

# Initial Environmental Examination

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## BAN: Urban Public and Environmental Health Sector Development Program: Barisal Controlled Landfill

Prepared by the Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh for the Asian Development Bank.

## **ABBREVIATIONS**

ADB	–	Asian Development Bank
BBS	–	Bangladesh Bureau of Statistics
BCC	–	Barisal City Corporation
BOD	–	Biochemical Oxygen Demand
CC	–	City Corporations
CCPIU	-	City Corporations Program Implementation Units
CLF		Controlled Landfill
COD	–	Chemical Oxygen Demand
DES	–	Domestic Environmental Specialist
DLS	-	Department of Livestock Services
DO	–	Dissolved Oxygen
DoE	–	Department of Environment
DSC	–	Design, Supervision, and Construction Consultant
DWASA	–	Dhaka Water Supply and Sewerage Authority
EA	–	executing agency
ECC	–	Environmental Clearance Certificate
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EU	–	European Unions
HDPE	–	High Density Poly-Ethylene
IEE	–	Initial Environmental Examination
IES	–	International Environmental Specialist
IMA	–	Independent Monitoring Agency
LGD	–	Local Government Division
LGRDC	–	Ministry of Local Government, Rural Development and Cooperatives
NGO	–	nongovernmental organization
OM	–	Operations Manual
O&M	–	operation and maintenance
PPTA	–	Project Preparation Technical Assistance
RCC	–	Reinforced Cement Concrete
RF	–	Resettlement Framework
RP	–	Resettlement Plan
SCMO	–	Safeguards and Community Mobilization Officer
SIEE	–	Summary Initial Environmental Examinations
SO	–	Safety Officer
STS	-	Secondary Transfer Station
ToR	–	Terms of Reference
UPEHSDP	–	Urban Public and Environmental Health Sector Development Program
UPEHU	–	Urban Public and Environmental Health Unit
WMD	-	Waste Management Department

## **WEIGHTS AND MEASURES**

ha	–	hectare
km	–	kilometer
m	–	Meter
Mm	–	millimeter
km/h	–	kilometer per hour

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## **I. INTRODUCTION**

### **A. Purpose of the Report**

1. With nearly 30% of the country's total population (around 140 million) currently living in urban areas along with a predicted to rise to 50% in the next 25 years and still a higher rate of urbanization than the previous ones, Bangladesh is beset with a situation of continued deterioration in the overall and general state of urban public and environmental health. Such a situation has its root in the existing services overwhelmed by continued influx of ever-increasing number of people in the urban areas and growth of slums and squatter settlements currently accommodating over 35% of the urban population. Disease prevention and health promotion in urban areas encompass a range of issues including water and sanitation, waste management, food safety, healthcare, awareness-raising, etc. These are all the responsibility of the city corporations and municipalities under the authority of the Local Government Division (LGD) of the Ministry of Local Government, Rural Development and Cooperatives (LGRDC). Most of these services are under-provided, particularly to the poor.

2. The Bangladesh Urban Public and Environmental Health Sector Development Program (UPEHSDP) aims to establish a sustainable approach to public and environmental health at national level to guide and support city corporations and municipalities in improving the quality of life and economic status of urban residents, especially the poor. This will be achieved by a range of measures, including: (i) creating an Urban Public and Environmental Health Unit (UPEHU) under LGD with a mandate to improve public health; (ii) improving staff and financial resources to enable city corporations and municipalities fulfill their responsibilities in public and environmental health; (iii) improving management of solid waste and hospital waste through municipality-managed public-private partnerships and other mechanisms; and (iv) improving food safety by providing food testing laboratories, food inspection services and sanitary slaughterhouses.

3. The program is being supported by ADB through: (i) a program loan to implement policy measures in institutional strengthening, financial reform, public/ environmental health strategies, governance and service delivery; and (ii) a sector loan, funding investments in municipal and hospital waste management, food safety, and pro-poor integrated services (water supply, sanitation, nutrition/ food security, and health of the urban poor). LGD of the MOLGRDC has been the Executing Agency (EA), whereas the six city corporations (Dhaka, Chittagong, Sylhet, Barisal, Khulna and Rajshahi) have been the implementing agencies. The Program is being implemented over a period of seven years (2010-2016) in the main urban areas of the country.

4. UPEHSDP has been classified by ADB as environmental assessment category B (some negative impacts but less significant than category A). The impacts of activities under the program loan, therefore, need to be reviewed by an Environmental Assessment of the Policy Matrix. The sector loan will be implemented via a series of subprojects, providing infrastructure and other improvements in a particular sector (waste management, food safety, etc). Four sample subprojects were developed by a Project Preparation Technical Assistance (PPTA) study and the environmental impacts of these were assessed by Initial Environmental Examinations (IEE) (or Environmental Reviews for Category C subprojects). Studies were conducted according to ADB Environment Policy (2002) and Environmental Assessment Guidelines (2003). Current IEE had been in line with the Environmental Assessment and Review Framework (EARF) developed for the purpose in 2009 and assessment of environmental impacts previously conducted on the above four sample subprojects developed through the PPTA study.

5. This Initial Environmental Examination (IEE) has been undertaken to (i) assess the extent and magnitude of impacts that the proposed Barisal Controlled Landfill subproject in Barisal City Corporation have on the overall environment within and around the subproject site; (ii) propose mitigation measures in respect of adverse impacts, enhancement of beneficial impacts; and (iii) formulate an Environment Management Plan (EMP).

## **B. Extent of IEE Study**

6. Bangladeshi law and ADB policy require that the environmental impacts of development projects are identified and assessed as part of the planning and design process, and that action is taken to reduce those impacts to acceptable levels. This is done through the environmental assessment process, which has become an integral part of lending operations and project development and implementation worldwide.

### **1. ADB Policy**

7. ADB's Environment Policy requires that environmental issues are taken into account in all aspects of the Bank's operations, and the requirements for Environmental Assessment are described in Operations Manual (OM) 20: Environmental Considerations in ADB Operations (2003). This states that ADB requires environmental assessment of all project loans, program loans, sector loans, sector development program loans, financial intermediation loans and private sector investment operations.

8. The nature of the assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects are screened for their expected environmental impacts and are assigned to one of the following categories:

(i) **Category A.** Projects that could have significant environmental impacts. An Environmental Impact Assessment (EIA) is required.

(ii) **Category B.** Projects that could have some adverse environmental impacts, but of less significance than those for category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.

A Category B project may be classified as B-sensitive if it involves environmentally sensitive activities. Such projects require IEE, but have the same requirements for disclosure and Environmental Management Plans as Category A.

(iii) **Category C.** Projects those are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.

9. For Category B projects the Draft IEE reports, Summary IEE (SIEE) and any other reports prepared to comply with ADB procedure (in this case the EA of the Policy Matrix) are reviewed by ADB's Regional Department Sector Division and Social and Environmental Safeguards Division. They are also reviewed in-country by the Executing Agency, and additional comments may be sought from project affected people and other stakeholders. All comments are incorporated in preparing final documents, which are reviewed by the Executing Agency and the national environmental protection agency (in this case the Department of Environment, DoE). The EA then officially submits the reports to ADB for consideration by the Board of Directors.

## 2. National Law

10. **Environmental Assessment, Protection, and Pollution Control.** The main provisions for environmental protection and pollution control in Bangladesh are contained in the Environmental Conservation Act (ECA) of 1995 and the Environmental Conservation Rules (ECR) of 1997. These legislations also provide the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed. Projects are classified as green, orange or red depending on their location and environmental impacts. As per ECR 1997, it is included in the Red Category in item 43 and described as 'Land-filling by industrial, household and commercial wastes'.

11. Rule 7 states that the proponent of such projects must obtain a Location Clearance Certificate and an Environmental Clearance Certificate (ECC) from the Department of Environment (DoE). For Red category projects this requires submission to the relevant DoE Divisional Officer of the following:

- (i) Completed Application for Environmental Clearance Certificate, and the appropriate fee, shown in Schedule 13 of the Rules;
- (ii) Report on the feasibility of the project;
- (iii) Report on the IEE for the project, and its Process Flow Diagram, Layout Plan;
- (iv) Report on the Environmental Management Plan;
- (v) No objection certificate from the local authority;
- (vi) Emergency plan relating to adverse environmental impact and plan for mitigation of the effect of pollution; and
- (vii) Outline of the relocation and rehabilitation plan (where applicable).

12. As part of the Environmental Clearance Certificate application, a detailed Environmental Impact Assessment and environmental management plans satisfactory to the Department of Environment must be prepared. During the process of preparing the 2009 Environmental Planning Document, DoE was consulted and it was indicated that ADB IEE, SIEE, Resettlement Framework and other reports prepared during project preparation would be acceptable to DoE as fulfilling many of their national EIA requirements. However, they will review IEEs upon further submission by LGD. All projects are to submit any further materials, if any, as per requirement of DoE toward obtaining the Environmental Clearance Certificate.

13. The Barisal Controlled Landfill subproject is considered to have some potential for environmental impacts therefore must conduct an IEE and prepare EMPs acceptable to DoE as part of the ECC application. Under the ECR DoE has 60 days to respond from the receipt of the ECC application for a Red category project. After obtaining location clearance on the basis of Initial Environment Examination (IEE) Report, the Environmental Impact Assessment (EIA) Report in accordance with the approved terms of reference along with design of Effluent Treatment Plant (ETP) and its time schedule shall be submitted within approved time limit.

14. In short, in a simpler language the timeframe for obtaining ECC is as follows. In case of red category projects, the DOE will issue Location Clearance Certificate (LCC) within 60 days after satisfactory submission of IEE report along with other relevant documents. The DOE will mention a specific timeframe for submission of EIA report in the LCC issued by them. Then in the next step the DOE will issue Environmental Clearance Certificate (ECC) within 60 days after satisfactory submission of EIA report. In addition to fulfillment of other relevant conditions of DOE, Effluent Treatment Plant (ETP) must be designed and its implementation schedule finalized before issuance of ECC from the DOE. Five individual applications for each of the

components in Package – 4 like MWTF in Dhaka, CLRs in Chittagong, Barisal, Rajshahi and Sylhet will be lodged in five local divisional offices with a view to obtaining ECC from these authorities separately.

15. **Other Policies, Plans, and Strategies.** In addition to ECA and ECR, there are a number of other policies, plans and strategies which are applicable to the subproject. These are National 3R (Reduce, reuse, recycle) Strategy for Waste Management 2010, The Local Government (City Corporation) Act 2009, and Medical Waste Management Rules 2008.

16. The National Building Code 2006 and National Labor Act 2006 have defined certain measures to ensure proper safety and work environment as well as the compensation measures to the laborers. By national law, in order to be compensated, Contractors must follow these safety provisions and compensation arrangements. The implementing agency must ensure that the appropriate occupational health and safety provisions have been included in the bidding documents and are being implemented by Contractor. As per the Safe Drinking Water Supply and Sanitation Policy 1998, provision for arsenic free drinking water and adequate sanitation will have to be ensured. The water quality needs to be monitored to ensure that the supplied water is safe for drinking.

17. The summary of environmental regulations and mandatory requirements for the proposed subproject is shown in **Table 1**.

**Table 1: Summary of Environmental Regulations and Mandatory requirements for the Barisal CLF Subproject**

<b>Acts/ Guidelines</b>	<b>Purpose</b>	<b>Applicability to the Subproject</b>
Environmental Conservation Act, 1995 and Environmental Conservation Rules, 1997	<ul style="list-style-type: none"> <li>- main provisions for environmental protection and pollution control in Bangladesh</li> <li>- provides the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed</li> <li>- projects are classified as green, orange or red depending on their location and environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>- As per ECR 1997, it is included the Red Category in item 43 and described as 'Land-filling by industrial, household and commercial wastes'.</li> <li>- Rule 7 states a Location Clearance Certificate and an Environmental Clearance Certificate (ECC) must be obtained from the Department of Environment (DoE).</li> <li>- Recommends standards for disposal of different types of waste.</li> </ul>
National 3R (Reduce, reuse, recycle) Strategy for Waste Management, 2010	<ul style="list-style-type: none"> <li>- The national 3R Goal for waste management is to achieve complete elimination of waste disposal on open dumps, rivers, flood plains by 2015 through mandatory segregation of waste at source as well as to create a market for recycled products and provide incentives for recycling of waste.</li> <li>- The main objective of the 3R Strategy is to delineate ways and means of achieving national 3R goals through providing a uniform guideline for all stakeholders.</li> </ul>	<ul style="list-style-type: none"> <li>- Source segregation is mandatory and gave directives to municipalities to pursue organic waste-recycling projects through composting, refuse derived fuel, and biogas via Public Private Partnerships (PPPs).</li> <li>- It makes clear that medium to large-scale organic waste-recycling projects will be implemented and managed by the private sector. Moreover, the strategy makes recommendations concerning issues such as tipping</li> </ul>



<b>Acts/ Guidelines</b>	<b>Purpose</b>	<b>Applicability to the Subproject</b>
		fees and access to municipal land for recycling projects.
Local Government (City Corporation) Act, 2009	<p>This Act was incorporated under Bangladesh Gazette on 15 October 2009. The act contains four sub-clauses regarding waste collection and management, which have been depicted as follows:</p> <ul style="list-style-type: none"> <li>– City Corporation will take all necessary steps to collect and dispose waste from all the roads, toilets, drains, structures and areas under its jurisdiction</li> <li>– The occupiers of all the structures and spaces within the jurisdiction of the City Corporation will be responsible for removing waste from their possession under the control and supervision of the Corporation.</li> <li>– Corporation will make arrangement for waste collection containers or other type of bins at different places of the city, and wherever such containers or bins are placed, the Corporation will ask the occupiers of the neighboring houses, structures and spaces to dump their wastes into these containers or bins through issuance of a general notice.</li> <li>– All the wastes removed or collected by or under direction of the staff of the Corporation as well as the wastes stored in the containers or bins established by the Corporation will be treated as the property of the City Corporation.</li> </ul>	Construction of CLF is necessary infrastructure to fulfill the responsibility of the City Corporations for collection, transportation and disposal of municipal solid wastes. Municipal solid waste will be collected in the Secondary Transfer Stations for onward transportation to the CLF site of the City Corporation outside the city with a view to arranging a safe and satisfactory disposal.
Medical Waste Management Rules 2008	The main objective is to control overall management including collection, treatment and disposal of medical waste in Bangladesh.	CLF will have a specific section to deal with medical wastes; these hazardous wastes will be collected, transported by special arrangement by the City Corporation and treated separately in the Medical Waste Management section of CLF.

### **C. Scope of the Study**

18. This is the IEE for the Barisal Controlled Landfill subproject. It discusses the environmental impacts and mitigation measures relating to the location, design, construction and operation of all physical works proposed under this subproject. This IEE report will clarify the situation to the Department of Environment and fulfill the requirement for obtaining Location Clearance Certificate and an Environmental Clearance Certificate (ECC) from DOE. This report will identify the potential environmental impacts due to implementation of the subproject and will suggest appropriate mitigation measures.

## **II. DESCRIPTION OF THE PROJECT**

### **A. Type, Category and Need**

19. This is a subproject in the field of solid waste management, and as explained above it has been classified by ADB as Category B because it is not expected to have major negative environmental impacts. Under ADB procedures such developments require an IEE to identify and mitigate the impacts, and to determine whether further study or a more detailed EIA may be required.

20. Improvements in solid waste management facilities are needed in Barisal and in other urban areas in Bangladesh because present services are inadequate. The main problems are that:

- (i) Although house-to-house waste collection by NGOs or CBOs is available in most urban areas, slum dwellers still mainly dispose of garbage on open spaces;
- (ii) Secondary waste collection has not expanded in line with the primary collection service because of inadequate cost recovery and insufficient public or private investment;
- (iii) The interface between private sector primary collection and municipality-run secondary collection systems is also inefficient mainly because of a lack of mechanization.
- (iv) Some improvement in the collection, storage and transportation of solid waste is anticipated after implementation of 4 Secondary Transfer Stations under UPEHSDP in different locations of the Barisal City; but the safe disposal of these wastes in the landfill site has not been properly addressed yet.

21. UPEHSDP will address this issue by implementing modern Controlled Landfill (CLF) in Barisal, which may then be replicated in other urban centers through further subprojects.

### **B. Location, Size and Implementation Schedule**

22. The Barisal CLF subproject will be implemented on the land acquired by the City Corporation with financial support from ADB through UPEHSDP; photographs of the proposed site are attached as Annex 2.

23. Location of the subproject is shown in the following map (Fig 1). The landfill site is located about 5 km far and to the north of Barisal City Center at Puran Para - Gauashawr. It is used as a landfill since 2007. The estimated volume of waste, currently on site is about 37,400 m<sup>3</sup>. The area of the landfill site is surrounded by private land to the south and the west, Herring Bone Bond road to the east (built by City Corporation). A perennial canal named "Sapania canal" is oriented east-west. Total area of land proposed for CLF is 22,258 m<sup>2</sup> (5.5 acres). The shape of the land is nearly rectangular (about 224 meters X 105 meters), which is suitable for construction of Controlled landfill. As per requirement of the EARF selection criteria #8 for waste management, it has been ensured that no habitation or sensitive receptors are within 250 meters of the proposed landfill site. Also it has been confirmed that the landfill (i) will not be constructed in areas where the groundwater table is less than 2 meters below the ground level; (ii) will not be constructed within the flood prone areas; (iii) are not within the environmentally sensitive areas; (iv) will not be constructed within or near water supply wells, and at least 500 meters of any downgraded wells; and (v) will ensure a buffer zone around the landfill with the distance agreed upon with the regulatory agencies. If during construction any of the criteria

cannot be adhered to, specific design options will be taken into consideration. NOC from the DPHE will be obtained if proposed landfill is within or near water supply wells or within 500 meters of any downgraded well.

24. Preliminary design of Barisal CLF subproject has begun in the end of 2012 and has been completed by the end of the year 2013. As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the Design and Supervision Consultants (DSC) team. Construction of the civil works and procurement of equipment would take around 18 months. So the operation of the CLF should therefore begin in late 2015 or early 2016.

### **C. Description of the Project**

25. In Barisal City Corporation, amount of 29,955 tons of solid waste per year is generated from different sources e.g. garbage and kitchen waste from household, plastic and paper materials from commercial areas, municipality etc. whereas total collection of waste around the city is 15,577 tons per year<sup>1</sup>. The wastes are collected by the city corporation and transported to the central disposal site. Usually the wastes are collected from roadside waste bins and households though there are some undefined points around the city where people throw wastes indiscriminately. Under the present situation, there are no secondary transfer stations but in near future four numbers of STSs will be implemented. The CLF site is being developed on the available size of the landfill at present being used for dumping solid waste.

26. Environmental pathway study was conducted to find out the existing condition of the landfill site and take appropriate interventions to be included in the project activities. Currently, a mixture of medical waste and household waste is dumped on an uncontrolled way. The presence of the waste has a negative impact on the environment, agriculture and human health. In particular, soil and groundwater pollution are to be expected.

27. In the pathway study it is been advised that at least the environmental protection measurement mentioned in the following paragraphs should be taken.

28. Physical separation between the pollution and the environment should be guaranteed (gates and fences, covering, trees, etc.);

- Groundwater protection by draining and treatment of the polluted water and leachate:
  - o The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant;
  - o To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.
  - o A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.
- Leachate reducing measurements:

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<sup>1</sup> Data collection by Ecorem-DDC JV

- To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m;  $K < 1.10^{-9}$  m/s).
- No uncontrolled landfill of untreated medical waste:
  - Medical waste should be collected and treated separately and should be disinfected and stored safely. No unauthorised persons and animals may come into contact with medical waste. Disinfected medical waste shall be stored safely in anticipation of future technology (for incineration).
  - Monitoring of quantity and quality of the waste for improving the environmental assessments.

29. Periodic control and measurements on the quality of the surrounding groundwater. Extra measurements can be proposed if negative impacts remain over a certain period of time. All measurements and laboratory analysis are recommended to be executed by an international credited laboratory for quality reasons.

30. The following are the modules used during the preliminary design of the landfill site:

- Module 1: Landfill for Household Waste
- Module 2: Medical Waste Treatment Facility
- Module 3: Area for Medical and Hazardous Waste (Bunkers)
- Module 4: Wheel Washing
- Module 5: Weighing Bridge
- Module 6: Zone for Wastewater Treatment
- Module 7: Pilot Composting Plant

31. **Landfill for Household Waste:** The landfill area will have protective fence of total height 3.00 meters to keep the area free from any trespassers. Surface water drainage ditch will be constructed just inside the protective fence to keep the area dry and free from accumulation of rain water or any other extra wash water within the landfill area. The surface drain will be one meter deep in the natural soil, having bottom width 1 meter, top width 3.5 meters, outside edge slope of 1:1 and inside slope of 2:3. There will be geo-textile lining for the surface drain. Next to the surface drain, one strip of 3 meters width will be kept reserve for installation or construction of utilities.

32. The entire landfill area will be divided into three cells. The cell – 2 and 3 will be developed at the present stage and the cell – 1 will be used for storage of existing waste in the landfill site. Landfill wall will be constructed surrounding the landfill area as well as to separate the two cells. The top of landfill wall will be at a level of 5.25 meters.

33. The landfill area will be backfilled by sand layer of variable thickness to attain a level surface for placing the liner system. The liner system will consist of serially from bottom to top (1) clay layer, 0.5 meter,  $k < 1.10^{-9}$  m/s; (2) geo-textile; (3) drainage layer, 0.4 meter,  $k > 1.10^{-4}$  m/s; (4) HDPE liner, 2.5 mm; (5) drainage geo-composite,  $k = 10^{-3}$  m<sup>2</sup>/s; and (6) drainage layer, 0.4 meter,  $k > 1.10^{-4}$  m/s.

34. The main leachate drainage pipe will be HDPE PN10, diameter 300 mm; and the side leachate drainage pipe will be HDPE PN10, diameter 110 mm. Both of these leachate drainage

pipes will be placed above the HDPE impermeable layer. On the other hand, the groundwater drainage pipe HDPE PN10, diameter 110 mm will be placed below the impermeable layer. Geotextile and filtering material gravel 16/32 will be placed around these pipes to prevent entrainment of sand and soil.

35. There will be inspection well in the junction point of main and side leachate drainage pipes. At the end point, there will be groundwater pumping well to pump the groundwater to surface drain. And the leachate will be pumped from the leachate well to the wastewater treatment plant. Control devices for groundwater and leachate have been incorporated; however, gas monitoring has not been incorporated due to budget constraints.

36. There will be no recycling facilities, only sorting places will be provided. This decision has been taken due to budget constraint as well as lack of adequate space in the landfill site. Wastes like plastics, glasses and tires will be taken out of the landfill site for probable recycling elsewhere.

37. **Medical Waste Treatment Facility:** This unit will contain autoclave for disinfection of disposable materials that will be taken to the bunkers. Plastic materials will be taken to the recycling plant, disinfected and grinded in the chemical disinfection and shredding unit for re-use. Sharps will be disposed in the closed bunkers for burial. Hazardous wastes will also be taken to the specific compartments in the bunkers.

38. **Area for Medical and Hazardous Waste (Bunkers):** This area is reserved for disposal of medical and hazardous wastes. There will be several compartments to deal with wastes from autoclave, ashes from the incinerator, sharps, etc.

39. **Wheel Washing:** Wheels of dump trucks and other vehicles entering the landfill site will be ensured to clean the wheels before ply in the public roads. Vehicles will pass through a depression where water will be available to wet and clean the wheels. There will also be arrangement for spraying water to the wheels and other parts of the vehicles by using water pumps and spraying nozzles.

40. **Weighing Bridge:** Weighing Bridge will be installed near the entry gate to facilitate weighing of the total solid waste carried by the dump truck and to maintain a record of total waste taken to the landfill site. Computerized system of weighing and recording will be there in the Checkpoint Cabin to ensure proper recording in an well maintained database and reporting properly in user friendly formats.

41. **Wastewater/ Effluent Treatment Plant (ETP):** Leachate will be pumped to the collection chamber from the landfill site as well as from the composting plant. Feed pump will be used to transport the leachate from this chamber to the equalization tank. Then treatment of this wastewater will be done by activated sludge method. Methane reactor will be used for separation of methane gas. Sedimentation tank will be used and chemicals like hydrochloric acid, ammonium hydroxide and ferric chloride will added for effective coagulation. Blowers will be used for aeration. Sludge will be recycled from the final clarifier and extra sludge will be returned to the landfill site for drying. The final effluent from the landfill site will meet the effluent standard as per ECR 1997. The general layout plan of wastewater/ effluent treatment plant has been shown in Fig 3.

42. **Pilot Composting Plant:** The overall dimension of the composting plant is 110 meters length X 27 meters width X 5 meters height. It has the following facilities like office room, dressing cum washing room, storage, packaging corner, fixed place for containers, and a big hall room (85 meters X 27 meters) having longitudinal drain passing along one side, etc. There are 3 options for construction namely shelter steel girder (F1), shelter double slab (F2) and pre-stressed beams (F3).

43. **Management of Existing Wastes:** For preparatory step the waste from the cell – 1 will be transported to the cells 2 and 3 temporarily for placement of impermeable clay layer in the bottom of Cell – 1. Then the existing wastes of the entire landfill site will be transported to the landfill Cell – 1 located in the North West corner of the site. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.

44. No additional chemical or heavy metal testing has been planned as part of the subproject because of the fact that there was no indication of presence of these kinds of wastes in the samples used for characterization of wastes in the pathway studies.

45. Implementation of small transfer stations under the separate package in UPEHSDP is anticipated to lead to a 50% reduction in operating cost of secondary collection services per tonne. This will free up significant resources to expand the coverage and quality of secondary collection services, as well as to pay for the operating and maintenance costs of the integrated waste treatment and disposal facility.

46. Modern electrical, mechanical machineries and equipment are also included in the subproject to operate the CLF to modern sanitary standards.

47. Figures 2 to 12 provide preliminary site layout plans including plans and different sections for medical waste treatment plant and the compost plant.

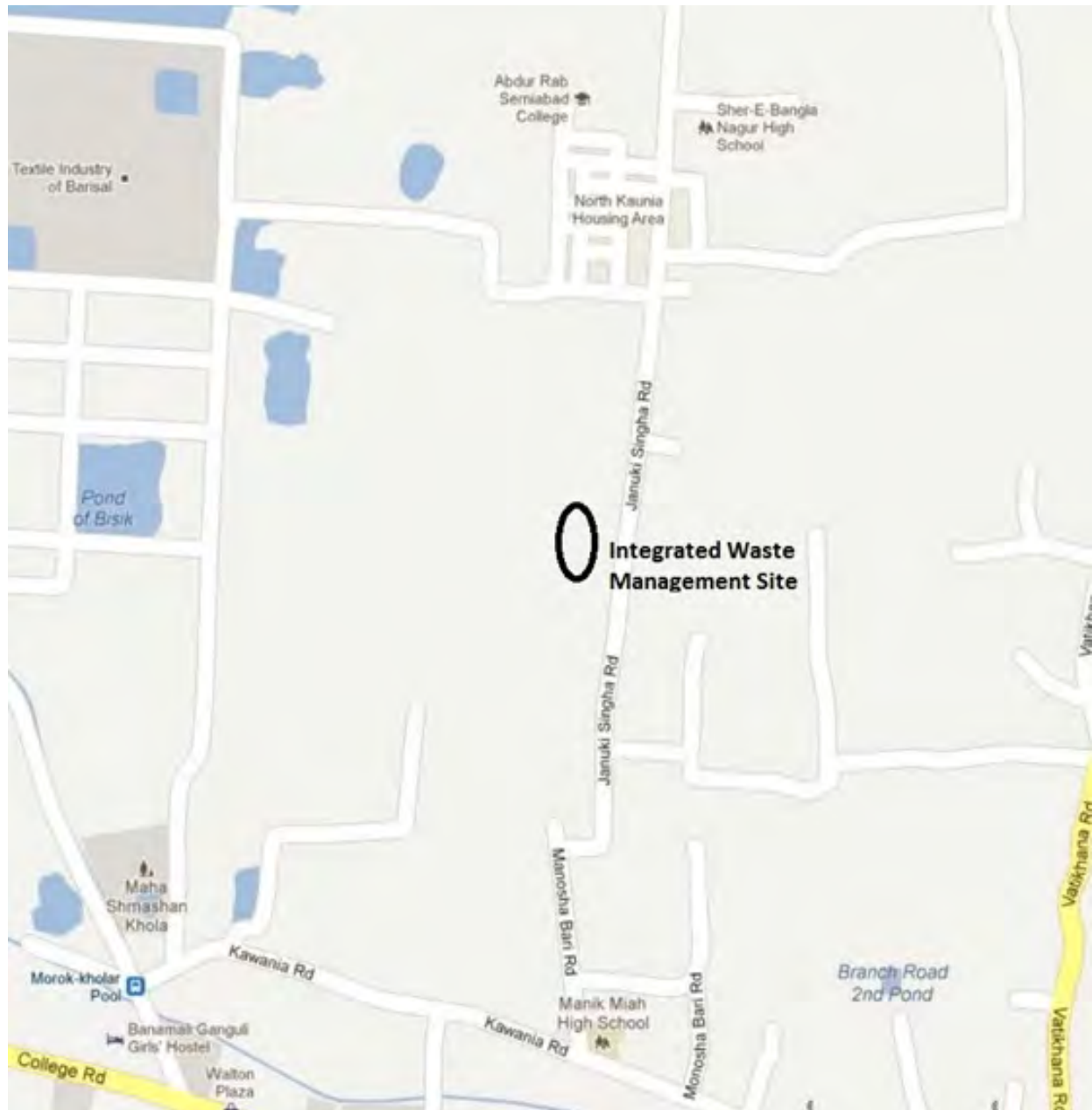


Fig 1: Controlled Landfill Site of Barisal near Kawania ( $22^{\circ}43'42''\text{N}$ ,  $90^{\circ}22'2''\text{E}$ )





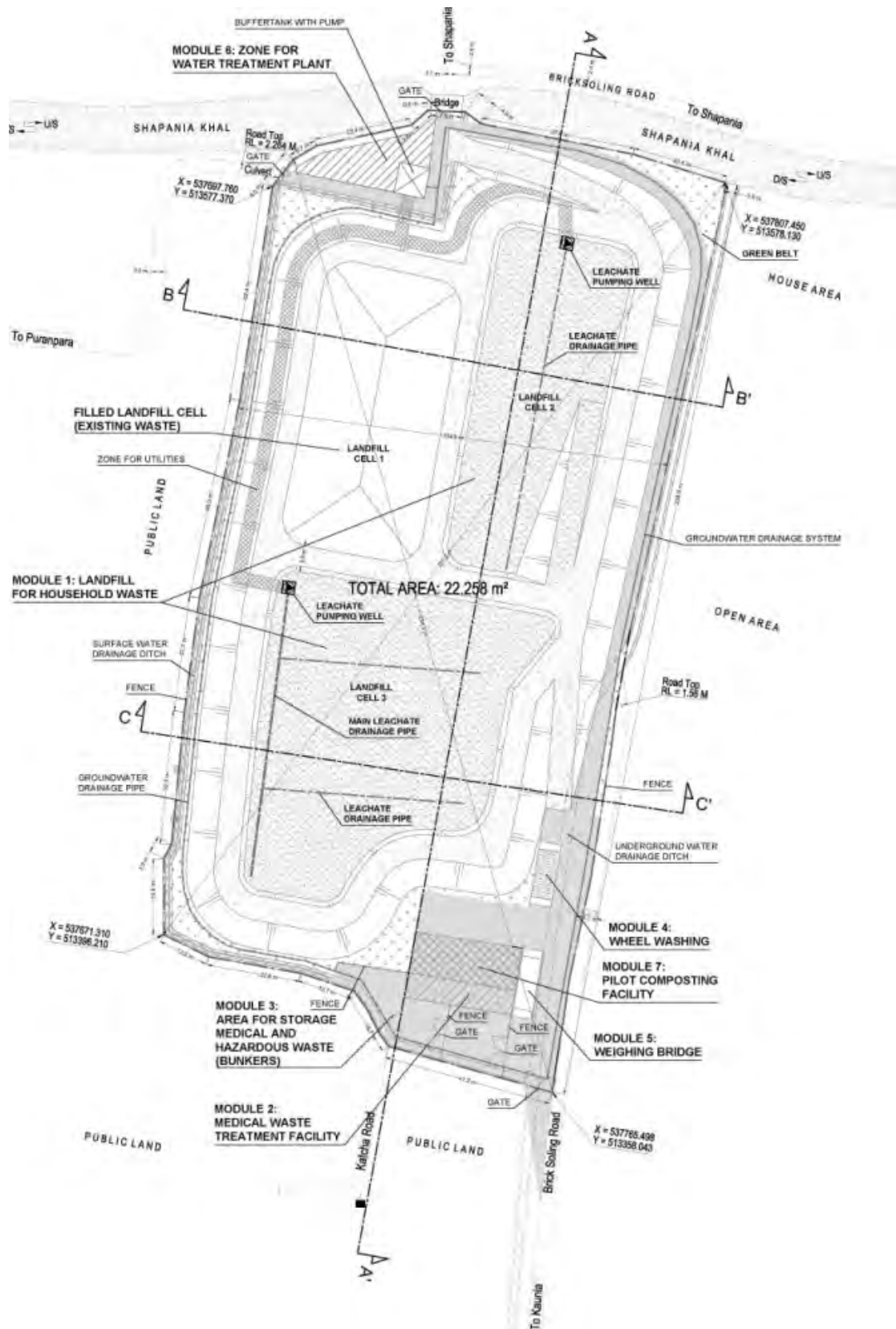


Fig 3: General Layout Plan

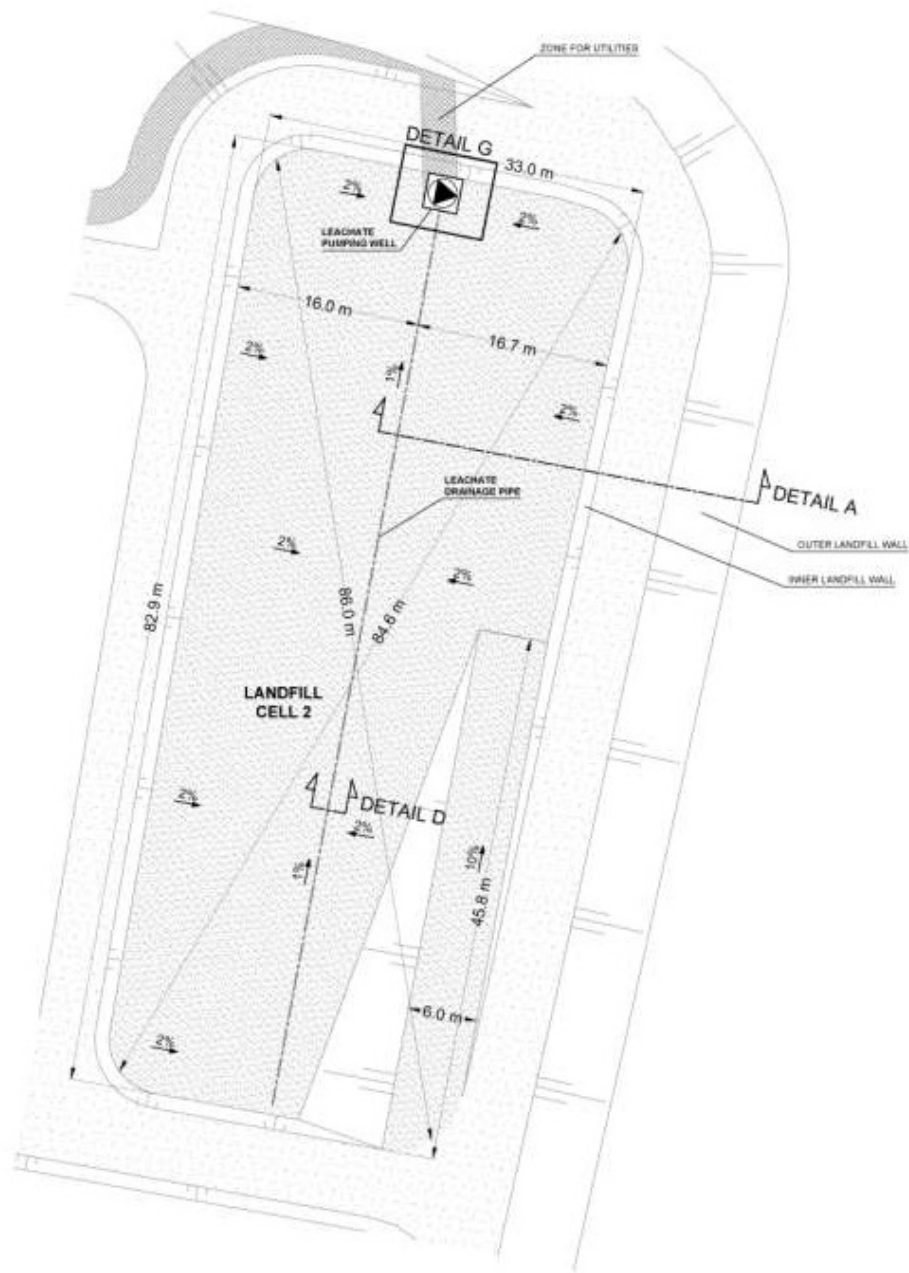


Fig 4: Cell 2 Details

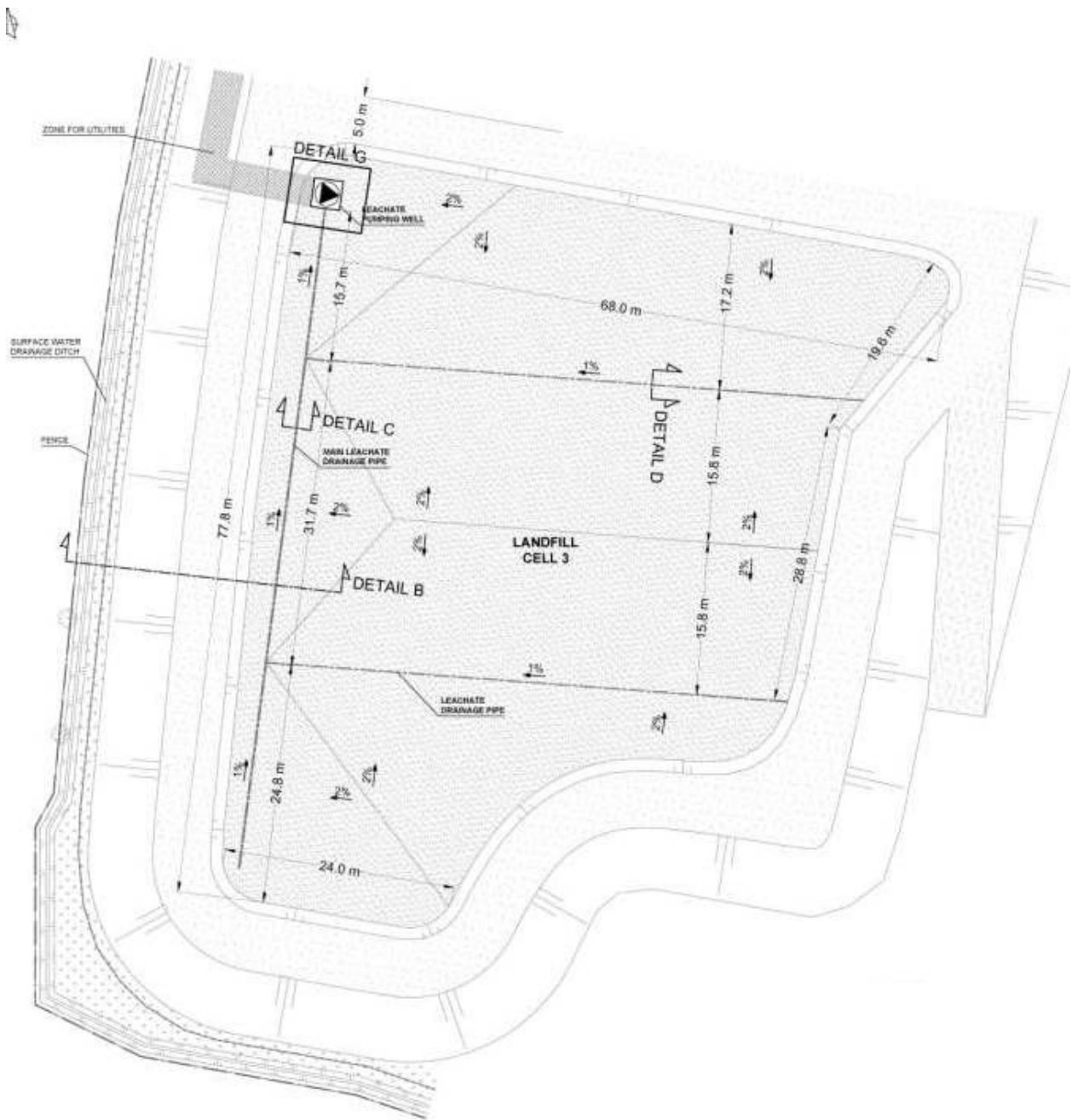


Fig 5: Cell 3 Details

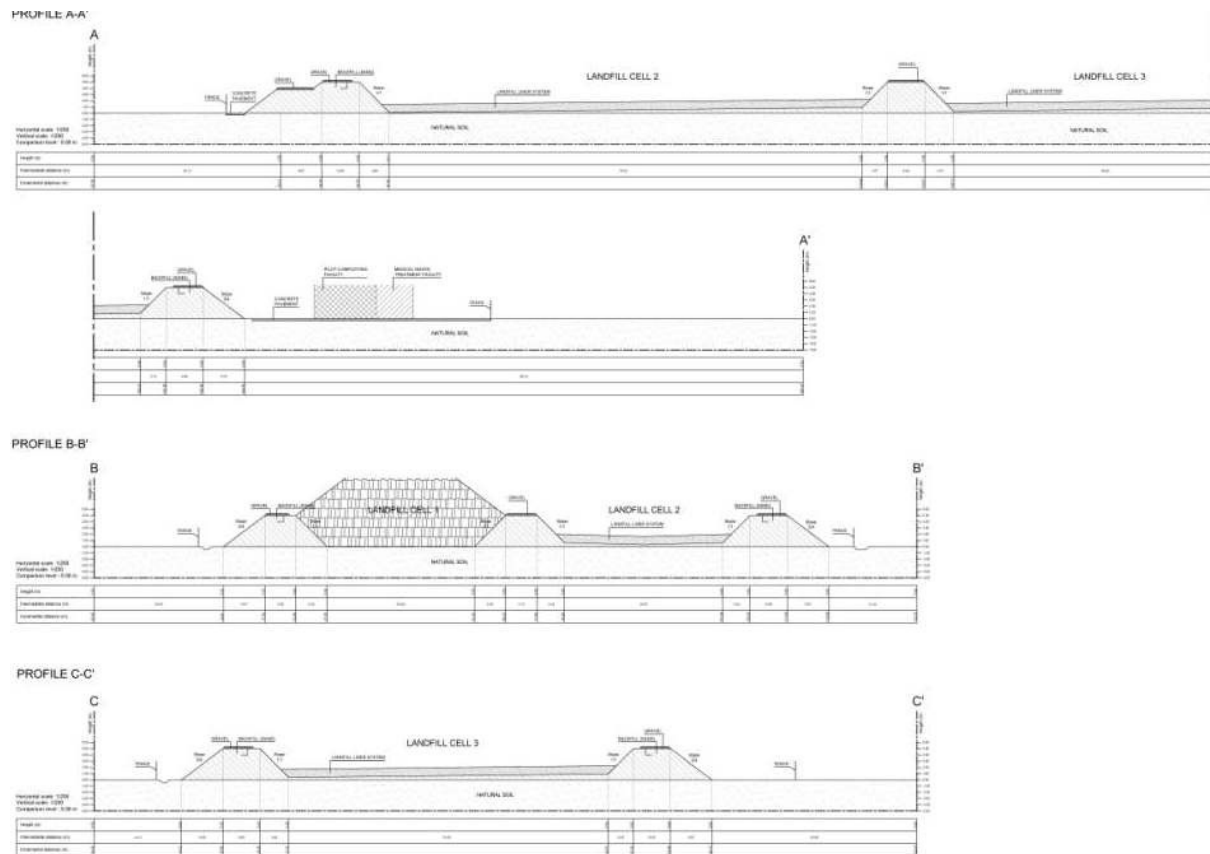


Fig 6: Landfill Sections

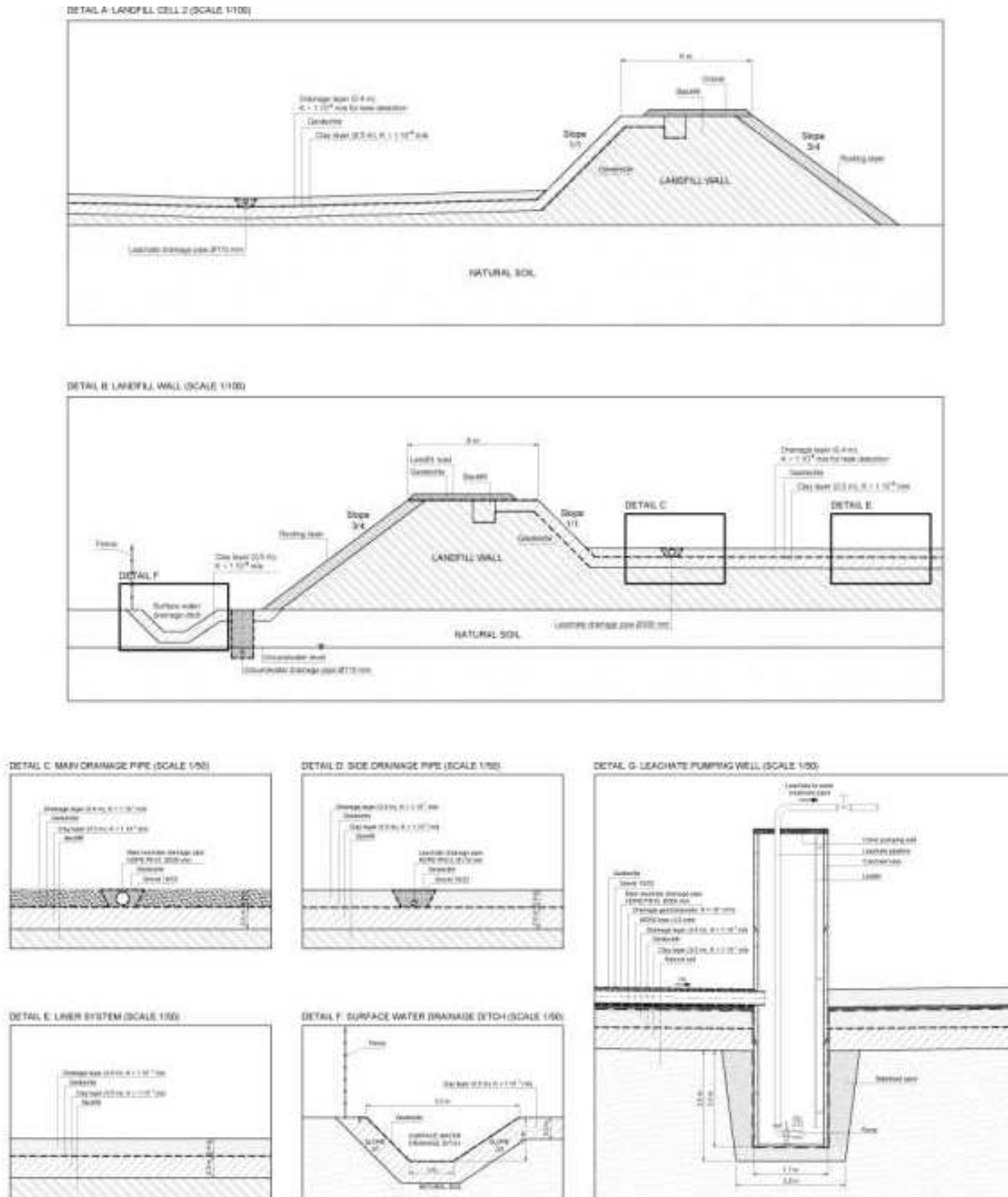


Fig 7: Landfill Technical Details

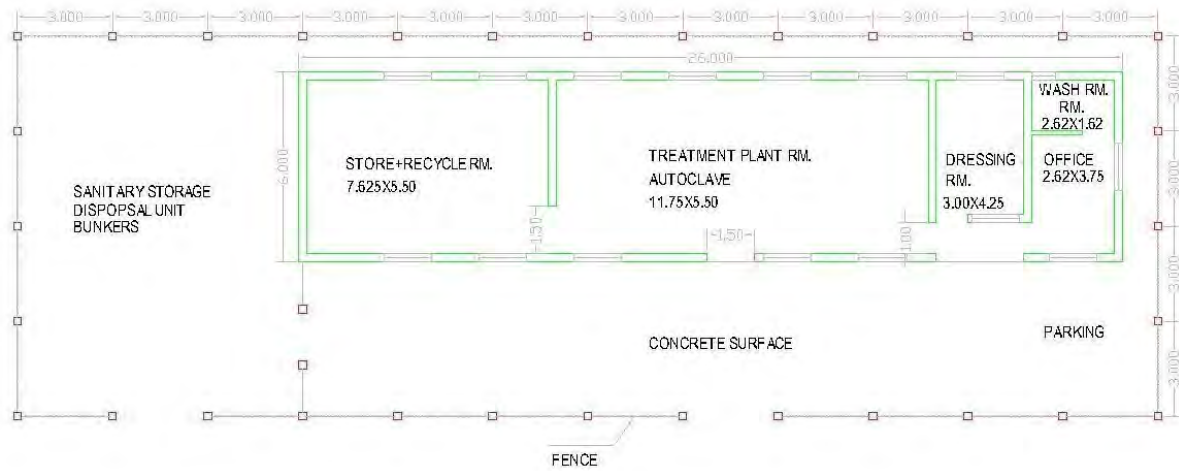


Fig 8: Medical Waste Treatment Plant

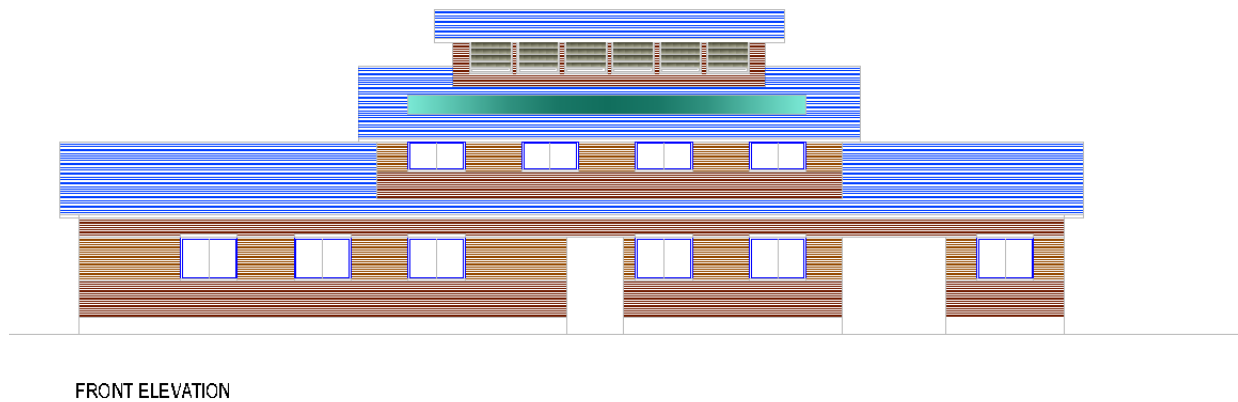


Fig 9: Front Elevation



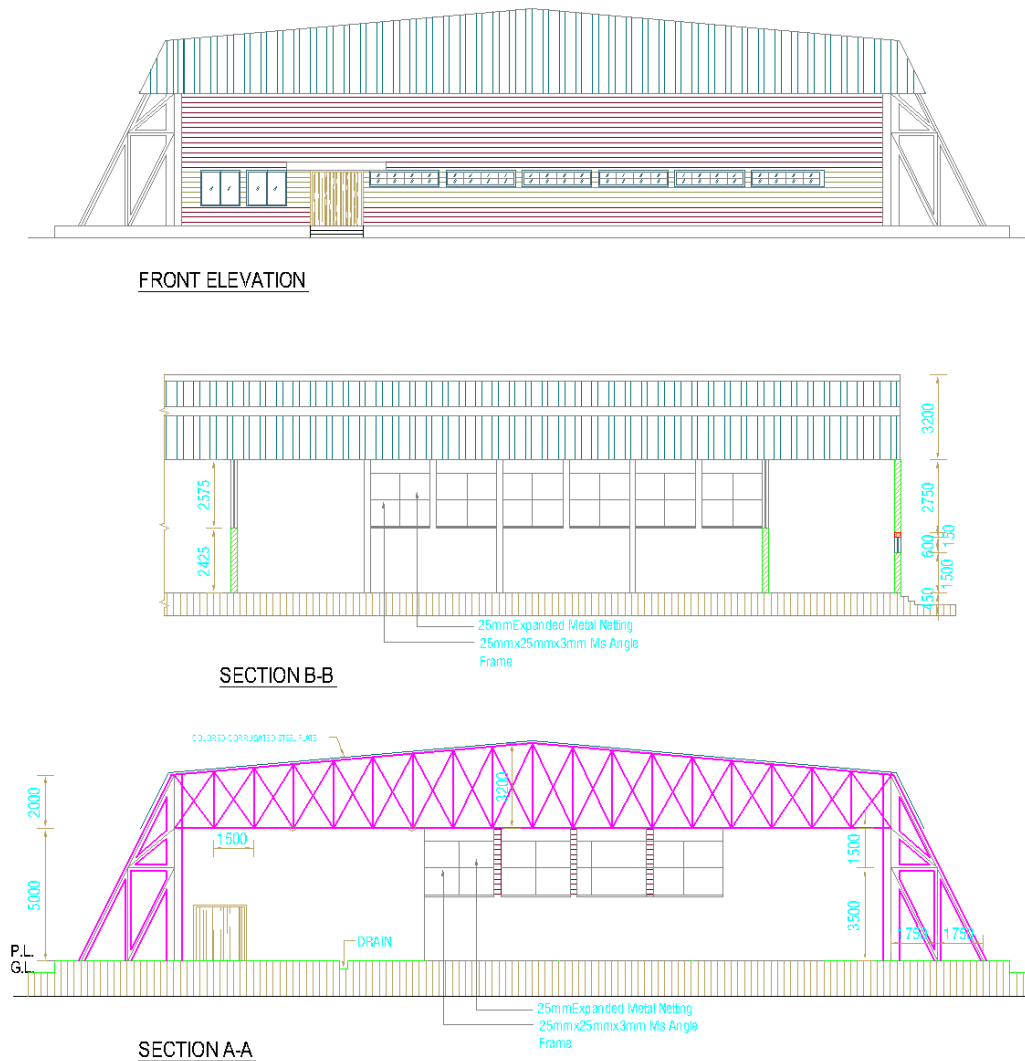


Fig 12: Elevation and Sections of Composting Plant

### III. DESCRIPTION OF THE ENVIRONMENT

#### A. Physical Resources

##### 1. Topography and Soils

48. The part of Bangladesh to which the city of Barisal belongs is dominated by the rivers Ganges, Jamuna and Meghna, which drain large quantities of water from the Himalayan Mountains into the Bay of Bengal, through a complex delta system of tidal tributaries and creeks, formed by sediment deposited by the rivers. Known as Gangetic-Bengal Plain, this part – the south central region – is flat and low lying particularly around the delta, which floods extensively in the rainy season.

49. Figure 13 representing the bio-ecological regions of Bangladesh shows the Ganges-Bengal Floodplain (4b) where the south central region, accommodating the city of Barisal,



belongs. This region of Bangladesh comprises the most productive ecosystems of the world. The landscape is formed on recent Gangetic estuarine sediments. Soils are therefore alluvial, and fine and loamy on ridges, but more clayey in depressions. The sub-soils at the proposed sites have a significant amount of clay mineral adequate as a material liner for a sanitary landfill site. The influence of the rivers is evident in the soils which are generally fertile. More than 70% of the sediment load of the region is silt; with an additional 10% sand<sup>2</sup>. Because of the sediment discharge and strong current, the morphology of the zone is very dynamic and thus erosion and accretion rates in the area are very high.

50. The topography of the proposed CLF site is flat and at grade with the adjacent and approach road. No elevation changes occur within or around the site. The subsurface is characterized by sandy clay with silt and very fine sand particles.

51. The type of soil available around the site of CLF is sandy soil, which is suitable for earth filling during construction activities. This soil will also be very good for covering the waste during the operation phase. Huge quantity of backfilling soil may be collected from dredging of soil from river bed. But additional clay will be required to be brought from outside.

## **2. Climate**

52. The climate in the subproject area is humid and sub-tropical, with a typical three season pattern. During the winter season (November-February), cool winds blow from the north-east. The weather is cool and dry. Rainfall, however, shows variations over the last decade (2001-2011) between 67 mm in November 2002 and 0 mm in February 2011. Average temperatures show, over the same period, variation between 23.1°C in November 2006 and 16.5°C in January 2003. Temperatures start to rise in March and reach the annual maximum of around 29.9°C in April-May, when daytime temperatures can exceed 35°C. Rainfall also increases, and this period is characterized by unstable weather. The monsoon begins in May-June as hot air rises over the Indian subcontinent, creating low pressure areas into which rush the cooler moisture-laden winds from the Indian Ocean and the Bay of Bengal. Around 70-80% of the annual rain falls during this time. The rain is often accompanied by strong winds, sometimes exceeding 100 km/h. Temperature and rainfall both decline post-monsoon, returning rapidly to the winter lows.

53. Wind data from the Bangladesh Meteorological Department Climate Division suggests that wind directions vary month-to-month in Barisal, though predominantly in the NW, S, and NE directions. As the CLF will be located far from the city center and properly maintained, windborne odor will get minimized.

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<sup>2</sup> Source: Internet.



Fig 13: Bio-ecological Map of Bangladesh

Source: Internet

54. Although weather patterns are broadly similar throughout the country, differences in topography, winds and other factors produce some quite marked local variations. This is particularly evident in the annual rainfall of around 2,537 mm in Barisal. Relative humidity, average dry bulb temperature, maximum and minimum temperatures and rainfall patterns are represented as under based on the raw data obtained from the Bangladesh Meteorological Department (Figures 14, 15, 16, 17 and 18)<sup>3</sup>.

<sup>3</sup> Source of raw data (Fig. 14,15,16,17 and 18): Bangladesh Meteorological Department, July 2012.

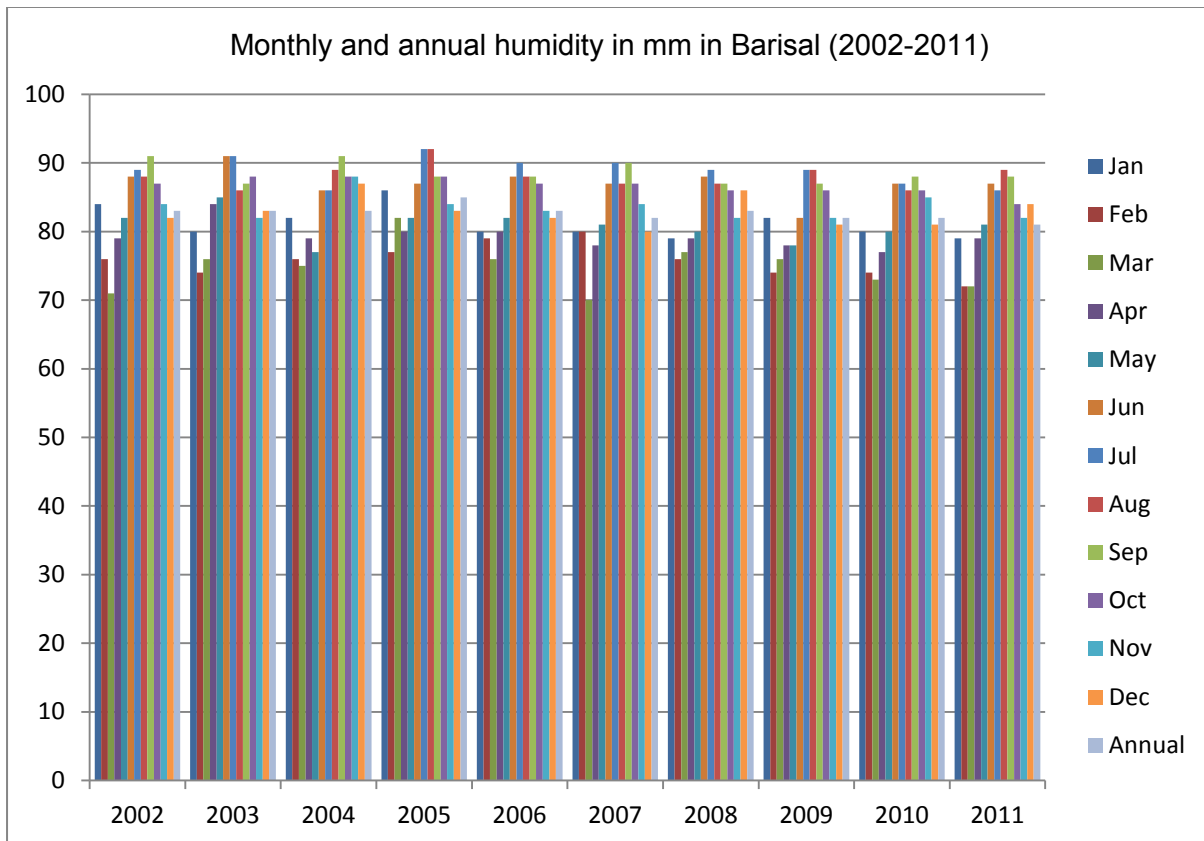


Fig 14: Monthly and annual humidity (%) in Barisal (2002-2011)

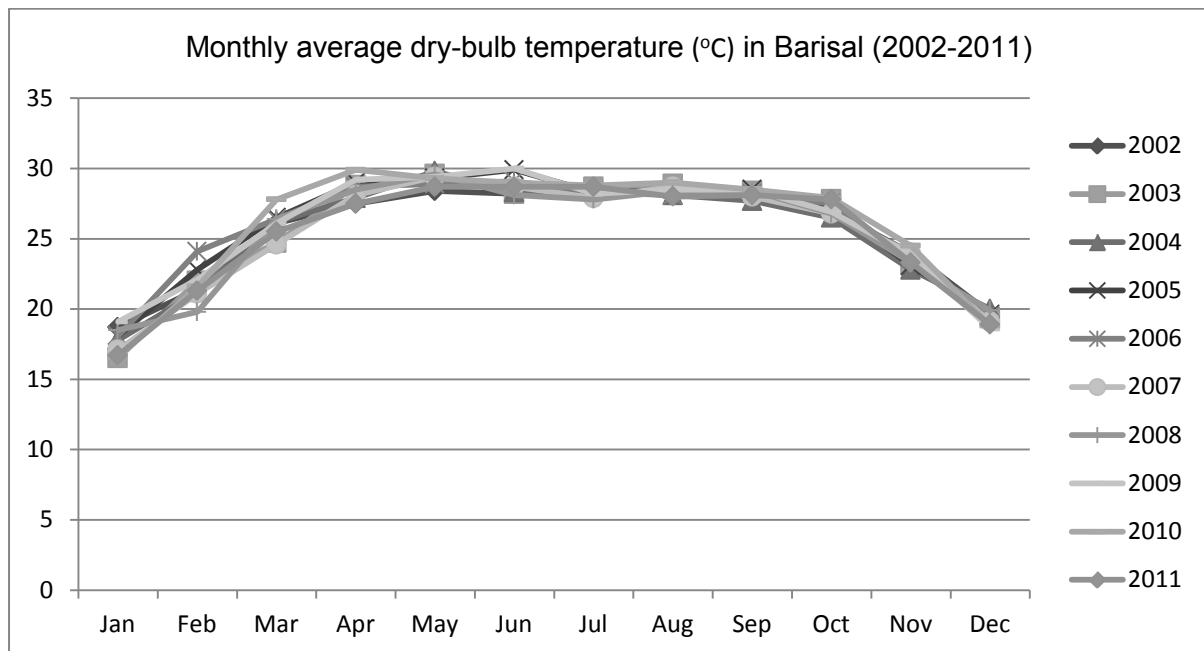


Fig 15: Monthly average dry bulb temperature (°C) in Barisal (2002-2011)

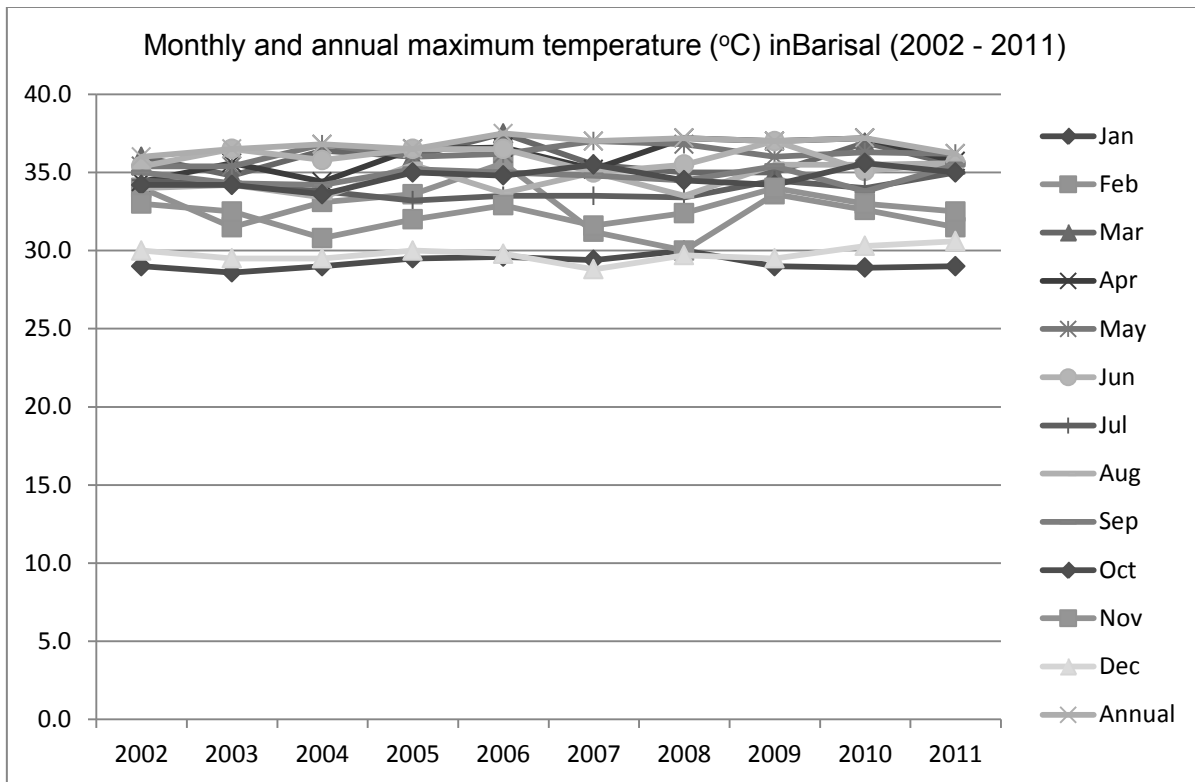


Fig 16: Monthly and annual maximum temperature (°C) in Barisal (2002-2011)

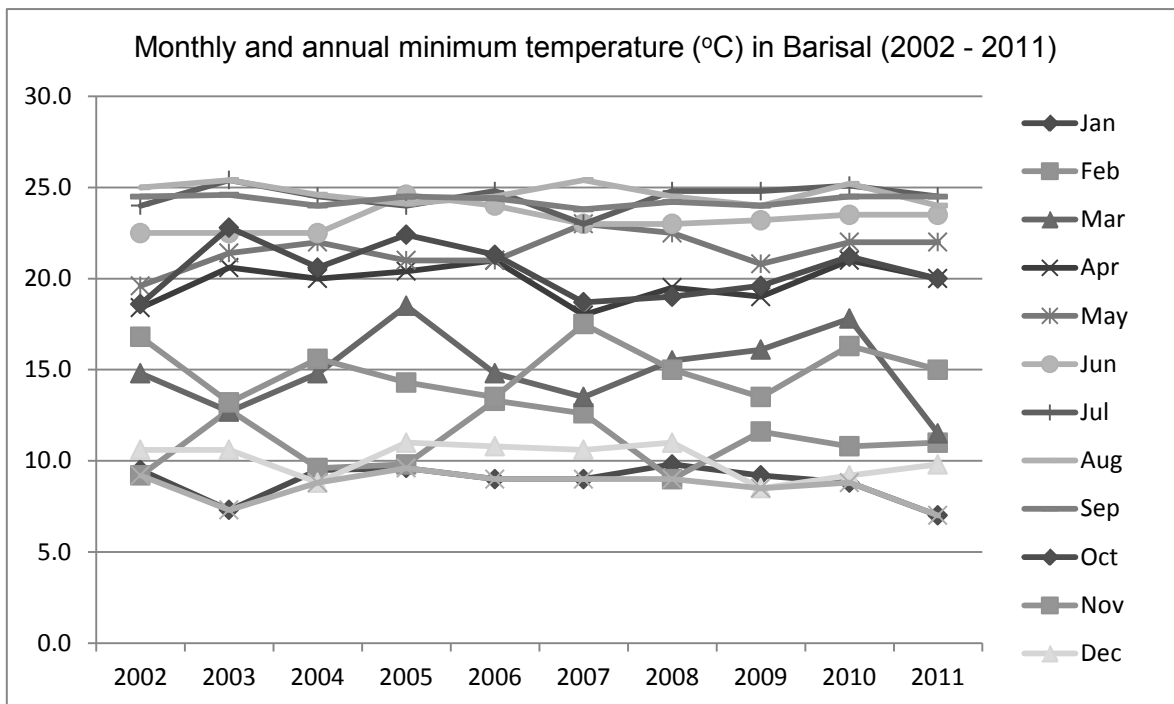


Fig 17: Monthly and annual minimum temperature (°C) in Barisal (2002-2011)

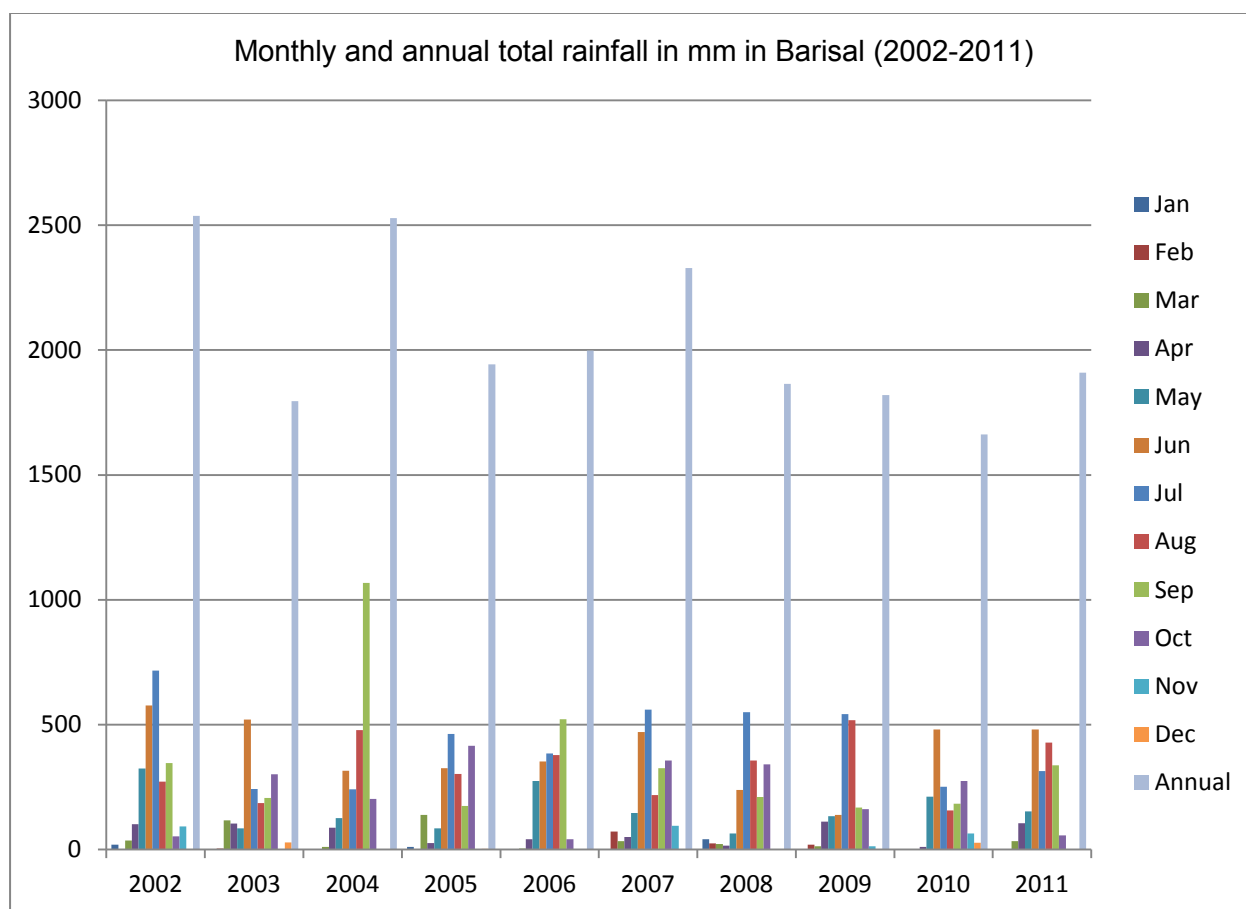


Fig 18: Monthly and annual total rainfall (mm) in Barisal (2002-2011)

### 3. Air Quality

55. Air quality is far better in the city of Barisal compared to those in cities of Dhaka, Chittagong and Rajshahi where rapid pace of urbanization, industrialization and overcrowding create major air quality problems. In 1988 the World Bank estimated that 15,000 deaths per year and a million cases of major illness are caused by air pollution in Dhaka, Chittagong and Rajshahi.

56. The main atmospheric pollutants are those produced by vehicles and industries and in particular by the burning of fuels. These include particulate matter, hydrocarbons, carbon dioxide, carbon monoxide, sulphur dioxide, oxides of nitrogen, lead, ammonia and hydrogen sulphide. Many of these cause respiratory problems in humans, plus other diseases if substances accumulate in the tissues. The main causes of the poor air quality are:

- (i) Poor roads and traffic management leading to severe traffic congestion;
- (ii) Use of high sulphur diesel by buses and trucks, and inadequate control of emissions;
- (iii) Heavy industrialization, and use of cheaper high-sulphur fuels (coal, wood and tyres) by smaller industries like brick kilns; and
- (iv) Poor solid waste management, so burning is the common method of treating garbage.

57. Surveys by the DoE show levels of Suspended Particulate Matter (SPM) and sulphur dioxide (SO<sub>2</sub>) in Barisal and other cities exceed Bangladesh Air Quality Standards, and levels of atmospheric lead are above World Health Organization (WHO) standards. These should fall over the next few years however, as laws are enforced reducing the number of two-stroke vehicles, and consumers change to vehicles using lower cost unleaded petrol and compressed natural gas.

#### **4. Surface Water**

58. The major surface water hydrology related to the city of Barisal is due to its location on the western bank of the river Kirtankhola and because of its topography, flood-risk and population density, the quality and quantity of surface waters are the prime issues for this city. Analysis results of the surface water samples collected from the Launch Ghat location of the city on 3 January 2011 during both low-tide and high-tide periods by the Barisal Divisional Office of the Department of Environment<sup>4</sup> show pH values 7.4 (low-tide) and 7.3 (high-tide), total alkalinity 38 mg/l (low-tide) and 32 mg/l (high-tide), DO 9.0 mg/l (low-tide) and 8.7 mg/l (high-tide), BOD 5.4 mg/l (low-tide) and 2.9 mg/l (high-tide), COD 150 mg/l (low-tide) and 64 mg/l (high-tide). Corresponding standard limits, as per Environment Conservation Rules, respectively, are: 6.5-8.5, 150 mg/l, 4.5-6.0 mg/l, 50 mg/l, and 200 mg/l.

59. The distance of the proposed CLF and effluent discharge point to the river Kirtankhola is about 4 kilometers. The leachate from the CLF will be treated and allowed to drain through the Sapania Khal passing from the north side of the CLF site. The Sapania is a perennial canal although the flow in the dry season is slightly less. There is high tide and low tide due to the influence of the Bay of Bengal. Downstream end of the khal falls in the Kirtankhola and the upstream falls in the Lakutia Khal and finally reaches the original river again. The width of the khal is about 35 ft and depth about 15 ft. The water is usually turbid and turbidity increases during the monsoon. The users of the river water are very few for boating only and in rainy seasons, which will not be impacted due to drainage of treated leachate from the landfill site.

#### **5. Groundwater**

60. There are three main aquifers in the central region of Bangladesh:

- (i) An upper (composite) aquifer, which can reach depths of 50 m and is covered with an upper silty clay layer of less than 20 m;
- (ii) A middle (main) aquifer of fine to heavy sands, which is generally 10-60 m thick and in most areas is hydraulically connected with the composite aquifer above; and
- (iii) A deep aquifer of medium, medium-to-fine or medium-to-coarse sand, which is generally found at depths below 100 m.

61. Except Dhaka where 80% of the domestic water supply is obtained from the middle aquifer, extracted by tube-wells throughout the city, elsewhere in the country, domestic water in urban areas is mainly abstracted from the surface and middle aquifers, which in many cases (including Rajshahi, Khulna and Barisal) are contaminated by naturally-occurring arsenic, iron and aluminum, plus sewage bacteria, pesticides and industrial chemicals. Groundwater tables often fall by several meters in the dry season, exacerbated by excessive drawdown by tube-

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<sup>4</sup> Department of Environment, April 2012.

wells. Supply of potable water is an increasing problem for the water and sewerage authorities because of the depleting supplies and source contamination.

62. Supply of potable water is an increasing problem for the water and sewerage authorities because of the depleting supplies and source contamination. Water for the CLF will initially be sourced from city corporation water supply but the contractor will arrange for digging well within the site for construction of CLF. The necessary clearance for digging well will be taken from the city corporation. The ground water table in CLF site is far more than 2 meters below the ground levels; so there is no risk of contamination of ground water resources during the operational stage of the CLF.

## **6. Geology and Seismology**

63. The National Seismic Zoning Map (Fig 19) produced by the Geological Survey of Bangladesh (GSB), divides the country into three regions: a high risk zone between Mymensingh and Sylhet in the north and north-east; a medium risk zone stretching diagonally from Rajshahi in the north-west through Dhaka and Comilla to Chittagong and Cox's Bazar in the south-east; and a low-risk zone in the south and south-west, around Khulna and Barisal. Seismic events in Bangladesh are relatively infrequent but historically have been severe. The Assam earthquake of 1897 was the largest in the region's history, when a force of 8.7 on the Richter scale caused extensive damage across Assam, Bengal and Bihar.

64. The record of approximately 150 years shows that Bangladesh and the surrounding regions experienced seven major earthquakes (with  $M_b = 7$ ). In the recent past, a number of tremors of moderate to severe intensity had already taken place in and around Bangladesh. The Sylhet Earthquake ( $M_b = 5.6$ ) of 8 May 1997, the Bandarban Earthquake ( $M_b = 6.0$ ) of 21 November 1997, the Moheshkhali Earthquake ( $M_b = 5.1$ ) of 22 July 1999, and the Barkal (Rangamati) Earthquake ( $M_b = 5.5$ ) of 27 July 2003 may be cited as examples. Fortunately the Barisal region is far from these earthquake incidences.





Fig 19: National Seismic Zoning Map of Bangladesh



## **B. Ecological Resources**

### **1. Habitats**

65. The main physical features of Bangladesh are its mainly flat and low-lying topography, the dominant presence of the major rivers that drain enormous catchments in surrounding countries, a seasonal monsoon that swells river volumes for several months each year, and the resulting floods that inundate large areas of land. It is not surprising therefore that those aquatic habitats are the country's most important ecological resources.

66. There is a wide array of aquatic habitats throughout the country: natural and man-made, permanent and ephemeral, of varying sizes and characteristics. The rivers and floodplains are the most important, as they support species that are exploited by man, are the most productive of the habitats, and attract other important species, such as birds. However, as in other environmental sectors, the rapid urbanization and industrialization of the country and its expanding population (particularly the urban poor who use natural resources to supplement both food and income) have brought large scale damage and degradation to these areas.

67. In both Khulna and Barisal the estuarine landscape was once dominated by mangrove trees, but these have been mainly cleared over the past 250 years as the swamps have been filled to provide land for development. These processes has removed a highly productive and important habitat, leaving an urban area that is a source of pollution and further habitat degradation, plus borrow pits that cover around 10% of the land and are used for aquaculture or as refuse dumps. There are no sensitive ecological features in the surrounding area of the CLF site. The area is generally urban in nature.

### **2. Rivers**

68. Most rivers in Bangladesh suffer under the influence of man, from the disposal of solid and liquid waste in urban and industrial areas around Barisal and the other cities and towns, and from the diversion of water upstream for irrigation and/ or power generation.

69. All the rivers support various faunal varieties including fish such as carp, catfish, loach, *hilsa* and shrimp, plus a variety of invertebrates and insects that have been little studied. It is not surprising that the ecology of the rivers has deteriorated under continued pressure exerted on them, and declining fish catches (from pollution, habitat degradation and over-exploitation) are just one indicator of the malaise.

70. Rivers nearer the coast, most of which being tidal in nature, such as the Kirtankhola in Barisal are subject to pollution by sewage and urban and industrial effluents.

71. Possibly the only reason why the major rivers have not become dead zones devoid of aquatic life is because of the cleansing effect of the seasonal monsoon, and, together with such a seasonal phenomena, in the case of the city of Barisal, the tidal effect. Both the processes facilitate very large quantities of water down the rivers, which dilutes the pollutants and transports them rapidly downstream, providing some temporary respite from the cocktail of chemicals that is present throughout the rest of the year.

### **3. Floodplains**

72. Floodplains are the natural lowlands alongside rivers, which are inundated each year in the monsoon as the increased volumes of water overflow river banks. These zones are important ecologically as they are the areas into which the adults of many species of fish migrate to breed. Floodplains are rich in nutrients from the inundated soil and decaying vegetation, and are also rich in food in the form of dead insects, soil invertebrates, and aquatic plankton that frequently bloom under such conditions. They are also protected from the strong currents in the main river, so are ideal areas for young fish to feed and grow, before entering the main river when water levels decrease. These areas also frequently attract large numbers of water birds, to feed on the juvenile fish in the shallow waters.

73. Like elsewhere in the country, floodplains in and around the Barisal city have been affected and degraded by flood protection schemes, land reclamation and urban development.

### **4. Other Aquatic Habitats**

74. There are a variety of other aquatic habitats throughout the country, and in urban areas these include man-made lakes in residential neighborhoods, permanent and ephemeral pools in natural lowlands (known as *bheels*), and flooded borrow pits excavated for building material. These are generally of little ecological value as the water is frequently polluted, and these areas are often characterized by dense growths of the water hyacinth *Echicornica crassipes*, which out-competes other plants through its rapid growth, although species such as water chestnut and lotus can be seen in places.

### **5. Terrestrial Ecology**

75. There are somewhat insignificant numbers of natural terrestrial habitats in and around inhabited areas of the city, because in most cases vegetation was cleared many years ago to provide land for development, and for agriculture in the suburbs. Terrestrial plants are now mainly limited to trees, shrubs and flowers grown alongside roads and in parks and gardens, and the crops and fruit trees planted in agricultural areas. The urban terrestrial fauna is very limited as a result, and mainly consists of animals able to live close to man, such as lizards and geckoes, scavenging birds like house sparrow and crows, mice, rats and other rodents, plus jackal, mongoose, squirrel and monkeys. There is a wider range of species in the farming areas, but even these are mainly animals that are commonly found close to man, such as cattle egrets.

### **6. Protected Areas and Endangered Species**

76. Some well known heritage sites are as follows: Rammohan Samadhi Mandir, Sujabad Kella, Sangram Kella, Sharkal Fort, Girja Mahalla, Bell's Park, Ebadullah Mosque, Kasai Mosque, Oxford Church, Shankar Math, Kali Bari of Mukunda Das, Joint Mosque at Bhatikhana, Aswini kumar town hall, Charkella, Durgasagar Dighi and one domed Mosque (Kasba). None of these heritage sites are in the close proximity of any of the proposed site for CLF.

77. The famous Kuakata beach is about 100 km far from the Barisal city. The remainder of the region consists of plains. The proposed CLF is located in the plain area thus there are no endangered species. Flora and fauna found in the subproject site are commonly found in developed and urban areas.

## **C. Economic Development**

### **1. Industry**

78. Compared with the rest of the five cities of Dhaka, Barisal, Khulna, Sylhet and Rajshahi, industries in the city of Barisal are insignificant in number.

79. Barisal is a rice producing center of Bangladesh. Balam (a kind of baasmati) is the most popular rice in Barisal. It is also famous for Betel Leaf, a typical south Asian chewing item. As Barisal is surrounded by river so fish is plenty in there. It is said "Dhan (paddy) Nadi (river) Khal (canal) ai tine Barisal." Means, paddy, river and canal these three things make Barisal. Coconut is very common in there as it is a coastal area. Hog Plum in Barisal is very famous.

80. The main exportable items are: fish, medicine, Empty Gelatine Capsules by Global Capsules Ltd., Biri (local tobacco) by Amrita Biri and Karokor Biri Factory, AMRITA Food, Branded all Spices, Sunflower oil, Atta, Maida, Bhutta powder-Suzi and handicrafts.

### **2. Infrastructure**

81. Like in most of the towns and cities in Bangladesh, infrastructure in the city of Barisal is a major problem where many facilities are inadequate to serve the needs of such a large population, after decades of under-funding and neglect.

82. Although the country has made significant progress in improving access to safe drinking water, but problems remain, particularly in the Barisal city with a significant chunk of the urban population, especially, the lower middle class and slum dwellers without access to piped water supply. Piped water is only provided in urban areas, and availability is often limited to a few hours per day or less, and treatment is rudimentary at best (typically by settlement of solids and addition of chlorine). Although 60% of urban slum-dwellers are reported as having access to piped water, surveys show that the average is one source per 76-110 households. The deficiencies of the water supply system therefore mean that most urban and rural households still collect a substantial proportion of their water from tube-wells and much of this is used without further treatment such as boiling.

83. There are open concrete storm drains alongside main roads in the city, but most are poorly maintained and blocked with silt and garbage, so they frequently overflow during rain. Even those that function are unable to cope with the volume of the monsoon rains, and flooding is frequent in the wet season. Many smaller towns and villages do not have a formal drainage system and storm water is left to stand in the streets and drain away gradually into natural creeks and ditches.

84. In the landfill site, there is one facility for collection of medical waste with inadequate capacity and with very poor and unhygienic management. It is expected that new medical waste treatment facility and compost plant will be installed in the sanitary landfill site to be developed under the UPEHSDP. At present, there are no transfer stations in BCC area but the collection, transportation and disposal of solid waste will be improved substantially after implementation of the CLF proposed in this subproject.

### **3. Transportation**

85. Barisal airport is not an international airport. Previously Bangladesh Biman and Air Parabat used this port for their flights from Barisal to Dhaka and Chittagong but now no more in operation.

86. Many Bus companies connect Barisal to other districts. Some of them are: Sakura Paribahan (Barisal-Dhaka) [AC/NON AC], Surovi Paribahan (Barisal-Dhaka) [AC/NON AC], Eagle Paribahan (Barisal-Dhaka), Druti Paribahan (Barisal-Dhaka), Hanif Enterprise (Barisal-Dhaka), Ilish Paribahan (Barisal-Dhaka), Sonartori Paribahan (Barisal-Dhaka), Saudia Paribahan (Barisal-Chittagong) [AC/NON AC], Tuhin Paribahan (Barisal-Rajshahi), Padma Paribahan (Barisal-Rajshahi), Sagorika Paribahan (Barisal-Sylhet), BRTC (Barisal-Chapainawabganj), BRTC (Barisal-Rangpur,Bogra), BRTC (Barisal-Dhaka), etc.

87. River is also a popular transport system with other districts. The luxurious launch journey connects between the south and Dhaka city. It is one of the most enjoyable night journeys ever anybody could get in his/her life. The launches are really royal, majestic and with pomp and pleasure. Some royal launches are: Sundarban 7, Sundarban 8, Surovi 6, Surovi 7, Surovi 8, Parabat 2, Parabat 7, Parabat 9, Parabat 11, Kirtonkhola 1, Kirtonkhola 2, Kalam Khan, Dipraj, etc.

### **4. Land Use and Site-specific Existing Condition**

88. The existing land use of the CLF site is established as landfill site, which is being used since the year 2007. There is one dilapidated medical waste treatment plant, which is no more in any kind of beneficial use. There are no existing structures or sheds used by the waste pickers/scavengers.

### **5. Power Sources and Transmission**

89. Like all other towns and cities of Bangladesh, the Bangladesh Power Development Board (BPDB) is responsible for the generation of power and distributes electricity to retail customers, as well as to the Rural Electrification Board (REB) in the city of Barisal. Power is provided to most urban areas through a network of electricity pylons and poles, mainly located beside roadways. This provides connections to individual houses, and revenue collection is by individual household meters. Generation is insufficient to offer a continuous supply, and the providers operate a system of “load-shedding” whereby they turn off the supply for 1-2 hours each day to conserve the resource. However, quite an insignificant number of hotels, businesses and the more wealthy residents use their own generators to augment the supply from the national grid.

### **6. Other Economic Development**

90. Agriculture is important in parts of the urban fringe of the city. Rice is the most important crop and farmers plant varieties with different flood tolerances (developed by the Bangladesh Rice Research Institute) in different seasons to obtain two or even three harvests. *Aus* rice is grown in March to June, followed by the flood-tolerant *Aman* in July to October, and in the dry season farmers plant a combination of *Boro* rice and vegetables. Wheat and potatoes are also important, along with fruit, in particular mango, banana and pineapple. Most of the produce is sold in markets in the city, although rice is also exported, after processing in one of the local mills.

91. There is also a growing aquaculture industry, particularly around the city of Barisal where there are numerous ponds culturing mainly shrimps for markets in Bangladesh and abroad. Timber is also important with large numbers of trees felled in surrounding forests and transported into the townships where they are processed for sale as wood or manufactured as furniture or other products.

## **D. Social and Cultural Resources**

### **1. Population and Communities**

92. According to an estimate of 2008 Barisal has a population of 210,374; male 53.28%, female 46.72%. Literacy rate among the town people is 85%. Main occupations are Agriculture 35.28%, agricultural laborer 18.76%, wage laborer 4.16%, commerce 13.89%, service 10.64%, fishing 3.45%, construction 1.25%, transport 1.72% and others 10.85%. Here population growth rate is 1.41%.

93. The majority of the people of Barisal (90.64 per cent) identify themselves as Muslims. This is followed by those of Hindus (8.38 per cent) and Christians (0.98 per cent). There are about 3,941 Mosques, 805 temples, 44 churches and 5 tombs within the city corporation area.

### **2. Health Facilities**

94. Health facilities are generally more widely available in towns and cities than in the rural areas, but the cost of the service means that it is not widely used by poorer people and slum dwellers in particular. This along with various other factors, including poor sanitation and nutrition (which decrease immunity and resistance), overcrowding (which facilitates disease transmission) and poor public and environmental health mean that the urban poor suffer disproportionately from ill health. As a result, child morbidity and mortality, malnutrition and growth retardation are all higher in slum areas. There are also gender inequalities, with mortality in years 1- 4 being 28 per 1,000 births in boys, compared to 38 in girls.

95. People in urban areas suffer many of the diseases associated with overcrowding and poor sanitation, including dysentery, diarrhea, whooping cough, gastro-enteritis, TB, etc. In the larger cities like Dhaka and Chittagong they also suffer respiratory problems and other illnesses caused by excessive exposure to traffic pollutants.

96. Public health facilities provide good service, but many are under staffed and under resourced, and ratios of beds per numbers of population are inadequate. Facilities are significantly better in the private sector, but care is expensive, and out of reach of any but the wealthier citizens.

### **3. Educational Facilities**

97. The city of Barisal has a number of well-established educational institutions. Among these, the Barisal Zilla School, the Sadar Girls' School, the Christian Missionary School, the B. M. School, the B. M. College, the Barisal College, the Syed Hatem Ali College, the Barisal Women's College, etc., are noteworthy. In total there is one public university, one medical college, one Cadet College, 18 Government colleges and 8 polytechnic institutes in Barisal.

98. Education level among the male population is remarkably higher than the female population. Up to SSC the percentage of male population is higher than that of female population. On the other hand none of the adult male or female population found to have education above HSC level. Percentage of female population is higher who did not attend any school. In other words they are illiterate (Table 2).

**Table 2: Level of education by gender in subproject area in percentage**

Education level	Male	Female	Total
1 TO 5	28.13	25.00	26.47
6 TO 10	34.38	30.56	32.35
SSC	12.50	11.11	11.76
HSC	00.00	05.56	02.94
BA	00.00	00.00	00.00
MA	00.00	00.00	00.00
Child	06.25	02.78	04.41
No Schooling	18.75	25.00	22.06
Total	100	100	100

Source: Socioeconomic Survey, October 2011 (Courtesy: Dr. Hafiza Khatun,)

#### **4. Socio-economic conditions**

99. The trend for rural-urban migration is largely a result of a lack of secure employment and sustenance in the rural areas, so people move to the cities where they believe there are better job opportunities. As noted above these rarely materialize and the end result is an increase in the urban poor, and an expansion of the slums. More than 82% of the population of Bangladesh lives on less than \$2 per day, and such people are mainly the urban poor and the rural poor. Slum dwellers in the towns and cities include people who are in regular employment, plus large numbers who are unemployed and who obtain an income from the streets where they can. Employed slum dwellers work mainly in construction or in factories, or as domestic servants, rickshaw operators, street vendors, etc.

100. Barisal is known as an inland river port city. City is also recognized as one of the prime business centers of Bangladesh. The survey<sup>5</sup> result identifies half of the male population of the subproject area earn their livelihood from business. As the subproject is being implemented in the city area agriculture and other occupation related to primary activities are found less in proportion. Only 3.13% of the total male population are found involved in agriculture. Among the total female population, 55.56% are found involved as housewives and more than 5% female population are involved with business. A total of 22% people found student of which female are more than the male population. About 10% of the male population work as day laborer. Average wage rate for the day laborer in the project area in Tk 250 per day but it is much higher for the skilled laborers.

101. Waste pickers are observed at the existing dumping site and consist of male, females, and children. This is often their primary source of livelihood made from recycling waste.

<sup>5</sup> Socioeconomic Survey, October 2011 (Courtesy: Dr. Hafiza Khatun).

## 5. Physical and Cultural Heritage

102. Bangladesh has many sites, buildings and artifacts that are of historical and cultural significance. Many date back to the British colonial period from the mid-19th to the mid-20th centuries, and some are from earlier periods, including the Muslim era of the 13th to 17th centuries, the Sena dynasty of the 12th and 13th centuries, and even the Gupta Buddhist era of the 4th to 7th centuries A.D. However, construction practices that pay scant regard to the possible discovery of ancient remains have meant that most of the older sites that remain are located well away from urban areas.

103. Durgasagar with an area of about 2,500 hectares is the largest pond or dighi of southern Bangladesh. It is located at Madhabpasa village of Babuganj upazila, about 11 km away from Barisal town. Locally it is known as Madhabpasha Dighi. According to a desire of Rani Durgavati, mother of Raja Joynarayan, the dighi was dug in 1780 (1187 BS). There are coconut trees around the dighi which together with the dighi are bounded by brick-walls. In the middle of the dighi, there is an island with bushes. Migratory birds usually come here during winter. The surrounding areas of the dighi have now been turned into a picnic spot. The proposed CLF sites are adjacent to any of the enumerated archaeological heritage and relics of Barisal.

## 6. Indigenous Peoples

104. Most inhabitants of Barisal are Bengalees (around 98%) and Muslims (around 90%), so this ethnic group comprises the majority of inhabitants of all the towns and cities. There are also small communities of certain ethnic minorities (mainly Hindu, Buddhist and Christian), who also live in urban areas, either integrated within the majority community or living in specific locations. There are, however, no indigenous tribal people permanently residing in Barisal. Of course, like other parts of Bangladesh, such communities are found in temporary locations only for livelihood earning purposes or in government, semi-government or non-government services.

105. Environmental degradation has made the lives of indigenous people even more difficult. They have become the victims of the negative impacts of modernization, as they lack the education and awareness to be able to harness and enjoy the positive benefits that Bangladesh's economic growth has created.

## IV. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

106. The present report assesses the impacts of the proposed activities on various environmental attributes of the project site.

107. **Methodology.** Issues for consideration have been raised by the following means: (i) input from interested and affected parties, if any; (ii) desktop research of information relevant to the proposed project; (iii) site visit and professional assessment by environment specialist engaged by the implementing agency; and (iv) evaluation of proposed design scope and potential impacts based on the environment specialist's past experience. Categorization of the project and formulation of mitigation measures have been guided by ADB's REA Checklist for Urban Development (Annex 1) and ADB Environment Policy.

## **A. Location and Design Impacts**

108. In the case of this subproject there are few impacts that can clearly be said to result from the design or location. This is because:

- (i) The infrastructure involves relatively straightforward construction at a single site, so it is unlikely that there will be major impacts when the facility is built;
- (ii) The proposed location of the CLF is in an area where the BCC authority has already acquired as per Government regulations and there is no running activities, and also there are no sensitive areas or receptors nearby; and
- (iii) If the CLF operates in the manner intended it should be hygienic and well managed facility that functions with few emissions and without major negative impacts.

109. Planning principles and design considerations have been reviewed and incorporated into the site planning process whenever possible. The concepts considered in design of the CLF are:

- (i) The CLF should be adequate in size to accommodate solid waste collected from the target area.
- (ii) All the ancillary facilities for CLF should be provided with safe water.
- (iii) Water points, hoses and cleaning equipment must be provided in appropriate locations in sufficient numbers. Cleaning program must be performed regularly.
- (iv) Industrial three phase electricity should be supplied and a standby generator installed.
- (v) CLF should have its own drain and all drains must be accessible for cleaning for efficient waste water system.
- (vi) The CLF area should be protected by fencing to keep out from trespassing people, animals specially dogs/ cats etc.
- (vii) Strict enforcement of relevant national rules in solid waste management.
- (viii) CLF of BCC could be managed by private organizations/ parties through competitive bidding process following government public-private partnership guideline.
- (ix) Techniques, installation, management and training should be focused on minimization of water consumption, minimization of energy use, minimization of emission to air and minimization of noise.
- (x) Future extensions or possibilities to add some other installation should be kept in mind during the design and during the period of construction.

110. Interested contractors will bid based on the concept and details included in the bid documents. The bidders will be advised to make their own diligence study prior to the bidding. Necessary documents and studies will be made available to them for their evaluation. It will be up to the bidders to maximize the use of resources made available to them.

111. No impact is anticipated due to the location as the proposed sites are owned by the Barisal City Corporation. Workers' camp and storage area for materials to be established by the contractor will be needed for the entire 18-month construction period. Proper arrangement for health and safety including water supply and sanitation should be ensured in these places as per criteria mentioned in the EMP.

## **B. Construction Impacts**

112. **Construction method.** The work comprises the construction of Controlled Landfill. The following are the scope of work:



- (i) Site preparation works particularly in (a) areas currently used for dumping, (b) areas with medical waste, (c) existing medical waste facility, and (d) areas used by rag-pickers/scavengers.
- (ii) Preparation of the ground by forming to level and grade and excavating locally for foundations or, if necessary, by excavating unsuitable fill material and replacing with imported compacted backfill.
- (iii) Shaping of ground to suit footings and floor slab layout and falls and to allow exterior ground drainage.
- (iv) Laying and backfilling over underground and under floor drains.
- (v) Boxing foundations and placing reinforcing with column starter bars.
- (vi) Pouring of slab and footings and curing.
- (vii) Construction of unreinforced masonry infill panels.
- (viii) Placing reinforcing, boxing, and pouring columns.
- (ix) Placing reinforcing for lintel beams and pouring concrete.
- (x) Casting in bolts and anchor plates as necessary in the columns and lintels.
- (xi) Fabrication and fixing roof trusses and bracing.
- (xii) Placing and fixing purlins.
- (xiii) Fixing roof cladding, gutters and downpipes.
- (xiv) Wall framing with cladding panels and insect mesh as necessary.
- (xv) Fixing of external rails for sliding doors.
- (xvi) Placing and fixing internal beams for rails plus fitting rails and hangers.
- (xvii) Constructing weather covers for sliding door rails.
- (xviii) Hanging of hinged doors.
- (xix) Internal wall and floor plastering as required.
- (xx) Painting as required.
- (xxi) Electrical Services.
- (xxii) Supply and/ or manufacture and installation of mechanical equipment.
- (xxiii) Construction of external effluent disposal system.
- (xxiv) Construction of solid waste disposal systems.

113. As explained above the land on which the CLF is to be constructed is being used as landfill site. This is open space beside the road that originates from the city center and passes further north; and easily accessible by the trucks. So during construction, there will be some very minor impacts like noise and dust due passage of construction materials carrying trucks on the people and there will be no issue of resettlement of affected persons.

114. Most of the site will be excavated to around 1.50 meter to create the cavities for the foundations of the buildings and paved areas. This will be done by backhoe digger and the excavated sand and soil will be loaded into trucks and transported to the municipal landfill for disposal.

115. All of the buildings and other structures will have Reinforced Cement Concrete (RCC) foundations, so metal reinforcing bars will be put into position in the cavities by hand. Concrete (mixed on site) will then be poured into the cavities to form the foundations and floors of the buildings and other structures and the paved surfaces of the roads.

116. The above-ground RCC elements will then be created by enclosing lengths of metal reinforcing in wooden shuttering and pouring in concrete, which sets to form the structure. This is then repeated in the next portion of reinforcing and so on to create the completed structure. The brick walls of the CLF ancillary buildings, toilets and boundary wall will then be created between the RCC supports by masons laying bricks and mortar by hand. Surfaces will be

finished by plastering or tiling, and corrugated iron roofing will be applied and connected up by hand. Doors, windows, electrical fittings and pipe-work for water supply and drainage will also be added by craftsmen and laborers.

117. All materials will be brought to site on small trucks and offloaded and positioned by hand, and a small crane will be used for any heavier elements such as the steel supports and reinforcing bars, doors and the metal gates for the entrance to the site. Due to limited size of the landfill, it will not be possible to accommodate the rubbish there and all debris will be cleared at the end of construction by loading into a truck and depositing at an identified disposal site. Disposal sites for excavated soils and contaminated materials will be identified and agreed upon with the DoE before the commencement of any civil works.

118. There is sufficient space for a staging area, construction equipment, and stockpiling of materials. However, the contractor will need to remove all construction and demolition wastes on a daily basis to an identified disposal site as described in the above paragraph.

119. **Screening Out Areas of No Significant Impact.** From the descriptions given it is clear that implementation of this subproject will not have major environmental impacts because the construction work is relatively straightforward, and will all be conducted at only one site within the jurisdiction of BCC. Because of this there are several aspects of the environment that are not expected to be affected by the construction process and these can be screened out of the assessment at this stage as required by ADB procedure. These are shown in **Table 3**, with an explanation of the reasoning in each case. These environmental sectors have thus been screened out and will not be mentioned further in assessing the impacts of the construction process.

**Table 3: Fields in which construction is not expected to have significant impacts**

Field	Rationale
Climate	Short-term production of dust is the only effect on atmosphere
Geology and seismology	Excavation will not be large enough to affect these features
Forests, wildlife, endangered species, protected areas	There are no forests, protected nature conservation areas or important habitats or species at or near this site
Coastal resources	Barisal CLF site is far from the sea and also such structure constructed in one site only will not affect the coastal resources
Agriculture, tourism	There is agriculture in the nearby area but will not be affected by the construction activities; there is no site for tourism at or near this site
Population and communities	Construction will not affect population numbers, location or composition
Health and education facilities	There are no schools, clinics, hospitals, etc at or near this site
Physical or cultural heritage	There are no culturally important buildings or locations at or near this site
Indigenous Peoples (IP)	The proposed site is not used by indigenous peoples or minority communities
Archaeology, paleontology	No material of archaeological or paleontological significance has been found by previous construction projects in this area
Ecological value	There are no protected areas in the vicinity of this site and no special ecological interest exists within the boundary of the site under consideration; construction should therefore have no ecological impacts.

120. **Impacts due to excavations.** Excavating the foundations for the buildings, roads, surface drains, walkways and other structures on the site will produce around 3,000 m<sup>3</sup> of waste soil and stone. This is a relatively small quantity so it can be taken to the selected and agreed municipal disposal site without special precautions to reduce the amount of dumping. The

material could be put to beneficial use if it was utilized at the landfill to cover waste, so arrangements should be made by the Contractors with the landfill operators to deposit the waste in a suitable location where it can be used for this purpose. The reserved cell of the CLF may be an option for this. In any case, disposal sites for excavated soils and contaminated materials will be identified and agreed upon with the DoE before the commencement of the excavation activities.

121. Excavation is likely to be conducted in the dry season to avoid the difficult conditions that can occur when earthworks are carried out during rain. Precautions will therefore be needed to limit dust so that it does not affect surrounding areas or workers on site. Another physical impact associated with large-scale excavation is the effect on drainage and the local water table if groundwater and/ or surface water collect in the cavities as they are dug.

122. **Impacts due to alteration of the site.** The presence of diggers, trucks and other vehicles and machinery and the developing structures as they are created will gradually alter the landscapes of this site. However most of the surrounding areas are generally not “busy” visually and there are no features of any special landscape interest at or around the site, so it should not be necessary to mask the construction site from view by erecting screens.

123. **Impacts on site-specific economy.** All of the construction related to this subproject will be conducted on land that is at present owned by the Barisal City Corporation and currently vacant. So there will be no impact on any site-specific economy. The livelihood of waste-pickers/scavengers, if any will not be affected during construction period and they will not be displaced during operation phase; and everything will be done as per agreed and approved resettlement plan.

124. Construction work can provide short-term socio-economic gains for local communities if contractors employ local people in the workforce. To ensure that these benefits are directed to communities that are most affected by the work, contractors are often encouraged to employ people who live in the immediate vicinity of construction sites. This is possible in this case because of the presence of inhabitation in the locality, so the contractor should offer employment to any persons who are willing to work on the present site (in breaking bricks and in other activities) and who are not already employed by some other company. Such persons are economically disadvantaged and this would be improved by even a relatively short period of temporary employment.

125. **Impacts on utilities.** There are no temporary infrastructures (power lines, water supply pipes, etc.) on the land proposed for CLF construction; so there will be no economic impacts from the disruption of supply of these facilities due to damage during construction.

126. **Impacts on accessibility.** Excavation work can also have economic impacts if heavy vehicles carrying materials to site and transporting excavated waste to the disposal site cause significant disruption of traffic, particularly where work is conducted in a semi-urban environment as this. However any such impacts should not be significant in this case, because dump trucks normally have a capacity of 25-30 m<sup>3</sup> and the disposal of 3,000 m<sup>3</sup> of soil and stone by about 100 truck movements will be spread over a period of few months.

127. **Impacts on social and cultural resources.** Construction activities inevitably produce noise and dust, and these plus the visual appearance of the site and restrictions in access caused by excavation and the presence of vehicles and machinery, are generally the factors that disturb people who live or work in the vicinity. These should however not be major problems in

this case as there are no people living on or near this site and the people who work there are already well adapted to this type of disturbance. The construction work is also small in scale, so it should not be necessary to apply measures to reduce noise, dust or other disturbance, beyond the dust suppression measures.

128. There are no major permanent public buildings at or near the site, and given the current land-use there are unlikely to be any locations that are of any special social or cultural importance to the community (shrines, meeting places, etc).

129. **Impacts on health and safety.** As is usual on construction sites, the health and safety of workers will need to be protected by measures which the contractor will be required to produce and apply. As adjacent areas are heavily used for the storage and processing of building materials, the contractor should also include measures to assure the safety of the public. The workers will also be needed to take special precautions as they will be required to work within area where unsorted solid waste, dumped medical waste, vectors like insects and rodents, wet wastes will be present with all its objectionable characteristics like excess bad smell/ odor, leachate all around, etc. So it will be needed that they should wear complete uniform usually adopted by the people working in the municipal solid waste disposal sites.

### **C. Operation and Maintenance Impacts**

130. For the first 2 years of operations of the CLF, the Contractor will manage the operations and maintain<sup>6</sup> the facility by itself or through a Contractor and if required, modify, repair or otherwise make improvements to the CLF. The Contractor, in consultation with Barisal City Corporation, will also develop a manual for the regular and preventive maintenance of the CLF.

131. The Contractor will be required to keep the ancillary sites of the CLF clean, tidy and orderly condition free of litter, waste material (whether solid or liquid) and debris. The Contractor will also be responsible for the maintenance of the approach roads to the CLF.

132. Sufficient, safe, potable and constant supply of fresh water will be made available at adequate pressure throughout the premises of the ancillary structures. Suitable facilities for washing of hands and nail brushes should be there, soap or detergent will be provided for the workers. All sanitary facilities will be equipped with suitable flushing appliance.

133. **Land contamination.** CLF will not contaminate the land the way other industrial operations can. The main reason for this is that CLF will have special impermeable layers underneath. Most land contamination is an aesthetics issue rather than one relating to pollution.

134. **Generation of Waste Materials and By-Products.** In general, pollutants generated from CLF include: wastewater from toilet and cleaning of premises, and leachate from the solid waste.

135. **Water contamination.** The wastes from CLF can end up in water bodies, polluting water resources. The main pollutants are wastewater from toilets and from cleaning of the premises, and the leachate from the stored solid waste in the CLF. The quantity of leachate becomes more in the rainy season. No chemicals are used in the CLF. Although the contaminants are non-toxic

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<sup>6</sup> Maintenance activities will include replacement of equipment and consumables, and also horticultural maintenance and repairs to equipment, pavements and other civil works which are part of the CLF.

in nature, they can introduce bacterial contamination and increase nitrates, phosphates and sulfates concentration in water, leading to health problems.

136. **Generation of Wastewater.** The liquid wastes of CLF are high in biological oxygen demand. The quantity of leachate may also be huge during especially in the rainy seasons. Special drains will be constructed to allow it to reach up to the leachate pond, where proper treatment will be ensured.

137. **Odor.** The tropical climate of Bangladesh enhances the process of degeneration of any organic material remaining in the solid waste collected from different parts of the city. Therefore, the CLF premises always give a particular stink. Excessive odor is a nuisance to locals and attracts vermin and scavengers.

138. **Noise.** Noise from the establishment can be a nuisance for communities living in the immediate vicinity of the CLF. Major sources of noise are the chaos created by the laborers working in the operation of the site and heavy vehicular movement to transport solid waste from the municipal areas to the CLF site.

139. **Health, hygiene, and safety.** Spread of diseases to workers and their families may occur due to inadequate provision of safety equipment and lack of practice of safety rules and precautions.

140. **Fires and release of hazardous gases.** Release of hazardous gases from the landfill sites may cause fire within the landfill area under operation.

141. **Topographical modification.** The implementation and subsequent operational activity of the landfill site may lead to unfriendly topographical alterations and modifications in the natural environment and overall landscape of the surrounding area.

142. **Gas migration.** Landfill gas migration due to pressure differentials and diffusion can occur. This can create an explosion hazard if the gas reaches sufficiently high concentrations on adjacent buildings.

143. **Vegetation covers alteration.** Nature of vegetation cover of the landfill site as well as the surrounding area will alter and will have an impact on the drainage pattern of the locality.

144. **Decline in land value.** Declination of land value may be an impact if the landfill site operation is not properly controlled and monitored.

145. **Displacement of waste-pickers/ scavengers.** Waste pickers and scavengers, if any will lose their livelihood because of change in the operational strategy of the landfill area.

146. When the CLF begins to function, it is expected to provide a modern sanitary facility for the workers and staff as well as systematic handling, transportation and disposal of solid waste without causing environmental pollution. Providing this occurs there should be few negative environmental impacts and there are several fields that should be unaffected. These are identified in Table 4 below, with an explanation of the reasoning in each case. These factors are thus screened out of the impact assessment and will not be mentioned further.

**Table 4: Fields in which operation and maintenance of the completed CLF is not expected to have significant impacts**

Field	Rationale
Geology, seismology	Operating a CLF should not affect these factors
Forests, wildlife, endangered species, protected areas	There are no forests, protected nature conservation areas or important habitats or species at or near the site
Coastal resources	Barisal CLF site is far from the sea and also such a structure situated in a single location will not affect the coastal resources
Tourism, population and communities, health and education facilities	There are no tourist attractions, inhabited areas or health/ education facilities near the CLF site
Physical or cultural heritage, archaeology, paleontology	There are also no areas of social, cultural or historical interest or importance near the site
Indigenous Peoples	There are no IP or minority communities near the sites

#### **D. Mitigation Measures**

147. There are no impacts that are significant or complex in nature, or that need an in-depth study to assess the impact. Thus, the subproject is unlikely to cause significant adverse impacts. The potential adverse impacts that are associated with design, construction, and O&M can be mitigated to acceptable levels with the following mitigation measures (Table 5).

**Table 5: Recommended Mitigation Measures**

Parameter	Mitigation Measures
<b>Planning phase</b>	
Updating of safeguard documents	- As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the DSC team.
Capacity Building	- Develop and submit for approval a capacity building and training program to ensure (i) all CLF workers are trained to the highest standards available in Bangladesh and given refresher training at least annually; and (ii) Barisal City Corporation and UPEHU staffs are given a high level of training and other support sufficient to achieve the expected standards.
Work schedule	- Ensure careful planning and scheduling of the activities. - Prepare a traffic management plan and road safety plan.
Barricades and warning signs	- Use easily transportable barricades and warning signs such as those made of high reflector plastic materials. - Also use aluminized rolled warning signs to warn the public.
Workers	- Employ workers with adequate experience, training, and know-how. It is always advantageous for the contractor to employ workers with adequate experience, training, and know-how in the line of work that they are doing. These people are usually reliable and can be counted upon to exercise good judgment in the field.
Community and public awareness	- Establish extensive coordination with Barisal City Corporation, Design and Supervision Consultants (DSC), Department of Environment, operators of landfill sites - A massive information campaign must precede any construction activity in order to make the public aware of the extent of the problem that might be present during the period of construction. - Open liaison channels should be established between Barisal City Corporation, the contractors, and interested and affected parties such that any queries, complaints, or suggestions can be dealt with quickly and by the appropriate persons.
Legislation, permits, and agreements	- In all instances, Barisal City Corporation, contractors and consultants must remain in compliance with relevant local and national legislation. - A copy of the IEE must be kept on-site and disclosed in Barisal City Corporation, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, and ADB websites. - Ensure Environmental Clearance is obtained prior to award of turnkey contract.
Access to site	- Access to site will be via existing roads. The contractor will need to ascertain the existing condition of the roads and repair damage due to construction.

Parameter	Mitigation Measures
Setting up of construction camp <sup>7</sup>	<ul style="list-style-type: none"> <li>- Choice of site for the contractor's camp requires the DSC environment management specialist's permission and must take into account location of local residents, businesses, and existing land uses. A site plan must be submitted to the environment management specialist for approval.</li> <li>- If the contractor chooses to locate the camp site on private land, he must get prior permission from the environment management specialist and the landowner.</li> <li>- Under no circumstances may open areas or the surrounding bushes be used as a toilet facility.</li> <li>- Recycling and the provision of separate waste receptacles for different types of waste should be encouraged.</li> </ul>
Establishing equipment lay-down and storage area <sup>8</sup>	<ul style="list-style-type: none"> <li>- Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by children, animals, etc.</li> <li>- The contractor should submit a method statement and plans for the storage of hazardous materials (fuels, oils, and chemicals) and emergency procedures.</li> </ul>
Materials management – sourcing <sup>9</sup>	<ul style="list-style-type: none"> <li>- The contractor should prepare a source statement indicating the sources of all materials (including topsoil, sands, natural gravels, crushed stone, asphalt, clay liners, etc), and submit these to the environment management specialist for approval prior to commencement of any work.</li> </ul>
Education of site staff on general and environmental conduct <sup>10</sup>	<ul style="list-style-type: none"> <li>- Ensure that all site personnel have a basic level of environmental awareness training.</li> <li>- Staff operating equipment (such as excavators, loaders, etc.) should be adequately trained and sensitized to any potential hazards associated with their task.</li> <li>- No operator should be permitted to operate critical items of mechanical equipment without having been trained by the contractor.</li> <li>- All employees must undergo safety training.</li> </ul>
<b>Construction phase</b>	
Excavated materials	<ul style="list-style-type: none"> <li>- Hauling vehicles must always be present at the excavation site.</li> <li>- The contractor can process the excavated materials and use these as selected backfill materials.</li> <li>- If excavated materials are not suitable for reuse, the contractor should deposit these in an area designated by Barisal City Corporation.</li> <li>- Coordinate with the landfill operators for the disposal of excavated materials.</li> <li>- Identify and obtain clearance from DoE for disposal sites of excavated soils and contaminated materials.</li> <li>- Obtain from the environment management specialist approval for disposal of excavated materials.</li> <li>- Remove waste rapidly by loading material onto trucks as soon as it is excavated;</li> <li>- Cover or damp down working areas and stockpiled soil in dry, windy weather; and</li> <li>- Use tarpaulins to cover loose material during transportation to and from the site.</li> <li>- Maintain record of excavated materials, disposal dates, and methods.</li> <li>- Conduct the work in the dry season will reduce these impacts, and as the excavation in this case is shallow and small in scale there should be no impact on the water table.</li> </ul>
Hauling of Construction Materials	<ul style="list-style-type: none"> <li>- The contractor must maintain all the materials necessary in his inventory so that these can be easily hauled to the construction site when needed.</li> <li>- Advance signage for affected parking areas must indicate duration and alternative parking arrangements.</li> </ul>
Access	<ul style="list-style-type: none"> <li>- The contractor should make available in his stock steel plates and wooden planks which will be deployed on top of excavations to provide temporary access to buildings, street crossings, and other areas where these will be necessary.</li> <li>- Advance road signage must indicate the road detour and alternative routes. Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/ complaints.</li> </ul>
Occupational health and safety	<ul style="list-style-type: none"> <li>- Employ workers with adequate experience, training, and know-how.</li> <li>- These workers should be led by an experienced supervisor or engineer, who will provide</li> </ul>

<sup>7</sup> Careful planning of the construction camp can ensure that time and costs associated with environmental management and rehabilitation is reduced

<sup>8</sup> Storage areas can be hazardous and unsightly and can cause environmental pollution if not designed and managed carefully.

<sup>9</sup> Materials must be sourced in a legal and sustainable way to prevent offsite environmental degradation.

<sup>10</sup> These points need to be made clear to all staff on site before the project begins.

Parameter	Mitigation Measures
	<p>the leadership in daily activities.</p> <ul style="list-style-type: none"> <li>- A general regard for the social and ecological well-being of the site and adjacent areas is expected of the site staff. Workers need to be made aware of the following general rules: (i) no alcohol/ drugs on site; (ii) prevent excessive noise; (iii) construction staff are to make use of the facilities provided for them, as opposed to ad hoc alternatives (e.g. fires for cooking, the use of surrounding bushes as a toilet facility); (iv) no fires permitted on site except if needed for the construction works; (v) trespassing on private/ commercial properties adjoining the site is forbidden; (vi) other than pre-approved security staff, no workers should be permitted to live on the construction site; and (vii) no worker may be forced to do work that is potentially dangerous or that he/ she is not trained to do.</li> <li>- Because of existence of solid waste all around in the CLF site, the workers will need to wear uniform, which is usually used by the workers in the solid waste disposal site.</li> <li>- The contractor must monitor the performance of construction workers to ensure that the points relayed during their induction have been properly understood and are being followed. If necessary, a translator should be called to the site to further explain aspects of environmental or social behavior that are unclear.</li> <li>- The rules that are explained in the worker conduct section must be followed at all times.</li> </ul>
Community health and safety	<ul style="list-style-type: none"> <li>- Contractor's activities and movement of staff will be restricted to designated construction areas.</li> <li>- Should the construction staff be approached by members of the public or other stakeholders, staff should assist them in locating the environment management specialist or contractor, or provide a number through which they may contact the environment management specialist or contractor.</li> <li>- The conduct of the construction staff when dealing with the public or other stakeholders should be in a manner that is polite and courteous at all times. Failure to adhere to this requirement may result in the removal of staff from the site by the environment management specialist.</li> <li>- Disruption of access for local residents, commercial establishments, institutions, etc. must be minimized and must have the environment management specialist's permissions.</li> <li>- Provide walkways and metal sheets where required to maintain access for people and vehicles.</li> <li>- Consult businesses and institutions regarding operating hours, and factor this in work schedules.</li> <li>- The contractor is to inform neighbors in writing of disruptive activities at least 24 hours beforehand. This can take place by way of leaflets placed in the postboxes giving the environment management specialist's and contractor's details or other method approved by the environment management specialist.</li> <li>- Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints.</li> <li>- The contractor will ensure that there is provision of alternate access to business establishments during the construction, so that there is no closure of these shops or any loss of clientage.</li> <li>- The contractor will ensure that any damage to properties and utilities will be restored or compensated to pre-work conditions.</li> <li>- Lighting on the construction site should be pointed downwards and away from oncoming traffic and nearby houses.</li> <li>- The site must be kept clean to minimize the visual impact of the site.</li> <li>- If screening is being used, this must be moved and re-erected as the work front progresses.</li> <li>- Machinery and vehicles are to be kept in good working order for the duration of the project to minimize noise nuisance to neighbors.</li> <li>- Notice of particularly noisy activities must be given to residents/businesses adjacent to the construction site. Examples of these include: noise generated by jackhammers, diesel generator sets, excavators, etc.</li> <li>- Noisy activities must be restricted to the times given in the project specification or general conditions of contract.</li> <li>- The environment management specialist and contractor are responsible for ongoing communication with those people who are interested in or affected by the project.</li> <li>- A complaints register (refer to the grievance redressal mechanism) should be housed at the site office. This should be in carbon copy format, with numbered pages. Any missing pages must be accounted for by the contractor. This register is to be tabled during monthly</li> </ul>



Parameter	Mitigation Measures
	<p>site meetings.</p> <ul style="list-style-type: none"> <li>- Interested and affected parties need to be made aware of the existence of the complaints book and the methods of communication available to them.</li> <li>- The contractor must address queries and complaints by: (i) documenting details of such communications; (ii) submitting these for inclusion in complaints register; (iii) bringing issues to the environment management specialist's attention immediately; and (iv) taking remedial action as per environment management specialist's instruction.</li> <li>- The contractor should immediately take the necessary remedial action on any complaints/ grievances received by him and forward the details of the grievance along with the action taken to the environment management specialist within 48 hours of receipt of such complaint/ grievance.</li> </ul>
Community and public awareness	<ul style="list-style-type: none"> <li>- Storage facilities and other temporary structures on-site should be located such that they have as little visual impact on local residents as possible.</li> <li>- Special attention should be given to the screening of highly reflective materials on site.</li> <li>- In areas where the visual environment is particularly important (e.g. along commercial/ tourism routes) or privacy concerns for surrounding buildings exist, the site may require screening. This could be in the form of shade cloth, temporary walls, or other suitable materials prior to the beginning of construction.</li> </ul>
Construction camps and storage areas	<ul style="list-style-type: none"> <li>- The contractor is to ensure that open areas or the surrounding bushes are not being used as toilet facility.</li> <li>- The contractor should ensure that all litter is collected from the work and camp areas daily.</li> <li>- Bins and/or skips should be emptied regularly and waste should be disposed of at the pre-approved site. Waybills for all such disposals are to be kept by the contractor for review by the environment management specialist.</li> <li>- The contractor should ensure that his camp and working areas are kept clean and tidy at all times.</li> <li>- After construction work, all structures comprising the construction camp are to be removed from site or handed over to the property owner/community as per mutual agreement (if established on private/community land).</li> <li>- The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these should be cleaned up.</li> <li>- All hardened surfaces within the construction camp area should be ripped, all imported materials removed, and the area should be top soiled and regressed.</li> <li>- The contractor must arrange the cancellation of all temporary services.</li> </ul>
Dust and air pollution	<ul style="list-style-type: none"> <li>- Vehicles travelling to and from the construction site must adhere to speed limits so as to avoid producing excessive dust.</li> <li>- Access and other cleared surfaces, including backfilled trenches, must be dampened whenever possible and especially in dry and windy conditions to avoid excessive dust.</li> <li>- Vehicles and machinery are to be kept in good working order and to meet manufacturer's specifications for safety, fuel consumption, etc.</li> <li>- The contractor is to have the equipment seen to as soon as possible should excessive emissions be observed.</li> </ul>
Noise levels	<ul style="list-style-type: none"> <li>- Noise-generating equipment must be fitted with silencers.</li> <li>- If a worker is exposed to noise above a noise exposure limit, the contractor must investigate options for engineered noise control such as using low-noise excavators, jackhammers, drills, and power generators.</li> <li>- If it is not practicable to reduce noise levels to or below noise exposure limits, the contractor must post warning signs in the noise hazard areas. Workers in a posted noise hazard area must wear hearing protection.</li> </ul>
Utilities	<ul style="list-style-type: none"> <li>- Prepare a list of affected utilities and operators</li> <li>- Prepare a contingency plan to include actions to be done in case of unintentional interruption of services.</li> </ul>
Water quality	<ul style="list-style-type: none"> <li>- Every effort should be made to ensure that any chemicals or hazardous substances do not contaminate the soil or water on-site.</li> <li>- Care must be taken to ensure that runoff from vehicle or plant washing does not enter the surface/ground water.</li> <li>- Site staff should not be permitted to use any stream, river, other open water body, or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing, or for any construction or related activities. Municipal water (or another source approved by the environment management specialist) should instead be used for all</li> </ul>

Parameter	Mitigation Measures
	<p>activities such as washing of equipment or disposal of any type of waste, dust suppression, concrete mixing, compacting etc.</p> <ul style="list-style-type: none"> <li>- All concrete mixing must take place on a designated, impermeable surface.</li> <li>- No vehicles transporting concrete to the site may be washed on-site.</li> <li>- No vehicles transporting, placing, or compacting asphalt or any other bituminous product may be washed on-site.</li> <li>- All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of or removed from the site.</li> <li>- Hazardous substance/ materials are to be transported in sealed containers or bags.</li> </ul>
Waste management	<ul style="list-style-type: none"> <li>- Wastes must be placed in the designated skips/bins which must be regularly emptied. These should remain within demarcated areas and should be designed to prevent wastes from being blown out by wind.</li> <li>- Littering on-site is forbidden and the site should be cleared of litter at the end of each working day/night period.</li> <li>- Recycling is to be encouraged by providing separate receptacles for different types of wastes and making sure that staff is aware of their uses.</li> <li>- All waste must be removed from the site and transported to a disposal site or as directed by the environment management specialist. Waybills proving disposal at each site should be provided for the environment management specialist's inspection.</li> <li>- Construction rubble should be disposed of in pre-agreed, demarcated spoil dumps that have been approved by the environment management specialist, or at disposal sites.</li> </ul>
Conservation of natural environment	<ul style="list-style-type: none"> <li>- As the work front progresses; the contractor is to check that vegetation clearing has the prior permission of the environment management specialist.</li> <li>- Only trees that have been marked beforehand are to be removed, if cutting of trees is required.</li> <li>- Clean the entire area and maintain immediately after completion of the construction activities to make sure that existing tranquility of the surrounding area is not disturbed in any way.</li> </ul>
Cultural and historical environment	<ul style="list-style-type: none"> <li>- Consult laborers who work on the site during the detailed design stage and in the unlikely event that there are social and cultural resources in the site; assistance should be given in relocating the site and any associated artifacts.</li> <li>- All the staff and laborers of the contractor are to be informed about the possible items of historical or archaeological value, which include old stone foundations, tools, clayware, jewelry, remains, fossils etc.</li> <li>- If something of this nature is uncovered, Department of Archaeology should be contacted and work should be stopped immediately.</li> </ul>
Safeguards supervisors	<ul style="list-style-type: none"> <li>- The contractor should appoint one environment safeguard supervisor who will be responsible for assisting the contractor in implementation of EMP, coordinating with the DSC, consultations with interested/ affected parties, reporting, and grievance redressal on a day-to-day basis. The resettlement issue will be resolved before the site will be handed over to the Contractor for construction activities.</li> </ul>
Post-construction and post-commissioning irregularities	<ul style="list-style-type: none"> <li>- Remove all plant/ machineries/ vehicles and any temporary structures including the workforce camps and warehouses for storage of materials after completion of construction.</li> <li>- Restore the original landscape of the surrounding area as much as possible.</li> </ul>
<b>Operation and maintenance phase</b>	
General	<ul style="list-style-type: none"> <li>- Develop O&amp;M Manuals to include all aspects of the management and operation of the CLF:</li> <li>- nature of waste that is accepted;</li> <li>- sequence and location of waste placement;</li> <li>- operation and maintenance of the gas collection system;</li> <li>- introduction of moisture or recirculation of leachate, leachate collection;</li> <li>- maintenance and cleaning of the leachate collection system; and</li> <li>- environmental monitoring, and maintenance of the final cover.</li> <li>- Train all CLF workers to the highest standards available in Bangladesh and given refresher training at least annually</li> <li>- Control access for public/personnel;</li> <li>- Lock rooms or cages for waste storage;</li> <li>- Clean toilets daily;</li> <li>- Provide clean hand washing areas adequate soap and towels;</li> <li>- Provide clothing and laundry service for workers; and</li> <li>- Clean facility after the work of each day. The waste storage area and other adjacent areas</li> </ul>

Parameter	Mitigation Measures
	should be sprinkled or sprayed regularly with disinfectants to avoid any spread of disease. - Insert plates and stops to prevent vermin from gaining access to the building. Where insect screening is required, this should consist of nylon insect mesh securely fixed to 150 × 50 reinforcing mesh with galvanized tie wire. Edges should be finished with a screw fixed beading strip where possible (all galvanized). - Audit implementation of O&M procedures at regular intervals (by an Independent Monitoring Agency)
Land contamination	- Do not store wastes outside the CLF areas to avoid issues of aesthetic nature
Wastewater	- After treatment, the discharge standards need to be followed similar to the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge
Odor	- Audit odor to identify and characterize sources and determine any action required. - Store wastes properly inside the premises, preferably in an aerated area to minimize biodegradation and foul odor - Vendors should be asked to pick up waste on a daily basis to minimize degradation and odor - Enclose wastes and by-products during transport, loading/unloading and storage - Carry out frequent cleaning of material storage areas to prevent odor
Vermin and pest	- Apply soil cover materials rigorously - Compact wastes properly - Carefully maintain general “good housekeeping” - Inspect site regularly to detect indication of prevalence of pests and vermin - Employ an experienced pest control specialist to deal with this problem in case significant numbers are identified.
Noise	- Activities and vehicle movements should be avoided after hours. - Vehicles should be fitted with silencers. - Vehicles and machinery are to be kept in good working order.

148. After handing over of the subproject, Barisal City Corporation will be responsible for operating the CLF and will be given support by the project in the form of staff training and financial assistance. ADB, LGD, Urban Public and Environment Health Unit (UPEHU) will need to ensure that the budget for such support is sufficient to ensure that the management and operation of the facility is to the expected high standard and that the elements listed above are provided.

149. The successful operation of the CLF in the manner intended should bring significant benefits to the citizens by keeping the environment cleaner than before. Removal of solid waste will be more organized and efficient; the BCC will save some money because of this higher efficiency of waste removal, which can be utilized for staff training and purchase of modern equipments necessary for this kind of operation.

150. Citizens will also gain from improved health as they will lose fewer working days through illness and will spend less on healthcare. In time there will be wider improvements in quality of life at various locations in the city as the general environment and public health will greatly improve as the practices of throwing garbage here and there will decline.

## V. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

### A. Project Stakeholders

151. Primary stakeholders are:

- (i) Companies that operate on the proposed CLF site;
- (ii) People who work at the site, either employed by a company or self-employed;
- (iii) Companies and workers operating in areas adjacent to the CLF site;

- (iv) Workers and companies operating at landfill site elsewhere in Khulna; and
- (v) Companies and private individuals who are benefitted from the existing landfill site.

152. Secondary stakeholders are:

- (i) LGD as the Executing Agency and UPEHU as implementer;
- (ii) Other government institutions whose remit includes areas or issues affected by the project (City Corporations, Planning Authorities, Department of Public Health Engineering, Local Government Engineering Department, Ministry of Finance, Ministry of Health, Ministry of Environment, Roads and Highways Department, etc);
- (iii) NGOs, CBOs and other representatives of persons who may be affected by the project;
- (iv) The beneficiary community in general; and
- (v) The ADB.

## **B. Consultation and Disclosure**

153. LGD/ UPEHU will extend and expand the consultation and disclosure process significantly during implementation of UPEHSDP. The UPEHU will appoint an experienced NGO to handle this key aspect of the program, who will conduct a wide range of activities in the target urban areas to ensure that the needs and concerns of stakeholders are registered, and are addressed in project design, construction or operation where appropriate. The program of activities will be developed during the detailed design stage, and is likely to include the following:

154. Consultation during detailed design:

- (i) Focus-group discussions with affected persons and other stakeholders (including women's groups, NGOs and CBOs) to hear their views and concerns, so that these can be addressed in project design where necessary; and
- (ii) Structured consultation meetings with the institutional stakeholders (Government bodies and NGOs) to discuss and approve key aspects of the project.

155. Consultation during construction:

- (i) Public meetings with major stakeholders to discuss and plan work programs and allow issues to be raised and addressed once construction has started; and
- (ii) Smaller-scale meetings to discuss and plan construction work with primary stakeholders to reduce disturbance and other impacts, and provide a mechanism through which affected persons can participate in project monitoring and evaluation.

156. Project disclosure:

- (i) Public information campaigns (via newspaper, TV and radio) to explain the project to the urban populations and prepare them for any disruption they may experience once the construction program is underway;
- (ii) Public disclosure meetings at key stages to inform the public of progress and future plans, and to provide copies of summary documents in the Bangla language; and
- (iii) Formal disclosure of completed project reports by making copies available at convenient locations in each target town, informing the public of their availability, and providing a mechanism through which comments can be made.

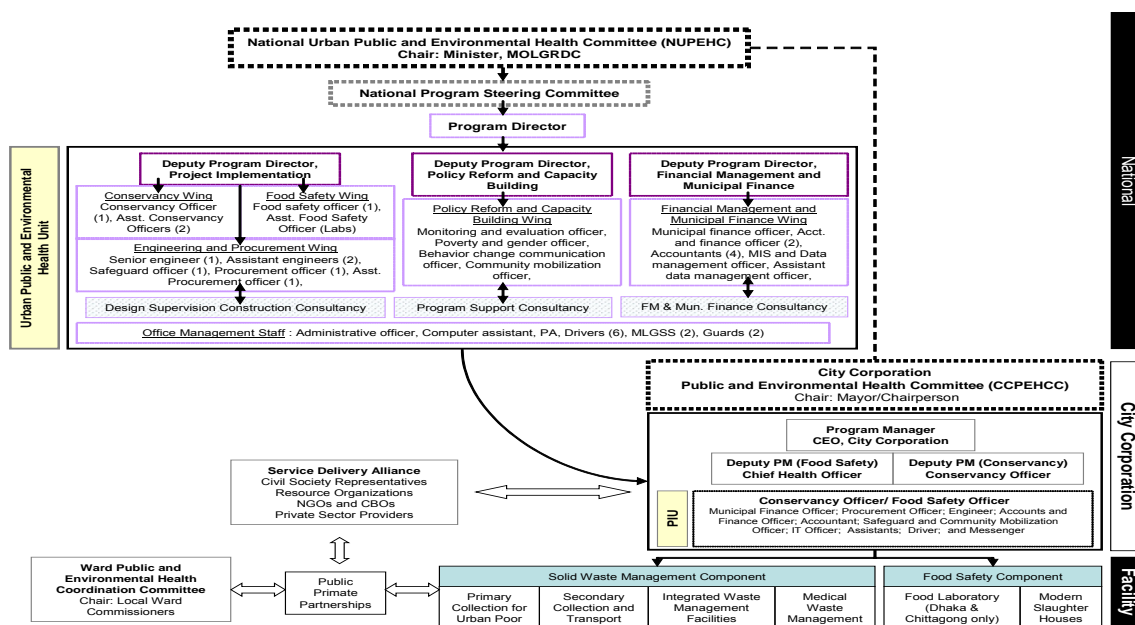
## C. Public Consultations Conducted

157. Different techniques of consultation with stakeholders were used by the PPTA Consultants during the planning stage of project preparation (interviews, public meetings, group discussions, etc). Details of these consultation meetings in the planning stage have been presented in the ANNEX 5. A questionnaire was designed and environmental information was collected. Apart from this, a series of public consultation meetings were conducted during the project preparation. Various forms of public consultations (consultation through ad hoc discussions on-site) have been used to discuss the project and involve the community in planning the project design and mitigation measures. Issues discussed and feedback received during preparation of IEE report along with details of date, time, location, and list of participants are given in Annex 3.

## VI. ENVIRONMENTAL MANAGEMENT PLAN

### A. Implementation Arrangement

158. Figure 20 is an organization chart showing how the project will be managed and implemented.



**Fig 20: Organization Chart for UPEHSDP**

159. **Local Government Division/ Urban Public and Environmental Health Unit.** LGD of the Ministry of Local Government, Rural Development and Cooperatives (LGRDC) will be the executing agency (EA) for UPEHSDP providing overall guidance for program implementation. LGD will have the overall responsibility to plan, organize, manage, supervise, coordinate and monitor the progress achieved. LGD will establish a support unit called the Urban Public and Environmental Health Unit (UPEHU) who will be responsible for day-to-day program implementation and will be headed by a full-time program director. UPEHU will function as the Program Management Unit (UPEHU), with responsibility for day-to-day implementation. A Safeguards Officer (SO) to coordinate resettlement and environmental safeguards for UPEHSDP will be part of the Policy and Program Wing of the UPEHU. Through the SO, the

UPEHU will ensure environmental compliance with ADB policy and national law across the entire program. This includes: (i) pre-approving final IEEs prior to submission to ADB for review and approval, and (ii) assisting in resolution of complaints and grievances related to IEE implementation not resolved at the CCPIU level.

**160. City Corporations/ Program Implementation Units.** City Corporation Project Implementation Units (CCPIUs) will be established in each City Corporation. The CCPIUs will include a Safeguards and Community Mobilization Officer (SCMO) who will receive training from the International Environmental Specialist (IES) and Domestic Environmental Specialist (DES) who will be assigned to work with the CCPIU staff to help monitor subprojects and to transfer implementation capability to the CCPIU team. The SCMO will work closely with the IRS and DRS in planning, implementing, and monitoring all project activities. The CCPIUs will: (i) screen and categorize sub-projects; (ii) assist in, public meetings and other consultation with stakeholders; (iii) facilitate activities of the IES/ DES in applying for Location and Environmental Clearances (LCs/ECs).

**161. Environmental Specialists.** A Design, Supervision, and Construction Consultant Team (DSC) will be contracted to assist the UPEHU and CCPIUs in implementing and managing the investment subprojects including environmental planning. Towards this, International and Domestic Environmental Specialists (IES and DES) within DSC will prepare IEEs in accordance with both ADB and Government of Bangladesh (GoB) policies during the feasibility and detailed design stage, and supervise contractors, with support from CCPIUs, during the construction process. The IES and DES will work in close coordination with UPEHU and CCPIUs. They will coordinate with the SO in the UPEHU to ensure all IEEs comply with ADB and GoB rules and guidelines. The IES and DES will also provide necessary training to CCPIUs to facilitate their monitoring of environmental impacts during construction and operation. It will provide support ensuring that all tasks of the CCPIU with regard to environmental implementation and monitoring are achieved. The IES and DES, in coordination with the contractors, will revise this IEE during detailed design stage and will ensure revised/updated IEE is approved by ADB and disclosed in LGD/ UPEHU and ADB websites.

**162. Contractors.** The Contractor shall at its own cost and expense:

- (i) Design, construct, supply, manage and maintain the CLF, in accordance with the provisions of the contract, good industry practice and applicable Laws;
- (ii) Observe and fulfill the environmental and other requirements as specified in the IEE/ EMP and under all applicable laws and applicable permits at all time during the service delivery period;
- (iii) Apply for and obtain all necessary clearances and/ or approvals for the construction of the CLF from all the concerned governmental agencies;
- (iv) Coordinate with DSC IES and DES on updating the IEE/EMP based on detailed designs;
- (v) Procure and maintain in full force and effect, as necessary, appropriate proprietary rights, licenses, contracts and permissions for materials, methods, processes and systems used in or incorporated into the subproject;
- (vi) Provide all assistance to the Project Manager as may be reasonably required for the performance of its duties and services under this subproject;
- (vii) Provide to DSC IES and DES reports on a regular basis during the service delivery period in accordance with the provisions of the contract;
- (viii) Appoint, supervise, monitor and control the activities of sub-contractors under their respective project contracts as may be necessary;

- (ix) Make efforts to maintain harmony and good industrial relations amongst the personnel employed by Barisal City Corporation in connection with the performance of the contractor's obligations under the contract;
- (x) Develop, implement and administer a surveillance and safety program for the CLF and the users thereof and the contractors' personnel engaged in the provision of any services under any of the project contracts including correction of safety violations and deficiencies, and taking of all other actions necessary to provide a safe and hygienic environment in accordance with applicable laws and good industry practice;
- (xi) Be responsible for safety, soundness and durability of the CLF, including all structures forming part thereof;
- (xii) Ensure that the CLF site remains free from all encroachments and take all steps necessary to remove encroachments, if any;
- (xiii) Remove promptly from the CLF site all surplus construction machinery and materials, waste materials (including, without limitation, hazardous materials and waste water), rubbish and other debris and keep the area in a neat, clean and hygienic condition and in conformity with the applicable Laws and applicable Permits.

## B. Capacity Building

163. A training program has been developed to build the capability of EA, city corporations, and CCPIUs. This will be conducted by the DSC and contractors. The contractor will be required to (i) conduct environmental awareness and orientation of workers prior to deployment to work site; (ii) train CLF workers to the highest standards available in Bangladesh and given a refresher training at least annually during the service delivery period; and (iii) provide EA, CCPIUs, UPEHU, etc. a high level of training and other support sufficient to achieve the expected standards.

164. The suggested outline of the training program is presented in Table 6. The capacity building and training program will be updated during the detailed design stage to incorporate the contractors output.

**Table 6: Indicative Capacity Building and Training Program for CLF Subproject**

Description	Contents	Schedule	Participants
<b>To be conducted by DSC</b>			
<b>Program 1</b> Orientation workshop	<b>Module 1 – Orientation</b> ADB Safeguards Policy Statement Bangladeshi Environmental Laws and Regulations  <b>Module 2 – Environmental Assessment Process</b> ADB environmental process, identification of impacts and mitigation measures, formulation of an environmental management plan (EMP), implementation, and monitoring requirements Review of environmental assessment report to comply with ADB requirements Incorporation of EMP into the project design and contracts	1 day	EA, LGD, UPEHU, and city corporation officials involved in the project implementation  CCPIUs
<b>Program 2</b> Orientation program/ workshop for contractors and supervisory staff	Environmental issues during construction Implementation of EMP Monitoring of EMP implementation Reporting requirements	1 day	CCPIUs contractors
<b>To be conducted by contractors</b>			
<b>Program 3</b> Orientation and	CLF implementation activities detailed in drawings; safeguard policy requirements as per ADB and	1 day	Staff and workers of the Contractor

Description	Contents	Schedule	Participants
safety Issues	Government of Bangladesh rules; safety instructions and use of PPEs <sup>11</sup> by the staff and workers		
<b>Program 4</b> Action plan for implementation of the CLF	Detailed action plan for implementation of the subproject in a timely and qualitative manner	1 day	Staff and workers of the Contractor

### C. Environmental Management Action Plan

165. The EMP will guide the environmentally sound construction of the subproject and ensure efficient lines of communication between the CCPIUs, DSC, and contractors. The EMP identifies activities according to the following three phases: (i) site establishment and preliminary activities, including finalizing IEE/EMP; (ii) construction stage; and (iii) post-construction/ operational stage. Table 7 outlines the mitigation measures and persons responsible for implementation and monitoring. The EMP will be updated by DSC during the detailed design stage. Note that the final IEE/EMP should be reviewed and cleared by the EA and ADB at time of detailed design and prior to commencement of construction work.

166. **Environmental monitoring program.** Prior to commencement of any civil work, the contractors will submit a compliance report<sup>12</sup> to the DSC ensuring that all identified pre-construction environmental impact mitigation measures as detailed in the EMP will be undertaken. The DSC will review the report, and thereafter CCPIUs will allow commencement of civil works. CCPIUs and the DSC will be responsible for monitoring.

<sup>11</sup> **Personal protective equipment (PPE)** refers to protective clothing, helmets, goggles, or other garment or equipment designed to protect the wearer's body from injury. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. Protective equipment may be worn for job-related occupational safety and health purposes, as well as for sports and other recreational activities. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, or masks, and others.

<sup>12</sup> This compliance report will include information on (i) barricades and warning signs; (ii) area for setting up of construction camps; (iii) methodology for surveys; (iv) area for establishing lay-down and storage; (v) sources of materials; (vi) records of environmental awareness, safety training, and orientation of workers prior to deployment to work sites; (vii) contact information of the environmental and resettlement supervisors; and (viii) construction method statement.



**Table 7: Environmental Management Action Plan**

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
<b>Planning phase</b>						
Appointment and duties of an ECO	An Independent Environmental Control Officer (ECO) must be appointed, who will monitor the Contractor's compliance with the environmental management plan.	Contractor	CCPIU	Appointment	Once	
	The ECO should be provided with a copy of an adjusted version of the EMP.	Contractor	CCPIU		Once	
	The Priority of the ECO is to maintain the integrity of the development conditions outlined in the EMP and must be enforced and adhered to at all time.	ECO	ECO		Continuous	
	The ECO must form part of the project management team and attend all project meetings.	Contractor	ECO	Attendance sheet meeting	Continuous	
Appointment and duties of EO	The Contractor must appoint an Environmental Officer (EO). This person will be required to monitor the situation with a direct hands-on approach, and ensure compliance and co-operation of all personnel. He should be fluent in the language of the employees.	Contractor	CCPIU	Appointment	Once	
Updating of safeguard documents	- As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the DSC team.	DSC with input from the contractor	CCPIU	Updated IEE/EMP	---	ADB Environment Policy EARF  ECR 1997
Legislation, Permits and Agreements	The Contractor shall ensure that all pertinent permits, certificates and permissions required for the project have been obtained prior to any activities commencing on site and ensure that they are strictly enforced/adhered to. This includes, for example, license for storage of flammable liquids and hazardous materials and other permits and legislative requirements applicable to the project.	Contractor	DSC CCPIU	Permits, certificates and permissions	Prior the start of the project	List of permits which have to be arranged by the Contractor
	The Contractor shall maintain a database of all pertinent permits and permissions required for the contract as a whole and for	Contractor	DSC CCPIU	database	Frequent	

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	critical activities for the duration of the contract. - In all instances, the City Corporations, Contractors and consultants must remain in compliance with relevant local and national legislation. - A copy of the IEE must be kept on-site and disclosed in the City Corporations, Local Government Division (LGD), Ministry of Local Government, Rural Development and Cooperatives, and ADB websites.					
Capacity Building	- Develop and submit for approval a capacity building and training program to ensure (i) all CLF workers are trained to the highest standards available in Bangladesh and given refresher training at least annually; and (ii) Barisal City Corporation and UPEHU staffs are given a high level of training and other support sufficient to achieve the expected standards.	Contractors	DSC CCPIU	Capacity building and training program	---	EARF  All applicable laws and regulations
Education of site staff on general and environmental conduct <sup>13</sup>	- Ensure that all site personnel have a basic level of environmental awareness training. - Staff operating equipment (such as excavators, loaders, etc.) should be adequately trained and sensitized to any potential hazards associated with their task. - No operator should be permitted to operate critical items of mechanical equipment without having been trained by the Contractor. - All employees must undergo safety training.	Contractor	DSC CCPIU	Records of training	Prior to start of civil works and every new employee	Revised/Updated IEE/EMP (capacity building)
Workers	Employ workers with adequate experience, training, and know-how. It is always advantageous for the Contractor to employ workers with adequate experience, training, and know-how in the line of work that they are doing. These people are usually reliable and can be counted upon to exercise good judgment in the field.	Contractor	DSC CCPIU	Workers list (for internal monitoring)	Prior to approval of detailed design documents	Detailed Design documents
Work schedule	- Ensure careful planning and scheduling of	Contractors	DSC	Plan and	Prior to	Detailed

<sup>13</sup> These points need to be made clear to all staff on site before the project begins.

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	the activities. - Prepare a traffic management plan and road safety plan.		CCPIU	schedules	approval of detailed design documents	Design documents
Community and public awareness	- Establish extensive coordination with the City Corporations, Design and Supervision Consultants (DSC), Department of Environment, operators of landfill sites - A massive information campaign must precede any construction activity in order to make the public aware of the extent of the problem that might be present during the period of construction. - Open liaison channels should be established between Khulna City Corporation, the Contractors, and interested and affected parties such that any queries, complaints, or suggestions can be dealt with quickly and by the appropriate persons.	Contractor	DSC CCPIU	Communication and participation strategy	Prior to approval of detailed design documents	Detailed Design documents
Access to site	Access to site will be via existing roads. The Contractor will need to ascertain the existing condition of the roads and repair damage due to construction.	Contractor	DSC CCPIU	Traffic management plan	Prior to approval of detailed design documents	No complaints received  Minimal traffic disturbance
Barricades and warning signs	- Use easily transportable barricades and warning signs such as those made of high reflector plastic materials. - Also use aluminized rolled warning signs to warn the public.	Contractors	DSC CCPIU	Lists and samples of warning signs and barricades	Prior to approval of detailed design documents	Detailed design documents
Method Statements	The Contractor shall submit written Method Statements to the Project Manager for the activities identified by the Project Manager or ECO. Activities that will require method statements include: -Concrete pre-cast and batching operation; -Crushing plant operation; -Storage facilities for any hazardous substances; -Emergency procedures; -Site establishment; -Removal and clearing of vegetation; -Materials, equipment and staffing requirements (camp establishment);	Contractor	DSC CCPIU	Method Statements	As necessary	

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	-Transporting the materials and/ or equipment to, from and within the site; -The storage provisions for the materials and/or equipment; -The proposed construction procedure designed to implement the relevant Environmental Specifications; Other information deemed necessary by the RE and/ or ECO.					
	The Contractor shall not commence work on that activity until such time as the Method Statement has been approved in writing by the Project Manager.	Contractor	DSC CCPIU	Approval Method Statement	As necessary	
Setting up of construction camp	- Choice of site for the contractor's camp requires the DSC environment management specialist's permission and must take into account location of local residents, businesses, and existing land uses. A site plan must be submitted to the environment management specialist for approval. - If the contractor chooses to locate the camp site on private land, he must get prior permission from the environment management specialist and the landowner. - Under no circumstances may open areas or the surrounding bushes be used as a toilet facility. - Recycling and the provision of separate waste receptacles for different types of waste should be encouraged.	Contractor	DSC CCPIU	Location plan	Prior to approval of detailed design documents	Approved location plan  Construction method  No complaints received
Establishing equipment lay-down and storage area	- Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by children, animals, etc. - The contractor should submit a method statement and plans for the storage of hazardous materials (fuels, oils, and chemicals) and emergency procedures.	Contractor	DSC CCPIU	Location plan	Prior to approval of detailed design documents	Approved location plan  Construction method  No complaints received
Materials management – sourcing	- The contractor should prepare a source statement indicating the sources of all materials (including topsoil, sands, natural gravels, crushed stone, asphalt, clay liners,	Contractor to submit sources of materials to DSC	DSC CCPIU	Lists of sources	Prior to approval of detailed design	Section 6 of contract All applicable permits (e.g.

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	etc), and submit these to the environment management specialist for approval prior to commencement of any work.				documents	from Mining Department for quarries, borrow pits, sands and gravel)
Existing Services and Infrastructure	The Contractor shall ensure that existing services (e.g. roads, pipelines, power lines and telephone services) are not damaged or disrupted unless required by the contract and with the permission of the RE.	Contractor, ECO, Project Manager	DSC CCPIU	Status of existing infrastructure	As necessary	
	The Contractor shall be responsible for the repair and reinstatement of any existing infrastructure that is damaged or services which are interrupted.	Contractor	DSC CCPIU		As necessary	
	Such repair or reinstatement will be to the Contractor's cost and shall receive top priority over all other activities.	Contractor	DSC CCPIU		As necessary	
Management of existing waste	One cell will be selected for storage and management of existing wastes. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
Treatment of leachate	<p>Groundwater protection by draining and treatment of the polluted water and leachate:</p> <p>The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant;</p> <p>To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.</p> <p>A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.</p> <p>Leachate reducing measurements:</p> <p>To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m; <math>K &lt; 1.10^{-9}</math> m/s).</p>	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents
Environmental incident	The Contractor must take corrective action to mitigate an incident appropriate to the nature and scale of the incident and must also rehabilitate any residual environmental damage caused by the incident or by the mitigation measures themselves.	EO, ECO, Contractor	DSC CCPIU		Continuous	
<b>Construction phase</b>						
Excavated materials	<ul style="list-style-type: none"> <li>- Hauling vehicles must always be present at the excavation site.</li> <li>- The contractor can process the excavated materials and use these as selected backfill materials.</li> <li>- If excavated materials are not suitable for reuse, the contractor should deposit these in an area designated by Barisal City Corporation.</li> <li>- Coordinate with the landfill operators for the disposal of excavated materials.</li> <li>- Obtain from the environment management</li> </ul>	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design documents</p> <p>Identify and obtain clearance from DoE for disposal sites</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>specialist approval for disposal of excavated materials.</p> <ul style="list-style-type: none"> <li>- Remove waste rapidly by loading material onto trucks as soon as it is excavated;</li> <li>- Cover or damp down working areas and stockpiled soil in dry, windy weather; and</li> <li>- Use tarpaulins to cover loose material during transportation to and from the site.</li> <li>- Maintain record of excavated materials, disposal dates, and methods.</li> <li>- Conduct the work in the dry season will reduce these impacts, and as the excavation in this case is shallow and small in scale there should be no impact on the water table.</li> </ul>					of excavated soils and contaminated materials
Management of existing waste	<p>For preparatory step the waste from the cell selected for storage of existing waste will be transported to the other cells temporarily for placement of impermeable clay layer in the bottom of selected cell. Then the existing wastes of the entire landfill site will be transported to the selected cell. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.</p>	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents
Treatment of leachate	<p>Groundwater protection by draining and treatment of the polluted water and leachate:</p> <p>The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant; To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.</p> <p>A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.</p>	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>Leachate reducing measurements:</p> <p>To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m; <math>K &lt; 1.10^{-9}</math> m/s).</p>					
Hauling of Construction Materials	<ul style="list-style-type: none"> <li>- The contractor must maintain all the materials necessary in his inventory so that these can be easily hauled to the construction site when needed.</li> <li>- Advance signage for affected parking areas must indicate duration and alternative parking arrangements.</li> </ul>	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design documents</p>
Access	<ul style="list-style-type: none"> <li>- The contractor should make available in his stock steel plates and wooden planks which will be deployed on top of excavations to provide temporary access to buildings, street crossings, and other areas where these will be necessary.</li> <li>- Advance road signage must indicate the road detour and alternative routes. Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints.</li> </ul>	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design documents</p> <p>Zero complaints from community/sensitive receptors</p>
Occupational health and safety	<ul style="list-style-type: none"> <li>- Employ workers with adequate experience, training, and know-how.</li> <li>- These workers should be led by an experienced supervisor or engineer, who will provide the leadership in daily activities.</li> <li>- A general regard for the social and ecological well-being of the site and adjacent areas is expected of the site staff. Workers need to be made aware of the following general rules: (i) no alcohol/drugs on site; (ii) prevent excessive noise; (iii) construction staff are to make use of the facilities provided for them, as opposed to ad hoc alternatives (e.g. fires for cooking, the use of surrounding bushes as a toilet facility); (iv)</li> </ul>	Contractor	DSC	<p>Occupational health and safety plan</p> <p>Number of accidents and work-related injuries</p> <p>Complaints from community</p>	As work progresses	<p>Construction method</p> <p>Detailed design documents</p> <p>Zero accident and work-related injuries</p> <p>Zero complaints from community and</p>



Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>no fires permitted on site except if needed for the construction works; (v) trespassing on private/commercial properties adjoining the site is forbidden; (vi) other than pre-approved security staff, no workers should be permitted to live on the construction site; and (vii) no worker may be forced to do work that is potentially dangerous or that he/she is not trained to do.</p> <ul style="list-style-type: none"> <li>- Because of existence of solid waste all around in the CLF site, the workers will need to wear uniform, which is usually used by the workers in the solid waste disposal site.</li> <li>- The contractor must monitor the performance of construction workers to ensure that the points relayed during their induction have been properly understood and are being followed. If necessary, a translator should be called to the site to further explain aspects of environmental or social behavior that are unclear.</li> <li>- The rules that are explained in the worker conduct section must be followed at all times.</li> </ul>					workers
Community health and safety	<ul style="list-style-type: none"> <li>- Contractor's activities and movement of staff will be restricted to designated construction areas.</li> <li>- Should the construction staff be approached by members of the public or other stakeholders, staff should assist them in locating the environment management specialist or contractor, or provide a number through which they may contact the environment management specialist or contractor.</li> <li>- The conduct of the construction staff when dealing with the public or other stakeholders should be in a manner that is polite and courteous at all times. Failure to adhere to this requirement may result in the removal of staff from the site by the environment management specialist.</li> <li>- Disruption of access for local residents,</li> </ul>	Contractor	DSC	<p>Complaints from community</p> <p>Activities based on the communication and participation strategy</p>	As work progresses	Zero complaints from community and workers

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>commercial establishments, institutions, etc. must be minimized and must have the environment management specialist's permissions.</p> <ul style="list-style-type: none"> <li>- Provide walkways and metal sheets where required to maintain access for people and vehicles.</li> <li>- Consult businesses and institutions regarding operating hours, and factor this in work schedules.</li> <li>- The contractor is to inform neighbors in writing of disruptive activities at least 24 hours beforehand. This can take place by way of leaflets placed in the postboxes giving the environment management specialist's and contractor's details or other method approved by the environment management specialist.</li> <li>- Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints.</li> <li>- The contractor will ensure that there is provision of alternate access to business establishments during the construction, so that there is no closure of these shops or any loss of clientage.</li> <li>- The contractor will ensure that any damage to properties and utilities will be restored or compensated to pre-work conditions.</li> <li>- Lighting on the construction site should be pointed downwards and away from oncoming traffic and nearby houses.</li> <li>- The site must be kept clean to minimize the visual impact of the site.</li> <li>- If screening is being used, this must be moved and re-erected as the work front progresses.</li> <li>- Machinery and vehicles are to be kept in good working order for the duration of the project to minimize noise nuisance to neighbors.</li> <li>- Notice of particularly noisy activities must</li> </ul>					

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>be given to residents/businesses adjacent to the construction site. Examples of these include: noise generated by jackhammers, diesel generator sets, excavators, etc.</p> <ul style="list-style-type: none"> <li>- Noisy activities must be restricted to the times given in the project specification or general conditions of contract.</li> <li>- The environment management specialist and contractor are responsible for ongoing communication with those people who are interested in or affected by the project.</li> <li>- A complaints register (refer to the grievance redressal mechanism) should be housed at the site office. This should be in carbon copy format, with numbered pages. Any missing pages must be accounted for by the contractor. This register is to be tabled during monthly site meetings.</li> <li>- Interested and affected parties need to be made aware of the existence of the complaints book and the methods of communication available to them.</li> <li>- The contractor must address queries and complaints by: (i) documenting details of such communications; (ii) submitting these for inclusion in complaints register; (iii) bringing issues to the environment management specialist's attention immediately; and (iv) taking remedial action as per environment management specialist's instruction.</li> <li>- The contractor should immediately take the necessary remedial action on any complaint/grievance received by him and forward the details of the grievance along with the action taken to the environment management specialist within 48 hours of receipt of such complaint/grievance.</li> </ul>					
Community and public awareness	<ul style="list-style-type: none"> <li>- Storage facilities and other temporary structures on-site should be located such that they have as little visual impact on local residents as possible.</li> <li>- Special attention should be given to the</li> </ul>	Contractor	DSC	<p>Complaints from community</p> <p>Activities based on the</p>	As work progresses	Zero complaints from community and workers

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>screening of highly reflective materials on site.</p> <p>- In areas where the visual environment is particularly important (e.g. along commercial/ tourism routes) or privacy concerns for surrounding buildings exist, the site may require screening. This could be in the form of shade cloth, temporary walls, or other suitable materials prior to the beginning of construction.</p>			communication and participation strategy		
Construction camps and storage areas	<p>- The contractor is to ensure that open areas or the surrounding bushes are not being used as toilet facility.</p> <p>- The contractor should ensure that all litter is collected from the work and camp areas daily.</p> <p>- Bins and/or skips should be emptied regularly and waste should be disposed of at the pre-approved site. Waybills for all such disposals are to be kept by the contractor for review by the environment management specialist.</p> <p>- The contractor should ensure that his camp and working areas are kept clean and tidy at all times.</p> <p>- After construction work, all structures comprising the construction camp are to be removed from site or handed over to the property owner/community as per mutual agreement (if established on private/community land).</p> <p>- The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these should be cleaned up.</p> <p>- All hardened surfaces within the construction camp area should be ripped, all imported materials removed, and the area should be top soiled and regressed.</p> <p>- The contractor must arrange the cancellation of all temporary services.</p>	Contractor	DSC	<p>Approved location plan</p> <p>Complaints from community</p>	As work progresses	<p>Approved location plan</p> <p>Zero complaints from community and workers</p>
Dust and air pollution	- Vehicles travelling to and from the construction site must adhere to speed limits	Contractor	DSC	Vehicle emission testing	As work progresses	No visible increase in

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	so as to avoid producing excessive dust. - Access and other cleared surfaces, including backfilled trenches, must be dampened whenever possible and especially in dry and windy conditions to avoid excessive dust. - Vehicles and machinery are to be kept in good working order and to meet manufacturer's specifications for safety, fuel consumption, etc. - The contractor is to have the equipment seen to as soon as possible should excessive emissions be observed,			records  Complaints from community		dust and particulate matters  Zero complaints from community
Noise levels	- Noise-generating equipment must be fitted with silencers. - If a worker is exposed to noise above a noise exposure limit, the contractor must investigate options for engineered noise control such as using low-noise excavators, jackhammers, drills, and power generators. - If it is not practicable to reduce noise levels to or below noise exposure limits, the contractor must post warning signs in the noise hazard areas. Workers in a posted noise hazard area must wear hearing protection.	Contractor	MASC environment management specialist	Complaints from community  Noise level monitoring record	As work progresses	ECR 1997
Utilities	- Prepare a list of affected utilities and operators - Prepare a contingency plan to include actions to be done in case of unintentional interruption of services.	Contractor	DSC	Number of affected utilities  Length of time to restore disrupted services	As work progresses	No disrupted service
Water quality	- Every effort should be made to ensure that any chemicals or hazardous substances do not contaminate the soil or water on-site. - Care must be taken to ensure that runoff from vehicle or plant washing does not enter the surface/ground water. - Site staff should not be permitted to use any stream, river, other open water body, or natural water source adjacent to or within the designated site for the purposes of bathing,	Contractor	DSC	Complaints from community  Waste disposal manifest/record	As work progresses	No visible increase in water pollution due to the project  Zero complaints from community

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>washing of clothing, or for any construction or related activities. Municipal water (or another source approved by the environment management specialist) should instead be used for all activities such as washing of equipment or disposal of any type of waste, dust suppression, concrete mixing, compacting etc.</p> <ul style="list-style-type: none"> <li>- All concrete mixing must take place on a designated, impermeable surface.</li> <li>- No vehicles transporting concrete to the site may be washed on-site.</li> <li>- No vehicles transporting, placing, or compacting asphalt or any other bituminous product may be washed on-site.</li> <li>- All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of removed from the site.</li> <li>- Hazardous substance/ materials are to be transported in sealed containers or bags.</li> </ul>					
Waste management	<ul style="list-style-type: none"> <li>- Wastes must be placed in the designated skips/bins which must be regularly emptied. These should remain within demarcated areas and should be designed to prevent wastes from being blown out by wind.</li> <li>- Littering on-site is forbidden and the site should be cleared of litter at the end of each working day/night period.</li> <li>- Recycling is to be encouraged by providing separate receptacles for different types of wastes and making sure that staff is aware of their uses.</li> <li>- All waste must be removed from the site and transported to a disposal site or as directed by the environment management specialist. Waybills proving disposal at each site should be provided for the environment management specialist's inspection.</li> <li>- Construction rubble should be disposed of in pre-agreed, demarcated spoil dumps that have been approved by the environment management specialist, or at disposal sites.</li> </ul>	Contractor	DSC	<p>Complaints from community</p> <p>Waste disposal manifest/record</p>	As work progresses	<p>No dumped wastes and litter at work sites at all times</p> <p>Zero complaints from community</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
Conservation of natural environment	<ul style="list-style-type: none"> <li>- As the work front progresses; the contractor is to check that vegetation clearing has the prior permission of the environment management specialist.</li> <li>- Only trees that have been marked beforehand are to be removed, if cutting of trees is required.</li> <li>- Clean the entire area and maintain immediately after completion of the construction activities to make sure that existing tranquility of the surrounding area is not disturbed in any way.</li> </ul>	Contractor	DSC	Vegetation clearing	As required	Only allowed trees/vegetation to be cleared
Cultural and historical environment	<ul style="list-style-type: none"> <li>- Consult laborers who work on the site during the detailed design stage and in the unlikely event that there are social and cultural resources in the site; assistance should be given in relocating the site and any associated artifacts.</li> <li>- All the staff and laborers of the contractor are to be informed about the possible items of historical or archaeological value, which include old stone foundations, tools, clayware, jewelry, remains, fossils etc.</li> <li>- If something of this nature is uncovered, Department of Archaeology should be contacted and work should be stopped immediately.</li> </ul>	Contractor	DSC	Chance finds	As necessary	All chance finds shall be reported and turned over to the Department of Archaeology.
Safeguards supervisors	<ul style="list-style-type: none"> <li>- The contractor should appoint one environment safeguard supervisor who will be responsible for assisting the contractor in implementation of EMP, coordinating with the DSC, consultations with interested/affected parties, reporting, and grievance redressal on a day-to-day basis.</li> </ul>	Contractor	DSC	Hiring and actual work	As work progresses	Continuous work output and reporting records
Post-construction and post-commissioning irregularities	<ul style="list-style-type: none"> <li>- Remove all plant/ machineries/ vehicles and any temporary structures including the workforce camps and warehouses for storage of materials after completion of construction.</li> <li>- Restore the original landscape of the surrounding area as much as possible.</li> </ul>	Contractor	DSC	Cleanliness of the site and surrounding area	End of construction phase	As specified in the O&M Manual and all applicable laws and regulations
<b>Operation and maintenance phase</b>						
General	- Develop O&M Manuals to include all	Contractor (up to	Barisal City	Specifications in	As determined	As specified in

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	aspects of the management and operation of the CLF: <ul style="list-style-type: none"> <li>- nature of waste that is accepted;</li> <li>- sequence and location of waste placement;</li> <li>- operation and maintenance of the gas collection system;</li> <li>- introduction of moisture or recirculation of leachate, leachate collection;</li> <li>- maintenance and cleaning of the leachate collection system; and</li> <li>- environmental monitoring, and maintenance of the final cover.</li> </ul> - Train all CLF workers to the highest standards available in Bangladesh and given refresher training at least annually <ul style="list-style-type: none"> <li>- Control access for public/ personnel;</li> <li>- Clean toilets daily;</li> <li>- Provide clean hand washing areas adequate soap and towels;</li> <li>- Provide clothing and laundry service for workers; and</li> <li>- Clean facility after the work of each day.</li> </ul> - The waste storage area and other adjacent areas should be sprinkled or sprayed regularly with disinfectants to avoid any spread of disease. <ul style="list-style-type: none"> <li>- Audit implementation of O&amp;M procedures at regular intervals (by an Independent Monitoring Agency)</li> </ul>	service delivery period)  Barisal City Corporation	Corporation (up to service delivery period)  Independent Monitoring Agency	the O&M Manual  Public health survey (5 years) <sup>14</sup>	in the O&M Manual	the O&M Manual and all applicable laws and regulations
Monitoring/ Waste composition, inventory and inspection	Landfill operator must ensure that a register is kept throughout the life of the facility of the quantities and characteristics of the waste deposited.	Contractor	City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
	Information on waste register must include the origin of waste, type of waste, date of	Contractor	City Corporation (up to service	Specifications in the O&M	As determined in the O&M	As specified in the O&M

<sup>14</sup> Public health survey will be conducted by the city corporation authority by its own source of fund with a view to evaluating the impact of operation and maintenance of the CLF. Outcome will be utilized to monitor the impacts and to make any changes in the modality of operation of the CLF to make it more public health friendly than before. Target population will be the residents within a distance of one kilometer around the CLF.



Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	delivery, identify of the producer or collector.		delivery period)  Independent Monitoring Agency	Manual	Manual	Manual and all applicable laws and regulations
	Regular visual inspection of the waste at the point of deposit should be undertaken to ensure that waste is properly sorted/ separated at the site	Contractor	City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Monitoring of gases, wastewater and water	Indicative parameters for environmental pollution like presence of inflammable gases and quality of water and groundwater will be monitored	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	ECR 1997 and applicable international guidelines
Land contamination	- Do not store wastes outside the CLF premises to avoid issues of aesthetic nature	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Wastewater	- After treatment, the discharge standards need to be followed similar to the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period)  Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	ECR 1997 (Rule 13: The standard limits of the discharge of liquid wastes shall be determined in accordance with the standards specified in Schedule 10)
Other wastes	- All other wastes arising in the CLF should be properly graded and disposed of by appropriate methods. - Disposed into a solid waste bin (skip) and immediately transport out of the CLFs in a	Contractor (up to service delivery period)  Barisal City	Barisal City Corporation (up to service delivery period)	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	closed wheel-barrow or similar other device.	Corporation	Independent Monitoring Agency			regulations
Odor	<ul style="list-style-type: none"> <li>- Audit odor to identify and characterize sources and determine any action required.</li> <li>- Carry out frequent cleaning of material storage areas to prevent odor</li> </ul>	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Vermin and pest	<ul style="list-style-type: none"> <li>- Apply soil cover materials rigorously</li> <li>- Compact wastes properly</li> <li>- Carefully maintain general “good housekeeping”</li> <li>- Inspect site regularly to detect indication of prevalence of pests and vermin</li> <li>- Employ an experienced pest control specialist to deal with this problem in case significant numbers are identified.</li> </ul>	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period)  Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Noise	<ul style="list-style-type: none"> <li>- Activities and vehicle movements should be avoided after hours.</li> <li>- Vehicles should be fitted with silencers.</li> <li>- Vehicles and machinery are to be kept in good working order.</li> </ul>	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Water use	<ul style="list-style-type: none"> <li>- Minimize water use through dedicated metering of water consumption</li> </ul>	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Health, hygiene, and safety	<ul style="list-style-type: none"> <li>- CLF workers should undergo regular medical check-up</li> <li>- CLF workers should be provided with protective gear like head cover, gloves, etc</li> <li>- Provide training on safety to staff to avoid accidents</li> <li>- Regularly monitor the CLF to ensure compliance with occupational health and safety rules</li> </ul>	Contractor (up to service delivery period)  Barisal City Corporation	Barisal City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations

## **D. Reporting**

167. The DSC will submit monthly monitoring reports to CCPIU, and the CCPIU will send semiannual monitoring reports to ADB. ADB will post the environmental monitoring reports on its website.

## **E. Environmental Costs**

168. The contractor's cost for site establishment, preliminary activities, construction, defect liability activities, and environmental mitigation measures related to EMP implementation during planning, design, construction, and operations will be incorporated into the contractual agreements and engineers costs, which will be binding on him for implementation.

169. The mitigation measures during the operation phase (after the service delivery period) are again of good operating practices, which will be the responsibility of the implementing agency (Barisal City Corporation). All monitoring during the operation and maintenance phase will be conducted by Barisal City Corporation; therefore, there are no additional costs.

170. The activities identified in the EMP mainly include site inspections and informal discussions with workers and local community, and this will be the responsibility of CCPIU with the assistance of DSC, costs of which are part of project management. The budget required for capacity building and training program mentioned in Table 6 is also included in the project management cost.

171. Table 8 presents the estimated cost to implement the EMP. The EMP and the costs for the EMP implementation will be updated during detailed engineering design. The figures show that the total cost of environmental management and monitoring for all subprojects in Barisal is Tk 22.5 million. This includes: the cost of the Independent Monitoring Agency, which will spend one week every month for five years, monitoring the operation of the CLF. It includes the cost of all surveys (long-term bi-annual wastewater monitoring will be done by DOE and test costs borne by operator according to DOE fee rates as per Schedule 14 of the ECR, 1997) and other expenses associated with implementing the EMP for this subproject during project implementation. It also includes the cost of the long-term survey of public health proposed in the EMP for this subproject.

**Table 8: Environmental Management and Monitoring Costs for Barisal CLF**

Item	Quantity	Unit Cost (TK.)	Total Cost (TK.)	Sub-total
<b>1. Monitoring during Construction (1.5 years)</b>				
Domestic Environmental Specialist	1 x 6 month	300,000 <sup>15</sup>	1,800,000	
Survey Expenses	Lump Sum	2,000,000	2,000,000	3,800,000
<b>2. Monitoring during Operation (5 years)</b>				
Independent Monitoring Expert	5 x 3 month	300,000	4,500,000	
Supporting Staff	5 x 3 month	200,000	3,000,000	
Survey Expenses	Lump Sum	5,000,000	5,000,000	12,500,000
<b>3. IEEs/EIAs required by ADB policy &amp; national law</b>				
Domestic Environmental Specialist	1 x 12 month	300,000	3,600,000	
Expenses (surveys, consultation, disclosure)	Lump Sum	1,000,000	1,000,000	4,600,000
<b>4. Survey of Public Health (5 years)</b>				
Domestic Consultant	5 x ½ month	300,000	750,000	
Supporting Staff	5 x ½ month	200,000	500,000	
Other Expenses	Lump Sum	350,000	350,000	1,600,000
<b>TOTAL COST (TK.)</b>				<b>22,500,000</b>

## VII. FINDINGS AND RECOMMENDATIONS

### A. Findings

172. The process described in this document has assessed the environmental impacts of all elements of the infrastructure proposed under the Barisal CLF subproject. Potential negative impacts were identified in relation to the design, construction and operation of the infrastructure, and mitigation measures have been developed to reduce all negative impacts to acceptable levels. These were discussed with specialists responsible for the engineering aspects of program development, and as a result some measures have already been included in the outline designs for the infrastructure. These include:

- (i) Ensuring that the site selected for the CLF is owned by the Government and does not contain any residential property, to avoid the need to relocate households; and
- (ii) Selecting a site that is in an uninhabited area where there are no sensitive receptors.

173. This means that the number of impacts and their significance has already been reduced by amending both the design and location of elements of the subproject.

174. Regardless of these and various other actions taken during the IEE process and in developing the subproject, there will still be impacts on the environment when the infrastructure is built and when it is operating. This is mainly because a functioning CLF can have major negative impacts on public health and safety, and environmental quality, if it is not operated to the highest professional standards. Because of these factors the most significant impacts are on the physical environment and the human environment.

175. In the construction phase there are not expected to be major negative impacts because the construction work is relatively straightforward and will be conducted at a single site. Other mitigation and enhancement measures are included in the EMP, which also shows the location of the impact, the body responsible for the mitigation, and the program for its implementation.

<sup>15</sup> Unit cost of domestic consultants is based on current rates and includes fee, travel, accommodation and subsistence.

176. Operation and maintenance of the completed CLF will be the responsibility of the contractor up to the end of the service delivery period and afterwards, the Barisal City Corporation. It will be vital that the facility operates to the highest professional standards because if this is not the case it could easily replicate the practices and effects that are common at existing CLF and *ad hoc* solid waste dumping places in the city. These include impacts on:

- (i) **Worker health and safety.** if equipment, procedures and hygiene are inadequate;
- (ii) **Environmental quality.** if solid waste is not properly collected, transported and disposed to proper positions on a daily basis.

177. The IEE includes a number of measures relating to the design to ensure that the facility operates to a high standard and avoids these and other impacts. The main measures are that:

- (i) All aspects of management and operation should be set out in O&M manuals prepared by an international expert in CLF management;
- (ii) Implement of the procedures is checked and audited by an Independent Monitoring Agency every month for the first five years;
- (iii) All workers are trained to the highest available standards and re-trained annually;
- (iv) Ensuring sufficient training and financial support to the Barisal City Corporation to achieve expected standards.

178. If these and the other mitigation measures recommended by the IEE are implemented, then the CLF should operate without significant negative impacts. Public health should therefore improve and there will also be economic benefits for the people in general because there will be less possibility of getting sick and subsequent absence of the workers in offices and factories.

179. Mitigation will be assured by a program of environmental monitoring conducted during both construction and operation to ensure that all measures are provided as intended, and to determine whether the environment is protected as envisaged. This will include observations on and off site, document checks, and interviews with workers and beneficiaries during the construction stage, and weekly monitoring of all practices at the CLF for the first five years of operation, by the IMA. Any requirements for remedial action will be reported to LGD/ UPEHU and ADB. There will also be a longer-term survey to monitor the expected improvements in public health.

180. Finally, stakeholders were involved in developing the IEE through face-to-face discussions on site and a large public meeting held in the town, after which views expressed were incorporated into the IEE and the planning and development of the project. The IEE and other documents will be made available at public locations in the town and summaries will be disclosed to a wider audience via the ADB website. The consultation process will be continued and expanded during project implementation, when a nationally-recognized NGO will be appointed to handle this key element to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation.

## **B. Recommendations**

181. There are two straightforward but essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. These are that LGD/ UPEHU should ensure that:

- (i) All mitigation measures proposed in this IEE report (Table 7) are implemented in full, as described in this document; and

(ii) The EMP of this report is updated during detailed design and also implemented in full during construction and operation period.

(iii) A copy of the EMP shall be kept on-site during the construction and operation period at all times. Also the SIEE is prepared and provided to contractors upon award of contract.

(iv) The EMP shall be made binding on all contractors operating on the site, and will be included in the contractual clauses. Non-compliance with, or any deviation from, the conditions set out in this document shall constitute a failure in compliance.

## **VIII. CONCLUSIONS**

182. The environmental impacts of the proposed CLF subprojects in the Barisal City have been assessed according to ADB guidelines and results reported in this IEE. The potential adverse environmental impacts are related to the (i) construction period, which can be minimized by the mitigating measures and environmentally sound engineering and construction practices; and (ii) operation period, which can be managed by the mitigation measures and environmentally sound O&M practices. Therefore, as per ADB Environment Policy, the project is classified as environmental category B and does not require further environmental impact assessment.

183. In relation to Bangladeshi ECR 1997, the Barisal CLF subproject is considered to have significant environmental impacts and can be classified as Red category. The environmental impacts can be mitigated by the measures mentioned in this IEE and EMP. So this IEE document will be sufficient and acceptable to DoE as part of the ECC application although further study to prepare EIA report for impact assessment at a later stage will be necessary.

### ANNEX 1: ADB Rapid Environmental Assessment Checklist

Screening Questions	Yes	No	Remarks
<b>A. Project Siting</b> Is the project area...			
▪ Densely populated?		X	
▪ Heavy with development activities?		X	The Landfill site is located in city corporation owned land. At present this is being used for dumping of municipal solid wastes.
▪ Adjacent to or within any environmentally sensitive areas?			
• Cultural heritage site		X	
• Protected Area		X	
• Wetland		X	
• Mangrove		X	
• Estuarine		X	
• Buffer zone of protected area		X	
• Special area for protecting biodiversity		X	
• Bay		X	
<b>B. Potential Environmental Impacts</b> Will the Project cause...			
▪ impacts on the sustainability of associated sanitation and solid waste disposal systems and their interactions with other urban services.		X	
▪ deterioration of surrounding environmental conditions due to rapid urban population growth, commercial and industrial activity, and increased waste generation to the point that both manmade and natural systems are overloaded and the capacities to manage these systems are overwhelmed?		X	
▪ degradation of land and ecosystems (e.g. loss of wetlands and wild lands, coastal zones, watersheds and forests)?		X	
▪ dislocation or involuntary resettlement of people?		X	There will be no dislocation or involuntary resettlement of people.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable group?		X	
▪ degradation of cultural property, and loss of cultural heritage and tourism revenues?		X	
▪ occupation of low-lying lands, floodplains and steep hillsides by squatters and low-income groups, and their exposure to increased health hazards and risks due to pollutive industries?		X	
▪ water resource problems (e.g. depletion/degradation of available water supply, deterioration for surface and ground water quality , and pollution of receiving waters?		X	
▪ air pollution due to urban emissions?	X		During construction activities for hauling of materials and operations of excavation equipment; During operations, odor from the

Screening Questions	Yes	No	Remarks
			solid wastes due to agitation and mixing
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical and biological hazards during project construction and operation?	X		During construction activities – occupational health and safety due to physical hazards; During construction activities – occupational health and safety due to physical and biological hazards
▪ road blocking and temporary flooding due to land excavation during rainy season?		X	
▪ noise and dust from construction activities?	X		During construction phase only
▪ traffic disturbances due to construction material transport and wastes?	X		During construction phase only
▪ temporary silt runoff due to construction?	X		During construction phase only
▪ hazards to public health due to ambient, household and occupational pollution, thermal inversion, and smog formation?		X	
▪ water depletion and/or degradation?		X	
▪ overpaying of ground water, leading to land subsidence, lowered ground water table, and salinization?		X	
▪ contamination of surface and ground waters due to improper waste disposal?	X		During construction phase only
▪ pollution of receiving waters resulting in amenity losses, fisheries and marine resource depletion, and health problems?		X	
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	
▪ social conflicts if workers from other regions or countries are hired?		X	
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?		X	
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	



## ANNEX 2: Photographs of the Proposed CLF Site and the Surrounding Areas



Medical waste spread over the premises



Dilapidated medical waste facilities



Unsafe sorting of medical waste by hand



Some areas still to be filled



Drive way inside the landfill site



Waste pickers in the landfill site



### **ANNEX 3: Records of Public Consultations Conducted**

The stakeholders' consultation meeting was held at Landfill site at Kawnia under the Ward #3, Barisal at 1-30 PM on 2 January 2013 with local people and Barisal City Corporation (BCC) officials.

The meeting was held with local people and Conservancy Officer (Mr. Deepak Lal Mridha) of BCC. Among the local people, most of them were laborers and engaged in landfill site and waste pickers who participated actively in the consultation. Local people and waste pickers were about 40% and the remaining were the employees of the city corporation. Total number of waste pickers in the CLR site is about 40 and discussion was held with the persons available during the visit. First 4 participants in the attendance sheet are the waste pickers and the remaining are city corporation officials.



*Meeting at CLF site in Barisal*

The Environment and Safeguard Specialist of Package-C Consultants welcomed all participants in the meeting and explained goals and objectives of the project. He told that the Government of Bangladesh through the BCC has undertaken a project to construct one modern slaughterhouse, one Controlled land fill and 4 secondary transfer stations in BCC area to keep the city free from environmental pollution. This project will benefit the local people by improving the environmental conditions.

It was known from the discussion that the land proposed for construction of the Controlled Landfill (CLF) is owned by the Barisal City Corporation. It is a big area of about 5.5 acres owned by the BCC, and it will be enough for construction of CLF as per design adopted in UPEHSDP. It is at present being used as the disposal site for dumping the solid waste from the entire city corporation area. The participant from the BCC clearly stated that the area proposed for construction of CLF will be kept free from any kind of external hindrance by the own initiative of the BCC during the construction activities by the contractor in the site.

It was disclosed in the meeting that the project would be implemented soon and the local people would get benefit of getting employment as soon as the construction works would start. They also expressed their willingness to get long-term deployment after the implementation of the CLF. It was disclosed to the participants that the local people would get preference during selection of staff and workers for running the CLF in a sustainable manner.

The participants were convinced that the socio-economic and environmental condition of the local people and the locality would be definitely better after implementation of the subproject and they showed their willingness to cooperate whole heartedly during construction and operation and maintenance phase of the CLF.

There were no issues left for discussion and the meeting was closed with a vote of thanks to all participants.

**Ministry of Local Government, Rural Development and Cooperatives**  
**Urban Public and Environmental Health Sector Development Project (UPEHSDP)**  
**Attendance Sheet**

Time: 1-30 PM

Date: 2/1/2013

Place of meeting: Landfill Site Kawnia, Barisal

Union: W-3

Thana: Sadar

Serial Number	Name of Participant	Father's/ Husband's Name	Address	Mobile Number	Signature
1	Abu Bakr	Jamil Uddin	Kawnia	—	
2	Abul Kalam	Altaf Hossain	Kawnia	01771496614	
3	Razia Begum	Abu Bakr	Kawnia	—	
4	Nilufa Begum	Abul Kalam	Kawnia	—	
5	Deepak Lal Mridha	Late Ganesh Chandra Mridha	Nutan Bazar	01711176125	
6	Dilara Khanam	Md. Jasim Uddin	New Bhatikhana	01682579011	
7	Laizu	Montu	Amanatganj	01935758188	
8	Musammat Mukul Aktar	Shahidul Islam	Alekanda	01770199135	
9	Md. Yusuf Ali	Md. Abul Hashem	Sree Kaut	01711021256	
10	Md. Shipon	Late A Jabbar	Kawnia	01716912913	

## Attendance Sheet

Date: 2/1/2013

Union: W/3

Thana: Sadar

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## **ANNEX 4: Environmental Pathway Studies – Barisal**



Joint Venture



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### **FIELD REPORT**

#### **ENVIRONMENTAL PATHWAY STUDIES - BARISAL**

September 10, 2013

#### **THE URBAN PUBLIC AND ENVIRONMENTAL HEALTH SECTOR DEVELOPMENT PROJECT (UPEHSDP)**

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## **Annexes**

Annex 1: Bore logs

Annex 2: Analysis Report

## **1      PURPOSE OF THE FIELD REPORT**

The purpose of the Field Report is to:

- To represent the analyses measured on the soil samples.
- To represent the analyses measured on the samples, ground water samples and surface water samples.
- To represent a short overview of all work done under the TOR

The present Report is the Field Report which contains all results of the Environmental Pathway Study In Barisal, performed in last two weeks of April. It has been prepared by the two partners Ecorem and DDC under the JV Ecorem-DDC.

The proposed landfill site of Barisal City Corporation is located at Kawnia about five kilometers to the north from the city center. Total area of the site is 600 decimal bounded by herring bone bond brick soling road. Shapania Khal (a perennial canal) flowing east-west from the northern side of the plot and it falls into the river Kirtankhola. It is being used as a waste dumping ground since 2002. It is learnt from the city officials that acquisition process for another 700 decimal of adjacent agricultural land is under way. Medical waste of the city is also dumped here at the north-east corner of the existing site. The site is accessible from the city center from the south – east and south-west. There is a road link from the northern side of the existing landfill site. The site is rectangular in shape and has a rough dimension of about 361ftx722ft.



## 2 GENERAL DESCRIPTION OF ACTIVITIES PERFORMED UNDER THE ENVIRONMENTAL PATHWAY STUDIES

For the purpose of the study some bore holes were made and four 1.5"inch diameter tube wells were installed in the first available aquifer. The drillings were done manually by slugger method. Since this is a high water table area (water table within the suction limit of 24'ft.from the ground level) suction mode manually operated conventional number six hand pumps were used to collect ground water samples. These boreholes will serve two purposes namely:

- 1) Collection of ground water samples for testing in the laboratory for the determination of the extent of ground water pollution by the leach ate of the waste being dumped at the landfill site; and
- 2) Determine the location of the ground water table.

The static water levels as measured on the 18<sup>th</sup> of July 2013 for the boreholes are shown in the table below:

Table 1: Particulars of observation wells at Barisal (4 nos.)

Sl. no.	Location	Depth (ft)	Diameter of the well (Inches)	Location of the strainer (ft)	Length of strainer (ft)	Type of pump	Depth of water table (SWL)	Date of installation	Sand trap (ft)	Remarks
1	Near the south west corner of the land fill site	56'	1.5"	44.5' to 51.5' from ground level	6'	Number six manually operated hand Pump	2.25 ft from the base of the pump	18.05.2013	2.5'	Pump base located at 9"above ground level
2	On the edge of the Brick soling road near the south east corner of the land fill site	54.5'	1.5"	42.5'to 48.5''- from ground level	6'	Number six manually operated hand Pump	2.75 ft from the base of the pump	18.05.2013	2.5'	Pump base located at 9"below road level
3	On the edge of the Brick soling road at the middle of the plot of the land fill site	56.5'	1.5"	45.0' to 51.0' from ground level	6'	Number six manually operated hand Pump	3ft from the base of the pump	19.05.2013	2.5'	Pump base located at 6"below road level

4	On the edge of the Brick soling road to the north east corner of the of the land fill site	52'-0"	1.5"	40.5' to 46.5' from ground level	6'	Number six manually operated hand Pump	4.58 ft from the base of the pump	19.05.2013	2.5'	Pump base located at 9" above road level
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Collection of soil sample from one borehole up to a depth of five meters from the ground level at an interval of 1.5'ft and choosing a representative sample for laboratory testing to ascertain the chemical contents to have an idea about the presence of pollutants of the wastes penetrated in the underlying soil strata.

One soil sample from a depth of 15 ft. was sent to the laboratory for testing. The soil sampling was done from borehole number 4 as shown in the site map (see annex).

For the purpose of waste characterization 3 current dumping spots were selected wherein the dump trucks are dropping the wastes now a days. The location of the waste collection points are shown on the site map (see annex). These points were selected for getting an impression about the character of the current waste stream.

Table 2: Calendar of the achieved work

Well site number/ Bore hole number	Start of drilling work	Completion of drilling and date of installation of observation well
1	18/05/2013	18/05/2013
2	18/05/2013	18/05/2013
3	19/05/2013	19/05/2013
4	19/05/2013	19/05/2013

### 3 ANALYSIS AND RESULTS

#### 3.1 Groundwater samples

##### 3.1.1 Way of sampling

4 water samples were collected from four observation wells installed at the landfill site. Before taking ground water samples, the tube wells were sufficiently pumped to bail out the standing water in the well. After that one liter of water was collected in plastic bottles. Care was taken while filling the bottle with water so that no air bubble is entrapped in the bottle.

##### 3.1.2 Analysis

Testing of the water samples were done in Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory in Dhaka.

##### 3.1.3 Results

Table 3: Results of analysis of sample no. B.H.-1

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10063	Water (B.H.-1, Barisal)	pH at 25.6 deg. C	7.04	4500-H <sup>+</sup> .B
		E. Conductivity	5615 $\mu$ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.009 mg/L	3113.B
		Arsenic (As)	0.616 mg/L	3114.C
		Iron (Fe)	12.5 mg/L	3111.B
		Mercury (Hg)	0.004 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	1714 mg/L	4110.B
		Bromide (Br)	8.05 mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	403 mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	Less than 3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	Less than 4mg/L	4110.B
		Sodium (Na)	891 mg/L	3500-Na.B
		Potassium (K)	26.1 mg/L	3500-K.B
		Calcium (Ca)	130 mg/L	3111.B
		Magnesium (Mg)	130 mg/L	3111.B
		Temperature	27.1 <sup>o</sup> C	2550.B
		BOD	6.85 mg/L	5210.B
		COD	14.2 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	33.0 mg/L	3500.B

Table 4: Results of analysis of sample no. B.H.-2

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10064	Water (B.H.-2, Barisal )	pH at 25.8 deg. C	7.05	4500-H <sup>+</sup> .B
		E. Conductivity	5015 $\mu$ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.009 mg/L	3113.B
		Arsenic (As)	0.422 mg/L	3114.C
		Iron (Fe)	15.2 mg/L	3111.B
		Mercury (Hg)	0.002 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	1541 mg/L	4110.B
		Bromide (Br)	6.97mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	402 mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	Less than 3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	Less than 4mg/L	4110.B
		Sodium (Na)	774 mg/L	3500-Na.B
		Potassium (K)	24.5 mg/L	3500-K.B
		Calcium (Ca)	229 mg/L	3111.B
		Magnesium (Mg)	112 mg/L	3111.B
		Temperature	27.2 <sup>o</sup> C	2550.B
		BOD	7.90 mg/L	5210.B
		COD	16.2 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	42.5 mg/L	3500.B

Table 5: Results of analysis of sample no. B.H.-3

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10065	Water(B.H.-3, Barisal)	pH at 26 deg. C	6.97	4500-H <sup>+</sup> .B
		E. Conductivity	5165 $\mu$ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.015 mg/L	3113.B
		Arsenic (As)	0.330 mg/L	3114.C
		Iron (Fe)	23.4 mg/L	3111.B
		Mercury (Hg)	0.026 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	1653 mg/L	4110.B
		Bromide (Br)	7.67 mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	478 mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	Less than 3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	Less than 4mg/L	4110.B
		Sodium (Na)	803 mg/L	3500-Na.B
		Potassium (K)	25.8 mg/L	3500-K.B
		Calcium (Ca)	212 mg/L	3111.B
		Magnesium (Mg)	125 mg/L	3111.B
		Temperature	27.3 <sup>o</sup> C	2550.B
		BOD	12.1 mg/L	5210.B
		COD	28.3 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	47.8 mg/L	3500.B

Table 6: Results of analysis of sample no. B.H.-4

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10066	Water(B.H.-4, Barisal )	pH at 26.1 deg. C	7.08	4500-H <sup>+</sup> .B
		E. Conductivity	4545 $\mu$ S/cm	2510.B
		Lead (Pb)	<0.01 mg/L	3113.B
		Cadmium (Cd)	< 0.001mg/L	3113.B
		Chromium (Cr)	0.078 mg/L	3113.B
		Arsenic (As)	0.402 mg/L	3114.C
		Iron (Fe)	12.5 mg/L	3111.B
		Mercury (Hg)	0.002 mg/L	3112.B
		Fluoride (F)	< 0.5 mg/L	4110.B
		Chloride (Cl)	1229 mg/L	4110.B
		Bromide (Br)	5.96 mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	473 mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	<3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	<4mg/L	4110.B
		Sodium (Na)	526 mg/L	3500-Na.B
		Potassium (K)	28.3 mg/L	3500-K.B
		Calcium (Ca)	197 mg/L	3111.B
		Magnesium (Mg)	121 mg/L	3111.B
		Temperature	27.1 <sup>0</sup> C	2550.B
		BOD	15.9 mg/L	5210.B
		COD	24.3 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	46.5 mg/L	3500.B

### 3.2 Surface water samples

Two surface water samples were collected in plastic bottles from the canal located at the northern boundary of the landfill site from predetermined location shown on the site map marked 5 and 6. Care was taken while filling the bottle with water so that no air bubble is entrapped in the bottle. In the laboratory test report this two spots have been designated as B.H.No.5 and B.H.No.6 although this two are surface water samples.

#### 3.2.1 Way of sampling

Bottles were dipped in water and filled up with water without entrapped air.

#### 3.2.2 Analysis

Testing of surface water samples were done in Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory in Dhaka.

#### 3.2.3 Results

Table 7: Results of analysis of sample no. B.H.-5 (surface water sample)

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10067		pH at 25.9 deg. C	7.26	4500-H <sup>+</sup> .B
		E. Conductivity	177 $\mu$ S/cm	2510.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
	Water(B.H.-5, Barisal)	Lead (Pb)	< 0.01 mg/L	3113.B
		Cadmium (Cd)	< 0.001mg/L	3113.B
		Chromium (Cr)	< 0.005 mg/L	3113.B
		Arsenic (As)	<0.005 mg/L	3114.C
		Iron (Fe)	0.52 mg/L	3111.B
		Mercury (Hg)	< 0.001 mg/L	3112.B
		Fluoride (F)	< 0.5 mg/L	4110.B
		Chloride (Cl)	14.3 mg/L	4110.B
		Bromide (Br)	<1mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	<1mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	<3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	5.6 mg/L	4110.B
		Sodium (Na)	14.4 mg/L	3500-Na.B
		Potassium (K)	3.68 mg/L	3500-K.B
		Calcium (Ca)	22.7 mg/L	3111.B
		Magnesium (Mg)	6.06 mg/L	3111.B
		Temperature	27.1 <sup>o</sup> C	2550.B
		BOD	0.82 mg/L	5210.B
		COD	3.63 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	2.52 mg/L	3500.B

Table 8: Results of analysis of sample no. B.H.-6 (surface water sample)

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10068	Water (B.H.-6, Barisal)	pH at 26 deg. C	6.75	4500-H <sup>+</sup> .B
		E. Conductivity	169 $\mu$ S/cm	2510.B
		Lead (Pb)	< 0.01 mg/L	3113.B
		Cadmium (Cd)	< 0.001 mg/L	3113.B
		Chromium (Cr)	0.009 mg/L	3113.B
		Arsenic (As)	< 0.005 mg/L	3114.C
		Iron (Fe)	0.81 mg/L	3111.B
		Mercury (Hg)	< 0.001 mg/L	3112.B
		Fluoride (F)	< 0.5 mg/L	4110.B
		Chloride (Cl)	11.5 mg/L	4110.B
		Bromide (Br)	<1mg/L	4110.B
		Nitrite (NO <sub>2</sub> )	2.79 mg/L	4110.B
		Nitrate (NO <sub>3</sub> )	<3 mg/L	4110.B
		Sulphate (SO <sub>4</sub> )	5.6 mg/L	4110.B
		Sodium (Na)	14.9 mg/L	3500-Na.B
		Potassium (K)	3.29 mg/L	3500-K.B
		Calcium (Ca)	18.9 mg/L	3111.B
		Magnesium (Mg)	5.65 mg/L	3111.B
		Temperature	27.2 <sup>o</sup> C	2550.B
		BOD	0.58 mg/L	5210.B
		COD	< 2 mg/L.	5220.B
		Ammonium(NH <sub>4</sub> )	0.65 mg/L	3500.B

### 3.3 Soil samples

#### 3.3.1 Way of sampling

Soil sampling was done by driving a 1.5”inch diameter GI pipe with attachment for collection of soil sample at the driving end of the pipe. While driving the pipe into the ground, soil enters into the attachment through the tip of the pipe. When the pipe with its attachment reaches the desired depth the pipe is withdrawn and soil entered into the attachment is collected in polythene bags and sealed for handing over to the BCSIR laboratory for testing. Soil sample was taken from borehole number one at 1.5ft intervals. Soil sample from a depth of 12 ft. was selected for analysis in the laboratory.

#### 3.3.2 Analysis

Testing of the sample was done in Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory in Dhaka

#### 3.3.3 Results

Table 9: Results of analysis of sample no. D-08 (soil sample)

Sample ID			Results								
Bore Hole No.	Sample No.	Depth (ft)	pH	Clay Content	Organic Matter	Lead (Pb)	Cadmium (Cd)	Chromium (Cr)	Arsenic (As)	Iron (Fe)	Mercury (Hg)
01	D-08	12.0'	7.02	24.11%	0.27%	9.67 ppm	0.03 ppm	26.52 ppm	0.54 ppm	0.168 %	Below detection level

Methodology:

- (1) pH: pH meter,
- (2) Clay content: Hydrometer method,
- (3) Organic Matter: Wet oxidation method,
- (4) Pb, Cd & Cr: Atomic Absorption Spectrophotometer,
- (5) As: Atomic Absorption Spectrophotometer with HVG,
- (6) Hg: Atomic Absorption Spectrophotometer with MVU,

Lab ID	Particulars of Supplied Sample	Name of Parameters		Concentration
A-10062	Soil Well No: 01 Sample No.D-08 Depth:12' KawniaVagar Barisal	Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthylene	Not detectable
			Anthracene	Not detectable
			Benzo(A) Anthracene	Not detectable
			Benzo(A)Pyrene	Not detectable
			Benzo (B)Fluoranthene	Not detectable
			Benzo (G,H,I)Perylene	Not detectable
			Benzo (K)Fluoranthene	Not detectable
			Chrysene	Not detectable
			Dibenz(A,H) Anthracene	Not detectable
			Fluorene	Not detectable
			Indeno (1,2,3- CD)Pyrene	Not detectable
			Phenanthrene	Not detectable
			Pyrene	Not detectable
A-10062	Soil Well No: 01 Sample No.D-08 Depth:12' KawniaVagar Barisal	Poly Chlorobiphenyl (PCB)	2,2',3,4,4',5,5'- Heptachlorobiphenyl	Not detectable
			2,2',3,4,4',5'- Hexachlorobiphenyl	Not detectable
			2,2',4,4',5,5'- Hexachlorobiphenyl	Not detectable
			2,2',5,5'- Tetrachlorobiphenyl	Not detectable
			2,4,4'- Trychlorobiphenyl	Not detectable
			2,6-Dichlorobiphenyl	Not detectable
A-10062	Soil Well No: 01 Sample No.D-08 Depth:12' KawniaVagar Barisal	Volatile Organic Compounds (VOC)	Chlorobenzene	Not detectable
			<i>CIS-1, 2-Dichloroethylene</i>	Not detectable
			Ethylbenzene	Not detectable
			O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2- Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable

Table 10: Description soil structure of soil sample no 1 (drilling hole 1)

Depth of sample	Description
0 – 1.5 ft	Dark Gray Clay
1.5 – 3 ft	Dark Gray Clay
3 – 4.5 ft	Dark Gray Clay
4.5 – 6 ft	Dark Gray Clay
6 – 7.5 ft	Dark Gray Clay
7.5 – 9 ft	Dark Gray Clay



Depth of sample	Description
9 – 10.5 ft	Dark Gray Clay
10.5 – 12 ft	Dark Gray Clay
12 – 13.5 ft	Dark Gray Clay
13.5 – 15 ft	Dark Gray Clay

### 3.4 Waste Characterization

#### 3.4.1 Way of analysis

**Selection of sampling point:** For ease of identification of different types of waste the city generates day to day preliminarily locations are identified where the waste stream is deposited. Due to the non-availability of equipment for moving the waste deposited by hydraulic dump trucks at the site, wastes are unloaded around the periphery of the site on the edge of the dumping spot along the brick soling roads. Due to heavy rainfall, accumulation of rain water and high water table in and around the site, loaded trucks can't enter into the dumping site. For which the trucks are unloading the wastes along the roads around the site.

**Collection of sample:** For the purpose of characterization of waste three spots were chosen from the waste dumping site at a distance of about one hundred feet apart from each other. The location of the collection spot has been shown on the site plan by a mark C-1(Sample-1), C-2 (Sample-2) and C-3 (Sample-3).

Waste samples weighing about 12 to 14kg roughly was collected in polythene bags from each of the spots. It was then segregated for the items mentioned in the table and put in polythene bags and weighed for each item individually on the spot.

#### 3.4.2 Results

As noted in the table below the majority of the waste present at the dumpsite in Barisal is Organic waste. Almost 70-80% of the present waste is of organic matter. the second most important waste streams are paper and plastic. Paper represents almost 10% of the waste and plastic between 3-9%. There are also some minor fractions like glass, textiles, construction waste, etc.

Waste Characterization							
Kawnia Waste Dumping Site							
Barisal City Corporation							
Sample collection date: 18 July 2013							
Waste Fractions	Sample 1		Sample 2		Sample 3		Remarks
	Wt.(kg)	Percentage %	Wt.(kg)	Percentage %	Wt.(kg)	Percentage %	
Paper	1.300	9.878	1.120	8.122	1.250	10.356	
Glass	-	-	0.020	0.145	-	-	
Metal	-	-	-	-	-	-	
Plastic	0.400	3.040	0.950	6.889	1.100	9.114	
Organic Materials (food, green waste etc.)	10.700	81.307	10.820	78.463	8.560	70.920	
Textiles	0.060	0.456	0.350	2.538	0.260	2.154	
Construction waste(concrete, bricks etc )	0.600	4.559	0.380	2.756	0.480	3.977	
Hazardous household waste	0.100	0.760	0.150	1.088	-	-	
(paints, oil and fats, batteries, electronics, etc)							
Other fractions	-	-	-	-	0.420	3.480	
Total (kg)	13.160	100.000	13.790	100.000	12.070	100.000	
Samples were collected from three points as shown on the site plan. It was then segregated and weighed. Sampling was done on 18 <sup>th</sup> July 2013.							

#### **4 CONCLUSIONS AND RECOMMENDATIONS**

It has been considered remarkable that the analyzed samples show no degree of pollution since they were collected for a polluted environment. Therefore the results discussed in these report only provide a very basic analysis on the contamination level of the dumpsite. The reason is likely the questionable way of transportation, preservation and the time between sample taking and analysis. As such following concerns have been raised by the second opinion analysis done in the Belgian laboratory:

- During the sample taking: no preservatives were added so following parameters could not be determined: Cyanide, phenol index, mineral oils, volatile combinations.
- During the sample taking: no metals could be determined due to fact that the sample has not been filtrated and acidified;
- During the sample taking: bottles were not filled out completely so determination of volatile combinations were impossible;
- The preservation term for following parameters has been expired, so following parameters could not be determined: Ammonia, Phenol index, cyanides, Orto-phosphate, volatiles preparation, COD, Chloride, Fluoride, Sulphate, Nitrite, Nitrate;
- Unknown method of transportation and preservation: Samples have not been stored in dark cooled places, which have an effect on the value of certain parameters.

It may be assumed that pollution is present or shall be present if no extra measurements are taken in the design of a controlled landfill. To minimize the negative effects of pollutants originating from the dumped household waste on the environment, the health of nearby inhabitants and on the quality and quantity of surrounding agricultural lands, at least the following measurements should be taken:

- Physical separation between the pollution and the environment;
- Draining and treatment of the polluted groundwater;
- Leachate reducing measurements (covering of waste, draining leachate, etc.);

During the design of the controlled landfill these recommendations will be taken into account.

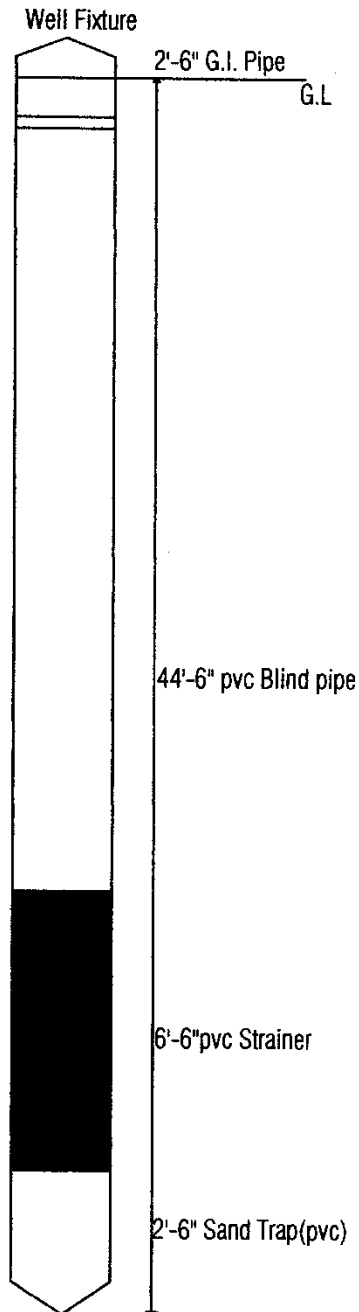
## **Annex 1: Bore logs**

# BORE LOG OF OBSERVATION WELL

Project: Contamination pathway Study , UPEHSDP  
Location: Landfill Site of Barisal City Corporation at kawnia  
Bore Hole No.1

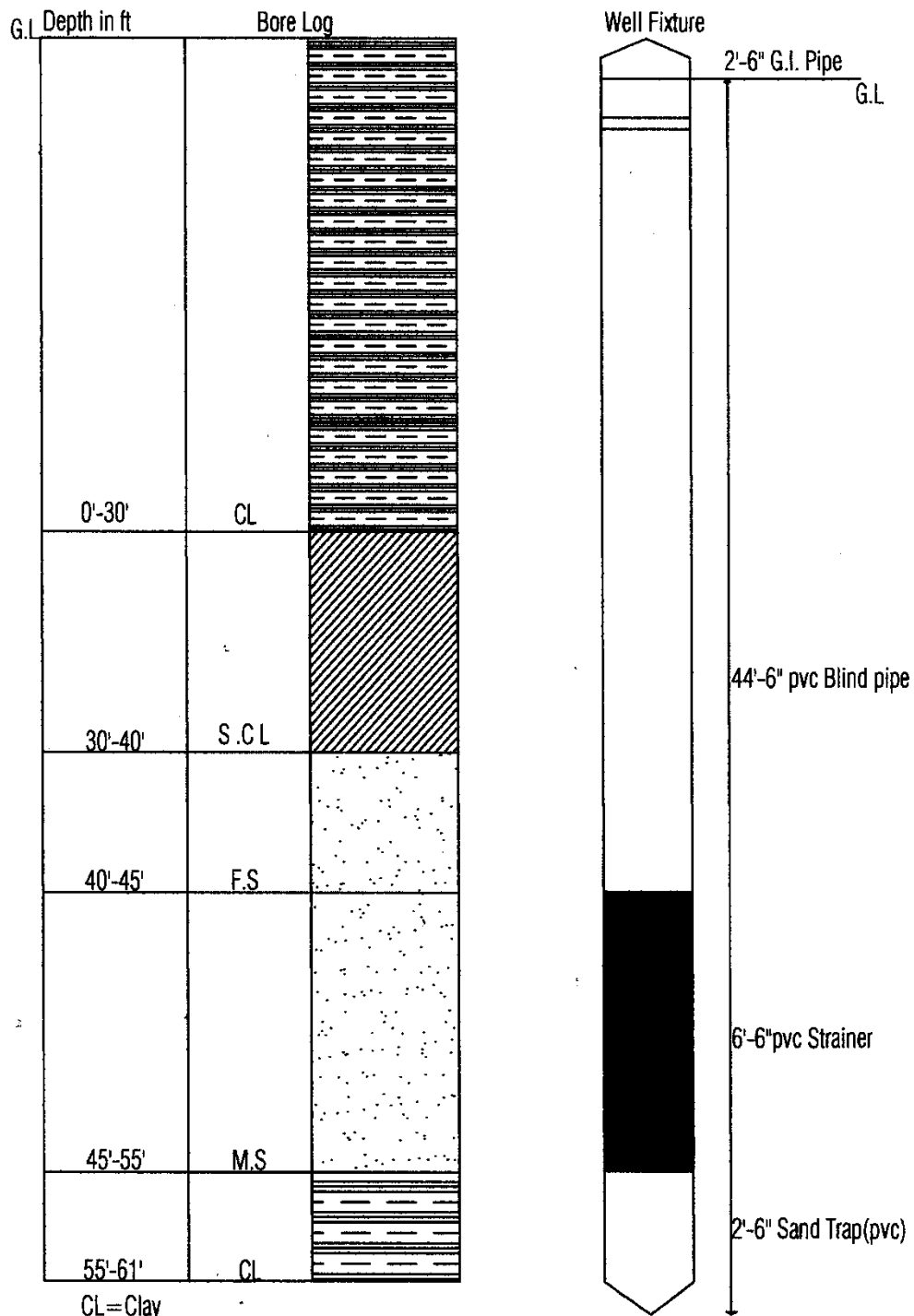
G.L	Depth in ft	Bore Log
	0'-15'	CL
	15'-20'	S.C.L
	20'-40'	CL
	40'-45'	S.C.L
	45'-57'	M.S
	57'-60'	CL

CL=Clay  
S.CL=Sandy Clay  
M.S= Medium Sand  
GI=Galvanized Iron  
Note: Note to scale



## BORE LOG OF OBSERVATION WELL

Project: Contamination pathway Study , UPEHSDP  
 Location: Landfill Site of Barisal City Corporation at kawnia  
 Bore Hole No.2



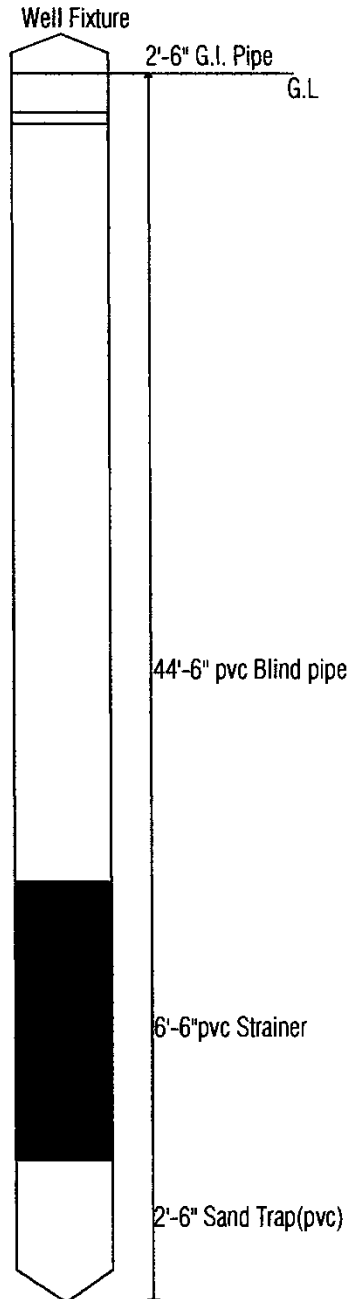
CL=Clay  
 S.CL=Sandy Clay  
 F.S=Fine sand  
 M.S= Medium Sand  
 GI= Galvanized Iron  
 Note: Note to scale

# BORE LOG OF OBSERVATION WELL

Project: Contamination pathway Study , UPEHSDP  
 Location: Landfill Site of Barisal City Corporation at Kawnia  
 Bore Hole No.3

G.L.	Depth in ft	Bore Log
	0'-37'	CL
	37'-45'	S.CL
	37'-45'	F.S
	45'-58'	M.S
	58'-60'	CL

CL=Clay  
 S.CL=Sandy Clay  
 F.S=Fine sand  
 M.S= Medium Sand  
 GI=Galvanized Iron  
 Note: Note to scale



# BORE LOG OF OBSERVATION WELL

Project: Contamination pathway Study , UPEHSDP  
 Location: Landfill Site of Barisal City Corporation at kawnia  
 Bore Hole No.4

G.L	Depth in ft	Bore Log
	0'-30'	CL
	30'-40'	S.C.L
	40'-55'	M.S
	55'-62'	CL

CL=Clay  
 S.CL= Sandy Clay  
 M.S= Medium Sand  
 GI=Galvanized Iron  
 Note: Not to scale

