

Safe & Environmentally Sound Ship Recycling (SENSREC) Project

Phase-I, Work Package 5b

(Programme No.: TC/151 Bangladesh – Phase I)

PROJECT DOCUMENT

***Document for Implementation of Phase-II of SENSREC Project in
Chittagong, Bangladesh***

**Establishing the Common Hazardous Waste
Treatment, Storage & Disposal Facility**

and

**Planning for Implementation of
the Training Modules**

Draft Final Report Submitted by:



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LIST OF ABBREVIATIONS

BRS	Basel, Rotterdam and Stockholm Conventions
BSRB	Bangladesh Ship Recycling Board
Capex	Capital Expenditure, Capital Cost
CETPs	Common Effluent Treatment Plants
CFR	Code of Federal Regulations
CHW-TSDF	Common Hazardous Waste-Treatment Storage Disposal Facility
CPCB	Central Pollution Control Board
CTSDF	Common Treatment, Storage and Disposal Facility
DEM	Digital Elevation Model
DOE	Department of Environment
DPP	Development Project Proforma
DPR	Detailed Project Report
DSS	Decision Support System
ECR	Environmental Clearance Report
EIA	Environment Impact Assessment
EMP	Environment Management Plan
ESP	Electro Static Precipitator
ETP	Effluent Treatment Plant
FS	Feasibility Study
GIS	Geographic Information System
GPR	Ground Penetrating Radar
IIT	Indian Institute of Technology
IDW	Inverse Distance Weighted
IEE	Initial Environment Examination
IMO	International Maritime Organization
IPT	Intermediate Public Transit
MCDA	Multi Criteria Decision Analysis
MERI	Multi-Electrode Resistivity Imaging

MHA	Maximum Horizontal Acceleration
MoEF	Ministry of Environment and Forests
MoEF&CC	Ministry of Environment, Forest and Climate Change
MSW	Municipal Solid Waste
NEPA	National Environment Policy Act
NGOs	Non-Governmental Organizations
NORAD	Norwegian Agency for Development Cooperation
Opex	Operating Expenditure; Cost of operation & maintenance
O&M	Operation And Maintenance
PMC	Project Management Consultant
PPE	Personal Protective Equipment
PT	Public Transit
RCRA	Resource Conservation Recovery Act
SDSS	Spatial Decision Support System
SIA	Social Impact Assessment
SPV	Special Protection Vehicle
SSC&P	Site Selection Criteria and Protocol
SSI	Site Sensitivity Index
SuDS	Sustainable Drainage Systems
ToRs	Terms of References
TSDf	Treatment Storage Disposal Facility
TD	Tender Document
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USEPA	United States Environment Protection Agency
USGS	United States Geological Society
VES	Vertical Electrical Sounding

Executive Summary

The purpose of the Phase-I of Safe and Environmentally Sound Ship Recycling (SENSREC) Project, is to undertake a comprehensive, targeted evaluation of the requirement to deliver sustainable ship recycling, taking into account the health, safety and environmental compliance aspects of ship recycling in the context of the prevailing social and economic circumstances. In addition, this project has also been designed to cater to the industries generating hazardous wastes in and around Chittagong. Thus, this project will improve ship recycling standards in Bangladesh towards compliance with the provisions of the Hong Kong Convention and other international conventions of relevance to the ship recycling industry, as well as provide safer and environmentally sounder method of managing industrial hazardous wastes.

The SENSREC project has been conceived and operated by the partnership of the International Maritime Organization (IMO), the Secretariat of the Basel, Rotterdam and Stockholm Conventions (BRS), and the United Nations Industrial Development Organization (UNIDO) in collaboration with the Ministry of Industries Government of Bangladesh and the Bangladesh Ship Breakers Association (BSBA). Phase-I of the SENSREC has been funded by the Norwegian Agency for Development Cooperation (NORAD).

This executive summary intends to summarise and highlight salient points deliberated in the "Project Document for Phase II" - which is the last deliverable of Phase-I of SENSREC Project (component 'b' of Work Package 5). The Project Document is divided into two portions, *namely*: Part A and Part B. The Part A encompasses the description and significance of all the essential tasks to be performed during the course of establishing the Common Hazardous Waste Treatment, Storage and Disposal Facility. In Part B, effort has been made to outline the necessary strategies for capacity building by implementing the training modules for the workforce in ship dismantling yards in Chittagong, Bangladesh.

Part A: The Proposed TSDF

The proposed Common Hazardous Waste Treatment, Storage and Disposal Facility (CHW-TSDF) is the important requirement for effective management of hazardous

wastes generated by the ship recycling sector as well as other industries in the region of Chittagong. It should be recognized that the process of establishing the so-called Treatment, Storage and Disposal Facility for management of hazardous wastes is a complex task and would call for managing the five kinds of broad tasks as outlined below:

1. Feasibility Study including site selection and Environmental Impact Assessment
2. Preparation of the Development Project Proforma (DPP) and approval
3. Preparation of Detailed Project Report (DPR) and Tender Document (TD)
4. Tendering process and awarding of contracts
5. Construction, erection and commissioning

The above five groups of activities will have to be carefully planned and orchestrated so that the proposed -TSDF project in Chittagong can be executed in a timely manner. **Figure 1** depicts the inputs and outputs of the above mentioned five groups of activities in a manner that the project can be managed with the least duplicate actions and unnecessary delays.

One of the most crucial and important steps happens to be the selection of site for establishing the proposed Treatment, Storage and Disposal Facility. This task is based on various screening criteria investigated under the feasibility study *e.g.* various buffering distances are applied to different attributes which is the function of perception of risk by community, degree of treatment given to hazardous waste, safety measures considered for landfill construction, experts' opinion based on their experience, transportation risk and hazard.

Various attributes such as lake or pond, river, water supply well, water resources, ground water table level, wetlands, flood plain, urban development, regulatory zone, airports, populated areas, fault zones, land slope, road network availability, land cost *etc.* can be considered for screening criteria based on their importance to the site. Finally, the site is approved and notified by the competent Ministry in Government of Bangladesh.

CHW-TSDF is likely to fall in "red category industry", as per the legal protocol for conducting EIA as stipulated by the Environment Clearance rules of Government of Bangladesh. Such industry calls for Initial Environmental Examination (IEE) followed by the detailed Environmental Impact assessment (EIA). After following the due diligent procedure for EIA, Draft EIA Report should be prepared followed by its final approval by the competent authority.

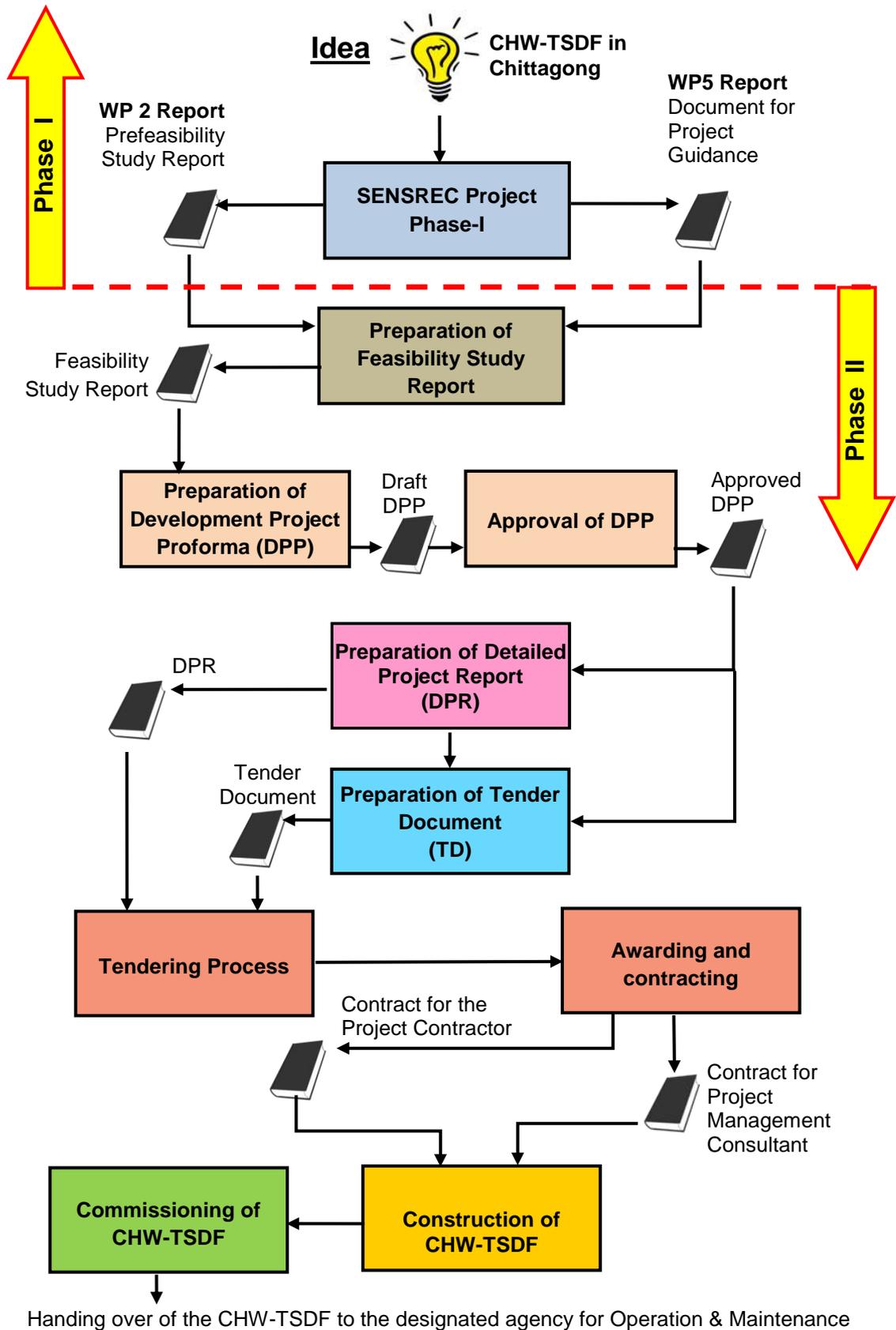


Figure 1: Process flow diagram for implementation of *CHW-TSDF Project*

At this stage, the Project Proponent needs to complete the so-called Development Project Proforma (DPP). On preparing DPP, the protocol for approval of DPP needs to be implemented by approaching the concerned Ministries and Authorities of Government of Bangladesh for the clearance of the said TSDF project.

The Detailed Project Report (DPR) will be developed on the basis of the EIA and feasibility study reports and the approved DPP by the concerned Ministry of Government of Bangladesh. Further, a consultant is appointed for the development of the Tender Document (TD), which typically describes requirements for three essential elements, namely: financial prequalification, technical prequalification and the commercial offer.

Based on the tender document, the tendering process is initiated for inviting the bidders. The selected bids among the bidders after scrutiny are shortlisted based on the prescribed criteria. The successful eligible contractor is selected and the contracts for the project contractor and the Project Management Consultant (PMC) are awarded.

Once the contract is signed between the Project Proponent and the contractors, construction shall be carried out based on the approved drawings and best engineering practices. The construction and erection will be carried out under the guidance and supervision of the Project Management Consultant.

During the commissioning phase, the contractor has the responsibility to start, operate and demonstrate the activities of TSDF, as specified in the contract document. At the end of commissioning, on demonstrating satisfactory performance fulfilling all contractual obligations, the contractor will hand over the TSDF to the Project Proponent for operation and maintenance

Part B: The Capacity Building Activity

Phase II of the SENSREC Project will also include the implementation of the training modules developed in Work Package 4 *i.e.* WP4 of Phase I. Here, a key requirement is for the BSRB (*i.e.* Bangladesh Ship Recycling Board) to take over the responsibility for implementing the training programmes. They will need to articulate and implement the strategy at the outset so that all the workers in the ship recycling industry would have the opportunity to receive the desired training as per the directions of the High Court.

One of the critical questions to be answered is related to desirable duration in which the BSRB would wish to train and certify adequate number of workers in the ship recycling industry so that the industry will not suffer. This should help in defining what facilities are needed and the necessary budget for enabling the training activities. As suggested above (in recommendation 'a') the responsible body for imparting the said training could be the so-called "special purpose vehicle" i.e. SPV. The BSRB itself may serve as the SPV or a committee under the supervision of BSRB could serve the function.

Further, the SPV and/or BSRB will also need to agree on implementing some important administrative actions, such as creating and maintaining a database of workers and also organise the certification of trained workers, the accreditation of training materials, the selection and certification of trainers, etc. All these issues are discussed in Chapter 13 and corresponding suitable recommendations are proposed.

Essential Institutional Mechanism and Empowerment

In order to make the proposed CHW-TSDF project in Chittagong successful, some of the critical functions will have to be assigned to empowered agencies and certain enabling mechanism will have to be put in place by the concerned Ministry of the Government of Bangladesh. It appears that there are four most important interventions required for engaging all the stakeholders of the project and making critical and significant decisions in a timely manner. Therefore, the concerned Ministry will have to address the following five tasks:

a) Creation of Special Purpose Vehicle: Creation of the "Special Purpose Vehicle (SPV)" is the essential step that should be undertaken before initiating any activity in the proposed TSDF project in Chittagong. It is envisaged that the SPV would serve as the "one window" facilitating agency appointed by the concerned Ministries in the Government of Bangladesh for initiating and navigating all the necessary steps during the course of implementation of Phase II of the SENSREC project. The SPV could be a standalone agency empowered by the concerned Ministries in the Government of Bangladesh. For example, the planned establishment of the BSRB (*i.e.* Bangladesh Ship Recycling Board) may prove to be most effective in carrying out of the functions of the "one window" facilitating agency (*i.e.* SPV).

b) Identification of Competent Project Proponent: It is envisaged that the "Project Proponent" will have to be identified for setting up of the TSDF as well as for operation and maintenance of the facility. This can be achieved in several ways. For example, the Project Proponent could be appointed by the concerned Ministry in the Government of Bangladesh and the individual (or group) should be empowered for the creation and operation of the facility. In such event, the concerned Ministry will carefully choose and empower the team members having critical, complementary and significant competencies related to construction, erection, commissioning and operation and maintenance of the proposed TSDF project in Chittagong.

Alternately, the Project Proponent could also be a private enterprise having relevant experience and enthusiasm for establishing and operating the said TSDF project. A formal process will have to be followed, through which, the most suitable bid shall be accepted and legally contracted for the construction, erection, commissioning and operation and maintenance of the proposed TSDF project.

c) Articulation of Business Model: The concerned Ministries and Departments in the Government of Bangladesh, with inputs from UN Specialized Agencies (UNIDO, UNEP, BRS), have the paramount responsibility for setting-up the "rules of game" by first making a resolution about SPV and secondly by articulating the "Business Model". If the project is started with a collectively developed and agreed "business model" for establishing the CHW-TSDF in Chittagong, there will be a win-win situation for all the stakeholders. It is strongly recommended that a private enterprise aspiring to own and operate (Project Proponent) a commercial TSDF should be mandated to contribute 25% as their collateral at the outset to ensure the commitment to the TSDF.

During the operation and maintenance phase of the said TSDF, it would be desirable that the tariff for pre-treatment, incineration or landfilling of hazardous wastes should be mutually agreed by SPV, Project Proponent and the generators of the wastes (including Bangladesh Ship Breakers Association and other industries).

d) Formulation of the Targeted Regulatory Instrument: The Project Proponent should ensure that the setting up and operating the said TSDF does not violate any laws and regulations of the land. It will also be necessary for the Government of Bangladesh to ensure that the hazardous waste generators (ship recyclers and other industries) will be held responsible for sending their wastes to the CHW-TSDF. In order to facilitate the regulatory process some dedicated and directed legal

instrument (for example Government Resolution, Gazette Notification, Ordinance, Legal regulation or amendment to the existing law) should be formulated. It will not only ensure the prevention of environmental damage due to hazardous wastes but will also ensure the success of the proposed business model.

e) Implementation of the Training Modules for the Ship Recycling Industry: There are requirements for the capacity building part of Phase II. A key requirement is for the BSRB (*i.e.* Bangladesh Ship Recycling Board) to take over the responsibility for implementing the training programmes. Also, a new “Training Facility” will have to be built if one aims at training at least 25,000 workers in a reasonable time frame (say within 5 years). Such a facility should have provision for multiple class-rooms and several laboratory facilities of rather larger sizes and in some cases certain labs will have to be built in multiple numbers. The ultimate objective should be to build a new facility – which is suitable for training at least 5,000 workers every year.

The Budgetary Estimates for Phase-II

Indicative Budget for the Proposed TSDF Project (Objective A): It would be useful to recall that the *WP2b Report* published earlier as a part of the deliverables from Phase-I the SENSREC project was a kind of "Pre-feasibility study" - in which some of the approximate infrastructure and budgetary requirement were published. It was estimated that the plan area of nearly 8 hectares (*i.e.* 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong for the assumed life period of 10 years of the facility. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.5 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

It is well understood that, in addition to the construction and erection costs reported in *WP2b Report*, a variety of short term study and investigation projects will have to be undertaken in the process of feasibility study including site selection and EIA. Those investigations could cost a total USD 1.2 million. Further USD 1.0 to 1.2 million (typically 8-10% of the construction cost) should be budgeted for covering the unforeseen and difficult to plan expenses including duties, local taxes *etc.* The budget for appointing the Project Management Consultant (PMC) could be in the

vicinity of 8-10% of the construction cost (USD1.0-1.2 million). Finally, a budget of USD 1.2 million is estimated for covering contingencies and unforeseen expenses (typically 5-12% of the construction cost).

Thus, for establishing the CHW-TSDF adequate for 10-year life, USD 16.1 million and the land area of 7.8 hectare (*i.e.* 19.3 acre) would be required to conduct all the required studies and investigations and for construction and erection of the facility. However, if the TSDF life-span is to be extended by another 10 years; an additional USD 37.8 million will have to be invested at that time, and additional land area of 7.2 hectare (*i.e.* 17.8 acre) will have to be allocated, in order to conduct all the required studies and investigations as well as for the construction and erection of the suitable additional landfills and for the replacement of the 10-year old incinerator by a new incinerator of higher capacity. A detailed discussed on the budget summarized above is presented at the end of Chapter 11.

Indicative Budget for the Capacity Building Activity (Objective B): In the second part of this Report, in Part B, effort has been made to outline the strategies for capacity building by implementing the training modules for the workforce in ship dismantling yards in Chittagong as well as an indicative budget for setting up of a “Training Facility” has been estimated.

Regarding a budget for the capacity building part of Phase II; it has to be noted that it will be possible to estimate this after the authorities reach a decision on the length of time required to train all workers in the ship recycling industry and the size of infrastructure required to achieve the scheduled task. Clearly, if one desires to complete the task of training all the workforce in rather short period of time, then multiple classrooms and multiple sets of laboratory facilities would be required to be built in the training facility.

In any case, in the present exercise, the costs have been estimated for constructing the adequate facility for completing training of 25,000 workers in 5 years (*i.e.* a facility containing all necessary infrastructure for the training 5,000 to 6,000 workers every year). The detailed basis-related and infrastructure-related assumptions made for the said budgeting exercise have been discussed in Chapter 13.

In the interim period, the Bangladesh Marine Academy (BMA) was highlighted as having the appropriate training knowledge and infrastructure to deliver ship recycling related training as reported in the WP4b Report ('Strategy for Sustainable Training

for the Ship Recycling Industry' authored by Stuart A. McKenna, Raphael Baumler and Rafet E. Kurt; the final version dated 20th December, 2016). Based on the assumptions described in the report, calculations were made to assess the total number of workers required to be trained per year with an increased capacity in training facilities and numbers of trainers. Approximate costs (summarised in the Annex to WP4 Part II) to utilise the BMA, training up to 1008 workers per year, were given as USD 160 per worker, plus the cost of international expertise and living expenses.

In the long term, it is envisaged that the “Academic and Administrative Building” having built-up area of 5,400 m² and the “Indoor Laboratories” having built-up area of 11,250 m². These buildings will have to be placed in the vicinity of each other. Yet, they should be built sufficiently apart so that adequate masterplan of the land can be made to provide for access area surrounding buildings, approach and access for firefighting, “rendezvous spot” for escape and shelter in case of disaster or accident, parking, roads, gardens, etc. Thus, a plan area of about 4 hectare (*i.e.* 10 acres) will have to be provided for construction of the proposed “Training Complex” designed to train 5,000 to 6,000 workers every year.

In addition, the “Outdoor Training Areas” will be needed. For this purpose it is envisaged that the outdoor training will be given in the wet-intertidal areas, intertidal zones and secondary cutting zones of the yards where the workers are employed. The *Production Supervisors* and *Health Safety and Environment Officers* in the respective yard will supervise the workers under training and report the progress to the *Training Institute*.

The proposed “Training Complex”, approximately, would require allocation of USD 7.1 million to cover the capital costs of construction, commissioning, modest furniture, laboratory equipment and fire-fighting systems. This budgeted costs, however, do not cover air conditioners, residential quarters, guest house, cost of land, or any recurring costs, or the operation and maintenance costs.

Chapter 1

Overview of the SENSREC Project (Phases I & II)

As had been stated in the Project Document for the **Phase-I of Safe and Environmentally Sound Ship Recycling (SENSREC) Project**, the purpose of the project is to undertake a comprehensive, targeted evaluation of the requirement to deliver safe and environmentally sound ship recycling, taking into account the health, safety and environmental compliance aspects of ship recycling in the context of the prevailing social and economic circumstances. This in turn, will improve ship recycling standards in Bangladesh towards compliance with the provisions of the Hong Kong Convention and other international conventions of relevance to the ship recycling industry.

1.1 Overview of Phase-I of the SENSREC Project

This project is designed to enhance the development of “safe and environmentally sound ship recycling in Chittagong, Bangladesh”, with the aim of improving the standards and therefore the sustainability of the industry. As a by-product, the project will assist the industry to eventually meet the requirements of the Hong Kong International Convention on the Safe and Environmentally Sound Recycling of Ships, 2009 (Hong Kong Convention), so that the Government of Bangladesh may be in a position to accede to the Convention, in due course.

It was envisaged that the project will be delivered in two phases. **Phase I** was concerned with the establishment of a number of actions to support the implementation of improved practices and upgrade others; taking into account the interests of key stakeholders including the Government of Bangladesh and the Bangladesh Ship Breakers’ Association (BSBA). The relevant ministries were also involved, coordinated through the Ministry of Industries, Government of Bangladesh.

In addition, the Secretariat of the Basel, Rotterdam and Stockholm Conventions (BRS), the United Nations Industrial Development Organization (UNIDO), and the

International Labour Organization (ILO), have also been the international partners who added value to the tasks by sharing their expertise, know-how, and in some cases, funding, to assist in creating opportunities for long-term improvements in safety, health, and environmental protection and, hopefully, in Phase II for the development of new infrastructure and implementation of capacity building through training of the workforce.

Accordingly, in Phase I, several studies and trial activities on these tasks, with preliminary infrastructure design and planning-related reports and guidance documents have been prepared through a carefully planned and managed set of five work packages. These five work packages focused the following areas, namely:

1. Study of economic and environmental impacts of the ship recycling industry in Bangladesh,
2. Planning the management of hazardous materials with an outline design of a downstream facility,
3. Refinement of Government One-Stop Service (GOSS),
4. Development of training modules as well as upgrading and preparation of new modules on safety, health and environmental compliance and
5. Preparation of a Project Document for Phase II of the SENSREC Project.

The 'Project Document' of Phase-I of the SENSREC Project has outlined the work-plan for the five work packages as follows:

Work Package 1: Study of the economic and environmental impacts of the ship recycling industry in Bangladesh

Outcome 1: Improved understanding and evaluation of specific economic and environmental impacts of the ship recycling industry in Bangladesh.

Output: Project reports and evaluation of stakeholder understanding from Phase I project closure meeting.

Target group: Decision-makers at government level and ship recycling industry.

Work Package 2: Plan the management of hazardous materials

Outcome 2: Assessment of the prevailing conditions and needs for environmentally sound hazardous waste management and an initial infrastructure design - with option selection, preliminary design and site selection for detailed planning and design to be carried out in Phase II of the project, including identifying funding partners for design and build.

Output: Comprehensive report consistent with requirements of Basel Convention and Hong Kong Convention; preliminary design, and costing achieved. Criteria for site selection produced.

Target group: Decision-makers at government level and ship recycling industry.

Work Package 3: Refinement of Government One-Stop Service (GOSS)

Outcome 3: Focused and knowledgeable service that will be able to implement improved safety and environmental standards in the yards in a cost effective and in a socio-economically appropriate way.

Output: Fit for purpose Bangladesh Ship Recycling Board (BSRB).

Target group: Decision-makers at government level.

Work Package 4: Development of training for health, safety and environmental compliance

Outcome 4: Improved training modules on occupational health, safety and the environment to assist the implementation of requirements on the ship recycling industry by decisions of the honorable High Court. Initial training of trainers delivered.

Output: Updated and improved training package and delivery of training activities.

Target group: Ship recycling industry and workers in ship recycling yards.

Work Package 5: Prepare Project Document for Phase II of the project

Outcome 5: Document summarizing all deliverables of Phase I and Project Document for Phase II.

Output: Project summary for Phase I and Project Document for Phase II produced;

Target group: Decision makers at government level.

The International Maritime Organization (IMO) assigned the last task of preparing “**Project Document**” (contribution to **Work Package 5b of Phase-I of SENSREC Project**) to the team comprising of Professor Shyam R Asolekar at Indian Institute of Technology Bombay (in the capacity of “International Consultant”) and associated team members in Bangladesh, *namely*: Mr Achintya Kumar Saha, Managing Director

of SDA Consultants in Dhaka and Mr Md Anwar Rana, Director of Western Marine Services in Chittagong. Further details of the Work Package 5b and the 'Terms of Reference' (TORs) assigned to the team are summarized below:

The Specific Objective of WP5b: *The international consultant will prepare the "Project Document" for the implementation of the proposed Phase II, namely: to plan and build the necessary infrastructure TSDF in Bangladesh, on the basis of the work that was carried out in the second work package of the project's Phase I. If appropriate, he will undertake any further studies that may be required and provide any necessary refinements to the preliminary design and the costing estimates for the TSDF that were produced in WP2.*

The international consultant will plan and define in the project document the necessary stages of Phase II of the project, including the necessary resources: for the management of the project; for procuring the services of consultants to the management; for the production of engineering and construction drawings; for the selection and for contracting of the contractors to build the TSDF; for independent supervision during the construction phase; and for any other activities that are necessary for the successful execution of the project.

The Consultant will undertake the following tasks:

- 1) If appropriate, undertake any further studies that may be required and provide any necessary refinements to the preliminary design for the TSDF produced in WP2;*
- 2) If appropriate, review the costing of the preliminary design of the TSDF produced in WP2;*
- 3) In case any modifications to the preliminary design and/or the costing of the TSDF become necessary, produce a short report outlining the changes and the rationale leading to the changes;*
- 4) During the execution of the assignment, and if appropriate with assistance from the project's Lead Consultant, seek the inputs of the Secretariats of UNIDO, BRS and IMO and of the Ministry of Industries of Bangladesh on matters of their competence, and on the extent of their involvement in Phase II of the project;*

- 5) *Conduct two fact-finding missions to Bangladesh (with possible visits to Dhaka, Chittagong and any other location necessary for the execution of the assignment);*
- 6) *Articulate guidance corresponding to the necessary stages of Phase II of the project. The planning activity would comprise of articulation of techno-commercial requirements in brief as well as the necessary resources required on part of the implementation agency/department of the Government of Bangladesh with respect to all necessary activities, including:*
 - a) *Guidance for developing the scope of environmental impact assessment (EIA) of the proposed “Common Hazardous Waste Treatment, Storage and Disposal Facility” (CHW-TSDF) or any impact assessment required by the regulatory authorities in Bangladesh; once the site selection has been undertaken and hydrogeological and geo-technical characterization of site has been completed;*
 - b) *Guidance for development of the “Detailed Project Report” (DPR) with the help of a competent consultant and/or turnkey service providers, based on the information available from Phase-I of the project. The DPR, to be developed in Phase II, will include detailed engineering exercise with preliminary drawings, bill of quantities and cost estimates;*
 - c) *Guidance for development of the “Tender Document” for constructing and commissioning the proposed CHW-TSDF in Chittagong. The “Tender Document”, to be developed in Phase II, will include the technical, financial and other criteria for establishing competency of the bidder as well as clearly outline the envisaged trajectory of the project through designing, construction and commissioning stages;*
 - d) *Guidance for procuring the services of consultants to manage the project as well as the expert agencies (service providers) to be appointed for performance of specific tasks through different stages of the project;*
 - e) *Guidance for selection of the consultant for overall project management and supervision during construction; and*
 - f) *Guidance for any other activities that may be necessary for the successful execution of the project.*
- 7) *Based on the above work, compile a “Project Document” i.e. “Scoping Document for Management of Implementation of the Project” for Phase II -*

which will be used by the implementation agency/department of the Government of Bangladesh during the course of planning and implementation the proposed Phase II, for the building of the necessary infrastructure for the proposed CHW-TSDF in Chittagong, Bangladesh;

- 8) *Direct the work of the national consultant(s) that will be contracted under this activity so that realistic inputs from Bangladesh could be incorporated in the “Project Document” to the extent possible;*
- 9) *Consult regularly with the project’s Lead Consultant on progress under the assignment;*
- 10) *Participate and contribute in a presentation on the outcome of the assignment for the project’s Closure Workshop.*

1.2 Overview of Phase-II of the SENSREC Project

In the previous section the overview of the Phase I of SENSREC Project was presented in brief. From this section onwards, effort has been made to present the overview and comments on some of the salient and critical aspects and issues associated with Phase II of the SENSREC Project.

The Specific Objectives to be Focused in Phase II: By and large, the Phase II will undertake “implementation” in two focus areas – which are designated here as **Objective A** and **Objective B**, respectively.

Objective A encompasses the description and significance of all the essential tasks to be performed during the course of establishing the so-called “Common Hazardous Waste Treatment, Storage and Disposal Facility” *i.e.* CHW-TSDF.

In **Objective B**, effort has been made to outline the “strategies for capacity building” by implementing the training modules for the workforce in ship dismantling yards in Chittagong, Bangladesh.

The Scope and Proposed Approach for Objective A: It should be recognized that the process of establishing the so-called Treatment, Storage and Disposal Facility (TSDF) for management of hazardous wastes is a complex task and would call for managing five kinds of broad activities. The following five groups of activities will

have to be carefully planned and orchestrated so that the proposed-TSDF project in Chittagong can be executed in a timely manner.

1. Feasibility Study including site selection and Environmental Impact Assessment
2. Preparation of the Development Project Proforma (DPP) and approval
3. Preparation of Detailed Project Report (DPR) and Tender Document (TD)
4. Tendering process and awarding of contracts
5. Construction, erection and commissioning

One of the most crucial and important steps happens to be the selection of site for establishing the proposed Treatment, Storage and Disposal Facility in Chittagong, which is followed by detailed Environmental Impact Assessment of the shortlisted site. This task is based on various studies listed below:

- Topographical Data using Digital Surveys
- Coastal Regulation Zone and Flood Map
- Seismological Data
- Meteorological Data
- Soil and Geotechnical Survey
- Ground Water and Hydrogeological Data
- Background Environmental Parameters
- Biodiversity and Data on Biological Environment
- Traffic Survey for Transportation Planning
- Socio-economic Aspects of the Project

CHW-TSDF is likely to fall in "red category industry", as per the legal protocol for conducting EIA as stipulated by the Environment Clearance rules of Government of Bangladesh. Such industry calls for Initial Environmental Examination (IEE) followed by the detailed Environmental Impact assessment (EIA). After following the due diligent procedure for EIA, Draft EIA Report should be prepared followed by its final approval by the competent authority.

The Scope and Proposed Approach for Objective B: In addition, Phase II of the SENSREC Project will also include the implementation of the training modules developed in Work Package 4 i.e. WP4 of Phase I. The WP4 activities were reported in two parts, namely: Parts 'a' and 'b'. The first part of WP4 included a training needs' analysis and thereafter the development of curricula for improved training modules on occupational health, safety and the environment to assist the

implementation of requirements on the ship recycling industry to fulfil the directives given by the honorable High Court and also of relevant national and international requirements.

The second part of WP4 (WP4b) included the development of the necessary training materials; the piloting of this training materials through “training of trainers” sessions; and also the development of a strategy for the future implementation of sustainable training for the ship recycling industry. This strategy has been created through a combination of the ACS Consortium’s expertise and knowledge in vocational education and training provision and the unique insights gained in this projects training needs analysis phase and training piloting activities.

The WP4b report on “*Strategy for sustainable training for the ship recycling industry*” (Authored by McKenna et al.; Final Version dated 20th December, 2016) has presented a set of recommendations which are designed to assist and guide the responsible persons and appropriate authorities in creating a roadmap for implementing a sustainable training programme for the ship recycling industry in Bangladesh. Those recommendations have been reproduced in Part-B of this “Project Document” in Chapter 13 (see sections 13.1 to 13.5).

1.3 The Essential Elements Required for Launching of Phase II

In order to make the proposed CHW-TSDF project in Chittagong successful, some of the critical functions will have to be assigned to empowered agencies and certain enabling mechanism will have to be put in place by the concerned Ministry of the Government of Bangladesh. It appears that there are four most important interventions required for engaging all the stakeholders of the project and making critical and significant decisions in a timely manner. A brief account of the four tasks and the nature of empowerment is described below:

a) Creation of Special Purpose Vehicle: Creation of the "Special Purpose Vehicle (SPV)" is the essential step that should be undertaken before initiating any activity in the proposed TSDF project in Chittagong. It is envisaged that the SPV would serve as the "one window" facilitating agency appointed by the concerned Ministries in Government of Bangladesh for initiating and navigating all the necessary steps during the course of implementation of Phase II of the SENSREC project. The SPV could be a standalone agency empowered by the concerned Ministries in the Government of Bangladesh. For example, the planned establishment of the BSRB

(i.e. Bangladesh Ship Recycling Board) may prove to be most effective in carrying out of the functions of the "one window" facilitating agency (i.e. SPV).

b) Identification of Competent Project Proponent: It is envisaged that the "Project Proponent" will have to be identified for setting up of the TSDF as well as for operation and maintenance of the facility. This can be achieved in several ways. For example, the Project Proponent could be appointed by the concerned Ministry in the Government of Bangladesh and the individual (or group) should be empowered for the creation and operation of the facility. In such event, the concerned Ministry will carefully choose and empower the team members having critical, complementary and significant competencies related to construction, erection, commissioning and operation and maintenance of the proposed TSDF project in Chittagong.

Alternately, the Project Proponent could also be a private enterprise having relevant experience and enthusiasm for establishing and operating the said TSDF project. A formal process will have to be followed, through which, the most suitable bid shall be accepted and legally contracted for the construction, erection, commissioning and operation and maintenance of the proposed TSDF project.

c) Articulation of Business Model: The concerned Ministries and Departments in the Government of Bangladesh, with inputs from UN Specialized Agencies (UNIDO, UNEP, BRS), have the paramount responsibility for setting-up the "rules of game" by first making a resolution about SPV and secondly by articulating the "Business Model". If the project is started with a collectively developed and agreed "business model" for establishing the CHW-TSDF in Chittagong, there will be a win-win situation for all the stakeholders. It is strongly recommended that a private enterprise aspiring to own and operate (Project Proponent) a commercial TSDF should be mandated to contribute 25% as their collateral at the outset to ensure the commitment to the TSDF.

During the operation and maintenance phase of the said TSDF, it would be desirable that the tariff for pre-treatment, incineration or landfilling of hazardous wastes should be mutually agreed by SPV, Project Proponent and the generators of the wastes (including Bangladesh Ship Breakers Association and other industries).

d) Formulation of the Targeted Regulatory Instrument: The Project Proponent should ensure that the setting up and operating the said TSDF does not violate any laws and regulations of the land. It will also be necessary for the Government of

Bangladesh to ensure that the hazardous waste generators (ship recyclers and other industries) will be held responsible for sending their wastes to the CHW-TSDF. In order to facilitate the regulatory process some dedicated and directed legal instrument (for example Government Resolution, Gazette Notification, Ordinance, Legal regulation, or amendment to the existing law) should be formulated. It will not only ensure the prevention of environmental damage due to hazardous wastes but will also ensure the success of the proposed business model.

e) Implementation of the Training Modules for the Ship Recycling Industry: There are requirements for the capacity building part of Phase II. A key requirement is for the BSRB (*i.e.* Bangladesh Ship Recycling Board) to take over the responsibility for implementing the training programmes. They will need to articulate and implement the strategy at the outset so that all the workers in the ship recycling industry would have the opportunity to receive the desired training as per the directions of the High Court.

One of the critical questions to be answered is related to desirable duration in which the BSRB would wish to train and certify adequate number of workers in the ship recycling industry so that the industry will not suffer. This should help in defining what facilities are needed and the necessary budget for enabling the training activities. As suggested above (in recommendation 'a') the responsible body for imparting the said training could be the so-called "special purpose vehicle" *i.e.* SPV. The BSRB itself may serve as the SPV or a committee under the supervision of BSRB could serve the function.

Further, the SPV and/or BSRB will also need to agree on implementing some important administrative actions, such as creating and maintaining a database of workers and also organize the certification of trained workers, the accreditation of training materials, the selection and certification of trainers, etc. All these issues are also discussed in Chapter 13 and corresponding suitable recommendations are proposed.

1.4 The Budget for Phase II

As stated earlier, by and large, the Phase II of SENSREC Project will undertake "implementation" in two focus areas – which are designated here as **Objective A** and **Objective B**, respectively.

Objective A encompasses the description and significance of all the essential tasks to be performed during the course of establishing the so-called “Common Hazardous Waste Treatment, Storage and Disposal Facility” *i.e.* CHW-TSDF.

In **Objective B**, effort has been made to outline the “strategies for capacity building” by implementing the training modules for the workforce in ship dismantling yards in Chittagong, Bangladesh.

Indicative budgets have been presented below for the activities listed above:

Indicative Budget for the Proposed TSDF Project (Objective A): It would be useful to recall that the *WP2b Report* published earlier as a part of the deliverables from Phase-I the SENSREC project was a kind of "Pre-feasibility study" - in which some of the approximate infrastructure and budgetary requirement were published. It was estimated that the plan area of nearly 8 hectares (i.e. 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong for the assumed life period of 10 years of the facility. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.3 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

In addition to the above mentioned budgetary estimates, in the present study (contribution from tasks undertaken in WP5b) an attempt has been made to estimate the other project related costs (other than the construction and erection costs). It is well understood that, in addition to the construction and erection costs reported in WP2b Report, a variety of short term study and investigation projects will have to be undertaken in the process of feasibility study including site selection and EIA. Those investigations could cost total USD 1.2 million. Further USD 1.0 to 1.2 million (typically 8-10% of the construction cost) should be budgeted for covering the unforeseen and difficult to plan expenses including duties, local taxes *etc.* The budget for appointing the Project Management Consultant (PMC) could be in the vicinity of 8-10% of the construction cost (USD1.0-1.2 million). Finally, a budget of USD 1.2 million is estimated for covering contingencies and unforeseen expenses (typically 5-12% of the construction cost). Therefore, all the studies and investigations discussed above will need allocation of **USD 4.8 million** up front – irrespective of a planning of TSDF for 10 year life or 20 year life.

In summary, for establishing the CHW-TSDF adequate for 10-year life, **USD 16.1 million** and the land area of **7.8 hectare (i.e. 19.3 acre)** would be required to conduct all the required studies and investigations and for construction and erection of the facility (details given in Chapter 11, Section 11.5 and Table 11.1).

It may be interesting to note that the above stated budgetary estimates are based on the budgetary figures provided by several professionals and contractors performing similar activities in India in the field of large infrastructure projects including wastewater treatment facilities, municipal solid waste, hazardous waste, and bio-medical waste management facilities.

If the TSDF life-span is to be extended by another 10 years; additional **USD 37.8 million** and the additional land area of **7.2 hectare (i.e. 17.8 acre)** will have to be invested at that time in order to conduct all the required studies and investigations as well as for the construction and erection of the suitable additional landfills and for the replacement of the 10-year old incinerator by a new incinerator of higher capacity (see **Table 1.1** for further details).

The silver lining to this is the fact that the investment for the facility having 20-years life can be established right away with USD 16.1 million and the additional USD 37.8 million investment will have to be made at the end of 10-years of operation. By then, both, the operator of the CHW-TSDF and the Regulating Authorities as well as the BSRD (or any SPV) would have understood the process technology and economics of hazardous waste management much more clearly due to 7-8 years of experience and all the concerned stakeholders would have better competencies.

As a result, a better, cost effective, suitable incinerator with hopefully improved technology and smaller environmental and energy footprint could be possibly available and the new incinerator will be better from the business perspective.

If the Government of Bangladesh makes a decision to establish the CHW-TSDF for 20-year operating life, the concerned authorities have to simply provide for a footprint of 15 hectare (i.e. 37.1 acre) land instead of 7.8 hectare (i.e. 19.3 acre) needed for establishing the facility having 10-year life.

Table 1.1: Funds needed for establishing the TSDF adequate for 10-yr life and additional funds required for extending the life by another 10 years

Sr No	Type of Waste or Area	Funds Needed now for Construction of CHW-TSDF having 10-year Life in million USD	Additional Funds Needed after 10-yr for Extending Life of the TSDF by another 10 years in million USD
1a	Landfillable Wastes for the first 10-yr period	2.50	
1b	Landfillable Wastes for the next 10-yr period		6.57
2a	Incinerator for the first 10-yr period	6.84	
2b	New Incinerator for the next 10-yr period		20.99
3	Bilge water + Scrubber Effluents + Landfill Leachates	0.47	1.38
4	Civil Work, storage and blending sheds, site development, infrastucture, chemical laboratory (modest), firefighting facility, green belt, etc.	1.47	4.34
Sub-total of the costs for construction and erection of CHW-TSDF =		11.28	33.28
5a	Initially, for obtaining the permission and approvals from the relevant Authorities and Agencies, certain investigations and assessments will be conducted. Those include EIA, hydro-geological and geo-technical surveys among several things.	4.80	
5b	After 10 years, for obtaining the permissions for extending the life by 10 years, the relevant Authorities and Agencies may demand that certain investigations and assessments be conducted afresh.		4.50
TOTAL =		16.1	37.8
		million USD	million USD

In sum, neither more funds nor additional efforts are needed today for planning 20-year life project. One needs to simply identify and notify a 15 hectare (i.e. 37.1 acre) plot of land and the investment of USD 16.1 million will be good enough to start the facility right away.

Indicative Budget for the Capacity Building Activity (Objective B): Regarding a budget for the capacity building part of Phase II; it has to be noted that it will be possible to estimate this after the authorities reach a decision on the length of time required to train all workers in the ship recycling industry and the size of infrastructure required to achieve the scheduled task.

In the interim period, the Bangladesh Marine Academy (BMA) was highlighted as having the appropriate training knowledge and infrastructure to deliver ship recycling related training as reported in the WP4b Report ('Strategy for Sustainable Training for the Ship Recycling Industry' authored by Stuart A. McKenna, Raphael Baumler and Rafet E. Kurt; the final version dated 20th December, 2016). Based on the assumptions described in the report, calculations were made to assess the total number of workers required to be trained per year with an increased capacity in training facilities and numbers of trainers. Approximate costs (summarised in the Annex to WP4 Part II) to utilise the BMA, training up to 1008 workers per year, were given as USD 160 per worker, plus the cost of international expertise and living expenses.

Clearly, if one desires to complete the task of training nearly all the workforce in Chittagong recycling yards in rather short period of time, then multiple classrooms and multiple sets of the laboratory facilities would be required to be built in the training facility, as discussed in chapter 13.

In any case, the one thing that might be possible and certainly desirable to evaluate at this stage would be the cost of building the adequate facility for completing training of 25,000 workers in 5 years (i.e. a facility containing all necessary infrastructure for the training 5,000 to 6,000 workers every year, as discussed in chapter 13). The detailed basis-related and infrastructure-related assumptions made for the said budgeting exercise have been discussed in Section 13.5 in Chapter 13.

It is envisaged that a group of 6 trainers will handle one “Stream”. Thus, 5,000 to 6,000 workers would be trained every year at the proposed “Training Complex” with the help of three sets of trainers functioning in parallel (named as Streams I, II and III). In total, nearly 150 persons at various levels will have to be employed at the training facility proposed here. The personnel will comprise of 22 trainers, 64 technicians 22 administrative staff and 42 personnel for providing several support services including janitors, staff for up-keep, security guards and gardeners.

It is envisaged that the “Academic and Administrative Building” having built-up area of 5,400 m² and the “Indoor Laboratories” having built-up area of 11,250 m². In addition, the “Outdoor Training Areas” will be needed. For this purpose it is envisaged that the outdoor training will be given in the wet-intertidal areas, intertidal zones and secondary cutting zones of the yards where the workers are employed. The *Production Supervisors* and *Health Safety and Environment Officers* in the respective yard will supervise the workers under training and report the progress to the *Training Institute*.

The above mentioned “Academic and Administrative Building” and “Indoor Laboratories” will have to be placed in the vicinity of each other. Yet, they should be built sufficiently apart so that adequate masterplan of the land can be made to provide for access area surrounding buildings, approach and access for firefighting, “rendezvous spot” for escape and shelter in case of disaster or accident, parking, roads, gardens, etc.

Thus, a plan area of about **4 hectare (i.e. 10 acres)** will have to be provided for construction of the proposed “Training Complex” designed to train 5,000 to 6,000 workers every year. The said facility will have the “Academic and Administrative Building” and “Indoor Laboratories” as well as adequate roads, access to each building and safety systems.

The proposed “Training Complex”, approximately, would require **USD 7.1 million** to cover the capital cost of construction, commissioning, modest furniture, laboratory equipment and fire-fighting systems. This budgeted costs, however, do not cover air conditioners, residential quarters, guest house, cost of land, or any recurring costs, or the operation and maintenance costs.

1.5 Cost-benefits and Risks Involved in Phase II

It is to be reiterated that the above calculations are based on the assumption that there will be yearly 6% annual growth in industrial sectors and approximately 4% annual growth in ship dismantling sector. However, this is probably not the case for each and every sector. Some may not grow at all while some may grow beyond our expectation. In any case, the country will progress over the years and so it is likely that the amounts of solid and liquid wastes will grow.

Finally, it is worth noting that the designs and estimates may contain inaccuracies due to the approximate nature of the inventory and a host of assumptions made in the course of development of this concept and cost estimates. Clearly, the systems designed on the basis of such an inventory and the costing based on several assumptions has given rise to at best “the approximate estimates”.

It is recommended that the Government should provide free land and infrastructure like water-supply, treated wastewater pipeline for disposal, power supply, approach roads and compound wall to stop access from villagers.

In addition, there will be more sectors, generating more wastes – which will be established as the time progresses. However, as the industries graduate to more progressed status, there will be waste minimization due to application of advanced technologies. Also, it is expected that industries will promote reduce, recycle and reuse-based practices (3Rs).

These factors may escalate or may retard the generation rate of the wastes over the period of coming 10 years - which has been assumed to be the life of the facility. Thus, there are several assumptions and several approximations adopted during inventory estimation and designing.

As regards to the risks and uncertainty related to the training activity, it would be prudent to bear in mind that there is no one correct answer for the issue of training. While one would want a short period to complete the training of all the desirable number of workers from the ship recycling industry, it would not be practical and cost effective to plan for a period of merely one year or two to complete this task. It appears that the workforce at such a scale can be serviced within rigor and with a desirable quality control and within the limits of practicality in, say, a period of five years.

Therefore, a prudent and practical plan should be developed by the concerned in the Government of Bangladesh and empower the group within SPV and/or BSRB to take practical steps of institution and infrastructure building for training as soon as possible and take permission of all the authorities in advance so that the workers in the interim period would not suffer for not having the 'Certificate of Training' during that period. The "date for mandatory requirement of training certificate" for getting employment, however, should be announced by the empowered authority three to four years in advance.

1.6 How to Address the Risks?

With a multiple component project involving different stakeholders a number of risks will present themselves in the process of implementation of CHW-TSDF as well as ensuring a high quality useful capacity building among the workforce in Chittagong. The following four key areas need more attention to minimize risk to Phase II:

1 Lack of Institutional Mechanism and Empowerment: As pointed out earlier, in order to make the proposed CHW-TSDF project in Chittagong successful, some of the critical functions will have to be assigned to empowered agencies and certain enabling mechanism will have to be put in place by the concerned Ministry of the Government of Bangladesh. It appears that there are four most important interventions required for engaging all the stakeholders of the project and making critical and significant decisions in a timely manner. Therefore, the concerned Ministry will have to address the following four tasks: (1) creation of an empowered agency to perform the facilitation and governance functions within the framework of the government; (2) identification of competent Project Proponent who would engage with the government in the capacity of an entrepreneur or service provider; (3) articulation of business model for the service provider so that the competent and professional entities can be attracted; and (4) formulation of a suitable legal agreement for regulators to ensure desirable performance for environmental protection.

2 Thorough Management of Time for Conducting Parallel Tasks: Special attention should be given to various stages of project implementation and their respective time schedules. For example, one of the most crucial and important steps happens to be the selection of site for establishing the proposed Treatment, Storage and Disposal

Facility in Chittagong, which is followed by detailed Environmental Impact Assessment of the shortlisted site.

3 Pay Attention to the Time Consuming Steps: As argued earlier, CHW-TSDF is likely to fall in "red category industry", as per the legal protocol for conducting EIA as stipulated by the Environment Clearance rules of Government of Bangladesh. Such industry calls for Initial Environmental Examination (IEE) followed by the detailed Environmental Impact assessment (EIA). After following the due diligent procedure for EIA, Draft EIA Report should be prepared followed by its final approval by the competent authority. This elaborate procedure involves several steps in series and involvement of multiple stakeholders (Governmental agencies, NGOs, community, complex legal procedure, public hearing and consultations with a variety of experts). As a result, the minimum time span for conducting "IEE + EIA" would take say, 16-18 months.

4 Infrastructure for Training and Empowered Agency: The success of training modules developed and delivered under WP4b activities can be implemented only when the infrastructure for imparting training is created. The two most important stakeholders for training will be the BSBA *i.e.* Bangladesh Ship Breakers' Association and the Ministry of Industries, Government of Bangladesh. Also, trainers will have to be employed with specific experience in imparting training to the workforce at all levels through administering the modules developed for training. Although, the yard owners will pick up the costs for training their employees, the facilitation should come from the governmental agencies.

1.7 Analysis of the Threats, Benefits and Opportunities for Bangladesh

Scio-Economic Assessment: The report on work conducted under Work Package 1 of Phase-I of SENSREC Project was submitted in July 2016. The report is entitled: "Contributions of Ship Recycling in Bangladesh: An Economic Assessment". The following text is extracted from this report to highlight the economic, industrial and social significance of the Ship Recycling Sector in Bangladesh:

"This study provides an up-to-date assessment of the overall contributions that the ship recycling industry has made to the economy of Bangladesh. It also discusses the domestic and international regulatory frameworks within which the industry is operating, together with other major factors and developments that

have, and will have, shaped the industry and impacted its economic performance.

. In this study, ship recycling is taken to encompass all economic activities involved in dismantling and converting imported end-of-life ocean-going vessels—through using labour, land, infrastructure, machinery, and various utilities and consumables—into steel and other recyclable and reusable commodities that are mostly sold in domestic markets. Bangladesh is one of the leading ship recycling countries in the world.

- *On average, the industry recycled over 175 ships totalling about 1.8 million light displacement tonnes (LDTs; the most relevant measurement unit in ship recycling) a year over the past decade to 2015.*
- *Over this period, the Bangladesh ship recycling industry has accounted for over 25 percent of the total ships scrapped (in LDTs) by the five leading ship breaking nations; the four other being India, China, Pakistan and Turkey.*
- *In 2015, Bangladesh became the top ship recycling country in the world, surpassing India once again since 2008.*
- *Despite the structural and cyclical ups and downs in the global shipping and ship recycling markets, the ship recycling industry in Bangladesh has managed a respectable growth, estimated at about 14 percent a year on average since 1980.*
- *With expanded capacity of breaking yards over the years, Bangladeshi breakers have imported relatively large and diverse range of ships for recycling.*

The internationally competitive ship recycling industry of Bangladesh is making valuable contributions to the national economy.

- *The industry has sustained its international competition due to a combination of factors including adequate domestic demand for steel scraps and reusable materials and products; proximity to critical infrastructure and a thriving industrial zone with many re-rolling mills and other 'linkage' industries; stable climate and geographical advantage; relatively affordable labour; mature entrepreneurship; and enabling and conducive regulatory environments.*

- *The industry generated output worth, on average, about Taka 53.3 billion (approximately US\$770 million; at 2009-10 constant prices) a year over the past five years to 2015.*
- *In terms of customs duties, income and other taxes, the industry has paid around Taka 5 billion (or, approximately US\$68 million) a year, providing an important source of government annual revenues. Additionally, the industry pays a substantial amount of fees and charges as required under the current regulatory and compliance frameworks.*
- *Importantly, the industry provides jobs to many thousands of skilled and semi-skilled workers coming from across the country, estimated to be between 25,000 and 40,000 full-time equivalent jobs in 2015.*

In addition to these direct contributions, the industry is making important indirect contributions to the national and local economies by supporting and stimulating a host of economic activities along its supply chain—upstream and downstream, including domestic steel manufacturing, ship building and repairing services.

- ✓ *Between 80 and 90 percent of all materials recovered from dismantled ships (measured in Metric tonnes) constituted various forms of steel scraps. Typically, between 50 and 60 percent of these recovered steel scraps are used in re-rolling mills in Bangladesh. As such, steel scraps recovered from ship breaking account for over half of the domestically sourced feedstock into total steel manufacturing in Bangladesh.*
- ✓ *Recycled ships are effectively imported feedstock for domestic steel manufacturing. In view of this, the import dependency for feedstock of domestic steel making would not have been reduced substantially by domestic ship recycling. But the substantial value-adding and employment opportunities that the ship recycling industry has been generating since 1980 would have been foregone had there been equivalent direct imports of steel scraps for domestic steel making.*
- ✓ *As such, for every Taka 1,000 of value-added generated by the ship recycling industry, there was an additional Taka 2,000 of value-added generated along the supply chain—upstream and downstream, implying a value-added*

multiplier of 3. Value-added includes wages and salaries, proprietary income, other proprietor income, and indirect business taxes.

- ✓ *In addition to steel scraps, ship breaking yards recovers substantial amount of non-ferrous metals (in the form scraps, sheets, nets and bar materials), estimated at 7,500 Metric tonnes in 2015 worth about Taka 1.2 billion (or about US\$17 million) at the 'yard gate' in 2009-10 constant prices.*
- ✓ *Ship recycling also recovers numerous machines, components and hardware such as pipes, chains, boats, anchors and propellers, the value of which was estimated at Taka 7.6 billion (about US\$111 million) at the 'yard gate' for the year 2015.*
- ✓ *By ensuring ongoing supply of key feedstock to domestic steel making as well as recovering other reusable or recyclable materials, ship recycling has contributed to the development and growth of many industries in Bangladesh, and thereby playing an important role in broadening and deepening the industrial base of the country.*

The substantial domestic demand for steel scraps and the expected ongoing global supply of recyclable ships from the pool of ageing global merchant ships suggest a promising outlook for the ship recycling industry in Bangladesh.

Nonetheless, global shipping and ship recycling markets are volatile by nature. As such, not only the industry will have to deal with market uncertainties, it will also be facing domestic and international regulatory frameworks and standards which are currently being developed or implemented. One of the critical regulatory requirements relates to safe and environmentally sound ship recycling practices under the Hong Kong Convention. Also, the beaching method of recycling that is used in Bangladesh may come under some threat if the controversial EU Regulation gets up."

Analysis of the Opportunities and Threats: As stated earlier, more than at least 25,000 full-time workers have been estimated to be working in the Bangladeshi shiprecycling zone at any one time. This number could even be as large as 40,000! The ship recycling and shipping markets as well as steel markets typically have considerable influences on the number of workers employed in the sector.

Another peculiar feature of the human resource engaged in this sector in Chittagong, Bangladesh is that the labour are often employed by subcontractors, this workforce has been identified to be predominately migrants from other regions of Bangladesh and likely to enter and exit the sector frequently over time.

Consequently, the estimate of those active within the industry, and therefore required to be trained, could be potentially higher than the estimates once the high worker turnover rate is factored in. Nevertheless, it is clear that the sector also provides secondary and tertiary employment and economic opportunities to many small and tiny entrepreneurs as well as service providers and merchants.

Presently, there is a substantial domestic demand for steel scraps in Bangladesh for several years. This is yet another extremely important driver for the Country for improving the sector. Now more than ever, there exists a great opportunity to obtain steel from the “ship dismantling activities” and fuel the industrialization in Bangladesh. As the country is getting industrialized and developed, the demand for recycled steel is rising and it will continue to grow in the years to come.

Clearly, the currently escalating ongoing global supply of recyclable ships from the pool of ageing global merchant ships has presented a fantastic opportunity for the ship recycling industry in Bangladesh. Unfortunately, this dream may turn sour because of the judgements given by the Honourable High Court in the case related to emissions of hazardous wastes and environmental pollution.

Even the international community and regulators, especially the ship owners, have started taking rather critical view of those countries that are not showing signs of improvement and self-correction. The new regimes like the Hong Kong Convention by IMO and the new European Regulation on ecofriendly dismantling and recycling of ships will continue to become one driving force for the ship owners and ship recyclers to transition to the sustainable futures.

In this context, it is rather obvious that it would be necessary to find a positive attitude and a sense of urgency among the ship recycling sector in Chittagong, Bangladesh. Better than ever, now they have a possibility of making a wise business decision and get engaged with the world community by improving the skills of their workforce and by improving the yards by adopting a better, efficient, safer and environmentally friendly technology for dismantling and recycling the ship hereafter.

The lesson from the world community is pointing in the direction of retraining workers and investing in modernization of the yards. Those who exceeded and those who are making honest efforts to obtain compliance certificates for “the Hong Kong Convention” as well as from the European Union have demonstrated that they already have and will continue to have tremendous economic future and the growth-opportunity in the years to come. Thus, the benefits for the sector if the workers are retrained and technologies are modernized is neither just a hope nor it is an academic theory. It is a reality from the examples in the ship recycling sector in India and China.

The Organization of this “Project Document”: This report is divided into two portions, namely: **Part A** and **Part B**. Part A encompasses the description and significance of all the essential tasks to be performed during the course of Establishing the Common Hazardous Waste Treatment, Storage and Disposal Facility. An effort has been made to give a systematic and elaborate advice on technical and management-related issues at every step of the way in this portion on the “Project Documents”. There are eleven Chapters in Part A (Chapters 2 to 12).

In Part B, effort has been made to outline the strategies for capacity building by implementing the training modules for the workforce in ship dismantling yards in Chittagong, Bangladesh. The details of the proposed strategy and budgetary costing of the capacity building task has been presented in Chapter 13.

PART 'A'

**Establishing the Common Hazardous Waste
Treatment, Storage & Disposal Facility**

Chapter 2

Overview of the Proposed TSDF Project Implementation Process

It is envisaged that the creation of a Common Hazardous Waste Treatment, Storage & Disposal Facility (CHW-TSDF) could be the most crucial requirement for effective management of hazardous wastes generated by the ship recycling yards and industries in Chittagong. It is with this conviction the Bangladesh Ship Breaking Association (BSBA), the Government of Bangladesh and the UN specialized agencies have undertaken the task of achieving safe and environmentally sound ship recycling in Chittagong ship dismantling yards.

This “**Project Document**” is the last contribution from **Work Package 5b** of **Phase-I, Safe and Environmentally Sound Ship Recycling (SENSREC) Project**. This Chapter aims at providing a brief outline of the Project and specific details on the scope and objective for Work Package 5b.

2.1 Overview of the Process for Establishing TSDF in Chittagong

At the outset, it should be recognized that the process of establishing the so-called Treatment, Storage & Disposal Facility for management of hazardous wastes is a complex task and would call for managing the five kinds of broad tasks as outlined below

1. Preparation of the feasibility study report
2. Preparation of the Development Project Proforma (DPP) and approval
3. Preparation of Detailed Project Report (DPR) and Tender Document (TD)
4. Tendering process and awarding of contracts
5. Construction, erection and commissioning

The above five groups of activities will have to be carefully planned and orchestrated so that the proposed CHW-TSDF project in Chittagong can be executed in a timely manner. **Figure 2.1** depicts the inputs and outputs of the above mentioned five group of activities in a manner that the project can be managed with the least duplicate actions and without unnecessary delays.

The first important step would be to embark upon feasibility study. The most important steps to be planned for feasibility study include:

Collection of required data through secondary sources or by commissioning certain studies for collecting the targeted data, which are Digital Survey and Topography, Coastal Regulation Zone and Flood Map, Meteorological and Seismological Data, Soil and Geotechnical Survey, Ground Water and Hydrogeological Survey, Background Environmental Parameters, Biodiversity and Forest Data, Traffic Survey and Transportation Planning, Socio-economic Aspects of the Project.

Based on the above studies, the Site Selection Protocol (SSP) and criteria need to be formulated. Further, upon implementation of the SSP, a rational decision on siting of the said TSDF can be arrived at by comparing and ranking the candidate sites identified by the revenue department.

It could be desirable to conduct several of the steps in parallel so that the entire procedure can be completed in reasonable time period. It must be remembered that the procedure of EIA Study and approval of draft EIA report could probably take the longest compared to the other steps.

More importantly, as CHW-TSDF is likely to fall in "red category industry", the stipulations for such category prescribed by Environment Clearance rules of Government of Bangladesh calls for Initial Environmental Examination (IEE) followed by the detailed Environmental Impact assessment (EIA). After following the due diligent procedure for EIA, Draft EIA Report should be prepared. Finally, the implementation of the protocol for approval of the draft EIA report and allocation and notification of the site is done for the construction of TSDF.

At this stage, the Project Proponent needs to complete the so called Development Project Proforma (DPP). On preparing DPP the protocol for approval of DPP needs to be implemented by approaching the concerned Ministries and Authorities of Government of Bangladesh for the clearance of the said TSDF project.

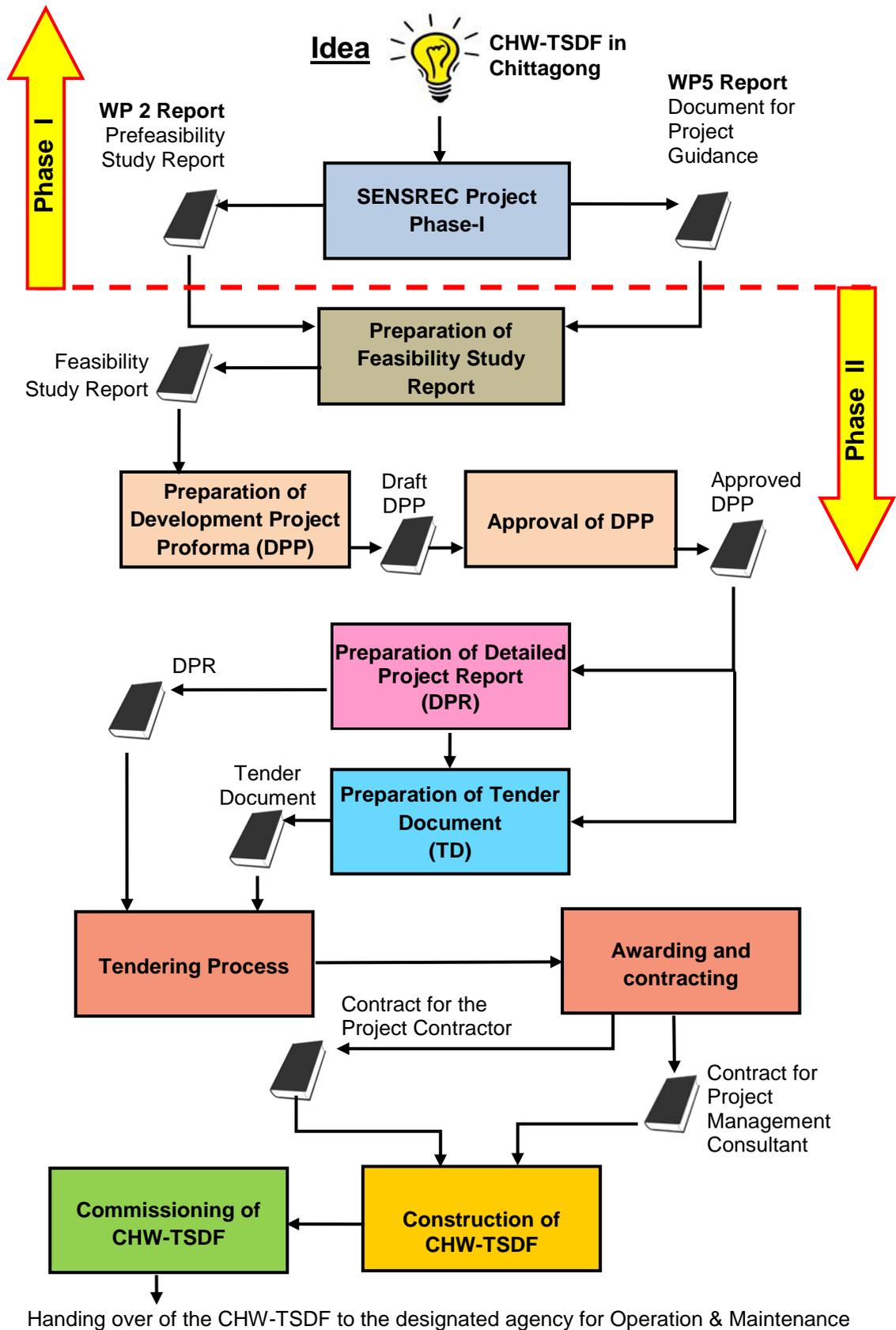


Figure 2.1: Process flow diagram for implementation of *CHW-TSDF Project*

Based on the EIA and feasibility study reports and the approved DPP by the concerned Ministry of Government of Bangladesh; the Detailed Project Report (DPR) should be developed with the help of consultants - which will act as the core document of the said TSDF project. Therefore, the DPR should include technical and financial, pre-qualification requirements and scope of work for the Project Contractor as well as Project Management Consultant (PMC). Further, a consultant is appointed for the development of the Tender document (TD). The Tender document typically describes requirements for three essential elements, namely: financial prequalification, technical prequalification and commercial offer. The selected bids among the bidders shall be shortlisted following the above criteria. Successful eligible contractor(s) is selected and the contracts for project contractor and Project Management Consultant (PMC) are awarded.

Once the contract is signed between the Project Proponent and the contractor(s), construction is to be carried out based on the good for construction drawings and documents issued under the Government of Bangladesh. The construction and erection has to be carried out under the guidance and supervision of Project Management Consultant (PMC). During the commissioning phase, the contractor has the responsibility to start, operate and demonstrate the activities of TSDF, illustrating the specifications mentioned in the contract document. On demonstrating satisfactory performance fulfilling all contractual obligations, the contractor will hand over the TSDF to the Project Proponent. The O&M manual as built drawings deliverable is made by the contractor(s) at the end of the project and is duly approved by the PMC.

2.2 Essential Institutional Mechanism and Empowerment

In order to make the proposed CHW-TSDF project in Chittagong successful, some of the critical functions will have to be assigned to the empowered agencies and certain enabling mechanism will have to be put in place by the concerned Ministry in the Government of Bangladesh. It appears that there are four most important interventions required for engaging with all the stakeholders of the project and making critical and significant decisions in a timely manner. Therefore, the concerned ministry will have to address the following four tasks, namely: (a) creation of an empowered agency to perform the facilitation and governance functions within

the framework of the government, (b) identification of competent Project Proponent who would engage with the government in the capacity of a entrepreneur or service provider, (c) articulation of business model for the service provider so that the competent and professional entities can be attracted and (d) formulation of a suitable legal agreement for regulators to ensure desirable performance for environmental protection. A brief description of the four tasks is presented below:

a) Creation of Special Purpose Vehicle: Creation of the "Special Purpose Vehicle (SPV)" is the essential step that should be undertaken before initiating any activity in the proposed TSDF project in Chittagong. It is envisaged that the SPV would serve as the "one window" facilitating agency appointed by the concerned Ministries of the Government of Bangladesh for initiating and navigating all the necessary steps during the course of implementation of Phase II of SENSREC project. The SPV could be a standalone agency empowered by the concerned ministries in the Government of Bangladesh. For example, the planned establishment of the BSRB (*i.e.* Bangladesh Ship Recycling Board) may prove to be effective in carrying out of the functions of the "one window" facilitating agency.

The coordinator (or Chief Executive Officer) of SPV should be a person having relevant expertise in management of complex projects requiring approvals and coordination between a variety of Ministries and Departments of the Government of Bangladesh. In the absence of creation of SPV, neither the project would be planned nor would it take off in the desired direction.

It would be interesting to note that the proposed TSDF project will only be initiated and navigated in the desirable direction with the help of empowered SPV. In the absence of SPV, the various project steps may get retarded and eventually the project may not go too far.

b) Identification of Competent Project Proponent: It is envisaged that the "Project Proponent" will have to be identified for setting up of the TSDF as well as for operation and maintenance of the facility. This can be achieved in several ways. For example, the Project Proponent could be appointed by the concerned Ministry in the Government of Bangladesh and the individual (or group) should be empowered for the creation and operation of the facility. In such event the concerned Ministry will carefully choose and empower the team members having critical, complementary and significant competencies related to construction, erection, commissioning and operation and maintenance of the proposed TSDF project in Chittagong.

Alternately, the Project Proponent could also be a private enterprise having relevant experience and enthusiasm for establishing and operating the said TSDF project. A formal process will have to be followed, through which, the most suitable bid shall be accepted and legally contracted with for construction, erection, commissioning and operation and maintenance of the proposed TSDF project.

In any case, whether private or government, it is hoped that abundant due diligent care shall be exercised by the concerned authorities and decision makers within the Government of Bangladesh. It should be ensured that the Project Proponent would have experience in establishing and operating TSDF project or equivalent experiences on one hand and would have financial capabilities for investing in the project on the other hand. In other words, the designated Project Proponent must be financially committed to the project and must be willing to see the project as the core of its long term business interests. One of the drivers for ensuring the commitment could be the requirement of (say) 25% funds to be invested in the project by the aspiring Project Proponent.

c) Articulation of Business Model: If the project is started with a collectively developed and agreed "Business Model" for establishing the CHW-TSDF in Chittagong, there will be a win-win situation for all the stakeholders. The experience in India and Turkey suggests that a private enterprise aspiring to own and operate (Project Proponent) a commercial TSDF should be mandated to contribute 25% as their collateral at the outset to ensure the commitment to the TSDF.

During the operation and maintenance phase of the said TSDF, it would be desirable that the tariff for pre-treatment, incineration or landfilling of hazardous wastes should be mutually agreed by SPV, Project Proponent and the generators of the wastes (including the Bangladesh Ship Breakers Association and other industries).

In sum, the proposed CHW-TSDF can be successfully planned and implemented in Chittagong only when the SPV is designated at the outset and the ground rules for identification and finalization of the so-called Project Proponent are mutually agreed and put forward to the potential investors and financial institutions in the beginning. However, the clarity on the desirable terms and conditions to be mandated for the Project Proponent may not be possible until the "Business Model" is planned and articulated meticulously. Thus, the concerned Ministries and Departments in the Government of Bangladesh with inputs from UN Specialized Agencies (UNIDO, UNEP, BRS) have the paramount responsibility of setting-up of the "rules of game"

by first making resolution about SPV and secondly by articulating the "Business Model".

d) Formulation of the Targeted Regulatory Instrument: The Project Proponent should ensure that the setting up and operating the said TSDF does not violate any laws and regulations of the land. It will also be necessary for the Government of Bangladesh to ensure that the hazardous waste generators (ship recyclers and other industries) will be held responsible for sending their wastes to the CHW-TSDF. In order to facilitate the regulatory process some dedicated and directed legal instrument (for example Government Resolution, Gazette Notification, Ordinance, Legal regulation, or amendment to the existing law) should be formulated. It will not only ensure the prevention of environmental damage due to hazardous wastes but also guarantee the success of proposed business model.

2.3 Comprehensive Budgetary Cost Estimates

It would be useful to recall that the *WP2b Report* published earlier as a part of Phase-I deliverable from the SENSREC project was a kind of "Pre-feasibility study" - in which some of the approximate infrastructure and budgetary requirement were published. It was estimated that the plan area of nearly 8 hectares (i.e. 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong for the assumed life period of 10 years of the facility. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.5 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

In addition to the above mentioned budgetary estimates, in the present study, an attempt has been made to estimate the other project related costs (other than the construction and erection costs). It is well understood that, in addition to the construction and erection costs reported in *WP2b Report*, a variety of short term studies and investigation projects will have to be undertaken in the process of feasibility study including site selection and EIA. Those investigations could cost total USD 1.2 million. Further USD 1.0 to 1.2 million (typically 8-10% of the construction cost) should be budgeted for covering the unforeseen and difficult to

plan expenses including duties, local taxes *etc.* The budget for appointing the Project Management Consultant (PMC) could be in the vicinity of 8-10% of the construction cost (USD1.0-1.2 million). Finally, a budget of USD 1.2 million is estimated for covering contingencies and unforeseen expenses (typically 5-12% of the construction cost).

Thus, the budgetary cost estimate for planning, designing and implementation of the proposed CHW-TSDF project in Chittagong works out to be USD 17 million. It may be interesting to learn that the above stated budgetary estimates are based on the budgetary figures provided by several professionals and contractors performing similar activities in India in the field of large infrastructure projects including wastewater treatment facilities, municipal solid waste, hazardous waste, bio-medical waste management facilities.

2.4 Organization of the 'Project Document' for Phase-II

As stated earlier, the international consultant was requested to prepare the "Project Document" for the implementation of the proposed Phase II, namely: to plan and build the necessary infrastructure of TSDF in Chittagong, Bangladesh and to outline the necessary strategies for capacity building by implementing the training modules for the workforce in ship dismantling yards in Chittagong, Bangladesh. As depicted in **Figure 2.1**, the relevant tasks to be undertaken in parallel and series during the course of implementation of the proposed CHW-TSDF Project in Chittagong, Bangladesh have been outlined and described in the beginning of this Chapter. Further, the details of each group of tasks are described in the subsequent Chapters in Part 'A' of this Project Document.

Thus, this Report describes the necessary stages of Phase II of the project, including the necessary resources for the management of the project; for procuring the services of consultants to the management; for the production of engineering and construction drawings; for the selection and for contracting of the contractors to build the TSDF; for independent supervision during the construction phase; and for any other activities that are necessary for the successful execution of the project. These details have systematically given in various chapters – which have been mapped in **Figure 2.2** for assisting the reader.

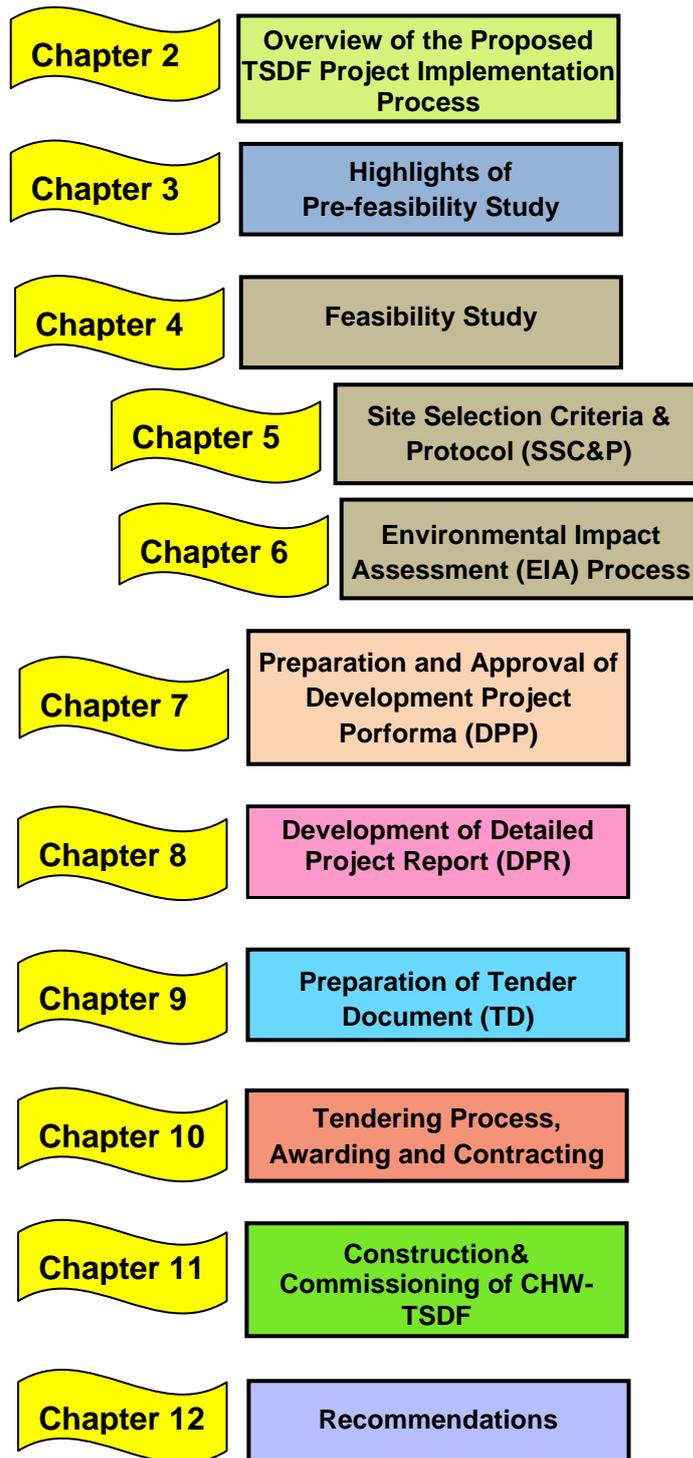


Figure 2.2: Organization of ‘Part A’ of the Report indicating the chapter numbers corresponding to the tasks to be performed for establishing CHW-TSDF in Chittagong (Objective A)

Chapter 3

Highlights of the Pre-feasibility Study (WP2 Report)

The inventories of hazardous wastes generated from the ship recycling industry in Chittagong and from the surrounding industrial areas were developed through a survey under Work Package-2 (WP2) of the Safe and Environmentally Sound Ship Recycling (SENSREC) Project. **Tables 3.1 and 3.2** in this report have been imported from the “Hazardous Waste Assessment Report” published as one of the earlier deliverables under WP2. These tables display the estimates of hazardous wastes generated by the ship recycling yards and from other industries in Chittagong region, respectively.

The data of ships dismantled in Chittagong over the past seven years was studied and the opinions of experts were considered before arriving at any conclusion regarding growth rate of recycling yards. In that light it was concluded that the ship recycling sector in Chittagong could grow at an annual rate of 4% in the near future.

Table 3.3 has been imported from the “Hazardous Waste Assessment Report” which summarizes the expected growth rates of different industrial sectors in Bangladesh and the corresponding comments made by different experts consulted by the team. Clearly, the rates are different for the sectors that were a focus of this report. In the light of expert opinion, it was concluded that the average of 6% annual growth rate for industrial growth in the coming decade will be possible for Bangladesh with fair certainty.

In any case, availability of a reliable "Common Hazardous Waste Treatment, Storage & Disposal Facility (CHW-TSDF)" is an important requirement for the effective management of hazardous wastes.

Like common effluent treatment plants (CETPs) where government and industry associations/companies participate in operation and maintenance, the operator of the CHW-TSDF facility can be a government agency, quasi-governmental agency, an industry association, a joint venture or a private sector company. Hazardous waste treatment is an expensive process that demands specialized supervision and instrumentation.

Table 3.1: Estimates of hazardous waste quantities generated from the Chittagong ship recycling yards (MT/yr)

Disposal Method	Recent Trend Minimum (MT/yr)	Recent Trend Maximum (MT/yr)	Average of the Range (MT/yr)	10-yr lifetime capacity @ 4% growth rate (MT)
Incinerable Wastes	5,400	6,400	5,900	71,000
Landfillable Wastes (Toxic + Inert)	7,500	10,300	8,900	107,000
Alternate gainful use or send to Municipal Solid Waste landfill			Nil	Nil
Grand Total			14,800	178,000

It is evident from the inventory assessment that the ship recycling sector has been producing sizable and comparable quantities of landfillable and incinerable wastes. However, the industrial sectors cumulatively generate comparatively negligible landfillable wastes but generate large quantities of incinerable wastes.

Table 3.2 Estimates of hazardous waste quantities generated by industries in Chittagong by waste type and disposal method (MT/yr)

Waste Type	Total waste generation rate (MT/yr)	Disposal Methods			
		Incineration (MT/yr)	Landfilling		Alternate gainful use or Municipal Solid Waste landfill (MT/yr)
			Toxic waste landfill (MT/yr)	Inert landfill (MT/yr)	
Tundish lining	25'192				25'192
ETP sludge	19'165	3'443	324		15'397
APC Dust	11'131				11'131
Contaminated solid waste	3'965	3'965			
Contaminated packaging	3'626	3'626			
Oily crude tank sediments	1'459	1'459			
Contaminated plastic waste	1'282	707			575
Bleaching earth	910				910
Spent Lubricants	251	251			
Flesh	222				222
Maintenance scrap	124	124			
Oil and grease	89	89			
Chemical residues	88	88			
Trimming dust	72				72
Raw hides cutting	66				66
Shaving dust	54				54
Asbestos	40			40	
Other contaminated materials	25	24		1	
Waste glasswool& insulation	8			8	
Yearly Sub-Total (MT/yr)	67'768	13'777	324	49	53'619
Episodic and aperiodic waste	678	138	3	0	536
Yearly Total (MT/yr) #	68'600	14'000	400		54'200
10-yr lifetime capacity @ 6% growth rate (MT) #	904'200	184'500	5'300		714'400

Rounded-off numbers

Note: In addition to the results shown above, biomedical waste generation from the hospital and health sector is estimated at 800 MT/yr (based on 6'400 beds). A dedicated facility will have to be created for it in Chittagong.

Table 3.3: Tentative "Design Basis" for the proposed TSDF in Chittagong

Sr No.	Disposal Method	Estimated Inventory		Tentative Design Basis		
		From the ship recycling yards (MT/year)	From the industrial areas (MT/year)	From ship recycling yards 10-yr lifetime capacity @ 4% growth rate (MT)	From other industries 10-yr lifetime capacity @ 6% growth rate (MT)	Total Waste 10-yr lifetime capacity (MT)
1	Incinerable Wastes	5,900	14,000	71,000	184,500	255,500
2	Toxic & Inert Landfillable Wastes	8,900	400	107,000	5,300	112,300
3	Bilge water + Scrubber Effluents + Landfill Leachates + Sewage?	100 m ³ /day	75 m ³ /day	0.45 million m ³	0.35 million m ³	0.80 million m³

As stated earlier, the annual growth rate of 4% (for growth in compound proportions) was assumed for the ship recycling sector and 6% growth rate was assumed for the industrial sectors and the appropriate multiplication factors were used to estimate the cumulative quantities of wastes to be subjected to the proposed TSDF over the life-time assumption of 10-years of the facility.

The site layout and ground plan for a typical TSDF has been presented below in **Figure 3.1**.

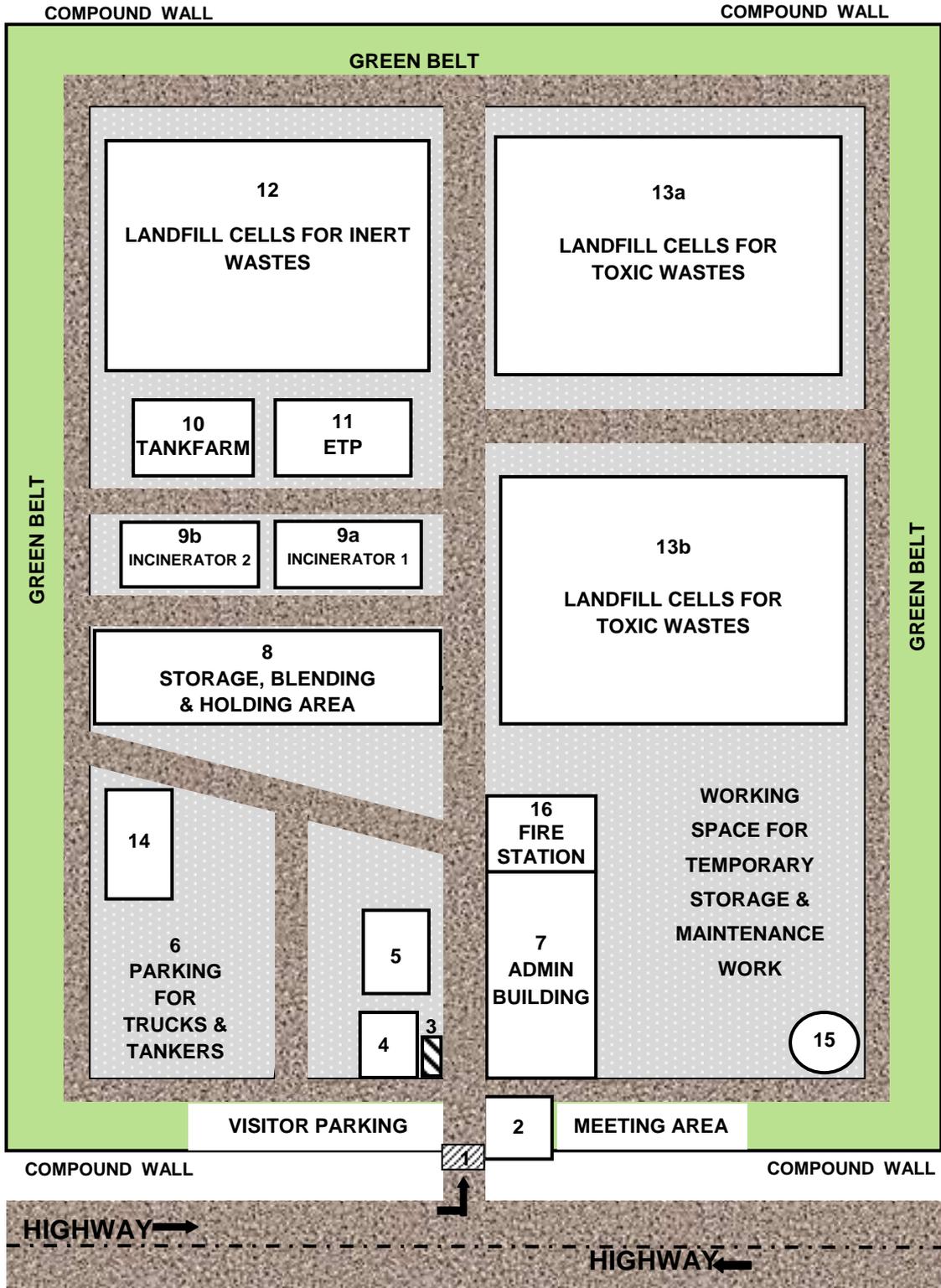


Figure 3.1: Layout and the ground plan for a typical TSD site
(Legend for the layout can be found on the next page)

Legend for Figure 3.1 i.e.the Ground Plan of a typical TSDF Site:

1	Secure entrance gate
2	Security and reception office
3	Weigh bridge
4	Quality & quantity records office, Laboratory
5	Dining hall, Workers' recreation, Doctor's room
6	Parking for trucks and tankers
7	Administrative building
8	Hazardous waste storage, blending and holding zone
9	Incineration plant, Stage 1 (Location 9a) and Stage 2 (Location 9b)
10	Tank farm to hold liquid wastes and waste oils
11	Effluent Treatment Plant (ETP)
12	Landfill cells for inert wastes
13	Landfill cells for toxic wastes (Location 13a and Location 13b)
14	Toilet-Bath complex
15	Overhead Water Tank
16	Fire Station

The above schematic representation is not to scale and it has been presented for illustrating a typical configuration and layout of the landfills, incinerators, effluent treatment farm *vis-à-vis* other utilities and administrative infrastructure. It is well recognized that the real-life situation would have a non-regular geometric shape to the assigned 8 hectare plot of land for building the facility.

It is envisaged that the development of the CHW-TSDF can be implemented by adopting actions and expenditures in two stages. In “Stage 1”, one facility should be constructed with landfill for the total inventory and an incinerator for ship recyclers only, plus the proportionate wastewater treatment facility.

Of the land required for creating a TSDF for management and disposal of hazardous wastes, a substantial footprint will be required to provide for several essential services at the TSDF site. It appears that one would need a plan area of about 20 acres (8 hectare footprint) for the proposed CHW-TSDF in Chittagong.

It is recommended that the Government should provide free land and infrastructure like water-supply, treated wastewater pipeline for disposal, power supply, approach roads and compound wall to stop access from local communities.

The TSDF, for both stages of development, will cost approximately USD 11.5 million (i.e. USD 6 million for Stage 1 and USD 5.5 million for Stage 2) - excluding the cost for land, utilities and project management (refer to **Table 3.4** for further details on cost break-up). These estimates may be amended as a result of ongoing work. The CHW-TSDF could be built over 18 to 24 months by creating a dedicated team by the Government of Bangladesh.

It is to be reiterated that the above calculations are assuming that there will be yearly 6% growth in industrial sectors and approximately 4% growth in ship dismantling sector. However, this is probably not the case for each and every sector. Some may not grow at all while some may grow beyond our expectation. In any case, the country will progress over the years and so it is likely that the amounts of solid and liquid wastes will grow.

In addition, there will be more sectors, generating more wastes – which will be established as time progresses. However, as industries graduate to a more progressed status, there should be waste minimization due to the application of advanced technologies.

Table 3.4: Break-up of land and capex requirements for the proposed TSDF in Chittagong corresponding to both the stages

Stage 1

Sr No	Waste to be treated and disposed off	Land Needed for landfill cells plus approach road and working space adjoining it (plan area) hectare i.e. ha	Land Needed for landfill cells plus approach road and working space adjoining it (plan area) acre i.e. ac	Funds Needed in 2016 million USD
1	Landfillable Wastes	1.40	3.46	2.50
2	Incinerable Wastes (Stage 1)	1.50	3.71	1.90
3	Bilge water + Scrubber Effluents + Landfill Leachates + Sewage?	1.00	2.47	0.22
4	Civil Works, storage and blending sheds, site development, infrastructure, chemical laboratory (modest), fire fighting facility, green belt, etc.	3.90	9.64	1.18
TOTAL =		7.80	19.28	5.80
		hectare	Acre	million USD

Stage 2

5	Incinerable Wastes (Stage 2)	Nil	Nil	4.92
6	Remodel and augment the existing ETP to treat Scrubber Effluents from the new incinerator	Nil	Nil	0.28
7	Additional Civil Works, storage and blending sheds for the new incinerator	Nil	Nil	0.37
TOTAL =		Nil	Nil	5.57
		hectare	Acre	million USD

Also, it is expected that industries will adopt reduce, recycle and reuse-based practices (3Rs) and some minimization of emissions will happen. However, it would be prudent to assume that the combined effect of these factors may escalate the generation rate of the wastes over the period of coming 10 years - which has been assumed to be the life of the facility.

The advanced industrial sectors, including ship recycling yards and other industries, in the future years will certainly be more thorough in sending larger quantities of wastes to the waste management facility and the overall wastes to be handled and treated will essentially grow in the regimes where better compliance can be achieved.

Finally, it is worth noting that the designs and estimates may contain inaccuracies due to the approximate nature of the inventory and the host of assumptions made in the course of development of this concept and cost estimates. Clearly, the systems designed on the basis of such an inventory and the costing based on several assumptions has given rise to at best “the approximate estimates”.

Chapter 4

Feasibility Study (FS)

The pre-feasibility study has been made available through the execution of SENSREC Project's Work Package 2 (*i.e.* WP2) and the highlights of that report have been presented in the previous chapter (Chapter 3). In the context of lessons learned from WP2 as well as based on the requirements of conceptualizing and planning of the proposed *Common Hazardous Waste Treatment Storage and Disposal Facility* (CHW-TSDF) the first important step would be to prepare the Feasibility Study (FS) Report. This chapter details the process of Feasibility Study.

4.1 Brief Description and Significance

Typically the following six salient steps would be required for preparation of the so called Feasibility Study Report:

- a) Creation of Special Purpose Vehicle (SPV);
- b) Collection of required data through secondary sources or by commissioning certain studies for collecting the targeted data;
- c) Articulation of the Site Selection Protocol (SSP) and criteria;
- d) Implementation of the SSP and decision of site;
- e) Undertaking of an "Environmental Impact Assessment" and preparation of the Draft EIA Report; and
- f) Finally, implementation of the protocol for having the EIA report approval and the allocated site notified for the construction of TSDF.

Creation of the "Special Purpose Vehicle (SPV)" is the essential step that should be undertaken before initiating any activity in the proposed TSDF project in Chittagong. It is envisaged that the SPV would serve as the "one window" facilitating agency appointed by the concerned ministries in Government of Bangladesh for initiating and navigating all the necessary steps during the course of implementation of Phase -II of SENSREC project. The SPV could be a standalone agency empowered by the concerned Ministries in the Government of Bangladesh. For example, the planned establishment of the BSRB (*i.e.* Bangladesh Ship Recycling Board) may prove to be

effective in carrying out of the functions of the "one window" facilitating agency (*i.e.* SPV).

It could be desirable to conduct several of the above steps in parallel so that the entire six-step procedure can be completed in a reasonable time period. It must be remembered that the procedure of EIA Study and approval of draft EIA report could probably take the longest compared to the other steps. Clearly, the efforts should be made to start some of the early steps in the EIA Study up-front in the Feasibility Study phase.

4.2 Input Data and Pre-requisites

The first activity during the “Feasibility Study Phase” happens to be related to the collection of all the relevant and required data for the implementation of SSP and the preparation of the Draft EIA report.

4.3 Important Steps and Procedure

The step-wise detailed procedure has been depicted in **Figure 4.1**. It would be advisable to start assigning the different required studies in parallel to carefully identified set of expert agencies and individuals (Guidance documents for all the recommended studies have been placed in the appendices). The steps for development of SSP as well as development of the "Site Selection Criteria" should also be initiated right at the beginning during the Feasibility Study phase.

Similarly, the steps involved in environmental Impact Assessment (EIA) of the selected site have to be undertaken contemporarily with SSP development. EIA and SSP reports form an integral part of the feasibility study. SPV should have the required organizational structure with experienced manpower and the required financial resources.

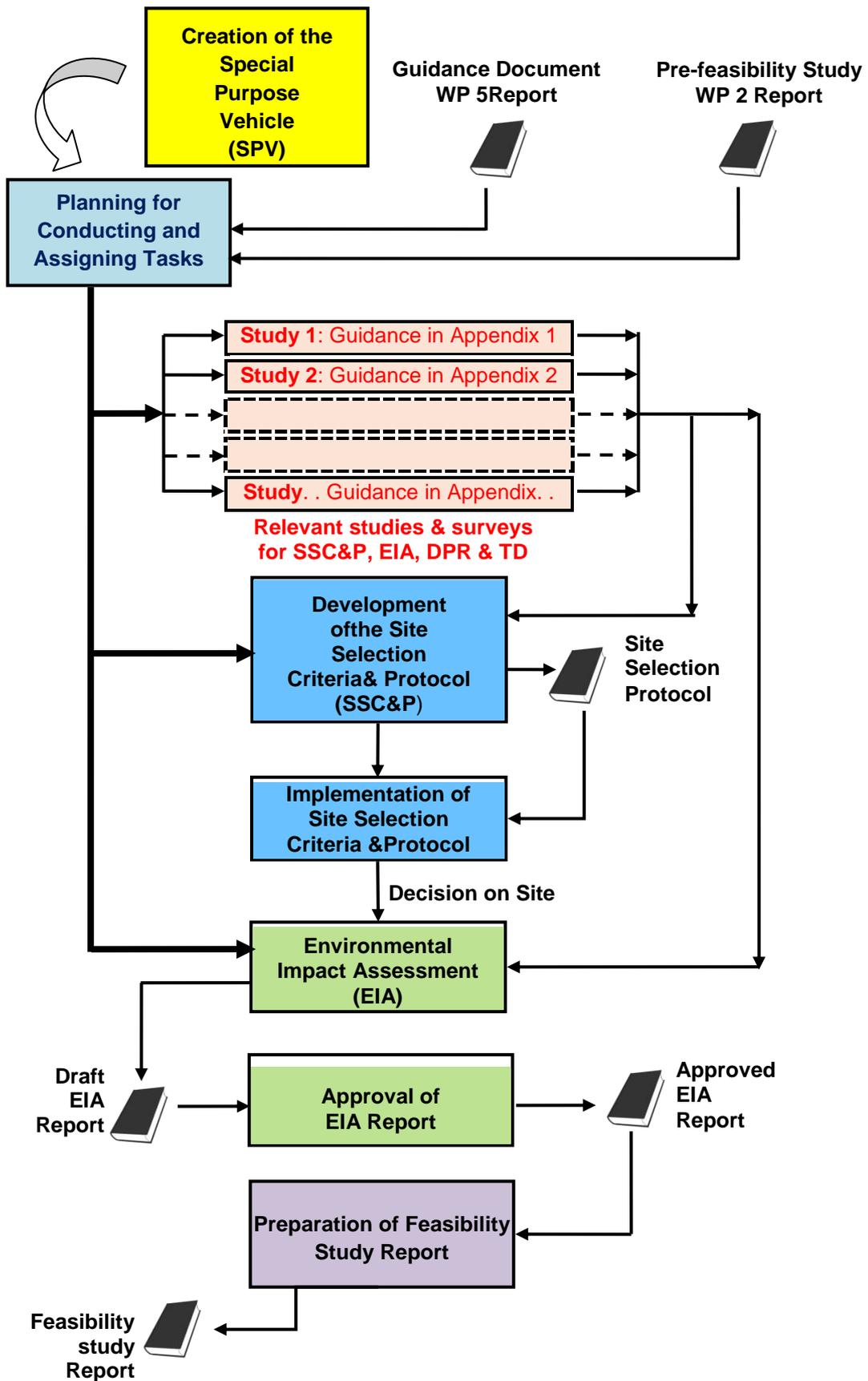


Figure 4.1: Process Flow Diagram for Preparation of Feasibility Study Report

4.4 Precautions

Collection of required data through secondary sources or by commissioning certain studies for collecting the targeted data would most probably prove to be the rate-controlling step.

During the initial period of the project implementation phase, it would be useful to consult with the expert agencies entrusted with the task of development of Site Selection Protocol as well as the agencies designated for conducting the EIA Study. The next two chapters, namely, Chapters 5 and 6, are dedicated to describing the process steps for the development and implementation of the SSP and EIA-related activities, respectively. In summary, if the data collection would not be undertaken up-front in the Feasibility Study phase, the tasks outlined in Chapters 5 and 6 will get delayed. The creation of Special Purpose Vehicle (SPV) is an essential step that should be incorporated before the commencement of feasibility studies. Lack of SPV can lead to delay in the project execution.

It is envisaged that the "Project Proponent" will have to be identified for setting up of the TSDF as well as for operation and maintenance of the facility. This can be achieved in several ways. For example, the Project Proponent could be appointed by the concerned Ministry in the Government of Bangladesh and the individual (or group) should be empowered for the creation and operation of the facility. In such event, the concerned Ministry will carefully choose and empower the team members having critical, complementary and significant competencies related to construction, erection, commissioning and operation and maintenance of the proposed TSDF project in Chittagong.

Alternately, the Project Proponent could also be a private enterprise having relevant experience and enthusiasm for establishing and operating the said TSDF project. A formal process will have to be followed, through which, the most suitable bid shall be accepted and legally contracted with, for construction, erection, commissioning and operation and maintenance of the proposed TSDF project.

The concerned Ministries and Departments in the Government of Bangladesh with inputs from UN Specialized Agencies (UNIDO, UNEP, BRS) have the paramount responsibility of setting-up of the "rules of game" by first making a resolution about SPV and second by articulating the "Business Model". If the project is started with a collectively developed and agreed "business model" for establishing the CHW-TSDF

in Chittagong, there will be a win-win situation for all the stakeholders. It is strongly recommended that a private enterprise aspiring to own and operate (Project Proponent) a commercial TSDF should be mandated to contribute 25% as their collateral at the outset to ensure the commitment to the TSDF.

During the operation and maintenance phase of the said TSDF, it would be desirable that the tariff for pre-treatment, incineration or landfilling of hazardous wastes should be mutually agreed by SPV, Project Proponent and the generators of the wastes (including Bangladesh Ship Breakers' Association and other industries).

The Project Proponent should ensure that the setting up and operating the said TSDF does not violate any laws and regulations of the land. It will also be necessary for the Government of Bangladesh to ensure that the hazardous waste generators (ship recyclers and other industries) will be held responsible for sending their wastes to the CHW-TSDF. In order to facilitate the regulatory process some dedicated and directed legal instrument (for example Government Resolution, Gazette Notification, Ordinance, Legal regulation, or amendment to the existing law) should be formulated. It will not only ensure the prevention of environmental damage due to hazardous wastes but also ensure the success of proposed business model.

Chapter 5

Site Selection Protocol (SSP) and Criteria

The hazardous waste landfill site selection is very critical issue for the human health, environment and also from the economic point of view. As there are no notified rules and regulations for CHW-TSDF siting by the Government of Bangladesh, this work becomes more important. Various algorithms have been developed for EIA processes, but no standard algorithm is developed for CHW-TSDF site. An attempt has been made here to develop a systematic path for CHW-TSDF.

5.1 Brief Description and Significance

In order to put a Common Hazardous Waste – Treatment Storage and Disposal Facility in service, special considerations must be given in site selection phase. Some protocols must be followed to identify which sites are to be considered for initial assessment and which sites to be excluded.

The site selection protocol and establishing some criteria are of utmost importance otherwise human environment interaction will be seriously affected. Any process begins with the recognition and definition of the decision problem. Broadly defined, the decision problem is a perceived difference between the desired and existing states of a system. It is gap between the desired and existing states as viewed by decision-makers. The problem definition overlaps the intelligent phase of decision making.

The so-called "intelligent phase" of decision making, this phase can be aided by using modern multi attribute of data management software; generally referred to as such as Geographic Information System (GIS). GIS is defined as an information system that is used to input, store, retrieve, manipulate, analyze, and output geographically referenced data or geospatial data, in order to support decision making. There are many GIS software available in global market, the major international software are ARC/INFO, Acr-view GIS, some of the India's software are ISROGIS and Geospace by ISRO, GISNIC from national informatics centre, GRAM

from IIT-Mumbai. The GIS capability for data storage, management, manipulation, and analysis offers major support in the problem definition stage.

In case of hazardous waste landfill site selection, the required site needs to meet all the environmental, social and economic aspects, therefore, siting a landfill or other facility requires consideration of numerous criteria, factors, and regulations. Massive amounts of spatial data are therefore processed for waste facility siting. Such difficulties are exacerbated even further when siting hazardous waste landfills, owing to their rigid environmental restriction. Mutual analysis of spatial data is, however, time consuming and tedious. Furthermore, the public approach of 'Not In My Back Yard' poses another major obstacle in the siting process. A candidate landfill or waste facility site is often abandoned owing to public opposition.

5.2 Input Data and Pre-requisites

Collection of required data through secondary sources or by commissioning certain studies for collecting the targeted data, which are Digital Survey and Topography, Coastal Regulation Zone and Flood Map, Meteorological and Seismological Data, Soil and Geotechnical Survey, Ground Water and Hydrogeological Survey, Background Environmental Parameters, Biodiversity and Forest Data, Traffic Survey and Transportation Planning, Socio-economic Aspects of the Project.

Table 5.1 gives the listing of proposed ten studies and data collection activities – which could be commissioned separately to consultants having appropriate competencies. The last column of Table 5.1 shows the appendix number corresponding to each of the studies listed in the Table. Those appendixes are placed at the end of this report with the objective of providing categorical and relevant guidance regarding the corresponding study and field work.

Data are of little value in and of themselves. To be useful, they must be transformed into information. When data are organised, presented, analysed, interpreted, and considered useful for the decision problem, they become information. Accordingly, geographical information can be defined as geo-referenced data that has been processed into a form that is meaningful to the decision maker and is of real or perceived value in the decision making process. Information is used by the decision maker and is derived from data.

Table 5.1: The titles of the special studies to be commissioned in parallel at the beginning of the “Feasibility Study” phase

Sr. No.	Title of The Study	Guidance Reference
1	Topographical Data using Digital Surveys	Appendix 1
2	Coastal Regulation Zone and Flood Map	Appendix 2
3	Seismological Data	Appendix 3
4	Meteorological Data	Appendix 4
5	Soil and Geotechnical Survey	Appendix 5
6	Ground Water and Hydrogeological Data	Appendix 6
7	Background Environmental Parameters	Appendix 7
8	Biodiversity and Data on Biological Environment	Appendix 8
9	Traffic Survey for Transportation Planning	Appendix 9
10	Socio-economic Aspects of the Project	Appendix 10

Screening Criteria

It is an integrated part of the site selection process for establishing hazardous waste landfill. The basic purpose of the screening criteria is to shortlist the candidate sites identified in and around the city of Chittagong. It can be achieved only when certain "screening criteria" are first established. A comprehensive set of attributes which reflect the concerns relevant to the decision problem, must be considered while evaluating and selecting study area. A different study area, which are the product of screening criteria are then compared with each other on the basis of comprehensive set of attributes.

In a screening criteria various buffering distances are applied to different attributes which is the function of perception of risk by community, degree of treatment given to hazardous waste, safety measures considered for landfill construction, experts opinion based on their experience, transportation risk and hazard. Various attributes such as lake or pond, river, water supply well, water resources, ground water table level, wetlands, flood plain, urban development, regulatory zone, airports, populated areas, fault zones, land slope, road network availability, land cost *etc.* can be considered for screening criteria based on their importance to site.

Screening criteria is purely based on primary data available which could be various updated maps, or if not, then remotely sensed data can be obtained from concerned regulatory institute. A secondary data *i.e.* detailed site data is applied for next step of

screening. Different layers are prepared for screening of different attributes such as water bodies, district boundaries, forest *etc.* A couple of decades back, preparation of attribute layers was done manually, which was time consuming process. But in this computer age a sophisticated tool like GIS is used for this purpose. This leads to fast and accurate analysis of study area.

Sensitivity Analysis

To obtain a ranking of sites, sensitivity analysis should be performed to determine robustness. Sensitivity analysis is defined as a procedure for determining how the recommended course of action is affected by changes in the inputs of the analysis. Specifically it aims at identifying the effect of changes in the inputs (geographical data and decision makers' preference) on the outputs (ranking of alternatives). The sensitivity analysis can be thought of as an exploratory process by which the decision-makers achieve a deeper understanding of the structure of the problem. It helps to establish the interaction between the various decision elements in order to determine the most preferred alternative.

In case of site selection for hazardous waste landfill a detailed site investigation program will comprise of subsoil investigation, ground water/ hydrogeological investigation, hydrological investigation, topographical and geological investigation, air quality data, public acceptance *etc.*

Ranking

Ranking technique involves the rank of decision factors in their relative order of importance. If there are 'n' decision factors, rank ordering would involve assigning the value of 1 to the most important factor, 2 to the second important factor and so on. This process could be reversed also. Scaling, rating, or ranking of each alternative relative to each decision factor is the second major component in the decision making approach (Canter, 1996).

Weighing method (also known as simple additive weighing method) or scoring methods are based on the concept of a weighted average. The weights are directly assigned to each attributes based on their relative importance. A total score is then obtained for each alternative by multiplying the importance, the weight assigned for each attribute by the scaled value assigned to alternative on that attribute, and summing the products over all attributes. When the overall scores are calculated for the alternatives, the alternative with the highest overall score is chosen.

Government of India, Ministry of Environment and forests, MoEF has noted following methodology for ranking of site alternatives:

- a) Select attributes for evaluation of site alternatives
- b) Apportion a total score of 1000 between the assessment attributes based on their importance through ranked pair wise comparison technique
- c) Develop site sensitivity index (SSIs) using Delphi technique
- d) Estimate score for each attributes for various candidate sites alternative using SSIs
- e) Add the score for individual site alternatives, to the rank alternatives based on the total score

Decision Making

In the hierarchical options of site selection framework, decision making is the last but the important step because, it helps in decision making at various levels including the Government, the industry, the regulatory authorities and the general public. The Government can develop policies and plan for implementation. The industrialist can identify the most suitable industrial site, matching both environmental and socio-economic considerations. Regulatory authorities can plan better pollution control and monitoring programmes and speed up the sanctioning of industries. Thus, the decision making process involves all the stakeholders concerns and reflect and represent them in some manner while developing the protocol.

In the process of decision making, GIS could play a vital role. But, GIS alone may not be sufficient for complete decision making. Along with GIS, spatial decision support system (SDSS), multi-criteria decision analysis (MCDA) technique, decision support system (DSS) can be incorporated to get realistic decision for the problem. Commercially available GIS systems tend to focus on supporting the first phase of the decision-making process. These systems offer unique opportunities to tackle more efficiently and effectively problems traditionally associated with data collection and analysis. They play an important role in the initial stage of decision making by storing and managing large amount of spatial data and information, and retrieving it whenever required.

As a result, it is suggested that by integrating appropriate decision support systems along with GIS platform, can possibly support the decision making process more

efficiently and meaningfully. A preliminary outline of process flow diagram for implementation of the site selection protocol is presented in **Figure 5.1**.

5.3 Important Steps and Procedure

The following tasks need to be performed, *i.e.* determination of site selection criteria, development of list of candidate sites and supporting information; filtration of selected sites and finally selection of site after evaluation and scrutiny.

GIS and other modern tools provide the facility of preparing different coverage of the selected attribute data. In GIS, by using buffering facility, unacceptable areas for hazardous waste site can be excluded. The **exclusionary criteria** adopted for the preliminary sites selection is presented in **Figure 5.2**.

Alternatives remaining after applying exclusionary criteria are then compared with each other on micro scale *i.e.* comparing each alternative based on their minimum cut off value. Considerations in the **non-exclusionary criteria** are given in **Figure 5.3**.

5.4 Precautions

A proper site selection process must be devoid of several mistakes, like inexperienced site selection team, inadequate budgetary and time frame, bad site selection data, influence from short term trends *etc.* The selected site after ranking of candidate sites should comply with the central and local government policies and regulations. Any discrepancy may lead to undue delay in the execution of the project and cancellation of the proposed site.

To make the process of site selection shorter and successful, the Department of Revenue and Land Records and the concerned Ministry in the Government of Bangladesh will have to be involved upfront so that the potential sites for setting up of the said TSDF could be identified with abundant care and the sites with questionable ownership titles and land record reservations would not appear in the list. It would be productive to ensure that the selected site after ranking of candidate sites should comply with the central and local government policies and regulations.

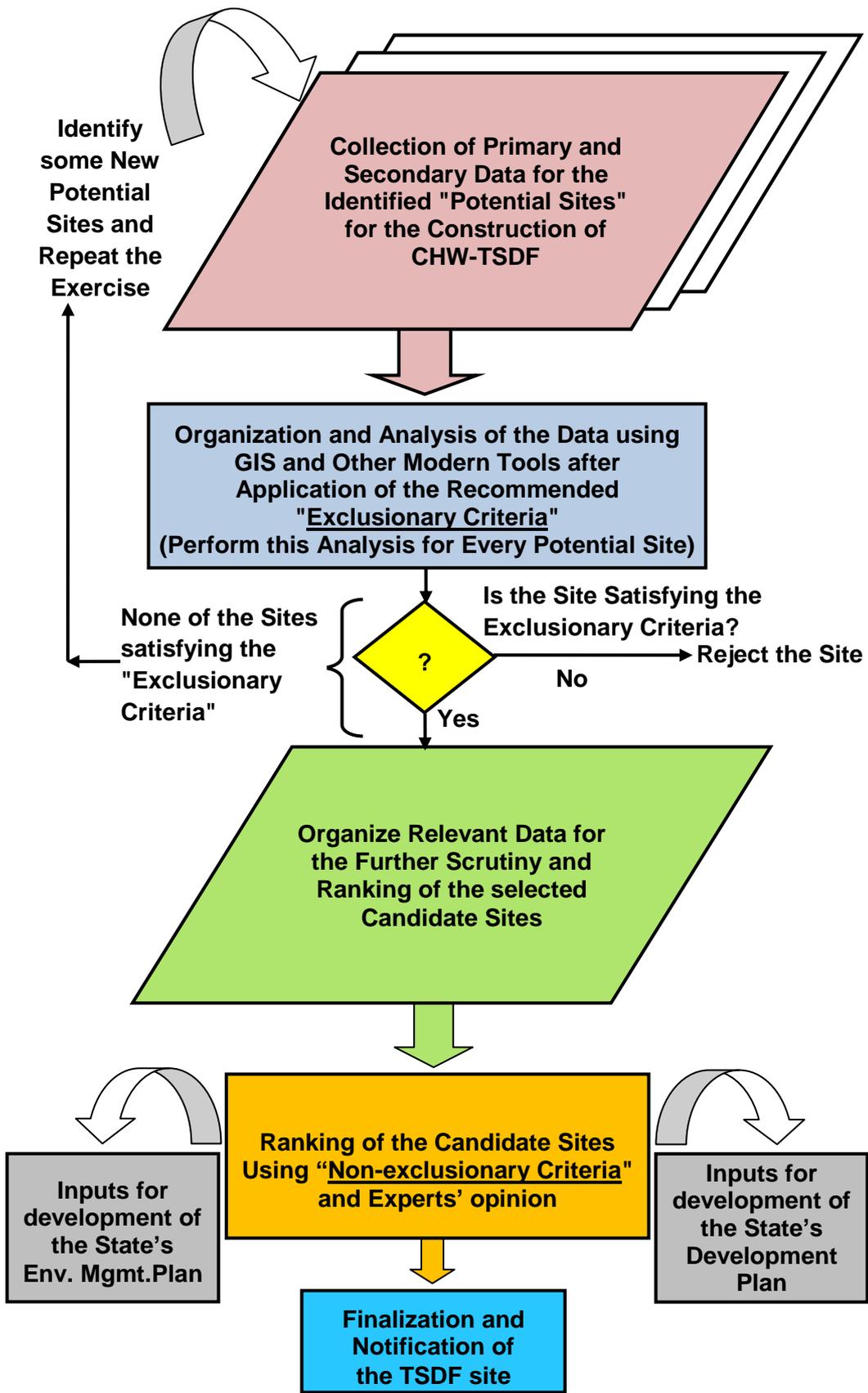


Figure 5.1: Process Flow Diagram for Implementation of the Site Selection Protocol

Elements of the “Exclusionary Criteria”

1.	Lake and Pond > 200 m
2.	River > 500 m
3.	Water supply well > 500 m
4.	Ground water level > 2m
5.	Wetland: Outside
6.	Flood plains > 100 years
7.	Urban development > 150 m
8.	Public parks > 500 m
9.	Highway > 500 m
10.	Historical or cultural sites > 500 m
11.	Habitation > 500 m
12.	Critical Habitat area: Outside
13.	Costal Regulatory zone: Outside
14.	Airports > 4000m
15.	Populated area > 2.5 km for population greater than 300,000
16.	Fault Zones > 80 m
17.	Land slope < 40%
18.	Road network accessibility < 1,000 m

Figure 5.2: Elements of the “Exclusionary Criteria” to be used for decision making during the preliminary screening of potential sites for development of TSDF

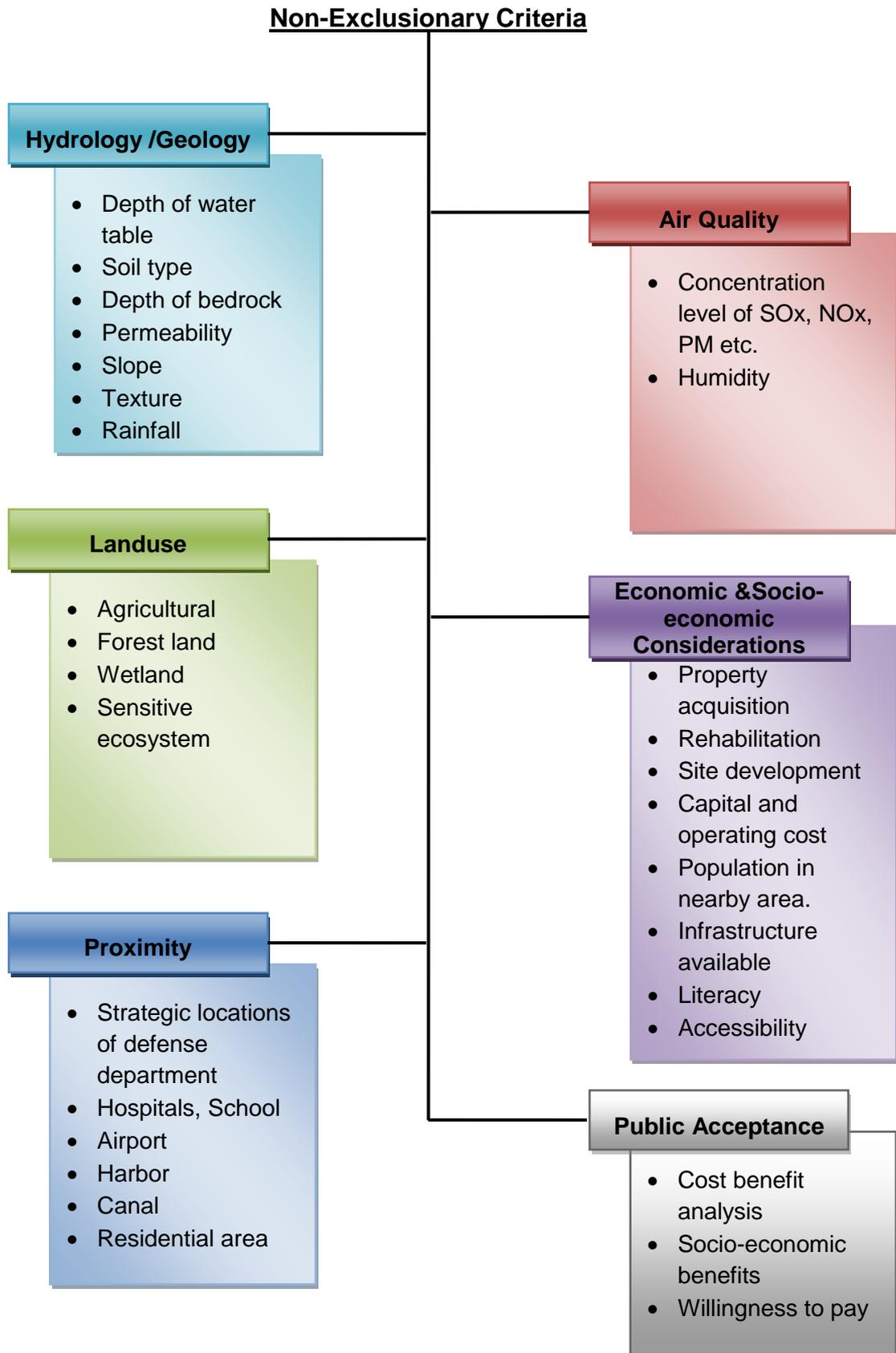


Figure 5.3: Essential Elements of Non-exclusionary criteria for ranking of the shortlisted sites for development of TSDf

Chapter 6

Steps and Procedures for Obtaining the Environmental Clearance Certificate in Bangladesh

EIA has been recognized as a basic environment management tool since it also helps to determine how and which preventive and mitigation measure should be taken during and after the formulation of a developmental project. The findings of EIA should be focused on the significant and essential issues, highlighting their relevance. The EIA process centers upon three core values of integrity, utility and sustainability.

6.1 Brief Description and Significance

Environmental Impact Assessment (EIA) can be viewed as a tool capable of guiding and harmonizing sustainable development. It can also be defined as an important management tool in order to ensure sustainability of the natural resources. It is a mandatory process before approval of any infrastructure project with a documentation of significant impacts on the environment (Zekeňáková and Zvijáková, 2017). EIA should clearly suggest potential impacts on environment, mitigation measures, monitoring and institutional measures to eliminate, compensate or reduce impacts to acceptable levels during construction as well as during the operational phase of the project (Panigrahi, and Amirapu, 2012).

EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures.

6.2 Input Data and Pre-requisites

Prior to EIA studies, the site selection has to be carried out as per site selection criteria and protocol. There is a requirement of "baseline data", which refers to the

collection of background information on the environmental, social and economic settings of the proposed project area. The establishment of baseline information is either through secondary sources when a database facility exists, or by field sampling. The task of baseline data formulation happens mostly during the scoping process and usually starts during the inception of the project. The process includes establishment of both the present and future status of the environment, in the absence of the project, taking into account the changes resulting from natural events and from other human activities (Glasson *et al.*, 2013). Establishment of a baseline will help in providing changes occurring due to the proposed project and will also aid in detecting actual change by monitoring once a project has been initiated. When establishing a baseline, information is gathered on:

- ✓ current environmental conditions;
- ✓ current and expected trends;
- ✓ effects of proposals already being implemented; and
- ✓ effects of other foreseeable proposals

6.3 Important Steps and Procedure

The step-wise detail procedure for EIA has been depicted in **Figure 6.1**. According to the Environment Conservation Act, 1995 and Environment Conservation Rules, 1997 of Bangladesh, environmental critical activities like chemical and industrial units which generate toxic wastes, waste disposal techniques like landfilling, incineration are all categorized under 'red category' projects which require an Initial Environmental Examination (IEE) for site clearance and an Environmental Impact Assessment (EIA) for environmental clearance. Hence it would be logical to categorize the Treatment Storage Disposal Facility (TSDF) in the red category industry.

The steps involved and the timeline for obtaining Environmental Clearance Certificate are explained in **Figure 6.2**. Screening is the very first step in EIA process which is undertaken by the Department of Environment (DOE) in Bangladesh. As the construction of Hazardous Wastes TSDF is expected to fall under "Red Category" industries, therefore, it would be mandatory to carry out preliminary environmental studies (i.e. Initial Environmental Examination) prior to detailed EIA studies.

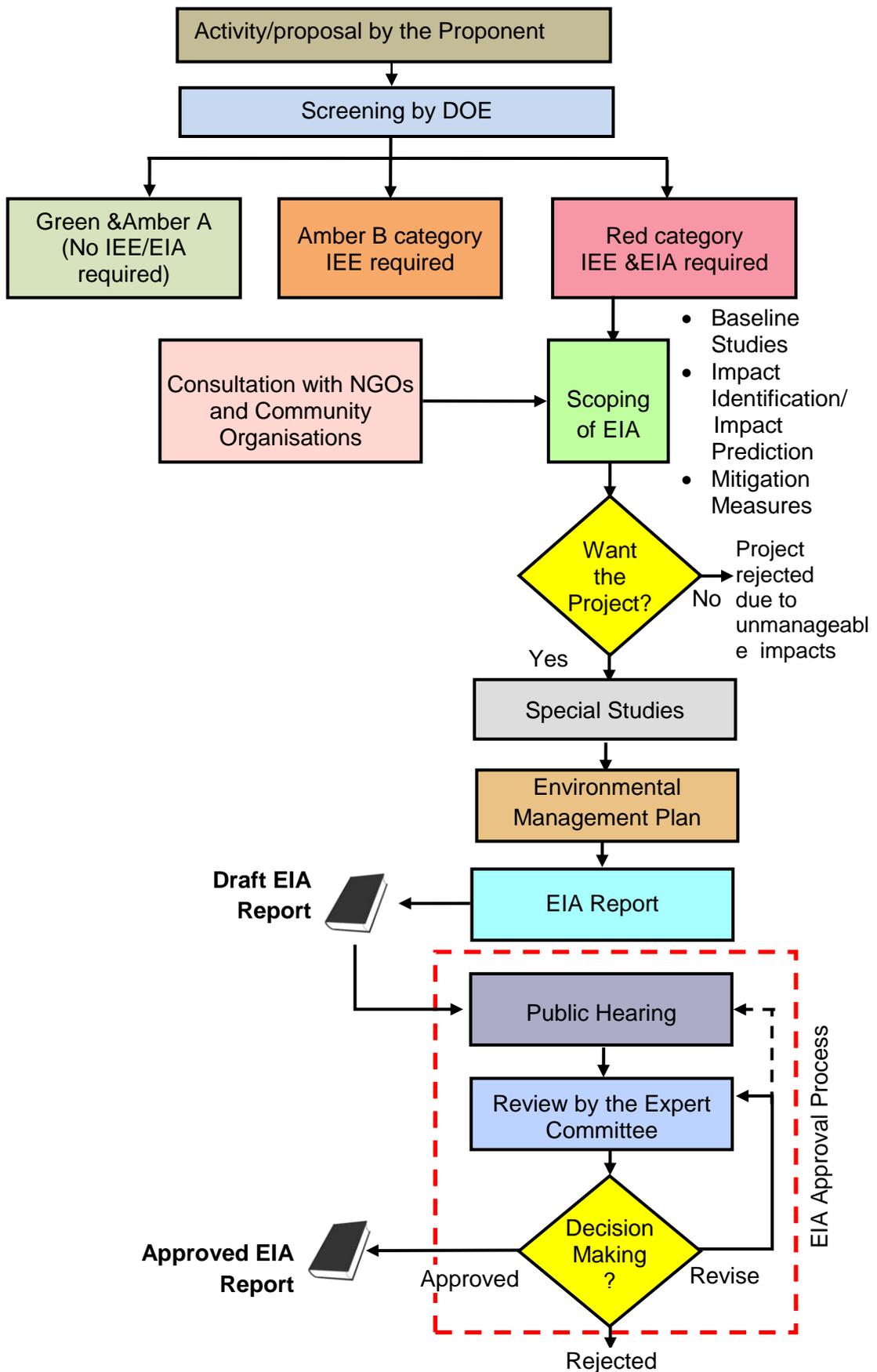


Figure 6.1: Process Flow Diagram for Steps to be Undertaken During the Course of "Environmental Impact Assessment" (EIA)

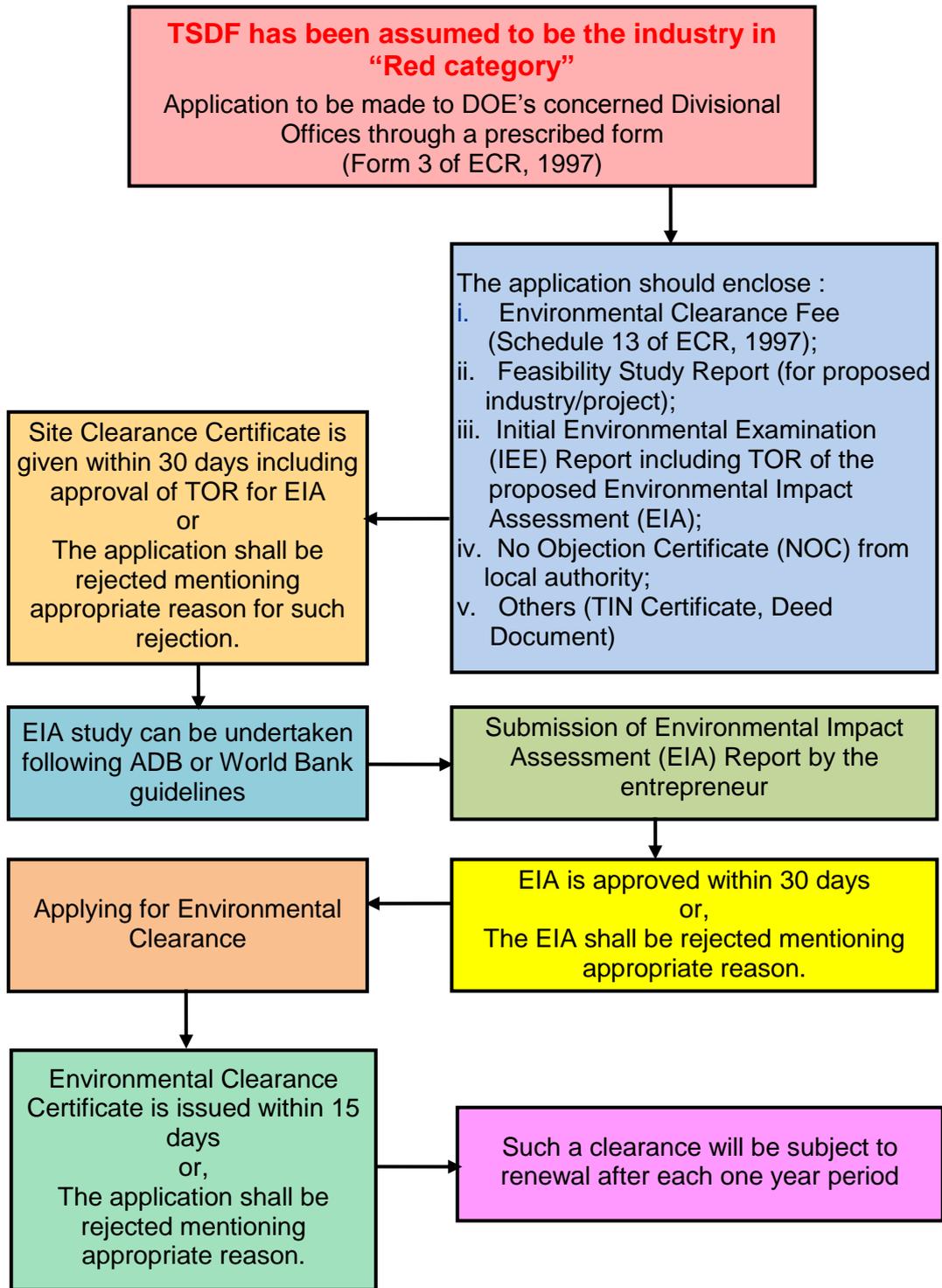


Figure 6.2: Steps Involved for Obtaining Environmental Clearance Certificate for Red Category Projects (Section-7 of ECR, 1997)

Typically, the EIA study focuses on addressing the issues that remain unresolved during the IEE exercise. It involves major components such as scoping, impact assessment, mitigation measures, monitoring programme, special studies if applicable (for instance risk assessment, resettlement and rehabilitation studies, compensatory forestation etc.) and documentation and communication. Possible environmental impacts are identified in the “Scoping step” after due consultation with NGOs and community organizations. The final stage of EIA involves review by the expert committee and public hearing.

Finally, it should be understood that the methods and procedures associated with EIA are different in different countries and regulatory regimes. Also, there is a tremendous variability in the expectations related to EIA of different sectors. The guidance given in this chapter on methods and processes related to EIA of the CHW-TSDF project has many limitations because of the effort of focusing the attention on EIA as per the red category industry in Bangladesh and particularly for a TSDF project between different sectors. Clearly, it would be productive to be more informed about the different methods and considerations in EIA in different countries and different sectors. With such broad lateral knowledge, one can possibly monitor (or perform) the processes in EIA for the TSDF project in Chittagong in an authoritative manner rather than adopting a mechanistic "procedure-oriented" approach. In the interest of limitations of space and organization of the main report, a standalone elaborative description on EIA has been presented in **Appendix 11**.

6.4 Precautions

The timeline for the execution of various steps in EIA studies has to be strictly followed by the authorities in order avoid delay in project execution. There should be full and active participation of the people within the project impact area at all the steps of the EIA procedure. The need for consultation with the representatives of the concerned ministries, donor groups and agencies, and other interested local parties has to be well understood. Lack of public consultation may lead to further delay (due to any public protest in future).

Chapter 7

Development Project Proforma (DPP)

The Development Project Proforma (DPP) is required in order to initiate the processing and to obtain subsequent approvals for the development project. This is a mandatory legal requirement of the Government of Bangladesh to be fulfilled at the outset. The DPP submission is made after the “Feasibility Study Report” is formally prepared and available with the Project Proponent.

7.1 Brief Description and Significance

DPP basically contains two parts, a brief summary and a detailed description of the project. In the primary formulation stage, the preliminary studies along with their necessity should be focused upon and in the detailed formulation stage each and every specific section of the project need to be explored so that the Approving Authority can scrutinize and evaluate the proposal and make a decision accordingly. Without a Development Project Proforma (DPP) a project cannot get approved in Bangladesh.

7.2 Input Data and Pre-requisites

Assessment of the project proposal could become possible only after relevant information is gathered and special studies are undertaken, if deemed necessary by the Project Proponent. This includes information about the Project Implementing Authority, the specific scope and objectives of the Project, description of the Project, time line, estimated costs, data on the selected site, *etc.* The special studies may focus on the operational issues of the proposed Development Project including potential environmental and ecological impacts of the Project and the corresponding mitigation measures, risk analysis and cost-benefit analysis.

7.3 Important Steps and Procedure

Manuals (Guidelines for DPP Part-1, 2014 and Appendixes for DPP Part-2, 2014) on preparing DPP should be followed and the DPP should be prepared as per the guidance available in the documents referenced earlier. Further, the approval of the proposed *Development Project* shall be handled by the empowered ministry or Agency on the basis of the submitted DPP on the said Project.

7.4 Precautions

It is extremely important to fulfill the requirements of preparation and presentation of DPP to the concerned Governmental Authorities in a timely manner and as thoroughly as one can. This is a mandatory requirement and any delays on this front may cause huge time and cost over-runs to the project.

Chapter 8

Detailed Project Report (DPR)

Subsequent to the preparation of DPP (as discussed in Chapter 7) and getting it approved from regulatory authorities of the Government of Bangladesh, the next task would be the preparation of the Detailed Project Report (DPR). The logical question to be asked in this context is when this DPR preparation should start? As depicted in figure 2.1, it is suggested to prepare the DPR after the approval of DPP by the Government Authorities. DPP is a statutory requirement for all the developmental projects of Bangladesh, therefore, it is recommended to perform all the activities such as DPR preparation and tendering process after the approval from the government.

8.1 Brief Description and Significance

Detailed project report is considered as a complete document that is meant to be used for making decisions for investments, preparation of Tender Document and also by the bidders during the process of tendering.

8.2 Input Data and Pre-requisites

Inputs of feasibility study and environmental impact assessment are required for creating an infrastructural plan, technical, financial and business model for the proposed project. A lot of data and information are obtained from the feasibility study report and EIA. The information includes site specific data such as subsoil investigation, ground water/ hydro-geological data, hydrological investigation data, topographical and geological investigation data, air quality data, public acceptance *etc.*

Infrastructural data acquisition including water supply, power supply, accessibility, and applicable regulatory laws and regulations will also prove to be important inputs for the preparation of the DPR.

8.3 Important Steps and Procedure

Preparation of DPR is one of the crucial steps in implementation of CHW-TSDF project (**Figure 8.1**). It is interesting to note that DPR is not a single document but a compilation of several documents. It involves the complete documentation of technical, financial and legal aspects of the project. One of the very important questions in this regard is “have all the relevant project costs been accounted for in addition to costs of physical construction works?” For example, **Table 3.3 and 3.4** are giving the design basis and construction costs of TSDF. Is it resolved that there are no other construction costs that are not accounted for? Further, what may be the other cost heads that have not been included in the above costs? Therefore, it is quite important to consider all the cost elements and assumptions (rates, methods of calculations, *etc.*) in the DPR. The preparation of DPR can be broadly classified into following steps:

- a) Collection of primary and secondary data from the previous studies (feasibility study and EIA).
- b) Basic processes and design specifications and implementation schedule. This will include details about the technology alternatives and selection for treating hazardous wastes, materials of construction, quality assurance during construction, design layout and land requirement, *etc.* It is necessary to incorporate the project implementation schedule in the DPR.
- c) Estimate budgetary costs for the proposed project. The project (construction) costs should cover distinct elements. There should be budgetary cost estimation for land, civil, mechanical and electrical requirements, physical infrastructure, component-wise cost, environmental compliance cost, cost of surveys & investigations, cost of shifting utilities, cost of surveys & investigations *etc.*
- d) Estimation of operation and maintenance budget and staffing planning. This may include O&M costing, contact labor planning, safety management *etc.*
- e) Creating a Business Model for assessing the commercial feasibility of the proposed project. For that purpose, the reasonable estimates of the costs of offering the services using the TSDF will have to be meticulously arrived at.
- f) Special consideration including closure plan, capacity building, health and transport facility, rehabilitation and resettlement costs *etc.*

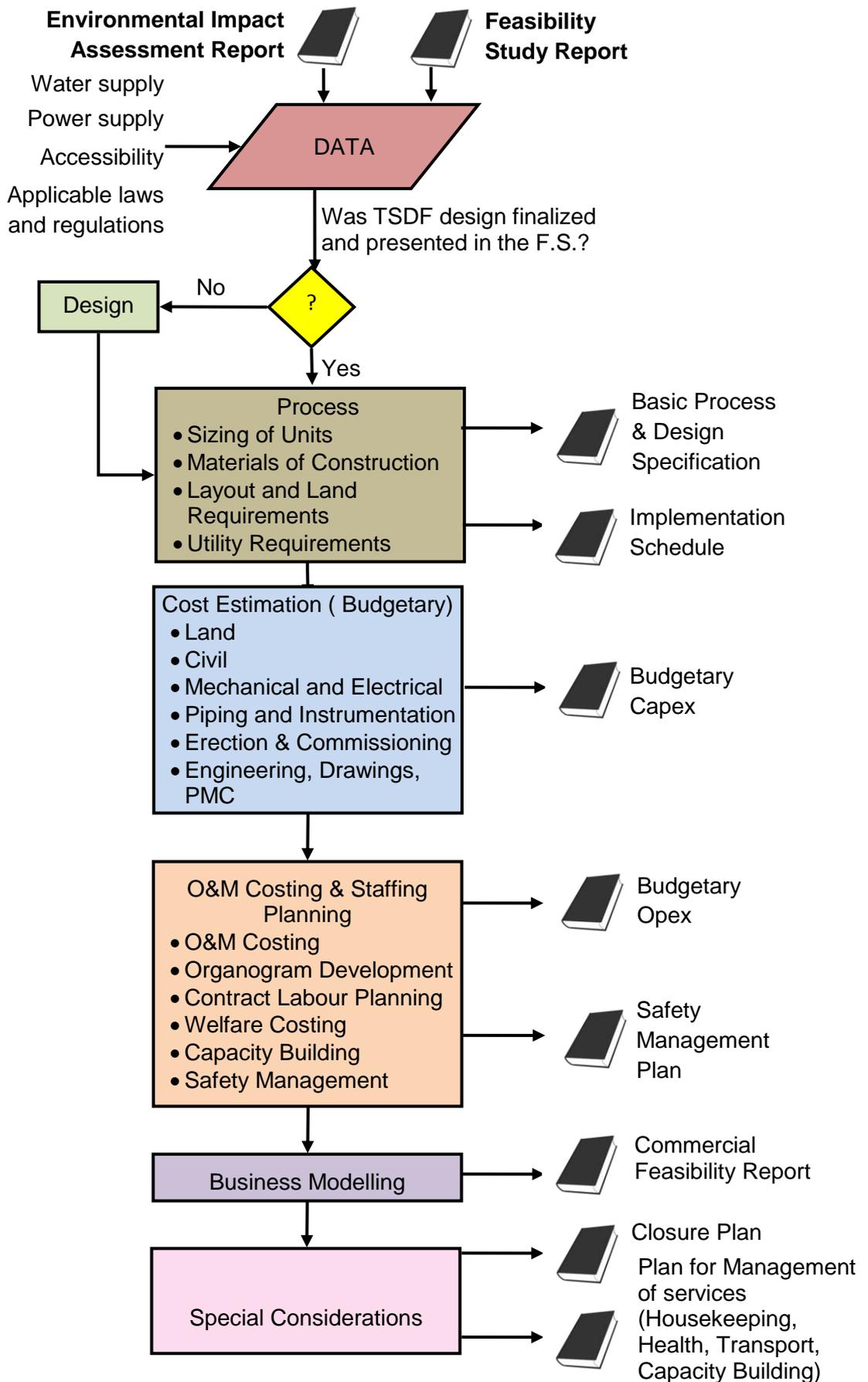


Figure 8.1: Process Flow Diagram for Preparation of Detailed Project Report (DPR)

Finally, it would be important to make sure that the consultant appointed for the development of the DPR should eventually include the ten essential elements in the draft DPR - which are listed in **Figure 8.2**

8.4 Precautions

Budgetary Capex and Opex should be estimated according to the existing economic conditions of the country. Post closure environmental liabilities and monitoring should also be taken into account while estimating the operation and maintenance costs.

The DPR is the most important document for planning the project followed by the implementation and execution of the project. Therefore, ample care should be taken while preparing the DPR to ensure the implementation of the project in a timely and efficient manner.

Essential elements to be included in DPR

-
1. Description of the proposed project including stakeholders and beneficiaries
(Data listed in properly organized appendices)
 2. Highlights of EIA and Selected Site
 3. Basic Process & Design Specification
 4. Implementation Schedule
 5. Budgetary Capex
 6. Budgetary Opex
 7. Safety Management Plan
 8. Commercial Feasibility Report
 9. Closure Plan
 10. Plan for management of services (Housekeeping, Health, Transport, Capacity Building)

Figure 8.2: Essential Elements to be Included in DPR

Chapter 9

Tender Document (TD)

Tender Document (TD) is an invitation for offers, which incorporates the sum of money, time and other conditions required to carry out the contractual obligations in order to complete a project, or a part of a project consisting of specified works.

Tendering process is initiated through the preparation of the Tender Document. In the context of construction, operation and maintenance of CHW-TSDF, the Tender Document invites an offer for the supply of service by competent contractors.

9.1 Brief Description and Significance

A typical Tender Document should include the following:

- 1) Prequalification Criteria indicating the Technical and Financial requirements. This will include the participating contractors' technical and financial capabilities including past experience of similar works.
- 2) The Tender Document should clearly specify the scope of the work for the contractor(s) as well as for the Project Management Consultant (PMC).
- 3) General conditions of contract and general specifications are also given in the Tender Document. General specifications specify the class and type of work, quality of materials *etc.* Detailed description of each item of work including materials and methods to be used along with quality of workmanship required must be provided.

9.2 Input Data and Pre-requisites

The preliminary activity during the preparation of the Tender Document happens to be the collection of all relevant and required data from the Detailed Project Report and Environmental Impact Assessment.

9.3 Important Steps and Procedure

The detailed procedure for preparing TD has been depicted in **Figure 9.1**. The different steps of TD preparation happen to be parallel and all data of DPR and EIA has to be incorporated during its preparation. The following important aspects must be included in the Tender Document:

- a) The notice inviting tender in specified forms
- b) Schedule of items of work with clear specifications
- c) General conditions
- d) Special conditions
- e) Layout plan, location of work
- f) Nearest road/railway link
- g) Set of drawings including working drawings
- h) Detailed specifications or reference to standard specifications for each item of work
- i) Rate of supply of power and the point of supply
- j) Location of water supply point
- k) Time for completion and the progress to be made at specified intervals of time
- l) Weather conditions in the area
- m) Amount of the EMD (*i.e.* Earnest Money Deposit) and the form in which it is to be paid
- n) Relevant financial and business related official documents as required by the legal procedure during the tendering process
- o) Amount of Security deposit to be paid/ deducted from running bills of contractors should be notified in the tender call notice
- p) Mode of payment for work done
- q) Organizational Chart of the tenderer
- r) Liquidated and un-liquidated damages

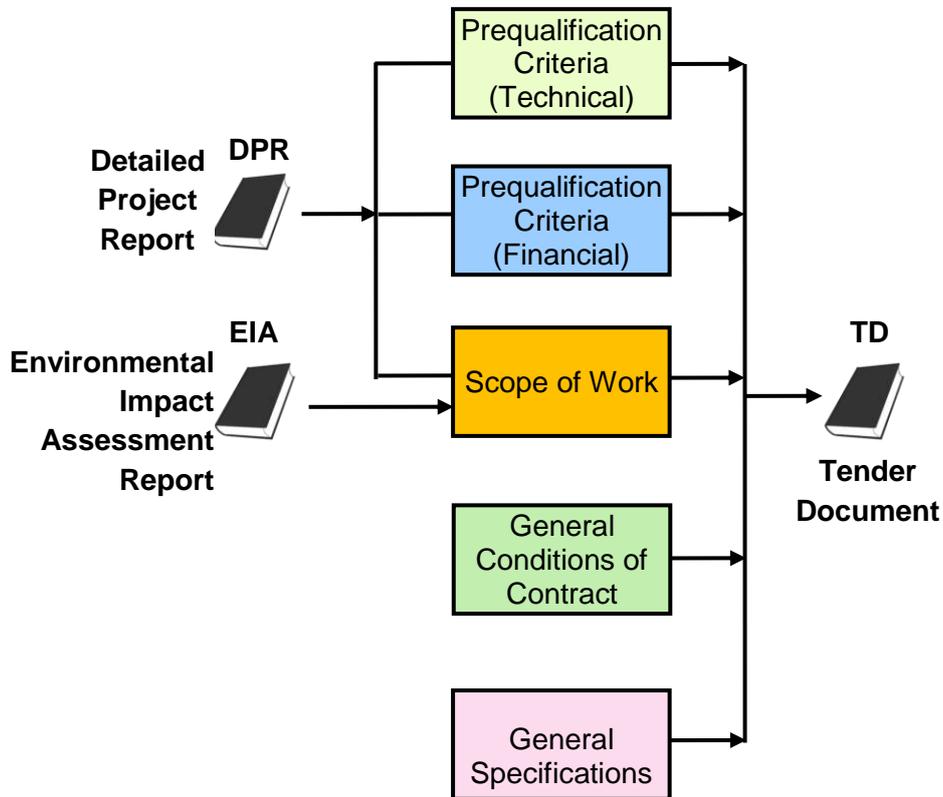


Figure 9.1: Process Flow Diagram for Preparation of Tender Document (TD)

9.4 Precautions

The Earnest Money Deposit is an important part of Tender Document (TD). It is the amount of money to be deposited along with the Tender Document to the department by the contractors quoting a tender. This money is a guarantee against the refusal of any contractor to take up the work after the acceptance of his tender. In case of refusal, this amount is forfeited. Thus it's vital so that the project will not get delayed at later stages.

The process of issuing the TD document should not be completed without including pre-qualification requirements and scope of work for the Project Management Consultant (PMC). Special conditions must be incorporated in the TD, which may include nature of the work, taxes and royalties included in the work, labor camp and amenities, compensations to labor in case of accidents *etc.*

Chapter 10

Tendering Process and Awarding

The Tender Document (TD) preparation has been highlighted in chapter 9. The subsequent activity will be tendering process followed by awarding and contracting. The Tenders are scrutinized for selecting the appropriate contractor for executing the proposed CHW-TSDF project. This chapter explains the activities of tendering and awarding of contracts.

10.1 Brief Description and Significance

In tendering and awarding process, typically the following steps would be adopted and followed:

- a) Preparation of Tender Document (as given in Chapter 9);
- b) Issue of notice inviting Tender;
- c) Technical clarification of the proposed project;
- d) Inviting and receiving proposals;
- e) Opening of the Tenders and Scrutiny of the received proposals; and
- f) Awarding the contract to the successful bidder whose proposal is accepted.

It is envisaged that the evaluation of Tender must be time bound and transparent so that the project execution happens in a prudent manner.

10.2 Input Data and Pre-requisites

The main pre-requisites for tendering process would be the Tender Document (explained in Chapter 9), DPR (explained in Chapter 8), and the approved EIA report (explained in Chapter 6). The Tender Document, its' details and clarifications and central and local legal norms have to be strictly adhered to while the contract has been finally awarded to the selected party and during the execution of the contract.

10.3 Important Steps and Procedure

The process of tendering and awarding has been basically categorized into two phases. The **First stage** comprises of issuing of the Tender Document, site visit, offering of the technical clarifications to the potential bidders and receipt of offers/bids. The **Second stage** includes scrutiny of the offers received from the bidders leading to selection of contractor(s) and award of contracts. The above two phases are presented in **Figure 10.1**.

Figure 10.2 depicts the **Second stage** in further detail. The “**contract documents**” for the selected project contractor and the selected Project Management Consultant will be prepared and legally awarded at the end of the contracting procedure.

Once the offer given by the selected bidder (*i.e.* aspiring contractor) is accepted, a legal agreement with the help of mutually agreed “contract document” should be entered by both the parties (*i.e.* the Project Proponent and the selected contractor) by following due diligent legal process.

10.4 Precautions

The parties competing for the award of contract should have the required organizational structure with experienced manpower, technical expertise and required financial resources. Ensuring the capacity of the party will guarantee that the project will not get delayed at later stages. It is highly recommended to carefully identify the expert agencies and individuals to evaluate the tender and understand the financial and technical capacity of the bidder. This will ensure the timely evaluation of the offers. The next chapter, namely, Chapter 11, is dedicated to describing the activities related to Construction and Commissioning of the CHW-TSDF. In summary, if the steps in tendering and finally the awarding of contracts are executed inefficiently, the construction and commissioning of the CHW-TSDF will get delayed.

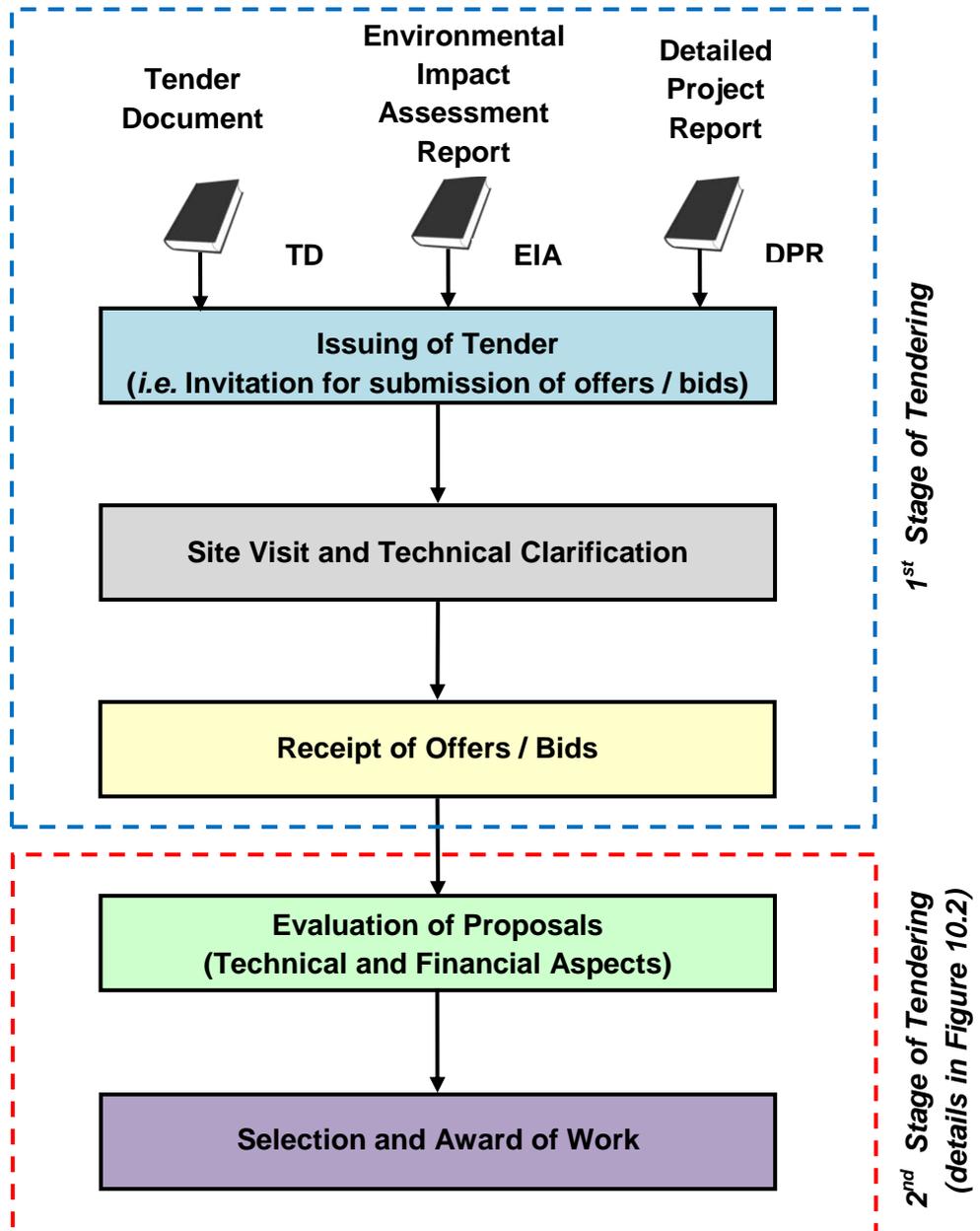


Figure 10.1: Process Flow Diagram for Tendering Process Comprising of Inviting and Receiving the Bids followed by Scrutiny of the Bids Aimed at Awarding of the Contracts

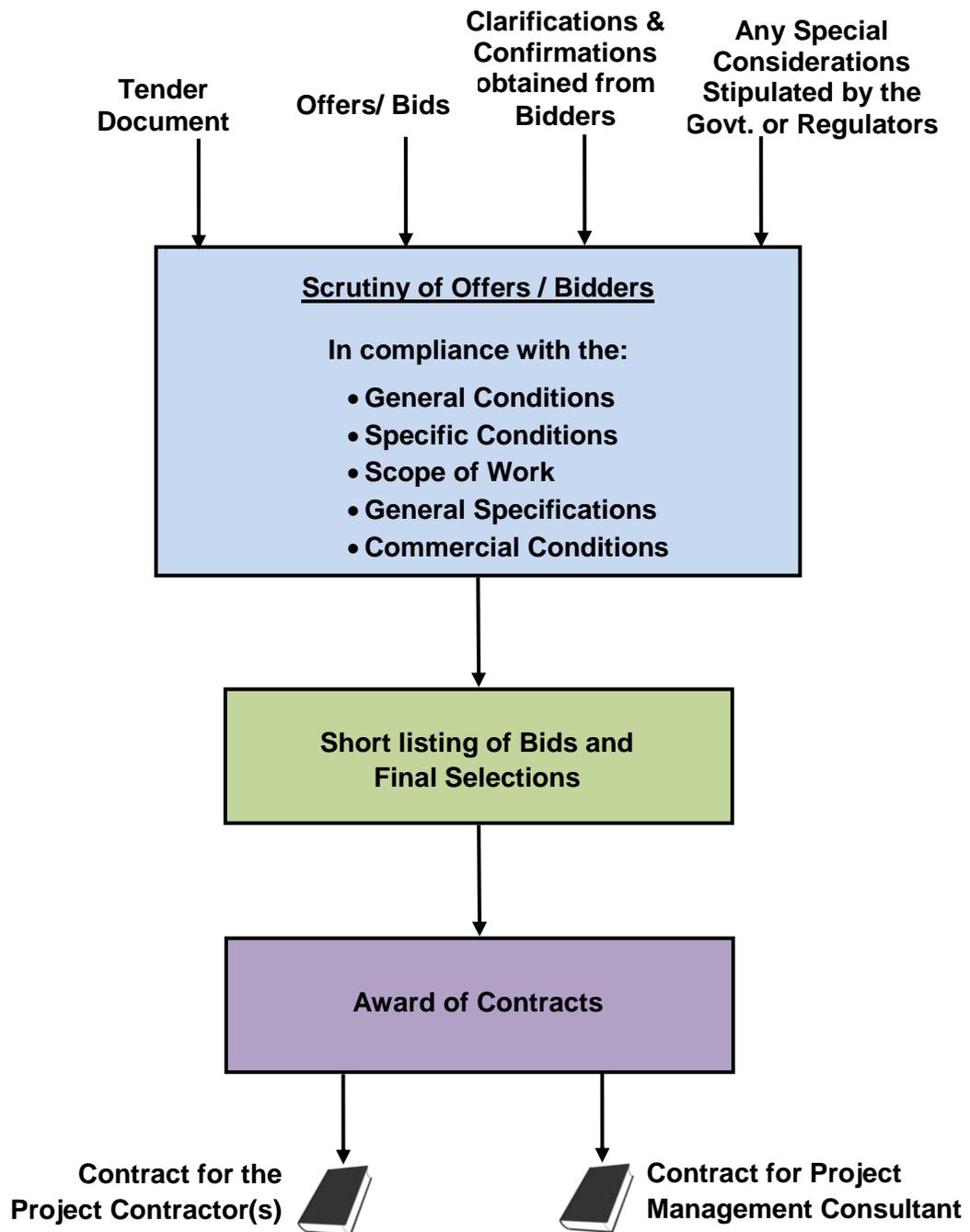


Figure 10.2: Detailed Process Flow Diagram for the *Second Phase* of the Tendering Process Culminating into Preparation of the Contract Award Documents

Chapter 11

Construction, Erection and Commissioning

TSDF project commissioning is the process of assuring that all the technical systems and components are installed, tested and operated according to the operational requirements of the contract. The Construction and Commissioning is an extensive process, which accepts input from contract documents and the construction drawings and details. The contract has to be signed between the government and the contractor(s) and should be in place for the construction activity to start.

11.1 Brief Description and Significance

The construction is to be carried out based on the good for construction drawings and documents issued under the government of Bangladesh. The work has to be carried out under the guidance and supervision of the Project Management Consultant (PMC). Drawings will be mutually agreed before commencing construction. In case of any discrepancy between the drawings and the contract document, the drawings will supersede the contract document and will be considered as final.

The main objective of commissioning is to ensure the secure and environmentally sound handover of the TSDF plant from the constructor to the operating agency, guaranteeing its operability in terms of its efficiency and performance. When the commissioning activity is executed in a planned and effective way, it normally represents an essential factor for the fulfillment of schedule, costs, safety and quality requirements of the project.

The construction and commissioning of a CHW-TSDF project involves a wholesome share of technical, financial and human resources. This process generally involves thousands of actions performed by individuals from all facets of the construction chain including manufacturers, distributors, suppliers, contractors, subcontractors, sub-sub-contractors, construction managers, consultants, allied professionals, project managers, developers, Project Proponent, government, end users, stakeholders *etc.*

11.2 Input Data and Pre-requisites

The construction of TSDf takes inputs from different stages of implementation depicted in Chapter 2. The Feasibility studies, EIA report, DPR, SSP provide inputs for initiating construction at the site. Final clearances from regulatory authorities are also made available. It could be desirable to start the ground preparation activities along with installing machinery and infrastructural requirements needed for the construction purposes.

11.3 Important Steps and Procedure

The important aspect of this chapter can be broadly categorized into four phases:

- I. **Planning for Construction Phase:** The construction and commissioning objectives are developed along with finalizing a commissioning plan. Schedule of quantities of work, set of drawings including working drawings, complete architectural and structural drawings will be made by the selected contractor. The details of materials, manpower and infrastructure should be planned in this phase. The final design submitted by the contractor is reviewed and approved by the PMC and the Project Proponent along with all other construction documents.
- II. **Construction Phase:** It includes the complete infrastructural development construction and erection, electrical, mechanical, piping and instrumentation works. Necessary commissioning scope meetings are held. There will be thorough review of all the relevant quality assurance and quality control (QA&QC) issues by the expert agencies and consultants engaged by the Project Management Consultant (PMC). It is important to note that the Project Proponent shall enter into a legal contract with the selected PMC right at the stage of entering the contract with the selected contractor.
- III. **Planning for Commissioning:** Planning for material, manpower and infrastructure required should commence sufficiently ahead of the completion of the construction phase so that there is no delay.
- IV. **Commissioning Phase:** The contractor will start and operate the TSDf under the conditions for the duration specified in the contract document. On demonstrating satisfactory performance fulfilling all contractual obligations, the contractor will hand over the TSDf to the Project Proponent.

The documentation of the entire activity has to be made so that it can be verified and approved.

11.4 Precautions

While the obligations of each party involved in the construction of CHW-TSDF are often detailed in the project documents and in various contracts, they are not always coordinated properly, which can lead to escalation of cost and delays in achieving substantial performance and total completion.

As stated earlier, in case of any discrepancy between the drawings and the contract document, the drawings will supersede the contract document and will be considered as final. Efforts should be made to have the set of drawings checked and validated by the Project Proponent as well as by the successful contractor(s) assigned the responsibility of construction and commissioning of project following the due formal process.

It is important to ensure that the contractor prepares the drawing and operation manuals on the basis of actual construction on ground and actual installation of the equipment. These drawings and the manuals will prove to be useful during the operation and maintenance (O&M) of the TSDF facility.

11.5 Budgetary Cost Estimates of the CHW-TSDF Project for 10 & 20-year Life

Budgetary Capital Costs for Construction of TSDF: It would be useful to recall that the *WP2b Report* published earlier as a part of the deliverables from Phase-I the SENSREC project was a kind of "Pre-feasibility study" - in which some of the approximate infrastructure and budgetary requirement were published. It was estimated that the plan area of nearly 8 hectares (i.e. 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong for the assumed life period of 10 years of the facility. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.3 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

Following the completion of the work for the WP2b report, an additional exercise for detailed cost estimation and budgeting was undertaken for comparing the land resources and funds needed for management of the TSDF for 20-year life period. **Table 11.1** depicts the budgetary estimates and footprints needed for establishing the proposed CHW-TSDF adequate for 10-year life and additional requirements for extending the life by another 10 years.

It is evident from Table 11.1 that for establishing the CHW-TSDF adequate for 10-year life, **USD 11.3 million** and the land area of **7.8 hectare (i.e. 19.3 acre)** would be required. However, if the TSDF life-span is to be extended by another 10 years an additional **USD 33.3 million** and an additional land area of **7.2 hectare (i.e. 17.8 acre)** will have to be invested after the first 10 years in order to construct and erect suitable additional landfills and replace the 10-year old incinerator by a new incinerator of higher capacity. It is interesting to note that the additional budget for extending life by 10 more years will have to be made available at the end of 10 years.

It may appear that nearly double area of land will be needed and far more funds will be required to extend life of the TSDF by another 10-year period. It would be instructive to understand the reason behind this fact. First of all, the cumulative quantities of wastes in landfillable as well as incinerable categories are not the same for the first 10-year and the next 10-year periods. As shown in Table 11.1, the life time capacities for landfillable wastes (compare 1a with 1b) as well as the incinerable wastes (compare 2a with 2b) corresponding to the next 10-year period are much larger than the first 10-years.

It is because the growth rates for ship recycling sector (annually 4%) and other industries (annually 6%) were uniformly used for both the 10-year periods. As a result, the second 10-year period had far more wastes and hence needed more land and more investment for both the categories of wastes. It is useful to note here that additional landfills need proportionate land and investment. However, the incinerable wastes would need a new incinerator having far higher capacity and therefore a high capital cost but it would not need a larger footprint. Lastly, one more escalation factor in the capital cost is on account of assuming an 8% annual inflation correction in the cost calculations while estimating the capital costs for the second 10-year period.

Table 11.1: Funds and footprints needed for establishing the TSDF adequate for 10-yr life and additional requirements for extending the life by another 10 years

Sr No	Type of Waste	Assumed Design Basis (Present Generation Rate) MT/yr	Assumed Design Capacity based on the appropriate growth rate (Lifetime Capacity) MT	Land and Funds Needed now for Construction of the CHW-TSDF having 10-year Life		Additional Land and Funds Needed after 10-yr for Extending Life of the TSDF by another 10 years	
				Plan Area in hectare	Funds Needed now in million USD	Additional Plan Area in hectare	Additional Funds Needed after 10 yrs in million USD
1a	Landfillable Wastes for the first 10-yr period	9,300	1,12,161	1.40	2.50		
1b	Landfillable Wastes for the next 10-yr period	9,300	1,67,597			2.10	6.57
2a	Incinerable Wastes for the first 10-yr period	19,900	2,55,379	1.50	6.84		
2b	Incinerable Wastes for the next 10-yr period	19900	4,35,383			1.50	20.99
3	Bilge water + Scrubber Effluents + Landfill Leachates	150 to 175 m3/d		1.00	0.47		1.38
4	Civil Work, storage and blending sheds, site development, green belt, infrastructure, chemical laboratory (modest), firefighting facility, etc.	Ballpark assumption		3.90	1.47	3.60	4.34
TOTAL =				7.80	11.28	7.20	33.28
				hectare	million USD	hectare	million USD

Note: These are the budgetary cost estimates for construction, erection and commissioning only. Other costs including costs for generating all the required documentation and reports in the initial phase of establishing the proposed CHW-TSDF and once more at the end of 8-years period in case of 20-year life of the project have to be accounted for separately.

Budgetary Costs for Conducting Various Studies and Investigations: In addition, initially, for obtaining the permission and approvals from the relevant Authorities and Agencies, certain investigations and assessments will be conducted. Those include EIA, hydro-geological and geo-technical surveys among several things. A detailed discussion has been presented in Chapters 4 through 9 of this report on the investigations that will be required and on the various reports and documents needed for obtaining permissions and for receiving bids from the prospective investors (project proponents).

It was well understood that, in addition to the construction and erection costs reported in WP2b Report, a variety of short term study and investigation projects will have to be undertaken in the process of the feasibility study, including site selection and EIA. Those investigations could cost a total USD 1.2 million. Further USD 1.0 to 1.2 million (typically 8-10% of the construction cost) should be budgeted for covering the unforeseen and difficult to plan expenses including duties, local taxes *etc.* The budget for appointing the Project Management Consultant (PMC) could be in the vicinity of 8-10% of the construction cost (USD 1.0-1.2 million). Finally, a budget of USD 1.2 million is estimated for covering contingencies and unforeseen expenses (typically 5-12% of the construction cost).

Thus, it is to be borne in mind that the above mentioned costs of USD 4.8 million will have to be budgeted for generating all the required documentation and reports in the initial phase of establishing the proposed CHW-TSDF – whether one intends to start a 10-year or a 20-year life project. However, in case the 20 year life for the facility was decided and a larger plot of land is provided for, then at the time of discarding the 10-year old incinerator and procuring and commissioning the new incinerator of higher capacity, the Department of Environment and the other relevant regulatory authorities will (most certainly) demand a new EIA and some more investigations.

Therefore, all the studies and investigations discussed above will need allocation of **USD 4.8 million** up front – irrespective of a planning of TSDF for 10 year life or 20 year life.

Further, if a 20-year life span is to be planned, additional studies and permissions may be required by the Governmental Agencies or Regulators. Therefore, after 7 to 8 years, for obtaining the permissions for extending the life by 10 years, the relevant Authorities and Agencies will have to be consulted and the required investigations

and assessments will have to be conducted. That activity will span approximately another 18 months period and a careful planning and execution of those investigations and paperwork will have to be completed ahead of time. A rough estimate for those investigations and report preparation, funds to the tune of USD 2.5 million (according to today's consultation and service fees) may be required. Therefore, for conducting the studies and investigations after 10-years from now, the allocation of **USD 4.5 million** will have to be made in case of the TSDF with 20-year life-span (after taking into account 8% inflation in 10 year period from now).

Discussion on the Costs Reported in This Study: As reported above, for establishing the CHW-TSDF adequate for 10-year life, **USD 16.1 million** and the land area of **7.8 hectare (i.e. 19.3 acre)** would be required to conduct all the required studies and investigations and for construction and erection of the facility. However, if the TSDF life-span is to be extended by another 10 years; additional **USD 37.8 million** and the additional land area of **7.2 hectare (i.e. 17.8 acre)** will have to be invested at that time in order to conduct all the required studies and investigations at that time as well as for construction and erection of the suitable additional landfills and replace the 10-year old incinerator by a new incinerator of higher capacity.

The silver lining to this is the fact that the investment for the facility having 20-years life can be established right away with USD 16.1 million and the additional USD 37.8 million investment will have to be made at the end of 10-years of operation. By then, both, the operator of the CHW-TSDF and the Regulating Authorities as well as the BSRB (or any SPV) would have gained enough insights into the process technology and economics of hazardous waste management by the virtue of the experience of 7-8 years and all the concerned stakeholders would have better competencies.

As a result, a better, cost effective, suitable incinerator with hopefully improved technology and smaller environmental and energy footprint could be possibly available and the new incinerator will be better from the business perspective.

If the Government of Bangladesh makes a decision to establish the CHW-TSDF for 20-year operating life, the concerned authorities will have to simply provide for a footprint of 15 hectare (i.e. 37.1 acre) land instead of 7.8 hectare (i.e. 19.3 acre) that is needed for establishing the facility having 10-year life.

In sum, neither more funds nor additional efforts are needed today for planning 20-year life project. One needs to simply identify and notify a 15 hectare (*i.e.* 37.1 acre) plot of land and the investment of USD 16.1 million will be good enough to start the facility right away.

Chapter 12

Recommendations for the Project on Creation of CHW-TSDF

12.1 Highlights of the Pre-feasibility Study

The inventories of hazardous wastes generated from the ship recycling industry in Chittagong as well as from the surrounding industrial areas were developed through a survey under Work Package-2 (WP2) of the Safe and Environmentally Sound Ship Recycling (SENSREC) Project. As published earlier in the *WP2a Report*, the estimates of hazardous wastes generated by the ship recycling yards and from other industries in Chittagong region, over the 10 years lifetime of the proposed TSDF, would be 255,500 MT of incinerable wastes and 112,300 MT of landfillable wastes.

It was evident from the breakdown, after the inventory (*WP2a Report*) assessment that the ship recycling sector has been producing sizable and comparable quantities of landfillable and incinerable wastes. On the other hand, the industrial sectors cumulatively generate comparatively negligible landfillable wastes and large quantities of incinerable wastes.

It is important to note that the annual growth rate of 4% (for growth in compound proportions) was assumed for the ship recycling sector and 6% annual growth rate was assumed for the industrial sectors and the appropriate multiplication factors were used to estimate the cumulative quantities of wastes to be subjected to the proposed TSDF over the life-time assumption of 10-years of the facility.

It was estimated that the plan area of nearly 8 hectares (*i.e.* 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.5 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

In summary, the earlier published *WP2b Report* has made a kind of "Pre-feasibility study" available at the outset of undertaking the tasks outlined in the current Work Package-5b (*WP5b*).

12.2 Essential Institutional Mechanism and Empowerment

In order to make the proposed CHW-TSDF project in Chittagong successful, some of the critical functions will have to be assigned to empowered agencies and certain enabling mechanism will have to be put in place by the concerned Ministry of the Government of Bangladesh. It appears that there are four most important interventions required for engaging all the stakeholders of the project and making critical and significant decisions in a timely manner. Therefore, the concerned Ministry will have to address the following four tasks: (a) creation of an empowered agency to perform the facilitation and governance functions within the framework of the government, (b) identification of competent Project Proponent who would engage with the government in the capacity of an entrepreneur or service provider, (c) articulation of business model for the service provider so that the competent and professional entities can be attracted and (d) formulation of a suitable legal agreement for regulators to ensure desirable performance for environmental protection. A brief account of the above four tasks and the nature of empowerment is described below:

a) Creation of Special Purpose Vehicle: Creation of the "Special Purpose Vehicle (SPV)" is the essential step that should be undertaken before initiating any activity in the proposed TSDF project in Chittagong. It is envisaged that the SPV would serve as the "one window" facilitating agency appointed by the concerned Ministries in Government of Bangladesh for initiating and navigating all the necessary steps during the course of implementation of Phase II of the SENSREC project. The SPV could be a standalone agency empowered by the concerned Ministries in the Government of Bangladesh. For example, the planned establishment of the BSRB (*i.e.* Bangladesh Ship Recycling Board) may prove to be most effective in carrying out of the functions of the "one window" facilitating agency (*i.e.* SPV).

b) Identification of Competent Project Proponent: It is envisaged that the "Project Proponent" will have to be identified for setting up of the TSDF as well as for operation and maintenance of the facility. This can be achieved in several ways. For example, the Project Proponent could be appointed by the concerned Ministry in the Government of Bangladesh and the individual (or group) should be empowered for the creation and operation of the facility. In such event, the concerned Ministry will carefully choose and empower the team members having critical, complementary and significant competencies related to construction, erection, commissioning and operation and maintenance of the proposed TSDF project in Chittagong.

Alternately, the Project Proponent could also be a private enterprise having relevant experience and enthusiasm for establishing and operating the said TSDF project. A formal process will have to be followed, through which, the most suitable bid shall be accepted and legally contracted for the construction, erection, commissioning and operation and maintenance of the proposed TSDF project.

c) Articulation of Business Model: The concerned Ministries and Departments in the Government of Bangladesh, with inputs from UN Specialized Agencies (UNIDO, UNEP, BRS), have the paramount responsibility for setting-up the "rules of game" by first making a resolution about SPV and secondly by articulating the "Business Model". If the project is started with a collectively developed and agreed "business model" for establishing the CHW-TSDF in Chittagong, there will be a win-win situation for all the stakeholders. It is strongly recommended that a private enterprise aspiring to own and operate (Project Proponent) a commercial TSDF should be mandated to contribute 25% as their collateral at the outset to ensure the commitment to the TSDF.

During the operation and maintenance phase of the said TSDF, it would be desirable that the tariff for pre-treatment, incineration or landfilling of hazardous wastes should be mutually agreed by SPV, Project Proponent and the generators of the wastes (including Bangladesh Ship Breakers Association and other industries).

d) Formulation of the Targeted Regulatory Instrument: The Project Proponent should ensure that the setting up and operating the said TSDF does not violate any laws and regulations of the land. It will also be necessary for the Government of Bangladesh to ensure that the hazardous waste generators (ship recyclers and other industries) will be held responsible for sending their wastes to the CHW-TSDF. In order to facilitate the regulatory process some dedicated and directed legal instrument (for example Government Resolution, Gazette Notification, Ordinance, Legal regulation or amendment to the existing law) should be formulated. It will not only ensure the prevention of environmental damage due to hazardous wastes but will also ensure the success of the proposed business model.

12.3 Data Collection and Special Studies

It is extremely important to collect the required data through secondary sources or by commissioning certain studies for collecting the targeted data. If the data collection

would not be undertaken up-front in the Feasibility Study phase, the tasks outlined related to selection of site as well as EIA would get delayed.

It would be advisable to conduct study on the following ten topics:

- I. Topographical Data using Digital Surveys
- II. Coastal Zone and Flood Maps
- III. Seismological Data
- IV. Meteorological Data
- V. Soil and Geotechnical Survey
- VI. Ground Water and Hydrogeological Survey
- VII. Background Environmental Parameters
- VIII. Biodiversity and Data on Biological Environment
- IX. Traffic Survey and Transportation Planning
- X. Socio-economic Aspects of the Project

12.4 Environmental Impact Assessment of the selected Site

There are two important tasks that are to be undertaken during the process of site selection; namely: (a) Articulation of site selection criteria and protocol and (b) Identification of the " Suitable site" for establishing the "Common Hazardous Waste Treatment, Storage & Disposal Facility" (CHW-TSDF). However, to make the process of site selection shorter and successful, the Department of Revenue and Land Records and the concerned Ministry in the Government of Bangladesh will have to be involved upfront so that the potential sites for setting up of the said TSDF could be identified with abundant care and the sites with questionable ownership titles and land record reservations would not appear in the list. It would be productive to ensure that the selected site after ranking of candidate sites should comply with the central and local government policies and regulations.

According to the Environment Conservation Act, 1995 and Environment Conservation Rules, 1997 of Bangladesh, environmental critical activities like chemical and industrial units which generates toxic wastes, waste disposal techniques like landfilling, incineration all are categorized under 'red category'

projects which require an Initial Environmental Examination (IEE) for site clearance and an Environmental Impact Assessment (EIA) for environment clearance. Hence it would be logical to categorize the Treatment Storage Disposal Facility (TSDF) in the red category industry. Therefore, it is recommended that both the "Initial Environmental Examination (IEE)" and "Environmental Impact Assessment (EIA)" be performed with the help of competent consultant.

It is strongly recommended that the so-called "public hearing" be organized to ensure open discussion and transparent decision making in the presence of people within the project impact area before approving the environment management plan (EMP) proposed and benefits proposed of the Project Proponent.

The timeline for the execution of various steps in EIA studies has to be strictly followed by the authorities in order avoid delay in project execution. The Department of Environment (DOE) of Government of Bangladesh has publicized the timeline for executing various steps in EIA, which is to be honored and adhered to by the Project Proponent in the interest of environment and the proposed project.

12.5 Fulfillment of the Mandatory Requirements during Implementation

Development Project Proforma (DPP) for the proposed CHW-TSDF project involves a standard format of government procedural format that is required to submit the project proposals to the competent authority in Government of Bangladesh. It is extremely important to fulfill the requirements of preparation and presentation of DPP to the concerned Governmental Authorities in a timely manner and as thoroughly as one can. This is a mandatory requirement and any delays on this front may cause huge time and cost over-runs to the Project.

DPR is the most important document for planning the project followed by implementation and execution of the project. Therefore, ample care should be taken while preparing the Development Project Report (DPR) to ensure implementation of the project in a timely and efficient manner. Budgetary capital costs and operating costs, Operating expenditure (Opex) and Capital expenditure (Capex), should be estimated according to the existing economic conditions of the country. Post closure environmental liabilities and monitoring should also be taken into account while estimating the operation and maintenance costs.

It is essential that the criteria for prequalification requirements and scope of work for the Project Contractor and the Project Management Consultant (PMC) should be carefully articulated in the Tender Document (TD). The parties (among the bidders) competing for the award of contract should have the required organizational structure with experienced manpower, technical expertise and financial capabilities. Ensuring the capacity of the party will guarantee that the project will not get delayed at later stages. It is highly recommended to carefully identify the expert agencies and individuals to evaluate the tender and understand the financial and technical capability of the bidder. This will ensure the timely evaluation of the offers.

The last but the most important steps during the implementation of the proposed TSDF project is construction and commissioning. In case of any discrepancy between the drawings and the contract document, the drawings will supersede the contract document and will be considered as final. Efforts should be made to have the set of drawings checked and validated by the Project Proponent as well as the successful contractor(s) assigned the responsibility of construction and commissioning of project following the due formal process.

12.6 Budgetary Cost Estimates

It would be useful to recall that the *WP2b Report* published earlier as a part of Phase-I deliverable from the SENSREC project was a kind of "Pre-feasibility study" - in which some of the approximate infrastructure and budgetary requirement were published. It was estimated that the plan area of nearly 8 hectares (i.e. 20 acres) would be required for establishing the proposed CHW-TSDF project in Chittagong for the assumed life period of 10 years of the facility. The budgetary cost estimate for construction, erection and commissioning of the proposed project worked out to be USD 11.5 million. It was also reported that the construction, erection and commissioning could possibly be managed in 18-24 months period by creating a dedicated team by the Government of Bangladesh to facilitate and monitor the project.

In addition to the above mentioned budgetary estimates, in the present study an attempt has been made to estimate the other project related costs (other than the construction and erection costs). It is well understood that, in addition to the construction and erection costs reported in *WP2b Report*, a variety of short term

study and investigation projects will have to be undertaken in the process of feasibility study including site selection and EIA. Those investigations could cost total USD 1.2 million. Further USD 1.0 to 1.2 million (typically 8-10% of the construction cost) should be budgeted for covering the unforeseen and difficult to plan expenses including duties, local taxes *etc.* The budget for appointing the Project Management Consultant (PMC) could be in the vicinity of 8-10% of the construction cost (USD1.0-1.2 million). Finally, a budget of USD 1.2 million is estimated for covering contingencies and unforeseen expenses (typically 5-12% of the construction cost). Therefore, all the studies and investigations discussed above will need allocation of **USD 4.8 million** up front – irrespective of a planning of TSDF for 10 year life or 20 year life.

In summary, for establishing the CHW-TSDF adequate for 10-year life, **USD 16.1 million** and the land area of **7.8 hectare (i.e. 19.3 acre)** would be required to conduct all the required studies and investigations and for construction and erection of the facility.

It may be interesting to note that the above stated budgetary estimates are based on the budgetary figures provided by several professionals and contractors performing similar activities in India in the field of large infrastructure projects including wastewater treatment facilities, municipal solid waste, hazardous waste, and bio-medical waste management facilities.

If the TSDF life-span is to be extended by another 10 years; additional **USD 37.8 million** and the additional land area of **7.2 hectare (i.e. 17.8 acre)** will have to be invested at that time in order to conduct all the required studies and investigations at that time as well as for construction and erection of the suitable additional landfills and replace the 10-year old incinerator by a new incinerator of higher capacity.

The silver lining to this is the fact that the investment for the facility having 20-years life can be established right away with USD 16.1 million and the additional USD 37.8 million investment will have to be made at the end of 10-years of operation. By then, both, the operator of the CHW-TSDF and the Regulating Authorities as well as the BSRD (or any SPV) would have understood the process technology and economics of hazardous waste management much more clearly due to 7-8 years of experience and all the concerned stakeholders would have better competencies by then.

As a result, a better, cost effective, suitable incinerator with hopefully improved technology and smaller environmental and energy footprint could be possibly available and the new incinerator will be better from the business perspective.

If the Government of Bangladesh makes a decision to establish the CHW-TSDF for 20-year operating life, the concerned authorities have to simply provide for a footprint of 15 hectare (*i.e.* 37.1 acre) land instead of 7.8 hectare (*i.e.* 19.3 acre) needed for establishing the facility having 10-year life.

In sum, neither more funds nor additional efforts are needed today for planning 20-year life project. One needs to simply identify and notify a 15 hectare (*i.e.* 37.1 acre) plot of land and the investment of USD 16.1 million will be good enough to start the facility right away.

PART 'B'

**Planning for Implementation of
the Training Modules**

Chapter 13

Planning for Implementation of the Training Modules

Phase II of SENSREC Project will also include the implementation of the training modules developed in Work Package 4 *i.e.* WP4a of Phase I. The WP4 activities were reported in two parts, namely: Parts ‘a’ and ‘b’. The first part of WP4 included a training needs’ analysis and thereafter the development of curricula for improved training modules on occupational health, safety and the environment to assist the implementation of requirements on the ship recycling industry to fulfill the directives given by the honorable High Court and also of relevant national and international requirements.

The second part of WP4 (WP4b) included the development of the necessary training materials; the piloting of this training materials through “training of trainers” sessions; and also the development of a strategy for sustainable training for the ship recycling. This strategy has been created through a combination of the ACS Consortium’s expertise and knowledge in vocational education and training provision and the unique insights gained in this projects training needs analysis phase and training piloting activities.

The WP4b report on “*Strategy for sustainable training for the ship recycling industry*” has presented a set of recommendations which are designed to assist and guide the responsible persons and appropriate authorities in creating a roadmap for implementing a sustainable training programme for the ship recycling industry in Bangladesh. Those recommendations have been extracted from WP4b Report authored by McKenna *et al.* and reported in this Chapter from Section 13.1 to Section 13.5, inclusive*.

13.1 Background

Bangladesh Ship Recycling Worker Estimates

25,000 to 40,000 full-time workers (SENSREC WP1 Final Report: *Contributions of Ship Recycling in Bangladesh: An Economic Assessment*) have been estimated to

* Extracted from WP4b Report, 'Strategy for Sustainable Training for the Ship Recycling Industry' authored by Stuart A. McKenna, Raphael Baumler and Rafet E. Kurt. (Final Version dated 20th December, 2016)

be working in the Bangladeshi ship recycling zone at any one time. The ship recycling and shipping markets as well as steel markets have considerable influences on the number of workers employed. Often employed by subcontractors, this workforce has been identified to be predominately migrants from other regions of Bangladesh and likely to enter and exit the sector frequently over time.

Consequently, the estimate of those active within the industry, and therefore required to be trained, could be potentially higher than the estimates once the high worker turnover rate is factored in.

Mandate for Ship Recycling Training

The Bangladeshi Honourable High Court has made the stipulation that all those employed in ship recycling activities require to be trained according to the following decree:

“A system of comprehensive training must be introduced to impart training to those who shall be employed for ship breaking activities. An Institute will be set up for the training purposes by BSBA at their cost for training such persons. The training period shall be at least 3 months duration. First 20 days shall be allocated for theoretical training, while the rest of the period shall be involved in practical vocational courses. No workers shall be allowed to be employed in the ship breaking yards without certificate showing completion of the course. (Honourable High Court Verdict on 6/4/11, regarding workers training)”

In WP4, Part I of the SENSREC project, this was interpreted into an approved curriculum which recommended:

- Theoretical training (in training facilities) of 3 weeks/15 days
- Practical vocational training (on the job training) of 47 days

For the theoretical training, eight modules were developed to be delivered over the course of 3 weeks:

- MODULE 1 - Ship Recycling Administration and Regulative Framework
- MODULE 2 - Job Hazard Awareness – Hazard and Risks
- MODULE 3 - Environmental Awareness
- MODULE 4 - Inventory of Hazardous Materials (IHM)
- MODULE 5 - Personal Protective and Safety Equipment
- MODULE 6 - Worker Wellbeing and Health
- MODULE 7 - Awareness and Handling of Hazardous Materials

- MODULE 8 – Vocational Education and Training

These modules are expected to be delivered in a mixture of classroom and practical based activities with the following minimum time recommended:

- Classroom activities for all workers (theory part 1):
 - Common training for all workers = 48 hours
 - 1 or 2 hours of theory for workers engaged in specific occupations (e.g. cutter team 2 hours and fitter team 1 hour)
- Practical activities for all workers (theory part 2):
 - One day on emergency escape, rescue and entry in enclosed spaces
 - Two days on fire fighting techniques
 - One day on first aid
 - One day on chemical/oil spill management
 - One day handling of hazardous material

Within this report, this information has been used as the reference point, baseline and justification for recommendations and the overall strategy for sustainable training.

13.2 Proposal for Comprehensive Supervision of Training

Ship Recycling Subcommittee on Training and permanent Ship Recycling Office for Training and Records

One of the most critical elements of achieving training sustainability in the Bangladeshi ship recycling zone is the establishment of management and administrative structures. This will ensure the proper management of administrative requirements and quality assurance processes demanded by any consistent training scheme (As a case study, the training system developed in Bangladesh to oversee seafarers' STCW Training would be useful to investigate when developing an equivalent for ship recycling industry).

For the purpose of this document, a basic framework made of two interconnected bodies is proposed for the supervision of training in the context of ship recycling: A coordination mechanism for strategic and governing functions and a permanent support body for the management of day-to-day operations.

Considering the number of workers to train (estimated to be between 25.000 - 40.000), two stable and permanent structures are considered necessary for training consistency:

- A supervisory mechanism or subcommittee developed under the Bangladesh Ship Recycling Board (BSRB) would oversee the overall training activities.
- The subcommittee would be complemented by a permanent and dedicated body/office in charge of day-to-day activities and administration.

As stated in the 2011 SBRR, training falls under the Bangladesh Ship Recycling Board (BSRB). Consequently, the board would ideally regulate, appoint and supervise a subcommittee and an administrative office in charge of training activities (Figure 13.1).



Figure 13.1: Management and Administration Hierarchy

Therefore, it is recommended that:

R1: A Ship Recycling Subcommittee on Training and a permanent Ship Recycling Office for Training and Records should be established. BSRB with BSBA support should regulate and control the activities of these bodies.

The main purposes of the Ship Recycling Subcommittee on Training and permanent Ship Recycling Office for Training and Records would be:

- To facilitate efficient and transparent decision making
- To cope with the difficulties in training tens of thousands of workers
- To allow access to yards only for trained work force
- To update, develop and assess training strategies
- To ensure adequate leadership on issues such as delivery, management and continuous improvement in the ship recycling training
- To support day-to-day training activities
- To monitor training efficiency and collect feedback
- To prepare regular activity reports and statistics to inform decision-makers and supervisory board
- To propose and conduct necessary evolutions

Composition of the Subcommittee should be determined by BSRB. It is suggested to include the following stakeholders:

- Representative of the relevant National Agencies related to ship recycling and workers' safety
- Representatives of the BSBA
- Any relevant stakeholders such as workers' representatives and NGOs supporting Occupational Safety and Health

These representatives could be elected and have fixed terms of office.

Initially, having the inclusion of external experts, either from local or international institutions with a proven track record in delivering vocational education, would allow for guidance and expert advice in the transitional phase of the members of the committee gaining the appropriate competences and experience required to independently manage the administration of the training programme.

The envisaged tasks that the Ship Recycling Subcommittee on Training would be, at least, the following:

- Determination of training strategy and budget
- Supervision of training system including infrastructures
- Selection and approval of ship recycling trainers as well as Continued Professional Development (CPD) of trainers
- Internal auditing/review of training system and trainers' performance for consistency in delivery of training
- External auditing from National Agencies

- Reporting on training efficiency and needs to BSRB or/and Ministry of Industries
- Assessment of training and modifications

The permanent Ship Recycling Office on Training and Records would be an administrative entity implementing and supervising the training. The office would assume, at least, the following functions:

- Serve as dedicated contact point for ship recycling training activities and manage requests from workers, yards, National Agencies, BSBA, etc.
- Day-to-day management of training, trainers, and trainees
- Scheduling and organisation of training sessions and refresher courses
- Administrative support for trainers and trainees
- Control of training budgets
- Training curriculum and material update/modification approval
- Training dispute resolution
- Record-keeping of training activities and feedback
- Gatekeeper and storage of database of workers training records
- Issuance and management of training certifications
- Manage authorized workers' database
- Workers data verification and edition of ID
- Establishment of statistics for training and workers
- Any other prescribed task such as recording of near-misses, incidents, accidents, investigations support, etc.

Worker Registration & Training Records

The Bangladesh Labour Act 2006 requires employers to maintain records (service book) of their workers and to issue letter of Appointment and identity cards (ID-Cards) (Chapter II of Labour Act).

Effective and strict implementation of such requirements would avoid untrained, undocumented, unidentified workers as well as underage labour to penetrate and work in ship recycling facilities.

Moreover, the 2011 SBRR demands that only trained workers can be employed in ship recycling yards. So, issuance of ID cards for workers authorized to work in ship recycling yards would be conditioned by the completion of approved training.

Such activities (training and issuance of ID-Card) would be conducted by the permanent Ship Recycling Office on Training and Records under BSRB Subcommittee on Training.

As documented in WP4, Part I of the SENSREC project, there are currently many proven and relatively inexpensive solutions for the effective record keeping, documentation and identification of workers at ship recycling gates.

The system recommended due to its functionality and simplicity was an ID-Card based system which is linked with a centralised database (hosted at permanent Ship Recycling Office for Training and Records).

The ID-Card would be inclusive of the following information recorded, physically as text on the card as well as electronically, as a minimum (**Figure 13.2**):



Figure 13.2: Example ID-Card

- Identity of card holder (Name / Date of Birth / Place of Birth / Reference to National ID number)
- Registration number issued by centralized database
- Capacity and special functions (if any)
- Training: name of training / date and location of training / validity date (eventually)
- Identification of employer
- Working condition details
- Issuance and expiry date
- Photograph and signature of card holder
- Any other data such as contact person in case of accident, blood group, etc.

Within the scope of the ship recycling training, the chosen registration and record keeping solution should be universal through the ship recycling zone. Therefore, it is recommended that:

R2: The BSRB establishes an ID-Card based worker registration and record keeping database system for ship recycling workers

and

R3: The Ship Recycling Subcommittee on Training and the permanent Ship Recycling Office on Training and Records of the BSRB should be empowered and considered as responsible for worker registration and upkeep of training records

The opportunity of conducting a systematic registration of workers as they attend training should contribute significantly to resolving the undocumented nature of the ship recycling workforce. Furthermore, this will eventually allow the enforcement of the requirement that all ship recycling workers must be trained, and will also solve the problem of underage workers.

Further Development of Training Materials

The created training materials/ programme will require periodical review (recommended every 2-3 years) by the Ship Recycling Subcommittee on Training to ensure they are fit for purpose and continuing to address the needs of the ship recycling zone. It is envisaged over time that updates and edits will be required. Therefore, it is recommended that:

R4: The Ship Recycling Subcommittee on Training periodically review training materials and implement a process for implementing upgrades/improvements/edits to the training programme

In addition, it is also identified that there will be a need to further develop/adjust the original SENSREC created training to incorporate refresher courses and courses to facilitate the upgrading of skills to support promotion e.g. a cutting helper becoming a cutter.

R5: The Ship Recycling Subcommittee on Training initiates the creation of refresher and skill upgrade courses based on the SENSREC training programme

13.3 Worker Engagement & Empowerment

Certification after completion of training

To empower the workers and show value in completing the ship recycling training programme, recognised certification of the skills they have learned is required. Certification of training can contribute substantially in contributing to the professionalization of the various roles of ship recycling workers. In addition to enhanced occupational safety and health, this can assist in addressing the high turnover of the workers.

Recognised certification is achieved through the accreditation of the training through the appropriate national body and this is further explained below.

Career Progression through Training

To further encourage training engagement, promotions and career progression should be linked to successful completion of training. For example, for the progression of a cutters assistant becoming a senior cutter, there should be a clear path of what qualifications and training are required along with how much 'time on the job' is required to be served before a potential promotion is considered.

13.4 National Authority Recognition and Supervision

Training Programme Accreditation

The created ship recycling training programme requires BSRB supervision and eventually other National Agencies to participate in the accreditation and recognisance of the qualifications of ship recycling trainers and the training undertaken by the workers.

The accreditation process will be required to be initiated by the Ship Recycling Subcommittee on Training and require guidance from those familiar with the accreditation of vocational education in Bangladesh.

In the longer term the training should be mapped in accordance with the appropriate levels in the Bangladesh National Qualifications Framework. This will allow for the ship recycling training programme to be nationally recognizable qualifications and

allow for workers to demonstrate validated skills if they wish to transfer employment to another sector.

External Auditing

As part of the accreditation of the training, the appropriate BSRB and other National Agencies should be conduct annual external audits of the trainers and the training facilities. The Ship Recycling Subcommittee and the permanent Ship Recycling Office on Training and Records could be utilised as contact points in undertaking these activities.

13.5 Training Infrastructure

Training Facility Requirements

In the Bangladeshi ship recycling industry, one of the issues of the most pressing concern is the physical location of where the training and associated administration will be centred.

From the findings of WP4, Part I of the SENSREC project it is evident that the present facilities, are insufficient and inadequate in quantity and quality to accommodate large number of trainees. Hosted inside the BSBA hospital, the BSBA institute remains of restricted capacity due to its size and lacks specialist training areas and equipment (e.g. to conduct firefighting techniques in enclosed spaces). For a training facility to appropriately deliver practical and effective training demanded by the approved curriculum, it is important that it includes a number of fundamental training capacities that allows for skills development in a safe and controlled manner.

In **Table 13.1**, an outline of the required training areas, specifications and estimated capacity has been suggested for a typical ship recycling training facility. The training areas and their specifications are the minimum infrastructural requirements for a training facility to be deemed as having the capacity to offer ship recycling training. Capacity estimates for each of the training areas is calculated in line with best practice for effective and safe training delivery. For example, the Bangladeshi Department for Shipping stipulate a maximum capacity for class based courses to be between 25-40 people. For safety critical training elements, such as confined space and fire safety training, best international practice recommends between 10 -12 people.

Table 13.1: Specifications of the Various Laboratories Required in the Training Facility

Training Area	Specifications	Estimated Capacity
Confined Space Training Area	<ul style="list-style-type: none"> • Tank with restricted access • Ventilation equipment • Rescue winch & harness • Gas and explosive Atmosphere meters • PPE 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>1 Day</p>
Fire Safety Training Area	<ul style="list-style-type: none"> • Safe and controlled zones for fire • Tank with restricted access • Fire fighting equipment • PPE 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>2 Days</p>
Hot Work Training Area	<ul style="list-style-type: none"> • Oxy fuel cylinders and trolleys • Oxy fuel cutting equipment • PPE 	<p>1 trainer can supervise up to 36 students at a time</p> <p>4 Days</p>
First Aid Training Area	<ul style="list-style-type: none"> • CPR dummy • First aid equipment • Recovery equipment (stretcher, ropes etc.) 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>1 Day</p>
Hazardous Materials Handling & Removal Training Area	<ul style="list-style-type: none"> • Asbestos removal equipment (negative pressure equip., enclosures etc.) • Oily water removal and separation • PPE 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>1 Day</p>
Working at Height Training Area	<ul style="list-style-type: none"> • Raised platform with secure attachment points • Harness and fall arrestor • PPE 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>1 Day</p>
Chemical/oil spill management Training Area	<ul style="list-style-type: none"> • Oil booms • Spill kits • PPE 	<p>1 trainer can support the training of up to 12 students at a time</p> <p>1 Day</p>
General Workshop	<ul style="list-style-type: none"> • General tools • PPE 	<p>1 trainer can supervise up to 36 students at a time</p> <p>1 Day</p>
Classrooms	<ul style="list-style-type: none"> • Large whiteboard • Projector • Laptop • A1 Flipchart • Stationary • U shape desk configuration and chairs 	<p>1 trainer can train a maximum of 36 students</p> <p>3 Days</p>
Other Spaces	<ul style="list-style-type: none"> • Equipment Store • Kitchen & Lunch Facilities • Toilet & Shower Facilities • Mosque • Offices • Graduation Space • Record Storage 	<p>Variable</p> <p>Support Standard Training Period of 15 Days</p>

Taking into consideration balancing the unique learning challenges of ship recycling workers and maximising the number of workers to be trained, the maximum training capacities recommended is 36 people for class based activities and 12 people for safety critical training elements.

Due to the scale and extent of infrastructure and equipment required to appropriately train workers, it is deducted that it will not be cost-effective or practical for every individual yard to invest in its own training facility. Instead, it is recommended that:

R6: A collective approach is needed in the form of establishing adequate bespoke ship recycling training facilities for the entire ship recycling zone. The Bangladesh Ship Recycling Board (BSRB) could coordinate and facilitate the development of such facilities in collaboration with BSBA.

Long Term Infrastructure Prospects

In the long term, it has been identified that dedicated training facilities are required for the Bangladeshi ship recycling industry to allow for the effective and safe delivery of training, secure the sustainability of the created SENSREC training materials and provide the foundation for future Bangladeshi ship recycling zone improvements. Therefore, one of the most urgent recommendations of this strategy is:

R7: An investigation into the optimal ship recycling training facilities size, location, design and funding/investor options should be initiated as soon as possible for the Bangladeshi ship recycling zone.

In terms of financing training facilities there are a number of alternatives that can be explored including the following:

1. A purely private collaborative enterprise through all yards contributing jointly in the initial investment and ongoing costs with a private organisation, such as the BSBA, responsible for the delivery, administration etc. - *potentially modelled on the Turkish Ship Recyclers Association's shared service approach*
2. A private/public partnership where the ship recyclers collectively negotiate through the BSBA with the Ministry of Industries and/or BSRB to agree on the

sharing of initial investment contributions, operational costs and organisational arrangements

3. The appropriate Bangladeshi Government Ministries invest in the establishment of the facility and maintain sole responsibility for its operation. Fees are charged on an annual or per worker basis to the ship recycling yards

Short Term Infrastructure Prospects

In the interim period it will take to investigate, plan and build bespoke training facilities for the ship recycling zone, alternative solutions to comply with training requirements and meet the demand for safe and controlled training are required.

Within the findings of WP4, Part I of the SENSREC project it was highlighted that key institutions in Chittagong with a successful track record of delivering vocational training exist. Among the various institutions available to support large scale training, one institution is particularly well adapted.

The Bangladesh Marine Academy (BMA), was highlighted as having the appropriate training knowledge and infrastructure to deliver ship recycling related training in the interim period. This is especially recommended in the training of trainers for the ship recycling zone. In this respect, BMA possesses staff, equipment and locations to perform demanding training such as confined space entry, firefighting, first aid etc.

Indeed, the ACS Consortium chose the BMA as the location of the training of trainers piloting activities and the positive feedback, from trainees and trainers alike, validated the BMA as a suitable training institute. Other local training institutions may also be considered.

R8: In the interim period, until a dedicated training facility is established, proven institutions such as the Bangladesh Marine Academy should be utilised to supported for ship recycling training.

Practical Infrastructure Realization

Overall, the scale of the challenge in addressing the provision of training infrastructure to be able to train such a vast number of workers is evident from the

estimates above. In the capacity estimations it was clearly seen that several training facilities were required to train the lowest estimate of workers in a period of around 2 years. This does not include the time it would take to physically build the training facilities.

In the current Bangladeshi context, it does not seem possible that the resources and funds will be available to support anywhere near the infrastructural requirements required to deliver the appropriate level of training provision in an acceptable timeframe. The planning, funding and building of even one training facility is envisaged to be a challenge and take a considerable amount of time

According to the senior management of the BMA, there is currently enough spare capacity to accommodate up to 28 training cohorts of 36 trainees per year. This will train merely 1,000 workers every year. Obviously, with such a small size of training facility, a long period (at least 25 years) may be needed to train the workforce in Chittagong.

Therefore, within a practical context of what can be achieved, a new “Training Facility” will have to be built if one aims at training at least 25,000 workers in a reasonable time frame (say within 5 years). Such a facility would have multiple class-rooms and several laboratory facilities of rather larger sizes and in some cases certain labs will have to be built in multiple numbers. The ultimate objective would be to build a new facility – which is suitable for training at least 5,000 workers every year.

13.6 Indicative Budget for Creation of Training Infrastructure

It was stated in the Final Version of WP4b Report (*‘Strategy for Sustainable Training for the Ship Recycling Industry’* authored by McKenna *et al.*; dated 20th December, 2016) that the envisaged training facility is required to be developed that addresses:

- a) the specific training features mentioned in Table 13.1.,
- b) being conveniently located near the ship recycling zone and,
- c) being of an appropriate size to address the large numbers of workers required to be trained.

As mentioned previously, anywhere in the range of 25,000 – 40,000+ workers are required by Bangladeshi law to undergo theoretical training in a training facility lasting a duration of 3 weeks/15 full days according to present requirements.

The Concept of “Cohort”: A practical realisation of the delivery of the content of the eight training modules (the approved 3 week/15 working days theoretical training) in a training facility is initially drawn up (as depicted in **Figure 13.3**). To give an indication of the scale of the challenge in developing the required training facility capacity, the following calculations and issues need to be taken in to consideration:

- A typical training facility is assumed which is of the specifications mentioned in Table 13.1.
- The schedule is arranged to achieve optimal use of the training areas and facilities.
- Each group of workers to be trained is defined as a **Training Cohort** of 36 trainees, which is the maximum number of recommended people to ensure efficient and effective delivery of training and go through the kind of visitations through the class rooms and laboratories, as illustrated in **Figure 13.3**.
- The Training Cohort is split into three equal groups for training which is safety critical or restricted by physical limitations. These are defined as **Sub Teams** and in order to ensure efficient, effective and safe delivery of training should contain no more than 12 people (as explained in Figure 13.3).
- In order to accommodate 108 trainees and optimise the utilisation of the training facility, it has been calculated each new training cohorts must have a staggered start every 7 working days.

The Concept of “Stream”: One typical “Stream” has 3 Cohorts at a given time, which undergo training in parallel. The maximum training capacity in a given “stream” is, thus, calculated to be a maximum of 108 trainees (3 Training Cohorts of 36 workers each) at any one time.

A typical implementation of three parallel streams is depicted in **Figure 13.4**. At any given time, therefore, in total 9 cohorts would be undergoing training and the curriculum will be administered and implemented by a set of three professional trainers – where each set of trainers comprises of 6 trainers, 24 technicians and supported by 6 administrative assistants.

Estimation of Workers Trained in the Proposed Facility: The detailed basis and infrastructure-related assumptions made for the said budgeting exercise have been depicted in **Tables 13.2, 13.3 and 13.4.**

- ✓ Calculations are made on how many working weeks are in the year (minus 2 weeks for holidays and 4 weeks for Ramadan period) and how many training sessions will be able to be conducted in this time according to the schedule in Figure 13.3. Therefore, out of 52 weeks in a given year, only 45 weeks are for working.
- ✓ Assuming 6 days of training every week, one would get optimised number of trained workers from the proposed training facility.
- ✓ This number is then multiplied by the number of trainees trained per training cohort to achieve the total number of workers trained per year.
- ✓ Extrapolation calculations are made to analyse the total training number of workers trained per year if the training facilities and number of trainers is increased. Finally, a calculation is made to estimate the number of years it would take to train the required number of workers (at least 25,000 workers).
- ✓ The number of trainers required to support the training activities of the 108 trainees (3 Training Cohorts) in each training “Stream” is calculated to be a minimum of 6 at any one time.
- ✓ Certain training areas will have a maximum capacity which place limitations on the number of trainees the facility is able to train at any one time. In Figure 13.4, it can be seen that the facility of Fire Safety Training is being utilised 100% of the time and is therefore likely to become a the limiting factor in this example. Therefore, two facilities have been proposed for the Fire Safety Training (see **Table 13.4**).
- ✓ Calculations are made to analyse, initially, the total number of workers trained per year according to the example above, and then if the training schedule and facility was to be further replicated in greater numbers (**Table 13.2**).
- ✓ The calculation suggests that annually on an average 5508 workers (can be trained in the facility proposed in this section (Basis: 15 day training per cohort, one day gap before next Cohort starts, three Streams in parallel, 272 days of teaching out of 365 days in a given year).

Indicative Budgetary Estimate for the Infrastructure: Regarding a budget for the capacity building part of Phase II it has to be noted that it will be possible to estimate this after the authorities reach a decision on what is the acceptable or desirable length of time required to train all workers in the ship recycling industry and therefore what should be the size of the infrastructure required to achieve the scheduled task. Clearly, if one desires to complete the task of training nearly all the workforce in rather short period of time, then multiple classrooms and multiple sets of the laboratory facilities would be required to be built in the training facility.

In any case, the one thing that might be possible and certainly desirable to evaluate at this stage would be the cost of building the adequate facility for completing training of at least 25,000 workers in 5 years (*i.e.* a facility containing all necessary infrastructure for the training 5,000 to 6,000 workers every year). It should be noted that once the five-year period is completed, the infrastructure would continue to operate because:

- a) the workforce may exceed the assumed population of 25,000 due to, either increasing volume of recycling work in Chittagong, and/or workers' high turnover; and
- b) there will be a need for refresher and skill upgrade courses for the workforce, as already anticipated in Recommendation 5 of the ACS Consortium, reproduced in Section 13.2 above.

The files used for our cost estimation and arriving at some kind of indicative budgetary estimates for the proposed training infrastructure are presented in **Tables 13.5 and 13.6.**

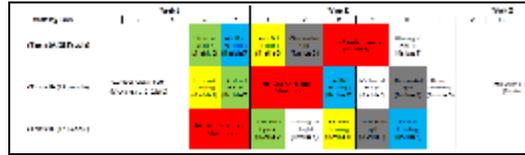
It is envisaged that a group of 6 trainers will handle one "Stream". Thus, 5,000 to 6,000 workers would be trained every year at the proposed "Training Complex" with the help of three sets of trainers functioning in parallel (named as Streams I, II and III). In total, nearly 150 persons at various levels will have to be employed at the training facility proposed here. The personnel will comprise of 22 trainers, 64 technicians 22 administrative staff and 42 personnel for providing several support services including janitors, staff for up-keep, security guards and gardeners.

		Week 1					Week 2					Week 3					
Working Days:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Training Cohort 1	Sub Team 1A (12 People)	General Classroom (Modules 1, 2, 5 & 6)			Confined Space (Module 2)	HazMat Handling (Module 7)	First Aid Training (Module 8)	Chemical/oil spill (Module 3)	Fire Safety Training (Module 5)		Working at Height (Module 5)	General Workshop (Module 8)	Hot Work Training (Module 8)				
	Sub Team 1B (12 people)				First Aid Training (Module 8)	Confined Space (Module 2)	Fire Safety Training (Module 5)		HazMat Handling (Module 7)	Working at Height (Module 5)	Chemical/oil spill (Module 3)						
	Sub Team 1C (12 people)				Fire Safety Training (Module 5)		Confined Space (Module 2)	Working at Height (Module 5)	First Aid Training (Module 8)	Chemical/oil spill (Module 3)	HazMat Handling (Module 7)						

Figure 13.3: A Typical Schedule for 3-week General Training Programme for One Cohort having 36 Workers

(Source: Final Version of WP4b Report, 'Strategy for Sustainable Training for the Ship Recycling Industry';

authored by Stuart A. Mckenna, Raphael Baumler and Rafet E. Kurt; dated 20th December, 2016)



Each of the coloured tiles shown below is a “Cohort” as depicted in Figure 13.3



Figure 13.4: Optimised Training Schedule for the three parallel “Streams” training 324 workers at any one time (each Stream having 3 Cohorts, and each Cohort having three Sub-Teams of 12 trainees, thus 108 Workers in each Stream)

Table 13.2: Design Basis for Planning of the Training Complex

Design Basis for Planning of the Training Complex	Stream I	Stream II	Stream III	Total Three Streams
Min. No. of Trainers	6	6	6	22
Min. No. of Technicians	18	18	18	64
Min. No. of Admin Staff	6	6	6	22
Min. No. of Janitorial, Up-keep, Security, Gardners, etc. (@ 75% of the above)	12	12	12	42
Total Workforce Number	42	42	42	150
Working Weeks per year (Assume there are holidays for 6 weeks)	45	45	45	
Working days per week	6	6	6	
Cohorts Trained per Year @ 15 working days training per cohort	51	51	51	153
No. of Workers per Cohort	36	36	36	36
Workers Trained per Year	1,836	1,836	1,836	5,508
Number of Years required to train about 25,000 Workers				5 years

Table 13.3: The Basis for Budgeting of the Academic and Administrative Building

Purpose of the Rooms	Estimated Capacity of Class-Rooms, etc.	Number of Persons	sq m per student	Number of Rooms	Total Area (sq m)
Class-Rooms suitable for one cohort	Class-Rooms of 50-persons capacity each	50	2.5	9	1,125
Seminar Halls	Seminar Halls of 150-persons capacity each	150	2.5	2	750
Administration Block	Offices for Administration	400	-	-	400
Support Services	Computer Centre, Library, Recreation Hall, Pantry, Conference Rooms, Board Room, Reception Area, etc.	400	-	-	800
Access areas	Lobbies, Corridors, Terreces, Staircases, Lifts, Toilets, Other utilities, Evacuation and fire-safety Infrastructure, etc. (typically @ 75% loading on cumulative built-carpet area)	400	-	-	2,306
				-	5,381

Table 13.4: The Basis for Budgeting of the Indoor Laboratories and Outdoor Training Areas

Purpose of the Laboratory	Estimated Capacity of One Lab	Length (m)	Breadth (m)	Number of Labs	Total Area (sq m)
Confined Space Training Area	1 training tank and trainer can support the training of up to 12 students at a time (1 day)	40	25	1	1,000
Fire Safety Training Area	1 trainer can support the training of up to 12 students at a time (2 days)	40	25	2	2,000
Hot Work Training Area	1 trainer can supervise up to 36 students at a time (4 days)	40	30	1	1,200
First Aid Training Area	1 trainer can support the training of up to 12 students at a time (1 day)	25	15	2	750
Hazardous Materials Handling & Removal Training Area	1 trainer can support the training of up to 12 students at a time (1 day)	50	30	1	1,500
Working at Height Training Area	1 trainer can support the training of up to 12 students at a time (1 day)	50	35	1	1,750
Chemical and oil spill management Training Area	1 trainer can support the training of up to 12 students at a time (1 day)	40	35	1	1,400
General Workshop	1 trainer can supervise up to 36 students at a time (1 day)	50	33	1	1,650
				10	11,250

Note: In addition, the outdoor facility will be needed. It is envisaged that the outdoor training will be given in the wet-intertidal areas, intertidal zones and secondary cutting zones of the yards where the workers are employed. The *Production Supervisors* and *Health Safety and Environment Officers* in the respective yard will supervise the workers under training and report the progress to the *Training Institute*.

Table 13.5: The Calculations for Estimating the Budgetary Costs for the Academic and Administrative Building

Estimates for Academic & Administrative Building
(Ground + 2 floors)

Cumulative Built Floor Area	5,400	SqM
Ground floor Area	1,800	SqM
First floor area	1,800	SqM
Second Floor	1,800	SqM
Cost Index	100%	

Description	Quantum	Unit	Rate in Rs/unit	Amount in Rs.
Civil Engg Works for the Building	5400	SqM	23500	1269,00,000
Extra for floor height over 3.35 M up to 3.95M by 0.6 M (0.3x270)	5400	SqM	540	29,16,000
SUB TOTAL I				1298,16,000
Extra for deeper foundation over 1,20 M 4X270=1080	1,800	SqM	1080	19,44,000
Earthquake resistance	1,800	SqM	1140	20,52,000
Extra for larger modules	1,800	SqM	1500	27,00,000
Firefighting with srpinkelers	3,086	SqM	750	23,14,286
Automatic firefighting system	3,086	SqM	500	15,42,857
CCTV	3,086	SqM	300	9,25,714
BMS	3,086	SqM		3,00,000
Furniture, projection facility, etc.	3,086	SqM	4700	145,02,857
Access area surrounding building & RG, Parking, Roads etc.	3600	SqM	2350	84,60,000
SUB TOTAL II				117,78,857
Internal water supply and plumbing 2% of sub total I	1298,16,000		2%	25,96,320
External service connections @ 0.5% of sub total I	1298,16,000		0.5%	6,49,080

Description	Quantum	Unit	Rate in Rs/unit	Amount in Rs.
Internal electrificatio @5%	1298,16,000		5%	64,90,800
Quality assurance @0.5%	1298,16,000		0.5%	6,49,080
SUB TOTAL III				103,85,280
SUB TOTALS i+ii+iii				1519,80,137
Totals adjusted to cost index 100%	1519,80,137		100%	1519,80,137
Add VAT @5%	1519,80,137		5%	75,99,007
Add notional escalation during construction period (for 2 years @4%/annum)	1519,80,137		4%	121,58,411
Consultancy fees for design and supervision @3%	1519,80,137		3%	45,59,404
Add contingencies @1%	1519,80,137		1%	15,19,801
Grand Total			INR	1778,16,760
			USD	25,40,239

Table 13.6: The Calculations for Estimating the Budgetary Costs for the Indoor Laboratories

**Estimates for Indoor Laboratory and Workshops
(Ground floor only)**

Cumulative Built Floor Area	11,250	SqM
Ground floor Area	11,250	SqM
Cost Index	100%	

Description	Quantum	Unit	Rate in Rs/unit	Amount in Rs.
Civil Engg Works for the Building	11,250	SqM	11750	1321,87,500
Extra for floor height over 3.35 M up to 5.00 M by 1.65 M (1.65x270/0.3)	11,250	SqM	743	83,53,125
SUB TOTAL I				1405,40,625
Extra for deeper foundation over 1,20 M 4X270=1080	11,250	SqM	540	60,75,000
Earthquake resistance	11,250	SqM	570	64,12,500
Extra for larger modules	11,250	SqM	750	84,37,500
Fire fighting with sprinklers	0	SqM	375	0
Automatic fire fighting system	0	SqM	250	0
CCTV	0	SqM	300	0
BMS	0	SqM	1	0
Furniture, Equipment, Demonstration facility, etc.	11,250	SqM	4700	528,75,000
Access area surrounding & RG, Parking, Roads etc.	22,500	SqM	2350	528,75,000
SUB TOTAL II				1266,75,000
Internal water supply and plumbing 1% of sub total	1405,40,625		1%	14,05,406
External service connections @ 0.1% of sub total	1405,40,625		0.1%	1,40,541
Internal electrification @2%	1405,40,625		2%	28,10,813
Quality assurance @0.5%	1405,40,625		0.5%	7,02,703
SUB TOTAL III				50,59,463

Description	Quantum	Unit	Rate in Rs/unit	Amount in Rs.
SUB TOTALS i+ii+iii				2722,75,088
Totals adjusted to cost index	2722,75,088		100%	2722,75,088
Add VAT @5%	2722,75,088		5%	136,13,754
Add notional escalation during construction period (for 2 years @4%/annum)	2722,75,088		4%	217,82,007
Consultancy fees for design and supervision @3%	2722,75,088		3%	81,68,253
Add contingencies @1%	2722,75,088		1%	27,22,751
Grand Total			INR	3185,61,852
			USD	45,50,884

SUMMARY

Budget for Academic Building + Indoor Labs

INR 4963,78,613

USD 70,91,123

Min Area for Academic Building + Indoor Labs

39,150 sq m

4 hectare

It is estimated that the “Academic and Administrative Building” having built-up area of 5,400 m² and the “Indoor Laboratories” having built-up area of 11,250 m² will have to be provided for. In addition, the “Outdoor Training Areas” will be needed. For this purpose it is envisaged that the outdoor training will be given in the wet-intertidal areas, intertidal zones and secondary cutting zones of the yards where the workers are employed. The *Production Supervisors* and *Health Safety and Environment Officers* in the respective yard will supervise the workers under training and report the progress to the *Training Institute*.

The above mentioned “Academic and Administrative Building” and “Indoor Laboratories” will have to be placed in the vicinity of each other. Yet, they should be built sufficiently apart so that adequate masterplan of the land can be made to provide for access area surrounding buildings, approach and access for firefighting, “rendezvous spot” for escape and shelter in case of disaster or accident, parking, roads, gardens, *etc.*

Thus, a plan area of about **4 hectare (i.e. 10 acres)** will have to be provided for construction of the proposed “Training Complex” designed to train 5,000 to 6,000 workers every year. The said facility will have the “Academic and Administrative Building” and “Indoor Laboratories” as well as adequate roads, access to each building and safety systems.

The proposed “Training Complex”, approximately, would require **USD 7.1 million** to cover the capital costs of construction, commissioning, modest furniture, laboratory equipment and fire-fighting systems. This budgeted costs, however, do not cover air conditioners, residential quarters, guest house, cost of land or any recurring costs or the operation and maintenance costs .

APPENDICES

Appendix 1

Topographical Data using Digital Surveys

The topographical information would be essential for making a rational decision on siting of the proposed common hazardous waste treatment storage and disposal facility (CHW-TSDF) in Chittagong. The TSDF project-related initial planning and designing activities will also be indeed facilitated with a clearer understanding of the topography since a large area of land would be needed for establishing the TSDF and relatively large quantities of earth mass would be required to be excavated and moved around at the site of construction.

Topographical study typically incorporates various land features like valleys, streams, hills and their undulations, the plateaus and the plains. The cutting and filling quantities are also calculated. Geology and topography are associated and are used as different layers because these different layers have different impacts on the site selection process (Şener et al., 2006). Landfill design is highly dependent on physical characteristics, such as topography, geology, and groundwater depth (Coelho et al., 2016).

Surveying is the process of preparation of a plan or map of the area. It is the art of determining the relative positions of points on, above, or beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation. It also includes the establishment of points by predetermined angular and linear measurements. The preparation activity involves the determination of location of points and the distances and angles between them.

In the process of surveying total stations, GPS receivers, theodolite, levels, retroreflectors, 3D scanners, radios, handheld tablets, GIS and surveying software are often employed. Among all, the GIS (Geographic information system) has proved to be probably the most significant and useful software for management of multi-attribute data and information. GIS is defined as a computer enabled system for capturing, storing, checking, validating, verifying and displaying the data related to positions on Earth's surface. In the recent times, even drones are used. The drone is a radio-controlled toy helicopter devised with a camera, night vision binocular and transmission contraptions.

Geographic information systems (GIS) and associated technologies are linked with photogrammetric methods and tools for digital topographic data collection and revision. The updating of digital topographic data is being carried out by using the photogrammetric methods. The photogrammetric methods are also used for production of the digital topographic planes at a scale 1:500 - 1:5000. (Nekhin and Zotov, 2000). These methods employ a photogrammetric scanner and cost efficient digital photogrammetric workstations. This will guide in computations of air and space images (mono and stereo) for central and panoramic projections. Instead of using the original negatives or positives, digital photogrammetric station makes use of digitized photos.

Nekhin and Zotov (2000) have explained in their publication that the modern photogrammetric instruments and technologies for topographic data collection and revision include the use of analytical plotters, modern digital instruments (photogrammetric scanner, cost-efficient digital photogrammetric stations), analytical and digital workstations for mapping and geographic information systems. (Source: Nekhin and Zotov, 2000). Further, these authors have outlined the steps as follows:

- *"integrate raster image and vector map data;*
- *digital stereocorrelation for procedures of inner, relative, absolute orientation;*
- *implement image processing procedures such as contrast enhancement, edge sharpening, vector on raster overlay;*
- *generate digital elevation models (DEMs);*
- *produce digital ortophotos and ortophoto maps; and*
- *produce new type of cartographic production, for example virtual reality scenes etc."* (Source: Nekhin and Zotov, 2000).

The proposed TSDF project in Chittagong would need digital surveys and topography related investigations for designing and planning of the facility - which are listed below:

(1) Elevation Map

In the preparation of the topographic map after digital surveys, the elevation range of the study area needs to be determined. The land morphological features can be evaluated using the slope grading and are typically specified in degrees format. In case of the steeply graded identified sites, landfills cannot be designed. The smaller

grades are typically considered to be more favorable than steeper gradients and prove to be more suitable for designing of landfills (Babalola and Busu, 2011).

(2) Highest Flood Level and Mean Sea Level

Through topographical survey, the highest flood level and mean sea level are determined. At least 100 year return period for the highest flood should be considered for siting of TSDF projects. The average level of the sea surface, calculated by the mean of hourly tide levels and used as the standard for determining terrestrial and atmospheric elevations and ocean depths is required in a TSDF project.

(3) Slope

Slope consideration has to be made so as to minimize pounding and incident infiltration. The construction and maintenance of TSDF in a steep slope is difficult and expensive. The gradient or slope is also an important factor of site selection since higher slopes would increase runoff of pollutants particularly from the landfills, and thereby contaminate areas further away from the landfill sites. A slope which is less than 12% is suited for the prevention of pollutant runoff.

(4) Hydrogeological Parameters and Properties

Sites on elevated areas will provide good hydrological conditions like a deep groundwater level and protection against flooding. The subsoil properties also play a role because they determine the rate of flow of surface water and groundwater and the possibility of fixation of certain cationic contaminants. Thus the hydraulic conductivity, cation exchange capacity of soil and pH of pore water will affect the efficiency of the containment of the waste.

The seismic condition of a candidate site must also be considered and the impact of the earthquakes on the performance of the selected design of the landfill must be predicted. Moreover, areas sensitive to mass movements like large scale slides due to gravitational forces and artesian conditions should be excluded. The existence of faults, especially active ones, may generate stability problems and should also be avoided. Areas with soluble rocks (*i.e.* limestone, gypsum) can cause serious problems because of hidden cavities that can cause sudden and strong subsidence. Such areas should therefore be ruled out.

Finally it is recommended that the Geographic information system (GIS) be used as a tool for management of data collected during the process of topographic surveys for implementation of TSDf project in Chittagong. It is widely accepted that GIS is an innovative and supportive tool for data management and information because it can handle large sizes of datasets on variety of subjects.

Kontos et al., (2003) has demonstrated that the tool of GIS can potentially be applied for a variety of data management tasks including the design and operation of Municipal Solid Waste (MSW) landfill sites. This technique makes use of a combination of spatial datasets with non-spatial data including both quantitative and qualitative data. The representation of topographic surfaces as grids, TINs (Triangulated Irregular Networks) and contour networks is an integral part of GIS enabled topographic survey (Milne and Sear, 1997).

Appendix 2

Coastal Zone and Flood Maps

The tasks of selection of site as well as the environmental impact assessment of the proposed CHW-TSDF Project in Chittagong cannot be undertaken unless one embarks on a proper coastal zone management and flood hazard mapping.

It should not be overlooked that Chittagong has been affected by tsunami, cyclones and floods over the years. It is well known that the frequency of such events will progressively go up as a result of serious impacts of global warming and climate change as well as due to altering and compromising flood plains and waterways in the process of urbanization and industrialization in and around Chittagong.

Coastal Zone Mapping:

Clearly, it is unlikely that one would select a location for establishing the proposed TSDF adjacent to the coast in Chittagong. However, abundant care will have to be taken while approving the site for the proposed facility at reasonable distances from the prevailing ship recycling yards as well as from the aspiring industries in and around Chittagong - who will potentially send their hazardous wastes to the TSDF. Therefore, a participatory and integrated approach will have to be adopted in a manner that the TSDF will avoid conflicts with the coastal communities and will not become a reason for pollution or destruction of coastal habitats.

It will be important on the part of the Project Proponent and *Project Regulatory Authority* to identify the land for establishing TSDF such that it remains out of reach of floods and inundations on one hand and does not spoil the coastal zone and ecology in Chittagong on the other hand. The 'Coastal Zone Regulatory Policy of Bangladesh would certainly guide the Project Proponent as well as the *Project Regulatory Authority* and the site for the project will be identified and notified in the light of coastal zone and flood maps in the proposed study.

Remotely sensed data will prove to be essential for preparing inventory of coastal data, mapping of the area, so as to have sustainable utilization of natural resources. Data comprising of geospatial details of the coastal zone in the vicinity of proposed project site, very high resolution satellite imagery, timeline images of the area,

cadastral maps, coastal zone management plan (CZMP) maps and field mapping may also prove to be useful.

Thus, the remote sensing technology will aid the understanding of the various components of the coastal environment like: demographic distribution, wetland conditions, status of the mangrove in the areas, coast specific landforms, changes in the shoreline, low tide and high tide conditions, tidal boundaries, coastal pollution, marine flora and fauna distribution, coastal currents, suspended coastal sediment dynamics, pollution loads in the area, *etc.* Shoreline data typically include type and beach condition, shore protection structures, coastal vegetation information including type and other characteristics which aid in effective coastal zone management (Lund and Wilbur, 2007).

Flood Hazard Mapping

The following definition of "Flood Hazard Map" has been extracted verbatim from "Flood Hazard Map Manual for Technology Transfer", by Kikuchi (2003):

"A map that graphically provides information on inundation (predicted inundation areas, inundation depth, etc.), as well as on evacuation (location of evacuation refuges, evacuation routes, dangerous spots on evacuation routes, etc.) in an easy-to-understand format".

Typically, the flood hazard map is publicized through a joint effort by the disaster management authority of Bangladesh and the concerned department of water resources, coastal zone and hydrology responsible for Chittagong coastal area. Flood hazard mapping is a crucial activity to be considered for siting CHW- TSDF project in Chittagong whose failure may cause a huge disaster (during an event of flood).

The flood mapping is basically done keeping in mind the features and characteristics of rivers, flooding mechanisms, social framework, viewpoints on flood protection, collaboration of river management and residents. For precise mapping of the coastal flood hazards, many factors are of concern which include the extend of developmental activities in the area, the types and strength of storms that historically have affected the area, the death toll and devastation due to the respective storms, onshore and offshore elevations, dynamic effects of climate change *etc.* The effects

of climate change and changes in relative sea level order are to be frequently updated to reflect the change in risk of flooding.

The land features that include coastline bluffs, dunes, and beach taken into account for developing models for holistic picture of coastal development in Chittagong encompassing the flood hazard models. Flood hazard mapping provides an insight into those coastal areas which are at due threat from flooding under extreme conditions. This also includes mapping of areas prone to erosion hence achieving reduction in erosion risk. This will help in reducing and mitigating the impact of coastal flooding. Land use and land value in coastal areas of Chittagong can thus be effectively judged by developing flood hazard map and coastal zone management strategies.

The estimation of the exposure of coastal communities in and around Chittagong to flooding could be a critical task for long term planning and risk assessment and site selection for CHW-TSDF project. The level of protection offered by existing coastal defenses is also to be accounted for. This will help in understanding whether and when overtopping of defenses will occur, flooding of defended areas *etc.* The main methods for flood mapping and coastal zone management for Chittagong may include deterministic modeling of coastal inundation using hydrodynamic or GIS-based models of varying complexity. However, estimates of future sea level rise are subject to considerable uncertainty (Purvis et al., 2008).

Geographic Information Systems (GIS) is used worldwide to produce flood hazard maps. It is an effective way of assembling data from different maps and digital elevation models. Using GIS, the extent of flooding can be calculated by comparing local elevations with extreme water levels. The damage to life and property can be prevented by regulating the flood hazard areas coupled with enactment and enforcement of flood hazard zoning (Bapalu and Sinha, 2005). Thus, this tool can be used effectively for mapping flood hazards in and around Chittagong.

Appendix 3

Seismological Data

Seismological data is an important aspect of geophysical survey - especially for the proposed Common Hazardous Waste management facility for disposal of hazardous wastes in Chittagong. The significance of seismological data may be considered crucial while assessing the sites only when the locations of potential sites and surrounding areas fall under "sensitive" seismological zone. The seismic activities have to be detected at site which includes response to site conditions, undermined areas, earth tremors, liquefaction potential of subsurface soils etc. (CPCB, 2001).

The following information on seismic parameters pertaining to municipal solid waste (MSW) landfill designing has been extracted verbatim from the US Environmental Protection Agency (USEPA) RCRA Document Subtitle D 258 entitled: "Seismic Design Guidance for Municipal Solid Waste (MSW) Landfill Facilities" authored by Richardson, Kavazanjian, and Matasovic (1995): Recommended seismological parameters are:

"Relative ground displacements (e.g., fault displacement) and from strong ground motions (e.g., ground accelerations) that can accompany an earthquake site for a MSW landfill. The impact of earthquake-induced strong ground motions on a MSW landfill must be addressed by the design engineer. The document establishes a lower value for the maximum horizontal acceleration (MHA) in lithified earth material (e.g. the peak bedrock acceleration) that must be considered in the design of landfill containment structures. The MHA may be based upon either a probabilistic map such as those published by the United States Geological Survey (USGS) or upon the results of a site-specific analysis. Landfill containment structures are defined to include liners, leachate collection systems, and surface water control systems."

The design of a landfill includes identifying the seismic impact zones.

"Seismic Impact Zones are defined in the Subtitle D regulations as an area having a 10% or greater probability that the peak horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull

(g), will exceed 0.10g in 250 years. These zones may be defined using seismic probability maps prepared by the USGS (USGS, 1982 and USGS, 1991) or by more detailed regional or site specific studies. The USGS maps present peak bedrock accelerations and velocities reflecting a 90% probability that the acceleration will not be exceeded over 10, 50 and 250 year interval periods".
(Source: Richardson, Kavazanjian, and Matasovic, 1995)

It is argued that the above mentioned seismological data should also be applied in case of the proposed CHW-TSDF project in Chittagong.

The USEPA 40 CFR § 264.18 (1992) as well as RCRA Document Subtitle D 258 (1995) further explain more on the aspect of above mentioned "Fault Zone Siting Criteria" elucidating that the new MSW or hazardous waste landfill or any kind of expansion of an existing landfill may not be located within 200 feet (60 meters) of a fault which has a previous experience of displacement that occurred in the Holocene period (The most recent epoch of the Quaternary period, e.g. within the last 10,000 to 12,000 years.). Similar regulation has been given by the Indian Guidelines for siting hazardous waste disposal sites (CPCB, 2001).

Generally, a device such as "sledgehammer" is used to generate seismic waves, sensed by receivers deployed along a preset geometry and then recorded by a digital device called as seismograph. Seismograph measures and records the earthquakes or tremors, which include details of force and duration.

In seismic survey, on the basis of typical propagation mechanism, waves are grouped primarily into direct, reflected, refracted, and surface waves. The main three types of seismic surveys include refraction, reflection, and surface-wave (depending on the specific type of waves being utilized). The seismic surveys utilize a specific type of wave and its specific arrival pattern on a multichannel recorder. For instance, reflected waves are employed for reflection survey. Generation of seismic waves is basically in two ways: actively (using an impact source like a sledgehammer) or passively (by natural like tidal motion, thunder *etc.* and cultural like traffic activities). Commonly adopted technique is the active type.

Seismic data supply a "time picture" of the structure of subsurface. The accurate analysis happens after the time data is converted to depth factor. The four types of seismic data that can be collected for TSDF Project in Chittagong are: (1) 2- D Reflection; (2) 3-D Reflection; (3) Shear Wave; and (4) Refraction (Sheriff, 1982).

- (1)** 2-D reflection seismic data supply the cross-sectional views in both the dip direction (acute angle that a rock surface makes with a horizontal plane) and strike direction (direction of the line formed by the intersection of a rock surface with a horizontal plane). Data on the lines are a combination of both in-plane and out-of-plane reflectors. These data are vital for earlier stages of an exploration program (mainly in frontier basins).
- (2)** 3-D reflection seismic data provide a resolved cross-sectional view along any azimuth within the area of survey. Time “slices” (maps) on any horizon can also be created. The nature and location of out-of-plane features can be precisely determined. As the acquisition costs are high, 3-D seismic techniques are by and large used for accurately defining the individual prospects.
- (3)** Shear wave data in association with conventional compression wave data, provide data on lithology, fractures, and the presence of hydrocarbons in the surveyed site.
- (4)** Refraction seismic data grant a deep crustal view of gross structure (basin scale to lithosphere-upper mantle scale), which aids in understanding the regional tectonics.

As stated in Appendix 1, the seismic condition of a candidate site must be considered and the impact of the earthquakes on the performance of the selected design of the landfill must be predicted. Moreover, areas sensitive to mass movements like large scale slides due to gravitational forces and artesian conditions should be excluded. The existence of faults, especially active ones, may generate stability problems and should also be avoided. Areas with soluble rocks (i.e. limestone, gypsum) can give great problems because of hidden cavities that can cause sudden and strong subsidence. Such areas should therefore be ruled out.

Appendix 4

Meteorological Data

Meteorology is an interdisciplinary scientific study of the atmosphere describing and quantifying the variables of Earth's atmosphere, which are very essential components of site selection criteria of the proposed CHW-TSDF project in Chittagong. These variables mainly consist of ambient temperature, wind speed and direction, air pressure, water vapor, humidity, rainfall, solar radiation, etc. These variables are considered primary in nature. The secondary (i.e. derived) variables of concern include atmospheric stability, mixing heights, turbulence.

Remote sensing and associated techniques are usually employed to measure the above mentioned parameters. In the process of selection of the instrument for a particular application, the parameter of concern should be guided by the objective of the application incorporating the required accuracy and resolution of the data, the cost of the instrument, the operation and maintenance, the competing needs of ruggedness and sensitivity, siting, installation, and calibration of the equipment, as well as costs associated with the quality assurance and processing of the data (Bailey, 2000).

Canter (1996) has presented the excellent advice on key meteorological data to be collected for the purposes of site selection and EIA-related studies that can be utilized for siting the CHW-TSDF project in Chittagong. He grouped the recommended meteorological data into three categories: (a) Data for characterization of dispersion of air pollution in and around the study area; (b) Data on qualitative description of the atmospheric dispersion of air pollutants emerging from the operation of the TSDF; and (c) Data required for building, parameter estimation and validation of air pollution and dispersion models for assessment of air quality at the TSDF site.

The main meteorological parameters which are important in designing landfill sites (such as the proposed CHW-TSDF in Chittagong), for solid waste treatment include wind orientation and pattern, precipitation (Rainfall) and ambient temperature (Babalola and Busu, 2011). The wind orientation and pattern is an important parameter of concern as the landfill site in Chittagong should not be in the direction

of the wind. The windrose diagram provides a succinct view of how wind speed and direction are typically distributed at that particular location. The details of the CHW-TSDF site, its morphology, frequency of wind orientation and pattern of the study area should be taken into consideration when developing the site selection criteria. The morphological aspect was determined in degrees, and the wind frequency is in meters/seconds.

The other main meteorological parameters of concern for the proposed hazardous waste disposal facility include annual average rainfall data and ambient temperature. The data of precipitation can be converted into Dbase format and then imported into ArcGIS as point data. In the analysis using ArcGIS processing software, data interpolation can be made using a widely used technique called the Inverse Distance Weighted (IDW). IDW technique involves the interpolation of ground based point data. The diurnal variation and seasonal trends are interpreted by utilizing the ambient air temperature conditions.

Appendix 5

Soil and Geotechnical Survey

Geotechnical investigations are performed to evaluate those geologic, seismologic, and soils conditions that are suspected to affect the safety, design cost effectiveness, and execution of a proposed CHW-TSDF project in Chittagong. The geotechnical investigation of the site must provide information on the subsoil and other associated geotechnical conditions which are prevailing within the site designated for the hazardous wastes disposal facility in Chittagong.

For designing the hazardous waste disposal facility (TSDF), the major siting criteria must include permeability and porosity of base material, the profile of groundwater and surface water (flow, direction and quality) *etc.* To identify the siting conditions in and around Chittagong, the underlying geological setting will aid along with the prevailing topographical and climatic conditions. The selection of the hazardous waste landfill site is very crucial as it could effectively influence the migration of contaminants from the hazardous wastes constituents. The facility is typically expected to resist and retard the migration of leaked and leached aqueous streams from the landfill. Insufficient and inappropriate geotechnical investigations may lead to faulty results and their subsequent interpretation may contribute to wrong designs, delays in construction schedules, expensive construction modifications, and use of substandard borrow material as well as environmental damage to the CHW-TSDF site.

A detailed evaluation of geotechnical parameters at the proposed TSDF site in Chittagong should involve:

- 1. Subsoil Investigation:** A geotechnical engineer may draw up the plan for the detailed investigation for soil profile study. This study will involve the depth of ground water table, stratification of subsoil, the nature and depth of bedrock, permeability, strength and compressibility of subsoil and drainage profile. The test pits or boreholes are to be excavated and lab scale studies are to be conducted for understanding the profile of soil strata. Such borings have to be drilled through the soil column to unweathered bedrocks (CPCB, 2001).

Soil testing and analysis are very essential elements for the classification and evaluation of the load bearing strength, slope stability of the designated site and settlement properties of the soil types encountered, as well as the permeability and attenuative properties of the soils to act as a barrier to leachate generation and groundwater contamination. As extracted verbatim from the World Bank Report (1997) entitled "Sanitary Landfill Design and Siting Criteria":

“All the investigative analysis procedures shall be in compliance with guidelines provided by regulatory authorities/ Government bodies, for soils surveys and testing. Classification, by particle size, plasticity, porosity, moisture content, Atterberg limits, etc. shall be adequate to classify each soil and indicate whether it's mixture of silt, clay, sand, gravel, etc.” (Source: World Bank Report, 1997).

For the sites identified for TSDf in Chittagong, there has to be enough on-site soil of appropriate quality, which can be used for construction of the plant particularly for landfill operations and requirements of soil cover. If sufficient soil could not be sourced from the site, suitable materials will have to be borrowed (or commercially purchased). There shall be inspection of off-site areas before actually procuring the required soil so that the required quantity and quality can be ascertained. The soil investigation must mainly comprise the below discussed soil properties as certain soil characteristics contribute in secure and economically feasible implementation and operation of a TSDf plant. The most common parameters that define soil property of a site are permeability, effective porosity, and workability. Soils with higher silt and clay fractions provide groundwater protection and are considered as economically cheaper site for constructing a TSDf plant. If clay is not available at a location, it must be hauled to the site, or substituted with a geosynthetic system to maintain water quality levels.

- 2. Hydrogeological Investigation:** A detailed investigation by groundwater consultant or hydro-geologist is considered essential for rationally deciding the potential location for siting of the TSDf in Chittagong. It is absolutely essential to cover the following hydrogeological parameters: depth to groundwater table and its seasonal variations, the groundwater flow direction and the water quality parameters. The groundwater level and flow patterns can be analyzed by groundwater wells. The permeability of the groundwater regime has to be studied in order to understand the mechanism of contaminant transport.

Since groundwater contamination issues are a major concern, geologic characteristics of a site are an important consideration. Hence geomorphology study acts as a key factor in decreasing the risk of contamination of the sub-surface ground profile. Earth material with low hydraulic conductivity, low effective porosity, and high retention (absorption, adsorption) of hazardous solutes should be considered ideal for CHW-TSDF locations in Chittagong.

Sampling of water at site shall be performed from at least one of the wells. A groundwater contour map has to be provided indicating the catchment area for the shallow groundwater. The infiltration rate plays a very crucial role in assessing the potential risk of contamination of groundwater and thus is a one of the major criteria for the development of landfill facility in a region (Babalola and Busu, 2011; Yazdani et al., 2015). Infiltration maps are prepared for hydro-geological investigation.

Infiltration Map: The data layers provide information on the properties of the ground, which can be used to guide local SuDS (Sustainable Drainage System) planning and design. These could be two types (URL- British Geological Survey):

The Detailed Map: The data layers provide information on the properties of the ground, which can be used to guide local SuDS planning and design. The data can be used to determine the likely limitations present at a site and make preliminary decisions on the type of infiltration SuDS that may be appropriate. It is anticipated that this map will be used by planners, developers, consultants and SuDS Approval Bodies. The dataset is intended to be used at a preliminary stage and is not a replacement for a site investigation.

The Summary Map: It comprises four summary layers, providing an indication of the suitability of the ground for infiltration SuDS. The layers summarize: the presence of severe constraints; the drainage potential of the ground; the potential for ground instability as a result of infiltration and the susceptibility of the groundwater to contamination. This map is anticipated to be of use in strategic planning and not for local assessment. It does not provide specific subsurface data or state the limitations of the subsurface with respect to infiltration.

More detailed description of hydrogeological investigations has been discussed in Appendix 6.

3. Geological and seismic investigation: Areas of permitted waste management units and facilities where treatment, storage, or disposal of hazardous waste will be conducted cannot be located within an area of a fault that has experienced movement any time during the Holocene epoch or floodplain or salt dome formations, salt bed formations, or underground mines or caves (USEPA 40 CFR 264 Subpart B, Section 264.18). Detailed investigation should indicate the quality of surficial rock, depth to hard rock strata, and possibility of interconnected aquifers *etc.* More detailed description of seismological data has already been given in Appendix 3.

As indicated in Indian guidelines (CPCB, 2001) and World Bank Report 1997, geophysical survey using seismic refraction or electrical resistivity is to be performed. It is appropriate to identify the type of conditions anticipated at the site and has to be designed to characterize the confining layer below the shallow aquifers and identify major layers of soil, weathered bedrock, and depth to bedrock. This shall be carried out in consultation with a geologist. Based on the investigations carried out on the field, adequate knowledge has to be developed for geotechnical investigations particularly for hazardous waste landfills and associated infrastructure, such as accessibility and internal roads. The seismic activities have to be detected and analyzed at site which includes response to site conditions, liquefaction potential of subsurface soils *etc.* (CPCB, 2001). The two fundamental parameters for geological investigation of a landfill site is “land slope” and “height” (Kontos et al., 2005).

Land Slope and Height: Slope refers to the measures of the rate of change of elevation at a surface location and normally expressed in percent or degree slope. The slope of the land surface is a crucial criterion because very steep slopes lead to higher excavation costs (Şener et al., 2010). It is reported that areas with high slope are not suitable for construction of landfill sites or TSDF plant. As indicated in the studies conducted by Akbari et al., (2008), for a landfill site, the slope should not be more than 20% with medium altitude surrounded by hills. Lin & Kao, (1999) suggested that a slope less than 12% would be suitable for the prevention of contaminant runoff. Many of the important landscape processes such as soil water content, erosion potential, runoff rates and velocity of overland and subsurface flow happens to get affected by the slope (Gorsevski et al., 2012). Hence it is an important factor especially for landfill construction and operation purposes as well as the stability from material weight. The slope map can be generated from the

triangulated irregular network (TIN) using the elevation surface values through interpolation using the topographic maps. The areas with high slopes are not ideal for waste disposal, and flat areas are not ideal either. The preferred areas for waste disposal are those with medium slope of not more than 20 degree.

Aspect: Aspect is simply the measure of the direction of slope. Odor from the landfill sites is considered as the major problem. Nearby settlements must not be affected from the odor that originates from the landfill. To evaluate the wind direction of the site, it is suggested to prepare an aspect map using a digital elevation model with a 30-30 m resolution (Şener et al., 2010). Aspect is often classified into four major directions namely; north, east, south, and west, or into eight major directions; north, northeast, east, southeast, south, southwest, west, and northwest.

4. **Miscellaneous Issues**: The undermined areas, earth tremors, sinkholes and surface subsidence are to be taken into account while designing the facility. The other major issues are land-use and land value which are briefly discussed below:

Land-Use: Land for siting the TSDf facility should be judiciously decided in order to minimize the potential hazards due to hazardous wastes pollution. Because there are some restrictions related to landfill sites, land use of the region must be considered. Forest/heath lands and pasture areas should not be used as hazardous wastes disposal sites (Şener et al., 2010). Public acceptance of unwanted facility site varies with land-usage. Land-use of lowest value in public opinion reduces conflict over higher valued land-uses.

TSDf location must be accessible to industries and other wastes generating locations in order to reduce the transportation costs. However, it is suggested that aesthetically and logically a buffer of 100 meter should be considered for siting the facility (Javaheri et al., 2006).

Land Value: Economic factors for site are based in three areas, explicitly, acquisition costs, and development and operation costs of each site. There are generally four parameters used to characterize the economy and safety, which are land cost (LC) as a percentage of the highest price, distance from highway (DH), distance from waste generation source (DWGS) measured by the driving time, and distance from airport runway (DAR) (Al-Jarrah and Abu-Qdais, 2006).

U.S. Department of Housing and Urban Development (2007) adds that in some cases the land and existing structures will have already been acquired. If the land and existing structures are being refinanced or reimbursed as a part of the development, then enter the relevant acquisition cost. However, if land and existing structures have already been acquired and the project is focused on renovating, demolishing, or otherwise developing the site, then it is not necessary to enter acquisition costs. According to DWAF (2005), there are 10 considerations under economic criteria. These consist of:

- The possible incorporation of the site into the waste disposal system, either immediately or in the future.
- The economies of scale. Large sites are economically more attractive.
- The distance of the site from the waste generation areas. This is directly proportional to transportation costs.
- The size of the operation. A disposal site must cater for the disposal of the waste stream over at least the medium term to justify the capital expenditure. In addition to the size of the landfill proper, the anticipated extent of the ultimate buffer zone should be considered.
- Access to the landfill site. This has cost convenience and environmental implications, especially if the roads have to be considered.
- The availability of on-site soil to provide low cost cover material. Importation of cover increases operating costs and cover shortage may reduce site life.
- The quality of the on-site soil. Low permeability clayey soil on site will reduce the cost of containment liner and leachate control systems.
- Exposed or highly visible sites. High visibility results in additional costs being incurred for screening.
- Land availability and/or acquisition costs. These dependent on present or future competitive land-uses such as agriculture, residential or mining.
- Other miscellaneous economic or socio-economic issues, *e.g.*, where the displacement of local inhabitants must be addressed.

Appendix 6

Ground Water and Hydrogeological Survey

Decision on any developmental project, such as the hazardous waste disposal facility in Chittagong, should take into account the hydrogeological and groundwater profile of the site. In the proposed site for construction of CHW-TSDF in Chittagong, it is essential to decipher sub-surface lithology, water table depth and infiltration rates of the soil profile.

The geophysical tests like Vertical Electrical Sounding (VES), Multi-Electrode Resistivity Imaging (MERI), Ground Penetrating Radar (GPR) scanning and hydrogeological tests like infiltration tests, groundwater table and water quality of the selected site will help in deciding the nature of the selected candidate site for the TSDF.

The geophysical and hydrogeological investigations conducted by any technique have to be cross-verified with the actual drilled soil log data (at designated locations) within the selected TSDF site. The details of aquifers, aquatic chemistry *etc.* will help in identifying physical environment around the proposed TSDF site (Sonkamble et al., 2013). This will facilitate understanding the potential chances of contamination to ground water in and around Chittagong.

A set of field investigations are required to be carried out in the proposed TSDF site in Chittagong, in order to compile hydro-geological profile maps and evaluate the overall hydrogeological conditions of an area. This will include details of hydraulic head, hydraulic conductivity, porosity, moisture content, specific yield, retention capacity, contaminant transport properties, hydrodynamic dispersion, diffusive adsorptive properties *etc.*

In the process of ground water profile surveying studies in Chittagong, it is recommended to identify the water-bearing levels, zones of water storage, water-bearing permeable rock, rock fractures, unconsolidated materials (gravel, sand, or silt), the filtering properties of rocks as well as amount of overburden pressure, quality and quantity of underground water.

Suitable hydrogeological survey has to be undertaken for the proposed TSDF site in Chittagong depending upon the scale and purpose of the survey. In a small-scale hydrogeological survey (1:1,000,000-1:500,000), studies are carried out in order to compile the data on hydrogeological maps in regions where minimum studies have been conducted for hydrogeological parameters (mainly, water-bearing properties of the rocks and the quality of the groundwater).

In the process of medium-scale hydrogeological surveys (1:200,000-1:100,000), the data from government hydrogeological maps, water-bearing profiles and studies on the water-bearing properties of rocks, quality and the regime of underground water, and associated geological phenomena of underground and surface water are compiled.

The extensive large-scale hydrogeological surveys (1:50,000 and greater) point to solve specific problems which occur at the stages of engineering and operational planning of any project which comprises factors like prospect for reserves of underground water, watering capacity of deposits etc. The medium and large-scale surveys often deploy drilling operations, measurement of the flow of water from various sources, measuring chemical composition of underground water, aero-visual observations, deciphering of aerial photographs etc.

The depth of groundwater table is defined as the distance between the ground surface datum and the groundwater table. It is crucial to prepare the Groundwater Table Map for the city of Chittagong because the depth to groundwater table from surface is an important parameter of concern in determining the contamination risk to groundwater. This will guide in controlling and mitigating the potential contamination due to the proposed hazardous wastes disposal sites. As reported in several studies, the precipitation, topography of the site and soil profile affects the rate of infiltration into the water table (Chuangcham et al., 2009).

Preparation of Groundwater Table Map for the selected site of TSDF requires baseline data on the parameters which control the occurrence and movement of groundwater (mainly geology, geomorphology, soils, land-use, lineaments *etc.*). In Chittagong, GIS and remote sensing enabled study utilizing lineaments and geologic maps in a digital form may be used to analyze and interpret the satellite data.

The process of preparation of map includes satellite data registration, correction (geometric and atmospheric) and processing of the image which includes

enhancement, filtration, classifications, resolution merging, checking and aligning with field data. The digitalized spatial data with mapped layers, including annual precipitation, geological data, lineament density, topographic elevation, slope of the area, drainage density and land-use pattern and the corresponding data are incorporated in the ground water map that will be prepared for our purpose (Sener et al., 2005).

Appendix 7

Background Environmental Parameters

Background environmental parameters can be defined as the procedures and activities that can be used to characterize and monitor the quality of the environment. For the development of the CHW-TSDF in Chittagong, environmental monitoring data can be used in the preparation of environmental impact assessment reports, as well as in many circumstances in which any anthropogenic activity can carry hazardous impacts on human health and the surrounding environment.

Environmental monitoring is the systematic measurement of key environmental indicators over the time within a particular geographic area. As suggested by Were (2013) and Barasa (2014), monitoring should typically focus on the most significant impacts identified in the EIA. Various types of monitoring activities are routinely undertaken for EIA as well as assessment of environmental performance. Thus a variety of monitoring activities are performed with the corresponding specific intentions. Some of those are described briefly below:

Baseline Monitoring: A survey should be conducted on basic environmental parameters in the area surrounding the proposed CHW-TSDF project in Chittagong before construction begins. Subsequent monitoring can assess the changes in those parameters over time against the baseline. The following environmental components have been recommended to be analyzed for collecting the baseline data in the Indian Guidelines (Source: CPCB, 2010):

Environmental Components	Monitoring Data-base line
Ambient Air Quality	Date of sampling, Temperature, Wind speed and direction, Monitoring results for standard air quality parameters to be enclosed
Soil quality (up to 1m depth)	Date of sampling, Depth of sampling and the soil characteristics for standard soil parameters including heavy metals to be enclosed
Surface /Ground water characteristics	Date of sampling, Depth of ground water table and direction of flow/depth of surface water at which samples taken, Characteristics for drinking water parameter to be indicated
Noise Levels in decibels	Date of sampling, Parameters to be monitored and indicated as per norms

Impact Monitoring: The biophysical and socio-economic (including public health) parameters within the proposed project area in Chittagong, must be measured during the project construction and operational phases in order to detect environmental changes, which may have occurred as a result of the project implementation e.g. air emission, dust, noise, water pollution *etc* (European Commission, 1999).

Compliance Monitoring: This form of monitoring employs a periodic sampling method, or continuous recording of specific environmental quality indicators or pollution levels to ensure project compliance with recommended environmental protection standards.

Sampling Methods: Monitoring should be regular and performed over a long period of duration. Interruptions in monitoring may result in generating insufficient data to draw accurate conclusion concerning project impact. As per the guidelines given by EPA (2007) the sampling methods adopted for performing environmental monitoring at the proposed CHW-TSDF site in Chittagong are broadly classified into two: grab and composite type of sampling (Adams, 1989; Chapman, 1996; APHA, 1996; Jones, 2001).

Grab Sample: A grab sample is a discrete sample which is collected at a specific location at a certain point in time. If the environmental medium varies spatially or temporally, then a single grab sample is not representative and more samples need to be collected.

Composite Sample: A composite sample is a sample consisting of two or more sub-samples mixed together in known proportions. These samples are made by thoroughly mixing several grab samples. These may be collected manually (by combining grab samples), or by an automatic sampler. The whole composite may be measured, or random samples from the composites may be withdrawn and measured.

A composite sample may be prepared using the samples taken either at different locations or taken at different times at the same location. It must be understood that the so-called composite samples represent an “average” of several measurements and contain no information about the variability encountered over the space or time.

When the sampling medium is very heterogeneous, a composite sample is more representative than a single grab sample. For example, in a study of the quality of aquatic environment in a river or lake, a 24-hour composite sample will provide more

reliable information than several grab samples drawn from a given location. Similarly, one can get a more reliable idea about the quality of water in a stretch of the river or in the lake by taking grab-samples drawn from several locations in the study area and then by combining them to make a “composite sample”.

Appendix 8

Biodiversity and Data on Biological Environment

One of the most serious threats due to the construction of a hazardous wastes disposal site in Chittagong could be the loss and degradation of habitats and biological diversity. Biodiversity is considered as absolutely critical to human sustainability. One of the most destructive of all anthropogenic activities is the deforestation and habitat fragmentation. The fragmentation of forests directly influences the ecological processes within them causing the loss of flora and fauna species from these areas. Thus, construction of a hazardous wastes disposal facility in Chittagong may have the adverse impact on the adjoining forest areas and the biodiversity. The biodiversity of the local area may also be hampered creating the so-called irreversible damage. It is important to note that the following detailed information has been sourced nearly verbatim from the report entitled “Siting, design, operation and rehabilitation of landfills”, published by Environmental Protection Authority, Victoria, Australia (2010).

The potential impacts on flora and fauna has been listed by EPA Victoria (2010) for studying the biological environment. The proposed CHW-TSDF project in Chittagong can cause the following impacts on the species’ diversity and the adjoining forest cover in and around Chittagong:

- Deforestation/clearing of vegetation
- Habitat loss and displacement of fauna
- Loss of biodiversity by impacts on rare or endangered flora and fauna
- Potential for spreading plant diseases and noxious weeds
- Litter from the landfill detrimentally impacting on flora and fauna
- Creation of new habitats for scavenger and predatory species
- Increased vehicular traffic in the area
- Erosion
- Alteration of water courses

It is recommended that, landfilling must not be done in some of the areas where there is rich biological diversity, such as:

- Critical habitats of taxa and communities of flora and fauna listed under the Flora and Fauna conservation acts
- State wildlife reserves listed under the Wildlife Acts
- Matters of national environmental significance as identified in the Environment Protection and Biodiversity Conservation Acts

A survey of the site and collection of comprehensive baseline environmental data are very essential steps in the assessment of potential impacts of the proposed CHW-TSDF project in Chittagong. The nature and extent of this data should be specific to the site, taking into account the size of the proposed operation and the risks posed to adjacent, sensitive areas. This includes potential impacts from scavenger birds on aircraft safety and water supplies, as well as impacts from predatory animals, such as feral cats, on surrounding native fauna. An expert in the field should be consulted for an assessment of potential impacts from scavenger birds or predatory animals (Source: EPA Victoria, 2010).

As stated in Canter (1996), a six step conceptual approach is required to address the biological impacts of any developmental activity. The generic steps for the proposed CHW-TSDF project in Chittagong adopted from Canter (1996) are as follows:

- (1) Identification of possible potential biological impacts of the construction at the proposed CHW-TSDF project in Chittagong. The impacts could be habitat losses and fragmentation, bioaccumulation, biomagnifications, toxic events etc.
- (2) Preparation of descriptive report of existing biological conditions and environmental setting in and around Chittagong in terms of types of habitats, site specific flora and fauna, endangered and threatened species etc.
- (3) Procurement of relevant laws, regulations or criteria (specific to the proposed CHW-TSDF site in Chittagong) regarding the biological resources, species and habitat protection.
- (4) Conduct of impact prediction activities including the use of case studies, physical and/or mathematical modeling, and based on professional judgment.
- (5) Use of relevant information from step 3, along with professional judgment and public input, to assess the significance of anticipated beneficial and detrimental impacts.

(6) Identification, development, and incorporation of appropriate mitigation measures for the adverse impacts (Source: Canter, 1996).

Biodiversity surveys are undertaken to find out what organisms exist in a given area. The data that is gathered from these surveys is used for numerous purposes such as:

- monitoring endangered populations
- evaluating conservation priorities of an area
- bioprospecting

Appendix 9

Traffic Survey and Transportation Planning

Traffic surveys are an integral component of a comprehensive traffic and transportation study for the proposed CHW-TSDF project in Chittagong. Measurement and analysis of the existing traffic and transportation characteristics is extremely important not only for developing comprehensive traffic and transportation plan in and around Chittagong but also for siting of the proposed CHW-TSDF project. Proximity to transportation routes - which can support heavy equipment and loads could possibly influence the usability of the given site in Chittagong for the construction of the TSDF. Most of the sites that are favorably considered have been selected on account of the lower costs associated with lower impacts while transporting construction material to the proposed TSDF site in Chittagong. Similarly, the sites which are accessible by the waste generating industries are typically preferred. Thus, the road network plays an important role in reducing the transportation cost in the context of the proposed TSDF project.

The baseline data would help in the selection of the TSDF sites in Chittagong particularly the vehicle movement patterns, travel characteristics, pedestrian and parking characteristics and available infrastructure facilities within the area. Such surveys are important to analyze the accessibility of the roads and approachability to the target industries in and around Chittagong.

Traffic survey is needed to evaluate various parameters such as road network, distance from residential areas, distance from populated centers *etc.* The road network map outlining the national highways and other major roads should be developed so that the vehicles transporting hazardous wastes do not have to crisscross the city of Chittagong. Such maps will also help in planning beneficial alignment of ring road around the city of Chittagong. Having close proximity to the source gives a long-term economic benefit to the generator of wastes, since distances of hauling the waste are reduced and also the risks of accidents diminish greatly.

In this context, the agencies developing TSDF projects in India have focused on the data collection activities such as classified traffic volume counts, origin-destination

surveys, road inventories and condition surveys, household socio-economic and travel surveys, speed and delay survey, public and IPT operator and user surveys, parking surveys, pedestrian surveys and rail gate closure surveys. In addition, significant data from secondary sources pertaining to demographic, socio-economic characteristics, public transport system *etc.* should also be collected as the part of the data collection activity.

The following steps have been recommended here for the planning transport and traffic surveys in Chittagong – which are extracted nearly verbatim from a book entitled “Survey methods for transport planning”, authored by Richardson, Ampt and Meyburg (1995):

1) The very first step is the preliminary planning, which includes estimating the cost of the surveys, personnel requirements and space requirements. Selection of the survey method is also one of the crucial components of traffic and transportation surveying. It includes the time frame for survey and data collection techniques.

Types of data collection techniques are as follows:

- a) Documentary searches
- b) Observational searches
- c) Household self-completion surveys
- d) Telephone surveys
- e) Intercept Surveys
- f) Household Personal Interview Surveys
- g) Group Surveys
- h) In-depth interviews

2) Selection of Sampling Procedures: where we decide the target population definitions, sampling units, sampling frame, sampling methods, sampling errors and sampling bias, sample size calculations and estimation of variance. Various sampling methods can be used, which as follows:

- a) Simple random sampling
- b) Stratified Random sampling
- c) Variable fraction Stratified Random Sampling
- d) Multi Stage Sampling
- e) Cluster Sampling
- f) Systematic Sampling
- g) Non Random Sampling Methods

- 3) Survey instrument design and conducting pilot surveys. The pilot surveys will include the adequacy of the sampling frame, variability of parameters within the survey population, non-response rate and method of data collection.
- 4) Data processing which can be done through various coding techniques.
- 5) Data analysis which can be done by Bivariate regression, Multivariate regression, Factor analysis, discriminate analysis, maximum likelihood estimation and logit analysis (Source: Richardson, Ampt and Richardson, 1995).

Primary Surveys should be conducted as a part of site selection credentials for the proposed TSDF project in Chittagong. The following primary traffic surveys should be conducted for studying and analyzing the existing traffic and travel demand characteristics and to prepare the transport infrastructure improvement plans and for identifying the proposed TSDF site:

- Road inventory survey
- Classified Traffic Volume Count Survey
- Origin-Destination Survey
- Intersection Turning Movement Survey
- Household Interview Survey
- Speed and Delay Survey
- Parking Survey
- Pedestrian Survey
- Rail Gate Crossing Survey
- Intermediate Public Transport Operator Survey
- Intermediate Public Transit (IPT) User Survey
- Public Transit (PT) User Survey
- Truck Operator Survey

Appendix 10

Socio-Economic Aspects of the Project

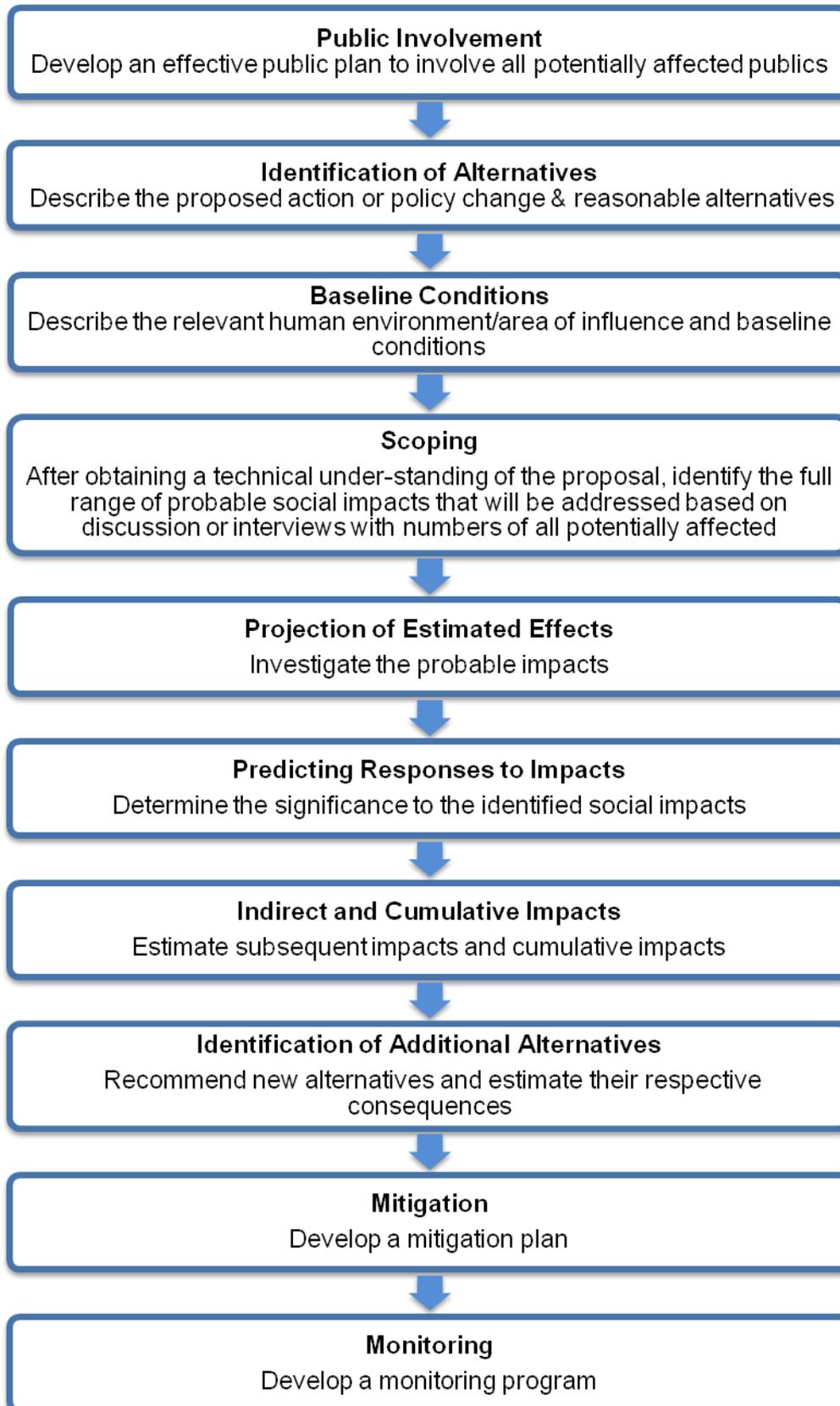
Socio-economic as well as environmental considerations have to be estimated and analyzed simultaneously in order to select the appropriate site for the proposed hazardous wastes disposal facility in Chittagong. Socio-economic impact assessment is an important contemplation for any developmental project (Alshammari et al., 2008; Pandiyan et al., 2011). The social impacts of a hazardous wastes disposal facility at Chittagong may occur in various forms. Therefore, it is very crucial to identify and consider all the possible social aspects while selecting the site for the proposed TSDF plant. There is now a growing concern over the displacement of people. This has given rise to the need to understand beforehand the implications of adverse project impacts so that mitigation plans could be put in place in advance.

The NIMBY phenomenon is both an important consideration and restraint to the establishment of a hazardous wastes management facility in Chittagong. The external cost and undesirable characteristics of landfills often cause people to perceive the hazards and risks as outweighing the long-term benefits.

Transportation, noise and congestion, lower property values, and lessening of community or personal self-image are the high costs perceived by the public. Costs and benefits are found to be directly proportional to the extent that an increase in the distance at which one lives from an undesired facility reduces the amount of perceived costs. Social impacts such as property price depreciation represent an external 'cost' of waste disposal and treatment facilities. Property values are also affected by their proximity to a new landfill. There could be other associated negative impacts due to the waste management facility. However, as a result of such developmental projects, there would be employment generation, business generation, infrastructure development, etc. (CPCB, 2003).

There are limited technical and social databases available in developing countries for making impact projections. As a result of which, extensive baseline data has to be collected for assessing the social impacts of any developmental projects such as the proposed hazardous wastes management facility in Chittagong (Lohani et. al., 1997). There are various steps involved in assessing the socio-economic impacts of siting,

constructing and operating a hazardous wastes management facility in Chittagong. There are mainly 10 steps in social impact assessment as mentioned below:



An Initial Social Impact Assessment should be carried out if the project impacts are likely to be minor or limited, which can be easily predicted and evaluated, and for which mitigation measures can also be prescribed easily. Information for initial social impact assessment of the proposed TSDF has to be obtained by field visits to areas that could be affected by the project and through discussions with people whom it may affect positively or otherwise.

The major advantages of assessing the social impacts of the proposed CHW-TSDF project would be identification of affected groups, assessment of potential social and economic impacts, avoiding adverse impacts, enhancing positive impacts, reducing costs and getting fast approval for the proposed project.

Assessment of Potential Risks

It is thus imperative to assess all the potential socio-economic risks before the execution of the proposed CHW-TSDF in Chittagong, so that appropriate mitigation measures can be adopted for minimization of the impacts. In the verbatim extract from the World Bank paper entitled “Impoverishment Risks, Risk Management, and Reconstruction-A Model of Population Displacement and Resettlement”, the eight most common impoverishment risks to the project area people, as described by Cernea (1996), are as follows:

- **“Landlessness:** *Expropriation of land removes the main foundation upon which peoples’ productive systems, commercial activities and livelihoods are constructed.*
- **Joblessness:** *Loss of employment and wages occurs more in urban areas, but it also affects rural people, depriving landless labourers, service workers, artisans, and small business owners of their sources of income.*
- **Homelessness:** *Loss of housing and shelter is temporary for the majority of displacees, but threatens to become chronic for the most vulnerable. Considered in a broader cultural sense, homelessness is also placelessness, loss of a group’s cultural space and identity.*
- **Marginalization:** *Marginalization occurs when families lose economic power and spiral downwards. It sets in when new investments in the area are prohibited, long before the actual displacement. Middle-income farm households become small landholders; small shopkeepers and craftsmen are downsized and slip below poverty thresholds. Economic marginalization is often accompanied by social and psychological marginalization and manifests itself in a downward mobility in social status, displaced persons’ loss of*

confidence in society and in themselves, a feeling of injustice and increased vulnerability.

- **Food Insecurity:** *Forced displacement increases the risk that people will undergo chronic food insecurity, defined as calorie-protein intake levels below the minimum necessary for normal growth and work. Sudden drops in food crops availability and income are endemic to physical relocation and hunger lingers as a long-term effect.*
- **Increased Morbidity and Mortality:** *The health of affected persons tends to deteriorate rapidly due to malnutrition, increased stress and psychological traumas. Unsafe water supply and waste disposal tend to proliferate infectious disease, and morbidity decreases capacity and incomes. The risk is highest for the weakest population segments – infants, children, and the elderly.*
- **Loss of Access to Common Property:** *Loss of access to commonly owned assets (forestlands, water bodies, grazing lands, and so on) is often overlooked and uncompensated, particularly for the asset less.*
- **Social Disarticulation:** *Community dispersal means dismantling of structures of social organization and loss of mutual help networks. Although this loss of social capital is harder to quantify, it impoverishes and disempowers affected persons.” (Source: Cernea, 1996)*

It is given to understand that most of the regional and international development banks are insisting on performing the SIA before considering any project proposal for funding. Therefore, it is suggested to perform Social Impact Assessment (SIA) simultaneously and efficiently along with Environmental Impact Assessment (EIA) for the proposed TSDf at Chittagong. In India, Social Impact Assessment (SIA) is generally carried out as part of the Environment Impact Assessment clearance process.

Appendix 11

Environmental Impact Assessment

Environmental Impact Assessment (EIA) can be viewed as a tool capable of guiding and harmonizing sustainable development. It can also be defined as an important management tool in order to ensure optimal use of natural resources. It is a mandatory process before approval of any infrastructure projects with a documentation of significant impacts on the environment (Zekeňáková and Zvijáková, 2017). EIA should clearly suggest potential impacts on environment for the mitigation, monitoring and institutional measures to eliminate, compensate or reduce impacts to acceptable levels during construction as well as during the operational phase of various projects (Panigrahi and Amirapu, 2012).

It is a recognized procedure of assessing credible impacts of projects in many countries and is currently being practiced in more than 100 countries. EIA as a mandatory regulatory procedure originated in the early 1970s, with the implementation of the National Environment Policy Act (NEPA) 1969 in USA. A large part of the initial development took place in a few high-income countries, like Canada, Australia, and New Zealand (1973-74).

However, there were some developing countries as well, which introduced EIA relatively early - Columbia (1974), Philippines (1978) (Sadler and McCabe 2002). In India, Environmental Protection and Sustainable Development have been the cornerstones of the policies and procedures governing the industrial and other developmental activities.

The Ministry of Environment, Forests and Climate Change (MoEF&CC) has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects.

One such initiative is the notification on Environmental Impact Assessment (EIA) of developmental projects issued in year 1994 under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for 29 categories of developmental projects.

Significance of EIA as a Tool

Environmental Impact Assessment (EIA) is more than technical reporting; it is meant to serve the larger purpose of protection and improvement of the environmental quality. It is a procedure to identify and evaluate the effects of activities (mainly anthropogenic) on the environment including the natural and social realms. It centers upon many scientific principles and technological developments in an integrated inter-disciplinary manner, evaluating phenomena and relationships as they occur in the real world. Many approaches as appropriate to the problems can be employed. Therefore, EIA should not be treated as an appendage, or an add-on, to a project, but be regarded as an integral part of project planning, and costs for carrying out EIA should be calculated as a part of planning. It does not provide decisions but its findings should be considered in policy- and decision-making and should be reflected in final choices.

EIA has been recognized as a basic environment management tool, since it also helps to determine how and which preventive and mitigation measure should be taken during and after the formulation of a developmental project. The findings of EIA should be focused on the significant and essential issues, highlighting their relevance. The EIA process centers upon three core values of integrity, utility and sustainability.

EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures. The EIA process in India consists of following steps (Asolekar and Gopichandran, 2005):

- 1) Screening
- 2) Scoping and consideration of alternatives
- 3) Baseline data collection
- 4) Impact prediction
- 5) Assessment of alternatives and delineation of mitigation measures
- 6) Public hearing
- 7) Environmental Management Plan

- 8) Decision making
- 9) Monitoring the clearance conditions

1) Screening: Screening step of EIA process aids in deciding if and at what level EIA should be applied. Every project has social, environmental and economic impacts. So it is important to establish mechanisms by identifying projects which require EIA, and this process of selection of project is referred to as “Screening”. This step helps in deciding, whether or not the project requires environmental clearance as per the regulatory and statutory requirements. The screening criteria are based upon:

- Scale of investment;
- Type of development; and
- Location of development

Screening process helps in deciding whether the activity of EIA needs to be:

- full or comprehensive
- more limited in nature
- further study needed to determine EIA requirement or
- no further requirement for EIA

2) Scoping and consideration of alternatives: Scoping is to determine what should be the coverage or scope of EIA study for a project proposal, having potentially significant environmental impacts. It also helps in developing and selecting alternatives to the proposed action and in identifying the issues to be considered in an EIA. Scoping has to be done by the authorized professional in consultation with the Project Proponent or impact assessment agency if needed.

Scoping mainly serves the following purposes:

- To consider and evaluate the main environmental impacts of a proposed project, possible alternatives and to extend the level of study to spatial and temporal scopes
- To determine the appropriate EIA methods relevant to the project’s potential environmental and socio-economic impacts
- To facilitate and provide information to bonafide residents in the project affected area so that they may take part in identification and assessment of the project's environmental and socio-economic impacts
- Scoping process is an important step in formulation of detailed ToR for impact assessment

There is a similar approach of scoping that enables the competent environmental authority to issue specific terms of references (ToRs) for different types of activity. This allows simple ToRs to be issued for routine projects, with more comprehensive ToRs being produced for larger or more unusual projects. ToRs shall discuss issues to be assessed during the impact study (identified by scoping studies), sufficient description of the specific work tasks for the EIA experts, stakeholder consultation and description of the experts required for the impact study.

One potential disadvantage of the ToRs approach is that it can place a great burden on competent authorities to define the scope of assessments, and can absolve developers of their responsibility to identify all the potentially significant impacts of their proposals. While the ToRs approach to scoping may well be appropriate for routine activities, it may limit the effectiveness of EIA for more complex ones (Ahmad and Wood, 2002).

3) Baseline Data: The term "baseline" refers to the collection of background information on the environmental, social and economic settings of proposed project area. The establishment of baseline information is either through secondary sources when a database facility exists, or by field sampling. The task of baseline data formulation happens mostly during the scoping process and usually starts during the inception of the project. The process includes establishment of both the present and future status of the environment, in the absence of the project, taking into account the changes resulting from natural events and from other human activities (Glasson et al., 2013). Establishment of baseline will help in providing changes occurring due to the proposed project and will also aid in detecting actual change by monitoring once a project has been initiated. When establishing a baseline, information is gathered on:

- current environmental conditions;
- current and expected trends;
- effects of proposals already being implemented; and
- effects of other foreseeable proposals.

In the process of scoping and baseline studies, the description and evaluation of baseline conditions (Morris and Therivel, 2001) should include:

- a clear definition and presentation of methods and results;
- indications of limitations and uncertainties of the baseline studies, e.g. in relation to data accuracy and completeness; and

- an assessment of the value of key receptors and their sensitivity to the various impacts.

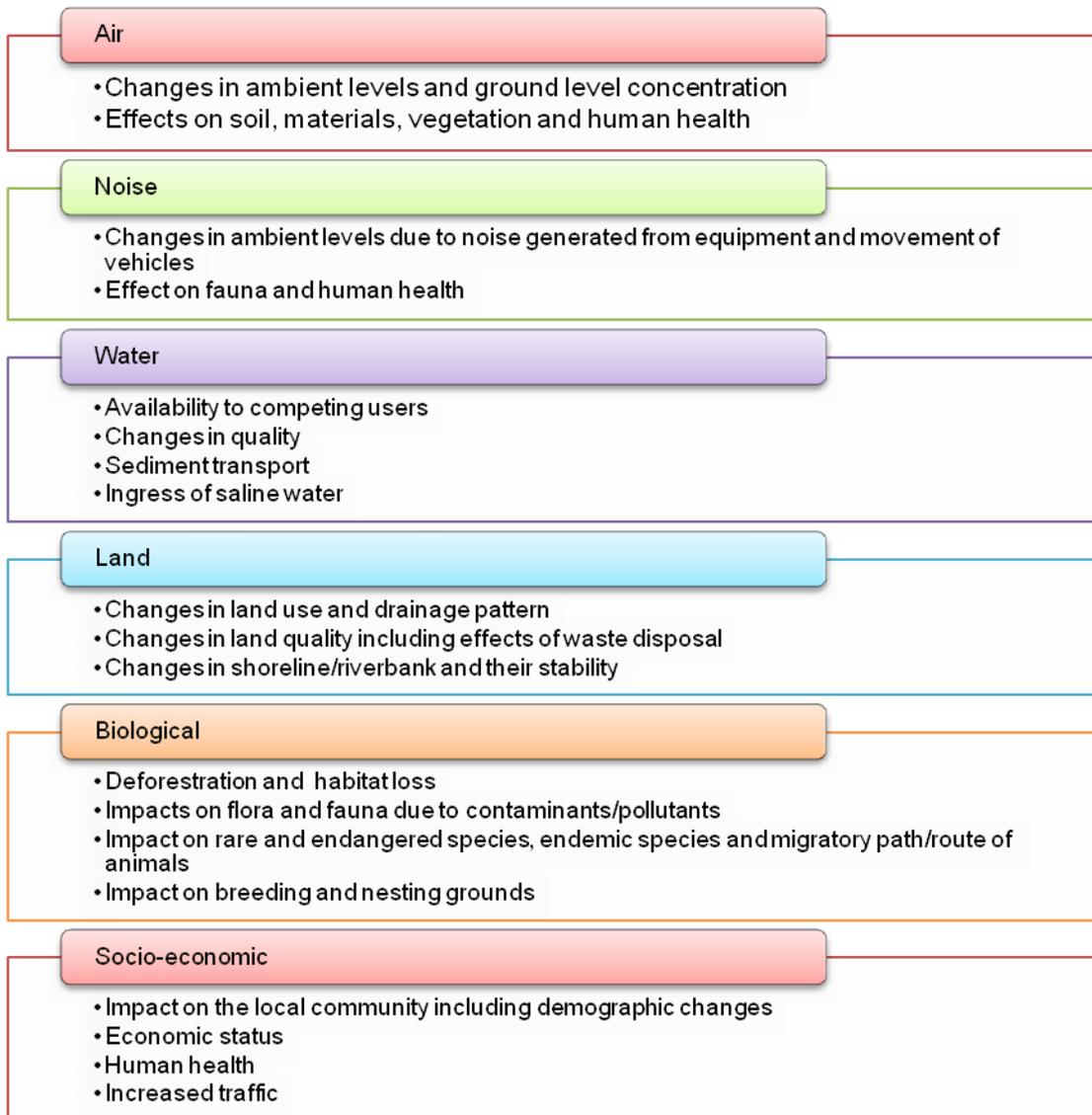
The baseline data collection must include aspects of concern for air, noise, water, land, biological species, society and economy as illustrated in **Figure 1**.

4) Impact prediction: Any developmental project, whether simple, small, large or complex has some environmental implications. Thus, impact prediction will aid in identifying all potentially significant environmental impacts (adverse and beneficial) and their magnitude when the project is implemented in comparison with the situation when the project is not carried out. Impact identification starts at the early stage of scoping when data on both the project and surrounding environment are made available. During the process of scoping more data become available on the environment and socio-economic conditions.

Earlier EIAs were generally focused only on impacts on the natural or biophysical environment (such as effects on air and water quality, flora and fauna, noise levels, climate and hydrological systems). However, over time, the importance of considering social, health and economic impacts were realized for conducting EIA in a logical and systematic approach. This trend has been driven partly by public involvement in the EIA process. It is reflected by the evolving definition of the term 'environment' in EIA legislation, guidance and practice.

After identification and analysis of all the credible impacts, their potential size and characteristics can be predicted. Impact prediction or forecasting is a technical exercise which utilizes physical, biological, socio-economic and cultural data to estimate the likely characteristics and parameters of impacts in the form of their magnitude, spatial occurrence *etc.*

The Impacts and baseline data collection in EIA study are explained in the following figure. The impacts on air, water and land are explained in the figure. The biological and socio-economic impacts are important to be disclosed while preparing an Environment Impact Assessment.



A range of methods and techniques may be employed. There can be a wide array of methods; from simple methods for impact identification to advanced methods, often involving the application of mathematical models. The various impact identification methods include checklists, matrices, networks, overlays and geographical information systems (GIS), expert systems and professional judgments.

Impact prediction enhances the 'mapping' of environmental consequences of the significant components of the project and its alternatives. Yet, the predictions on impacts can never be absolute. The impact prediction exercise should broadly include the following environment, social and economic aspects:

Environmental Impacts

- Impact on nature (positive, negative, direct, indirect, cumulative);
- extent/location (area/volume covered, distribution);
- timing (during construction, operation, decommissioning, immediate, delayed, rate of change);
- duration (short term, long term, intermittent, continuous);
- reversibility/irreversibility;
- likelihood (probability, uncertainty or confidence in the prediction);
- significance (local, regional, global); and
- magnitude of impact (severe, moderate, low)

Social Impacts

- Demographic impacts such as changes in population numbers and characteristics (such as sex ratio, age structure *etc.*);
- community impacts including changes in social structures, organisations and relationships;
- socio-psychological impacts including changes to individual quality of life and well being, sense of security or belonging *etc.*; and
- Cultural impacts including changes to shared customs, traditions and value systems (*e.g.* language, dress, religious beliefs and rituals) archaeological, and environmental features with religious or ritual significance.

Economic Impacts

- Project Cost;
- Beneficiaries;
- Requirement; and
- Cost-Benefit analysis approach.

5) Assessment of Alternatives and Delineation of Mitigation Measures:

Assessment of alternatives is a vital aspect in conducting an EIA process. It typically involves the comparison of a set of alternatives to the developed project in comparison to a set of decision factors. The alternatives in consideration must also give the 'no project' option priority. Ranking has to be given for the alternatives and then selection has to be made on basis of the best environmental option with optimum socio-economic benefits to the community at large. The significance of the project has to be quantified considering the consequence and likelihood mitigation. This involves the introduction of measures to avoid, reduce, remedy or compensate

for any significant adverse impacts. Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option. The objectives of mitigation measures are maximizing the project benefits and curtailing undesirable impacts to environment and society.

Impact Mitigation Measures: All measures for preventing any occurrence of impacts should be made to locate the developmental activities in an area free of: agricultural lands, cyclones, earthquakes, ecologically sensitive, erosion, forests, flooding, human settlements, landslides, natural scenic beauty, water logging. If the impact of any developmental activity demands for change in process/raw material/technology/wastes disposal etc; proper measures should be taken in order to find out the required substitutes. The various impact mitigation measures adopted from MoEF&CC, India is described below:

AIR

- Attenuation of pollution through green belts
- Suspended particulates removal through employing devices like cyclones, settling chambers, scrubbers, electrostatic precipitators (ESP), and bag houses.
- Pollutant gas control using absorption (liquid as a media), adsorption (molecular sieve), and catalytic converters.
- Uses of protected, controlled environment through personal protective equipment (PPE) like oxygen masks, etc.
- Control of stationary source emission (including evaporation, incineration, absorption, condensation, and material substitution).
- Dilution of odourant (dilution can change the nature as well as strength of an odour).
- Odour counteraction or neutralise (Certain pairs of odours in appropriate concentrations may neutralise each other).
- Odour masking or blanketing (certain weaker malodours may be suppressed by a considerably stronger good odour).

NOISE

- The mitigation measures for noise impact may include damping, absorption, dissipation, and deflection method through sound enclosures, applying mufflers, mounting noise sources on isolators, and/or using materials with damping properties.
 - Ensuring the performance specifications for noise control.
-

- Ear protective devices should be used.

WATER

- Ensuring sustainable use of ground/surface water, to prevent flooding/water logging/depletion of water resources. Included are land use pattern, land filling, irrigation channel construction and rainwater harvesting and pumping rate.
- Minimise flow variation from the mean flow.
- Segregation of different types of wastes.
- Storing of oil wastes in lagoons should be minimised in order to avoid possible contamination of the ground water system.
- Segregation of oil handling areas from surface runoff helps in handling easier else oil separation will be necessary at the wastewater treatment facility.
- All effluents containing acid/alkali/organic/toxic wastes should be processed by treatment methods (biological/ chemical processes).
- Control of waste streams having suspended solids may be minimised by controlling discharge of such streams (mainly sanitary sewage and industrial wastes).
- All activity that increases erosion or contributes nutrients to water (thus stimulating algae growth) should be minimised.
- Waste streams having high TDS, treatment methods must include removal of liquid and disposal of residue by controlled land filling to avoid any possible leaching of the fills. Surface runoffs around mines or quarries should be collected, treated and disposed.
- Cooling towers must aim for zero liquid discharge systems. They can convert once-through systems into closed systems. Treated wastewater (such as sewage, industrial wastes, or stored surface runoffs) can be used as cooling water makeup.
- Waste-containing radioactivity should be treated separately by means of de-watering procedures, and solids or brine should be disposed of with special care.

LAND

- The environmental impact of soil erosion can best be mitigated by ensuring that disturbance to vegetative cover happens only from the specific site and adjacent areas on which construction is to take place. Land clearing activities should be kept to the absolute minimum and use crushed stone rather than asphalt or concrete for surfacing parking areas should be attempted.

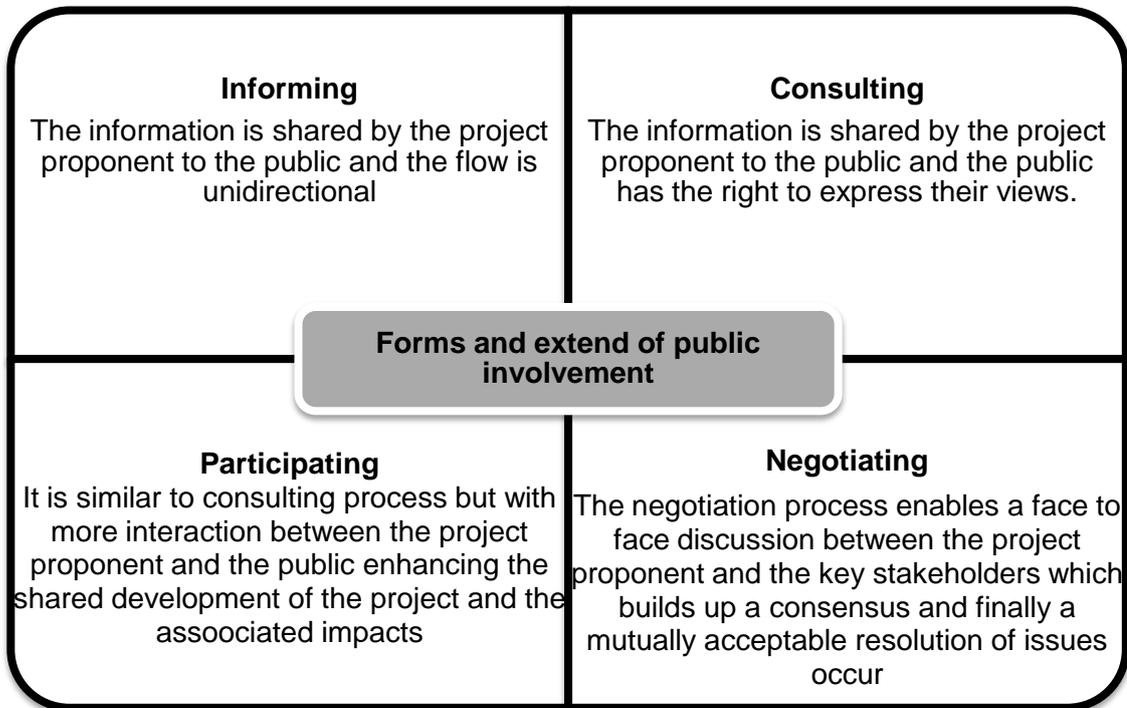
- Minimizing the disturbance to the existing vegetation can help in mitigating the increases in surface runoff. Vegetation along watercourses should not be cleared indiscriminately. Potholes or swamps shall not be drained unless absolutely necessary for successful completion of the activity.
- Construction, land management, or mining activities that result in the soil being laid bare could be scheduled in such a way that some type of vegetative cover appropriate to the site could be established prior to the onset of intense rain or windstorms. If grass is to be seeded, mulch of straw will help to protect the soil from less extreme erosive forces until vegetative and root development begins.
- Natural drainage patterns can be maintained by preparing sodden waterways or installing culverts.
- Steep slopes can be terraced, thereby effectively reducing the length of slope.
- Check dams built near construction sites can reduce the quantity of eroded soil particles reaching free-flowing streams or lakes.
- Use of floating foundations and height restrictions in earthquake zones and increased foundation height, wall strength, and roof support in areas periodically subject to cyclones can reduce the hazards.
- All forms of temporary structures should be avoided from the flood plain, and all permanent structures should be raised to a height above the level which flood waters can be expected to reach once every 100 years (100-year flood).
- Installation of underground drainage structures helps to reduce sediment loads.
- Engineering plans can be drawn to reduce the area of earth cuts on fills, provide physical support for exposed soil or rock faces, concentrate or distribute the weight loading of foundations to areas or state better able to support that weight.
- Use small charges for mining/blasting.
- Restricting the number, frequency and area of movement of heavy machinery.
- Compatibility between adjacent land uses can best be assured by providing a green belt between the proposed activity and nearby affected properties.

6) Public Hearing: Public hearing aims to assure the quality, comprehensiveness and effectiveness of the EIA. This will aid in the decision-making process, hence taking into account the public views. Public hearing has now been accepted as a critical step in the EIA process. The major affected persons during any projects may include:

- Bonafide local residents;
- Local associations;
- Environmental groups active in the area; and

- Any other individual located at the project site / sites of displacement.

Anyone likely to be affected by the proposed project is entitled to have access to the executive summary of the EIA. The various forms of public involvement as adapted from: Bass et al., (1995) in an EIA are described below:



7) Environment Management Plan: The EIA process is strengthened with Environment Management Plan (EMP) for carrying out of the proposed project. The environment management plan should include following factors:

- Delineation of mitigation and compensation measures for all the identified significant impacts;
- Delineation of unmitigated impacts;
- Physical planning including work programme, time schedule and locations for putting mitigation and compensation systems in place; and
- Delineation of financial plan for implementing the mitigation measures in the form of budgetary estimates and demonstration of its inclusion in the project budget estimates.

8) Decision Making: At this stage, decisions are made in consultation between the Project Proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary) so as to whether to accept, defer, or reject

the project. The decision on environmental clearance is arrived at, through a number of steps including evaluation of EIA and EMP.

9) Monitoring the Clearance: Monitoring will enable the regulatory agency to review the validity of predictions and the conditions for implementation of the EMP. It should be done during the establishment and after the commissioning of a project. This is not only to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports were correct or not. Where the impacts exceed the predicted levels, corrective action should be taken.

Roles of Stakeholders' in the EIA Process

Stakeholder participation in an EIA process increases the transparency of systematic environmental assessment of a project. It will aid in such a way that all those with a stake in the outcome of a project can actively participate in decisions on planning and management. These participants can include Project Proponents, public, government bodies, NGOs, academic and expert groups, business bodies *etc.* (Irish EPA, 1995). Stakeholders are a vital part of the EIA activity and play a pivotal role at different levels like local project level, regional or country levels, international level. The diverse participators in EIA will help in addressing relevant issues, including those perceived as being important by other sectoral agencies, public bodies, local communities, affected groups, and others and will facilitate information flows between proponents and different stakeholder groups. This will help in enhancing the understanding and 'ownership' of a project, addressing issues that may occur in environment and mitigation opportunities that might be overlooked (Hughes, 1998).

Participation of stakeholders in EIA centers upon the interaction between the various stakeholders of proposed project and the decision-making process. The various stakeholders involved in a typical EIA process (Aloni et al., 2015) mainly include:

- Local residents and local associations who are directly affected by the proposal;
- Project Proponent and other beneficiaries;
- Government agencies;
- Non-Governmental Organizations (NGOs); and
- Other interested groups/ parties, like academics *etc.*

Local residents and local associations: Individuals or groups in the project affected community will want to know what is proposed; what the likely impacts are; and how their concerns will be understood and taken into account. The local communities will aid in deciding the future of the project and will demand assurance that their views will be carefully listened to and their concerns are addressed. As these stakeholders have knowledge of the local environment, the baseline data can be effectively mapped out.

Project Proponent: The Project Proponent can be an individual or group of people who advocate for the project whose aim is to shape the proposal to give it the best chance of success. The Proponent tries to gain the public understanding and tries to address the grievances of people. The EIA process will be aided through using public inputs on alternatives and mitigation and understanding local knowledge and values.

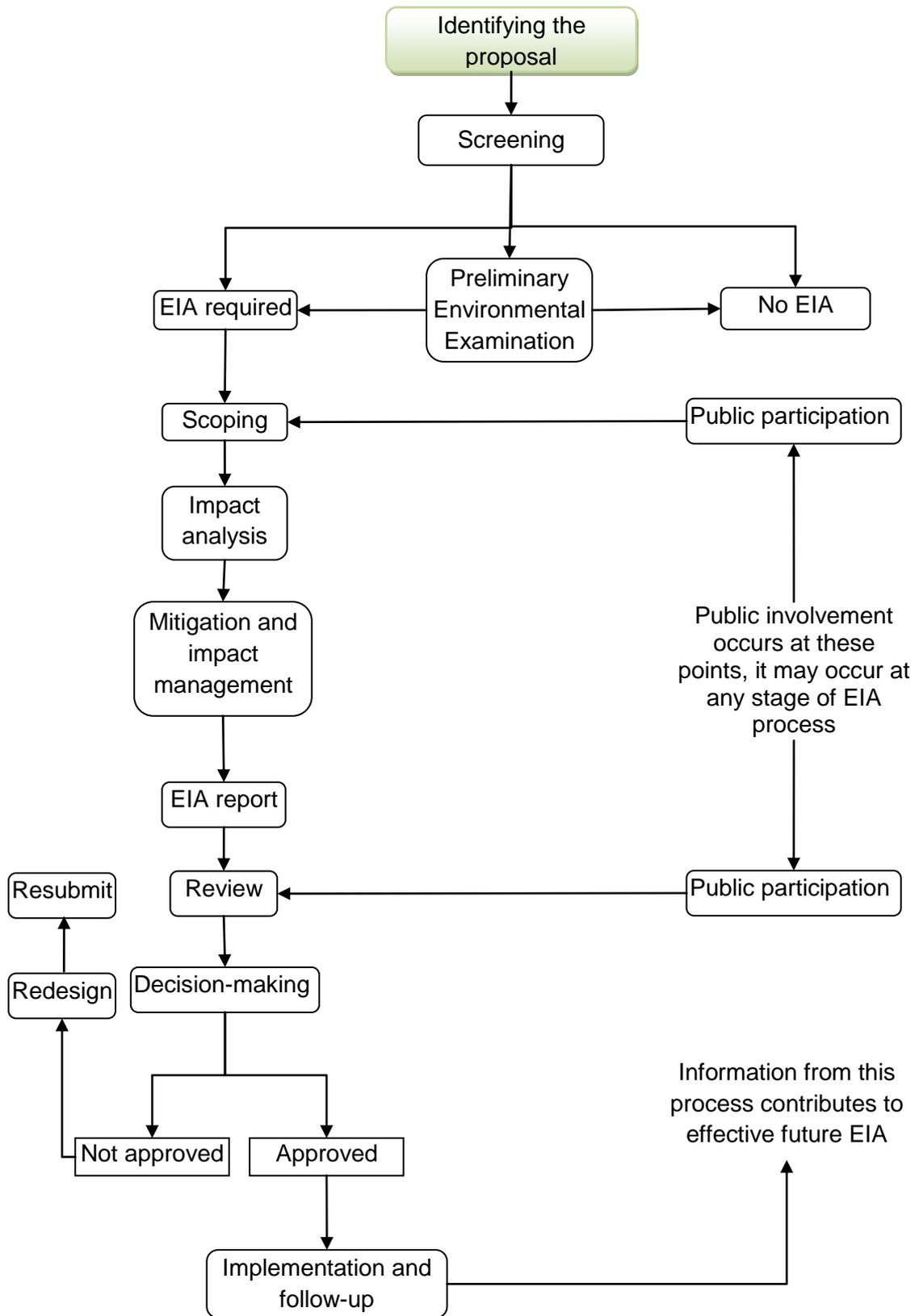
Government agencies: Any project requires approval of the government agencies. The government machinery involved in the EIA process will want to have their policy and regulatory responsibilities addressed in impact analysis and mitigation consideration.

Non-Governmental Organizations (NGOs): The Non-Governmental Organizations can provide a useful policy perspective on aiding the various steps of EIA. They can easily identify projects in their area, with potential adverse environmental effects and monitor the compliance with EIA requirements. Their views may also be helpful when there are difficulties with involving local people.

Other interested groups/ parties: The other interested groups include those who are experts in particular fields and can make a significant contribution to the EIA process. Usually the Proponents, public and government agencies deal great into the EIA process, yet substantive information about the environmental setting and effects will come from outside sources that include academic bodies, environment experts, consultants *etc.*

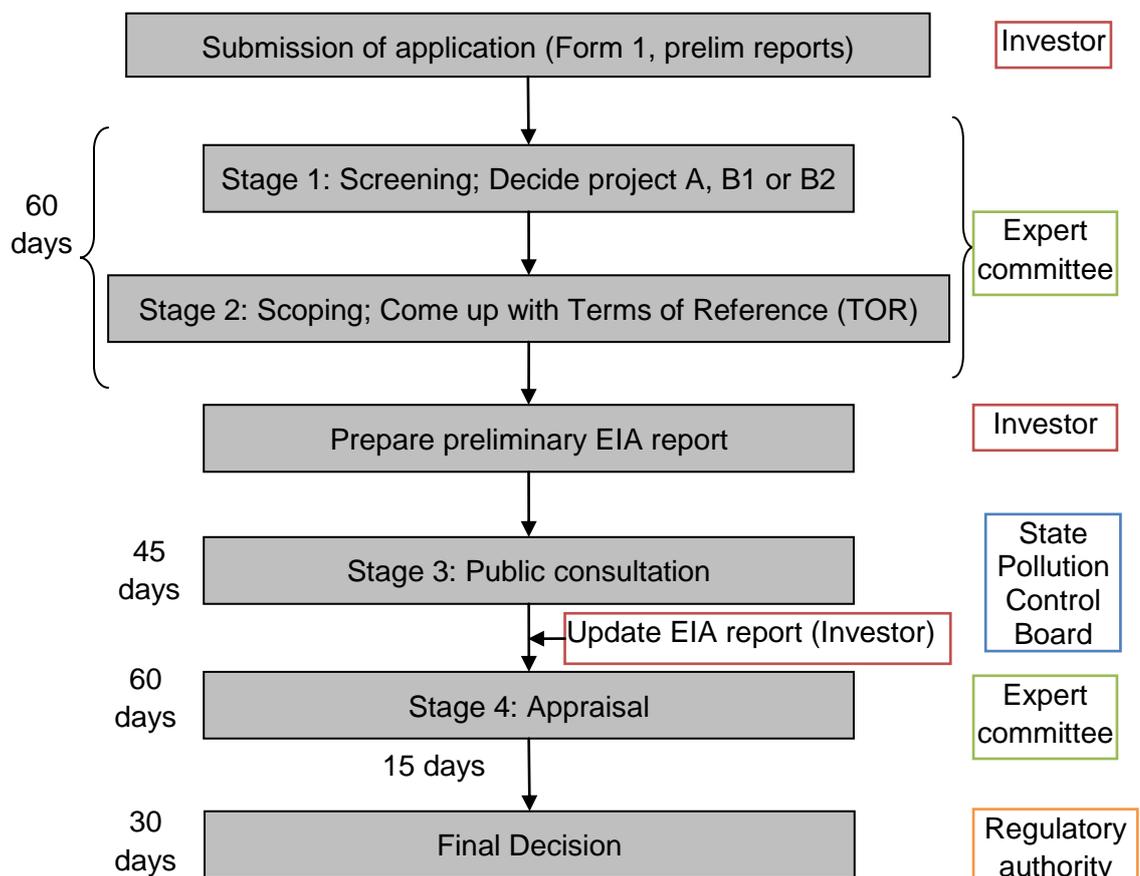
Generalized EIA process

The particular components, stages and activities of EIA will vary between different countries and yet has a common structure. Generalized EIA Process Flowchart adapted from Sadler and McCabe 2002 is described below:



EIA process in India

As per the new rules of Indian Government from the date of its publication (14th September, 2006), the required construction of new projects or activities or the expansion or modernization of existing projects or activities listed in the Schedule of the notification (MoEF, 2006, Environment Impact Notification, Government of India) can be undertaken in any part of India only after the prior environmental clearance from the Central Government or, as the case may be, by the State Level Environment Impact Assessment Authority, in accordance with the procedure specified hereinafter in this notification. The Summary of EIA process, rough timelines in India and the stakeholders involved are explained in below figure. It is adapted from MoEF2006, Environment Impact Notification, Government of India.



Case Example: EIA of Hazardous Waste Landfill Site

(Asolekar and Gopichandran, 2005)

In India, the need for disposal of toxic and harmful liquids, solids, and sludge were answered by articulating regulations for disposal of hazardous wastes. Under the authority invested in the Ministry of Environment and Forests (MoEF), now MoEF&CC (Ministry of Environment, Forest and Climate Change), the Government of India, as empowered by the "Environment Protection Act" of 1986, promulgated three sets of rules regarding hazardous wastes, chemicals and micro-organism. More specifically, the "Hazardous Waste Management and Handling (HWM&H) Rules" of December 1989 aimed at solid and semisolid hazardous wastes generated by 18 categories of industries potentially producing the toxic, flammable, reactive, and corrosive wastes, in solid, sludge as well as fluid phases. The rules provided so called "cradle to grave" guidelines for generators, transporters, operators of disposal facilities, and the state governments regarding monitoring.

The MoEF, Gol published in the: "Gazette of India, Extraordinary, Part II-Section 3, Sub-Section (ii) vide a No. S.O. 10(E)" dated January 8, 1999 under powers conferred by sections 6, 8, and 25 of the environment (Protection) Act, 1986 (29 of 1986); invited objections from persons likely to be affected within a period of 60 days with regards to the intention of Gol to amend HW&M Rules of 1989. 48 objections and responses were received and duly considered. Subsequently, in exercise of the powers conferred by sections 6, 8, and 25 of the environment (Protection) Act, 1986; the Gol notified the amendments to the HWM&H Rules on January 6, 2000. These rules which are referred to as the "Hazardous Waste (Management and Handling) Amendment Rules, 2000" have come into force on the date of publication in the official gazette.

Time and again, the implementing authorities, especially the State Pollution Control Boards (SPCBs) had indicated difficulties in identifying hazardous waste generating units based on the 18 categories listed in the Schedule appended to the HWM&H Rules, 1989. In fact, the State Governments were required to identify sites for the disposal of hazardous wastes after ascertaining the suitability of the sites through EIA studies. They were also required to prepare and maintain an inventory of such sites. Inability of the State Governments in identifying hazardous waste landfill sites has been put forward as the reason by industries in defense of prevailing improper management of hazardous wastes by the industries (Asolekar, 2000).

As per the amendments, the responsibility for identification of sites for establishment of Common Treatment, Storage and Disposal Facility (CTSDF) and individual Treatment, Storage and Disposal Facility (TSDF) is jointly assigned to the occupier, industrial association, and the respective State Government. In this context the following four pointers need to be articulated by generating further discussion:

- What is preliminary EIA? It is not clear if it stands for “Rapid EIA”.
- If the State is going to be one of the role players even in identification/selection of disposal site; what is the guarantee that this amendment will result in faster notification of sites?
- How would a Project Proponent for CTSDF and occupier who desires to start a captive TSDF facility be treated?
- Do the existing state laws allow acquisition of land by private / government TSDF facilities? Projects like roads, dams, bridges, airports, railways area normally are allowed to acquire the land for “larger public good”. What about waste disposal projects?

Summary

EIA has been introduced as an important policy initiative to ensure conservation of natural resources and to promote integration of environmental concerns in developmental projects. It has now been accepted as an integral component of sound decision-making with the objective of foreseeing and addressing the potential environmental problems and concerns at an early stage of project planning and design. The mandatory EIA has become a comprehensive exercise involving responsible regulators, administrators, NGOs and active citizens. The tool of EIA has become the center-piece of decision-making process that enables sustainable development.

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