as an active port; viewers from the north, east, and south will see the terminal as just one part of

a larger river port complex. The main visual impact will be from close viewpoints in the west. Looking from the west, the relatively flat and green current landscape will be replaced with large coal stockpiles.

157. Visual impacts will be managed as follows:

(i) Immediately following construction, a line of trees will be planted along the western and southern perimeters of the site. This will afford a natural screen to viewers close to the site.
(ii) Lighting to support the operations will be carefully designed so that lights are fixed as low as possible and directed to the ground or away from possible view locations.
(iii) Structures will have non-reflective coatings.

158. **Construction Phase**. The contaminant concentrations in soils, groundwater, surface water, and sediments generally meet the site assessment criteria. Hence, the risk to human health and the environment are considered minimal.

159. The Coal Terminal soils have a relatively low porosity because of their high clay content. Hence, any contamination introduced to the soil during demolition and construction works is likely to be restricted to the surface soils. Given the preferential contaminant migration pathways at the site, contamination resulting from construction activities is likely to move off-site in surface waters. Likely receptors include the Bhairab River and on-site depressions or ponds. Tubewells already constructed across the site also present a potential migration pathway for contaminants to enter groundwater.

160. Prior to the demolition and removal of the on-site buildings and infrastructure, a hazardous building materials inspection will be conducted for all existing buildings. Based on the types of materials found on-site, suitable dumps should be sourced to dispose of hazardous materials in line with industry best practice. The outcomes of this inspection would be included in the site CEMP.

161. In summary the CEMP—as a part of the overall EMP—will include the following mitigation measures:

(i) Exposed land areas will be limited to the area required; following completion of construction, any exposed areas will be revegetated as quickly as possible, thereby limiting erosion and runoff.
(ii) During the earthworks phase, water trucks and/or sprinkler systems will be used to maintain moisture content in any exposed areas so that there is limited potential for dust emissions.
(iii) Vehicles on-site will use clearly defined access roads wherever possible.
(iv) Coal stockpile management will involve the use of sprinkler systems to control dust impacts.
(v) Sediment fences, filter socks, or hay bales will be placed around the site to limit sediment laden runoff.
(vi) Hydrocarbons will be stored in temporary or mobile bunded areas with the capacity to hold 110% of the volume of the largest container within the bund.
(vii) A register will be established to monitor the use of hazardous materials; it will include a list of the hazardous materials present on-site, the volume currently

being stored, the storage location, and the location of the associated material safety data sheets.

(viii) Surface runoff will be collected in sumps across the site.

162. **Operational Phase.** Solid waste generated by daily operations at the site will be disposed of in on-site bins before being taken to an appropriate landfill location. Pollutant traps will be incorporated into the drainage design, thereby minimizing contaminants entering waterways. Liquid wastes will be managed according to the wastewater management strategy and the sewage management plan; both parts of the EMP.

163. Fuel, chemical, and oil storage areas will be bunded to 110% of storage vessel capacity to ensure that potential leakages and spills are contained. The impact of hydrocarbon contamination will be minimized through an emergency or spill response plan and hazardous materials management. This plan will form part of the EMP and would include details of procedures to be followed in the event of a hydrocarbon spill (responsibilities, incident investigation, and remediation actions to be undertaken).

164. Stockpiles of coal will be maintained on specially designed compacted areas, with water sprayers used to control dust generation. Leachate and runoff generated through dust suppression measures could be directed to the settling pond, which could limit the migration of contaminants off-site. Once contaminants have settled in the pond, the sludge will be removed from the pond and disposed off-site at an appropriate landfill location.

165. Water for general fire protection will be provided by a water truck that will be stationed permanently within the rail loop. A fire detection system and sprinkler system will be installed in the rail dumper and reclaim tunnel. Fixed firefighting monitors on the barge berth will be used in case of a barge fire.

166. Drainage lines will be installed to direct site runoff to an on-site settling pond. The storm-water collection and treatment pond will have sufficient capacity to retain site runoff from a 24-hour storm having a return period of at least 10 years. The pond will be equipped with a reagent delivery mechanism to facilitate settling of contaminants and to adjust pH as required before controlled outflow to the river.

167. The site will be fenced on all sides and access will be controlled through gates with guard posts.

2. Water Quality

168. Water quality sampling undertaken under the EIA for the construction of the Rupsa Bridge downstream of the proposed port site found that the Rupsa River is highly turbid, and that concentrations of suspended solids, lead, oil, grease, and electrical conductivity within the river exceeded permissible limits set by the Bangladesh Department of Environment. Industry discharges were considered the main cause of this exceedance.

169. The large number of ships, ferries, fishing boats, and other vessels that regularly use the Bharaib and Rupsa rivers contribute further to water pollution through the regular discharge of oil and oily substances. Fuel and oil spills are also reportedly common along the river system.

170. In addition to industries and vessels, a significant contributor to water pollution is Khulna's drainage system; all drains ultimately discharge into the Bharaib and Rupsa rivers.

Storm water, household refuse, and wastewater, including sewage, are discharged without treatment through the drainage system to the rivers.

171. Water pollution generated in the Khulna city area is considered a potential threat to the Sundarbans.

172. Mitigation measures will be implemented to minimize potential adverse impacts on water quality. These will include

- (i) development of an erosion and sediment control system as a part of the construction and operational activities at the port site; the system will include specifications for the design of coal stockpiles to minimize erosion;
- (ii) provision of a drainage system and settling pond to collect and treat site runoff prior to discharge to the Rupsa River; any water discharged from the site will meet Government surface water quality standards;
- (iii) collection and disposal of sludge from the settling pond and solid waste at the site to an approved disposal area to prevent discharge into the river; an existing solid waste disposal site exists in Khulna at Rajbandh, and locations for several others have been proposed.

3. Air Quality

173. As they do in most of the country, air quality for particulates (PM10 and PM2.5) in Khulna already exceed Government standards, especially during the dry season. This is partly a result of local emissions and partly a result of the “Asian Brown Cloud” over the region (discussed above in the Phulbari Coal Mine section, para. 64). Measured PM10 and PM2.5 concentrations at the Khulna terminal site are found in Table A1.22.

174. For other pollutants, such as NO2 and SO2, the general situation is better. Table A1.23 shows the results of the passive sampling program for NO2 and SO2 at three locations in the Khulna area: i) the MPA01 site is located at the MPA site in Khulna city; ii) the BG01 site is located in Batiaghata 15 km south of Khulna and is predominantly agricultural land; and iii) the NP01 site is located in Noapara on the eastern side of the Khulna–Jessore national highway around 29 km north of Khulna city and is dominated by rice fields and beels, with some small settlements. The three site alternatives are discussed below in Chapter V ("Alternatives").

175. Emissions of airborne particulate matter are the major air quality issue for the development and operation of the Khulna terminal, regardless of the site chosen. Emissions of gaseous pollutants will be generated from engine emissions of vehicles and stationary equipment. However, these emissions will be minimal and within Pollution Prevention and Abatement Handbook, and will be distributed over the entire site. Estimated emissions of PM10 and PM2.5 from the operation of the terminal at mean wind speed are shown in Table A1.24.

176. Dispersion modeling to predict impacts from the operations has been undertaken. The results of the modeling show that the 99th percentile of predicted ambient concentrations of PM10 (24-hour) generated by emissions from the site operations will be below the AAQS of the Government.

177. However, when likely background concentrations are added to the predicted values, Government standards may be exceeded during the non-monsoon period. Predicted annual average concentrations are significantly lower than the 99th percentile of the 24-hour average

concentrations. The predicted annual average concentrations are less than half the annual average standard currently being considered by the Government for adoption (current Government standards do not yet include annual average limits). Predicted PM10 concentrations for the Bhairab River Coal Terminal at Khulna are found in Table A1.25. The receptor points at the Coal Terminal in Khulna are found in Table A1.21.

178. Predicted dust deposition rates resulting from site emissions are estimated in the EIAs. While there are no Government guidelines for assessing dust deposition, a review of international guidelines indicates that the potential exists for community nuisance at the deposition rates predicted. The predicted levels of 1–6 (maximum 9) g/m2/month are close to the nuisance threshold of 5.6–19.5 g/m2/month as advised by North Ayrshire Council. Refer also to the assessment of dust depositions in the Phulbari area (para 73). The predicted increase in annual average dust deposition rates for the Khulna site (MPA site) is outlined in Table A1.26.

179. Structural mitigation measures that have been included in the design of the terminal are in accordance with the world's best practice. Proactive management of fugitive dust emissions during the operation of the site will be a part of the EMP. The proposed automated fugitive dust emissions management system (part of the overall EMP), where dust suppression is linked to continuous meteorological monitoring, will result in substantial emissions reduction.

180. The following are some of the principal mitigation strategies that will be adopted during construction and operation of the Coal Termina in Khulna l to ensure that all guidelines and environmental requirements are fulfilled. Details will be developed in the EMP.

(i) Mitigation measures to reduce dust emissions have been incorporated in the design of the Coal Terminal site. Proactive site management, strict control of visible emissions, and a strong community liaison program will help reduce potential community annoyance.

(ii) Structural mitigation measures included in the design of the Coal Terminal are in line with current best practice. The emissions inventory shows that the most significant emission source is wind erosion from the coal stockpiles. A reduction in the size of the stockpiles would reduce emissions but would limit backup storage capacity for supply disruptions from the mine, affecting the economic viability of the Project. This issue will be decided during the detailed design phase.

(iii) The proposed automated fugitive dust emissions management system, where dust suppression is linked to continuous meteorological monitoring, will result in substantial emissions reductions.

(iv) The issue of most concern is the impact of particulate matter emissions at the Combined Military Hospital (receptor #4) currently under construction on Bangladesh Navy land to the north of the site. This receptor would be considered a “sensitive” area under the current standards of the Government and is therefore subject to significantly lower PM10 (24-hour) limit. Various alternative mitigation measures (such as installation of ventilation systems or adjustment of the operations) are planned if emissions from the site lead to exceedance of this limit, as outlined in the EMP.

4. Noise Quality

181. Background noise levels in the area are influenced by road and river traffic, industrial noise sources, community noise sources such as mosques, and noise from insects and frogs. Continuous noise from the flour mill opposite the Coal Terminal in Khulna site on Old Jessore Rd was clearly audible at the two baseline monitoring locations. The baseline noise monitoring results indicate that ambient LAeq noise (equivalent continuous sound pressure level that represents the steady sound level which is equal in energy to the fluctuating level of the measurement period) levels slightly exceed the Government noise standard for mixed areas during both the daytime and nighttime periods at the security office at the Coal Terminal site. Ambient LAeq noise levels comply with Government noise standards for mixed areas at the Port Health Department location located in the Coal Terminal site. A summary of the measured noise levels at the preferred Coal Terminal site in Khulna is found in Table A1.27.

182. Eight receptor points were selected to provide an understanding of noise impacts in the residential and other potentially noise-sensitive areas around the site. Predicted noise impacts from the construction phase are found in Table A1.28. The locations are the same as for the air pollution impact studies (see para. 177) and are found in Table A1.21.

183. Noise modeling was undertaken for a wide range of operational scenarios, which considered both equipment and procedural alternatives as listed in Table A1.29. An iterative approach was taken to determine conditions when daytime and night-time noise criteria are met. Two viable alternatives were determined. The viable alternatives also outline the equipment choice and operational mitigation measures needed to meet Government limits. The mitigation measures needed are indicated in the listing. Details will be developed in the EMP.

- (i) Alternative 1 utilized bulldozers to reclaim material from the stockpiles. In this alternative, the stockpiles in the areas that the dozers will operate will be maintained at a height of at least 12m to provide a noise barrier. If this stockpile height cannot be achieved, nighttime operations may need to be modified. Bulldozer activity will also be restricted from operating between the stockpiles and the reclaim conveyor from 9 pm to 6 am.
- (ii) Reversing alarms for the dozers may need to be switched off or modified during the night-time. Alternatives to normal reversing alarms include:
  - (a) the use of alarms that sense background noise levels and only emit an alarm signal up to 5 dB(A) higher than the background noise level;
  - (b) the use of directional alarms that reduce the area of disturbance;
  - (e) the use of strobe lights instead of audible alarms;
  - (d) the use of radar systems that sense obstacles and automatically apply the brakes; and
  - (e) improvements to driver visibility such as the use of video monitors.
- (iii) Alternative 2 investigated the use of a gravity reclaim method. For this alternative there will be no need to use dozers during the night-time, and therefore no need to maintain a stockpile noise barrier. A dozer will still be required to manage the stockpiles; this would be limited to daytime hours.
- (iv) Implementation of a noise monitoring program at sensitive receptors adjacent to the Coal Terminal site in Khulna.
- (v) If monitoring indicates that Government limits are being exceeded during southerly wind conditions, operational controls, such as restricting dozing operations to the southern areas of the stockpiles, will be applied.

(vi) The rail loop will be designed with a slight uphill gradient and locomotive operators will be trained to reduce the occurrence of wagon bunching. If wagon bunching occurs frequently and there is community reaction, additional mitigation measures, such as the use of rigid or slackless couplings, will be investigated.
(vii) The rail loop will be all welded rail, regularly maintained, and rail lubricators will be used to reduce curve squeal and noise from track discontinuities.
(viii) Idling of main line locomotives and decoupling and coupling to the train should be undertaken in the middle or northern parts of the marshalling yard area, as separation distances to residences are greatest in these areas.
(ix) Only one main line locomotive should be operated at a low notch setting for the trips between the marshalling yard and the refueling area. The other locomotive should be shut down.
(x) Residents in the areas within 30 m (either side) of the new rail line from the existing public rail line to the site will be resettled or offered another form of compensation. This is addressed in the resettlement plan.

184. The noise modeling and subsequent assessment examined continuous noise from the Project. However, there are a number of sources that can generate high levels of short-term noise. These include impact noise from rail wagon bunching, curve squeal as wagons travel around curves in the rail, reversing alarms, and impact noise from dozer operations. However, this will be minimized as trains will move slowly through the rail loop to facilitate unloading. Rail lubricators will be used as a further precautionary measure to keep the track greased.

185. The following are some of the principal mitigation strategies that have been incorporated in the design of the Coal Terminal in Khulna to ensure that all guidelines and environmental requirements are fulfilled. Details will be developed during the detailed design phase and incorporated in the EMP:

(i) The rail unloading facility will be located in the northeast corner of the site, away from residences to the west.
(ii) The unloading facility will be housed in a masonry building to reduce noise emissions.
(iii) The rail loop has been designed to include a slight uphill gradient to reduce wagon bunching.
(iv) Rail line lubricators will be used to grease the rail, minimizing the potential for curve squeal.
(v) The stockpiles have been designed so that noise emissions from dozers reclaiming coal in the nighttime will be shielded, reducing impacts on the residential areas to the west.
(vi) The power generation units will be placed in special acoustic enclosures.
(vii) Low noise conveyors will be specified.
(viii) Low noise dozers procured for the Project will comply with world-class standards.

5. Biological Environment

186. Construction for the port site, such as piles for port berths, will potentially have direct impacts on aquatic habitats. In particular, construction would result in disturbance to benthic sediments and associated benthic invertebrates. However, this disturbance would be localized and temporary, and would therefore be unlikely to result in any significant reduction in the aquatic biodiversity of the area.

187. The following are some of the principal mitigation strategies that will be implemented to address potential impacts to aquatic and terrestrial biodiversity to ensure that all guidelines and environmental requirements are fulfilled. Further details are in the EMP.

(i) Minimization of structures and disturbance to benthic sediment during construction.
(ii) Revegetation of the site with trees and shrubs, including along roadsides and the riverbank if practicable. Revegetation will not only restore some habitat for fauna species, but may also serve a screening function and mitigate visual impacts as well as increasing infiltration and reducing site runoff.
(iii) Implementation of the mitigation measures to protect water quality (see para. 172).

6. Social Impact

188. The proposal will result in the loss of all on-site residences and associated infrastructure. This will require the relocation of approximately 3,200 people (employees of MPA). In addition a limited number of squatters living south of the site may require relocation as a result of rail loop construction.

189. All resettled MPA employees will remain employed by the MPA and are not expected to lose their income as a result of the proposal. It is expected that the contrary will be the case, as MPA's activities associated with the shipment of coal will expand, guaranteeing a more certain employment future for MPA employees. Those who currently work at Mongla Port proper will be located closer to the port, resulting in reduced travel times (presently MPA employees live about 50 km from Mongla Port, which necessitates a 45-minute to 1-hour commute each way via MPA bus). The relocation of MPA buildings and employees from the Khulna site is in line with the MPA's own development plan for the Mongla Port. The relocation site near the MPA already exists and houses several buildings.

7. River and Marine Transport in the Sundarbans Area

190. Parts of the proposed transport corridor are aligned through the world's largest mangrove forest, the Sundarbans, which extends from southwest Bangladesh into southeast India. The Floating Transfer Vessel (FTV) is to be stationed off Akram Point, adjacent to the confluence of the Sibsa and Pussur Rivers, and is within the SRF (although it is upstream of the World Heritage Area boundary). The FTV will be at least 1.3 km from the nearest shoreline in the southwest. The corridor is illustrated in Figure 5.

191. The SRF supports a diverse vertebrate assemblage; 453 species have been recorded from the whole SRF area, at least 58 of which are categorized as threatened. Studies show that the Pussur River area of the SRF supports a total of 123 species of wildlife, of which six species are amphibians, 26 species are reptiles, 67 species are birds, and 24 species are mammals—together representing about 13.8% of the total wildlife species recorded in Bangladesh.

192. Fishing is highly regulated in the Pussur River area of the SRF, so limited information regarding the species available could be obtained from catch data. A total of 224 fish, 44 mollusk, and 39 crustacean species, and 72 phytoplankton, 28 zooplankton and 33 benthic genera were recorded recently in the SRF in limited aquatic surveys undertaken for the ADB-funded Sundarbans Biodiversity Conservation Project. From the data obtained, the Pussur River appears to support high species diversity, particularly in its lower reaches. Like mangrove

forests around the world, the whole Pussur River system of the SRF is a nursery habitat for many aquatic and marine species. Threatened species of the Sundarbans that use the habitats of the Pussur River area of the SRF include the royal Bengal tiger (*Panthera tigris*), saltwater crocodile (*Crocodylus porosus*) and the Gangetic river dolphin (*Platanista gangetica*).

193. Sundri trees appear to be increasing affected by a "top-dying" phenomenon, in which the crowns of the trees die, resulting ultimately in the death of the tree. The cause of this phenomenon, which occurs in greatest intensity along riverbanks, is uncertain. It may be caused by salinity changes or excessive sediment deposition over root systems. Riverbank erosion may also be a contributing factor.

194. The following are some of the principal mitigation strategies that will be incorporated into barging, coal transfer, and shipping operations to ensure that all guidelines and environmental requirements are fulfilled. Further details will be in the EMP:

(i) A detailed biodiversity study will be undertaken in relation to the proposed operations. This will include a detailed review of existing information (including the references cited in this report), and detailed baseline surveys at representative aquatic, inter-tidal, and shoreline sites along the proposed route. In selection of survey sites, consideration will be given to their suitability for use in long-term biodiversity monitoring.

(ii) Mitigation measures relating to water quality and pollution prevention will be taken, and a Fuel and Oil Management Plan and a Fuel and Oil Spill Contingency Subplan with specific reference to the SRF will be drawn up. Mitigation measures will include appropriate exchange of ballast and bilgewater prior to arrival in Bangladesh waters from foreign ports, containment and disposal of waste at an appropriate onshore facility, and training in appropriate waste management practices.

(iii) All vessels used in the proposed barging and shipping operations will be coated with TBT (tributyltin)-free anti-fouling paint.

(iv) No crew members will be permitted to go ashore within the SRF.

8. Social Situation

195. The Sundarbans contains 40% of Bangladesh's total government-owned forests and generates a sizable amount of revenue for the Bangladesh Department of Forestry. It is estimated that the Sundarbans contributes approximately BDT 4 billion annually to the nation's gross domestic product (GDP). More than 30 products are harvested from this area, including wood products, fishery-bred fish, and non-wood products.

196. While the average household in fishing communities in Bangladesh is typically larger than the national average (6.4 persons in fishing households versus the national average household size of 5.4 persons), the average household size in the surveyed communities (4.7 persons) is in line with the average household size recorded by the 2001 population census for the Khulna Division.

197. Because fishing activities are seasonal, fishing incomes fluctuate throughout the year. The survey results indicated that most households spend BDT 2,000–3,000 per month, which is greater than the average monthly income for most households. Seventy-nine households (20.7%) have taken out loans to help fund their household expenditures.

V. ALTERNATIVES

A. No Project

198. The natural gas reserves of Bangladesh, which currently supply most of the nation's electricity, are dwindling and may be depleted within the next 15 years. Unless a new energy resource were to be discovered and supplied, the predicted depletion of gas supplies would have serious adverse impacts on the economic goals of the Government and the living conditions of the people of Bangladesh.

199. Specifically, the impacts for communities in northwest Bangladesh could include:

- (i) an increasing gap between electricity supply and demand;
- (ii) decrease in air quality if, as predicted, clay brick production is increasingly fueled by high-ash, high-sulfur, low-calorific-value coal and biomass; and
- (iii) continued deforestation of remaining natural forests for use as biomass fuel with associated adverse impacts on endangered flora, fauna, and air quality.

200. The Project will provide an opportunity to avoid the above adverse impacts by, for example:

- (i) developing a major mining province in Bangladesh, and making available an important coal resource;
- (ii) providing energy resource security through diversification of energy supplies, and tapping into an energy resource that will curb growing demand for the declining gas resource;
- (iii) providing direct and indirect employment opportunities in construction and mine operation;
- (iv) strengthening local and regional economies and creating opportunities for poverty reduction by stimulating the growth of industry, growth of local cottage industries, manufacturing, and service delivery;
- (v) providing training and opportunities for professional, technical, skilled, and unskilled local communities;
- (vi) accelerating the pace of economic and social development and raising the standard of living by improving local and regional road, rail, power, communication, water supply, sanitation, health, and community infrastructure;
- (vii) generating export earnings and reducing the volume of imported poor-quality coal; and
- (viii) supplying high-quality, low-cost coal for the domestic market.

B. Technology Alternatives

201. **Underground Mining Scenario**. The depth, thickness, and geological configuration of a coal seam determine the mode of extraction. In the Phulbari coal basin, separation between the coal and overlying Upper Dupi Tila aquifer is limited. High geothermal gradients are reported within the coal aquifer at Barapukuria but not detected in the Phulbari coal basin. Extraction of coal with the underground mining methods was considered but ruled out on the basis of poor coal resource recovery, low production rates, and the fact that ground caving following coal extraction would eventually interact with the highly permeable Tertiary aquifer system. This presents an unacceptable operational risk associated with ground collapse and mine flooding.

202. To reduce the degree of breaching of the overlying rock, an underground mine at Phulbari would require maintaining significant ground-supporting pillars, resulting in difficult mining conditions and low coal production. It is estimated that a coal recovery ratio of less than 10% would be achieved; thus, most of the in-situ coal reserve would not be extracted and the majority of this valuable resource would be left under the ground with no way of extracting it.

203. Underground longwall mining can also cause land subsidence, the extent dependant on the depth of coal, overlying strata and width and height of the longwall. Subsidence can cause damage to structures and significant hydrological and land use impacts. At Phulbari the depth to the most significant coal is around 150–250 m and land subsidence of several meters could be expected.

204. On the basis of the above, development of the deposit by underground mining is not considered a viable option.

205. **Open Cut Mining Scenario**. Shallow and flat to slightly dipping coal seams, and thick coal deposits are usually mined by the open cut method. Open cut mining is generally less costly per tonne of coal mined than underground mining. Internationally, the open cut method for coal extraction is a common option, especially for shallow coal seams such as that at Phulbari. There is a long and successful history of open cut mining operations in many parts of the world. The US Mine Safety & Health Administration indicates that from 1989–1997 the number of accidents in underground mines was 3.8 times higher than in open cast mines, per tonne of coal produced. Production data from 1997–2003 from the National Mining Association indicates that the manpower productivity in open cast mines is around 2.5 times higher on average than in underground mines. Open pit mining accounts for around 80% of coal production in Australia and some 70% in the USA, two of the world’s largest coal producers.

206. The open cut mining method uses large but relatively uncomplicated machinery in open space areas. It requires the utilization of large, highly productive excavators, trucks, and bulldozers. If groundwater is present, dewatering bores are installed to maintain dry working conditions in the pit.

207. To access the coal in an open cut mining operation, a large slot is excavated into the overburden and the removed overburden and topsoil are stockpiled. Dewatering tubewells keep the open cut dry. As mining proceeds further, the waste overburden can be used to infill the mined out area once the coal is removed. Previously removed topsoil will be placed on top of the backfilled mine area to complete the land surface rehabilitation. When mining ceases, the groundwater level is allowed to recover. In some cases a remnant final void is converted into a freshwater lake. The entire mine project area can be rehabilitated and restored to profitable agricultural activity.

208. After assessment of the advantages and disadvantages of open cut and underground mining, the open cut method of mining was identified as the only technically viable, economically sustainable, environmentally manageable and socially acceptable development option. The open cut method has several local, regional, and national economic advantages, and has much fewer technical risks and health and safety risks for mine personnel.

C. Railway Transportation Route Alternatives

209. Rail upgrades will greatly improve the capacity, reliability, and safety of existing rail routes. Upgrades will also effectively create new import and export routes in western

Bangladesh. Upgrades will also improve vehicular and passenger safety at existing level crossings. In addition, the Project will contribute to institutional strengthening and capacity building of Bangladesh Rail.

210. The selections of coal rail transportation routes to the domestic and international markets are based on assessments that considered many factors, including suitable terminal locations, market information, travel distances and transport efficiencies, social and environmental impacts, rail track suitability, and track upgrade costs.

211. The rail alternatives assessment indicates that preferred transport routes for distribution of coal to the international market would be through river ports at Khulna, Noapara, or Batiaghata—all in southwest Bangladesh. These options provide:

- (i) comparatively short travel distances to the Coal Terminal in Khulna, as they follow a direct north–south corridor;
- (ii) relatively minor track upgrade and/or rehabilitation requirements;
- (iii) relatively minor impacts of existing rail traffic;
- (iv) minimal environmental impacts following the EMP; and
- (v) socio-economic benefits to the region through improved rail services.

212. Operational arrangements and organizational alternatives are also examined. This is an important consideration, as it will significantly influence the reliability and efficiency of the transport system. Five options were considered, and a preferred solution identified.

D. River and Marine Transportation Route Alternatives

213. The river and marine transport component of this Project will provide benefits through improved operations and institutional strengthening of the MPA, improved river access for larger vessels, and improved environmental and safety risk management in this area.

214. The river and marine alternatives assessments indicate that preferred transport routes for distribution of coal to the international market would be through Khulna. Batiaghata and Noapara were also recommended for further investigation. Mongla is considered suitable with respect to river and marine criteria. However, Mongla is limited by the absence of a rail connection. Akram Point is identified as a suitable location for coal transfer operations.

215. These preferred options provide:

- (i) comparatively short barge cycle times,
- (ii) relatively minor river improvement requirements,
- (iii) relatively minor impacts on existing river traffic,
- (iv) minimal environmental impacts following the EMP, and
- (v) socio-economic benefits to the region through improved river access.

E. Coal Transport Barges (Type and Fleet Size)

216. A number of coal transport barging options were assessed as part of the alternatives analysis process. The assessment recommended an 8,000 deadweight tonnage self-propelled barge, which features a flexible loading and unloading set-up, high maneuverability, and a large carrying capacity.

217. The size of the fleet should be optimized to correspond to coal production levels from the mine. At peak production a fleet of eight self-propelled barges will transport coal south down the Pussur River to a floating transfer vessel at Akram Point. Any deviation from the recommended optimal fleet size will lead to inefficiencies in the transport system, affecting the profitability of the Project.

F. Barge to Ship Coal Transfer Operations

218. Options for transferring the coal from the barges to the ships have been assessed. The assessments concluded that a combination of a floating transfer vessel and self-loading grabbers on Handymax vessels would be the optimal design (including, for example, "protection mats" during floating transfer vessel operations). By combining these two options, both Handymax and Panamax ships can be efficiently loaded at rates that facilitate Asia Energy's coal production schedule.

G. Barge Operational Arrangements

219. A time charter of barges will ensure that state-of-the-art equipment is used that reduces safety and other risks associated with poor equipment. The time charter operational arrangement will also be the most effective for vessel scheduling and optimization of the river/marine transport system.

H. Dredging at the Outer Bar

220. Several alternatives have been considered for developing the proposed dredging operations at the Outer Bar, taking into account shipping requirements, meteorological and hydraulic variables, bathymetry, safety issues, environmental impacts, and capital and recurrent costs. The preferred dredging alignment and depth is considered the optimal design because it enables ships to navigate the channel with minimal environmental and safety impacts. A trailing suction hopper dredge is considered suitable for the operating conditions at the Outer Bar and has thus been recommended for these works.

I. Possible Locations for Reloading Facilities

221. Fourteen sites have been investigated as potential terminal sites for distribution of coal to international markets. Based on an assessment of rail and river marine transport factors, three sites have been chosen for further assessment.

222. **Bhairab River Coal Terminal (Khulna).** (This is the same as the "Coal Terminal in Khulna" discussed above.) This site is located in Khulna city adjacent to the Bhairab River. It is an industrial property owned by the MPA and currently houses MPA residences and a river freight port operation, among other uses. The terminal will stimulate local development by expanding industrial production and generating employment in the Khulna area. The Project also fits in with local planning initiatives and allows the MPA to continue its development plan to transfer uneconomical activities from the Coal Terminal site in Khulna.

223. **Rupsa River Coal Terminal (Batiaghata)**. This site is located 15 km south of Khulna and is predominantly agricultural land, supporting rice and shrimp-farming activities. It also contains a number of small villages that would be affected. The loading berth would be located on the western bank of the Rupsa River. To develop this site, a 25 km rail extension that bypasses Khulna city and provides rail access to Batiaghata would be required.

224. **Bhairab River Coal Terminal (Noapara)**. This site is located on the eastern side of the Khulna–Jessore national highway, 29 km north of Khulna city. The majority of the site is currently rice fields and beels, with some small settlements. Construction of a loading berth on the banks of the Bhairab River would be required, as would a coal transfer conveyor from the site to the loading berth. The conveyor would also need to cross the highway.

225. Detailed investigations were undertaken into operational, economic, and environmental and socio-political issues associated with each of these potential coal terminal sites. The comparative analysis was divided into four main subsections:

(i) environmental and social impacts,
(ii) capital and recurrent costs,
(iii) suitability under local conditions, and
(iv) institutional and monitoring requirements.

226. The comparative analysis indicates that the Bhairab River Coal Terminal in Khulna is the most suitable of the three sites considered in this assessment. While this was among the least preferred with regards to air, noise, and traffic impacts, it had a higher relative score in many areas, including impacts on occupational patterns and livelihoods, flooding, affected areas, and land use. In particular, the Khulna site was strongly supported by a number of key stakeholders, including the MPA and the Khulna City Council, as it fits in with local development plans and objectives. In addition, these stakeholders recognized the potential for associated industry and employment generation benefits. The Khulna site was also considered suitable because of its long history of port, barging, and freight activities, whereas development of a coal terminal at the other two sites would result in substantial changes in land use. However, mitigation of the environmental and social impacts associated with air and noise pollution will require careful consideration (although this would have been the case regardless of which site was chosen). Resettlement issues will also need to be appropriately addressed as there will be more people to relocate with this alternative. However, the resettlement of these people is not considered a significant limitation as the majority (69%) already live in MPA employee housing, and suitable relocation sites exist on MPA-owned land. The relocated people (mainly MPA employees) will actually save at least 2 hours per day in reduced commuting time.

227. The Bhairab River coal terminal (Noapara) site and the Rupsa River coal terminal (Batiaghata) site both have advantages and disadvantages and therefore scored almost the same. Navigation to either of these sites would be more difficult than navigation to the Khulna site. Navigation to or from the Noapara site would require smaller—and consequently more—barges. Impacts on usage of existing agricultural lands would be greater and livelihood restoration costs higher for the Batiaghata site. The added cost of the rail extension required for the Batiaghata site was one more major difference between these two sites.

228. In summary, the comparative analysis demonstrates that the Bhairab River Khulna MPA site is the preferred location for the Project. However, it is important to note that while this site rated more highly than the other two sites, this does not mean that the other two sites are unsuitable. In fact, all three sites are compatible with the development objectives, and all three could be considered suitable provided all environmental, socio-political, institutional, and operational issues were well managed.

VI. ENVIRONMENT MANAGEMENT PLAN

A. Environmental Clearance Certificate

229. The Government of Bangladesh provided an environmental clearance certificate for the Project (Department of Environment Clearance/2053/2004/2195) dated 11 September 2005. Appendix 2.

B. Environment Management Plan

230. The EMPs for the Project form the practical guide to the implementation of the environmental and social mitigation measures that have been formulated for the Project. They set out "what, who, how, when and at what cost" these measures will be achieved. The EMPs are also the primary mechanism for management, accountability, and reporting on the Project's environmental and social performance. The EMPs have been developed without reference to detailed design. Consequently, it is envisaged that the EMPs will be revised and updated following the completion of the detailed design phase of the Project. In addition, a construction environmental management plan (CEMP) will be developed for all components of the Project. These CEMPs will incorporate the findings and recommendations of the project EIAs and the EMPs as well as conditions of consent stipulated by the Government and financing bodies, if any.

231. The EMP consists of various detailed subplans like the CEMP, water management plan, air quality management plan, noise and blasting management plan, biodiversity management plan, waste management plan, hazardous materials management plan, community health and safety plan, and coal handling preparation plan. These plans are prepared in the various corresponding EIAs and are subject to review during the detailed design phase. The follow-up of the implementation of these plans is the responsibility of the Project environment department.

232. Monitoring programs for each subplan include the following elements. Responsibility for implementing the subplans rests with the Project environment department organization.

- (i) indicators to be measured,
- (ii) methods and, where relevant, equipment to be used,
- (iii) sampling locations and frequency,
- (iv) trigger values that signal the need for corrective action,
- (v) any specific training requirements, and
- (vi) monitoring and reporting procedures.

233. The monitoring programs are comprehensive for all components of the Project. Table A1.3 outlines the monitoring programs for the various components.

234. Implementation of mitigation measures and monitoring, including responsibilities and authorities, is organizationally divided into application fields (air quality, water quality, etc.); monitoring method; parameter measured; frequency; and responsible person and/or organization. Table A1.4 outlines the general implementation plans applicable for the various Project components. Table A1.5 outlines the tasks and responsibilities for the environment teams in general.

235. Some aspects of project development and implementation will be subcontracted. The contractor will be required to adhere to all EMPs. Ability to meet the conditions and standards

stipulated in the EMPs will be a key requirement for bidders participating in the tender process. The EMPs will be maintained as controlled documents to ensure that all relevant parties are informed of any changes in mitigation measures and procedures that could affect the environment. Where operations are undertaken via contract, the contractors will be required to update the section of the EMP relevant to their operations. All amendments to the responsibilities, operations and procedures, and the control document outlined in the EMPs, must be submitted to the environmental manager for approval prior to their implementation.

236. All procurements will be made in accordance with the Environmentally Responsible Procurement Principles (defined in http://www.sustainableprocurement.net/).

237. An integral component of all EMP subplans is consideration of potential impacts on the community. Details of the public consultations undertaken during preparation of the environmental and social impact assessment studies are available in the supporting documents (such as EIAs).

238. Asia Energy will establish a procedure for identifying, recording, responding, and reporting complaints from the community relating to construction and operational issues, such as noise and air emissions, vibration, and lighting. Mechanisms for registering complaints about land acquisition, compensation, and assets registration will be provided under the grievance resolution section of Asia Energy's research and development division. The Coal Terminal in Khulna environment officer will maintain a community complaints register that will document the nature of each complaint. Staff induction training for all transportation elements of the Project will stress that all community complaints should be taken seriously and will describe the procedure for documenting and reporting any complaints directed to Khulna Coal Terminal and river and marine transportation staff and contractors.

239. The Phulbari and Khulna Project information centers will also provide an avenue for dissemination of important project-related information. For example, local communities will need to be educated to on mitigating risks associated with increased river traffic and other safety risks. The information centers will also provide information about job availability associated with the Project and skills training opportunities for qualified applicants.

240. Reporting and review links the information gained through monitoring and observation systems to the internal continual improvement process and to external stakeholders. There is a built-in mechanism for feedback to identify systems within the EMP that require improvement. It also provides external stakeholders with an opportunity to be further informed of the status and performance of the Project's environmental management system.

241. Incident reporting and investigation is an important means of accident prevention. An essential component of successful accident prevention is a culture of open communication and transparency in the workplace, whereby incident reporting is undertaken in a routine manner. Reporting also provides the opportunity to engage with external stakeholders and promote transparency in management processes. External reporting mechanisms include disclosure of information to affected parties and regulatory authorities.

242. The internal reporting mechanism is intended to capture, verify, and analyze monitoring data. Daily site inspections, observations, and maintenance records also form an important aspect of this day-to-day gauge of environmental performance.

243. Data and observations documented will be incorporated into a monthly environmental summary report. This report will include data on each environmental value potentially affected by the Project. The Project's environmental performance will be reported to the Government, financiers, shareholders, the community, and other stakeholders. Reporting will be achieved through a number of avenues, with the type and level of information provided tailored to suit the audience. Major reporting media are:

(i) **Environmental monitoring report**. Verified monitoring data will be collated into an environmental monitoring report. This report will be forwarded to the Department of Environment on a monthly basis together with a summary analysis of the results, which includes an assessment of the Project's regulatory compliance status.

(ii) **Quarterly environmental report**. The environment manager will review results from monitoring systems for trends and anomalies on a quarterly basis and prepare a quarterly environmental report for inclusion in the annual environmental management report. This report will include: monitoring result summaries and analysis, including an assessment of the Project's compliance with regulatory requirements and stated objectives; incident reporting sheets; community concern and complaint handling activities; and details of mitigating actions undertaken to rectify or prevent environmental harm.

(iii) **Annual environmental management report**. This will be prepared at the end of each calendar year and made publicly available. The purpose of this document is to provide the Government, project financiers, the community, and other stakeholders with information on the environmental performance of the Project, identify areas for improvement, and suggest appropriate targets, activities, and initiatives for the upcoming year.

(iv) **Quarterly newsletters, fact sheets, and workshops**. Additional reporting to the local community will be undertaken through provision of quarterly newsletters, fact sheets, and workshops. Reporting media will be prepared and delivered by the community liaison officer with the prior informed consent of the health, safety, and environment (HSE) manager and assistance and input from the environment manager and environment officer as required. The Project's environmental and social performance will also be reported in Asia Energy's annual report.

244. The particular ADB requirement for biannual reports will be met by Asia Energy as a part of its regular reporting under the EMPs. The disclosure of monitoring data will be carried out in accordance with general transparency policies.

245. To ensure that management subplans and associated administrative functions are implemented in accordance with the requirements of this EMP, periodic internal and external audits will be conducted. Auditing programs will be initiated and overseen by the environment officer under the direction of the environment manager.

246. Internal audits will be conducted on a two-tiered basis. Ongoing "spot-checking" will be undertaken by the environment manager and/or environment officer to ensure day-to-day activities are being undertaken in accordance with standard operating procedures; for example, correct completion of checklists or equipment calibration as per the predefined schedules.

247. An internal audit program, which will include auditing specific environmental management components, will be prepared. Auditors will generally comprise senior mine personnel, preferably not working in the audited area, a staff member of the environment

department of another Asia Energy mining project, or a member of the parent company. Audit results and any remedial actions will be reported to the HSE manager.

248. External auditing will be undertaken by a certified auditor on an annual basis. Auditing reports will be submitted to senior mine management, including the Board of Directors, for review.

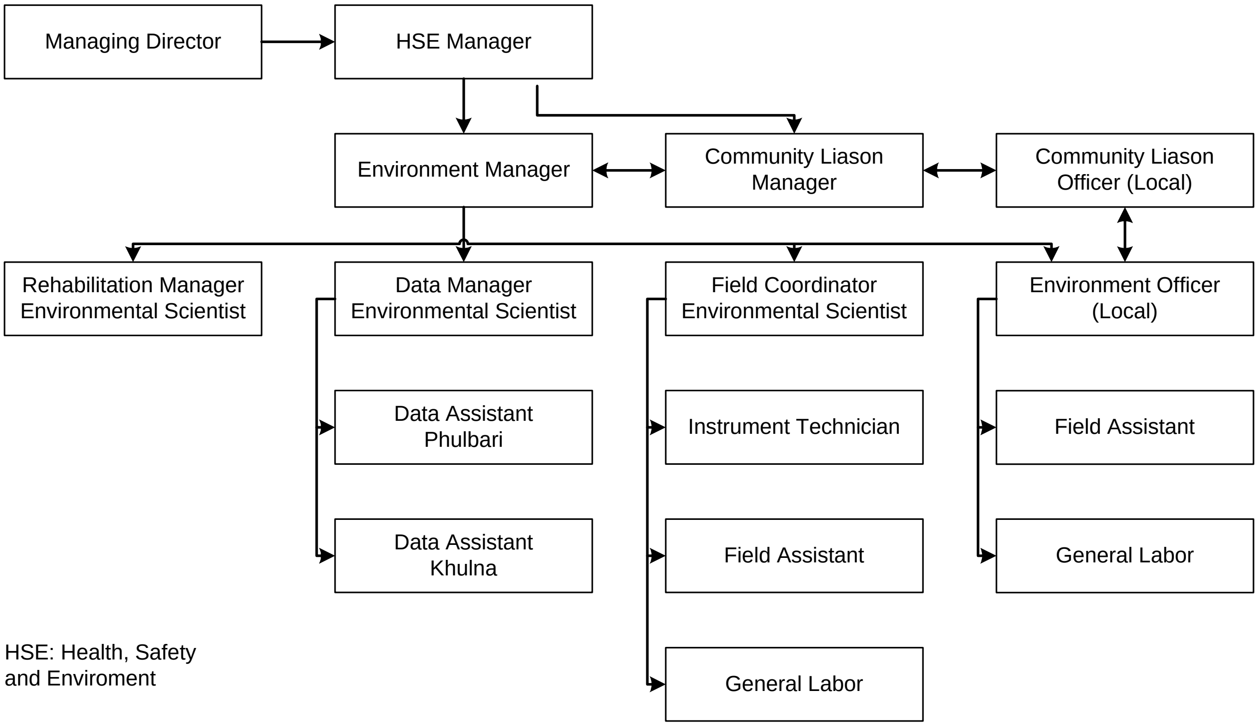
249. Internal and external auditing activities may result in issuance of corrective action reports (CARs) or observations of concern. CARs are generally issued in the case of regulatory non-compliance, or where an issue or activity has the potential to cause human or environmental harm. Where a CAR is raised, a report separate to the overall auditing report will be issued that identifies the area of concern and the timeframe within which it must be rectified. Corrective action undertaken to close out the CAR must be documented and signed off by the environment manager. Where issues raised under a CAR are not addressed to the satisfaction of the auditor within the specified period of time, the matter will be identified in the Project's annual report as a 'nonconformance'. Observations of concern are generally issued for activities or situations where corrective action should be undertaken to avoid the potential for the matter to become a CAR in the future. These issues must be addressed, but no separate report will be raised and they will not be reported in the Project's annual report.

250. Asia Energy recognizes the need for proactive senior management involvement in the environmental management of its operations. The tasks and responsibilities of the environment team are found in Table A1.5. In addition, as a leader in environmental practices, Asia Energy will seek to encourage its service providers to conduct their business in an environmentally responsible manner. As part of this commitment, review and evaluation have been incorporated into the management framework to ensure the systematic evaluation of the effectiveness of the company's environmental mitigation measures. The intended outcome of the review process is to identify areas for improvement or the need to alter approaches to environmental management, mitigation measures, or policy. This approach is also required for sectors of the transport route which are not directly under the control or influence of Asia Energy, such as rail transport and dredging activities.

251. Asia Energy is committed to independent periodic reviews of its environmental and social management of the Project and specifically to review and revise EMPs as appropriate prior to any activity being implemented.

252. The organization of the project environment department is found in Figure 7**.**

Figure 7: Project Environment Department Organization



Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. All EMPs for the Project.

253. Table A1.1 lists the most important issues that will be handled under the EMP. The complete EMP consists of a large amount of detailed documents—one plan for each main component and its respective subcomponents. Table A1.2 lists the supporting EIA documents. Table A1.6 indicates the cost estimates and the allocated budgets for the mitigation measures.

254. The initial budget for implementation of the EMP, including training, monitoring and public consultation is around USD 95 million. That corresponds to 7–8% of the total initial investment for the Project. The operational costs for the EMP are estimated at around USD 8 million annually, which corresponds to around 3% of the total operational costs. Cost Estimates for the implementation of the EMPs are listed in Table A1.6. Asia Energy will also periodically review cost estimates for EMP implementation and revise allocated budgets as appropriate.

C. Risk Assessment

255. A risk assessment is included in all project components. However, since the issues related to the Sundarbans World Heritage Area are particularly sensitive, the risk assessment covers this area in the most detail. Several factors need to be examined to determine the environmental risks posed by ship operations in close proximity pose to the Sundarbans World Heritage Area. The risk assessment must consider not only the consequence of a potential oil spill or other accident, but also how often potential accidents are likely to occur, what mitigation measures are put in place to minimize the risk of such accidents occurring, what

countermeasures are put in place to minimize losses if such accidents occur, and the ability to effectively use countermeasures.

256. Bangladesh is a signatory to two International Maritime Organization (IMO) conventions pertinent to oil pollution:

(i) 1973 International Convention for the Prevention of Pollution from Ships (MARPOL Convention), which aims to control pollution of the sea by oil, chemical, and other harmful substances that might be discharged during the course of a ship's operation or when a ship is damaged. Signatories to the convention are required to inspect ships in port and at sea, trace and prosecute polluting ships, and ensure that there are adequate port facilities for receiving waste from ships.

(ii) 1990 International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC Convention), which requires signatories to inspect ships, maintain a national contingency plan for responding to oil pollution incidents, and provide technical assistance to other signatories in the event of such incidents. Ports and harbors, ships, and offshore installations are required to have their own approved oil pollution contingency plans and to report pollution incidents when they occur. They, and signatory governments, must put in place equipment for combating incidents, hold training exercises, and have communication facilities to allow them to respond without delay to pollution incidents.

257. Because of the Bangladesh Government's inconsistent implementation of rules and regulations in many fields, it is still uncertain whether these conventions have been fully incorporated into their Merchant Shipping Act 1983 and Inland Shipping Ordinance 1976. There are also uncertainties about the extent and ability of Bangladesh to enforce these conventions, and about the availability of resources (equipment, competence, training), and the extent of cooperation with other departments.

D. Likelihood

258. Undoubtedly the first issue to come up in oil pollution risk analysis of the area is the potential severity of an accident. Severity is determined by a number of factors. Risk is determined by combining the severity with the likelihood of an accident. Once the severity and likelihood are established, then the risk can be determined. Risk may range from extremely high (unacceptable) to low (acceptable).

259. The barges and loading platform—like the ferries, launches, fishing boats, and coasters in the project area—will operate using diesel fuel, which is generally described as a non-persistent oil and is considered to have a relatively low environmental impact because of the oil's physical properties and its rapid weathering characteristics in a spill.[1] While under pilotage, Panamax and Handymax vessels will also operate under diesel. Dissipation generally takes about 4 days, but may be quicker in rougher weather and sea conditions.

260. Heavy fuel oil is generally described as a persistent oil. It behaves differently and has a higher viscosity, wax content, and density than diesel, and also has a larger environmental

[1] (weathering occurs through spreading, emulsification, evaporation, oxidation, dissolution, dispersion, biodegradation, and/or sedimentation.)

impact than diesel. However, while it is more resistant to weathering than diesel fuel dispersion through natural process is possible. Heavy fuel oil will mainly be used in the open sea.

261. The likelihood of a accident caused by collision in the Akram Point area will be very low. According to MPA data, the volume of vessel traffic movement currently averages about one vessel per day. (However, the frequency of movements will increase when the area is developed as a result of the Project.) If all vessels (local and foreign) comply with IMO's 1972 Convention on the International Regulations for Preventing Collisions at Sea (COLREGS Convention), and if that convention is enforced by the MPA, then there will be only two points of crossings of the shipping routes at Akram Point.

262. Furthermore, because of the nature of the river system and the need to navigate at safe speeds in the Akram Point area, any collision would not involve vessels travelling at a full speed and/or under heavy displacement. As such, the force of any collisions would be low. The probability of a collision resulting in penetration damage to the double bottom tanks of small general cargo vessels would also be low (and would be even lower for Panamax or Handymax vessels).

263. Two areas where capable navigation will be of paramount importance will be the entrance to Zulfiquar Channel (which leads to Akram Point) and the Pavanga Shoal (8.5 nautical miles due south of Akram Point). Because the sea floor in both areas consists of sand and silt (indeed, the river bed is of the same composition), grounding would not cause rupture to the bottom hull of a Panamax or Handymax vessel, so the likelihood of an oil spill from the double bottom fuel tanks is again remote.

264. Each Panamax and Handymax vessel will only be present in the area for fewer than 5 days in the year. When considered in ship years and in the context of low volume of traffic, that is one vessel entering/departing every 2 days. There is therefore low exposure to hazard and a low likelihood of an accident.

265. In summary, the likelihood of a major oil spill caused by a marine accident is remote. Accident statistics for the Mongla Port area (where current organizational resources, equipment, and training are limited) are listed in Table A1.33. Bulk carrier accidents, annual frequency, and quantity of spill for Panamax vessels (global terms) are found in Table A1.34.

E. Response Arrangements and Equipment

266. Currently there is no clear organizational structure in place to respond to accidents. No specialized equipment is available in Bangladesh but this will be provided as a part of the Project implementation.

267. A national contingency plan is contained within the provisions of the Marine Environment Act (1990), which is aimed at prevention, control, and response to marine pollution. This has not yet been enacted but would be the basis of future response. Overall administration of pollution control lies with the Ministry of the Environment, although the director of the Department of Shipping has the task of organizing cleanup operations, particularly in the event of an incident outside port limits.

F. Prevention

268. The likelihood of an accident occurring can be reduced in the following ways. The detailed activities and requirements will be outlined in the EMP. It is of crucial importance that the Government plays an active part in any prevention actions. Asia Energy will work closely with the Government in order to ensure that the activities are fully implemented.

269. By a ship operator:

(i) Full compliance with International Maritime Organization (IMO) regulations, classifications, etc. for both barges and coal ships. (This ensures that vessels, crews and operations meet international regulatory standards and industry best practices with regard to construction, navigation equipment, competency and= drills).
(ii) Insist that trained and certified pilots take vessels from Mongla Fairway Buoy to Akram Point and back.
(iii) Vetting of the coal ships, their crew, and operations. This will ensure that only ships of a high standard carry the coal. (Studies document that 25% of the world's poorer fleets are involved in more than 50% of the world's ship accidents. At the other end, 25% of the safest ships are involved in only 7% of total accidents.)
(iv) Enhanced training of barge crews in best practice navigation, shipboard oil pollution control and bunkering operations. (Studies show that human error accounts for 80% of accidents.)
(v) Robust safety management operating procedures and contingency plans will ensure that crews and ship managers operate in a way that exposes the environment to the least amount of risk.
(vi) Tug escort service for coal ships in case of engine failure. (Vessels should also be equipped for oil spill containment.)
(vii) Communicate information and intelligence between MPA, pilots, and Meteorological Office on sea and berthing conditions.
(viii) Monitoring the progress of barges (AIS and tracking system to a central control at Coal Terminal in Khulna.)

270. By the Government:

(i) The waters should be made safer to navigate by dredging a deeper channel to reduce the risk of grounding.
(ii) Wrecks in and around the Zulfiquar Channel should be removed.
(iii) Sarwar Sand (7 nautical miles due south of Hiron Point) is sandbar which must be avoided when entering Zulfiquar Channel, which leads to Akram Point. Pavanga Shoal (8.5 nautical miles due south of Akram Point) is also an area of shallow water that will require caution. These features should be well marked 24 hours a day with cardinal buoys.
(iv) Channel buoys should be put in place and fully illuminated.
(v) Pilot manpower should be increased and their competence enhanced by putting them through training on simulators.
(vi) Areas where caution needs to be exercised in the crossing points near Akram Point should be well marked.
(vii) Designated bunkering zones (with oil spill containment equipment easily accessible) should be put in place in Mongla Port, away from the Sundarbans.

(viii) Clear strategies and procedures for operations in adverse weather conditions should be put in place. This will require close cooperation with the Met Office.

(ix) Legislation should be tightened to improve the quality of local sea crafts and the competency of local seafarers and operators. Community education for local boat operators should be improved so that they better understand how to deal with increased traffic and are more aware of larger vessels.

VII. ECONOMIC ANALYSES

271. The Project will have significant positive implications for the economy of Bangladesh, not only by providing an alternative source of energy, but also in terms of other beneficial impacts at the local, regional, and national level. However, progressive use of agricultural land and other land for mine development will temporarily affect the settlements and livelihood of people located within the project area. That will naturally involve a certain cost to society.

272. At the national level, the benefits of the Project include direct earnings for the Government in the form of royalties and taxes; indirect earnings for the Government in the form of enhanced revenue for Bangladesh Railway and MPA, which will charge for coal transportation and use of port facilities for coal export; earnings and savings of foreign currency; a new commodity for export; provision of an alternative source of energy; substantial increase of GDP and gross national income (GNI); and enhancing private investment and attracting foreign direct investment (FDI).

273. However, the Project also involves costs, mostly at the local level. These include temporary loss of agricultural (and other) land for the mining operation; loss of other assets in the project area; partial loss of or disturbance to existing means of livelihood; the psychological cost of involuntary relocation; disturbance to local cereal production; increased vulnerability of poor people in the project area; disruption to social bondage; and general impacts on the environment. The Project has an extensive plan to mitigate these losses.

274. The Project will provide several direct and indirect environmental benefits. The exchange to low-sulfur coal is a direct benefit; improved traffic management and risk management related to shipping in one of the largest rivers in Bangladesh is an indirect benefit. The cooperation with the Government, and the subcontracting of various organizations that need to perform according to “best practice” will build capacity and be a direct benefit. The direct impacts on the environment will be managed by strictly enforced, monitored, and reported mitigations measures.

275. About 11,300 people have some employment in the Project-affected area. Most of these people are involved in informal activities and/or in subsistence agriculture. The Project will directly create some 1,200 to 2,100 full-time jobs at Phulbari. Many other jobs will be created during construction, ongoing revegetation programs and in spin-off activities. Up to 800 new jobs will also be created in the proposed mine-site power station, on the railways, and in Mongla and Khulna ports. The Project's training program will also help the affected people find better-paid jobs or start new businesses. Allowing for a multiplier of 10 additional jobs for every direct job, in total the Project can create more than 20,000 new direct and indirect jobs.

276. More than 80% of the agricultural land will be restored after it has been mined, either for crop production or for natural forest that will be created on the overburden dump. Valuation of land with and without the Project using a dividend discount model suggests that the net loss in value of land is only USD 57 million. This is less than half of 1 year’s contribution of the Project

to GNI. Loss of other assets, such as residential and other structures, SMEs, trees, livestock, and poultry, will be more than offset by the compensation and rehabilitation schemes of the Project.

277. The most conservative estimate of the Project's contribution to GNI appears to be more than seven times higher than the worst-case scenario of income loss as a result the Project. The most bullish estimate of the Project's contribution to current GDP is 1.0 % per annum.

278. Economic analysis of the Project is based on a comparative study examining what would happen with and without the Project at the local, regional, and national levels, excluding multiplier effects. The difference between the valuations of two scenarios provides an estimate of the benefits of the Project for the country.

279. Key economic highlights based on most conservative estimates

(i) contribution to GDP over project operational lifetime USD 15.5 billion;
(ii) equivalent to USD 442 million per annum, or 0.7% of current GDP;
(iii) average annual contribution to GNI USD 233 million;
(iv) direct earnings of the Government USD 3.4 billion–USD 5.3 billion;
(v) Bangladesh Railway additional net earnings USD 1.4 billion;
(vi) cumulative net foreign exchange earnings USD 8 billion;
(vii) annual impact on balance of payments USD 250 million;
(viii) equivalent to 7% of annual remittances from abroad;
(ix) net loss in value of land USD 57 million; and
(x) maximum net loss in agricultural production 17% over project lifetime.

VIII. PUBLIC CONSULTATION AND DISCLOSURE

A. Public Involvement

280. In general terms, the mining of coal at Phulbari accords with the Government's social and economic objectives and the aspirations of its people, who collectively seek poverty reduction. To ascertain the specific views of the community and interested stakeholders about the Project, the EIA has been undertaken in an environment of open consultation. The entire process has been underpinned by free, prior, and informed consultations with stakeholders, including local communities, NGOs, various levels of government, inter-ministerial committees, and outside stakeholders. These consultations have resulted in broad community support for the Project.

281. Public Consultation has been and remains a continuous process. Apart from waves of face-to-face discussions with affected people on demographic and resettlement issues that fed information into the resettlement plan, specifically in the locality of the Project, public consultations were carried out at levels of village, local administration and district administration. Two noteworthy consultations with full public disclosure with the Phulbari Municipality including prominent members of the local civil society at Phulbari were held on 22nd March 2005, and with the Deputy Commissioner (DC) and all District level Government officials on 7 September 2005 at the district capital, Dinajpur.

B. Project Information Center

282. A Project Information Center was established in Phulbari township for the Phulbari area on 12 April 2005. This information centre has made the following information available to its visitors:

(i) written and audiovisual information about the Project and the methods of extraction to be used;
(ii) information on similar projects undertaken in other countries;
(iii) Project information sheets in both Bengali and English providing a general background to the Project and also on specific subjects such as open cut coal mining, programs to boost local agricultural production, water management, resettlement and entitlements options;
(iv) Project news updates;
(v) a video on the study area in Bengali and English; and
(vi) a Project video in Bengali and English.

283. Since it opened, the information centre has had an average of 20 people visit each day. Many of the visitors have signed a visitors' book, with 80% of them writing in support of the Project.

284. A second information center is being established in Khulna with the same function as the one in Phulbari.

C. Consultations with Key Government and Union Stakeholders

285. Discussions about the Project have been held with government representatives at the national, district (Dinajpur), Khulna City, Mongla Port, and subdistrict–Upazila (Phulbari, Birampur, Nawabganj, Parbatipur) levels. The purpose of these discussions has been to:

(i) determine government stakeholder reactions to the Project;
(ii) obtain stakeholder views about potential project impacts on various economic, social, and environmental issues;
(iii) develop strategies to minimize potential social and environmental impacts in conjunction with government stakeholders; and
(iv) ensure government participation in the design of impact mitigation measures.

D. Consultations with NGOs and CBOs

286. Meetings were held with local non-government organizations (NGOs) and community-based organizations (CBOs) operating specifically within the study area as well as with those working on relevant studies, such as the health impact assessment, at the national level. All NGOs working in Phulbari were also invited to a meeting to discuss the proposed Project and express any concerns, suggestions, or questions they had about it.

287. A contract with one central NGO has already been agreed upon. Details of the engagement of the NGOs will follow in the detailed design phase.

E. Village- and/or Ward-Level Consultations

288. Consultations were initiated at a village level with male and female representatives invited to discuss the proposed Project. The goal of these consultations was to obtain their views on the positive and negative socioeconomic impacts that may arise from the proposed Project; and to obtain their suggestions on potential mitigation measures for these impacts. The consultations involved the distribution of project information sheets, oral presentations about the Project, and detailed discussions on the stakeholders' opinions and queries in reference to the Project.

F. Individual and Group Discussions

289. Focus group discussions and interviews were held with various categories of people. The aims of these discussions were:

(i) to obtain the views of various categories of vulnerable groups within the study area, to discuss the Project's associated impacts and benefits on those groups, and to ascertain those groups' expectations regarding project benefits;
(ii) to hear suggestions for mitigating any anticipated adverse impacts and increasing anticipated benefits of the Project; and
(iii) to obtain the opinion of these groups about potential socio-economic impacts of the proposed Project.

290. Group discussions have been held with the following categories of people:

(i) households headed by women,
(ii) ethnic minority groups,
(iii) landless people and those living on public land,
(iv) agricultural and nonagricultural wage laborers, and
(v) business enterprise owners.

G. Subject Specific Surveys

291. A number of surveys and studies have been undertaken, including:

(i) a household demographic and socio-economic survey;
(ii) a resettlement survey to obtain the relocation preferences of persons facing displacement;
(iii) a town planning survey focused on Phulbari township designed to obtain information about existing buildings (type and condition), public utilities, and access to facilities;
(iv) interviews and qualitative and quantitative surveys to provide baseline information for a health impact assessment; and
(v) village checklist survey.

292. Although these various surveys and subject-specific studies have focused on accumulating specific information and socioeconomic data, they have also provided stakeholders an opportunity to ask questions and express opinions about the Project.

293. The Project, although opposed by some people, is supported by the majority of local community residents, even with the understanding that a considerable number of residents will

have to be resettled. Future concerns from affected people will be addressed via procedures outlined in the resettlement plan and the indigenous peoples' development plan, and also via the Project information centers.

IX. CONCLUSIONS

294. Bangladesh's limited energy resources and low level of power consumption have been identified as major impediments to the country's economic development. Mining the Phulbari coal basin will provide Bangladesh with a vital new long-term source of sustainable energy. It will also accelerate the pace of Bangladesh's industrial growth, convert the country into an energy exporter, and bring much-needed industry and jobs to the predominantly subsistence-farming economy of the northwest region. Studies forecast that the Phulbari Coal Project will increase Bangladesh's GDP by 0.7–1.0 % per annum. The Project will create more than 2,000 new jobs directly and up to 10 times that number in spin-off and support industries. In summary, the Phulbari Coal Project will do more than just develop a coal mine; it will also serve as a catalyst for major economic development and will help the country alleviate poverty and achieve sustainable growth.

295. The Project includes three main components: the Phulbari Coal Mine component; a railway transportation component; and a component to build a coal terminal in Khulna, including a barging activities facility and an offshore reloading facility for transfer of coal to seagoing ships. The Coal Terminal in Khulna is located on a previously developed industrial site. The railway transportation component is subject to partial financing by ADB's public sector loan, and a full-scale environmental impact assessment will be carried out under the proposed public sector loan.

296. The principal potential negative impacts on the environment are ambient air pollution, noise, groundwater changes, surface water pollution, spills, dredging, and ship collision. These and other potential impacts have been comprehensively studied in more than 100 Environmental Impact Assessment (EIA) reports, and measures have been put in place to mitigate and manage them in accordance with national and international best practices—including ADB and World Bank standards.

297. Air pollution is a combination of background conditions (such as the Asian Brown Cloud) and local emissions. The standards (ADB, WB and GoB) for some pollutants (mainly particulate matter, PM10) are currently exceeded at points within the project areas during unfavorable meteorological conditions. The Project's contribution to air quality in the mining area will vary from point to point. For PM2.5 the contribution from the Project varies with an average of 4 µg/m3 compared to a cumulative background level of 70 µg/m3. When likely background concentrations are added to the predicted values, standards may be exceeded during the non-monsoon period in the Coal Terminal area in Khulna. Mitigation measures, such as emission-reducing equipment and the spraying of coal in various sectors of the transportation chain, will combined with comprehensive monitoring system keep air pollution at acceptable levels.

298. Current noise levels also already exceed the standards (ADB, WB and GoB) at some points within the project areas. The current excess emanates mainly from "community noise" created by vehicles, industrial plants, radios, televisions, insects, birds, and frogs. A number of mitigation measures (including low-noise equipment and operating methods) will ensure that noise impacts from the Project satisfy Government standards (although standards may occasionally be exceeded during certain nighttime situations under adverse weather conditions; in such situations, operations will be curtailed or temporarily halted).

299. Surface-water conditions in the project area differ from the norm in Bangladesh because the Project is removed from any large river systems that cause frequent flooding. Groundwater conditions, on the other hand, are consistent with prevailing conditions in Bangladesh because the Project is located along the country's main aquifer. The mine and the Phulbari township will be protected against even the most extreme flooding by embankments constructed of material from the mine overburden. The mine dewatering systems, which will initially be installed as a ring of dewatering bores around the box cut footprint, will have potential impacts on local hydrology. Dewatering activities will cause groundwater drawdown of approximately 25 m at a distance of 4 km from the mine pit, and 15 m at a distance of 6 km. This may result in reduced groundwater availability to the local farming community. However, various mitigation procedures, including injection of water back into the aquifer and a reticulated water supply for irrigation and for affected townships and villages, will ensure that the Project in reality will have a positive effect on the surrounding area. Clean water from the dewatering bores will not require treatment before being released to watercourses and/or directed to irrigation systems, aquifer injection systems, the regional water supply, and the construction camp. Surface-water runoff from rain falling on areas disturbed by the mine will be directed to retention and/or sedimentation ponds.

300. No sal forests or major beels will be directly affected by mining activities. All conservation significant species recorded within the project Area have a wide distribution within Bangladesh; therefore, the mine footprint area is not considered vital to the survival of any of these species.

301. The barges running from the Coal Terminal in Khulna to the offshore reloading facility will be leased from world-class operators to ensure state-of-the-art design and safety conditions during of the Project. The shipping channel has been charted in as straight a line as possible, and as far from the shoreline of the Sundarbans as possible. The floating transfer vessel will be at least 1.3 km from the nearest shoreline.

302. Dredging to maintain the shipping channel is expected to remove about 7.5 million tonnes of sediment in the first year, reducing to and leveling out at about 3.0 million tonnes by the fifth year. The quantities of sediment being disposed of are considered insignificant compared with the 200–500 million tonnes per year discharged every year from the Ganges–Brahmaputra–Meghna river systems.

303. The Environment Management Plans (EMP) consist of various components, such as the construction EMP, water management plan, air quality management plan, noise and blasting management plan, biodiversity management plan, waste management plan, hazardous materials management plan, community health and safety plan, and coal handling preparation plan. These plans are prepared in the various corresponding EIAs and are subject to review during the detailed design phase. Comprehensive monitoring is already in operation and will be enhanced during implementation of the various project components. The Project's environmental performance will be reported to the Government, financiers, shareholders, the community, and other stakeholders. Reporting will be achieved through a number of avenues, with the type and level of information provided tailored to suit the relevant audience. The initial budget for implementation of the EMP accounts for 7–8% of the total initial investment for the Project. The annual operational costs for the EMP account for about 3% of the total project operational costs. Besides the EMP, the Project has developed an elaborate social management plan that includes a comprehensive resettlement plan, an indigenous peoples' development plan, and a public consultation and disclosure plan.

304. In addition to direct economic benefits, the Project also will also have the following direct benefits on the environment. Many of these are also social benefits.

(i) The Phulbari mine's coal is of much better quality than the high-sulfur, high-ash, and generally low quality fuel used today in Bangladesh (e.g., in kilns manufacturing bricks). Use of the mine's coal will thus reduce overall air pollution. The sulfur content of the coal from India that is used today in Bangladesh is 4–5%. The Phulbari coal has a sulfur content of less than 1%. By switching to the Phulbari domestic source, a reduction of around 100,000 tonnes of sulfur emissions will be achieved annually.

(ii) Shipping on the Rupsa River will be safer. There will be reduced risks of accidents and pollution, while the traffic management plan will ensure stricter control of all vessels using the river.

(iii) The railway between Phulbari and Khulna will improve the transportation system in the region. The traffic management scheme will also reduce the risk of accidents despite increased rail traffic intensity.

(iv) New forest area will be generated on the rehabilitated land; after mining, land will be returned to agricultural use.

(v) It is estimated that crop yields in the recovered mining areas will increase.

(vi) The Government, in cooperation with Asia Energy, will provide institutional training for agencies involved (particularly the local agencies) and the subcontracting of various services will develop a private sector within modern environmental management.

305. All potential impacts have been assessed and additional monitoring and studies have been carried out in the most sensitive areas. Mitigation measures—designed based on the studies—ensure that all Government, World Bank, ADB guidelines, and Equator Principles will be fully met. Institutional and organizational arrangements are in place to cope with the development of the Project and the implementation of the mitigation measures. An independent review by URS consulting firm has concluded that the Project is sufficiently robust within acceptable tolerance levels at this stage to permit lending. In addition, ADB's specialists have also been involved in the review process for over a year.

TABLES

Table A1.1: Summary Matrix of Potentially Significant Environmental Impacts and Their Mitigation Measures

1. The implementation of the mitigation measures; the follow up of the measures; and the reporting of the measures and the monitoring will follow the Project Environment Department Organization as outlined in paragraph 252.

Environmental Component	Potential Impact	Mitigation Measures
A. Phulbari Coal Mine		
1. Water Management Plan		
Dewatering of the Upper Dupi Tila Aquifer.	• Reduction in groundwater availability for domestic or local business purposes • Reduction in groundwater availability for irrigation purposes and sal or plantation forests • Reduction in artesian pressure head beneath Ashoorar Beel (or other beel of conservation significance) • Changes to hydraulic regime, and increased scouring and sediment transportation through discharge of aquifer waters to the Little Jamuna and Khari Pul water courses during the dry season • Discharge of up to 1 cubic meter of water in the dry season. Thus the Little Jamuna River may have small quantities of flow, whereas now it is currently dry in the dry season. The volume is small compared with the flow capacity of around 250 cubic meters per second (m3/sec). • Changes to ambient river and beel water chemistry as a result of groundwater discharges • Changes to ambient river and beel water temperature as a result of groundwater discharges • Land subsidence in the order of 2 meters (m) at the mine crest, reducing to 0.02 to 0.4 m at a distance of about 5 km from the mine. • Potential mobilization of arsenic contained within sediments into groundwater • Restricted access across the Little Jamuna River during the dry season	• A potable water supply system will be provided, either through piped networks from the dewatering bores, construction of deep tubewells, or assistance with deepening existing tubewells. Water supply to Phulbari township will be from the Project's dewatering system. • Water from the Project's dewatering system will be injected into the Upper Dupi Tila aquifer to the west of the Little Jamuna River, east of the Nalsissa creek and south of the mine footprint (but north of Ashoorar Beel). This is expected to reduce project-induced water level drawdown at these locations and outside the injection ring to zero. Aquifer injection is expected to be beneficial for farmers in its area of influence, as groundwater-level drawdown will fluctuate less, providing a water table closer to the surface during the dry season than currently occurs. • For locations within the aquifer injection ring, irrigation distribution systems will be provided, either through piped networks from the Project's dewatering system, construction of deep tubewells, or assistance with deepening existing tubewells. • Biodiversity monitoring will assess impacts on flora. If required, surface water from the mine and/or dewatering system will be released for specific environmental purposes. • Partial connection between Ashoorar Beel (and other beels of conservation significance) and the Upper Dupi Tila aquifer is thought to occur via slow vertical leakage through the Madhupur Clay. If there is significant connection between Ashoorar Beel and the Upper Dupi Tila, the aquifer injection system should mitigate any adverse impacts. However, pressure head, water levels, water chemistry, and aquatic biota will be monitored to assess connectivity and any associated impacts, and remedial action taken where necessary. • Controlled discharge of groundwater into the Little Jamuna River with velocities not to exceed peak wet season velocity • Existing flow regimes to the Khari Pul creek to be maintained or increased during the dry season, but seasonal fluctuations and flow

Environmental Component	Potential Impact	Mitigation Measures
		velocities will be maintained. Required flow volumes and velocities will be determined in consultation with the Department of Fisheries and the community based fisheries management project participants at Ashoorar Beel. • Construction of energy dissipaters to reduce velocity of water entering rivers and prevent scouring at discharge points • Additional protection to particular sections of river if monitoring indicates project-induced erosion is occurring • Prior to the commencement of mine activities, baseline water quality data will be thoroughly reviewed and water quality objectives for ambient conditions established. • Treatment is not planned as NACOM (2005)[1] advise that groundwater will be suitable for pre-mining uses and aquatic biota. Appropriate treatment will be provided should monitoring indicate that discharge waters are having an adverse impact on pre-mining uses or aquatic biota. • It is expected that mixing the relatively small amounts of Permian groundwater (which may have high temperatures) with groundwater from the Upper Dupi Tila and Lower Dupi Tila sands in the mine pit at surface collection points prior to discharge will sufficiently cool these waters. However, monitoring of discharge water temperatures will be linked to the "real-time" monitoring system to ensure that high-temperature waters are not released. • A survey will be conducted within the anticipated (modeled) area of influence before commencement of year 1 mine dewatering. • Aquifer injection as described above will also reduce the extent and magnitude of land subsidence close to injection points. A reduction in impacts of up to 0.5 m beyond 500 m from the mine crest has been predicted through aquifer injection (GHD, 2005c). Aquifer injection should substantially reduce the area and degree of subsidence. • Design of resettlement areas will consider anticipated land subsidence. • Drainage design and/or amendments to maintain existing off-site drainage patterns in project-affected areas • Burial of coal rejects in the base of the pit with a compacted Lower Dupi Tila clay cap • Discharge of up to 1 cumec of water may occur in the dry season. However, in comparison with the 250 cumec capacity of the river, this is considered an insignificant amount. Although there may be a small continuous flow in the dry season, no significant severance issues are

[1] Nature Conservation Management

Environmental Component	Potential Impact	Mitigation Measures
		expected. Thus, mitigation measures are not considered necessary.
Diversion of the Khari Pul creek	• Change in the sediment load and hydraulics of the Khari Pul creek and, by association, Ashoorar Beel	• The channel of the diverted river section will be sinusoidal to slow water velocity and minimize erosion and turbidity. Conceptual design of the channel is contained in GHD (2005b). • New channel bed and banks will be stabilized as soon as possible after construction. • Sediment and erosion control measures as described in the soil management plan will be employed during construction and until vegetation is stabilized.
Naturally occurring floods and wet season rainfall	• Disruption of mining activities resulting from inundation of the pit and infrastructure • Potential loss of life	• A flood levee will be constructed around the mine to protect the site from a probable maximum flood event. The flood protection bund will be at least 3 m high. • Raising of mine infrastructure area by approximately 3 m • Construction of a rainfall retention storage in the bottom of the pit with runoff pumped to an ex-pit treatment pond
Construction of project bunds (flood levee, sound bund, visual mound), 120 m high ex-pit overburden dump and mine infrastructure	• Degradation of water quality through erosion of cleared areas and fuel leakages with subsequent potential impacts on aquatic ecology • Changes in flood behavior • Loss of water to the catchments of the Little Jamuna River, Khari Pul creek, and Ranikantor Beel	• Prior to the commencement of mine activities, baseline water quality data will be thoroughly reviewed and water quality objectives for ambient conditions established. • Implementation of the soil management plan • Overburden dumps and bunds will be graded to facilitate collection and treatment of runoff until rehabilitation and vegetation works are stabilized. • Hydrological modeling has indicated that isolation of the mine site will have a minimal impact on flood behavior in the runoff catchment area. • Controlled release of compensatory groundwater from the Project's dewatering system and treated "dirty" water systems to maintain or enhance riparian flows. • Maintain the overflow channel between the Khari Pul and Little Jamuna water courses to emulate existing exchange of river waters during major flood events.
Provision of sanitary, cooking, and washing facilities for mine personnel	• Contamination of ambient surface water bodies through discharge of untreated sewage water and potential subsequent impacts on aquatic ecology • Public health risk resulting from discharge of pathogens from sewage into surface water bodies • Adverse impact on aquatic fauna resulting from release of untreated sewage	• Collection of all domestic sewage and treatment in septic systems and lagoons, with discharge to the adjacent Akrar Beel to meet the Bangladesh Standard for Sewage Discharge. A description of the proposed treatment system is provided in GHD (2005d). • A description of the planned wastewater treatment facilities (leachate and industrial water) is provided in GHD (2005d). Treated effluent will be reused on-site.
Mining. Coal processing. Coal, topsoil and overburden	• Discharge of water contaminated by sediment, chemicals, or acid mine drainage, which may degrade the ambient water quality of surrounding groundwater or surface-water bodies • Sediment and/or chemical contamination of surface water	• Prior to the commencement of mine activities, baseline water quality data will be thoroughly reviewed and water quality objectives for ambient conditions established. Water from the mine pit and runoff from stockpiles, maintenance, and coal processing areas will be removed to

Environmental Component	Potential Impact	Mitigation Measures
stockpiling. Dust suppression. Equipment maintenance and repair.	runoff derived from rainfall	on-site water treatment facilities, including oil and grease separators and sedimentation ponds. Conceptual water treatment facility design and operational details are contained in GHD (2005d). • Flocculants may be used to facilitate sediment settlement in ponds prior to discharge. Sediment sludge in the mine infrastructure area or other permanent) sedimentation ponds resulting from this activity will be buried in the in-pit or ex-pit overburden dumps. • Treatment facilities will incorporate detention basins to attenuate peak runoff flows and ensure a minimum 24-hour residence time in sedimentation ponds. • Preferential on-site reuse of “dirty” and/or treated water • Encapsulation and burial of pyritic material in the in-pit and ex-pit overburden dumps to prevent oxidation and water infiltration. Acid mine drainage (AMD) mitigation options and conceptual design of the in-pit and ex-pit overburden dumps are contained within the Project’s waste management plan. • Chemical treatment of AMD waters, for example by liming prior to reuse on-site • Burial of carbonaceous reject material to minimize the risk of arsenic mobilization • Repair crews responsible for field repair of heavy equipment will be equipped with cleanup kits to contain and treat spills of fuel or other liquid waste such as lubricating or hydraulic oils. • Diversion of direct rainfall runoff water from "undisturbed" areas to off-site discharge areas via a network of diversion drains
On-site storage of fuel and other chemicals, use of fueling stations, washdown bays, and mechanical workshops	• Contamination of groundwater and surface waters through leakage and spills	• Fuel and chemical storage areas will be bunded to contain 110% of the storage volume. • Redundancy tanks will be provided in the event of development of a leak or other maintenance requirement in a primary storage tank. Washdown areas, fueling stations, and maintenance areas will be constructed on hardstands and graded to facilitate collection of runoff and spills via pits and pipes. Water will pass through oil and grease separators prior to discharge to general runoff treatment in sedimentation ponds. • Treated water will be preferentially reused on-site.
Accidental release of untreated wastewater or mine site-derived "dirty water" off-site	• Contamination of adjacent rivers, beels, soils, and sediments • Adverse impact on downstream human users and aquatic biota	• The real-time monitoring system will alert the data manager to any unplanned or uncontrolled discharges off-site. • Emergency procedures will be formulated and incorporated into the relevant EMP prior to the implementation phase of the Project.
Use of agricultural chemicals for mine	• Leaching of fertilizers, pesticides, or herbicides into surface water and groundwater systems, with potential adverse	• Use of agricultural chemicals will be controlled following International Finance Corporation (IFC) and other best practice

Environmental Component	Potential Impact	Mitigation Measures
rehabilitation and landscaping	impacts on biota and/or human health	techniques, with emphasis on use of biodegradable chemicals where practicable
2. Soil Management Plan		
Clearance of surface vegetation Construction of infrastructure Movement of mechanical plant. Topsoil stripping. In-pit and ex-pit overburden dumping. Mining operations. Storage of fuel and other chemicals	• Exposure of topsoils to wind and water erosion • Compaction of soils resulting from movement of heavy movement. • Potential for movement of topsoils and other sediments off-site to increase turbidity and sedimentation of nearby waterways. • Potential for AMD leakage from high-risk materials placed within overburden dumps to leach contaminants from in-situ soils and sediments and adversely impact upon biota. • Potential for chemical leakages and spills to contaminate soils.	• Prior to each phase of mining, update and implement the relevant EMP to include phase-specific control and mitigation measures • Implementation of the Project's water management plan • Where possible, time surface earthworks activities to coincide with the dry season • Time vegetation clearance to occur immediately prior to soil and overburden stripping • Install diversion drains and sediment fences prior to starting earthworks • Collect and treat contaminated and/or excessively turbid water in settlement ponds and/or with flocculants before discharge to any off-site area or reuse on-site • Minimize the area and time of ground disturbance by progressively rehabilitating disturbed areas • Minimize movement of equipment and establish set transport routes and loading areas • Dust suppression on exposed areas using water trucks and automatic sprinkling systems • Regularly inspect control measures and ensure that they are maintained in an operable state • Encapsulate high-risk AMD material within an inert impermeable material and bury it within the overburden dumps • Collect, monitor, and treat leachate from the overburden dumps • Contour overburden dumps to minimize erosion • Rehabilitated landforms will be constructed so that they are geotechnically stable and resistant to wind and water erosion. Particular attention will be paid to preventing erosion of the ex-pit overburden dump during the monsoon period when flooding may occur. • Bund chemical storage, plant maintenance, and plant washdown areas • Excavation of soils where hydrocarbon spills exceeding 20 liters or hazardous chemical spills have occurred ,and placement of these soils in specific bunded areas for rehabilitation, removal from site, or placement within designated encapsulated locations within the overburden dumps
Overland flow of rainfall runoff from rehabilitated areas and discharge of	• Potential for increased erosion of in-situ soils and riverbanks with subsequent loss of adjacent agricultural land • Saturation of riverbanks leading to slumping and subsequent loss of adjacent agricultural land	• Placement of ESC measures to prevent movement of soils off-site. • Channelling of water to rivers through identified discharge points • Placement of energy dissipater structures to slow water velocity and prevent riverbank scouring at discharge and downstream locations

Environmental Component	Potential Impact	Mitigation Measures
excess mine water into the Little Jamuna River and Khari Pul creek		• Engineering measures will be employed to stabilize riverbanks where monitoring indicates project dewatering activities are exacerbating riverbank erosion.
Topsoil stockpiling	• Depletion of oxygen, particularly at the base of the stockpile • Loss of structure through compaction • Depletion of nutrients • Weed infestation • Contamination of soils through excessive application of pesticides or fertilizer	• Where possible, place stripped soils onto rehabilitation areas and revegetate immediately • Locate stockpiles away from trafficable or mine areas, trees, or watercourses and place on flat areas or along the contour to minimize erosion • Contour overburden dumps and stockpiles to minimize water erosion • Place sediment fencing at the foot of all stockpiles, and where necessary construct clean-water diversion channels to divert storm water away from the stockpiles • Clearly signpost topsoil stockpiles to prevent contamination or disturbance • Record stockpile locations and volumes on an annual basis. Cover recently placed or short-term stockpiles with jute mesh, mulched hay, or other similar covering. • Ensure that stockpiles are generally less than 2 m deep and set out in windrows to maximize surface exposure to the atmosphere to help maintain soil oxygen levels and health • Fertilize and vegetate stockpiles to be kept for longer than 6 months with a cover crop of deep rooting and nitrogen fixing species to maintain topsoil viability and minimize erosion • Control weed growth by spot spraying with specific herbicides • Fertilizer will be applied only in response to results of soil testing undertaken as part of the monitoring program of the soil management plan. • Weed control will be undertaken by manual measures where practicable. Pesticide use will comply with the IFC's pesticide handling and application guidelines.
Establishment of vegetation on rehabilitated areas	• Contamination of soils through excessive application of pesticides or fertilizer	• Fertilizer will be applied only in response to results of soil testing undertaken as part of the monitoring program of the soil management plan. • Weed control will be undertaken by manual measures where practicable. Pesticide use will comply with the IFC's pesticide handling and application guidelines and pest management policy.
3. Air Quality Management Plan		
Overburden removal, dumping and coal extraction	• Elevated ambient concentrations of PM10, PM2.5, and TSP off-site	• Exposed areas will be limited to the minimum required for mining operations • Completed overburden emplacement areas will be revegetated as

Environmental Component	Potential Impact	Mitigation Measures
		soon as possible • Installation of spray systems for dust suppression on dumping bins and stockpiles • Minimization of drop distances for all materials-handling processes through appropriate design of operations and operator training
Haulage of overburden and coal	• Elevated ambient concentrations of PM10, PM2.5, and TSP off-site	• Regular watering of haul and access roads using dedicated water trucks • Haul roads will be clearly defined using marker posts so that areas for vehicle traffic are controlled. • Roads no longer required will be revegetated as soon as possible. • Haul roads to be maintained by surface grading to minimize excessive road surface wearing
Coal handling and processing in the area of the coal handling and processing plant (CHPP)	• Elevated ambient concentrations of PM10, PM2.5, and TSP off-site	• Installation of an automated system of water cannons or sprinklers linked to real-time meteorological monitoring for control of dust emissions from the CHPP stockpiles • Use of biodegradable chemical suppressants that act as binders or wetting agents to minimize fugitive emissions from the CHPP area during worst-case weather conditions, such as easterly winds during the winter. • Installation of spray systems, filters, or other emission control devices on crushers and drill rigs • Conveyors to be covered or fitted with dust suppression systems • Conveyor transfer points to be enclosed and means for cleaning the return belt will be provided • Dust from free fall of materials at the conveyor discharge point should be minimized through the use of luffing feeders, chutes, or similar equipment • Monitoring of equipment emissions to identify items requiring maintenance
Blasting activities	• Elevated ambient concentrations of PM10, PM2.5, and TSP off-site	• Limited blasting during adverse weather conditions • Use of dust aprons on drilling equipment. • Optimized confinement of blasting charges
General equipment fleet	• Elevated ambient concentrations of PM10, PM2.5, and TSP off-site	• Regular preventative maintenance on all equipment to minimize particulate-matter emissions from diesel engines
All activities	• Excessive occupational exposures to airborne particulate matter or other pollutants	• Occupational exposures to air pollutants will be assessed at regular intervals. Where exposures exceed the government limits, appropriate engineered controls, management measures or, as a last resort, the provision of personal protective equipment will be implemented.
4. Noise and Blasting Management Plan		
Installation of groundwater pumps and construction of	• Noise-related community annoyance	• Prior to commencement of activities such as construction, drilling, and installation of pumps, a basic noise impact assessment will be undertaken. This will involve identifying any nearby residential areas,

Environmental Component	Potential Impact	Mitigation Measures
infrastructure		determining the activities likely to generate substantial noise and determining the level of risk that the project noise limits may be exceeded or that community annoyance is likely to occur. Where there is a significant risk, noise controls and/or management measures will be applied to the activities, and special noise monitoring studies during the activities will be undertaken. • Earthworks and other noisy activities for the construction of the CHPP to be restricted to the daytime only (6 am–9 pm). • Haulage of overburden from the pit to the mine infrastructure area for the construction period to be limited to daytime only.
Blasting	• Overpressure and ground vibration impacts	• Prior to commencement of normal blasting operations (if required), a series of trial blasts will be undertaken to facilitate accurate prediction of impacts from normal blasting. This will require monitoring of overpressure and ground vibration in at least two locations surrounding the mine. The monitoring will continue throughout the duration of the blasting program. Where monitoring determines a significant impact, blast designs may need to be modified and scheduled to occur during non-enhancing weather conditions.
General activities.	• Noise	• Regular noise monitoring (see below). The community will be advised in advance of any unusually noisy activities. A community hotline will be established and procedures to document and act upon community complaints will be implemented. • An analysis of measured noise levels, meteorological parameters, and site operations will be undertaken to determine the risk of excessive noise impacts during operations. This information can then be relayed to mine management so that activities can be modified to reduce impacts. • Opportunities to incorporate additional noise controls or specify quieter equipment during detailed design and ongoing operation of the Project will be investigated, particularly for haul trucks and the CHPP. • A detailed review of noise emissions and impacts from project activities will be carried out at regular intervals during the project life. • A 15 m high noise bund will be constructed around the CHPP area. • A 15 m high noise bund will be constructed along the western boundary of the mining pit in the area where the mine passes East Phulbari. • Dumping and earthworks activities in the ex-pit area will be concentrated in the areas closest to the center of the mine during the nighttime. • Haulage of reject material from the CHPP to the mining pit will be restricted to the daytime period until residential areas close to the haul road have been resettled.

Environmental Component	Potential Impact	Mitigation Measures
		• Truck transport of coal to the local market will to limited to the daytime. • Alternatively, the truck access road to the CHPP area will be located on the eastern side of the noise bund. • Occupational noise exposures will be assessed. Where LAeq (8 hour) noise exposures have the potential to exceed 85 dB(A), mitigation through engineered noise controls, management measures or, as a last resort, through the provision of personal protective equipment will be implemented.
5. Biodiversity Management Plan		
Mine pit excavation and construction of infrastructure	• Habitat loss, with consequent potential for adverse changes to species diversity and abundance, including that of threatened species	• Mining and associated activities to be limited to the mine footprint • Homestead vegetation and roadside vegetation to be retained or relocated wherever possible • Beels within the mine footprint to be retained if possible • In-pit and ex-pit overburden dumps to be progressively rehabilitated and revegetated after appropriate soil preparation. • Initial revegetation to involve plantation of fast-growing grass and/or forage species to prevent the spread of weeds • A mix of local and exotic timber species, fruit-bearing species, and fodder species to be used in vegetation of rehabilitated and resettlement areas, but locally indigenous species, particularly sal (Shorea Robusta) and associated canopy and understory species including medicinal plants, to be given priority wherever feasible • The margins of the Khari Pul creek to be revegetated south of the ex-pit overburden dump to the edge of the mine lease to create a wildlife corridor • Feasibility of undertaking further revegetation to link the wildlife corridor with sal forest areas adjacent to Ashoorar Beel to be investigated. • Consideration to be given to the enhancement of important habitat areas that are not directly affected by mining through revegetation or other activities. • Regular maintenance activities to be carried out to ensure the viability of all revegetated areas. • Opportunities to establish captive breeding programs and/or threatened species research within the project area to be investigated. • The ex-pit overburden dump to be reserved for biodiversity conservation
Loss of ponds	• Decreased fish production	• Compensatory ponds may be provided.
Alterations to existing hydraulic regimes (surface	• Adverse changes to aquatic species diversity and abundance, including that of threatened species, with consequent decrease in fish production	• Appropriate sediment and erosion controls to be implemented in accordance with the soil management plan • Khari Pul creek diversion to be designed to maintain fish passage to

Environmental Component	Potential Impact	Mitigation Measures
water)		Ashoorar Beel and areas further downstream, and to incorporate appropriate habitat features • Water quality monitoring data to be supplied to the Department of Environment and the Department of Fisheries, to provide assurance that parameter concentrations are acceptable to aquatic species • Existing flow regimes to the Khari Pul creek to be maintained or increased during the dry season, but seasonal fluctuations and flow velocities will be maintained. Required flow volumes and velocities will be determined in consultation with the Department of Fisheries and the community based fisheries management project participants at Ashoorar Beel.
Alterations to existing hydraulic regimes (groundwater)	• Adverse impacts to terrestrial vegetation and to dry season levels of beels	• Water from the Project's dewatering system will be injected into the Upper Dupi Tila aquifer to the west of the Little Jamuna River, east of the Nalsissa creek, and south of the mine footprint (but north of Ashoorar Beel). This is expected to reduce project-induced aquifer drawdown at these locations and outside the injection ring to zero. Details of the design and operation of the proposed aquifer injection system are contained within GHD (2005e). Aquifer injection is expected to mitigate impacts on identified sal forest areas of conservation significance. • Partial connection between Ashoorar Beel (and other beels of conservation significance) and the Upper Dupi Tila aquifer is thought to occur via slow vertical leakage through the Madhupur Clay. If there is significant connection between Ashoorar Beel and the Upper Dupi Tila, the aquifer injection system should mitigate any adverse impacts. However, pressure head, water levels, water chemistry and aquatic biota will be monitored to assess connectivity and any associated impacts, and remedial action taken where necessary. • Irrigation systems will supply areas within the aquifer injection ring of influence to maintain agricultural crops and plantation forests.
Increased population density as a result of resettlement	• Increased pressure on biodiversity resources	• An extensive awareness campaign for biodiversity conservation aimed at local communities within and around the study area to be implemented
6. Mine Rehabilitation and Closure Plan		
Overburden removal and stripping and storage of topsoil for rehabilitation purposes	• Material unsuitable for identified post-mining land uses is placed at the surface of ex-pit and in-pit overburden dumps • Water and wind erosion of exposed in-situ and stockpiled soils and overburden materials	• Characterization of overburden materials prior to their removal and identification of preferred placement sites in ex-pit or in-pit overburden dumps • Placement of stripped materials in a manner that prepares the overburden ground suitably for application of top soil. • Implementation of the soil management plan
Placement of overburden and	• The Khari Pul creek will no longer flow in its original course because the ex-pit overburden dump will be placed in its flow	• Hydrological integrity of the Khari Pul creek will be maintained through planned diversion of the creek around the eastern edge of the

Environmental Component	Potential Impact	Mitigation Measures
reject material from the coal washery in overburden dumps	path; this will necessitate construction of a new channel to compensate for the loss of water catchment for the Khari Pul creek and Ashoorar Beel • Water and wind erosion of overburden dumps • Land subsidence of the overburden dumps and /or collapse of ex-pit overburden dump • Contamination of ground and surface water though leaching of contaminants buried within the overburden dumps • Spontaneous combustion of coal toppings, partings, and processing wastes	ex-pit overburden dump. The diverted section of creek will be carefully designed to replicate or enhance the existing hydrological regime. The creek diversion will remain in place after cessation of mining. • Flow from the Khari Pul creek to Ashoorar Beel will be maintained by grading the overburden dumps to drain toward the river and beel, and supplementing flow with groundwater from project dewatering activities if required. • Implementation of the soil management plan • Implementation of the project water management plan • Contouring of the ex-pit overburden dump into a series of benches and batters with benches back-sloped to minimize erosion on batter faces • Construction of non-erosive drainage paths to channel rainfall runoff off the overburden dumps via designated discharge points • Contour ripping to a depth of 50 to 100 centimeters • Armoring the outside face of the overburden dumps using upper Permian hard rock • Rapid revegetation of overburden dumps utilizing succession planting as identified in the relevant EMP. • Landforms established during the rehabilitation and closure process will be engineered so that they are geotechnically stable and resistant to erosion by wind and water. • Where subsidence occurs, drainage paths will be altered to prevent subsidence-induced pooling of water. • Encapsulation of pyritic or other hazardous materials within at least 2 m of compacted clay or another impermeable material. • Capping of the overburden dumps with clay or other impermeable layer to minimize water infiltration • Convex shaping of upper section of ex-pit overburden dump to minimize water infiltration • Carbonaceous materials (other than the coal product) will be placed in the bottom of the in-pit overburden dump. All final surfaces will be covered with inert material. Clay will be placed over "hotspot" areas.
Revegetation of rehabilitation landforms	• Vegetation does not grow to required standard or dies	• Investigation into the reason for vegetation failure and implementing appropriate remedial actions, which may include liming, fertilizing, replanting, pest control, and/or watering • Fencing off of rehabilitated areas to prevent disturbance
Cessation of mining activities (or abandonment of other disturbed areas)	• Degradation of abandoned land, leading to unsuitability for identified post-mining land uses • Injury to mine employees or local residents caused by uneven and/or unstable ground	• Rehabilitation will be undertaken in a progressive manner throughout the LOM. Replacement of topsoil and vegetative cover on abandoned land as soon as practicable after mining activities cease • The mine site will be managed such that at all stages of the Project, access to active mine areas will restricted to authorized personnel

Environmental Component	Potential Impact	Mitigation Measures
Creation of final rehabilitated landform	• Loss of visual amenity • Disruption of hydrological regime of the Khari Pul creek and Ashoorar Beel	• Long-term visual impacts of the in-pit overburden dump will be mitigated by return of the land to forestry and agricultural use • Visual impact of the ex-pit overburden dump will be minimized through selective use of the land for extension of current forestry activities, including agro forestry and sal forest. • Flow to Ashoorar Beel will be maintained by grading the overburden dumps to drain toward the Beel. • Drained water will pass through detention and/or sedimentation ponds until the dumps are adequately revegetated.
Mine Closure	• Geotechnical or other failure (e.g., vegetative, water quality) of rehabilitated sites • Community health risks caused by residual contamination from sediment ponds, product stockpiles, or chemical storage areas	• Rehabilitated sites will be monitored and managed for a period of 5 years following cessation of mining activities. • Prior to tenement relinquishment, a contamination study will be conducted to ensure that no residual health risks resulting from contaminated soil or water on the project site remain. Any contamination identified will be remediated prior to site relinquishment.
Financial planning	• Insufficient funds to complete rehabilitation and/or monitor and, where necessary, remediate rehabilitated land	• Adequate provisions will be made within the forward budgeting process to facilitate the rehabilitation and closure process.
7. Waste Management Plan		
Use of raw and processed materials, and energy consumption	• High production costs • Depletion of natural resources	• Materials consumed by Project activities will be recorded and reported as part of the annual reporting process.
Land clearing within the mine footprint	• Generation of vegetative wastes (4,158 hectares of the mine footprint will be cleared) • Generation of infrastructure wastes, including concrete, metal, and bitumen (50 m3/year during construction)	• Chip wood waste for use in stockpile revegetation, landscaped areas on the mine site, and landscaping of the extended Phulbari township. • Separate unchipped woody waste to be recycled for the community to use as fuel or to make furniture • Compost leafy waste and combine with stockpiled topsoils to maintain nutrient levels and permeability • Sort waste and store materials that can be reused for construction of mine infrastructure. Recycle remaining infrastructure waste by making it available to the local community for use in construction activities • Dispose of non-recyclable, non-hazardous waste by burying it in the project landfill • Dispose of hazardous wastes in accordance with the hazardous materials management plan
Construction of infrastructure, and road and rail deviations	• Generation of small amounts of concrete, oil, and metal wastes	• Separation at source of all recyclable materials for sale to the local community • Burial of non-recyclable, non-hazardous wastes within the project landfill
Construction village and mine operations	• Wastewater (41 million liters/year effluent from mine operations areas. 49 million liters/year effluent from	• Installation of a septic system and wastewater treatment lagoons (see GHD (2005d) for a description of planned facilities) and preferential

Environmental Component	Potential Impact	Mitigation Measures
buildings.	construction village while operational.) • Generation of paper waste from offices (540 m3/year.) • Generation of domestic wastes such as paper, food scraps, and sewage from both office and accommodation facilities. • Generation of medical wastes from first aid facilities. (<1 m3/year hazardous waste.)	reuse of effluent on-site • Treatment of all wastewater in on-site water treatment facilities and preferential reuse on-site. • De-sludging of septic systems and treatment in designated lagoons • Separation of all recyclable materials (for example bottles, paper, clothing) for selling to local community • Placement of visible receptacles for recyclable and non-recyclable litter with clear signposting of what is considered recyclable waste • Sewage sludge will either be treated and used as fertilizer in the rehabilitation process, treated and sold to the local community as fertilizer or soil condition, or buried within the project landfill. Burial of non-recyclable, non-hazardous wastes within the project landfill • Disposal of hazardous wastes as per the hazardous materials management plan. • Disposal in the hazardous wastes section of the project landfill as per the hazardous materials management plan.
Soil and overburden stripping	• Generation of overburden materials, including high-risk AMD material (3,554 Mbcm overburden material including 8.316 million m3 stripped of topsoil, and 840 Mbcm high-risk AMD material)	• Stockpiling of topsoil for use in rehabilitation • Disposal of non-AMD-producing overburden to the overburden dumps. Encapsulation of high-risk AMD material within an inert lining and disposal within the overburden dumps
Coal washery operation and coal stockpiling	• Coal washery reject, including rock, coal fines, and pyritic material (maximum of 1.0 million tonnes per year (t/yr) coal reject (including a maximum of 400,000 m3 tailings/yr) • Coal washery maintenance wastes, including oils and machinery parts • Generation of leachate from coal stockpiles (small amounts of washing wastewater; small amounts of waste gear box oil; small amounts of metal and plastic machinery parts; 36.5 million liters/year leachate from coal stockpiles)	• Coarse reject will be conveyed to a reject bin from where they will be transported by truck for disposal either within the ex-pit overburden dump or by selective placement at the base of the mine pit. • Sand-sized fine coal rejects will be encapsulated and disposed of within designated areas of the overburden dumps. Leachate from coal stockpiles will be collected and treated in the Project's wastewater treatment facilities, and preferentially reused on-site.
Maintenance of production plant	• Generation of waste oil and grease, and other chemicals such as brake fluid, paint, and solvents • Generation of plant-part wastes, including tires, engine, and equipment body parts, transport and storage drums, and batteries (100 m3/yr solid waste; 2.5 million liters liquid wastes; 50 m3/yr hazardous wastes)	• Separation at source of all recyclable materials for sale to the local community. Burial of non-recyclable, non-hazardous wastes within designated areas of the project landfill. Treatment of liquid wastes in on-site wastewater treatment facilities and preferential reuse of effluent on-site • Disposal of hazardous materials in accordance with the hazardous materials management plan
Water and sewage treatment	• Generation of sewage and water-treatment sludges (30 m3/yr)	• Sewage will be treated within the Project's sewage treatment plant. • Sewage sludge may be treated and used or sold as a fertilizer or placed within the project landfill.
Mine decommissioning	• All plant, office and accommodation buildings, the rail loop, diversion drains, and water treatment facilities are abandoned.	• Mine plant will be sold to other mining projects. • Any infrastructure no longer required will be removed, and

Environmental Component	Potential Impact	Mitigation Measures
	These structures may become derelict and pose a risk to human health and safety.	demolition wastes will be recycled for use within the local community. Contaminated sites will be appropriately remediated.
Storage of wastes. Placement of wastes within the project landfill	• Infestation by vermin • Unpleasant odor • Contamination of in-situ soils and watercourses by corrosion of metals, leakages, and storm-water runoff	• Storage of wastes containing foodstuffs in sealed containers prior to disposal within the project landfill • Placement of a layer of impermeable clay soils or geofabric to prevent migration of leachate into landfill bed soils. Installation of diversion drains to divert storm-water runoff away from the landfill site • Installation of bunding and drainage around stockpiles and storage areas to channel any leachate to water collection points for treatment
Waste disposal.	• Contamination of air, soil, water • Risks to human health	• Burning of wastes will be prohibited. • Collection and treatment of leachate from disposal areas • Bunding of storage areas • Staff with responsibility for disposal of waste will be issued appropriate protective clothing.
8. Hazardous Materials Management Plan		
Transport, storage, use, and disposal of hazardous materials	• Contamination of soils or groundwater and/or surface water resulting from leakages or spills during loading or transport. Human harm resulting from contact, ingestion, or inhalation of hazardous materials. Adverse impacts on biota resulting from contact with hazardous materials or contamination of habitat.	• Hazardous materials will be transported to the project site by rail where possible. Where this is not possible, transport by road will only be contracted out to appropriately experienced and licensed couriers. • Where appropriately experienced couriers are not available, Asia Energy will provide a suitable transport vehicle. • Where transport occurs by road, transit through towns and villages will be avoided where possible and practicable. • Asia Energy will use appropriately qualified personnel to train all staff in the safe management and handling of hazardous materials. • All employees who are required to handle hazardous materials will be issued appropriate protective clothing and training will stress the importance of wearing this clothing and how to use specialized equipment. • First aid facilities on-site will be equipped with emergency showers and eyewash facilities and medical staff will be trained in treatment of accidents and illnesses arising from contact with hazardous materials. • Storage facilities will be floored with an impermeable substance, bunded to contain at least 110% of the volume of the largest storage container, and fitted with sumps to contain and drain leaks and spills. These facilities will also be fitted with appropriate ventilation, lighting, and fire-fighting equipment. • Storage facilities will be secure and access will only be granted to authorized personnel. • Storage, loading, and fueling facilities will not be sited within 100 m of a natural water body. • Material safety data sheets will be held by the health, safety, and environment (HSE) manager with copies in both English and Bengali

Environmental Component	Potential Impact	Mitigation Measures
		kept in easily accessible locations in storage areas for use by handling staff. • All hazardous materials transported and stored on-site will be clearly labeled and stored and/or transported in containers that are appropriate to the quantity and characteristics of the material. • Quantities of hazardous materials imported, transported, stored, used, and disposed of will be recorded in a hazardous materials register and reported annually. • Where possible and safe, hazardous wastes will be recycled for use on-site or sold for use in another facility. • Non-recyclable hazardous wastes will be appropriately treated, contained, encapsulated, and either placed in the project landfill or buried in designated areas within the overburden dumps. • A record will be kept of the off- and on-site location where hazardous materials are disposed of. • Spill kits will be maintained at loading and storage areas. • An emergency preparedness and response plan will be developed, reviewed, and updated an annual basis. Copies of the plan will be held by the human resources manager, the mining operations manager, and the HSE manager. Training in emergency procedures will be given during staff inductions and on an annual basis thereafter. • Excavation of soils where hazardous chemical spills have occurred and placement in designated bunded areas for treatment and/or burial in the hazardous wastes section of the project landfill. • Information and advice on the transport and use of hazardous materials and the potential impacts on surrounding communities will be provided via the ongoing community consultation process. A procedure for receiving, recording, and responding to community concerns and complaints will be developed as part of the community consultation strategy.
B. Coal Terminal in Khulna		
Soil landscape and contamination	• Release of contaminants from existing buildings and infrastructure during clearing of the site prior to construction • Importation of potentially contaminated fill • Soil erosion • Disturbance of potential acid sulfate soils leading to mobilization of sorbed metals • Deterioration of soil structure through compaction • Land and water contamination through inappropriate waste management procedures and practices • Land and water contamination through inappropriate fuel and oil handling and maintenance	• Hazardous buildings will be inspected prior to site clearance, and demolition and health and safety management and waste handling procedures will be updated to reflect the findings of the inspection. • A register of hazardous buildings will be established to record the building location and the nature and disposal location of any hazardous material. • Fill material will be tested prior to importation to ensure contaminant concentrations do not exceed Dutch Intervention Values. • Construction and operational erosion and sediment control procedures will be developed as part of the project construction environment management plan and environment management plan

Environmental Component	Potential Impact	Mitigation Measures
	• Human exposure to soil containing contaminants • Leaching of contaminants from stockpiles into soil and groundwater	(EMP). • Soil stockpile management procedures will be implemented. • The area of land disturbance will be minimized by issuing clearing crews with "no-go" areas. • Non-hardstand areas will be vegetated as soon as possible after earthworks are completed and monitored for erosion and vegetation growth. • Gross pollutant traps will be incorporated in site drainage and water treatment facilities, and inspected and maintained as needed. • Solid waste will be disposed of in on-site bins before being taken to an appropriate landfill location. • Stockpiles will be located on sealed hardstand areas with water sprays used to control dust generation. • Leachate from stockpiles will be directed to the settling pond. Sludge from the settling pond will be disposed of at an appropriate landfill location. • Spill response equipment will be made readily available and all personnel will be trained in its use. • Spill response equipment will be located at fuel storage areas and equipment maintenance areas. • A maintenance schedule will be developed and implemented to ensure regular and timely maintenance of plant and equipment. This will minimize the likelihood of hydrocarbon leaks. • Fuel, oil, and chemical storage areas will be bunded to 110% of storage vessel capacity for the largest tank to ensure containment from potential leaks or spills.
Air quality	• Cumulative ambient air quality is likely to exceed government air quality standards during the dry season in Khulna city adjacent to the Coal Terminal footprint. • Coal Terminal employees may suffer respiratory impairment through exposure to dust or other emissions in the work environment. • Community annoyance from coal dust deposition	• Implementation of soil conservation measures • A community liaison program will be developed to provide information to residents and receive feedback or complaints about dust emissions. • Complaints will be investigated promptly by Coal Terminal management and remedial action taken where required. • Appropriate protective respiratory equipment will be supplied to workers potentially exposed to emissions exceeding acceptable levels. • Low sulfur fuel will be sourced and used if possible. • A real-time environmental monitoring and management system will be implemented that includes monitoring of meteorological parameters, ambient particulate matter concentrations, and coal stockpile moisture levels. • Relationships between site operations, meteorological conditions, and ambient particulate matter concentrations will be developed and used to forecast conditions that may give rise to adverse impacts.

Environmental Component	Potential Impact	Mitigation Measures
		Operational activities will be amended accordingly. • Water cannons or sprinklers linked to this system will be used to control dust emissions from coal conveyors and stockpiles. • Where possible, conveyors will be fitted with removable dust covers and transfer points will be fully enclosed and fitted with dust suppression sprays. • The stacking boom will be set to minimum elevation while undertaking stockpile stacking operations. • Sufficient drag chain feeders will be provided along the reclaim conveyor to minimize travel distances for the bulldozers when reclaiming the coal. • Implementation of an air quality monitoring program to verify the effectiveness of mitigation measures • Should monitoring indicate that government standards are being exceeded, additional measures will be developed. This may include provision of ventilation systems for the combined military hospital to the north of the site. • Excessive or unnecessary vehicular use will be avoided, and vehicle speeds around the Coal Terminal in Khulna will be limited to minimize dust generation. • Site plant and equipment will be regularly maintained to ensure that it is in good working order. • Consideration will be given to development of an empty-wagon cleaning facility at the unloading terminal. The need for an enclosure with an emission controlled air exhaust system will be monitored and evaluated. • Employees responsible for cargo unloading will ensure that product arriving at the Coal Terminal in Khulna is of adequate moisture content at the rail unloading area. • Regular communication will be maintained between Coal Terminal staff and staff at the Phulbari Coal Mine to provide feedback regarding product moisture content. • A number of standard dust control mitigation measures, such as the use of water carts to damp down exposed surfaces, will also be employed. • Emergency response measures will be established and personnel will be trained in emergency response procedures. Stockpile management procedures conducive to the control of spontaneous combustion will be implemented.
Noise	• Ambient noise conditions may exceed government noise quality standards in areas adjacent to the rail spur and the Coal Terminal in Khulna, particularly during southerly wind	• Construction activities that are particularly noisy, such as earthworks and demolition, will be limited to daytime only. A program to manage construction noise impacts through regular community liaising and a

Environmental Component	Potential Impact	Mitigation Measures
	conditions. • Government noise standards for "silent" areas will be exceeded at the Bangladesh Naval Hospital to the north and schools to the southwest of the Coal Termina in Khulna l. • Elevated ambient noise levels may cause sleep disturbance of residents in close proximity to the Coal Terminal in Khulna and/or rail spur. • Hearing impairment may be caused through exposure to industrial noise sources.	noise monitoring program will be implemented. • Low-noise plant and equipment will be selected for project activities wherever feasible. This will include procurement and use of low-noise-emitting hybrid yard locomotives (or a similarly low-noise-emitting alternative) for moving wagons between the marshalling yard and Coal Terminal in Khulna. • Consultation with the management of the hospital and schools will be undertaken to determine proper mitigation measures. Mechanical ventilation systems and acoustic glass to achieve satisfactory internal noise levels, and/or to relocation of the schools will be undertaken if required. • Vehicle and other plant muffler systems will be included in the ongoing maintenance of the equipment. Replacement or repairs will be undertaken as required. • Toolbox talks, environmental awareness training, and operating procedures will be used to direct the workforce in appropriate stockpile management. • The workforce will be provided with personal protective equipment for hearing protection. This equipment may include personal protective equipment such as ear plugs and ear muffs. • Roads and fixed plant will be designed and sited to maximize shielding and attenuation of noise.
Water resources	• Release of contaminated or poor quality water from construction dewatering operations (such as draining ponds and lowering the level of near-surface groundwater) • Deterioration of the water quality of the Bhairab River through the release of storm water contaminated by hydrocarbons and waste materials. • Deterioration of water quality in the Bhairab River resulting from release of sewage and industrial wastewater. Impacts may include decreased dissolved oxygen concentrations, changes to salinity concentrations and pH, introduction of contaminants, increased biochemical and chemical oxygen demand, and increased concentrations of nutrients and pathogens. • Deterioration of water quality through deposition of suspended coal dust in nearby water bodies. Impacts may include increased turbidity, smothering of sediments, and changes in salinity and/or pH values. • Inappropriate hydrocarbon management practices leading to a fuel or oil spill. • Localized contamination of the shallow aquifer resulting from infiltration of contaminated storm water or from fuel or oil	• Implementation of soil conservation and contamination mitigation measures. • Preparation of a pre-construction water quality report that targets the potential impacts of releasing water from the construction dewatering program. • Implementation of air quality management and control measures as described above for air quality. • Construction of energy dissipaters to reduce velocity of water entering rivers and prevent scouring at discharge points. • Regular monitoring of site-wide waste management and disposal practices. • A waste segregation area will be established for the separation of recyclable and reusable material. • Color-coded bins will be provided for different waste streams, including general waste, oily waste, and recyclable waste. • A waste management procedure will be developed as part of the project EMP. • A hazardous material management procedure will be developed as part of the project EMP. • Training and awareness programs for all personnel

Environmental Component	Potential Impact	Mitigation Measures
	leaks or spills. • Deterioration of water quality in the surrounding environment through the disturbance of potential acid sulfate soils during the construction phase. • Spillage of coal resulting from the capsizing of vessels, loading error, or wind or water erosion, resulting spillage of coal into the Bhairab River. • Water resource consumption through potable water use, dust suppression activities, vehicle washing, and fire fighting.	• A sewage treatment unit will be installed that has the capacity to treat sewage generated by personnel on each shift as well as sewage discharged from coal trains. • A comprehensive oil spill response procedure that includes provisions for responding to environmental emergencies will be developed and implemented as part of the project EMP. • Procedures for the cessation of all coal handling and loading operations in the event of adverse weather conditions will be developed and strongly enforced. • Spill kits will be provided at fuel and oil storage and handling areas and will include booms and skimmers, absorbent mats and rolls, absorbent material in bulk (Drysorb), and detergents. • A coal spill response procedure will be prepared and implemented. This procedure will be implemented in coordination with the project emergency response plan. This should include regular drills to ensure emergency preparedness. • A drainage system and water treatment facilities will be installed to capture and remove gross contaminants, grit, oil, and grease and to promote settlement of suspended clay, sediment, or coal particles. The treatment tank will have sufficient capacity to retain site runoff from a 24-hour storm having a return period of at least 10 years. The tank will also be equipped with a chemical dosing mechanism to facilitate settlement of suspended particles and contaminants and to adjust pH as required before controlled outflow to the Bhairab River. • The volumes of water supplied to the site through extraction from deep tubewells will be monitored to ensure drawdown does not affect adjacent water users. • Water-conserving bathroom fixtures will be installed in administration and amenities buildings (low-flow shower heads and low-water-use toilets). • A rainwater collection and reuse system will be installed on the roof of the administration buildings for internal non-potable uses (for example toilet flushing). • A recycled industrial wastewater system will be installed.
Biodiversity	• Displacement of flora and fauna using the site • Deterioration of habitat values caused by fugitive dust and noise emissions • Reduced photosynthesis as a result of increased sedimentation of the Bhairab, Rupsa, and Pussur rivers. • Disturbance of benthic sediments and flora and associated invertebrates through construction activities such as building piles for berthing	• Designated clearing areas and "no-go" zones will be identified prior to commencement of site clearing activities to minimize the removal of habitat areas. • Disturbed areas will be stabilized as soon possible. Locally native species will be used in landscaping works for non-hardstand areas. • Mature, existing trees will be maintained where they do not interfere with the safety of the Coal Terminal in Khulna operations. • Cleared vegetation will be mulched and used in the site landscaping

Environmental Component	Potential Impact	Mitigation Measures
	• Deterioration of habitat values through release of coal, fuel, oil, or other contaminants into water bodies or other activities resulting in water quality reduction. Impacts on biodiversity will depend upon type and amount of pollutant but may include damage, injury, or mortality of aquatic and/or shoreline biota, or changes to species abundance and diversity.	works. • Disturbance to bed and banks of the Pussur River will be minimized to reduce risk of impact on aquatic flora and fauna. The importance of minimizing disturbance in this area will be communicated to the workforce through toolbox talks and environmental awareness material. • Implementation of soil and sediment conservation measures • Implementation of air quality controls and management measures • Implementation of noise emission controls and management measures • Implementation of water quality and waste controls and management measures • Implementation of oil and coal spill response procedures • Implementation of a biodiversity monitoring program as part of the project EMP.
Environmental pollution, health, and safety	• Annoyance, sleep disturbance, and health impacts from noise emissions that exceed Government noise emission limits • Community annoyance from dust deposition • Potential for risk of harm to personnel and the local community • Contamination of land and water through inappropriate disposal of waste products, including sewage and hazardous wastes. This may result in adverse impacts on surface water users—most notably on the Bhairab River and those persons who use this river for fishing, washing, and drinking purposes. • Increased use of local landfills leading to reduced availability for community use • Increased nuisance caused by vermin attracted to waste disposed of inappropriately • Increased risk of human health deterioration through exposure to pathogenic material • Increased risk to fisheries catch through chronic or acute contact with hazardous wastes, or through deterioration of habitat	• Implementation of noise and fugitive dust emission controls and management measures as described in above • Implementation of water quality management and control measures as described above • Regular maintenance of Coal Terminal in Khulna plant and equipment and barges • Training of equipment operators and barge crew to ensure that all aspects of operations are undertaken in accordance with best practice procedures • Development of an emergency response plan that includes installation of emergency response equipment to combat events such as coal spill and fire • All personnel required to handle hazardous materials will be provided with personal protective equipment suitable for the hazardous material being handled. • The community liaison program will include a mechanism to ensure that potentially affected river users and local residents are kept informed of any known water pollution events so that use of surface water and contact with the river can be minimized during these times. • Provision of compensation for river users who experience a loss or reduction in income as a result of project-induced water pollution • On-site first aid facilities will be provided and employees will be informed of the location and services provided at these facilities.
Visual amenity	• Changes to visual amenity, with the Coal Terminal in Khulna and coal stockpiles dominating the landscape from all directions. However, these changes will be compatible with existing on-site and adjacent land uses.	• A 2 m high solid fence will be constructed around the site that will shield views of ground-level operations. • Immediately following construction, a line of trees will be planted along the western and southern perimeters of the site to afford a natural screen to viewers close to the site.

Environmental Component	Potential Impact	Mitigation Measures
		• Lighting will be carefully designed so that lights are fixed as low as possible and directed to the ground or away from possible view locations. • Structures will have non-reflective coatings.
C. River and/or Marine Transportation		
Land use	• Land cannot support pre-transport activities. This may be as a result of barge wake causing loss of land from riverbank erosion, or soil and/or sediment contamination resulting from inappropriate hydrocarbon handling procedures and practices and/or waste management practices.	• Ongoing monitoring of bank erosion will be undertaken in areas classified as being 'critical in the EMP. Should monitoring identify project-induced accelerated erosion processes, vessel speed will be evaluated and adjustments will be made to operating criteria where necessary. Alternate mitigation measures include engineering bank protection works and vegetation bank stabilization works. • Procedures for hydrocarbon use, transfer, and storage will be developed and strongly enforced.
Air quality	• Ambient air quality may not satisfy Government air quality standards in villages adjacent to the transport corridor and/or at Akram Point • Community annoyance from "dusting" events caused by wind gusts	• Regular maintenance of project barge and floating transfer vessel (FTV) engines and education and training of barge operators and mechanics so that they understand the need for adequate maintenance • Use of low sulfur diesel fuel if available • Use of water sprays on coal product • Loading of barges to ensure minimal surface area exposure of coal product • Use of chemical surface treatments if water spraying proves insufficient to prevent 'dusting'
Noise	• Ambient noise conditions may exceed Government nighttime noise limits on land at points along the barging route where barges come within 120 m of the shore • Hearing impairment caused by exposure to industrial noise sources • Localized disturbance of nocturnal wildlife activities in the vicinity of Akram Point	• Noise emission limits will be established during the procurement of new barges. A limit of 75 dB(A) or less when measured at any point 7 m from the barge is recommended. • Nose monitoring will be undertaken along the banks of potentially impacted areas as part of the project EMP. Should monitoring indicate Government noise limits are not being met, further controls, such as additional source control, slight adjustments in the route, or go-slow areas, may be implemented. • Hearing protection will be provided to any personnel who are exposed to occupational noise. In the event of a community complaint, additional insulation of engine compartments will be considered to reduce noise levels. • The biodiversity monitoring program will include measures to determine whether noise emissions are adversely impacting wildlife adjacent to the FTV at Akram Point. Should monitoring indicate significant disturbance, further measures to reduce noise emissions will be considered.
Coastal and estuarine processes	• Increased riverbank erosion or changes to sediment transport and accretion processes from dredging, barging, and/or shipping activities.	• Monitoring of riverbank erosion processes as described above. • Monitoring of salinity concentrations will be undertaken as part of the regular water quality and biodiversity monitoring programs.

Environmental Component	Potential Impact	Mitigation Measures
	• Increased salinity resulting from changes in coastal processes. • Sediment suspension resulting from dredging activities. • Release of contaminants or localized decreases in dissolved oxygen concentration resulting from dredging activities. • Deterioration of water and/or sediment quality as a result of inappropriate handling or accidental release of untreated sewage, bilgewater, or other wastewater. • Deterioration of water quality, sediment quality, and/or contamination of riverbanks resulting from oil or coal spills (including those resulting from collisions or groundings). • Deterioration of water quality, sediment quality, and/or contamination of riverbanks as a result of inappropriate disposal of solid waste. Release of contaminants through use of anti-fouling chemicals on vessel hulls. • Surface water contamination or release and/or establishment of exotic biota resulting from ballast water exchanges. • Water consumption through spraying the coal to suppress dust, washing activities and use of potable water onboard vessels.	• Geotechnical studies, including coring of sediments to design depth, will be undertaken as part of detailed dredging design studies. Samples of cored sediments will be sent for chemical analysis to confirm suitability for deep sea disposal. • Suspended solid loads and turbidity levels will be monitored during dredging and disposal operations to quantify any resultant increase. • A sewage treatment unit will be provided on all vessels to treat sewage to the sewage discharge standards of the Government prior to discharge. • Bilgewater from the floating transfer vessel will not be directly released into the surrounding environment. Instead, a holding tank will be installed to retain any "bilge" water onboard until it can pumped into a waste barge and taken to shore for treatment either at the Coal Terminal in Khulna or at suitable facilities at Mongla Port. • Solid and/or or hazardous wastes will be segregated and stored in appropriate containers onboard each vessel before transfer to an appropriate landfill in Khulna or Mongla. • All barges used in the proposed barging operations will be coated with tributyltin (TBT)-free anti-fouling paint as per IMO regulations. Vetting processes will be applied to the selection of shipping agents, which will include the requirement for use of TBT-free anti-fouling paint on vessels. • Vetting procedures will be implemented to encourage oceangoing vessels to exchange ballast water prior to entering the Outer Bar navigation channel. Ships used for the transport of product to international markets will require a ballast eater management plan that conforms to the International Convention for the control and Management of Ships' Ballast Water and Sediments. • The use of hoses for cargo cleanup will be discouraged. • An awareness program will be developed and implemented to educate crew about the need for water conservation and pollution control. • Regular monitoring of discharged effluents will be undertaken to ensure compliance with Government standards. **Hydrocarbon Management:** • A shipboard oil pollution plan (SOPEP) will be developed in accordance with Regulation 26 of Annex I of MARPOL[2] 73/78. This SOPEP will include contingency provisions and will be developed with reference to the draft national oil spill contingency plan and related studies to ensure specific relevance to the Sundarbans.

2 International Convention for the Prevention of Pollution from Ships

Environmental Component	Potential Impact	Mitigation Measures
		• Comprehensive oil spill management procedures will be developed and implemented for barging and shipping operations. The procedures will comply with all international shipping conventions and will include guidelines for handling oil spills. The procedures will also include provisions for responding to environmental emergencies. • Procedures for the cessation of all shipping and loading operations in the event of adverse weather conditions will be developed and strongly enforced. Cyclone moorings or other safe anchorage will be provided for use during adverse weather. • All vessels will be required to carry appropriate spill containment and treatment equipment, including booms and skimmers, absorbent mats and rolls, absorbent material in bulk (Drysorb), and detergents. • An oil record book will be maintained on each vessel and subjected to regular review. The following measures will be implemented to minimize the potential for oil spills to occur during refueling of the FTV: • Tendering documents will include a requirement for FTV fuel suppliers to work to best practice refueling operations and standard operating procedures as specified by Asia Energy. • FTV refueling and bunker supply contracts will only be awarded to operators who are equipped and trained in best practice refueling operations. • Periodic "spot checking" and regular auditing of refueling procedures and maintenance activities will be incorporated into the project EMP. • Refueling of the Floating Transfer Vessel (FTV) will only occur at Akram Point or at designated Khulna or Mongla fueling facilities. To minimize the potential for accidents leading to oil spill, it is recommended that the Ministry of Shipping, MPA, and/or Bangladesh Inland Water Authority (BIWTA) implement the following measures: • Enforcement of compliance of all vessels with the IMO's International Regulations for Preventing Collisions at Sea Convention (COLREGS Convention). • Tightening the GoB's Inland Shipping Ordinance to improve the structural quality of local vessels and competency of local masters. • Upgrading and regularly maintaining navigational hardware such as buoys and channel markers. • Providing training and education programs for local masters. Coal Handling and Spillage: • Spillage mats will be deployed over the side of vessels to direct any spillage back onto the deck where it will be recovered during the normal

Environmental Component	Potential Impact	Mitigation Measures
		course of discharge. • A maintenance program will be launched for loading and unloading equipment, including the belt "return" scrapper. • A regime of sweeping up and placing cargo residue into the cargo containment area will be implemented. • Procedures for responding to coal cargo spill will be prepared and implemented for each vessel. These procedures will be implemented in coordination with the safety and emergency response plan. • A regular maintenance program will be applied to all vessels. The program will ensure proper functioning of steering and navigation systems, and ensure structural integrity of the hull and fuel tanks. The maintenance system will be subject to audit. • Enhanced navigation equipment will be installed on barges, including global positioning system (GPS), radar, and other electronic navigation systems to minimize the potential for grounding or collisions. • Vessels will be manned by certified crew with proper qualifications. The crew will undergo training and familiarization in simulators for navigation of river with respect to barge design. • Progress of barges along the rivers will be monitored via automated tracking and regular contact with the MPA and BIWTA traffic control centers. Hazardous material handling procedures will be developed to manage hazardous material on vessels.
Biodiversity	• An increase in the risk of oil and coal spills from collisions, groundings, and founderings, which may adversely impact on the biodiversity of the Sundarbans Reserve Forest (SRF) and the Sundarbans World Heritage Area • Risk of fuel spillage during refueling operations at the FTV • Removal or smothering of benthic organisms near the navigation channel and/or Swatch of No Ground as a result of dredging activities • Oxygen depletion, release of contaminants, and/or reduction in light penetration near the navigation channel and/or Swatch of No Ground caused by dredging activities, with resulting adverse impacts on fisheries and other fauna • Disturbance of nocturnal wildlife activities through light and noise emissions, particularly from the FTV • Release of ballast water introducing organisms and pathogenic material of foreign origin to the surrounding environment • Introduction of contaminants through maintenance activities and the use of anti-fouling paints on vessel hulls	• Implementation of the mitigation and management measures described above • Crew will be trained to a high level to ensure safe and efficient operations. Vessels and operations will be in full compliance with International maritime Organization (IMO) regulations and classification requirements (i.e. vessels, crews, and operations meet international regulatory standards for construction, navigation equipment, competency, and drills, as well as comply with operational procedures such as the COLREGS Convention). • Safe vessel pilotage will be required by ship owners for movements inside Mongla Fairway Buoy. • All project ships will be required to use the dredged navigation channel • Vessel quality will be controlled by instituting a regime of vetting coal ships, crew, and operations. • Refueling of the FTV will take place only at Akram Point, or in Khulna or Mongla. Barges and ships will not refuel within the limits of the SRF. • Fueling processes will follow best practice operating procedures,

Environmental Component	Potential Impact	Mitigation Measures
	• Direct impacts to fauna through vessel strike (e.g., injury or mortality of cetaceans and turtles) • Displacement of river fauna as a result of vessel operations (e.g., Gangetic dolphin) • Riverbank erosion from barge and ship wake, with consequent impacts on the biodiversity of the Pussur River system of the Sundarbans • Risk of increased human disturbance to biodiversity at Akram Point associated with crew presence on the FTV (i.e., waste discharges or visitation of nearby terrestrial areas for harvesting wildlife and/or forest products) • Reduction of habitat values (including deterioration of water quality) through pollution stemming from inappropriate waste and/or hydrocarbon management practices • Reduction of habitat values through deterioration in air quality or coal dust deposition • Increase in salinity in the Pussur River estuary leading to adverse impacts on salt-sensitive species	and any spills or other environmental emergencies will be responded to in an appropriate and timely manner. • All shipping and loading activities will be suspended in the event of a tropical cyclone or other adverse conditions that prevent safe operation. Vessels will either proceed to sea for safety or seek shelter in protected inlets until the weather system has passed. • Crew from the FTV will be prohibited from accessing terrestrial components of the Sundarbans in the vicinity of Akram Point. In addition, the operation of small local boats will be prevented to discourage the congregation of "local floating" businesses. • Equipment producing light and noise emissions on the FTV will be sensitively designed and operated. This will include discreet onboard lighting that does not point outwards unnecessarily and acoustic damping hoods on engines to reduce noise impact. • Benthic sampling will be conducted using cored samples obtained during the geotechnical study phase of detailed dredging design. • A monitoring program will be developed.
Infrastructure and services	• Potential for damage to the Rupsa Bridge resulting from a collision with a project barge • Communities and businesses in the region adversely affected if damage requires closure of the Rupsa Bridge • Ferry and boat crossings operations may be disrupted to avoid the potential for accidents and collision with project barges	• The Ministry of Shipping should undertake an evaluation of the adequacy of existing fendering systems at the Rupsa Bridge and assess whether they are adequate to protect the bridge. Asia Energy will assist the Ministry of Shipping with providing improved fendering should it be deemed necessary • It is recommended that the BIWTA places radar beacons to mark the position of the Rupsa Bridge piers so that they appear on radar screens. • Barge operators will adhere to the COLREGS Convention and best practice bridge management procedures from the coal barge to reduce the likelihood of collisions. Barges will also sail at reduced speed when passing the Rupsa Bridge to reduce the incidence of collisions.
River and marine traffic	• Increased potential for accidents involving local boats, causing injury or possibly even death	To reduce impacts associated with the operation of barges, Asia Energy will: • Ensure that coal barge crews are trained, examined, certified and performing to international best practices standards • Ensure that all barges are fitted with GPS, radar and/or other electronic navigation systems to prevent grounding or collisions, such as depth sounders, radar, and radio equipment for communication with other vessels and the MPA and BIWTA traffic control centers • Ensure that barges are in compliance with international statutory and regulatory standards • Undertake an asset register of existing ferry routes across the river and provide GPS locations and maps of existing river crossings to

Environmental Component	Potential Impact	Mitigation Measures
		barge operators so that they will be aware of the presence of local vessels at these points For shipping activities, Asia Energy will: • Vet coal shipping vessels and control of the conditions of the types of vessels carrying the coal • Work with the appropriate agencies to ensure the upgrade and improvement of existing navigation marks and aids as necessary • A local NGO will be engaged to deliver appropriate training in the villages located along the river–marine transportation corridor. The purpose of the training will be to ensure that local communities are aware of the anticipated increase in river traffic resulting from barging and shipping activities, and to provide education and information tools about how to minimize exposure to the dangers of increased river traffic. • Asia Energy will also establish a river safety program, coordinated through the BIWTA, that will provide for the installation and upgrade of lighting facilities at existing ferry crossings to ferries them more visible to barge operators at nighttime. • Asia Energy will liaise and coordinate with the MPA and BIWTA to respond to river or marine accidents, and casualties, should they occur.
Health and safety	• Contaminated water supplies • Direct health impacts on communities and river users from exposure to hazardous substances and contaminated water • Reduction in nutrition as a result of reduced fish availability	• Implementation of mitigation and management measures identified above • Implementation of the water pollution event strategy as described above • Monitoring of fish catch as described above. In the event that project operations cause a long-term decline in the fish catch, Asia Energy will contribute to a marine protection and development fund to assist with the financing of training in alternative income generating activities.

All abbreviations are explained in the Glossary unless explained above.
Source: All EIAs and EMPs for the Project. Please refer to Table A1.2.

Table A1.2: EIA Supporting Documents for the SEIA

A. Mine Site Phulbari Supporting Documents

1. Volume 1

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
ESIA_Vol-1_Executive Summary.pdf	
ESIA_Vol-1_Abbreviations.pdf	
ESIA_Vol-1_Chapter 01_Introduction.pdf	
ESIA_Vol-1_Chapter 02_Legal & Policy.pdf	Legal and Policy Considerations
ESIA_Vol-1_Chapter 03_Methodology.pdf	
ESIA_Vol-1_Chapter 04_Consultation.pdf	Consultation with Stakeholders
ESIA_Vol-1_Chapter 05_Project Alternatives.pdf	
ESIA_Vol-1_Chapter 06_The Project.pdf	
ESIA_Vol-1_Chapter 07_Existing Biophysical Environment.pdf	
ESIA_Vol-1_Chapter 08_Existing Socio-economic Environment.pdf	Description of the Socio-economic Environment
ESIA_Vol-1_Chapter 09_Biophysical Impact Assessment.pdf	
ESIA_Vol-1_Chapter 10_Socio-economic impact.pdf	Socio-economic Impact Assessment
ESIA_Vol-1_Chapter 11_Ancillary Development.pdf	
ESIA_Vol-1_Chapter 12_Cum Impacts.pdf	Cumulative Impact
ESIA_Vol-1_Chapter 13_Management Plan.pdf	Environmental & Socio-Economic Management Plan/Procedure
ESIA_Vol-1_Chapter 14_Project Justification.pdf	
ESIA_Vol-1_Chapter 15_Risks and Opportunities.pdf	
ESIA_Vol-1_Chapter 16_Conclusion Recommendation.pdf	
ESIA_Vol-1_Chapter 17_References.pdf	
ESIA_Vol-1_Chapter 18_Glossary.pdf	
ESIA_Vol-1_Appendix A1-A3.pdf	A1 – Environmental Site Clearance, A2 – Environmental Clearance Certificate, A3 – Mine Lease and Exploration Licences

2. Volume 2

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
ESIA_Vol-2_Sect-1_Life of Mine Plan.pdf	
ESIA_Vol-2_Sect-2_Geology & Resource Assessment GHD.pdf	Coal Geology & Resource Assessment
ESIA_Vol-2_Sect-3_Geotechnical Report, Feasibility Study.pdf	Geotechnical Study
ESIA_Vol-2_Sect-4_Mine Infrastructure Feasibility Study.pdf	
ESIA_Vol-2_Sect-5_Functional Design of River Diversion, Feasibility Study Report.pdf	
ESIA_Vol-2_Section 6_ESIA_Rehab Closure Plan_16.05.06.pdf	Rehabilitation and Mine Closure Plan
ESIA_Vol-2_Section 7_Legislation_27.09.05.pdf	
Section 8_Vol-2_Mine Water Balance Report.pdf	ESIA_Vol-2_Section 8
Section 9_Vol-2_Transport Report_Final.pdf	ESIA_Vol-2_Section 9 - Coal Transportation – Initial Environmental Examination
ESIA_Vol-2_Sect-10_Railway Report-Canarail.pdf	ESIA_Vol-2_Section 10 - Rail Transportation Feasibility Study
Vol-2_Sect-11_Marine Port Feasibility Report.pdf	ESIA_Vol-2_Section 11 - Ports Infrastructure
Vol-2_Sect-12_Shipping & Barging.pdf	ESIA_Vol-2_Section 12 - Marine Transportation Feasibility Study
Vol-2_Sect-13_Dredging Study_DEMAS.pdf	ESIA_Vol-2_Section 13 - Improvement of Pussur River and its Approach Channel Feasibility Study

3. Volume 3

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
ESIA Vol 3 Section 1_Air Quality_17.05.06.pdf	ESIA Vol 3 Section 1- Air Quality Impact Assessment
ESIA_Section 2_Vol-3_Noise and blasting_15.05.06.pdf	ESIA Vol 3 Section 2 - Noise and blasting impact assessment
Section 3_Vol-3_Biodiversity Report_Final.pdf	ESIA Vol 3 Section 3
ESIA_Vol-3_Section 4-Agricultural Report.pdf	ESIA Vol 3 Section 4
ESIA_Section 5_Vol-3_ESAP_15.05.06.pdf	ESIA Vol 3 Section 5- Environmental and Social Action Plan
Section 6_Vol-3_Soils Report_Final.pdf	ESIA Vol 3 Section 6
ESIA_Vol-3_Section 7_Hydrology Report_15.05.06.pdf	ESIA Vol 3 Section 7
ESIA_Sect-8_Vol-3_Groundwater Model_Final.pdf	ESIA Vol 3 Section 8 – Numerical Groundwater Model
Section 9_Vol-3_Water Quality Assessment_11-30-05.pdf	ESIA Vol 3 Section 9 – Water Quality/Chemistry
ESIA_Vol-3_Section 10 - Arsenic Report_Final.pdf	ESIA Vol 3 Section 10
Vol-3_Sect-11_Acid Mine Drainage feasibility report, 23.09.05.pdf	ESIA Vol 3 Section 11
ESIA_Section 12_Vol-3_Irrigation Report_Final.pdf	ESIA Vol 3 Section 12
Section 13_Vol-3_East Phulbari Water Supply_Final.pdf	ESIA Vol 3 Section 13
ESIA_Sec-14_Vol-3_River Recharge_Final.pdf	ESIA Vol 3 Section 14

4. Volume 4

Chapters as File Name		**Report Title** (if it is not properly reflected in the file name)
ESIA_Vol-4_Sec-01_PCDP Report.pdf		Public Consultation and Disclosure Plan
ESIA_Vol-4_Sec-02_Resettlement Report.pdf		Resettlement Plan
ESIA_Vol-4_Sec-03_Town Planning Report		Phulbari New Town and Village Infrastructure Study
	Town Report- Volume1-Main Report-October 2005 Final.pdf	
	Town Report- Volume2-Appendices-October 2005 Final.pdf	
	Town Report- Volume3-Drawings-October 2005 Final.pdf	
ESIA_Vol-4_Sec-04_IPDP Report.pdf		Indigenous People Development Plan
ESIA_Vol-4_Sec-05_Archaeology Report.pdf		
ESIA_Vol-4_Sec-06_Population Projection.pdf		
ESIA_Vol-4_Sec-07_Health Impact Assessment.pdf		
ESIA_Vol-4_Sec-08a_Economic Benefits Report.pdf		
ESIA_Vol-4_Sec-08b_Agricultural Report.pdf		Impact of Mining Activities on Agriculture

B. Coal Transportation Supporting Documents

1. Volume 1

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Abbreviations.pdf	
Executive Summary.pdf	
Master TOC_Coal Transportation.pdf	
Chapter 01_Introduction.pdf	
Chapter 02_Methodology.pdf	
Chapter 03_Legal & Policy Considerations.pdf	
Chapter 04 _Consultation.pdf	Consultation with Stakeholders
Chapter 05_Alternatives.pdf	Project Alternatives
Chapter 06_The Project.pdf	Project Description
Chapter 07_Rail Transportation - Existing Conditions.pdf	Rail Coal Transportation - Existing Conditions
Chapter 08_Rail Transportation.pdf	Rail Transportation – Impact Assessment & Mitigation measures
Chapter 09_Khulna Coal Terminal - Existing Conditions.pdf	Bhairab River Khulna Coal Terminal (Khulna)- Existing Conditions
Chapter 10_Bhairab River Khulna Coal Terminal.pdf	Bhairab River Khulna Coal Terminal (Khulna)- Impact Assessment & Mitigation measures
Chapter 11_River & Marine Trans_Existing Conditions.pdf	River & Marine Transportation - Existing Conditions
Chapter 12_River & Marine Trans.pdf	River & Marine Coal Transportation - Impact Assessment & Mitigation measures
Chapter 13_Risk Assessment.pdf	
Chapter 14_Management Plans.pdf	
Chapter 15_Project Benefits.pdf	
Chapter 16_Conclusion.pdf	
Chapter 17_References.pdf	

2. Volume 2: Coal Transport Infrastructure

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol-2_Sect-01_Marine Port Feasibility Studies_Sandwell.pdf	Marine Ports facilities Feasibility Study_Sandwell, October 2005
Vol-2_Sect-02_River Channel Improvements_DEMAS.pdf	Improvement of Pussur River & Its Approach Channel Feasibility Study_ Demas, November 2005)
Vol-2_Sect-03_Rail Transportation Feasibility Study_CANARAIL.pdf	Rail Transportation Feasibility Study_CANARAIL, October 2005
Vol-2_Sect-04_Marine Transport Feasibility Study_John Campbell.pdf	Marine Transportation Feasibility Study_Quay Marine Solution, November 2005
Vol-2_Sect-05_Railway Upgrade Packages.pdf	Rail Upgrade Packages_SMEC, February 2006
Vol-2_Sect-06_Khulna Rail Marshalling Yards.pdf	Conceptual Plans for Khulna Rail Marshaling Yards_SMEC, February 2006
Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol-2_Sect-07_Design for water supply, storm water and wastewater management in khulna port.pdf	Conceptual Design for Water Supply, Storm-water and Wastewater Management in Khulna Port_ACE, March, 2006

3. Volume 3: Environmental Technique Study

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol 3_Sect 1_Baseline Biodiversity Literature Review.pdf	Baseline Biodiversity Literature Review_IUCN
Vol-3_Sect 2_Biodiversity Baseline Assessment.pdf	Baseline Biodiversity Study NACOM_March, 2006
Vol 3_Sect 3 _ Biodiversity Impact Assessment.pdf	Assessment of Biodiversity Impact on Coal Transportation_IUCN, March 2006
Vol-3_Sect 4_Khulna Coal Terminal Contamination Assessment.pdf	Khulna Coal Terminal Contamination Assessment_SMEC, March 2006
Vol-3_Sect 5_Bhairab River Khulna Coal Terminal Noise and Air Quality Assessment.pdf	Assessment of Potential Air Quality and Noise Impacts at the Bhairab River Khulna Coal Terminal, Khulna, Bangladesh _Golder Associates, March 2006
Vol-3_Sect 6_Rail Transportation Noise and Air Quality Assessment.pdf	Assessment of Potential Air Quality and Noise Impacts from the Rail Transportation of Coal _Golder Associates, March 2006
Vol-3_Sect 7-Hydraulic Study.pdf	Hydraulic Study FOR THE Phulbari Coal Projects_IWM, JUNE 2006
Vol-3_Sect 8_Greenhouse Gas Report.pdf	Greenhouse Gas Emission Assessments_Energy Strategies, March 2006
Vol-3_Sect 9_Surface Water Quality Assessment.pdf	Water Quality Monitoring Methodology and Data_SMEC, March 2006
Vol-3_Sect 10_Groundwater Impact Assessment.pdf	Drawdown Extent of Khulna Water Supply Bore_Coffey, April 2006

4. Volume 4: Management Plans

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol-4_Sect-1_EMP_06.06.06.pdf	Environment Management Plan_SMEC, May 2006
Vol-4_Sec-2_Resettlement Report_10.06.06.pdf	Resettlement Plan_SMEC, April 2006
Vol-4_Sec-3_River Traffic Management Plan 23rd may 06.doc revised 3.pdf	River Traffic Management Plan_ Quay Marine Solution, March 2006
Vol-4_Sect-4_Rail transport energy use_12.04.06.pdf	Energy, Waste & Hazardous Materials Management During Rail Construction and Operations Use _SMEC, March 2006
Vol-4_Sec-5_EIA data for Dredging of approach channel to Pussur river.pdf	EIA data for Dredging of Approach Channel to Pussur River_Demas, March 2006

5. Volume 5: Alternatives Analysis

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol-5_Sect-1_Final Batiaghata Rail Alignment.pdf	Report on Preliminary Investigation of Rail Route From Khulna Bypass Offtake to a Site Approximately 8 KM South of Khulna_AEC, February 2006
Vol-5_Sect-2_Connecting Road from Khulna road bypass to Batiaghata port.pdf	Investigation of Connecting Road from Khulna Road Bypass to Batiaghata Port_ AEC, February 2006
Vol-5_Sec-3_Batiaghata and Noapara terminal sites noise and air quality assessment _2_.pdf	Assessment of potential air quality and noise impacts at the alternative Khulna Coal Terminal sites at Batiaghata and Noapara in Bangladesh_Golder Associates, April 2006
Vol-5_Sect-4_Alternatives Khulna Coal Terminal Contamination Assessment 03 06 06.pdf	Contamination Assessment -Alternative Khulna Coal Terminal Sites_SMEC, March 2006
Vol-5_Sec-5_Traffic and Safety Assessment Alternatives Analysis_RevC_.pdf	Traffic and Safety Assessment (Alternatives Analysis) Final Report_SMEC, May 2006
Vol-5_Sect-06_Part 1_RRCT_Batiaghata _alternative_ 31-05-06.pdf	Rupsa River Khulna Coal Terminal (Batiaghata)_SMEC, March 2006
Vol-5_Sect-06_Part 2_BRCT_Noapara _alternative__31-05-06.pdf	Bhairab River Khulna Coal Terminal (Noapara)_SMEC, March 2006
Vol-5_Sect-6_Part 3_Social Demographic Survey Questionnaire_31-05-06.pdf	Questionnaire for Demographic and Socio-Economic Survey_SMEC, March 2006

6. Volume 6: Legal, Risk, and Social

Chapters as File Name	**Report Title** (if it is not properly reflected in the file name)
Vol 6_Sec 1 - Transportation and Handling of Coal for Marketing.pdf	Transportation and Handling of Coal for Marketing LEGAL REQUIREMENTS_IUCN, April 2006
Vol-6_Sec-2_Risk Assessment.pdf	Environmental Risk Assessment_DNV, April 2006
Vol-6_Sect-03_Land use maps_01.06.06.pdf	Land Use Maps_ SMEC, April 2006
Vol-6_Sec-4_Traffic Report Level Crossing Impact Assessment_Rev6_.pdf	Impact of Coal Transportation on Level Crossing_SMEC, May 2006

All abbreviations are explained in the Glossary unless explained in the text.
Source(s): All EIAs for the Project.

Table A1.3: Summarized Environmental Monitoring Programs

A. Phulbari Coal Mine

1. Water Management Plan

Parameter	Location	Frequency of Monitoring			
		Ambient			Discharge to Surface Water
		Surface Water	Sediments	Groundwater	
pH	All locations	Weekly	pH	All locations	Weekly
Turbidity	All locations	Weekly	Turbidity	All locations	Weekly
Temperature	All locations	Weekly	Temperature	All locations	Weekly
Dissolved Oxygen	All locations	Weekly	Dissolved oxygen	All locations	Weekly
Electrical Conductivity	All locations	Weekly	Electrical conductivity	All locations	Weekly
Total Dissolved Solids	All locations	Weekly	Total dissolved solids	All locations	Weekly
Total Suspended Solids	All locations	Weekly	Total suspended solids	All locations	Weekly
ORP	All locations	Weekly	ORP	All locations	Weekly
Total Coliforms and E. coli	All locations	Quarterly	Total coliforms and E. coli	All locations	Quarterly
Metals^	Ambient locations, coal processing and overburden dump, runoff discharge points	Quarterly	Metals	Ambient locations Coal processing and overburden dump runoff discharge points	Quarterly
Alkalinity / Hardness^	All locations	Quarterly	Alkalinity / hardness	All locations	Quarterly
Total Nitrogen, Nitrate, Nitrite, Ammonia	Ambient locations	Quarterly	Total nitrogen, nitrate, nitrite, ammonia	Ambient locations	Quarterly
	Runoff discharge points where fertilizers used STP effluent discharge points	N/A	N/A	Runoff discharge points where fertilizers used STP effluent discharge points	N/A
Total Phosphorus, Phosphate	Ambient locations	Quarterly	Total phosphorus,	Ambient locations	Quarterly

Parameter	Location	Frequency of Monitoring			
		Ambient			Discharge to Surface Water
		Surface Water	Sediments	Groundwater	
			phosphate		
Total Phosphorus, Phosphate	Runoff discharge points where fertilizers used	N/A	Bi-annually (TP only)	Runoff discharge points where fertilizers used	N/A
	STP effluent discharge points	N/A	N/A	STP effluent discharge points	N/A
Total Organic Carbon	All locations	Quarterly	Total organic carbon	All locations	Quarterly
Cation / Anion Balance^	All locations	Quarterly	Cation / Anion Balance^	All locations	Quarterly
Sulfate and sulfide	All locations	N/A	Sulfate and sulfide	All locations	N/A
Sodium Absorption Ratio	In discharge waters to be used for irrigation	Quarterly	Sodium absorption ratio	In discharge waters to be used for irrigation	Quarterly
Pesticides/Herbicides	Ambient locations	Quarterly	Pesticides/herbici des	Ambient locations	Quarterly
Pesticides/Herbicides	Runoff discharge points where pesticides/ herbicides used	N/A	Annually	Runoff discharge points where pesticides/ herbicides used	N/A
Organic Compounds	All locations	Quarterly	Organic compounds	All locations	Quarterly
Fish catch assessment surveys: species inventory and abundance, catch/unit effort for different gear types	All locations	Bi-annually, twice per event	Fish catch assessment surveys: species inventory and abundance, catch/unit effort for different gear types	All locations	Bi-annually, twice per event
Zooplankton and benthic sample collection: species inventory, species and group abundance	All locations	Bi-annually, twice per event, opportunistic	Zooplankton and benthic sample collection: species inventory, species and	All locations	Bi-annually, twice per event, opportunistic

Parameter	Location	Frequency of Monitoring			
		Ambient			Discharge to Surface Water
		Surface Water	Sediments	Groundwater	
			group abundance		
Mollusc sample collection, catch assessment surveys: species inventory and abundance	All locations	Bi-annually, twice per event, opportunistic	Mollusc sample collection, catch assessment surveys: species inventory and abundance	All locations	Bi-annually, twice per event, opportunistic
Grain size	All locations	N/A	Grain size	All locations	N/A
River Height	Automatic gauges	Continuously	River height	Automatic gauges	Continuously
River Height River Flow	Staff gauges	Weekly and continuously respectively via telemetric system linked to stream gauges	River flow	Staff gauges	Weekly and continuously respectively via telemetric system linked to stream gauges
Groundwater level	All locations	N/A	Groundwater level	All locations	N/A
Hydraulic integrity	Diversion drains Sediment basins / treatment facilities	Weekly and after each major storm event (rainfall exceeding 100mm in a 24-hour period)	Hydraulic integrity	Diversion drains, sediment basins / treatment facilities	Weekly and after each major storm event (rainfall exceeding 100mm in a 24-hour period)
Hydraulic integrity Sediment level	Diversion drains Sediment basins/treatment facilities. Water storages Diversion drains Sediment basins / treatment facilities	Weekly and after each major storm event (rainfall exceeding 100mm in a 24 hour period) Weekly and when telemetric systems indicate hydraulic integrity may be breached. Weekly and after each major storm event (rainfall exceeding 100 mm in a 24 hour period)			

ORP: Oxidation Reduction Potential
N/A: Not applicable

2. Soil Management Plan

2. A monitoring program will be implemented to evaluate the extent of impacts and effectiveness of mitigation measures. Indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing impacts of mining and associated activities, and the effectiveness of mitigation measures. Specific programs are presented for:

(i) the 'real time' telemetric monitoring system,
(ii) sediment control,
(iii) chemical storage and handling areas, and
(iv) stockpiled and rehabilitated soils.

3. Air Quality Management Plan

Parameter	Location	Frequency of Monitoring	Length of Monitoring
Total Suspended Particulates PM 10 PM 2.5 Dust deposition	Tapered element oscillating microbalance (TEOM) automatic samplers linked to the telemetric system will be installed in eastern Phulbari township and at the southern weather station. Manually operated monitoring will occur initially at the locations used for the baseline air quality assessment. However, these locations will be reviewed at regular intervals to ensure that the most effective program is in place.	At least one sample per week in at least two locations. Continuous monitoring via the telemetric system. At least two samples per week in at least two locations until the real time monitoring system is in place. The real time monitoring system will include continuous monitoring of PM10. At least one sample per week in at least two locations. One sample per month in at least four locations.	Duration of the Project.
Meteorology	Project weather stations.	Continuously via the telemetric system.	
Occupational exposures	Work areas throughout the site.	Dependent upon assessed level of risk.	An annual review shall be undertaken throughout the duration of the Project.
Moisture Content	Haul roads and soil stockpiles.	Haul roads will be monitored visually on a continuous basis by equipment operators and management. Moisture content in the coal stockpiles will be monitored continuously through sensors linked to the telemetric monitoring system.	Duration of the Project.

4. Noise & Blasting Management Plan

Parameter	Location	Frequency of Monitoring	Length of Monitoring
LA10 LA90 LAeq Lmin Lmax	Noise loggers linked to the telemetric system will be installed in residential areas closest to the prevailing mining operations. Manually operated monitoring will occur initially at the locations used for the baseline ambient noise assessment. However, these locations will be reviewed at regular intervals to ensure the most effective program is in place.	Unattended noise logging to be carried out continuously via the telemetric system. Attended noise monitoring to be carried out during at least one day time and one night time period each week.	Duration of the Project.
	Blast monitoring in at least two locations. The locations will be selected to represent potential worst case impacts depending upon the location of blasting.	Every blast.	Duration of the Project.
	Project weather stations.	Continuously via the telemetric system.	Duration of the Project.
	Work areas throughout the site.	Dependent upon assessed level of risk.	An annual review shall be undertaken throughout the duration of the Project.

5. Biodiversity Management Plan

3. Monitoring is a necessary component of the BMP; it is required in order to evaluate accurately the actual impacts of mining activities and the effectiveness of mitigation measures, particularly where uncertainty exists as to the likely nature and extent of impacts, both of mine development and of mitigation. Implementation of a monitoring program will facilitate the identification of management deficiencies at an early stage, so appropriate adjustments can be implemented.

4. The monitoring program will be undertaken by an appropriately qualified and experienced NGO under the supervision of the field coordinator. Monitoring will be undertaken according to a yearly schedule; with sampling during the wet season and the dry seasons. It will be largely based on the use of indicator species, groups and/or sites. Indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing impacts of mining and associated activities, and the effectiveness of mitigation measures.

5. The indicators that will be used for monitoring of ecosystem quality and biodiversity within the study area and surrounds are described in the detailed environmental monitoring plan (EMP).

6. Waste Management Plan

6. A monitoring program will be implemented to evaluate the extent of impacts and effectiveness of mitigation measures. Indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing the impacts of waste generation and the effectiveness of waste management strategies and mitigation measures.

7. The Health, Safety and Environment (HSE) manager will maintain a waste management register for monitoring and recording details of wastes produced and volume and location of disposal. The register will include the following details:

(i) type of waste;
(ii) weight of waste (in tonnes);
(iii) location of where waste was reused, recycled, stockpiled or disposed;
(iv) date waste reused, recycled, stockpiled or disposed; and
(v) if wastes are recycled or disposed of off-site, to whom and where it was sold or transported to (this information will be used to identify areas where wastes produced and/or sent to landfill can be reduced).

8. Field monitoring staff and/or the contractor will inspect waste treatment, disposal and storage areas on a daily basis for signs of uncontrolled leachate leakages. Monitoring of diversion drains and sediment fencing will be as per the water and soil management plans. Monitoring of effluent from treatment plants, and ambient surface and groundwater quality will be as per the Project's water management plan.

7. Hazardous Waste Management Plan

9. A monitoring program will be implemented to ensure and evaluate the effectiveness of this Plan. Indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing the effectiveness of management measures and strategies.

Parameter	Monitoring Frequency
Integrity of pipes, taps and seals	Weekly
Plant and equipment checks for presence of oil and fuel leaks	Weekly
Recording quantities and location of material transported, used and stored on-site	Weekly
Integrity of storage containers	Weekly
Integrity of Project landfill	Daily
Integrity of bunds and sumps	Monthly and after a spill has occurred
Audit of spill kits	Monthly and after a spill has occurred
Correct use of protective clothing and equipment	Continuous
Emergency response preparedness	Annually
Handling of materials in accordance with Material Safety Data	Continuous
Sheets (MSDS) recommendations	Daily
Security for hazardous materials	As per the Project’s water management plan
Creation and discharge of aqueous hazardous materials	As per the occupational, health and safety plan and the air quality
Workplace health and safety, including exposure to workplace air contaminants.	management plan

8. Community Health and Safety Plan

10. The monitoring program will determine the effectiveness of the mitigation measures. The community health and safety monitoring program will be in addition to monitoring activities that have been identified in other subplans in the EMP. The following indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing the success of community health and safety management in the area by Asia Energy.

Parameter	Monitoring Frequency
Number of reported traffic pedestrian accidents	Daily
Number of reported heavy vehicle accidents	Daily
Other injuries to or fatalities of local community members	Daily
Community complaints regarding health and safety issues	Daily
Monitoring implementation of planned measures	Monthly

11. Asia Energy will also engage a health-based NGO or participating organization over a period of 3 years to:

(i) provide limited health care;
(ii) liaise with local health care service providers;
(iii) undertake specific health monitoring activities;
(iv) ensure the sustainability of health services and infrastructure within resettled and host areas; and

(v) undertake health awareness rising via community education programs on subjects such as nutrition, sanitation and clean drinking water.

12. Training programs will be initiated by this NGO to assist local health workers play a role in health-related data into the future to assist in the sustainability of this monitoring program into the future. Local health providers will also be strengthened through the provision of training and support in the delivery of health programs. Health data collected via the household surveys undertaken will be used as baseline of the existing health situation in the community. It is intended that monitoring will commence prior to the commencement of mining and associated activities, so that a more robust set of baseline data is established for comparison with data collected during and post mining.

Parameter	**Monitoring Frequency**
Incidence and prevalence of sexually transmitted infections (STIs) in the community: total number of STIs	Monthly
treated	Monthly
Incidence of HIV/AIDS in the community: number of positive HIV tests	Monthly
Number of cases vector-borne disease	Monthly
Number of vaccine preventable diseases, infant mortality rate/1000 live births	Monthly
Under 5 mortality rate/1000 live births	Monthly
Food basket monitoring to record any increase in the cost of food and changes in nutrition levels	Monthly
Community weight and growth monitoring, specifically weight and growth monitoring for children below two	
years of age	Monthly
Cases of malnutrition	Monthly
Monitoring of disease patterns/notifications in the community	Monthly
Assistance at delivery by trained health workers	Monthly
Number of reported cases of domestic violence	Monthly
Number of suicide attempts	

9. Occupational Health and Safety (OHS) Program

13. An audit system will be developed to help ensure that the OHS management systems, technical standards and physical conditions in the work areas comply with established standards and legislative requirements. Safety statistics will be compiled to facilitate trend analysis and evaluate the progress and success of the OHS system against established targets. The table below outlines the monitoring schedule to be conducted on various OHS aspects. External audits by accredited auditors will also be conducted to provide an independent assessment of the system. The overall performance of the OHS system will be monitored throughout the life on mine.

14. Project goal's for the mine site are:

(i) nil fatalities;
(ii) nil lost time injuries;
(iii) achieve and maintain a certified OHS management system from an accredited auditor;

(iv) each department will have an OHS inspection and audit program in place which will continuously improve safe work procedures, workplace health hand safety and emergency response procedures;
(v) any areas of concern identified by the departmental audits or inspections will be managed by an OHS prioritized action plan; and
(vi) all accidents and incidents, regardless of whether there is a personal injury, property or equipment damage or near miss shall be investigated to determine causes and corrective action required to prevent a recurrence.

15. Safety statistics will be compiled on all incidents that occur on the site. They will be compiled on a weekly basis and compared against key performance indicators (KPI) established for the site and respective departments. KPIs relating to injury/incidents will include the number of:

(i) days free from incident and injury;
(ii) near misses reported;
(iii) lost time injuries (LTI) and lost time injury frequency rate (LTIFR);
(iv) injuries reported; and
(v) medical treatment injuries (MTIs) duration rate.

16. Positive performance indicators may also be measured. Examples for possible inclusion include:

(i) compliance with audit requirements;
(ii) compliance with safe act observations (SAOs) ;
(iii) number of inspections completed compared to those scheduled;
(iv) number of audits completed compared to those scheduled; and
(v) number of toolbox and safety meetings conducted compared to those scheduled.

17. The HSE Manager will conduct a monthly analysis of accidents and incident data to develop reports for each department showing the following:

(i) number of injuries;
(ii) number of LTIs;
(iii) number of medical treatment injuries(MTIs) duration rates; and
(iv) any trends in accidents or injuries.

18. The manager HSE will also conduct quantitative safety performance analysis and calculations undertaken on a monthly basis to develop the following reports:

(i) project safety statistics including a report on any significant incidents, safety statistics against targets, any workers' compensation costs and expenditure against budget; and

(ii) any required reports to the Government.

Aspect	Parameter	Frequency of Monitoring
Noise	Onsite (including point source areas) and surrounding areas.	Refer to noise and blasting management plan.
Air pollution	Dust monitoring for particulate concentrations and composition (including ambient, point source and vehicle emissions).	Refer to air quality management plan.
Hazardous material handling and storage	Conduct hazardous material audits (labeling, material safety data sheets register, dangerous goods listing, hazardous substances register and bunding, placarding, storage requirements, procedures for disposal and fire exhausting equipment).	Annual audits.
Fire and emergency	Practice emergency procedures, fire drills, fire detectors, alarm systems and fire-fighting equipment.	Every 3 months.
STI and HIV AIDS	Voluntary STI and HIV testing.	Pre-employment and periodic medical examinations as well as behavior monitoring.
Health surveillance	Monitoring of individuals for the purpose of identifying changes in health status that may be due to occupational exposure to a hazard.	Pre-employment and periodic medical examinations.
Fit for work program	Drug and alcohol random testing.	Randomly test 1% of total workforce daily.
Building and structural facilities	Building safety audits (structurally safe, provide adequate protection, lighting, signage and noise conditions, flooring is non-skid and even, etc).	Annually.
Confined spaces	Confined space audit (permanent safety measures for ventilation, monitoring and rescue operation).	As required – prior to access.
Equipment and tools	Maintenance audits.	Annually.
Accidents	Occupational accident and dangerous occurrence/incident monitoring (not including reporting).	Fortnightly.
Fatigue	Monitoring employees' breaks, hours per day worked and days of continual work to ensure that adequate rest occurs to	Monthly.

Aspect	Parameter	Frequency of Monitoring
	prevent fatigue.	
Ergonomics	Workplace assessments to ensure that their posture is correct.	Each workplace to be audited at least monthly.
Traffic management	Number of employees accredited, monitoring of roadworks, road control devices, speed compliance.	Monthly.
Management of sub-contractors	Auditing compliance of sub-contractors OHS performance, assessing details of processing and procedures that ensure that subcontractors work in a safe manner.	Monthly.

10. Rehabilitation and Closure Plan

19. A monitoring program will be implemented to evaluate the progress and success of rehabilitation activities. Indicators have been selected to provide an efficient measurable, verifiable and easily comprehensible means of assessing impacts of mining and associated activities, and the effectiveness of rehabilitation strategies. Monitoring of rehabilitated landforms will be undertaken throughout the life of mine (LOM) and for 5 years after mine closure, or as agreed with the Government. A checklist of monitoring parameters will be developed for each rehabilitated area and will include the items outlined in the detailed EMP. Water quality monitoring is described in the Project's Water Management Plan.

20. To enable timely interventions in potential emergency situations, critical water management systems will be continuously monitored via a 'real time' telemetric monitoring system (with electronic reporting back to an onsite control room. Critical management systems for rehabilitation purposes which will be linked to the telemetric system include: ambient river water flows, rainfall, and key water quality parameters such as pH and turbidity. Emergency trigger values will be programmed into the telemetric system. Should any of these systems reach a predetermined "critical" level, an automatic alarm will sound to alert the on duty Control Room officer to a potential emergency situation.

Aspect	Parameter	Frequency of Monitoring
Soil health (rehabilitated areas only).	Soil fertility (nutrient content).	Annually for 3 years after rehabilitation or 1 year after mine closure.
	Soil pH.	Annually for 3 years after rehabilitation or 1 year after mine closure.
	Salinity.	Annually for 3 years after rehabilitation or 1 year after mine closure.
Acid mine drainage / spontaneous combustion.	Oxygen ingress induction rate.	Ongoing until 1 year after mine closure.
	Temperature profile.	Ongoing until 1 year after mine closure.
	Water flux through the overburden dumps (determined using lysimeters and/or piezometers.	Ongoing until 1 year after mine closure.
Revegetation.	Integrity of fencing surrounding rehabilitated areas.	Weekly.
	Species diversity.	Annually as part of biodiversity monitoring for 3 years after rehabilitation or until rehabilitated area has stabilized.
	Plant cover and density.	Annually as part of biodiversity monitoring for 3 years after rehabilitation or until rehabilitated area has stabilized.
Post mine landforms.	Subsidence.	Quarterly for approximately 5 years following infill of rehabilitated areas during mining, and for 1 year after mine closure.
Post mine uses.	Agricultural productivity.	Annually.
Soil erosion.	Rate of erosion.	Annually.
	Photographs.	Annually.
Water quality.	As per surface and groundwater monitoring programs.	As per surface and groundwater monitoring programs.
Geotechnical stability.	Subsidence.	Weekly and following significant storm events.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Environment Management Plan. Section 5, Volume 3

B. Coal Transportation

1. Coal Terminal in Khulna

Parameter	Parameter	Frequency	Location
Meteorological data	Wind speed and direction; precipitation; and temperature	Continuous	Noise logging location 1.
Suspended particulates	PM10; PM2.5	1 sample every 3 days until trends are established (minimum of 1 year). Thereafter 1 sample every 6 days.	Noise logging location 1 and 2.
Dust Deposition	Dust deposition	Continuous (monthly average)	Noise logging location 1 and 2.
Noise – Unattended logging	Leq, L10, L90, Lmax	Continuous	Noise logging location 1 and 2.
Noise – Attended monitoring at defined points	Leq, L10, L90, Lmax	Spot check (Weekly (day and night) spot checks for first quarter of operations). Thereafter, spot checks monthly or in response to complaint investigation.	Receptor 1, 2, 5, 6, 7. 2 noise logging sites. Receptor 5 and 7. 2 noise logging sites.
Water – background	pH, EC, TSS, BOD, DO Total colifoms, nutrients (including total phosphate total nitrogen, nitrate, and ammonia), metals (including aluminum) and total petroleum hydrocarbons.	Monthly	Upstream monitoring point 1. Downstream monitoring point 1.
Water – site wastewater release	Megaliters pH, EC, TSS, temperature, total petroleum hydrocarbons.	Monthly Daily during discharge	Outlet of discharge point. Outlet of discharge point.
Water – consumption	Megaliters.	Monthly	(i) Outlet of deep tube well 1. (ii) Outlet of central water storage tank supplying site water. (iii) Outlet of deep tube well 2 supplying central water storage. (iv) Outlet of deep tube well 2 supplying accommodation water. (v) Outlet of recycle water line supplying site water. Outlet of discharge point.
Sewage	pH, nitrate, phosphate, temperature, TSS, BOD, DO, total colifoms,	Weekly following installation for a 3 month period.	Sewage treatment plant.

Parameter	Parameter	Frequency	Location
		If reliably producing effluent of an acceptable standard monitoring will be undertaken on a quarterly basis	
Site Inspections	Disturbance areas, erosion control and soil handling practices, evidence of contamination, waste disposal and segregation practices, weed infestation, and vehicular movements.	Daily	Various.

BOD = Biochemical (biological) oxygen demand is a test used to measure the concentration of biodegradable organic matter present in a sample of water, DO = dissolved oxygen, EC = electro-conductivity, pH = A measure of the activity of hydrogen ions (H+) in a solution, TSS = Total suspended solids is a water quality measurement.
All abbreviations are explained in the glossary unless explained above.

2. River and Marine Coal Transportation

Parameter	Frequency	Location
PM10/ PM2.5	In the event of a complaint.	Determined by complaint location.
Dust Deposition	In the event of a complaint.	Determined by complaint location.
Noise	Monthly attended monitoring along the river bank to 3 kilometers downstream of the coal terminal for the first 12 months of operation. If monitoring indicates the Government noise limits are satisfied, monitoring will be undertaken only in the event of a complaint.	At 500m intervals to 3 km south of the Coal Terminal. One sensitive receptor location within 120m of the navigation channel. Otherwise determined by complaint location.
Waste – volume generated for each waste stream	Documented weekly.	Waste segregation area on barge or Floating Transfer Vessel.
Water	Monthly in the first 12 months of operations and quarterly thereafter.	
Floating Transfer Vessel Bilge Water : pH, EC and TSS	Weekly, or following a rainfall event that fills the tanks to 50% of capacity.	FTV bilge water holding tank.
Land – barge wake induced bank erosion	Quarterly	
Fuel Consumption	Monthly	Each vessel.
Biodiversity	Bi-annually; once each in the dry and monsoon seasons.	

3. Dredging: Environmental Management Plan

Parameter	Parameter	Frequency	Location
Energy consumption	Kilolitres of diesel/fossil fuels used for the operation of plant equipment.	Monthly monitoring of energy consumption via fuel/electricity records. Annual energy audit.	Electricity consumption records.
Greenhouse gas emissions	Kilolitres of diesel/fossil fuels used for the operation of plant equipment.	Monthly.	Fuel consumption records.
Suspended particulates	PM10; PM2.5	In response to a complaint.	Dependent on complaint.
Dust Deposition	Dust deposition	In response to a complaint.	Dependent on complaint.
Noise – Unattended logging	Leq, L10, L90, Lmax	In response to a complaint.	Dependent on complaint.
Noise – Attended monitoring at defined points	Leq, L10, L90, Lmax	In response to a complaint.	Dependent on complaint.
Water – consumption	Megaliters.	Monthly	Dependent on complaint.
Sewage	pH, Nitrate, Phosphate, Temperature, TSS, BOD, DO, Total Coliforms.	Weekly following installation for a 3-month period. If reliably producing effluent of an acceptable standard monitoring will be undertaken on a quarterly basis	Sewage Treatment Unit.
Water Quality	Dissolved oxygen Suspended sediment and turbidity	Weekly while dredgers are operating.	At selected locations within 250 meters of dredging operations.
Sediments	Presence and concentration of metals Grain size analysis	Prior to commencement of dredging activities to confirm suitability for off-shore disposal.	Along dredging line.

BOD = Biochemical (biological) oxygen demand is a test used to measure the concentration of biodegradable organic matter present in a sample of water, DO = dissolved oxygen, pH = A measure of the activity of hydrogen ions (H+) in a solution, TSS = total suspended solids is a water quality measurement.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Environment Management Plan. Section 1, Volume 4.

Table A1.4: Implementation of Mitigation Measures and Monitoring Responsibilities and Authorities

Monitoring	Method	Parameter	Frequency	Responsibility
Air Quality				
Emergency preparedness and personnel competence	Drills and competency-based assessment	N/A	Biannual	Health and safety officer
Air quality (dust deposition, PM10, and PM2.5)	Volumetric sampler gravimetric sampler	Dust deposition, PM10, PM2.5	On the receipt of a complaint Every 6 days	Environment officer field assistants
Noise				
Noise emission monitoring at locations	Attended noise monitoring using a handheld sound level meter or logger	Leq, L10, L90, and Lmax	Spot check (weekly [day and night] spot checks for first quarter of operations). Thereafter, spot checks monthly or in response to complaint investigation	Field assistants as directed by the environment officer
Noise emission monitoring at locations	Noise logger	Leq, L10, L90, and Lmax	Ongoing	Field assistants as directed by the environment officer
Land Resources				
Disturbance areas	Visual inspection	Cleared area	Weekly	Site supervisor
Erosion controls and soil handling practices	Site inspection	Erosion controls, evidence of scouring soil stockpile integrity and condition	Weekly or following a rainfall event	Site supervisor
Site audit—sediment and erosion controls	Audit	Compliance with the sediment and erosion control plan	Biannual (or prior to the completion of works)	Environment officer
Contamination				
Incident of contamination	Site inspection	Dependent on type of contamination	Daily	Site supervisor
Spill kit contents, condition, and location.	Inspection	Spill kit contents	Monthly	Environment officer
Site audit	Audit	Hydrocarbon and hazardous material management audit	Annual (or prior to completion of works)	Environment officer
Waste Management				
Waste disposal and segregation practices	Site inspection	Waste management	Daily	Site supervisor
Waste audit	Audit	Segregation and disposal practices	Biannual (or prior to the completion of works)	Environment officer
Toolbox talks	Work discussion	Waste management	Toolbox talk undertaken pre-start of shift (topic of discussion is rotated)	Site supervisor (information supply and input from the environment officer)

Monitoring	Method	Parameter	Frequency	Responsibility
Water Management				
Water consumption	Water meter	Megaliters	Monthly	Environment officer
Sewage effluent quality	Water sampling	pH, nitrate, phosphate, temperature, TSS, BOD, DO, total colifoms	Weekly following installation for a 3-month period. If reliably producing effluent of an acceptable standard, monitoring will be undertaken on a quarterly basis	Field assistant
Wastewater discharge	Water sampling	Megaliters pH, EC, TSS, temperature, total petroleum hydrocarbons.	Monthly (during no discharge) Daily (during discharge)	Field assistant Field assistant
Background water	Water sampling	pH, EC, TSS, BOD, DO, total colifoms, nutrients (including total phosphate total nitrogen, nitrate, and ammonia), metals (including aluminium), and total petroleum hydrocarbons	Monthly	Field assistant
Toolbox talks	Work discussion	Water management	Toolbox talk undertaken pre-start of shift (topic of discussion is rotated)	Site supervisor (information supply and input from environment officer)
Biodiversity				
Disturbance areas	Visual inspection	Cleared area	Weekly	Shift foreman
Weed infestation	Visual inspection and weed mapping	Various weed species	Pre-start of works and monthly thereafter	Site supervisor (with input from the environment officer)
Vehicular movements	Site and work observations	Routes traveled	Ongoing	Shift foreman
Hazardous Material				
Site inspection of storage and distribution facilities	Visual inspection	Equipment integrity	Daily	Shift foreman
Emergency preparedness and personnel competence	Drills and competency-based assessment	Competency	Biannual	Operations manager and HSE manager
Contamination investigation following any release of hazardous materials to the surrounding environment	Contamination investigation (methodology dependent on material released)	Dependent on suspected source of contamination	As-needed basis	Environment officer

BOD = Biochemical (biological) oxygen demand is a test used to measure the concentration of biodegradable organic matter present in a sample of water, DO = dissolved oxygen, EC = electro-conductivity, pH = A measure of the activity of hydrogen ions (H+) in a solution, TSS = total suspended solids is a water quality measurement.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Environment Management Plan. Section 1, Volume 4

Table A1.5: Tasks and Responsibilities (Environment Team)

21. Environmental personnel with responsibilities for the Coal Terminal in Khulna will liaise directly with the established environmental department of the Phulbari Coal Mine.

22. Personnel with specific environmental management responsibilities relating to the Coal Terminal operations are detailed below.

A. Managing Director

23. The managing director holds ultimate responsibility for environmental management of the Phulbari Coal Mine Project, including the Coal Terminal operations. Specifically, this responsibility encompasses:

(i) ensuring that sufficient resources and equipment are allocated for environmental purposes;
(ii) incorporating environmental management aspects in project planning;
(iii) ensuring that project operations are performed in accordance with environmental requirements; and
(iv) reviewing the effectiveness of the system for continual improvement.

B. Health, Safety, and Environment (HSE) Manager

24. The HSE manager, while based at the Phulbari Coal Mine, will have responsibility for ensuring the effective implementation of health, safety, and environmental management systems at the Coal Terminal in Khulna. This responsibly extends to the development and auditing of environmental management systems, and supervising and mentoring environment officers. Specifically, the responsibilities for the HSE manager include:

(i) ensuring that training is provided to improve awareness of environmental issues;
(ii) heading a Phulbari Coal Mine Project environment committee, which will meet on a quarterly basis to discuss environmental management issues at the Phulbari Coal Mine, and in the rail transport corridor, Coal Terminal in Khulna, barging operations, and ship-loading activities;
(iii) liaising with heads of environmental management in other government agencies and NGOs;
(iv) developing and updating the environment management plans;
(v) auditing the environment systems;
(vi) investigating recurrent examples of nonconformance; and
(vii) consulting with the division head on environmental matters.

C. Coal Terminal in Khulna /Operations Manager

25. The Coal Terminal/operations manager will be responsible for ensuring the effective implementation of environmental controls at the Coal Terminal. Specifically, this responsibility includes:

(i) liaising with the HSE manager with regard to environmental management activities;
(ii) ensuring that operations staff are sufficiently resourced to undertake their allocated environmental management responsibilities;

(iii) ensuring that environmental management is incorporated into the day-to-day operations of the Coal Terminal; and
(iv) overseeing the implementation of corrective actions, as advised by the environment officer.

D. Environment Officer

26. An environment officer will be located at the Coal Terminal in Khulna and will be responsible for the day-to-day implementation of environmental controls, monitoring regimes, and community liaison programs for the terminal and barging operations. Specifically, responsibilities include:

(i) monitoring and reporting on the environmental management performance, including environmental performance criteria;
(ii) supervising field assistants responsible for day-to-day environmental monitoring activities;
(iii) assisting site supervisors with environmental aspects of site inspections;
(iv) liaising with employees on environmental matters;
(v) auditing the environmental performance of barging operations against contract obligations as they relate to environmental management;
(vi) liaising with the manufacturers of monitoring instrumentation and developing an equipment maintenance system;
(vii) contracting suitably qualified parties to maintain and repair monitoring equipment on an as-needs basis;
(viii) ensuring that all nonconformance and environmental incidents are reported and that corrective actions are taken;
(ix) reviewing inspection reports and ensuring that any required actions are initiated;
(x) attending meetings to discuss environmental issues; and
(xi) liaising with environmental representatives from customer and community groups.

E. Site Supervisor/Foremen

27. Site supervisor/foremen are responsible for directing and coordinating the labor force, including subcontractors, in the daily execution of the work in a safe and workmanlike manner that meets the Project's environmental obligations. Specifically, responsibilities include:

(i) undertaking daily site inspections;
(ii) ensuring that environmental controls are established and maintained as per the subplan;
(iii) ensuring that environmental protection requirements are communicated to all personnel and subcontractors under his or her control;
(iv) monitoring the effectiveness of control measures and reporting environmental nonconformance to the environment officer; and
(v) rectifying work to comply with environmental requirements.

F. Field Assistants

28. Field assistants will be responsible for undertaking environmental monitoring activities, field investigations, and data entry. Responsibilities include:

(i) organizing access to monitoring locations;
(ii) organizing the logistics of sample transport and laboratory testing in consultation with the environment officer;
(iii) inspecting field monitoring equipment and reporting any faults to the environment officer;
(iv) entering monitoring results into an environmental data management system; and
(v) providing support to the environment officer on an as-needed basis

29. Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Environment Management Plan. Section 1, Volume 4

Table A1.6: Cost Estimates for the Implementation of the EMPs

A. Phulbari Coal Mine

30. The table includes costs that may be included elsewhere in project planning and design documentation (e.g., infrastructural mitigation measures).

Item	Capital Cost (USD)[a]	Recurrent Costs (USD/pa)
Management Sub-Plans		
Water Management Plan	78,859,100	4,184,500
Soil Management Plan	n/a [b]	n/a [b]
Air Quality Management Plan	401,000	45,000
Greenhouse Gas and Energy Management Plan	210,000	6,500
Noise and Blasting Management Plan	5,045,000	44,000
Biodiversity Management Plan	190,000	57,000
Mine Rehabilitation and Closure Plan	2,239,000	1,073,000
Waste Management Plan	370,000	280,000
Hazardous Materials Management Plan	280,000	60,000
Community Health and Safety Plan	28,500	65,800
Occupational Health and Safety Plan	900,000	220,000
Project Environment Department Costs		
Workforce	n/a	715,000
Monitoring/Water Bore Land Security	n/a	150,000
Department Vehicles	80,000	4,000
Fuel Costs	n/a	5,000
Auditing		
Internal	n/a	20,000
External	n/a	50,000
Community Support		
Community Sponsorship	n/a	200,000
Subtotal	88,602,600	7,179,800
Enhancement Programs under Consideration		
Water Management Plan	100,000	n/a
Greenhouse Gas and Energy Management Plan	235,000	n/a
Biodiversity Management Plan	40,000	10,000
Mine Rehabilitation and Closure Plan	200,000	8,000
Subtotal	575,000	18,000
Total	**89,177,600**	**7,197,800**

n/a: Not applicable.
[a] Includes cost of monitoring equipment already purchased by Asia Energy.
[b] All costs included in the water management and mine rehabilitation and closure plans.
Source: All EMPs for the Project. Please refer to Table A1.2.

B. Coal Transportation

Item	Capital Cost (USD)	Recurrent Costs (USD/pa)
Sub-plan A : Coal Terminal in Khulna	2,531,000	200,000
Sub-plan B : River and Marine Coal Transportation	1,870,000	277,000
Sub-plan C : Dredging Operations	1,230,000	90,000
Total	**5,631,000**	**567,000**

Note: The table does not include the costs for mitigation and monitoring costs for the railway upgrade since that is a part of the public Sector loan arrangements.
Source: All EMPs for the Project. Please refer to Table A1.2.

Table A1.7: Current and Proposed Ambient Air Quality Guidelines for Selected Pollutants

Item	**Current Ambient Air Quality Standards for Bangladesh**					**Proposed Ambient Air Quality Objectives (AQMP, 2003) (c)**	**World Bank Guidelines for Mining and Milling—Open Pit(d) (World Bank, 1995)**
Pollutant	**Averaging time (a)**	**Industrial and mixed**	**(Government, 1997) Commercial and mixed**	**Residential and Rural**	**Sensitive (b)**		
NO_2	Annual	n/a	n/a	n/a	n/a	100 µg/m3 (0.053 ppm	100 µg/m3
	24-hour	100 µg/m3 (as NO_x)	100 µg/m3 (as NO_x)	80 µg/m3 (as NO_x)	30 µg/m3 (as NO_x)	n/a	200 µg/m3
SO_2	Annual	n/a	n/a	n/a	n/a	80 µg/m3 (0.03 ppm)	100 µg/m3
	24-hour	120 µg/m3	100 µg/m3	80 µg/m3	30 µg/m3	365 µg/m3 (e) (0.14 ppm)	500 µg/m3
PM10	Annual	n/a	n/a	n/a	n/a	50 µg/m3 (f)	100 µg/m3
	24-hour	500 µg/m3	400 µg/m3	200 µg/m3	100 µg/m3	150 µg/m3 (g)	500 µg/m3
PM2.5	Annual	n/a	n/a	n/a	n/a	15 µg/m3 (h)	n/a
	24-hour	n/a	n/a	n/a	n/a	65 µg/m3 (i)	n/a

n/a: Not applicable, All abbreviations are explained in the Glossary unless explained above.
Notes:
(a) Averaging times are not stated in the current ambient air quality standards for Bangladesh. However, monitoring is generally carried out and reported over 24-hour periods.
(b) At national level, sensitive area includes areas around monuments, health centers, hospitals, archaeological sites, educational institutions, and government-designated areas (if any).
(c) The objectives proposed by the Air Quality Management Project, Department of Environment, are equivalent to US Environmental Protection Agency standards and were to be satisfied over time through implementation of clean air action plans. The proposed objectives are independent of land use.
(d) World Bank Air Quality Guidelines apply at the property boundary. Note that the World Bank's General Environmental Guidelines are substantially lower than the guidelines for open pit mining.
(e) Not to be exceeded more than once per year.
(f) The objective is attained when the annual arithmetic mean is less than or equal to 50 µg/m3.
(g) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m3 is equal to or less than 1.
(h) Spatially averaged over designated monitors
(i) The form is the 99th percentile.
Source: Government of Bangladesh. Environmental Conservation Act.

Table A1.8: Summary of Sampling Results for PM10, PM2.5, and TSP in Phulbari
(November 2004–June 2005)

	Sampling Location							
Parameter	**AN01**	**AN02**	**AN03**	**AN04**	**AN05**	**AN06**	**AN07**[a]	**AN08**
A. PM10 (24-hour) concentration in µg/m3								
Government PM10 (24-hour) standard	200	200	200	200	200	200	400	200
Average	87	95	78	110	93	100	163	96
Maximum	228	150	190	248	153	200	359	207
Minimum	1	31	7	2	22	5	1	2
Number of samples	71	10	10	13	12	13	67	14
Percentage of days exceeding government standard	6.1	0.0	0.0	23.1	0.0	0.0	0	7.7
B. PM2.5 (24-hour) concentration in µg/m3[b]								
Average	67	60	54	95	70	72	106	49
Maximum	162	179	107	192	84	109	240	96
Minimum	6	8	9	11	54	9	12	13
Number of samples	35	7	5	6	4	5	28	5
C. TSP (24-hour) concentration in µg/m3								
Average	133	140	70	161	182	163	301	186
Maximum	400	238	183	271	369	265	499	435
Minimum	4	21	2	5	15	106	79	89
Number of samples	42	6	6	5	7	5	34	7

All abbreviations are explained in the Glossary unless explained above.

[a] The difference in the standards of the Government for sampling location AN07 is the that the location is categorized as “commercial and mixed,” which has a higher standard than “residential.”

[b] There is no current Government standard for PM2.5.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 1, Volume 3 (Part I).

Table A1.9: Monitoring and Receptor Locations for Point Air Quality Impact Predictions and Noise Predictions in Phulbari

Receptor[a]	ID Location (UTM)	Comment
1	(698750, 2815258)	Receptor is at the air and noise monitoring location AN01. This represents a point just south of the site boundary
2	(702634, 2816489)	Receptor is close to the southeastern boundary of license area B
3	(703742, 2817713)	Receptor is in a settlement area to the southeast of the project area
4	(703510, 2821603)	Receptor is in a settlement area to the east of the mine footprint
5	(702358, 2824474)	Receptor is at the air and noise monitoring location AN05 to the northeast of the site
6	(698459, 2825636)	Receptor is at an existing settlement just north of the northern boundary of the mine footprint
7	(696059, 2822691)	Receptor is in the settlement area just outside the northwest boundary of the mine footprint
8	(696117, 2821409)	Receptor is in the Phulbari township just west of the Little Jamuna River. This point is the closest point in area of Phulbari township that will not be relocated to the mining pit boundary
9	(695877, 2820445)	Receptor is at the southern boundary of the area of Phulbari township that will not be relocated, and just west of the Little Jamuna River. The receptor is also directly west of the northern end of the coal preparation plant
10	(695479, 2819695)	Receptor is in a settlement area on the western side of the Little Jamuna River, west of the coal preparation plant
11	(697004, 2820909)	Receptor is the south of the existing Phulbari township, east of the Little Jamuna River
12	(696978, 2821640)	Receptor is about midway along the eastern boundary of the Phulbari township following the resettlement of the eastern-most part of the township
13	(696942, 2822300)	Receptor is in the northeast corner of the Phulbari township following the resettlement of the eastern-most part of the township
14	(698303, 2820973)	Receptor is southeast of the eastern-most part of Phulbari township. This receptor is the closest point in the existing township to the haul road and proposed conveyor
15	(698460, 2821585)	Receptor is at the eastern boundary of the existing Phulbari township
16	(697577, 2822156)	Receptor is north of the eastern-most part of the Phulbari township

[a] Receptors 14, 15, and 16 were selected to assess noise impacts in the Year 5 assessment period only.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Volume 3 (Part I).

Table A1.10: Predicted PM10 (24-Hour) Concentrations at the Discrete Receptors in Phulbari

Scenario	Receptor															
	1[a]	**2[a]**	**3[a]**	**4[a]**	**5[a]**	**6[a]**	**7[a]**	**8[a]**	**9[a]**	**10[a]**	**11[a]**	**12[a]**	**13[a]**	**14[a b]**	**15[a b]**	**16[a b]**
A. Maximum 24-hour concentration (µg/m3)																
Government ambient air quality standards	200	200	200	200	200	200	200	400	400	400	400	400	400	400	400	400
Year 5 (Project only)	60	60	68	215	241	88	133	154	88	71	118	173	179	153	174	226
Year 5 (cumulative)	200	210	203	375	340	203	208	358	377	362	412	386	410	402	468	392
Year 15 (Project only)	45	37	45	162	44	38	74	78	135	166	151	119	128	N/A	N/A	N/A
Year 15 (cumulative)	199	192	205	321	200	186	201	362	376	366	395	391	377	N/A	N/A	N/A
Year 25 (Project only)	50	46	56	109	32	30	43	59	128	133	73	59	59	N/A	N/A	N/A
Year 25 (cumulative)	196	206	216	269	185	176	185	332	377	366	339	331	331	N/A	N/A	N/A
Year 33 (Project only)	142	134	154	139	48	48	57	75	155	154	95	85	67	N/A	N/A	N/A
Year 33 (cumulative)	270	294	314	299	197	180	191	334	393	408	336	332	329	N/A	N/A	N/A
B. Average over all hours (µg/m3)																
Year 5 (Project only)	6	5	5	13	22	14	18	14	15	14	15	18	26	18	23	25
Year 5 (cumulative)	72	72	72	80	89	80	84	164	165	164	165	168	176	168	173	175
Year 15 (Project only)	5	4	4	12	4	4	11	15	22	20	29	27	21	N/A	N/A	N/A
Year 15 (cumulative)	71	70	70	78	70	70	77	166	173	170	179	177	171	N/A	N/A	N/A
Year 25 (Project only)	7	4	4	8	3	3	6	9	18	18	15	10	10	N/A	N/A	N/A
Year 25 (cumulative)	73	70	70	75	69	69	72	160	168	168	165	160	160	N/A	N/A	N/A
Year 33 (Project only)	16	13	12	12	4	4	8	11	20	21	16	12	9	N/A	N/A	N/A
Year 33 (cumulative)	82	79	78	78	70	70	74	162	171	170	166	162	159	N/A	N/A	N/A

N/A: Not available

[a] Predicted cumulative concentrations at receptors 1–7 are based on background concentrations measured outside the existing Phulbari township, while predicted cumulative concentrations for receptors 8–16 are based on background concentrations in the Phulbari township.

[b] Residences in the areas represented by receptors 14, 15, and 16 will be relocated by year 6; therefore, these receptors have only been used in the year 5 assessment stage.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 1, Volume 3 (Part I).

Table A1.11: Predicted increased dust deposition in Phulbari

Scenario	Receptor															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**[a]	**15**[a]	**16**[a]
Predicted increase in dust deposition rates (g/m2/month)																
Year 5	0.4	0.4	0.4	0.9	1.6	1.2	1.7	1.1	1.2	1.1	1.2	1.5	2.2	1.4	1.9	2.1
Year 15	0.4	0.3	0.3	0.9	0.4	0.4	1.2	1.7	2.3	2.0	3.5	5.2	3.5	N/A	N/A	N/A
Year 25	0.6	0.4	0.4	0.7	0.3	0.3	0.6	1.0	1.9	1.9	1.6	1.1	0.8	N/A	N/A	N/A
Year 33	1.4	1.1	1.1	1.0	0.3	0.3	0.8	1.2	2.1	2.3	1.6	1.2	1.0	N/A	N/A	N/A

N/A: Not available

[a] Residences in the areas represented by receptors 14–16 will be relocated by year 6; therefore these receptors have only been used in the year 5 assessment stage.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Volume 3 (Part I).

Table A1.12: Government of Bangladesh and World Bank Guidelines for Environmental Noise[a]

Category of Area	Government Standards for Sound (Environment Conservation Rules 1997, Schedule 4)		World Bank General Environmental Guidelines (Pollution Prevention and Abatement Category of area Handbook 1998) ([a])	
	Day (6 am–9 pm)	Night (9 pm–6 am)	Day (7 am–10 pm)	Night (10 pm–7 am)
Silent[b]	45 dB(A)	35 dB(A)	Not applicable	Not applicable
Residential area	50 dB(A)	40 dB(A)	LAeq 55 dB(A)	LAeq 45 dB(A)
Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60 dB(A)	50 dB(A)	-	-
Commercial area	70 dB(A)	60 dB(A)	LAeq 70 dB(A)	LAeq 70 dB(A)
Industrial area	75 dB(A)	70 dB(A)	-	-

All abbreviations are explained in the Glossary unless explained above.

[a] The guidelines state that noise abatement measures should achieve either the levels given [in the table] or a maximum increase in background levels of 3 dB(A). Measurements are to be taken at noise receptors outside the property boundary. Noise levels to be measured as log equivalent over 1-hour time periods. Note that there are no specific criteria for environmental noise presented in the World Bank Guidelines for Mining and Milling—Open Pit.

[b] Silent zones are areas up to a radius of 100 m around hospitals, educational institutions, or special establishments declared or to be declared as such by the Government. Use of vehicular horn other signals and loudspeakers is prohibited in silent zones.

Source: Government of Bangladesh. Environmental Conservation Act.

Table A1.13: Details of the Baseline Noise Monitoring Locations in Phulbari

Location	Mauza/ Village	Union/ Paurashava	Upazila	Comments
AN01	Joynagar	Daulatpur	Phulbari	Location is at the southern project meteorological station, to the south of the project area
AN02	Prayagpur	Khanpur	Birampur	Location is to the southeast of the project area, close to the southeast corner of license area B
AN03	Bara Raghunathpur	Golapganj	Nawabganj	Location is to the southeast of the project area, on the eastern side of the Khari Pul creek
AN04	Uttar Sahabazpur	Joypur	Nawabganj	Location is to the east of the project area, close to the boundary of the proposed ex-pit dump
AN05	Manju Para	Joypur	Nawabganj	Location is to the northeast of the project area
AN06	Mobarakpur	Hamidpur	Parbatipur	Location is close to the northern boundary of the project area
AN07	Suzapur	Phulbari Paurashava	Phulbari	Location is in the west Phulbari township, approximately 100 m from the main road, on top of a single-story market building
AN08	Purba Narayanpur	Khayerbari	Phulbari	Location is within the area where the CHPP and mine infrastructure will be located

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Volume 3 (Part I).

Table A1.14: Summary of Measured Baseline Noise Levels (dB(A)) in Phulbari

Descriptor	AN01	AN02	AN03	AN04	AN05	AN06	AN07	AN08
Day time (6 am–9 pm)								
Average LA10 [a]	47	44	47	46	48	52	61	53
Average LAeq [b]	45	43	46	45	47	52	59	51
10th percentile LA90	33	33	31	32	35	38	43	38
Nighttime (9 pm–6 am)								
Average LA10	46	46	49	52	59	59	51	55
Average LAeq	44	44	47	50	57	57	50	54
10th percentile LA90	32	36	36	39	40	46	31	44
Number of sample days	60	29	30	15	30	15	45	29

All abbreviations are explained in the Glossary unless explained above.

[a] The LA10 noise level (the noise levels exceeded for 10% of the 60 minute measurement interval) is often used when assessing the impacts of road-traffic noise, as road-traffic noise is characterized by short-term fluctuations caused by passing vehicles.

[b] The LAeq noise level is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level of the measurement period. This descriptor is often used to assess industrial noise impacts.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Volume 3 (Part I).

Table A1. 15: Receptor Locations for Point Noise Predictions in Phulbari

Receptor ID [a]	Location (UTM)	Comment
1	(698750, 2815258)	Receptor is at the air and noise monitoring location AN01. This represents a point just south of the site boundary
2	(702634, 2816489)	Receptor is close to the southeastern boundary of license area B
3	(703742, 2817713)	Receptor is in a settlement area to the southeast of the Phulbari township
4	(703510, 2821603)	Receptor is in a settlement area to the east of the mine footprint
5	(702358, 2824474)	Receptor is at the air and noise monitoring location AN05 to the northeast of the site
6	(698459, 2825636)	Receptor is at an existing settlement just north of the northern boundary mine footprint
7	(696059, 2822691)	Receptor is in the settlement area just outside the northwest boundary of the mine footprint
8	(696117, 2821409)	Receptor is in the Phulbari township just west of the Little Jamuna River. This point is the closest point in the Phulbari township area that will not be relocated to the mining pit boundary
9	(695877, 2820445)	Receptor is at the southern boundary of the area of Phulbari township that will not be relocated and just west of the Little Jamuna River. The receptor is also directly west of the northern end of the coal preparation plant
10	(695479, 2819695)	Receptor is in a settlement area on the western side of the Little Jamuna River, west of the coal preparation plant
11	(697004, 2820909)	Receptor is south of the existing Phulbari township, east of the Little Jamuna River
12	(696978, 2821640)	Receptor is about midway along the eastern boundary of the Phulbari township after the resettlement of eastern part of town
13	(696942, 2822300)	Receptor is in the northeast corner of the Phulbari township after resettlement of the eastern-most part of the township
14*	(698303, 2820973)	Receptor is southeast of the eastern-most part of Phulbari township. This receptor is the closest point in the existing township to the haul road and proposed conveyor
15*	(698460, 2821585)	Receptor is at the eastern boundary of the existing Phulbari township
16*	(697577, 2822156)	Receptor is north of the eastern-most part of the Phulbari township

[a] Receptors 14 to 16 were selected to assess noise impacts in the year 2 and year 5 assessment periods only. Residents in these areas will be relocated between years 3 and 6.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Vol 3.

Table A1.16: Predicted Noise Impacts from the Project (dB(A)) in Phulbari

	Receptor															
Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Year 2 day—neutral	18	15	16	25	34	43	37	38	49	45	43	39	44	62	41	52
Year 2 night—neutral	<15	<15	<15	23	30	44	36	33	29	25	34	38	44	35	38	52
Year 2 night—inversion	16	18	22	30	36	49	42	39	35	32	40	43	49	40	43	55
Year 5 day—neutral	25	21	22	33	34	36	37	35	39	41	37	39	36	61	44	48
Year 5 night—neutral	25	22	22	32	17	36	37	35	37	35	37	39	36	62	45	47
Year 5 night—inversion	31	29	30	38	23	42	42	40	42	40	42	44	41	62	49	51
Year 15 day—neutral	27	25	26	41	27	27	33	36	40	42	37	35	32	N/A	N/A	N/A
Year 15 night—neutral	27	25	26	33	<15	27	34	36	38	39	37	35	32	N/A	N/A	N/A
Year 15 night—inversion	34	32	33	39	<15	34	40	41	43	44	41	39	37	N/A	N/A	N/A
Year 25 day—neutral	29	28	29	41	21	20	26	31	38	41	34	29	26	N/A	N/A	N/A
Year 25 night—neutral	29	28	28	25	<15	20	26	31	36	35	34	29	26	N/A	N/A	N/A
Year 25 night—inversion	35	35	35	31	15	28	33	37	41	41	39	35	32	N/A	N/A	N/A
Year 33 day—neutral	34	34	35	39	21	18	25	31	38	41	35	30	26	N/A	N/A	N/A
Year 33 night—neutral	34	34	35	26	<15	19	25	31	36	35	34	29	26	N/A	N/A	N/A
Year 33 night—inversion	40	40	40	32	15	26	32	36	41	40	39	35	33	N/A	N/A	N/A
Year 38 day—neutral	37	35	34	26	<15	<15	24	30	38	41	34	29	26	N/A	N/A	N/A
Year 38 night—neutral	37	35	34	26	<15	<15	23	29	36	35	34	29	25	N/A	N/A	N/A
Year 38 night—inversion	42	40	39	32	20	21	30	35	41	39	39	34	32	N/A	N/A	N/A

N/A: Not available
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Section 2, Volume 3 (Part I).

Table A1.17: Existing Conditions and Proposed Upgrades for the Rail Corridor Segments

Existing Conditions	Proposed Upgrades
Segment 1: Khulna to Darsana Junction • 126 km of single-track broad gauge main line with wooden and steel sleepers • 146 bridges, the longest being 18.3 m • 22 stations, 131 level crossings (52 are manned and 79 unmanned), and 22 passing loops ranging from about 476 m to 870 m • Number of trains operating on this section is 22 per day, with permissible speeds ranging from 30 to 75 km/hr • This section of track is currently undergoing rehabilitation and further works are proposed by Bangladesh Railway	• Full track rehabilitation, including supply and installation of prestressed-concrete sleepers, ballast, and 52 kg rail welded into continuous-welded rail: 56 km • Supply and installation of 90 lb "A" rail welded into continuous-welded rail: 70 km • Track tamping and lining (This covers the 70 km of track where new rail will be installed. The 56 km of full rehabilitation noted above includes tamping and lining): 70 km • Loop line extensions, total length: 2 km • Repairing existing masonry bridge piers and abutments, and replacing most wooden bridge sleepers with either wood or steel ones: 160 m of bridges
Segment 2: Darsana Junction to Ishwardi Bypass • 82.3 km of double-track broad gauge main line with wooden and steel sleepers • 61 bridges including the 1,720 m long Hardinge Bridge, which crosses the Ganges-Padma River approximately 8 km west of Ishwardi, and several bridges over 50 m • 12 stations, 39 level crossings (19 are manned and 20 unmanned), and 8 passing loops, ranging from about 570 m to 743 m • Number of trains operating on this section is 26 per day with permissible speeds ranging 30 to 80 km/hr • This section of track is currently undergoing rehabilitation and further works are proposed by Bangladesh Railway	• Full track rehabilitation, including supply and installation of prestressed-concrete sleepers, ballast, and 52 kg rail welded into continuous-welded rail: 108 km • Supply and installation of prestressed-concrete sleepers: 12 km • Supply and transport of ballast: 12 km • Track tamping and lining (This covers the 50 km of track where rehabilitation was previously carried out by BR, but where mechanical tamping was not done. The 104 km of full rehabilitation noted above includes tamping and lining): 50 km. • Repairing existing masonry bridge piers and abutments, and replacing most wooden bridge sleepers with wood or steel ones: 4,650 m of bridges
Section 3: Ishwardi Bypass to Shantahar Junction • 72 km of both double-track dual gauge (DG) main line and single-track DG main line with prestressed-concrete sleepers • 69 bridges, with three over 100 m in length • 17 stations and 19 level crossings (nine are manned and 10 unmanned), and 22 passing loops, ranging from about 624 m to 870 m • Number of trains operating on this section is 24 per day with permissible speeds ranging from 30 to 95 km/hr • This section of track has been recently rehabilitated	• Replace worn, older, 90 lb rail with new, heavier, 52 km Indian rail: 24 double track km. • Partial double-tracking of 8.5 km of rail line • Loop line extensions, total length: 1.5 km
Segment 4: Shantahar Junction to Phulbari • 79.5 km of single-track DG main line with prestressed-concrete sleepers • 43 bridges, none of which are major bridges • 14 stations, 48 level crossings (14 are manned and 34 unmanned), and 20 passing loops, ranging from about 640 m to 925 m • Number of trains operating on this section is 22	• Replace worn, older, 90 lb rail with new, heavier, 52 kg Indian rail: 25 double track km • Partial double-tracking of 26.1 km of rail line • Loop line extensions, total length: 2.3 km

Existing Conditions	Proposed Upgrades
per day, with permissible speeds ranging from 30 to 95 km/hr • This section of track has been recently rehabilitated	
Segment 5: Ishwardi Bypass to Joydebpur/Gazipur • 171.5 km of single-track DG main line with prestressed-concrete sleepers. • 197 bridges, including the 5 km Jamuna Bridge, and 63 multi-span steel bridges up to 150 m in length • 22 stations, 125 level crossings (35 are manned and 95 unmanned), and 16 passing loops, ranging from about 495 m to 727 m • Number of trains operating on this section is 14 per day with permissible speeds ranging from 30 to 95 km/hr • This section of track has been recently rehabilitated	• Replace worn, older, 90 lb rail with new, heavier, 52 kg Indian rail: 16 DG track km

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 7, Volume 1.

Table A1.18: Segment Description for the Train Corridor

Segment	Description	Distance
Segment 1:	Khulna to Darsana Junction This segment is dominated by calcareous dark gray and brown floodplain soils. This soil type occupies a significant section of central and western Bangladesh.	126 km
Segment 2:	Darsana Junction to Ishwardi Bypass Between Darsana Junction and Ishwardi Junction the soil characteristics are similar to that of segment 1, that is, calcareous dark gray and brown floodplain soils. At Ishwardi Junction a narrow section of calcareous alluvium is traversed.	82 km
Segment 3:	Ishwardi Bypass to Shantahar Junction This rail segment crosses five soil types. Initially, the rail corridor passes through a minor section of calcareous alluvium before entering the dominant expanse of calcareous dark gray and brown floodplain soils. The rail corridor then enters the eastern section of an area of calcareous dark gray floodplain soils with lime particles before traversing acid basin clays. Shantahar Junction itself is located within a section of gray floodplain soils.	72 km
Segment 4:	Shantahar Junction to Phulbari Between Shantahar Junction and Phulbari the soil is predominantly a gray floodplain type. Closer to Phulbari, the rail corridor crosses gray terrace soils before reaching Phulbari, which is located on red-brown terrace soil of the Madhupur Clay.	79.5 km
Segment 5:	Ishwardi Bypass to Joydebpur-Gazipur Several soil types are present between the Ishwardi Junction and Joydebpur-Gazipur. From Ishwardi Junction calcareous dark gray and brown floodplain soils are found. The soil changes to a gray floodplain soils, and then non-calcareous alluvium adjacent to the Brahmaputra-Jamuna River. Joydebpur is surrounded by red-brown terrace soils.	171.5 km

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 7, Volume 1.

Table A1.19: Noise Monitoring Results along the Rail Corridor

Location	Rail Segment (S)	Distance from Railway (meters)	Ldn (dB(A))	Comments
MP01	S5. Ishwardi Junction to Gazipur	12	70	Noise logger was in a rural area with no obstructions between the railway and the logger
MP02	S5. Ishwardi Junction to Gazipur	20	65	Noise logger was in a rural area with no obstructions between the railway and the logger. A highway was located 150 m from the logger location.
UP01	S5. Ishwardi Junction to Gazipur	20	62	Noise logger was in a rural area with no obstructions between the railway and the logger.
UO02	S5. Ishwardi Junction to Gazipur	15	66	Noise logger was in a rural area with no obstructions between the railway and the logger.
ST01	S4. Phulbari to Shantahar	100	62	No obstructions between the logger and the railway
ST02	S4. Phulbari to Shantahar	50	64	Noise logger close to a railway marshalling yard. No obstructions between the logger and the railway
AN01	S4. Phulbari to Shantahar	155	64	Noise logger was in a rural area with no obstructions between the railway and the logger
NT01	S3. Shantahar to Ishwardi Junction	150	56	No obstructions between the logger and the railway. Location was in a rural area
NT02	S3. Shantahar to Ishwardi Junction	50	67	Location was in an urban area with limited obstructions between the logger and the railway
PD01	S2. Ishwardi Junction to Darsana	50	70	No obstructions between the logger and the railway. Industrial noise sources also in the area
PD025	S2. Ishwardi Junction to Darsana	100	68	There were some single-story residences between the logger and the railway
JS01	S1. Darsana to Khulna	50	64	There were some obstructions between the logger and the railway. Road-traffic noise also significant at this location
JS02	S1. Darsana to Khulna	100	70	The logger was on the roof of a building in the main urban area of Jessore. There were buildings of similar height between the railway and the logger location.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 7, Volume 1.

Table A1.20: Level Crossings per Segment in the Rail Corridor

Rail Segment (S)	Segment Length (km)	No. Major Stations	No. Minor Stations	No. Crossings	Crossings per km
S1. Khulna–Darsana	126	5	11	190	1.5
S2. Darsana–Ishwardi Bypass	82	4	4	59	0.7
S3. Ishwardi Bypass–Shantahar Junction	72	5	7	43	0.6
S4. Shantahar Junction–Phulbari	80	7	5	59	0.7
Total	**360**	**21**	**27**	**351**	**1.0**

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 7, Volume 1.

Table A1.21: Receptor Locations Used for Air Quality and Noise Modeling at the Coal Terminal in Khulna

Receptor ID	Approximate Location (UTM45)	Comments
1	761312, 2527967	Residential area opposite the main road access point to the site
2	761454, 2528044	Tax commissioner’s residence just north of the site boundary
3	761561, 2528275	Four-story residential building north of the site
4	761621, 2528247	Three-story hospital for the Bangladesh Navy, north of the site
5	762472, 2527767	Residential area on opposite side of river
6	761935, 2527163	Unapproved residential development in railway land south of the site
7	761589, 2527412	Four-story residential building west of the site on Old Jessore Rd
8	761630, 2527223	Schools located on the western side of Old Jessore Rd opposite the southwest corner of the site.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.22: Measured PM10 and PM2.5 Concentrations at the Coal Terminal in Khulna

Sample Finish Date	PM10 (μg/m3)	PM2.5 (μg/m3)	Sample Finish Date	PM10 (μg/m3)	PM2.5 (μg/m3)
2005-12-22	173	148	2006-01-31	286	225
2005-12-24	113	106	2006-02-02		193
2005-12-26	117	89	2006-02-04	324	
2005-12-28		291	2006-02-06	250	181
2005-12-30	247	214	2006-02-08		206
2006-01-01	192	162	2006-02-10	226	189
2006-01-03		138	2006-02-12		194
2006-01-05	260	209	2006-02-14		135
2006-01-07	262	216	2006-02-16	109	
2006-01-09	313	253	2006-02-18	109	54
2006-01-11	199	186	2006-02-20	83	
2006-01-13	299	254	2006-02-22	128	70
2006-01-15	250	202	2006-02-24	122	72
2006-01-17	312	262	2006-02-26	98	58
2006-01-19	150	138	2006-02-28	143	80
2006-01-21	298	195	2006-03-02	187	120
2006-01-25	250	184	2006-03-04	188	124
2006-01-27	178	156	2006-03-06	80	59
2006-01-29	211	179	2006-03-08	74	48

All abbreviations are explained in the Glossary unless explained above.
Source: Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Section 5, Volume 5. Figure 8.

Table A1.23: Results of the Passive Sampling Program for NO2 and SO2 at Three Alternative Locations in the Khulna Area (ppb)

Sampling Location	**Average NO2 Concentration** (Government standard is 53 ppb annual average)	**Average SO2 Concentration** (Government standards are 140 ppb for 24-hour average and 30 ppb for annual average)
A. Sampling period 1: 25 January 2006–30 January 2006		
MPA01	24	5
BG01	10	4
NP01	110	2
B. Sampling period 2: 7 February–12 February 2006		
MPA01	18	3
BG01	10	3
NP01	15	<2

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 9, Volume 1. Table 9.3 and Section 3, Volume 5. Table 3.

Table A1.24: Estimated Emissions of PM10 and PM2.5 from the Operation of the Coal Terminal in Khulna at Mean Wind Speed

Emission Source	Estimated PM10 Emissions at Mean Wind Speed in kg/hour	Estimated PM2.5 Emissions at Mean Wind Speed in kg/hour
Stockpile loading	0.25	0.08
Barge loading	0.09	0.03
Wind erosion from stockpiles	4.19	0.837
Receiving conveyor transfer points	1.07	0.533
Loading conveyor transfer points	0.40	0.100
Dozers operating on the stockpiles	3.99	0.275
Rail unloading	0.01	0.005
Dozer engine emissions	0.19	0.193
Power generation unit emissions	0.43	0.427
Total	10.62 kg/hr (93 tonnes per year)	2.48 kg/hr (21.7 tonnes per year)

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.25: Predicted PM10 and PM2.5 Concentrations for the Coal Terminal in Khulna

Receptor	PM10 Concentrations (μg/m^3)	
	Maximum 24-Hour Concentration	Annual Average
Government Standard	150	50
1	75	10
2	115	19
3	90	16
4	110	23
5	40	5
6	145	22
7	125	18
8	110	16

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.26: Predicted Increase in Annual Average Dust Deposition Rates for the Coal Terminal in Khulna

Receptor	Increase in Annual Average Dust Deposition Rate (g/m^2/month)
1	3
2	6
3	6
4	9
5	1
6	5
7	6
8	5

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.27: Summary of the Measured Noise Levels at the Coal Terminal in Khulna

Location and Monitoring Period	Daytime Period (6 am–9pm)			Nighttime Period (9 pm–6 am)			
	Avg L10	Avg Leq	10th Perc L90	Avg L10	Avg Leq	10th Perc L90	Avg Ldn
MPA01: 13–17 July 2005 and 20 Dec 2005–04 Jan 2006	54	52	41	46	46	36	54
MPA02: 20 Dec 2005–4 Jan 2006	57	57	45	48	46	38	58
MPA04: 12–26 July 2005 and 7–14 Jan 2006	68	66	50	60	60	42	69
MPA05: 10–14 Mar 2006	56	57	43	46	51	35	64
MPA06: 10–14 Mar 2006	50	53	40	48	54	40	63

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Section 5, Volume 3.

Table A1.28: Predicted Noise Impacts from the Construction Phase (dB(A)) at the Coal Terminal in Khulna

Receptor	1	2	3*	4*	5	6	7*	8
Government ambient noise standards: Receptors 4 and 8 (silent zone)—45 dB(A) for day and 35 dB(A) for night All other receptors (mixed area)—60 dB(A) for day and 50 dB(A) for night								
Predicted noise level—calm conditions	56	63	59	60	51	60	66	61
Predicted noise level—1.5 m/s wind toward the north	57	63	60	61	53	57	66	59

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.29: Predicted Noise Impacts for Recommended Equipment and Operations (Leq, dB(A)) at the Coal Terminal in Khulna

Alternatives	Receptors							
	1	**2**	**3**[a]	**4**[a]	**5**	**6**	**7**[a]	**8**
Government ambient noise standards: Receptors 4 and 8 (silent zone)—45 dB(A) for day and 35 dB(A) for night All other receptors (mixed area)—60 dB(A) for day and 50 dB(A) for night								
Base case (Scenario 1) Main line locomotive near Receptor 7. Two dozers operating close to the feeders in the northern stockpile. One dozer operating in the stockpile area closest to Receptor 7. Stockpiles assumed to be empty. All receiving and loading conveyors operating. Barge at load-out point.	48	51	52	54	46	50	66	55
Alternative 1 (Day) (Scenario 6B) Special design locomotive near Receptor 7. Two dozers assumed to be in south of stockpile area and third dozer assumed to be at closest point on stockpiles to Receptor 8. Stockpiles assumed to be empty. All receiving and loading conveyors operating. Barge at load-out point. 1.5 m/s wind from the south.	47	50	52	53	47	52	62	57
Alternative 1 (Night) (Scenario 8) Special design locomotive near Receptor 7. Loading bulldozers assumed to be south of the stockpile area. All receiving and loading conveyors operating with the stockpiles half-full. Barge at load-out point. 1.5 m/s wind from the south.	43	48	51	53	46	43	48	38
Alternative 2 (Day) (Scenario 9B) Three dozers operate in the day only and the chain feeders are removed because of gravity system. One dozer operating in the stockpile area closest to Receptor 7. Stockpiles assumed to be empty. All receiving and loading conveyors operating. Barge at load-out point. 1.5 m/s wind from south.	50	53	53	55	46	47	62	52
Alternative 2 (Night) (Scenario 10B) Chain feeders are removed because of gravity system. Special design locomotive near Receptor 7. Stockpiles assumed to be empty. No dozers operating. All receiving and loading conveyors operating. Barge at load-out point. 1.5 m/s wind from the south.	44	48	51	53	41	40	47	40

All abbreviations are explained in the Glossary unless explained above.

[a] Receptors 3, 4, and 7 are multi-story buildings. Noise level predictions were made for each floor level and the highest predicted noise level is presented in the table.

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 10, Volume 1.

Table A1.30: Distribution of Coal between the Different Markets (Destinations) and the Transport Means

Destination	Transport Component	Million Tonnes (Mt)
Local domestic	Mine gate and road	0.5
National domestic	Rail	2.5
India via Darsana	Rail	4.0
Export via Khulna	Rail, barge, ship	8.0
Total		**15.0**

Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Project.

Table A1.31: Barge Design Specifications

Parameter	
Dimensions	96.0 m x 24.5 m
Max. dwt	8,000 mt dwt
Draft	4.5 m
Engines	2 x 1,200 bhp diesel engines
Empty speed	10 knots
Loaded speed	8 knots
Crew accommodation	15

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 6, Volume 1.

Table A1.32: Typical Ship Dimensions for Transportation to International Markets

Item	Handymax	Panamax
Length	185 meters	225 meters
Beam	32 meters	32.25 meters
Max draft	12 meters	13 meters
DWT	46,000 Mt	70,000 Mt

All abbreviations are explained in the Glossary unless explained above.
Source: Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 6, Volume 1.

Table A1.33: Accident Statistics for the Mongla Port Area

LRFP Casualty Info 1990–2004	No. Accidents	Days on Water	Accident Frequency/Ship Years
Collisions (Mongla Port)	2	2	2.237 E-06
Fire (Mongla Port)	5	5	1.398 E-05
Stranding (Mongla Port)	3	5	8.387 E-06
Stranding (Hiron Point)	2	2	2.237 E-06
Fatalities (Fire)	7	5	1.957 E-05
Avg. vessels/year (1990–2004)	350		

Source: Accident data from Lloyd's Register Fairplay (LRFP) 1990 to 2004. Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 6, Volume 1

Table A1.34: Bulk Carrier Accidents, Annual Frequency, and Quantity of Spill for Panamax (global terms)

Accident Type	**Freq. of Spill/Ship Year**	**Spill Quantity Tonnes/Ship Year**
Collision	7.2 E-05	1.9 E-02
Contact	7.2 E-05	1.9 E-03
Foundering	9.0 E-05	9.9 E-02
Hull, machinery and/or equipment	3.6 E-05	1.4 E-04
Wrecked or stranded	2.9 E-04	2.0 E-01

Source: DNV's FSA study. Environmental and Social Impact Assessment (ESIA) of Asia Energy's Phulbari Coal Mine Project. Coal Transportation. Chapter 6, Volume 1.

ENVIRONMENTAL CLEARANCE DATED 11 SEPTEMBER 2005

Government of the People's Republic of Bangladesh
Department of Environment
www.doe-bd.org
Head Office, Paribesh Bhaban
E-16 Agargaon, Dhaka-1207

Memo No: DoE/Clearance/2053/2004/ 2195

Date : 11 / 09 / 2005

Subject: Environmental Clearance for Phulbari Coal Project, Dinajpur.

Ref: 1) Your Application dated 30/07/2005.

With reference to the above, the Department of Environment (DOE) is pleased to approve the Environmental Impact Assessment (EIA) report and award Environmental Clearance in favour of Phulbari Coal Project of Asia Energy Corporation (Bangladesh) Pty Ltd. located in the Upazillas of Phulbaril, Birampur, Parbatipur & Nawabgonj of Dinajpur District subject to the following terms and conditions:

1. The activity under Phulbari Coal Project shall not result in the loss or containment of any materials that would affect health or will have damaging impact on the environment or natural resources.
2. The Environmental Management Plan as stipulated in the EIA shall have to be implemented and all the mitigation measures shall have to be strictly followed throughout the life of the project.
3. Special attention and necessary measures will have to be taken to curb dust and noise pollution, ensure water availability for people, treatment of wastewater, rehabilitation of land and re-generation of greenery.
4. Rehabilitation of human settlement or compensation for any loss due to the project activity will have to be ensured in line with the national requirements and international best practices.
5. Proper and adequate on-site precautionary and occupational health & safety measures shall have to be ensured to protect life and property.
6. Proper and adequate sanitation facilities shall be ensured in labor camps throughout the project activities.
7. An environment friendly solid waste management should be in place during whole the period of the project in the field.
8. All parameters of effluent, gaseous emission, noise, solid waste, hazardous waste, etc. shall be within the limits in the Environment Conservation Rules (ECR) 1997. In case of non-coverage of ECR 1997 the World Bank Environment, Health and Safety Guidelines will have to be consulted and adhered to.
9. Environmental monitoring program will have to be duly implemented and an environmental monitoring report containing, among others, data generated from the environmental monitoring program will have to be submitted to DOE (both Rajshahi Divisional Office and Head Office) on a monthly basis throughout the life of the project.
10. All the required mitigation measures suggested in the EIA report along with the emergency response plan are to be strictly implemented and kept operative/functioning on a continuous basis.

11. Full and adequate utilization of the techniques for mitigation of pollution and environmental damage as well as that for treatment of wastes shall be ensured.
12. At the time of commercial production of Coal utmost precautionary measures should be taken to reduce the possibility of accident.
13. The wastewater shall be treated properly and the treated water be discharged through a discharge channel to the nearby river/canal.
14. Arrangement must be made for dust suppression in the Coal dumping yard.
15. To reduce dust, spraying of water over the extracted coal should be carried out continuously.
16. In case of emergency situation, Rajshahi Divisional Office and Headquarters of the Department of Environment (DOE) located at Nishindhara, Bogra will have to be notified immediately with the information on nature of emergency, personnel affected, measures taken, follow up measures etc.
17. Rehabilitation of human settlement or compensation for any sort of activity which will incur damage or loss of public or private property or any natural resources shall be addressed as per Government of Bangladesh rules and regulations.
18. Asia Energy Corporation (Bangladesh) Pty Ltd. shall extend active cooperation to DOE officials while they visit the project site.
19. DOE may cancel this Clearance, after serving appropriate notice, in case of non-compliance of any of the above conditions.
20. This Clearance is valid for one year from the date of issuance and Asia Energy Corporation (Bangladesh) Pty Ltd. shall apply for renewal to the Rajshahi Divisional Office of DOE at Bogra with a copy to the Headquarter at Dhaka at least 30 days ahead of expiry.

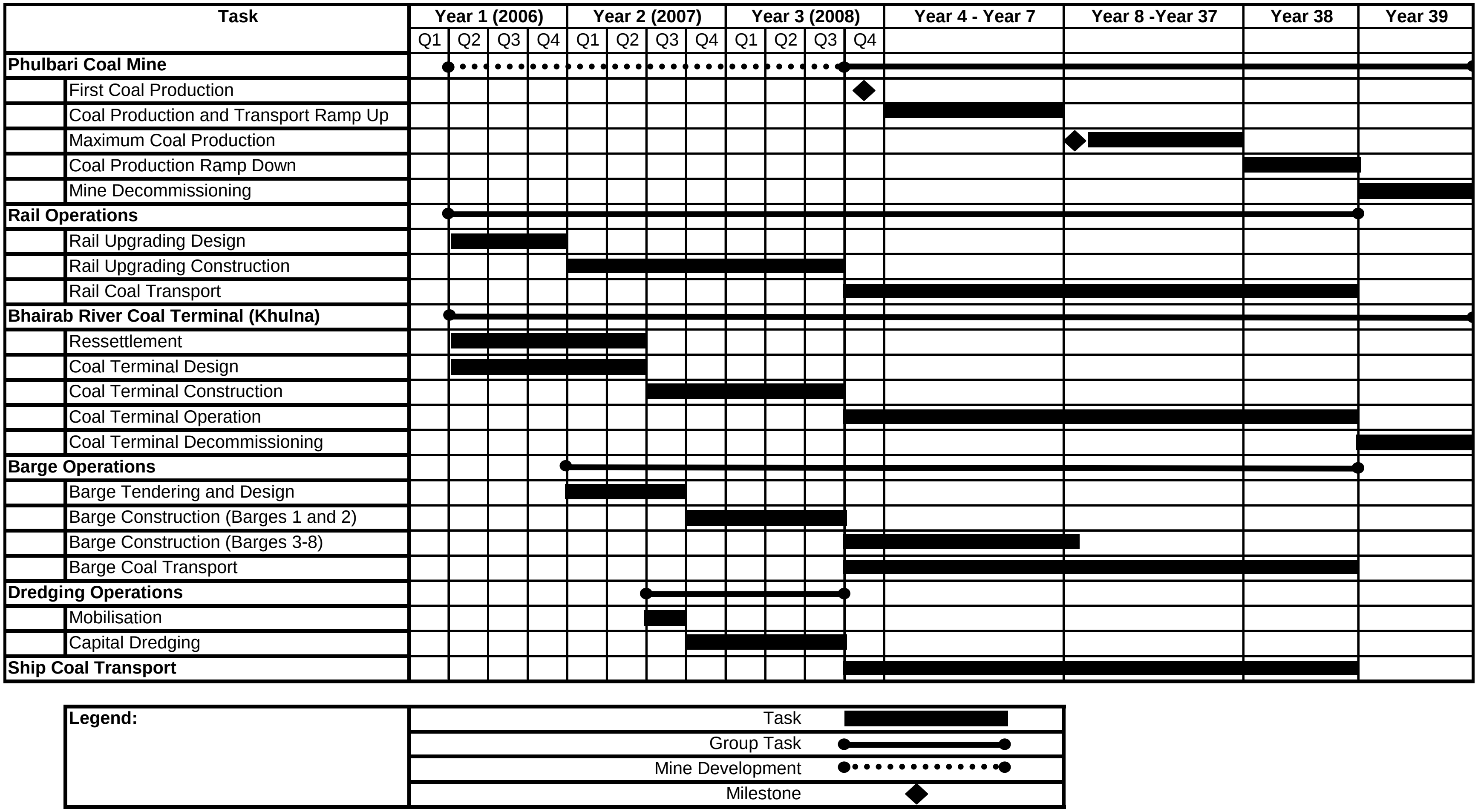
(Syed Nazmul Ahsan)
Research Officer
and
Member Secretary
Environmental Clearance Committee

Dr. Mushfiqur Rahman
General Manager
Asia Energy Corporation (Bangladesh) Pty Ltd.
Plot # 2(B), Block # SE(C), Road # 138
Gulshan # 1, Dhaka-1212.

Copy Forwarded to :

1) Private Secretary to the Hon'ble Secretary, Ministry of Environment and Forest, Bangladesh Secretariat, Dhaka.
2) Deputy Director, Department of Environment, Rajshahi Division, Bogra.
3) Staff Officer to the Director General, Department of Environment, Head Office, Dhaka.

WORK PLAN FOR THE VARIOUS COMPONENTS OF THE PROJECT



Q1 = First quarter, Q2 = Second quarter, Q3 = Third quarter, Q4 = Fourth quarter
Sources: All ESIAs for the Project