<u>CLEAN DEVELOPMENT MECHANISM</u>

PROJECT DESIGN DOCUMENT (CDM-PDD)

Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India

Submitted to

Prototype Carbon Fund (PCF)

September 2003

By

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LIST OF ABBREVIATIONS

1	ABIL	-	ASIA BIO ENERGY (INDIA) LIMITED
2	BIMA	-	BIOGAS INDUCED MIXING ARRANGEMENT
3	CDM	-	CLEAN DEVELOPMENT MECHANISM
4	CO2	-	CARBON DIOXIDE
5	CPCB	-	CENTRAL POLLUTION CONTROL BOARD
6	DOC	-	DEGRADABLE ORGANIC CARBON
7	DOCF	-	FRACTION OF DEGRADABLE ORGANIC CARBON THAT ACTUALLY DEGRADES
8	ENKEM	-	ENKEM ENGINEERS PRIVATE LIMITED
9	ENTEC	-	ENTEC UGM BH OF AUSTRIA
10	EPC	-	ENGINEERING PROCUREMENT & CONSTRUCTION
11	ETP	-	EFFLUENT TREATMENT PLANT
12	FOD	-	FIRST ORDER DECAY
13	GHG	-	GREENHOUSE GAS
14	IDFC	-	INFRASTRUCTURE DEVELOPMENT FINANCE COMPANY LIMITED
15	IPCC	-	INTERGOVERNMENTAL PANNEL ON CLIMATE CHANGE
16	IUT	-	INNOVATIVE UMWELLTECHINK GES.MBH
17	JEL	-	JURONG ENGINEERING LIMITED, SINGAPORE
18	LDA	-	LUCKNOW DEVELOPMENT AUTHORITY
19	LNN	-	LUCKNOW NAGAR NIGAM
20	MCF	-	METHANE CORRECTION FACTOR
21	MNES	-	MINISTRY OF NON-CONVENTIONAL ENERGY SOURCES
22	MSW	-	MUNICIPAL SOLID WASTE
23	OECD	-	ORGANIZATION OF ECONOMIC COOPERATION AND DEVELOPMENT
24	PCF	-	PROTOTYPE CARBON FUND
25	PDD	-	PROJECT DESIGN DOCUMENT
26	QA	-	QUALITY ASSURANCE
27	QC	-	QUALITY CONTROL
28	SPCB	-	STATE POLLUTION CONTROL BOARD
29	SPM	-	SUSPENDED PARTICULATE MATTER
30	SWDS	-	SOLID WASTE DISPOSAL SITES
31	TPA	-	TONNS PER ANNUM
32	TPD		TONNES PER DAY
33	UNFCCC	-	UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
34	UPPCL	-	UTTAR PRADESH POWER CORPORATION LIMITED
35	UPSEB	-	UTTAR PRADESH STATE ELECTRICITY BOARD

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A. GENERAL DESCRIPTION OF PROJECT ACTIVITY

A.1 Title of the project activity:

Municipal Solid Waste Treatment cum Energy Generation, Lucknow, India

A.2. Description of the project activity:

The project involves setting up of a Municipal Solid Waste (MSW) processing facility which utilizes methane generated from treatment of MSW to generate power. About 300 tonnes per day (TPD) of MSW is proposed to be processed to generate 5.6 MW (gross) electricity and 75 TPD of organic manure. Greenhouse gas emissions reduction results from the capture and utilization of methane, from power generation, and from use of organic fertilizer produced from the treatment of MSW to replace chemical fertilizers.

Note: The proposed project has 3 separate components that result in emission reduction, namely:

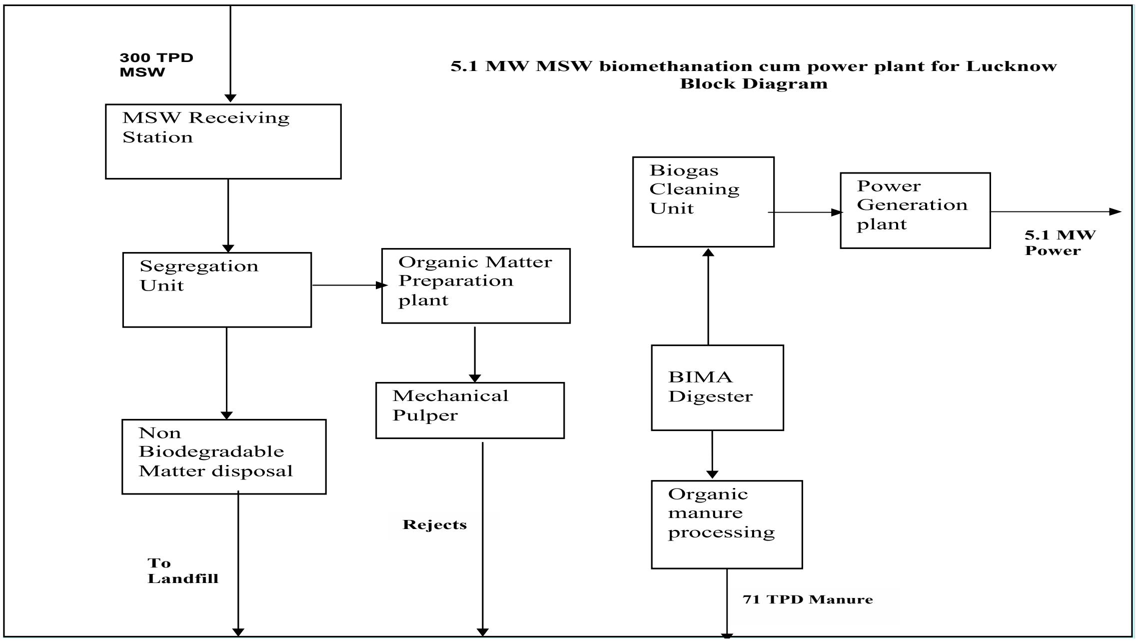
- Biomethanation of municipal solid waste resulting in reduction of methane escaping into the atmosphere
- Displacement of fossil fuel from power generation from methane during biomethanation; and
- Displacement of chemical fertilizer by the organic fertilizer produced by biomethanation.

The following PDD and the annexed new methodologies for the baseline and monitoring plan deal exclusively with the component on biomethanation of municipal waste. While reference is made to emission reduction from the other two components, this PDD and the annexes DO NOT include the necessary documentation for these components. These will be submitted as separate documents.

The facility is located at Lucknow in the state of Uttar Pradesh in India and is being built by Asia Bioenergy India Limited (ABIL). Lucknow has a population of around 3 million which generates about 1500 TPD of solid waste. The MSW required for the facility would be supplied by the Lucknow Nagar Nigam (LNN).

ABIL shall segregate the biodegradable matter from the MSW and process the same through anaerobic digestion in specifically designed reactors to generate biogas rich in methane content. This gas shall be used, after due treatment, in gas engines to generate electric power. The waste heat contained in the flue gases from the engine shall be recovered for generation of additional electric power. After meeting the auxiliary power requirements, ABIL shall export power to the grid of UP Power Corporation Ltd. (UPPCL), originally known as UP State Electricity Board (UPSEB). ABIL's contracted capacity to UPPCL is stated at 5.1 MW. After the generation and recovery of the biogas, the remaining material in the digester shall be dried and sold as bacteria free manure rich in organics. The project would produce about 75 TPD of organic manure. This manure is suitable for agricultural and gardening / plantation applications. A flow chart of the plant is given in Figure 1. The plant shall be operating for 23 hours a day for about 360 days in a year and thus shall generate about 40 Million Units (net of auxiliary consumption) of electricity annually.

Figure -1



Contribution to sustainable development

From an environmental perspective, the project helps in avoidance of methane emission (a greenhouse gas with high global warming potential) as well as any leachate that would otherwise have generated from the current practice of waste disposal. By generating electricity through utilising the biogas produced from the digester, the project helps in replacing power from carbon intensive thermal sources. Further by producing organic manure the project helps in replacing the use of chemical fertilisers and hence contributes to environment and health of the general public in many ways.

From social perspective, the project helps in bettering the environmental conditions in the city of Lucknow by hygienic treatment of solid waste resulting in improvement in health standard in the city. The segregation of waste prior to biomethanation results in separation of large quantity of inert non-biodegradable matter like metals, earth etc. Many of these items could be recycled, thereby providing monetary benefits to poor local folks, especially women. Without the project the rag pickers in the city would have operated in the same unhygienic conditions as they do presently, and would have been exposed to serious health risks while collecting the recyclables from the open dumping sites. The project proposes to provide employment opportunity to the rag pickers who can collect the recyclables from the plant. It is expected that the treatment cum power plant would employ about 30 persons directly, whereas a large number of persons would be indirectly involved in the waste collection, marketing of fertilizers etc.

From an economic angle, the project by converting the waste into valuable products (electricity and manure) helps in reducing the demand on the limited natural resources.

Being a project that contributes significantly to environmental improvement and social development in many ways while deriving the economic value of wastes, can be considered to contribute significantly to sustainable development.

A.3. Project participants:

The project is being executed by Asia Bioenergy India Limited (ABIL) – a Special Purpose Vehicle company formed through consortium of the following companies:

1. Enkem Engineers Private Limited (Enkem)
2. Entec UGM BH of Austria (Entec)
3. Jurong Engineering Limited, Singapore (JEL)

Details of the parties involved in the project and their respective roles are provided below in the tabular form.

Sl. No.	Project Participants	Type of entity	Key Roles
1	Asia Bioenergy India Limited (ABIL)	Private	Project developer and sponsor
2	Lucknow Nagar Nigam (LNN)	Government	Supplier of required quantity of waste at the project facility
3	Uttar Pradesh Power Corporation Limited (UPPCL)	Government	Buyer of electricity from the project
4	Ministry of Non-conventional Energy Sources (MNES)	Government	Provider of capital subsidy to the project
4	Infrastructure Development Finance Company Limited (IDFC)	Private	Principal lender to the project
5	Prototype Carbon Fund (PCF)	Public-Private Partnership	Proposed buyer of the carbon credits

It is proposed that the emission reductions will be purchased by, among others, the Prototype Carbon Fund.

The Prototype Carbon Fund (Attention: Ken Newcombe, MC4-414, 1818 H Street, Washington DC 20433, USA. Tel +1-202-473-6010; Fax: +1-202-522-7432) is designated as the main contact point for all aspects related to the CDM activity.

Contact details of the Prototype Carbon Fund, IDFC and ABIL are provided at Annex I.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1 Host country Party(ies): India

A.4.1.2 Region/State/Province etc.: Uttar Pradesh (State)

A.4.1.3 City/Town/Community etc: Lucknow (City)

A.4.1.4 Detail on physical location & identification of the project

The project site is spread over an area of 5 acres and is located at village Barawan Khurd in Pargana Tehsil within Lucknow city limits. The site is located at a distance of about 15 KM from Lucknow Municipal office and is about 1.5 KM from Dubagga wholesale market complex on the Lucknow-Hardoi road. River Gomati flows at a distance of about 3.5 KM from the site. The site has stiff over consolidated clayey /sandy silt soil. Ground water table lies at 16 m below the ground surface. There is also a thick vegetation cover surrounding the project site. The site has been earmarked by Lucknow Development Authority (LDA) for the MSW project.

Lucknow, a city with a population of about 3 million, generates about 1500 TPD of MSW, of which about 1000 TPD is collected daily. The MSW is disposed in a haphazard manner at open dumps leading to the deterioration of environment and outbreak of diseases. Moreover, with ever increasing population, the resources of the municipal authorities are stretched to the limits to provide the essential services of clean up. Further with increased land cost and competing uses for vital land space, it is becoming increasingly difficult to locate new space for the disposal of the wastes. Hence there is urgency for an effective waste disposal system.

A.4.2. Category(ies) of project activity

Biomethanation of Municipal Solid Waste Treatment with Power generation. This is a new category not yet published in the UNFCCC website.

This PDD and the annexed new methodologies for the baseline and monitoring plan deal exclusively with the component on biomethanation of municipal waste. While reference is made to emission reduction from the other project components, this PDD and the annexes do not include the necessary documentation for these components. The new methodology for estimated emission reduction from power generation (in India) is being submitted as a new methodology for another project. The baseline and monitoring methodology and emission reduction from the displacement of chemical fertilizers by the organic manure produced during biomethanation will be submitted as a separate new methodology at a later date.

A.4.3. Technology to be employed by the project activity:

Generating biogas by processing MSW is considered to be the heart of the project. For gas generation through biomethanation process the project would use the Biogas Induced Mixing Arrangement (BIMA) technology, developed and patented by Entec, Austria.

In biomethanation process, the process of digestion of biodegradable organic matter is carried out in a closed vessel through anaerobic digestion. The process is catalyzed by enzyme secreted by microorganisms in the culture and it helps in recovering more methane than the composting process. Since the digestion occurs in a closed vessel called reactor, the leachate generated could be easily collected and disposed off after treatment. In this case, however, the leachate is proposed to be used as a feed in the reactor solving the problem of leachate disposal. The methane rich biogas is collected and gainfully utilized to produce power. The process leaves behind organic manure, free of bacteria which is a substitute for chemical fertilizers like ammonia and urea, which generate large amounts of CO_2 during manufacture.

Technology for waste segregation is provided by Innovative Umwelltechnik Ges.mbH, (IUT). IUT for this project provides the basic engineering, lay out of sorting plant, waste receiving area, complete drawings for waste handling conveyors from unit to unit and supply of key equipment like drum screen, shredders, ballistic separators etc. IUT provides the performance guarantee for recovery of organics and removal of most of the in-organic component from the MSW.

Enkem Engineers the technology partners of IUT have entered into an exclusive licensee agreement for India where for future projects the basic engineering and key equipment will be supplied by IUT and detailed engineering and fabrication of some sorting plant equipment will be carried out by Enkem.

Entec, Austria has provided the technology for High Rate Anaerobic Digestion. Enkem Engineers are already their exclusive licensee in India and are implementing many projects under the Ministry of Non-conventional Energy Sources' (MNES) program. Entec provides complete details of the digester and approves each project with a royalty for the digester portion. Some key equipment in the whole plant like pulpers, gas balloon is also supplied by Entec. For future projects part of the supply will be made locally.

The gas engine has been purchased from Jenbacher, Austria as no Indian company manufactures 100% gas engine.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

In the absence of the project, MSW generated in the city of Lucknow would have been disposed at unmanaged Solid Waste Disposal Sites (SWDSs or also referred in this PDD as unmanaged landfills), as is the current practice. Anaerobic decomposition of organic matter in the MSW by methanogenic bacteria leads to the production of a significant amount of methane from SWDSs which escapes into the atmosphere adding to the emission of greenhouse gases. By processing the MSW as outlined in the proposed project (which utilizes a BIMA digester for the anaerobic decomposition of the waste) methane gas produced is efficiently captured and utilized to generate power. The electricity generated from the project replaces electricity in the grid resulting in the displacement of fossil-fuel fired electricity, thereby resulting in additional reduction of greenhouse gases. The digester also produces organic manure which can be used to displace energy intensive chemical fertilizer and the replacement of chemical fertilizer leads to additional reduction in CO2 emissions.

On the average, the project is expected to generate about 101848 tons of emission reductions annually from the methane capture component alone. Refer to E.5 for quantification of the emission reduction achieved by the project.

The same reductions will not occur in the absence of the proposed project activity as the present practice of land disposal of MSW is expected to continue in the future. The current practice involves collection of the garbage and dumping it at specified sites (generally unused land in the outskirts of the cities, having large pits and hence longer life). This environmentally undesirable practice continues because of the inability of the municipal authorities in India to provide adequate waste management services due to their being ill-equipped with resources, especially financial resources, The limited funds allocated for such services within the Municipalities hinder the extension of waste collection services to the entire municipal limits, which is considered the first step in the process of MSW management. Proper treatment and disposal of MSW would require significant additional financial resources. Given the weak financial health of the municipalities in India and the limited options for raising additional financial resources, it is likely that, at best, there will be only small incremental improvement in the way MSW is managed in India for the foreseeable future despite MSW Rules, 2000.

It is expected that the main driver for any improvement in MSW management practices in India will be the Municipal Solid Wastes (Management and Handling) Rules, 2000 (Details available at http://www.envfor.nic.in/legis/hsm/mswmhr.html),which was formulated by the Ministry of Environment and Forests (MoEF), Government of India. The rules provided for staged compliance with December 2003 set as the deadline for complete compliance. There has not, however, been any noticeable change in the MSW management across the cities and municipalities in the country and no city in India seem to be in a position to comply with the MSW Management Rules by the deadline of December 2003. In the context of poor enforcement of regulations in the country and the lack of financial resources with municipalities in India, it is expected that there will be only slow incremental improvement in the way MSW is managed in India for the foreseeable future. This would mean that unmanaged solid waste disposal sites would continue to be the prevalent means of waste management, leading to significant adverse environmental impact, including the emission of methane into the atmosphere.

A.4.5. public funding of the project activity:

No public funding from Parties included in Annex I is used in the project.

B. BASELINE METHODOLOGY

B.1 Title and reference of the methodology applied to the project activity:

"Biomethanation of Municipal Solid Waste in India"

This is a proposed new methodology and the details are provided in Annex 3 and 4.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity

As pointed out in Section A. 4.4 the treatment and disposal of municipal solid waste is guided by the MSW (Management and Handling) Rules, 2000. The rules provide a framework for waste management and require the cities/municipalities to have technically sound disposal options in place by December, 2003.

The MSW Management Rules, therefore, have to be the starting point for the development of the baseline scenario for the waste management sector in India. While the framework for waste management has been created by the MSW Rules, no additional provision for financial resources for the already cash-strapped municipal bodies has been made for addressing the problem. As a consequence the municipal bodies lack the financial resources and, in most cases, technical capacity to comply with the MSW Rules. Therefore, compliance with the rules is expected to be achieved over a very long period of time.

The rules identify the whole range of acceptable technical options for treatment and disposal of MSW, including landfilling with separation of biodegradable waste, composting, biomethanation and incineration, that have to be in place by December 2003.

In the years since the formulation of the MSW Management Rules, some cities have started the planning for sanitary landfill facilities and composting. There has not, however, been any noticeable change in the MSW management across the cities and municipalities, and no city in India seems to be in a position to comply with the MSW Management Rules by the deadline of December 2003. The single largest cause for inaction has been the poor financial health of municipal bodies and the absence of any additional allocation or appropriation by the state or central (federal) government for waste management.

In the context of the poor enforcement of environmental regulation in India and in the absence of allocation of substantial financial resources to deal with the waste management problem, it is likely that unmanaged solid waste disposal sites would continue to be the prevalent means of waste management, leading to significant environmental impacts, including the emission of methane into the atmosphere. It is very likely that there can be, at best, only slow incremental improvement in the way MSW is managed in India for the foreseeable future.

The baseline scenario, therefore, is the continuation of the current practice (disposal of MSW at the unmanaged solid waste disposal sites) with gradual changes to the acceptable technical options (composting cum landfilling, landfilling with inertization and biomethanation, etc.) expected over a period of time linked to percentage compliance with MSW Management Rules. The percentage of compliance can be assumed for the calculation of the baseline emissions. The percentage compliance figures can be taken from the annual compliance reports to be prepared by CPCB from time to time. As per the MSW Rules, the Central Pollution Control Board is mandated to monitor and report the level of compliance based on the annual compliance report to be provided by various State Pollution Control Boards in India. The national level of compliance reported by the Central Pollution Control Board, which would determine the baseline emissions, is incorporated in the method proposed here.

The city of Lucknow where the proposed project is to be situated is a typical city in India facing the solid waste management challenge. Lucknow municipal authorities are barely able to provide collection services for just 1000 tons of MSW out of 1500 tons of MSW generated daily but, like other cities in India, will be expected to comply with the MSW Management Rules. The baseline scenario depicted in Annex 3 of this PDD applies accurately to the context of Lucknow.

B.3. Description of how the methodology is applied in the context of the project activity:

Using the arguments provided in Annex 3 for determining the baseline scenario for municipal waste management, there is compelling case indicating that Lucknow would be one of the cities which would be unable to comply with the MSW Management Rules in the short to medium term.

B.4. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity

Following section 6 of Annex 3 (on new methodologies), an assessment of possible options to determine the plausible and feasible options was carried out. The outcome of the analysis indicates that the feasible options that are consistent with the MSW Management Rules include

- Composting with landfilling of inert material
- Landfilling after inertization of the waste and
- Biomethanation.

Analysis of costs and other barriers (summarized in the table below) clearly indicate that the biomethanation project is additional.

Barrier (as elaborated in the report for the 10th Meeting of the Executive Board)	As it applied to biomethanation to demonstrate additionality
Investment Barriers	Unmanaged landfills have little or no cost associated with their operation and is hence the baseline scenario from the point of view of lowest cost option. Analysis of the tipping fee* (as described in Annex 3) indicates that the tipping fee required for biomethanation to achieve 15% project IRR is about Rs 566 per tonne (see Annex 5). The other two plausible alternatives require a tipping fee of Rs 195 and Rs 161 per tonne of waste for landfilling with inertization and composting with landfilling respectively.
Technological barriers	Biomethanation is the most technologically advanced of the 3 options and is perceived to have much greater technological risk
Barrier due to prevailing practice and the project not being common practice	This would be the first biomethanation project for treating municipal solid waste in India. The technology has not even been applied widely in OECD countries for municipal solid waste treatment.

* The three feasible options mentioned above are subjected to a detailed tipping fee analysis to determine the least cost option from the municipalities' perspective. Figures for the Biomethanation have been taken from the project under consideration in Lucknow. In the analysis however, all the external subsidies and financial supports have been ignored. Figures for the landfill and the compost cum landfill options are taken from design data after suitable treatment and adjustment to represent the equivalent size as that of the biomethanation project for comparison purpose.

Since the baseline scenario is limited compliance to the MSW Management Rules with municipal waste in Lucknow predominantly being disposed in unmanaged landfills, emission reduction results from the avoided methane emissions.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity:

The project boundaries are limited to the geographic boundaries of the project site, i.e. the site where all the facilities of the project are located. The following project activities and emission sources are considered within the project boundaries.

- Biogas generation from anaerobic digesters
- Utilisation of the biogas in the gas engines for power generation
- Production of organic manure

For the purpose of the baseline for MSW treatment options, the country has been taken as the system boundary as the primary driver for these projects, as the MSW Rules are a central government subject, regulated by the Ministry of Environment and Forests, Government of India.

Therefore emission reductions to be achieved by the project have been linked to the country's compliance with the MSW Rules. For example if the country's compliance is estimated to be 10% in a given year, this would mean that in the context of the project 90% of the MSW would still be disposed as per the present practice of land disposal. Hence the credits earned from the project are expected to be lower by 10% in that particular year. The options achieving 10% compliance might have further GHG emissions associated with activities envisaged in those options. However for conservative purposes, they have not been considered in the emission reduction estimates. This means that percentage compliance with the MSW rules is a critical parameter that needs to be monitored.

B.6. Details of baseline development

B.6.1 Date of completing the final draft of this baseline section :

15/08/2003

B.6.2 Name of person/entity determining the baseline:

The baseline is determined by the following two entities, which are also the project participants as stated in A.3.

Infrastructure Development Finance Company Limited
ITC Centre, 3rd Floor
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C. DURATION OF THE PROJECT ACTIVITY / CREDITING PERIOD

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

15/07/2003

Starting date of the project activity has been defined as the date on which the project started trial processing of waste.

C.1.2. Expected operational lifetime of the project activity:

30 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period *(0D/MM/YYYY)*:

C.2.1.2. Length of the first crediting period *(in years and months, e.g. two years and four months would be shown as: 2y-4m)*:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date *(DD/MM/YYYY)*: 01/12/2003

Unless necessary approvals are obtained by the date mentioned above, the crediting period can be expected to start from the date when an approved monitoring methodology for the project becomes available.

C.2.2.2. Length (max 10 years): *(in years and months, e.g. two years and four months be shown as: 2y-4m)*

10 Years

D. MONITORING METHODOLOGY AND PLAN

D.1. Name and reference of approved methodology applied to the project activity:

National compliance with the MSW Rules (in percentage terms) along with regular monitoring of input (to the biomethanation plan) MSW characteristics.

A new methodology for this is being proposed. Refer to Annex 4 for details.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The baseline emissions of CH_4 depends upon the quantity and quality of wastes. Therefore regular monitoring of both quantity and characteristics of wastes especially the organic content of the MSW is an essential requirement. Since baseline emissions are also linked to compliance level that is expected to be achieved at a country level, it is also required to monitor the percentage compliance that may be achieved on a yearly basis, by looking at the performance of the municipalities in the country and the progresses made by them on waste management.

Accordingly the monitoring methodology is considered justified for the project.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
D3-1	*GHG emission from baseline*	*MSW input to the plant*	*TPD*	*Measured*	*Daily*	*100%*	*Both paper & electronic*	*12 years*	*Each load of MSW to be weighed at the plant entry*
D3-2	*GHG emission from baseline*	*Organic Content of MSW (DOC)*	*%*	*Measured*	*Daily*	*Sample*	*Both paper & electronic*	*12 years*	*Organic content to be analysed through sample analysis in the lab*

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
None identified									

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/paper)	For how long is data archived to be kept?	Comment
D5-1	*Compliance with MSW Rules at country level*	*Quantity of MSW treated and disposed in compliance with MSW Rules*	*TPD*	*Yes*	*Electronic*	*12 years*	*At the end of each year data pertaining to each class-A municipality in India will be collected. Data on municipalities complying with MSW Rules only will be collected and recorded*
D5-2	*Compliance with MSW Rules at country level*	*GHG Emissions from the compliant options*	*TPD*	*To be estimated*	*Electronic*	*12 years*	*GHG emissions from various options complying with MSW rules only would be estimated and recorded.*

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

Data *(Indicate table and ID number e.g. D.4-1; D.4-2.)*	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D3-1	*Low*	*Yes*	*Not applicable*
D3-2	*Medium*	*Yes*	*Not applicable*
D5-1	*Medium*	*No*	*The data will be reported by the municipal bodies and aggregated by State/ Central Pollution Control Board. The Project entities will have no jurisdictional authority on the State/ Central Pollution Control Board or the municipal bodies.*
D5-2	*Medium*	*No*	*The data will be reported by the municipal bodies and aggregated by State/ Central Pollution Control Board. The Project entities will have no jurisdictional authority on the State/ Central Pollution Control Board or the municipal bodies.*

D.7 Name of person/entity determining the monitoring methodology:

The monitoring methodology is determined by the following two entities, which are also the project participants as stated in A.3.

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E. CALCULATION OF GHG EMISSIONS BY SOURCES

E.1 Description of formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary: (for each gas, source, formulae/algorithm, emissions in units of CO2 equivalent)

GHG Emission from the Project

The only source of GHG emission from the project is the combustion of the biogas in the presence of air in the gas engine. The CH_4 rich biogas when combusted is expected to produce CO_2 as per the following reaction.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Since this is something which would not have happened in the absence of the project, there is a need to subtract the quantity of CO_2 emitted from the baseline case to get the correct estimate of GHG reduction achieved from the project.

As the IPCC Good Practice Guidance advocate that CO2 emissions from landfill gas recovery combustion are of biogenic origin and should not be included in national totals (IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, footnote 4 on page 5.9), CO2 emissions to be resulted from combustion of the CH4 in the gas engine are not considered as the project emissions and hence have not been included in the emission reduction quantification.

E.2 Description of formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is measurable and attributable to the project activity: (for each gas, source, formulae/algorithm, emissions in units of CO2 equivalent)

No leakage requiring quantification is applicable.

E.3 The sum of E.1 and E.2 representing the project activity emissions:

With the justification provided in E.1 and E.2 emissions from the project activity is considered to be nil.

E.4 Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline: (for each gas, source, formulae/algorithm, emissions in units of CO2 equivalent)

Baseline Emissions
As already discussed, disposal of MSW at the unmanaged SWDSs is considered as the baseline with gradual changes expected over a period of time linked to percentage compliance with MSW rules. The % compliance assumed for the baseline is as follows.

Period	Expected level of compliance with MSW Rules (in terms of waste treated as per the rules)
Upto 2003	0%
2003-2007	10%
2007-2011	30%
2011-2015	50%

Zero percentage compliance assumes that 100% of the waste is disposed as per the current practice of open land disposal. As the percentage of compliance with MSW rules increase over time percentage of waste landing up in uncontrolled SWDSs (BAU) decreases accordingly. Therefore the baseline emissions of CH4 are expected to decrease with time. To start with, compliance with the rules has been assumed to be zero percentage which means that all the wastes are expected to be disposed in uncontrolled SWDSs.

Anaerobic decomposition of organic matter in the MSW by methanogenic bacteria leads to emission of significant amount of methane from SWDSs. Amount of methane that is generated at the SWDSs depends upon the following factors

- Waste disposal practice
- Waste composition (presence of degradable organic matter)
- Physical factors such as moisture and temperature in the landfills

The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*IPCC Guidelines*) outline two methods to estimate CH4 emissions from solid waste disposal sites, the IPCC default method (theoretical gas yield method) and the First Order Decay (FOD) method. Consistent with Annex 3 theoretical gas yield methodology is chosen to estimate emissions from the baseline scenario. Therefore,

Methane Emissions from Landfill (TPD) = MSW_T x DOC x DOC_F x MCF x F x C

Where :

MSW_T	=	Total MSW disposed at the landfill (TPD)
DOC	=	Degradable organic carbon fraction in the MSW
DOC_F	=	Fraction of DOC that actually degrades
MCF	=	Methane correction factor for Land fill
F	=	Fraction of Methane in Landfill gas (0.5 default value)
C	=	Carbon to methane conversion factor (16/12)

The above equation would estimate the rate of emissions of CH4 to the atmosphere (that could have been emitted to the atmosphere in the absence of the project).

While site specific data on all the variables are available in the context of the project, the only information that is not available is pertaining to the methane correction factor. Therefore, IPCC recommended value for methane correction factor is used for the purpose of estimation. Figures used in the formula are tabulated below.

Variables	IPCC Default Values for India	Project Specific Value	Values used
DOC	0.18	0.28 (to be monitored)	0.18
DOC_F	0.77	0.55 (digester specific data)	0.77
MCF	0.6	-	0.6
F	0.5	0.65	0.5

The project specific values as mentioned in the above table are generated from the analysis that has been undertaken for MSW in Lucknow for the purpose of the project. The analysis was carried out for the specific purpose of the designing of the digester. Since the data is generated through limited analysis carried out for the project, estimation of CH4 emissions has been based on the IPCC default values.

Further, since the project is being designed to treat about 300 TPD of MSW, the same figure is used to estimate the baseline emissions. Summary of the baseline emissions is presented below. The calculations assume that 100% of is disposed in unmanaged landfills.

Assumptions Parameters	Units	Values	Comments
GHG Potential of CH4		21	
Molecular Mass of CH4		16	
Molecular Mass of CO2		44	
MSW to be treated	TPD	300	to be monitored
No. of days of operation	Days	360	to be monitored
Degradable Organic Carbon		0.18	to be monitored
Fraction of DOC that actually degrades		0.77	
CH4 Correction Factor		0.6	
Fracion of CH4 in Landfill gas		0.5	
Carbon to methane conversion factor	-	1.33	
Landfill Emission Calculations			
CH4 from landfills	TPD	**16.63**	
Annual CH4 from landfills	TPA	**5987.52**	
Annual CO2 equivalent from Landfills	TPA	**125738**	

Since it is assumed that the baseline would change depending upon the percentage compliance that is achieved with the MSW rules, an additional variable namely compliance percentage has been introduced and year wise baseline emissions is estimated and presented in the following table. It may be noted that in the baseline emission estimations, the emissions have been adjusted to reflect the improvement in compliance with time. The compliance option itself however might result in some degree of GHG emissions (e.g. a compost plant can be expected of emitting CO2 emissions). However, for conservative estimates the same has not been considered.

Years	Compliance	BAU	Landfill Emissions Calculations					Compliance adjusted CO2-E
	%	%	MSW	DOC	CH4	Annual CH4	CO2-E	
			TPD		TPD	TPA	TPA	TPA
1	0	100.00%	300	0.18	16.632	5987.52	125738	125738
2	10%	90.00%	300	0.18	16.632	5987.52	125738	113164
3	10%	90.00%	300	0.18	16.632	5987.52	125738	113164
4	10%	90.00%	300	0.18	16.632	5987.52	125738	113164
5	10%	90.00%	300	0.18	16.632	5987.52	125738	113164
6	30%	70.00%	300	0.18	16.632	5987.52	125738	88017
7	30%	70.00%	300	0.18	16.632	5987.52	125738	88017
8	30%	70.00%	300	0.18	16.632	5987.52	125738	88017
9	30%	70.00%	300	0.18	16.632	5987.52	125738	88017
10	30%	70.00%	300	0.18	16.632	5987.52	125738	88017
Total Emissions during in 10 years								**1018477**

E.5 Difference between E.4 and E.3 representing the emission reductions of the project activity:

Same as E.4 since E.3 is nil.

E.6 Table providing values obtained when applying formulae above:

Provided in E.4.

F. ENVIRONMENTAL IMPACTS

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts

The proposed project does not result in significant environmental impacts. In fact it would lead to a significant improvement in the quality of environment of Lucknow city. Some of the environmental concerns of the project with respect to emissions and discharges from the plant have been addressed and taken care in the design of the project. These are described in the following paragraphs.

Impact on Water

Wastewater is generated from the dewatering section of the plant. This wastewater is recycled to the pulper and used as dilution water in feed preparation as water is required for make up. During summer more fresh water will be required. Thus, there is no contamination of local water bodies and no land pollution from this project.

Sewage is discharged due to domestic consumption of water. This is treated in suitably designed septic tanks and the overflow from the septic tanks is sent to the ETP for further treatment. The ground water resources are not affected since care is taken to prevent the percolation of wastewater through the ground.

Impact on Air

The main source of air pollution is the gas exhausted from engines that are used for conversion of biogas to electrical energy. Nitrogen oxides, sulphur oxides and particulates are the main pollutants in the exhaust. These pollutants are released to atmosphere as a result of combustion processes. Emissions (per unit of electricity generated) from biogas combustion will tend to be higher than for energy generation from high efficiency natural gas plants but lower than generation with coal fired plants.

Five engines are used for electricity generation and the exhaust from these engines constitutes the air pollution. The characteristics of the exhaust are shown in Table 3.1. Since the constituents are well below the prescribed standards no air pollution control equipments are used. Each engine is provided with a stack of 16.0 m height so that ground level concentration of SO_X, NO_X, CO and particulate matter are well below the prescribed norms. This helps to mitigate air pollution thereby protecting the local people and settlements from air pollution problems.

Odour Problems
Odour is an unavoidable part of Solid Waste Management. Adequate odour control mechanism is used to overcome odour problems. Pipes are laid in the treatment plant over the shields to collect the obnoxious gases. A blower of capacity 38000m^3/hr has been provided. This system sucks the odour producing gases from various sections of the treatment plant like
1) Waste collection area
2) Drum screens
3) Sorting area
4) Ballistic separator
5) Mechanical Pulper
6) Hydrolysis tanks
7) Screw Press Building etc.

The collected gases are transported to a square GI duct of 700mm. The odourous gases from the ducts are led to bio filters for further treatment. The treated gases are then vented off into the atmosphere.

Biofilteration is an air pollution control technology which utilises microorganisms to biologically degrade odours and other volatile air pollutants contained in waste air streams. The microorganisms exist on the surface, and in a thin water film surrounding the surface of the biofilter material. During the biofiltration process, the contaminated air is slowly pumped through the biofilter material. The pollutants are adsorbed onto the filter material's surface, and absorbed into the water film. Simultaneously, the microorganisms biologically consume i.e. metabolize the pollutants, producing energy, biomass, and metabolic end products, mainly CO_2 and H_2O. The biofiltration process results in a complete decomposition of the pollutants, creating no hazardous byproducts. A biofilter of size 40.2m x 11.60m to 6.8m shall be provided to treat the odour producing gases.

Fresh air at the rate of 3500 m^3/hr is supplied to the hand sorting area by means of blowers to ensure that the personnel working in the hand sorting section are unaffected. This odour control mechanism ensures the complete removal of odour in the plant area and hence the plant personnel and other people in the neighbouring areas are unaffected by odour problems. Moreover, this odour control mechanism conforms to the German Health Standards.

Solid Waste Storage
The sorting plant has 2 portions – a collection area and a sorting area. The entire segregation plant is covered. The incoming wastes are unloaded in the collection area, which is covered. The collection pit is provided with doors operating automatically. The weight of dumped wastes open the door and waste collect in the pit. When no wastes are unloaded and tipped, the doors remain shut. Thus, the entire collected waste is covered thereby avoiding unsanitary conditions. Since, waste is collected and stored in a closed area nuisance of odour, flies, rodents, bird menace and fire hazard shall be minimized.

There is no scope for littering of waste and transmission of diseases through vectors arising from these wastes.

The incoming waste is transferred to a conveyor by means of a tipper. The conveyor carries the waste from collection area to sorting area. Waste is handled mechanically through all the stages of the treatment except in the hand sorting section Protective transparent shields are provided through which the inorganic materials like paper, plastic etc. are removed as per the requirement. This sorting area is well ventilated with fresh air being circulated regularly.

Waste Residues

The project generates some amount of solid rejects. These wastes are the segregated inorganic materials like glass, plastic, metal pieces, paper etc. The segregation plant is designed to segregate the incoming wastes at the rate of 40 tons/hour. The required waste quantity is about 300 tons/day and it is a mixed waste. As per the design the entire quantity can be sorted in 8 hours. The amount of waste residues produced is expected to be about 105 tons daily. However, the quantity of waste residue produced depends on the nature of waste sent to the plant. These wastes shall be disposed off in LNN designated landfill sites. The recyclables such as paper, glass, plastics etc. shall be recovered and reused for different purposes prior to landfilling. The sludge obtained from the ETP shall be sent to the compost yard for production of organic manure. It is later proposed to set up a RDF based power plant from the recovered waste residues in the future.

Noise

Noise is generated during transportation and construction. Noise generated during construction of the plant shall generally be within the permissible limits. Larsen and Toubro, the civil EPC contractor shall do the needful to reduce the noise levels below the permissible limits during construction.

During operation, noise is expected only from the engines. Since it is planned to use container type of gas engines, the noise generated from these engines outside the engine room will be less than 40 dB.

Potential impacts of the project and proposed mitigation measures are summarized in the following table.

Potential Impact	Mitigation Measure
Water Pollution	The wastewater discharged from the dewatering section of the plant shall be recycled and reused in the process. A portion of the wastewater shall be sent to the pulper and the remaining shall be reused as dilution water in feed preparation. Thus, there is no wastewater discharged form the process into the environment. Sewage produced due to domestic consumption of water shall be treated in septic tanks. The overflow from the septic tanks shall be dispersed through trenches.

Air Pollution	The main source of air pollution especially the regulated pollutants such as oxides of sulphur and nitrogen, CO and SPM is the stack exhaust from the gas engine. These constituents would be well within the prescribed limits and hence no air pollution control equipments are required. The emissions are discharged through stacks of 16.0 m height so that the ground level concentrations of SO_X, NOx, CO and particulate matter meet the prescribed tolerance limits and ensure environmental compliance.
Odour Control	Effective odour control mechanism is adopted. This method has compliance with German Health Standards. Pipes are laid in the treatment plant over the shields to collect the obnoxious gases. The gases from different sections of the treatment plant are sucked by blowers of capacity 38000m^3/hr. The collected gases are transported to a square GI duct of 700mm From the duct the odourous gases are led to bio filters for further treatment. The treated gases are then released into the atmosphere.
Solid Waste Storage	The incoming wastes are unloaded in the collection area, which is covered. The collection pit is provided with doors operated automatically. The weight of dumped wastes open the door and waste collect in the pit. When no wastes are unloaded and tipped, the doors remain shut. Thus, the entire collected waste is covered thereby avoiding unsanitary conditions. Since, waste is collected and stored in a closed area nuisance of odour, flies, rodents, bird menace and fire hazard shall be minimized. There is no scope for littering of waste and transmission of diseases through vectors arising from these wastes.

F.2. If impacts are considered significant by the project participants or the host Party: please provide conclusions and all references to support documentation of an environmental impact assessment that has been undertaken in accordance with the procedures as required by the host Party.

Given the nature of the project it does not attract the provision of the Environmental Impact Assessment notification of the Ministry of Environment & Forests. Therefore no Environmental Impact Assessment study has been undertaken for the project. However, a report on the environmental and social review of the project has been prepared, relevant aspects of which have been summarized at F.1.

G. STAKEHOLDERS COMMENTS

G.1. Brief description of the process on how comments by local stakeholders have been invited and compiled:

Since the proposed project does not attract the provisions of the Environmental Impact Assessment Notification of the Union Ministry of Environment & Forests, the requirement on public hearing is not applicable to the project. Therefore, no formal public hearing has been conducted for the project. Being first of its kind of project in the country, the project has gained wide publicity through media coverage. Although there are no adverse opinions on the effectiveness of the technology in addressing the waste management issue, concerns have been raised on the commercial viability of the project.

The immediate neighbourhood of the project site includes a small settlement of population and a wholesale vegetable market complex within a radius of about 3 KMs. The vegetable market association, one of the local stakeholders, strongly favours the project as they believe that with suitable arrangements with the project, the vegetable wastes piles degrading in the market area can easily be lifted on a regular basis and the general aesthetics and environmental condition of the surrounding can improve.

So far there have not been any concerns from the local community. However, as a best practice, the project has established a public relation committee which will interact with the local community on a regular basis and respond to and address concerns if any on a mutual agreement basis.

G.2. Summary of the comments received:

So far there have been no adverse comments on the project barring the ones relating to commercial viability.

G.3. Report on how due account was taken of any comments received:

The comments on commercial viability can only be addressed in due course once the project gets implemented.

ANNEX 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

(Please copy and paste table as needed)

Organization:	Prototype Carbon Fund
Street/P.O.Box:	MSN MC4-414, 1818 H Street NW
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E-Mail:	knewcombe@worldbank.org
URL:	www.PrototypeCarbonFund.org
Represented by:	
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Salutation:	Mr.
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Middle Name:	J.
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Department:	Environment
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Represented by:	
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Salutation:	
Last Name:	Subramani
Middle Name:	
First Name:	P
Department:	
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Direct FAX:	
Direct tel:	
Personal E-Mail:	

ANNEX 2

INFORMATION REGARDING PUBLIC FUNDING

The project involves no public fund from any Annex 1 Party.

ANNEX 3

NEW BASELINE METHODOLOGY

1. Title of the proposed methodology:

Biomethanation for Municipal Solid Waste Management in India

2. Description of the methodology:

2.1 General approach

The proposed Baseline New Methodology is based on Marrakesh Accord 48 (a), namely

- Existing actual or historical emissions.

2.2. Overall description (other characteristics of the approach):

Waste management in urbanizing India is a big challenge. MSW (municipal solid waste) generated in the cities are invariably disposed in unmanaged solid waste disposal sites, causing serious degradation of land and water resources and pose a threat to public health. Further, anaerobic decomposition of organic matter in the MSW by methanogenic bacteria leads to the production of a significant amount of methane which escapes into the atmosphere adding to the emission of greenhouse gases and contributes to the threat of climate change.

Recognizing the increasing problem and growing concerns, and responding to a Supreme Court ruling based on a public interest litigation, the Ministry of Environment and Forests issued the Municipal Solid Wastes (Management and Handling) Rules (2000). The rules identify the whole range of acceptable technical options for treatment and disposal of MSW, including landfilling with separation of biodegradable waste, composting, biomethanation and incineration, that have to be in place by December 2003.

In the years since the formulation of the MSW Management Rules, some cities have started the planning for sanitary landfill facilities and composting. There has not, however, been any noticeable change in the MSW management across the cities and municipalities, and no city in India seems to be in a position to comply with the MSW Management Rules by the deadline of December 2003. The single largest cause for inaction has been the poor financial health of municipal bodies and the absence of any additional allocation or appropriation by the state or central (federal) government for waste management.

In the context of the poor enforcement of environmental regulation in India and in the absence of allocation of substantial financial resources to deal with the waste management problem, it is likely that unmanaged solid waste disposal sites would continue to be the prevalent means of waste management, leading to significant environmental impacts, including the emission of methane into the atmosphere. It is very likely that there can be, at best, only slow incremental improvement in the way MSW is managed in India for the foreseeable future.

The baseline scenario, therefore, is the continuation of the current practice (disposal of MSW at the unmanaged solid waste disposal sites) with gradual changes to the acceptable technical options (composting, landfilling with inertization and biomethanation, etc.) expected over a period of time linked to percentage compliance with MSW Management Rules. The percentage of compliance can be assumed for the calculation of the baseline emissions. The percentage compliance figures can be taken from the annual compliance reports to be prepared by CPCB from time to time. As per the MSW Rules, the Central Pollution Control Board is mandated to monitor and report the level of compliance based on the annual compliance report to be provided by various State Pollution Control Boards in India. The national level of compliance reported by the Central Pollution Control Board, which would determine the baseline emissions, is incorporated in the method proposed here.

The emissions in the baseline scenario will depend on the measures implemented by cities across India and reported by the municipalities to the State/Central Pollution Control Board from time to time (see Attachment A to this Annex).

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

A. Baseline Scenario Greenhouse Gas Emissions

The baseline scenario is the continuation of the current practice (disposal of MSW at the unmanaged solid waste disposal sites) with gradual change expected over a period of time linked to percentage compliance with MSW Management Rules leading to waste management consistent with the acceptable technical options (composting, landfilling followed by inertisation and biomethanation, etc.). The percentage of compliance assumed for the calculation of the baseline emissions is summarized in the following table. It should be noted that the actual level of compliance will be determined based on the annual report to be provided by the municipal bodies to the State/Central Pollution Control Board (See Attachment A to this Annex) on compliance status.

Period	Expected level of compliance with MSW Rules (in terms of waste treated as per the rules)
Up to 2003	0%
2004-2007	10%
2007-2011	30%
2011-2015	50%

Zero percentage compliance in 2003 assumes that 100% of the waste in all the monitored cities and municipalities is disposed in unmanaged solid waste disposal sites in 2003. As the compliance with MSW rules increases over time the fraction of waste landing up in unmanaged solid waste disposal sites decreases accordingly. Therefore, the baseline emission of methane from unmanaged solid waste disposal sites is expected to decrease with time. In the period 2004 to 2007, it is assumed that 10% of the waste is processed/treated and disposed utilizing acceptable technological options such as composting; implying that all biodegradable material is removed from the incoming waste and only the inert and inorganic material is landfilled according to the MSW Management Rules. Assuming conservatively that the removed biodegradable waste undergoes fully aerobic decomposition and no methane is generated; the baseline scenario emissions in the period 2004 to 2007 will be 90% of the estimated methane yield from the waste handled by the biomethanation plant (the project).

Methane Generation from Landfills

Amount of methane that is generated at the unmanaged solid waste dumpsites depends upon the following factors:

- Waste disposal practice
- Waste composition (presence of degradable organic matter); and
- Physical factors such as moisture and temperature in the landfills

The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*IPCC Guidelines*) outline two methods to estimate CH4 emissions from solid waste disposal sites, the IPCC default method (theoretical gas yield) and the First Order Decay (FOD) method.

The first order decay method

The most commonly used method is the first order decay method, which assumes that methane is emitted over a long period of time rather than instantaneously. The kinetic approach takes into account the various factors, which influence the rate and extent of methane generation and release from landfills. One of the most important information that is required to estimate CH4 emissions is the waste degradability factor, which is a very site specific. Countries, where engineered landfills are already in operation and data on methane emissions etc. are recorded, it is possible to establish empirical relations to develop such site specific data. In the context of India, no such facilities are in operation. According to the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,* the *IPCC Guidelines* do not provide default values or methods for the estimation of some key parameters needed to use the first order decay method. These data are very dependent on country-specific conditions, and currently there are not enough data available to give reliable default values or methods for them.

Although a more realistic approach, due to lack of availability of data on some of the key variables, the first order decay method is not proposed in the methodology for estimating methane emission from the baseline scenario.

Theoretical gas yield methodology

This is the simplest method for calculating methane emissions from landfills. This is based on a mass balance approach, and does not incorporate time factors unlike the first order decay method. Rather this methodology assumes that all potential methane is released from waste in the year the waste is disposed off. This method requires the availability of data on the waste characteristics (such as degradable organic carbon in the waste and fraction of organic carbon that actually degrades). This information can be directly estimated through appropriate sampling techniques for incoming waste (see section on monitoring plan).

With increasing awareness on waste management, some studies have been conducted in India and there is adequate information available with respect to the waste characteristics in India. Additionally, IPCC has also recommended default values to enable estimation of methane emissions from MSW in the national inventories. Country specific data coupled with the default values recommended by IPCC can therefore be used to estimate methane emissions from unmanaged municipal solid waste dumpsites to give the estimates of the greenhouse emissions in the baseline scenario.

Suitability of the method

The time factor considered in the kinetic method only distributes the same emissions over years in which the waste decomposes. Since slow change in waste management practice is likely in India for the foreseeable future, the mass balance method is considered reasonable.

It is also possible to use the methane available in the digester output (in the proposed project) as the methane emissions that could have occurred from the landfill. However, this would not be conservative estimate of the likely emissions in the baseline scenario since digester is specifically designed to degrade the organic waste in a shorter time frame.

In balance, the mass balance method has been used as the methodology for the purpose of estimation of methane emissions from the baseline scenario (unmanaged municipal solid waste dumpsites).

Methane emissions using theoretical gas yield methodology

According to the theoretical gas yield method, CH4 emission from landfills is represented by the following equation.

$$\text{Methane Emissions from Landfill (TPD)} = MSW_T \times DOC \times DOC_F \times MCF \times F \times C$$

Where :

MSW_T	=	Total MSW disposed at the landfill (TPD)
DOC	=	Degradable organic carbon fraction in the MSW
DOC_F	=	Fraction of DOC that actually degrades
MCF	=	Methane correction factor for Land fill
F	=	Fraction of Methane in Landfill gas (0.5 default value)

C = Carbon to methane conversion factor (16/12)

The above equation would estimate the rate of emissions of methane to the atmosphere from a landfill.

While site specific data on all the variables are available in the context of the project, the only information that is not available is pertaining to the methane correction factor. Therefore, IPCC recommended value for methane correction factor is used for the purpose of estimation. Figures used in the formula are tabulated below.

Variables	IPCC Default Values for India	Project Specific Value
DOC	0.18	To be monitored
DOC_F	0.77	Use default unless project specific data is available (see section on Monitoring)
MCF	0.6	
F	0.5	

Greenhouse Gas Emissions from the Biomethanation Project

The theoretical gas yield model based on mass balance that is used to estimate the baseline scenario emissions can be used for the biomethanation unit as well. The summary of the parameters for the gas yield equation are as follows

Variables	IPCC Default Values for India	Project Specific Value
DOC	0.18	To be monitored
DOC_F	0.77	Use the same value as the baseline scenario emissions estimation
MCF	0.6	
F	0.5	Biomethanation digester specific data and can be monitored; typically 0.65

The procedure for the estimating the emission reduction (along with the default values based on IPCC recommendations) is summarized in the table below.

Assumptions			
Parameters	**Units**	**Values**	**Comments**
GHG Potential of CH4		21	
Molecular Mass of CH4		16	
Molecular Mass of CO2		44	
MSW to be treated	TPD	300	to be monitored
No. of days of operation	Days	360	to be monitored
Degradable Organic Carbon		0.18	to be monitored
Fraction of DOC that actually degrades		0.77	
CH4 Correction Factor		0.6	
Fraction of CH4 in Landfill gas		0.5	
Carbon to methane conversion factor	-	1.33	
Landfill Emission Calculations			

		MSW Treatment cum Energy Generation
CH_4 from landfills	TPD	**16.63**
Annual CH_4 from landfills	TPA	**5987.52**
Annual CO_2 equivalent from Landfills	TPA	**125738**

4. Definition of the project boundary related to the baseline methodology:

CDM projects can have two different boundaries: one for the determination of the baseline scenario, and another for monitoring and the calculation of ERs. The determination of the project boundaries depends on the project circumstances under which a baseline methodology is used. The baseline determination boundaries most often defined where possible alternatives to the proposed project are likely to be found, therefore

- *Geographic boundary*: The project site for monitoring and calculating the emission reduction from the project.
- *System boundary*: The urban waste management system in India. The reported level of compliance of the cities and municipal bodies is used to estimate the baseline scenario emission reduction (see section 3 A of this Annex)
- *Time boundary*: Current situation and planning cycle for a reasonable number of years (e.g. 7 or 10 year and up to 21 years in line with the CDM crediting periods). For this methodology, the choice of crediting period is left to the specific proponent of the biomethanation project in India.

Methane and carbon dioxide are the two greenhouse gases covered by proposed class of waste management projects (biomethanation). Consistent with the arguments in Annex 3 of NM0004 (Salvador da Bahia Landfill Gas Project) documentation other potential source of emissions (CO_2 emissions from plastic decomposition) that might offset any reductions achieved was also considered. Arguments similar to those in NM004 apply for ignoring CO_2 emissions from plastic. It should also be noted that diligent segregation of waste precedes biomethanation process initiation and the likely level of plastic in the waste will be negligible.

5. Assessment of uncertainties:

The key sources of uncertainty that are expected to influence the baseline emission reductions are those pertaining to the data used for emission estimations. Data on waste characteristics especially the degradable organic carbon content (DOC) is the principal uncertainty, which influences the emissions significantly. Uncertainty associated with this and also with other parameters that are linked to waste characteristics is however expected to be significantly minimised by using the daily analysis of the MSW characteristics as proposed in the monitoring methodology.

In the present methodology it is assumed that all the CH_4 generated from the landfill is released to the atmosphere. In reality, CH_4 release to the atmosphere is likely to depend upon the degree of oxidation that occurs as the gas diffuses through the landfill cover material. This aspect has not been captured in the methodology and hence still remains a potential uncertainty in the emission estimation.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

The Tenth Report of the Executive Board suggests that as part of the basis for determining the baseline scenario an explanation should be provided of, through the use of the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario. The Report also provided examples of tools that may be used to demonstrate that a project activity is additional and therefore not the baseline scenario include, among others:

(a) Narrowing of potential baseline scenario option
A comprehensive review of the MSW Management Rules (2000) suggests that the following options (or combination their of) need to be implemented by the municipalities if the provisions of the MSW Management Rules are to be complied with.

- Incineration
- Compost
- Sanitary landfiling
- Biomethanation

<u>Incineration</u>

Incineration of MSW as an option for disposal has been widely discussed in the country and there have been strong protests from the public and the NGOs on the grounds of associated environmental hazards. Although there have been counter arguments on availability of control measures to contain air pollutants such as the dioxins and furans, this is not likely to be accepted as a solution because of the following reasons.

- Control measures are expensive
- Regular monitoring of such pollutants are cost prohibitive
- Poor track record of monitoring by the regulatory agencies to check the emissions of such pollutants

Added to the above disadvantages is the perceived technology risk. Already the country has seen the failure of the technology in Delhi. A plant designed to generate 3.7MW at Timarpur has been lying idle for the reason that the characteristics of waste, especially the high moisture content of waste of Indian, does not favour incineration. Therefore, incineration is <u>not</u> considered as a feasible option in the context of India and is being dropped from further analysis.

<u>Composting as an option for waste treatment</u>

Although composting is accepted by the public as a favourable option for waste treatment, success has been limited only to very small size compost plants. Several projects involving composting on commercial scale have faced difficulty in India for the following reasons

- Limited/ difficult market for compost
- Trade-off between technology (and hence quality of compost) and cost
- Higher cost involved

Acceptance of the compost at present is believed to be linked to the quality of the compost. A compromise is often made in the quality keeping the cost in mind. Quality of compost suffers because of the mixed nature of the wastes and it is required to segregate the waste properly into organic and in organics before further processing for producing compost. Other disadvantages of composting are that the inert fraction still needs to be disposed off in a proper landfill as per the requirement of the MSW rules. Composting in combination with landfilling of inert material is retained as a feasible option for further analysis.

Landfilling as an option for waste treatment

Designing a proper sanitary landfill for disposing MSW to the standards prescribed by the MSW Management Rules is also considered a high cost option since it requires that all biodegradable waste be inertized (aerobically decomposed) before landfilling[1]. As a consequence of the high cost this option does not attract private investors. Such projects require higher financial aids in forms of subsidies, tipping fees etc. to enhance viability. This is considered a potential option for compliance with the MSW rules. Sanitary landfilling with provision of suitable inertization before disposal is retained as an option for further analysis.

Biomethanation as an option for waste treatment

Although, waste to energy through biomethanation as a possible solution to the urban MSW problems is being widely talked about, high technology risk and capital investment are seen as the key barriers to such projects. In fact the present project under consideration is being implemented as a demonstration project which might decide the future of the technology to be applied in rest of the country. Biomethanation as an option for treatment and disposal of MSW is retained as a feasible option for the baseline scenario for further analysis.

(b) Assessment of barriers facing the proposed project activity class

Biomethanation of solid waste faces a number of barriers as a consequence of which it can be demonstrated that a project activity proposing biomethanation is not in the baseline scenario.

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[1] The process of decomposition of biodegradable waste is similar to that in the composting process. Inertization before landfilling option, however, does not require segregation of biodegradable waste to get compost. Inertized biodegradable waste will contain material making it unsuitable for use as compost.

Investment barrier

A number of other, financially more viable alternative, to biomethanation exist for treating municipal solid waste. To demonstrate the greater financial extractives of other options, the methodology requires the identification of the lowest tipping fee option. Tipping fee is defined as the fee that is payable per ton of waste to be treated and disposed (in compliance with the MSW Management Rules) by the waste management operator in addition to any other revenues that the operator may realize from implementation of a given option to earn a reasonable return on the project. The option requiring the least tipping fee will accurately reflect the decision variable for the municipality as this is the cost incurred by it for waste treatment and disposal. The tipping fee calculated to ensure the same project IRR (internal rate of return, say, 15%) for all the options including all financial costs. All technical and financial parameters have to be consistent across the 3 options (Composting with landfilling, landfilling with inertization, and biomethanation).[2] Spreadsheet for carrying out this analysis (with cost data on the 3 options is included with the submission.

For the typical range of costs typical in India, the tipping fee for composting with landfilling or landfilling with inertization will require tipping fee in the range of Rs 80 to 100 per tonne of waste to give a project IRR of 15% (see spreadsheets). While project specific costs will vary, tipping fee for biomethanation is likely to exceed Rs 400 per tonne of waste to achieve project IRR of 15% (without including revenues from the sale of greenhouse gas emission reductions).

Technological barrier

While all the three options (Composting with landfilling, landfilling with inertization, and biomethanation) require a higher level of technology in comparison to the baseline options, biomethanation is a much more advance technology. It should be noted that even in the OECD countries biomethanation is not widely applied for municipal solid waste treatment. Landfilling with inertization followed by composting and landfilling are less technologically advanced alternative to biomethanation and involves lower risks due to the performance uncertainty and low market share.

Barrier due to prevailing practice and the project type not being common practice

As indicated, biomethanation is not applied widely even in OECD for municipal waste treatment. There is no existing project utilizing biomethanation technology for municipal solid waste in India.

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[2] No financial cost other than the land cost is incurred for the baseline scenario under which waste is predominantly disposed at unmanaged dumpsites and hence it is not meaningful to include this option in the financial analysis.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

The project boundary (and emissions) will be around the biomethanation project being proposed. The baseline emissions are based on the waste management practice in the country (see section 2.2 and 3.A for more details). As a consequence potential leakage is captured in the baseline scenario emissions.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

The starting point for the development of the baseline scenario is the MSW Management Rule of 2000. The MSW Management Rules were formulated by the Ministry of Environment and Forests after growing concern in India with the lack of progress in addressing the problem resulted in a Supreme Court directive to the Government to tackle the problem. The baseline scenario will evolve with the way solid waste is managed. According to the MSW Management Rules, municipal bodies have to report on the status of the implementation of the MSW Management Rules to the State/ Central Pollution Control Board. These reports form the basis for determining the baseline scenario emission reduction.

9. Assessment of strengths and weaknesses of the baseline methodology:

Strengths: The main strength of the proposed methodology is that it is able to capture the evolving waste management practice in India in the baseline scenario thereby eliminating or minimizing leakage.

Weakness: Reliance on data provided by municipalities to the State Pollution Control Board which in turn is synthesized by the Central Pollution Control Board is a potential weakness in the methodology. It is possible that municipalities and states with lowest compliance standard will not report data, making it difficult to utilize the proposed methodology. The way to address the issue is to utilize national level averages on the compliance with the MSW Management Rules. The national level averages are likely to report higher compliance than truant states or municipalities.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

The baseline scenario is based on the MSW Management Rules issued by the Government of India in 2000. The baseline scenario is therefore fully consistent and supportive with National and sectoral policies. At the same time, the baseline scenario acknowledges the enormous challenge that the Government of India, the state authorities, and, most importantly, the local municipal bodies face in addressing the waste management problem. To take into account the national, state and local circumstances, the baseline methodology developed proposes to monitor the level of compliance to the MSW Management Rules in quantifying the baseline scenario emission reduction. Through this, the methodology attempts not to punish but to modestly reward forward looking policies and goals reflected in the MSW Management Rule.

Attachment A to Annex 3

[Reference to the "Rule" in the Attachment below is to the Municipal Solid Waste (Management and Handling) Rules 2000]

Form - II
[see rule 4(4)]
Format of Annual Report to be submitted by the Municipal Authority

(i) Name of City/Town:................................(ii) Population:................................
(iii) Name of municipal body:..
and Address...

....

Telephone No. : ....
Fax : ....

(iv) Name of Incharge dealing with municipal solid wastes ....
with designation ....

1. Quantity and composition of solid wastes
(i) Total quantity of wastes generated per day
....

(ii) Total quantity of wastes collected per day
....

(iii) Total quantity of wastes processed for :
....

(a) Composting :
....

(b) Vermiculture :
....

(c) Pellets
....

(d) Others, if any, please specify
....

(iv) Total quantity of waste disposed by landflling
....

(a) No. of landfill sites used :
(b) Area used :
(c) Whether Weigh-bridge facilities available : Yes No
(d) Whether area is fenced : Yes No
(e) Lighting facility on site : Yes No
(f) Whether equipment like Bulldozer, Compacters etc. available. (Please specify): ....
(g) Total Manpower available on site : ....
(h) Whether covering is done n daily basis : Yes No
(i) Whether covering material is used and whether it is adequately available : ....
(j) Provision for gas venting provided : Available Not available (Yes/No)
(k) Provision for leachate collection : Provisions made Provisions not made

2. Storage facilities

(i) Area covered for collection of wastes : ....
(ii) No. of houses covered : ....

(iii) Whether house-to-house collection is practised (if yes, whether done by Municipality or through Private Agency or Non-Governmental Organisation) : ....
(iv) Bins : ....

Specifications Existing Proposed
(Shape & Size) Numbers for future
....

(a) RCC Bins (Capacity) :
(b) Trolleys (Capacity) :
(c) Containers (Capacity) :
(d) Dumper Placers :
(e) Others, please specify :

(v) Whether all bins/collection spots are attended for daily lifting of garbage : Yes No

(vi) Whether lifting of garbage from dustbins is manual or mechanical i.e. for example by using of front-end loaders (please tick mark) please tick mark) please specify : Manual Loader Others,

3. Transportation

	Existing number	Actually	Required/Proposed
(i) Truck :			
(ii) Truck-Tipper :			
(iii) Tractor-Trailer :			
(iv) Refuse-collector :			
(v) Dumper-placers :			
(vi) Animal Cart :			
(vii) Tricycle :			
(viii) Others(Please specify) :			

4. Whether any proposal has been made to improve solid wastes management practices

....
....
....

5. Are any efforts made to call for private firms etc. to attempt for processing of waste utilising technologies like :

Waste Utilisation Technology	Proposal	Steps taken (Quantity to be propossed)
(i) Composting :		
(ii) Vermiculture :		
(iii) Pelletisation :		
(iv) Others, if any : Please specify		

6. What provisions are available and how these are implemented to check unhygienic operations of :

(i) Dairy related activities :
(ii) Slaughter houses and unauthorised slaughtering :
(iii) Malba (Construction debris) lifting :
(iv) Encroachment in Parks, Footpaths etc. :

7. How many slums are identified and whether these are provided with sanitation facilities :

8. Are municipal magistrates appointed for taking penal action. : Yes No

[If yes, how many cases registered & settled during last three years (give year wise details)]

9. Hospital waste management

(i) How many Hospitals/Clinics under the control of the Corporation
(ii) What methods are followed for disposal of bio-medical wastes ?
(iii) Do you have any proposal for setting up of common treatment facility for disposal of bio-medical wastes
(iv) How many private Nursing Homes, Clinics etc. are operating in the city/town and what steps have been taken to check disposal of their wastes

Dated: Signature of Municipal Commissioner

ANNEX 4

NEW MONITORING METHODOLOGY

Proposed new monitoring methodology

1. Brief description of new methodology

The baseline scenario envisages that, initially, MSW is disposed in unmanaged landfill. Over time, there is gradual compliance to the MSW Management Rules (see section 3 of this Annex). The emissions from the baseline scenario therefore require the estimation of methane emissions from unmanaged landfill and the level of compliance to the MSW Management Rules. Therefore

Baseline Emissions = (Methane Emission from Landfill) X (Fraction of non-compliance to MSW Management Rules)

Fraction of non-compliance is obtained from the consolidated report on compliance prepared by the municipalities and reported to the State/ Central Pollution Control Board in India (see Attachment A to Annex 3). Thus the level of compliance is monitored.

Methane Emission from Landfill is determined according to the theoretical gas yield method, which is obtained by the following equation.[3]

$$\boxed{\text{Methane Emissions from Landfill (TPD)} = MSW_T \times DOC \times DOC_F \times MCF \times F \times C}$$

Where :

MSW_T	=	Total MSW disposed at the landfill (TPD)
DOC	=	Degradable organic carbon fraction in the MSW
DOC_F	=	Fraction of DOC that actually degrades
MCF	=	Methane correction factor for Land fill
F	=	Fraction of Methane in Landfill gas (0.5 default value)
C	=	Carbon to methane conversion factor (16/12)

Value of parameters[4]

Degradable organic carbon (DOC)

3 See Chapter 5 of *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* accepted by the IPCC Plenary at its 16th session held in Montreal, 1-8 May, 2000.

4 This section is largely based on Chapter 5 of *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* accepted by the IPCC Plenary at its 16th session held in Montreal, 1-8 May, 2000.

Degradable organic carbon is the organic carbon that is accessible to biochemical decomposition. It is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream. Based on the *IPCC Guidelines*, estimates DOC using default carbon content values can be estimated using the following equation:

$DOC = (0.4\ A) + (0.17\ B) + (0.15\ C) + (0.3\ D)$

Where:

A = Fraction of MSW that is paper and textiles

B = Fraction of MSW that is garden waste, park waste or other non-food organic putrescibles

C = Fraction of MSW that is food waste

D = Fraction of MSW that is wood or straw

The default carbon content values for these fractions can be found in the *IPCC Guidelines* (Table 6-3, Reference Manual). However, obtaining values by performing waste generation studies and sampling of different waste disposal streams at the proposed project is recommended. Survey data and sampling results should be reported and record of these should be maintained. In addition, it is important that inventory agencies exclude lignin from their DOC calculations if the default value (0.77) for DOCF is used, as discussed below.

Fraction of degradable organic carbon dissimilated (DOCF)

DOCF is an estimate of the fraction of carbon that is ultimately degraded and released from unmanaged landfill, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in unmanaged landfill. The *IPCC Guidelines* provide a default value of 0.77 for DOCF. Based on a review of recent literature, it appears that this default value may be an overestimate. It should only be used if lignin elemental carbon is excluded from the DOC value.

Methane correction factor (MCF)2

The methane correction factor (MCF) accounts for the fact that unmanaged landfill produce less CH4 from a given amount of waste than managed landfill, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged landfill. The MCF in relation to solid waste management is specific to that area and should be interpreted as the ‘waste management correction factor’ that reflects the management aspect it encompasses.

The *IPCC Guidelines* present default values for MCF, which are presented in table below.

SWDS CLASSIFICATION AND METHANE CORRECTION FACTORS	
Type of Site	**Methane Correction Factor (MCF) Default Values**
Managed [a]	1.0
Unmanaged – deep (≥5 m waste)	0.8
Unmanaged – shallow (<5 m waste)	0.4
Uncategorised SWDS [b]	0.6

[a] Managed SWDS must have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include some of the following: cover material, mechanical compacting or levelling of waste.
[b] The default value of 0.6 for uncategorised SWDS may be inappropriate for developing countries with a high percentage of unmanaged shallow sites, as it will probably lead to overestimation of emissions. Therefore, inventory agencies in developing countries are encouraged to use 0.4 as their MCF, unless they have documented data that indicates managed landfill practices in their country.

Source: Reference Manual of the *IPCC Guidelines*.

SWDS: Solid Waste Disposal Site or landfill.

Fraction of CH4 in landfill gas (F)
Landfill gas consists mainly of CH4 and carbon dioxide (CO2). The CH4 fraction F is usually taken to be 0.5, but can vary between 0.4 and 0.6, depending on several factors including waste composition (e.g. carbohydrate and cellulose). The concentration of CH4 in recovered landfill gas may be lower than the actual value because of potential dilution by air, so F values estimated in this way will not necessarily be representative.

While site specific data on all the variables are available in the context of the project, the only information that is not available is pertaining to the methane correction factor. Therefore, IPCC recommended value for methane correction factor is used for the purpose of estimation. Figures used in the formula are tabulated below.

Variables	IPCC Default Values for India	Project Specific Value
DOC	0.18	To be determined based on a sample survey to determine the waste characteristics, in particular the following fractions: A = Fraction of MSW that is paper and textiles B = Fraction of MSW that is garden waste, park waste or other non-food organic putrescibles C = Fraction of MSW that is food waste D = Fraction of MSW that is wood or straw
DOC_F	0.77	Use default unless project specific data is available; ensure that lignin elemental carbon is not included in the DOC value.
MCF	0.6	Use default unless project specific data is available landfill classification, in particular the dept of the unmanaged landfill
F	0.5	Use default unless project specific data is available

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
2-1	*GHG emission from baseline*	*MSW input to the plant*	*TPD*	*Measured*	*Daily*	*100%*	*Both paper & electronic*	*12 years*	*Each load of MSW to be weighed at the plant entry*
2-2	*GHG emission from baseline*	*Organic Content of MSW (DOC)*	*%*	*Estimated from sample measurement of waste characteristics*	*Monthly or seasonal*	*Sample*	*Both paper & electronic*	*12 years*	*Organic content to be analyzed through sample analysis in the lab to determine the waste characteristics, in particular the fractions of paper and textiles, garden waste, park waste or other non-food organic putrescibles, or food waste*
2-3	*Compliance with MSW Rules at country level*	*Quantity of MSW treated and disposed in compliance with MSW Rules*	*TPD*	*Obtained from the reports prepared by the municipal bodies for the State/ Central Pollution Control Board*	*Electronic*	*5 years*	*Paper (report obtained from State/ Central Pollution Control Board*	*12 years*	*At the end of each year data pertaining to each class-A municipality in India will be collected. Data on municipalities complying with MSW Rules only will be collected and recorded*

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources
(Please add rows to the table below, as needed.)

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
None identified									

4. Assumptions used in elaborating the new methodology:

(Please list information used in the calculation of emissions which is not measured or calculated, e.g. use of any default emission factors)

The following assumptions are made in the estimation of the emissions from the baseline scenario.

Variables	IPCC Default Values for India	Project Specific Value
DOC_F	0.77	Use default unless project specific data is available; ensure that lignin elemental carbon is not included in the DOC value.
MCF	0.6	Use default unless project specific data is available landfill classification, in particular the dept of the unmanaged landfill
F	0.5	Use default unless project specific data is available

The following assumptions are made to determine the greenhouse gas emissions from the Project

Variables	IPCC Default Values for India	Project Specific Value
DOC	0.18	To be monitored
DOC_F	0.77	Use the same value as the baseline scenario emissions estimation
MCF	0.6	
F	0.5	Biomethanation digester specific data and can be monitored; typically 0.65

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

Data *(Indicate table and ID number e.g. 3.-1; 3.-2.)*	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
2-1	*Low*	*Yes*	*Not applicable*
2-2	*Medium*	*Yes*	*Not applicable*
2-3	*Medium*	*No*	*The data will be reported by the municipal bodies and aggregated by State/ Central Pollution Control Board. The Project entities will have no jurisdictional authority on the State/ Central Pollution Control Board or the municipal bodies.*

6. What are the potential strengths and weaknesses of this methodology? *(please outline how the accuracy and completeness of the new methodology compares to that of approved methodologies).*

Strength: Simple practical method to determine baseline emissions taking into account national goals and priorities (the MSW Management Rules) and allowing for incorporation of national circumstances and constraints (lack of data from operational managed or unmanaged landfills).

Weakness: the baseline emissions will depend on the level of compliance to the MSW Management Rules at the State/ Central (federal). This data is to be prepared by municipal bodies with limited technical capability leading to the risk of poor data on compliance. It is suggested that consistency of data at the municipal and state level be cross-checked with national level aggregates and more conservative values be used.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

The proposed methodology for methane emissions from uncontrolled landfills has been adapted from the IPCC default methodology to determine methane emissions from waste management for national inventories. See chapter 5 of *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* accepted by the IPCC Plenary at its 16th session held in Montreal, 1-8 May, 2000.

ANNEX 5 :
TIPPING FEE ANALYSIS ASSUMTIONS & RESULTS FOR VARIOUS OPTIONS

1. Compost cum Landfill Option

Key assumptions & results for Landfill with compost as the MSW treatment & disposal option

The option assumes that waste is properly segregated before composting to produce good quality compost which can have a better market acceptance. The inorganic and other inerts contents of the MSW are disposed off in the landfill. Sale of compost & tipping fee are considered the two revenue streams for the option

Parameters	Units	Values	Comments
MSW required to be treated and disposed	TPD	300	For comparison purpose 300 TPD of waste has been considered for all the options
Recyclables	%	15%	MSW characteristics of Lucknow
Moisture	%	45%	MSW characteristics of Lucknow
Organic Content	%	60%	MSW characteristics of Lucknow
MSW density	Tons/M3	0.9	MSW characteristics of Lucknow
Capital cost without land cost	Rs. Lacs	1652.1	Figures taken for a similar project under consideration
Capital cost including land cost	Rs. Lacs	2090.3	land requirement is linked to the inertisation efficiency
Segregation efficiency of the sorting plant	%	90%	Figure taken from similar project under consideration
Compost output	% of MSW	32%	depends upon the organic content of MSW and the composting process
Inorganic & inerts required to be disposed in the landfill	% of MSW	31%	depends upon inorganic and inert content of the MSW
Land required for landfill	Sq.M.	42075	Height of the landfill is considered to be 8 M
Project IRR	%	15%	
Period over which the return is calculated	Years	10	
Tipping Fee required for 15% Project IRR without land cost	Rs/Ton MSW	87.6	
Tipping Fee required for 15% Project IRR with land cost	Rs/Ton MSW	161.4	

2. Landfill with Inertization Option

Key assumptions & results for Landfill with inertisation as the MSW treatment & disposal option The option assumes that waste is suitably inertised before being disposed in the sanitary landfill. Tipping fee is the only source of revenue for the option			
Parameters	**Units**	**Values**	**Comments**
MSW required to be treated and disposed	TPD	300	For comparison purpose 300 TPD of waste has been considered for all the options
Recyclables	%	15%	MSW characteristics of Lucknow
Moisture	%	45%	MSW characteristics of Lucknow
Organic Content	%	60%	MSW characteristics of Lucknow
MSW density	Tons/M3	0.9	MSW characteristics of Lucknow
Capital cost without land cost	Rs. Lacs	**122.4**	Figures taken for a similar project under consideration
Capital cost including land cost	Rs. Lacs	695.6	land requirement is linked to the inertisation efficiency
Inertised waste required to be landfilled	TPD	109	depends upon the inertisation efficiency
Inertisation Efficiency	% of MSW	36%	data taken from a similar project under consideration
Land required for landfill	Sq.M.	64281	Height of the landfill is considered to be 8 M
Project IRR	%	15%	
Period over which the return is calculated	Years	10	
Tipping Fee required for 15% Project IRR without land cost	Rs/Ton MSW	97.69	
Tipping Fee required for 15% Project IRR with land cost	Rs/Ton MSW	194.58	

3. Biomethanation Option

Key assumptions & results for Biomethanation as the MSW treatment & disposal option The option assumes that waste is properly segregated before fed to an anaerobic digester for production of biogas. The inorganic and other inerts contents of the MSW are disposed off in the landfill. Sale of electricity, organic manure, & tipping fee are considered as the 3 revenue streams for the project			
Parameters	**Units**	**Values**	**Comments**
MSW required to be treated and disposed	TPD	300	For comparison purpose 300 TPD of waste has been considered for all the options
Recyclables	%	15%	MSW characteristics of Lucknow
Moisture	%	45%	MSW characteristics of Lucknow

Organic Content	%	60%	MSW characteristics of Lucknow
MSW density	Tons/M3	0.9	MSW characteristics of Lucknow
Capital cost without land cost	Rs. Lacs	7403.0	Figures taken for a similar project under consideration
Capital cost with land cost	Rs. Lacs	7,842.92	land requirement is linked to the sorting plant's efficiency & inert and inorganic content of waste
Sorting plant efficiency	%	90%	Figure taken from the project under consideration
Compost output	% of MSW input	25%	Figure taken from the project under consideration
Inert & inorganics to the landfill	% of MSW input	31%	linked to inert & inorganic content of the waste
Land required for landfill	SQ.M	52355	linked to waste that required disposal
Project IRR	%	15%	fixed at the same level for all options
Tipping Fee required for 15% Project IRR without land cost	Rs/Ton MSW	473	
Tipping Fee required for 15% Project IRR with land cost	Rs/Ton MSW	566	