JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Methane Capture and Destruction at the Solid Waste Landfill in the City of Lviv, Ukraine

Document Version Number: 01

Sectoral Category 13, Waste Handling and Disposal

30/01/2009

A.2. Description of the project:

Purpose of the Project

The "Methane Capture and Destruction at the Lviv Solid Waste Landfill, Ukraine" project (hereinafter referred to as the "Project) will build and operate a Landfill Gas (LFG) collection and flaring system in order to avoid emissions of methane being released into the atmosphere and to produce Emission Reduction Units (ERU's) for sale under the Joint Implementation mechanism of the Kyoto Protocol. LFG is produced from decay of organic waste in the anaerobic conditions that are created in a landfill body. LFG contains approximately 50% methane (CH_4) which is a greenhouse gas (GhG).

Services currently provided by the Landfill

The Lviv Solid Waste Landfill (herein referred to as the "Landfill") is the only landfill servicing the city of Lviv, a regional centre in the western part of Ukraine with population of 800,000. The Landfill was founded in 1957 and is located 5 km north of the city. It is estimated that to date a total of 25.6million m^3 (5.9 million tons) of solid waste has been deposited at the site and in recent years the rate of disposal continues to be in the magnitude of approximately 240,000[1] tons per year.

Management of the Landfill

The Landfill is owned and managed by Lviv City Municipality (herein referred to as "Lviv municipality."). It has a total area of 38.8 hectares of which 26.5 hectares is in use.

Planned LFG collection, flaring and associated activities

[1] Source: Report on Results of the Lviv SW Landfill Pump-Testing

The Lviv municipality has signed a concession agreement[2] granting the rights for degasification of the Landfill and utilization of LFG to the Ukrainian private company LLC Gafsa (herein referred to as the "project developer") for a 10-year period. Under the terms of the agreement the Project will be owned, managed and operated by LLC Gafsa.

As described more fully in section A.4.2, the Project will involve the following main activities (herein referred to collectively as the "project activity"):

- Landfill remediation
- LFG collection
- Gas flaring
- LFG-to-electricity generating unit and start-up fossil fuel fired generating unit to supply energy to run the project
- Monitoring the destruction of LFG

Expected Impacts of the Project

Analysis of the Landfill site indicates that approximately 91.7 Mm^3 of LFG will be collected by the Project over the period 2009- 2012. The Project is expected to achieve an estimated 434,533 tonnes of CO_2e reductions over the 4-year commitment period.

As described in Section F, the Project will also provide environmental, economic and social benefits to the local area as follows:

- improved safety of the Landfill because of the destruction of LFG which is a potential fire hazard
- improved local environment because capturing and destroying LFG reduces bad odour
- improved local environment because LFG collection and remediation activities will help to reduce seepage of LFG and leachate in the vicinity of the Landfill site
- increased foreign investment and technical innovation in the waste management sector of Ukraine through import of technology for LFG recovery and utilisation
- enhanced knowledge of the best landfill management practices in Ukraine

A.3. Project participants:

[2] Gafsa-Lvov Municipality Agreement Translation NY

Party involved*	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (host country)	• Gafsa Ltd • Zbyranka Landfill Recovery LLC	No
UK	• Carbon Capital Markets Limited	No

A.4. Technical description of the project:

A.4.1. Location of the project:

A.4.1.1. Host Party(ies):

Ukraine

A.4.1.2. Region/State/Province etc.:

Lviv region

A.4.1.3. City/Town/Community etc.:

Lviv City, Zhovkivskiy region, Grybovychi village

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

The Lviv landfill is located 5 km north away from the Lviv city, not far from the village Grybovychi. The Lviv city is located in the western part of Ukraine, 80 km away from the border with Poland. Coordinates for Lviv are 49.54.05.06 N and 24.02.22.17. E.

Figure 1 Geographical location of Lviv project

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

This section describes the technologies and measures to be employed for the project activities listed in A.2.

LFG collection system

Vertical perforated plastic gas extraction wells will be established in the waste material. The following features of the system will be determined during the design phase of the Project:

- Configuration of the wells in accordance with the depth and slope of different parts of the Landfill
- Number and spacing of the wells in accordance with results of soil boring and gas pumping tests

The wells will be connected to a gas control plant through a network of horizontal underground non-perforated piping consisting of a header, sub-headers and laterals installed within the Landfill and around its perimeter. The LFG collection system will employ the following technologies:

- The flow of gas will be controlled at each of the individual vertical extraction wells by a valve located at the top of the well piping
- Each wellhead will be equipped with a secure monitoring chamber and monitoring ports for gas composition, pressure, and temperature readings
- Dewatering points at strategic low points will allow for effective condensate management

Integrated booster and gas flaring station

This project will adopt Hofstetter technology. The **HOF***GAS ®- Ready C* is a complete extraction and flaring station for safe and economic degassing of landfill sites. The integrated booster and flare station ("integrated station") will consist mainly of a manifold for the incoming pipes, flow control valves, gas blower and pressure boosting pumps, enclosed high-temperature flare stack and gas monitoring and analysis system.

The gas blower system creates a vacuum at slightly less than atmospheric pressure in order to pull LFG through the piping system from the wells. The LFG is transported through a demister and filter to protect the equipment from excessive moisture and particulates in the gas.

A controlled combustion with concealed flame is guaranteed by the **HOF***GAS®- Efficiency* high temperature flare. The flare design will incorporate safety features including controlled flame ignition system and flame arrestor device to prevent flashback to the fuel feed pipe. A control panel will incorporate all flare controls, motor starters, alarms and interlocks to ensure safe operation of the integrated station.

The complete degassing unit is built in a ventilated container, which makes the **HOF***GAS®- Ready/C* plant theft-proof, decreases sound levels outside and also protects it from environmental influences. The electrical PLC control is located in a separate compartment.

LFG generator and back-up power supply for the Project

A portion of the LFG collected will be utilised in a LFG-to-Energy ("LFGTE") unit to produce electricity to power the Project. Only ERUs from landfill gas destruction will be claimed.

The Project will also utilise a start up gasoline generator to provide back-up power to the project activity. The gasoline generator will be used on an as needed basis.

Monitoring the destruction of LFG

The design of the integrated station will include monitoring equipment in order to fully implement the monitoring plan that is described in Section D and Annex 3. In summary, the monitoring system will comprise of the following technologies:

- flow meter to measure the volumetric flow of the gas to the flare and the LFG generator;
- LFG pressure and temperature transmitters for calculation of the gas mass flow rate;
- gas analyser to measures the composition of the LFG delivered to the flare;
- sampling points and portable instrumentation for laboratory analysis of the LFG;
- thermocouple to monitor the temperature of the flame in the stack and control the automated air louver to maintain the temperature within the desired range
- continuous, automated data logging system

Origin of the technology

The expected origin and standard of the technology described in this section is summarised in the table below:

Component	Imported or locally manufactured	Standard
Wells	Locally manufactured	According to local standards
Gas collection system	Locally manufactured	According to local standards
Flaring system	Imported from EU	According to EU Standards
Gasoline power plant	Locally manufactured	According to local standards
Gas engine and generator sets	Imported from EU	According to EU Standards
Monitoring and control systems	Imported from EU	According to EU Standards

A.4.3. Briefly explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

Decomposition of solid waste under anaerobic conditions produces LFG, which is released into the atmosphere as an anthropogenic emission. Tests of LFG from the Lviv landfill confirm that the gas contains between 50% and 55% methane which is a powerful greenhouse gas.

As summarised in Section A.4.2 the Project will reduce greenhouse gas emissions by capturing the LFG and combusting it in order to destroy the methane producing CO_2 and a small quantity of other byproduct gases. The CO_2 released during the combustion process was originally fixed via biomass so when released, it is carbon neutral in the carbon cycle.

Section B.1 demonstrates that the most likely alternative to the Project is for the Lviv municipality to continue the current practice of releasing all LFG produced at the Landfill into the atmosphere over the crediting period. New requirements for improved management of LFG were introduced at a national level in June 2005; however there is widespread non-compliance because many local authorities are not able to afford the additional cost burden of installing and operating systems for LFG collection.

The Lviv municipality has decided to partner with a private sector partner to collect the LFG and destroy the methane component for the purpose of generating emission reductions. At this time, the only incentive to attract private sector investment is the opportunity to produce and sell ERUs under the Joint Implementation mechanism of the Kyoto Protocol. Consequently, in accordance with guidance provided by the CDM Executive Board, Section B.2 concludes that the project activity is would not have occurred in absence of the project.

A.4.3.1. Estimated amount of emission reductions over the crediting period:

Estimated ERUs for the proposed project activity is approximately 434,533 tonnes CO_2eqv over the 3.75-year crediting period starting in April of 2009. Between 2009 and 2012 the Project is expected to mitigate on average 115,875 tonnes per year of CO2e.

	Years
Length of crediting period	**3.75**
Years	**Estimate of annual emission reductions in tonnes of tonnes of CO_2 equivalent**
2009 (from April)	79,400
2010	112,434
2011	118,340
2012	124,359
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	434,533
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	115,875

A.5. Project approval by the Parties involved:

Letter of Endorsement for the Lviv LFG project from the Ministry of Environmental Protection of Ukraine is available on request.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

Baseline methodology for landfill gas project activities

This Project makes use of the CDM Executive Board Approved Consolidated baseline and monitoring methodology for landfill gas project activities ACM0001 Version 9.1 in order to determine the baseline. ACM0001 also makes reference to the CDM Executive Board 'Tool for the demonstration and assessment of additionality' Version 5.2 ("the Additionality Tool").

Identification of all alternatives to the project activity consistent with current laws and regulations

(This sub- section corresponds to Step 1 of the Additionality Tool. The purpose of this sub- section is to define all the alternatives to the project activity.)

The following alternatives, including the proposed project activity undertaken without ERUs, the may be considered to be possible alternative baseline scenarios:

- Alternative 1: Disposal of the waste at the landfill with electricity generation using landfill gas captured from the landfill site.
- Alternative 2: Disposal of the waste at the landfill with flaring of gas captured from the landfill as a non-JI project.
- Alternative 3: Disposal of the waste at the landfill without capture of landfill gas (current situation).

Alternative 1:

The main barrier is of financial nature, since the revenues from power sales do not outweigh the high investment, i.e., the project's IRR is significantly below market expectations, and thus not capable to attract investors. It would be necessary for the Lviv municipality to invest in establishing a connection to the national electricity grid because none exists at the Lviv Landfill.

In many countries LFG- to- Energy ("LFGTE") projects receive regulatory and policy support to become commercially viable to attract public and/or private sector investment. In Ukraine however, due to the large number of other development priorities faced by national and local levels of government there are no policies to support utilisation of organic waste or promote renewable energy. LFGTE projects are not eligible to receive government support, subsidies or other investment incentives of any kind.

Lastly, Ukraine is overcapacitied for production of electricity. The National Energy Strategy sets the approach for the energy sector in Ukraine and the electricity sector in particular. In order to achieve the key objective of reducing dependence on imported fossil fuels the strategy prioritises increased use of local coal and nuclear power as well as energy efficiency and energy saving

measures. There is less priority on renewable energy generation, particularly small-scale private sector initiatives.
However, there are power offtakers within two kilometres from the LVIV landfill and there is grid power available within this area.

The specific circumstances of the Lviv Landfill combined with the policy and regulatory environment in Ukraine renders this alternative not probable, but with the nearby offtakers and grid accessibility, the alternative is possible.

Therefore, Alternative 1 could be a baseline scenario.

Alternative 2:
The project activity requires funds for construction of the required facilities and to maintain operations. There are no known or funding sources available to support this project and the existing regulatory requirements regarding emissions control is not expected to be followed as mentioned above. Furthermore, this alternative does not itself provide any potential revenue to the landfills and it is therefore, not considered a plausible alternative.

Therefore, Alternative 2 is not a probable baseline scenario.

Alternative 3:
On June 17, 2005, the State Committee of Ukraine for Construction and Architecture resolved to introduce new requirements for LFG management. National Construction Standard DBN V.2.4-2-2005 Basics of Sites Design requires the landfill operator to implement LFG collection and flaring/utilization at all landfills.

Due to its widespread noncompliance around the country (also see "Analysis of other activities" of B.2 below), it is plausible that there would continue to be complete atmospheric release of LFG from the Lviv landfill during the crediting period.

Therefore, Alternative 3 could be a baseline scenario.

<u>Investment Analysis</u>

(This sub-section corresponds to Step 2 of the Additionality Tool. The purpose of this sub-section is to demonstrate that the alternative scenarios are less costly than the project activity in order to conclude that the proposed JI project is not the most financially/economically attractive option for the Lviv municipality and to rule out alternative baseline scenarios.)

Alternative 1 would generate income. Therefore, the investment comparison analysis, with the financial indicator of IRR is used to assess this alternative.

Power generation systems require significant investment as a project option. Theoretical landfill gas forecasts show potential gas for 3.150 MW of capacity at this site. With a capital expenditure for civil works on the landfill, gas collection system and the engines (not including the required transmission lines and transformer stations), this alternative will yield a 0% IRR, rendering this alternative financially unfeasible.[3] Additionally, power generation is not the project developer's main line of business.

Table 1 Costs for Alternative 1

Item	Cost or Value
Engines	€ 947,740
Civil works	€ 2,164,990
Opex and Admin	€ 35,872 per annum
Taxes	25%
Power Price	$25/MWh
IRR	0%

Finally, the Project and Alternative 3, the only remaining probable baseline scenario, generate no financial or economic benefits other than JI related income. Therefore, it is appropriate to apply a simple cost analysis to demonstrate that the Project without ERUs is more costly than the alternative of total atmospheric release of LFG. The table below shows that the engineering, procurement and construction costs for the gas collection system are substantial.

Table 2 Costs associated with project activities

Item	Cost, €
EPC	2,133,265
Contingencies %	5.0%
Total EPC	2,239,928

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

The purpose of this section is to demonstrate the 'additionality' of the emission reductions that are described in Section A.4.3.1. 'Additionality' refers to the requirement that greenhouse gas emissions after implementation of the Project are lower than those that would have occurred in the most plausible alternative scenario to implementation of the Project.

Section B.1 utilises ACM0001 to demonstrate that the most plausible alternative scenario to implementation of the Project, the baseline scenario, is complete atmospheric release of LFG from the Lviv landfill. Steps 1 and 2 and 3 of the Additionality Tool have already been completed in order to demonstrate this result. Consequently it is only necessary to complete the final step of the Additionality Tool in this section.

[3] Note that for comparison, corporate bond rate yields from Bloomberg as of January 30, 2009 were greater than 7.375% and government bond rates, without the risk premium increase, were minimum 6.59% on a 2010 return.

Analysis of other activities

(This sub-section corresponds to Step 4 of the Additionality Tool. The purpose of this sub-section is a credibility check to complement the investment analysis and barrier analysis completed in the previous section.)

A survey of landfills in Ukraine demonstrates that the 2005 Standard is not systematically enforced. The following table summarises information for a representative sample of landfills servicing cities with a population of more than 200,000:

Table 3 Common Practice[4]

	Number of inhabitants serviced by landfill (‘000)	Rate of waste disposal in 2004 (uncompacted, ‘000 m^3/ year)	Total amount of waste (uncompacted, million m^3)	Starting year	Total landfill area (ha)	LFG control in operation in 2005
Alushta	60	120	3.6	1960	6.9	None
Yalta	150	240	6.5	1973	5.7	None
Cherkassy	310	360	4.8	1992	9	Passive venting
Ivano-Frankivsk	230	260	3.0	1992	22.4	None
Khmelnitsky	250	490	14.8	1956	8.8	None
Kirovograd	280	260	10.9	1949	23	None
Kremenchug	245	290	12.3	1965	28	None
Lutsk	215	340	3.6	1991	9.9	None
Rivne	245	400	12.2	1959	24.5	None
Vinnitsa	385	340	5.1	1985	5	None
Zhytomyr	300	300	8.0	1957	18.7	None

To date one project for LFG collection and flaring has been implemented in Ukraine. This was a demonstration project at the Lugansk landfill during 2002 which was supported by grant financing from EcoLinks and USAID in order to promote adoption of improved LFG management techniques and clean technologies. Three LFG extraction wells, collection piping and a flare were installed at the landfill and monitored for one year.

[4] Identification and preparation of ProjectPreCheck (PPC) documents for LFG collection and utilization projects in Ukraine. Final report. For KfW Entwicklungsbank; by DECON Gmbh, SEC “Biomass”, June 2005

Since 2003 there have not been any follow-up activities associated with the Lugansk landfill demonstration initiative even though a number of other LFG project activities are currently under consideration and/ or development under the Joint Implementation mechanism of the Kyoto Protocol.

Conclusions of the Additionality Tool

Step 1 has identified realistic and credible alternative scenarios to the project activity registered as a JI project. These are in compliance with legislation in Ukraine taking into account the degree of enforcement at the national level.

Step 2 demonstrates that the proposed project activity is more costly than the probable alternative and, therefore it is not the most financially/ economically attractive of the available options. It was also demonstrated that Alternative 3 is the probable baseline.

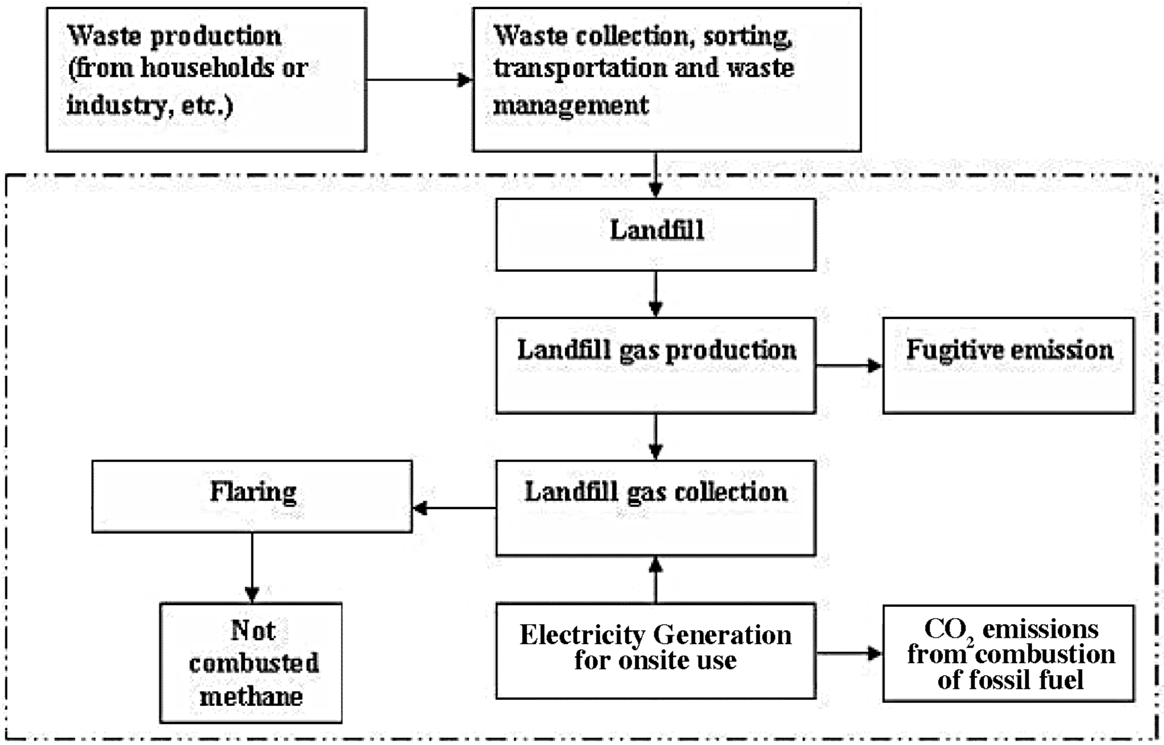
Step 3 was not required

Step 4 has identified one similar activity that has been observed but has identified donor grant funding and technical support as the essential distinction with the project activity.

Since all steps have been satisfied, the conclusion of the Additionality Tool is that the project activity is additional.

B.3. Description of how the definition of the project boundary is applied to the project:

The project boundary is the site of the project activity where the gas is captured and destroyed as demonstrated in the figure below:



The electricity used for the project activity is from the LFG generating unit and the start-up fossil fuel generating unit, both of which are included within the project boundary. Electricity for the project is not sourced from the grid or electricity that would have been generated by power generation sources connected to the grid.

Table 4 Summary of project boundaries

	Source	Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions from atmospheric release of LFG in the baseline.
		N_2O	No	N2O emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	No	Electricity is not consumed from the grid or generated onsite/offsite in the baseline scenario.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emission from thermal energy generation	CO_2	No	Thermal energy generation is not included in the project activity.

		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source due to occasional use of gasoline generating unit for start-up and back-up purposes.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

20/12/2008

Carbon Capital Markets Ltd.
Suite 1910, Level 19, Tower E2
1 East Chang An Avenue, DongCheng District
Beijing, China 100738
Email: kevin.lok@carboncapitalmarkets.com

Carbon Capital Markets Ltd. is also a project participant listed in annex 1.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

The project is expected to start on 01 April 2009.

C.2. Expected operational lifetime of the project:

15 years

C.3. Length of the crediting period:

During the first commitment period:

4 years (2009-2012)

Beyond the first commitment period:

Within the second commitment period to be established under Kyoto Protocol, and further to recent Ukrainian government recognition, the project will request ERUs for the duration of, but not exceeding the project operational lifetime.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The approved monitoring methodology applied to this project activity is ACM0001 Version 9.1. The methodology also refers to the following CDM Executive Board approved Methodological Tools that are relevant to this monitoring plan:

- **"**Tool to determine project emissions from flaring gases containing methane" (Version 01) EB 28, Annex 13 (herein referred to as "EB 28 Annex 13")
- "Tool to calculate baseline, project or leakage emissions from electricity consumption" (Version 01) EB 39, Annex 7 (herein referred to as "EB 39 Annex 7")
- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" (Version 4) EB 41, Annex 10 (herein referred to as "EB 41 Annex 10")

The monitoring methodology is based on direct measurement of the amount of methane captured and destroyed in the flare and the LFG electricity generating unit. The main variables that need to be determined are the quantity of methane actually captured, quantity of methane flared and quantity of methane destroyed to generate electricity. The actual tonnage of methane emissions reduced by the project is calculated based on flow rate of the landfill gas, its methane concentration, and the destruction/conversion efficiency of the combustion equipment.

The monitoring plan provides for the continuous measurement of both quantity and quality of LFG captured and fed to the combustion equipment using continuous flow meters and an on-line gas analyzer. Temperature and pressure of the landfill gas will also be measured.

Project emissions from incomplete combustion in the flare are taken into account in the monitoring plan. The combustion efficiency of the enclosed flare is determined according to Methodological Tool to determine project emissions from flaring gases containing methane. This tool provides for continuous monitoring of the composition of the residual and exhaust gas in order to determine flare efficiency. Alternatively, flare efficiency can be determined using a 90% or 50% default value which is applicable provided that operation of the flare system complies with manufacturer's specifications.

The fossil fuel fired start- up generating unit will be a source of project emissions. These will be monitored in accordance with the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) by measuring the quantity of fossil fuel fired and the quantity of electricity generated in order to calculate the appropriate emission factor.

Calibration and maintenance of all the monitoring equipment will be conducted in accordance with manufacturer's requirements.

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

This project will not monitor emissions in the project scenario and baseline scenario but instead makes use of Option 2- please refer to Section D.1.2

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived?	Comment
1. $LFG_{total, y}$	Total amount of landfill gas captured at Normal Temperature and Pressure	Flow meter	m^3	C	Continuous	100%	Electronic	Calculated as the sum of the amount of LFG flared and combusted in a power plant
2. $LFG_{flare, y}$	Amount of landfill gas flared at Normal Temperature and Pressure	Flow meter	m^3	m	Continuous	100%	Electronic	
3. $LFG_{electricity, y}$	Amount of landfill gas combusted to produce electricity in the LFG generating unit at Normal Temperature and Pressure	Flow meter	m^3	m	Continuous	100%	Electronic	
4. PE_{flare}	Project emissions from flaring	Various	tCO_2e	C	Continuous	100%	Electronic	Monitored and calculated as described in Methodological Tool to determine project emissions from flaring gases containing methane - see parameters 9 to 15 below

5. W_{CH4}	Methane fraction of the landfill gas	Continuous gas quality analyser	m^3 CH_4/ m^3 LFG	M	Continuous	100%	Electronic	Measurements aggregated to hourly averages
6. T	Temperature of the landfill gas	Temperatur e transmitter	^oC	M	Continuous	100%	Electronic	Measurements aggregated to hourly averages
7. P	Pressure of the landfill gas		Pa	M	Continuous	100%	Electronic	Measurements aggregated to hourly averages
8. $Hours_{elec, y}$	Operation of the LFGTE generating unit	Hours		M	Annually	100%	Electronic	
9. $PE_{EC, y}$	Project emissions from electricity consumption	Various	tCO_2e	C	Continuous	100%	Electronic	Calculated in accordance with Approved methodological “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”(version 01) - see parameters 17 and 18 below
10. $fv_{CH4, h}$	Volumetric fraction of methane in the residual gas in the hour h	Continuous analyzer	% or ppm	M	Continuous	100%	Electronic	
11. $fv_{i, h}$	Volumetric fraction of gas i in the residual gas in the hour h, where i = CO, O_2, CO_2, H_2 and N_2	Continuous analyzer	% or ppm	C	Continuous	100%	Electronic	The project will only measure the methane content and assume the remaining part as N_2

12. $FV_{RG, h}$	Volumetric flow rate of the residual gas at normal condition in the hour h	Continuous flow meter	m^3/ h	M	Continuous	100%	Electronic	
13. t_{O2}	Volumetric fraction of O_2 in the exhaust gas of the flare in hour h	Continuous analyzer	% or ppm	M	Continuous	100%	Electronic	
14. $fv_{CH4, FG, h}$	Concentration of methane in the exhaust gas of the flare at normal conditions in hour h	Continuous analyzer	ppm or %	M	Continuous	100%	Electronic	
15. T_{flare}	Temperature in the exhaust gas of the flare	Type N Thermo-couples	^oC	M	Continuous	100%	Electronic	
16.	Other flare operating parameters, if applicable			M				This should include all data and parameters that are required to monitor whether the flare operates with the range of operating conditions according to manufacturer's specifications.
17. FC_y	Quantity of fossil fuel fired in the start up generator in year y	Meter	Mass or normalised volume unit per year	M	Continuous	100%	Electronic	Consistency of metered consumption will be cross- checked with annual energy balance that is based on purchased quantities and stock changes of fossil fuel.

18. EG_y	Quantity of electricity generated in the start up generator in the year y	Electricity meters	MWh	M	Continuous	100%	Electronic	All electricity is consumed by the project activity. Since no electricity will be sold it is not possible or necessary to cross-check the meter readings with receipts.
19. NCV_y	Average net calorific value of the fossil fuel used in the year y	Values provided by the fuel supplier in invoices	GJ / mass or volume unit	E	Per invoice	100%	Electronic	

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

In accordance with ACM0001, the following equation is used to calculate emission reductions achieved by the project activity:

$$ER_y = (BE_y - PE_y) \qquad (1)$$

Where:

ER_y = Emission reductions in year y (tCO_2e/ year)

BE_y = Baseline emissions in year ((tCO_2e/ year)

PE_y = Project emissions in year y (tCO_2e/ year)

The equations used to calculate baseline emissions and project emissions are presented here in the order in which they appear in ACM0001, with clear indication of where the method has been adapted to suit the specific requirements of this project activity such as where:

- Some parameters are set to equal zero because they are not applicable to the project activity
- Default values have been used

- An option/ alternative method of calculation has been selected and followed in accordance with the guidelines provided in the relevant section of ACM0001 or the accompanying methodological tools

Baseline emissions

$$BE_y = (MD_{project,\,y} - MD_{BL,\,y}) * GWP_{CH4} + EL_{LFG,\,y} * CEF_{electricity,\,BL,\,y} - ET_{LFG,\,y} * CEF_{thermal,\,BL,\,y} \qquad (2)$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2e/ year)
$MD_{project,\,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4) in project scenario
$MD_{BL,\,y}$	=	The amount of methane that would have been destroyed/combusted during the year in the absence of the project, due to regulatory and/or contractual requirement in tonnes of methane (tCH_4)
GWP_{CH4}	=	Global Warming Potential value for methane for the first commitment period
$EL_{LFG,\,y}$	=	Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh)

$\mathbf{CEF_{elec,\ BL\ ,y}}$	=	CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh
$\mathbf{ET_{LFG,\ y}}$	=	The quantity of thermal energy produced utilizing the landfill gas which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ
$\mathbf{CEF_{ther,\ BL\ ,y}}$	=	CO2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$MD_{BL,\ y}$	0	See explanation below
GWP_{CH4}	21 tCO_2e/tCH_4	IPCC default value
$EL_{LFG,\ y}$	0	No electricity is displaced (See Section B.1)
$CEF_{elec,\ BL\ ,y}$	0	Not applicable because no electricity is displaced
$ET_{LFG,\ y}$	0	No thermal energy is displaced
$CEF_{ther,\ BL\ ,y}$	0	Not applicable because no thermal energy is displaced

<u>Methane destruction in the baseline</u>

According to description of the baseline for this Project in Section B.1, there are no regulatory or contractual requirements specifying $MD_{BL,y}$. Therefore, according to ACM0001 the following equation should be used to calculate destruction of methane in the baseline scenario:

$$MD_{BL,\ y} = MD_{project,\ y} * AF \qquad (3)$$

The Adjustment Factor should be calculated taking into account the project context. As explained in Section B.1, in the case of the project activity, AF =0.

Methane destruction in the project activity

The formula used to determine $MD_{project, y}$ is as follows:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal, y} + MD_{PL,y} \qquad (4)$$

Where:

$\mathbf{MD_{flared, y}}$	=	Quantity of methane destroyed by flaring (tCH4)
$\mathbf{MD_{electricity, y}}$	=	Quantity of methane destroyed by generation of electricity (tCH4)
$\mathbf{MD_{thermal, y}}$	=	Quantity of methane destroyed by generation of thermal energy (tCH4)
$\mathbf{MD_{PL, y}}$	=	Quantity of methane sent to pipeline for feeding into natural gas distribution network (tCH4)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$MD_{thermal, y}$	0	There is no methane destroyed by generation of thermal energy in the project activity
$MD_{PL, y}$	0	There is no methane sent to pipeline in the project activity

Methane destruction in the flare

The formula used to determine $MD_{flared, y}$ is calculated as follows:

$$MD_{flared,y} = (LFG_{flared,y} * w_{CH4y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (5)$$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3)

w_{CH4} = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3 CH_4 / m^3 LFG)

D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)

$PE_{flare,y}$ = The project emissions from flaring of the residual gas stream in the year y (tCO_2)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
w_{CH4}	Measurement on same basis as $LFG_{flare,y}$	The measurements are comparable so long as both are taken on the same basis, either wet or dry or alternatively a conversion is made in accordance with guidance provided by ACM0001
D_{CH4}	0.0007168 tCH_4/m^3CH_4	This is the density of methane at standard temperature and pressure

The formula for calculation of methane density D_{CH4} in every specific hour is:

$$D_{CH4} = \frac{P_{CH4}}{\frac{R_U}{MM_{CH4}} \times T_{CH4}} \qquad (6)$$

Where:

D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)

P_{CH4} = Measured pressure of methane in the hour *h* (Pa)

R_U = Universal ideal gas constant (8 314 Pa.m3/kmol.K)

MM_{CH4} = Molecular mass of methane (kg/kmol)

T_{CH4} = Measured temperature of methane in the hour *h* (K)

This approach will be taken unless the installed flow meters automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.

Methane destruction by generation of electricity

$MD_{electricity}$ represents the quantity of methane destroyed for the generation of electricity in the Project Activity and is expressed by the following equation:

$$MD_{electricity,\ y} = LFG_{electricity,\ y} * W_{CH4y} * D_{CH4} \qquad (7)$$

Where:

$LFG_{electricity\ y}$	=	Quantity of landfill gas used to generate electricity during a year measured in cubic meters (m^3)
W_{CH4y}	=	Average methane fraction of the LFG as measured during the year and expressed as a fraction (m^3 CH_4/m^3 LFG)
D_{CH4}	=	Density of methane expressed in tonnes of methane (tCH_4/m^3 LFG)

<u>Using EB 28 Annex 13, "Tool to determine project emissions from flaring gases containing methane", to calculate Project Emissions from flaring</u>

Project Emissions from flaring will be determined following the procedure described in EB 28 Annex 13 which involves the following seven steps:

STEP 1: Determination of the mass flow rate of the residual gas that is flared

STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis

STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis

STEP 6: Determination of the hourly flare efficiency

STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

The flare efficiency is calculated for each hour in the year and EB 28 Annex 13 provides two options for calculating this parameter:

- This Project will use Option 2 which involves continuous monitoring of the methane destruction efficiency of the flare with reference to the result of gas analysis before and after flaring of the gas.
- The Project may also refer to Option 1 to determine flare efficiency. This involves assuming 90% or 50% default efficiency factor based on flare parameters meeting the manufacturer's operating specifications (such as temperature and flow rate of residual gas at the inlet of the flare).

Project Emissions from combustion of fossil fuels

Project Emissions are calculated using the formula:

$$PE_y = PE_{EC,\ y} + PE_{FC,\ j,\ y} \qquad (8)$$

Where:

$\mathbf{PE_{EC,\ y}}$ = Emissions from consumption of electricity in the project case. The project emissions from electricity consumption will be calculated following the Project Emissions Tool

$\mathbf{PE_{FC,\ j,\ y}}$ = Emissions from consumption of heat in the project case

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation

$PE_{FC, j, y}$	0	There is no consumption of heat in the project case

According to the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, calculation of emission from consumption of electricity is based on the quantity of electricity consumed and an emission factor for electricity generation:

$$PE_{EC, y} = \sum EC_{PJ, j, y} * EF_{EL, j, y} * (1 + TDL_{j, y}) \quad (9)$$

Where:

$EC_{PJ, j, y}$ = Quantity of electricity consumed by the project electricity consumption source *j* in year y (MWh/ year)

$EF_{EL, j, y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO_2/ year)

$TDL_{j, y}$ = Average technical transmission and distribution losses for providing

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$TDL_{j, y}$	0	According to the Tool this simplification should be made in the case of Scenario B - electricity consumption from an off-gird captive power plant- which applies to the project activity

According to Approved methodological "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(version 01) (EB 39 Annex 7), Scenario B "Electricity consumption from an off-grid fossil fuel fired captive power plant" the emission factor of the captive power plant is calculated as follows:

$$EF_{EL,j/k/l,y} = \frac{\sum_n \sum_i FC_{n,i,t} \times NCV_{i,t} \times EF_{CO_2,i,t}}{\sum_n EG_{n,t}} \qquad (10)$$

Where:

$FC_{n,i,t}$	=	Quantity of fossil fuel type *i* fired in the captive power plant *n* in the time period *t* (mass or volume unit)
$NCV_{i,t}$	=	Average net calorific value of fossil fuel type *i* used in the time period *t* (GJ/ mass or volume unit)
$EF_{CO2,i,t}$	=	Average CO_2 emission factor of fossil fuel type *i* used in period *t* (tCO_2/ GJ)
$EG_{n,t}$	=	Quantity of electricity generated in captive power plant *n* in time period *t* (MWh)
i	=	Fossil fuel types fired in the captive power plant *n* in the time period *t*
j	=	Sources of electricity consumption in the project
n	=	Fossil fuel fired captive power plants installed at the site of the electricity consumption source *j*
t	=	The monitored period (e.g. the year)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$EF_{CO2, i, t}$	73,000kg/TJ	This is the IPCC default value used at the upper limit, which is most conservative.
i	Gasoline	This is the only fossil fuel used to generate electricity for the project
j		There is only one source of electricity consumption for this project
n	1	Only one captive power plant has been installed- this is the fossil fuel fired start up generating unit

D.1.3 Treatment of leakage the monitoring plan:

No leakage effects need to be accounted according to ACM0001. There is no treatment of leakage in the monitoring plan.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

This is not applicable as no leakage effects need to be accounted according to ACM0001.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

This is not applicable as no leakage effects need to be accounted according to ACM0001.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent)

Please see Section D 1.2.2 for details.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project

There are no procedures for collecting and archiving information on environmental procedures required by the host party.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	**Uncertainty level of data (high/medium/low)**	**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**
1. $LFG_{total, y}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
2. $LFG_{flare, y}$	Low	
3. $LFG_{electricity, y}$	Low	
4. PE_{flare}	Low	Data treatment and calculations will incorporate a comprehensive QA/ QC procedure that will be documented for the purposes of verification.
5. W_{CH4}	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas.
6. T	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
7. $Hours_{elec, y}$	Medium	Operation hours will be checked against the temperature of flaring and the results of gas analysis.
8. $PE_{EC, y}$	Low	Data treatment and calculations will incorporate a comprehensive QA/ QC procedure that will be documented for the purposes of verification.
9. $fv_{CH4, h}$	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas. Adjustments will be made to wet/ dry basis as appropriate, if required.
10. $fv_{i, h}$	Low	Not applicable
11. $FV_{RG, h}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
12. t_{O2}	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas.

13. $fv_{CH4, FG, h}$	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas Adjustments will be made to wet/ dry basis as appropriate, if required.
14. T_{flare}	Low	Thermocouples will be maintained, calibrated and replaced every year, or in accordance with manufacturer's specifications.
15. Other flare operating parameters	Not yet specified	Not yet specified
16. FC_y	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. The metered consumption of fossil fuel by the project will be cross- checked with annual energy balance based on purchased quantities and stock changes.
17. EG_y	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan

The project developer, equipment provider and local staff will work together to setup and maintain the operational and management structure for implementation of the monitoring plan outlined in Annex 3 of this PDD.

Local site engineers will be responsible to maintain monitoring equipment and supervise the electronic logging of all continuously monitored data parameters relating to methane destruction and project emissions. The local site engineers will receive training on equipment maintenance and calibration, data logging and transfer of electronic data for archiving at off-site locations.

A JI Monitoring Manager will be responsible for Quality Control and Quality Assurance on the raw data as well as processing the data and making Emission Reduction calculations in accordance with the Monitoring Plan.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan

20/12/2008
Carbon Capital Markets Ltd.
Suite 1910, Level 19, Tower E2
1 East Chang An Avenue, DongCheng District
Beijing, China 100738
Email: kevin.lok@carboncapitalmarkets.com

Carbon Capital Markets Ltd. is also a project participant listed in annex 1.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

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The Project emissions are potentially represented by three sources:

1. Fugitive methane emissions due to not captured LFG.

One source of project emissions identified within the system boundary is fugitive methane emissions from the landfill, i.e. methane not captured by the collection system. It is assumed that the gas collection system installed will capture approximately 50% of the total amount of gas released by the landfill in the baseline scenario. This figure is obtained from considering the percentage of the landfill covered by LFG extraction wells (in average 70%), well efficiency (80%) and well availability (90%). Therefore, the remaining 50% of fugitive emissions will be considered as Project emissions.

***Note:** these emissions are not caused by the Project, but would take place also in the baseline scenario.

The fugitive methane emissions from not captured LFG can be estimated from the following equation:

$$PEy_1 = W_{CH4,y} * D_{CH4} * (1-CE) * GWP_{CH4} \qquad (11)$$

where:

PE_{y1}	estimated project emissions from non captured methane, tonnes CO_{2eq}
$W_{CH_4,y}$	methane generated at the landfill, m^3 of CH_4
D_{CH4}	methane density, kg/m³ of CH_4[5]
CE	LFG collection efficiency
GWP_{CH4}	global warming factor of methane, GWP = 21

2. Fugitive methane emissions in the flare due to the flare efficiency *(applicable for LFG flaring option only)***.**

Another relevant source of project emissions is methane not combusted in the flare. This source is covered through the parameter "flare efficiency" ($\eta_{flare,h}$ [%]), which enters the calculation of the

[5] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m_3CH_4.

emission reductions. Depending on availability of the monitoring equipment, either a default value of flare efficiency of 90% will be used or continuous monitoring of flare efficiency will be used to claim more than 90% efficiency methane destruction. In further calculations, the more conservative option of default value of 90% flare efficiency is applied.

If the LFG electricity is produced, efficiency of LFG combustion in power engines is 100%.

The methane emissions in the flare due to the flare efficiency can be estimated from the following equation:

$$PE_{y2} = W_{CH_4,y} * D_{CH4} * (1\text{-}CE) * (1\text{-}FE) * GWP_{CH4} \qquad (12)$$

where:

***PE**y2* estimated project emissions from non combusted methane, tonnes CO_{2eq}
FE flare efficiency

Landfill gas collection efficiency is estimated at the level of ***CE= 70%***.

Default value for flare efficiency is fixed at the level of ***FE=90%***.

3. CO_2 emissions resulting from electricity used by LFG pumping equipment

Emissions from fossil fuel (gasoline) / LFG used during the Project for energy requirement on site under project activity during the year y, in TJ are determined according to the following equation:

$$PEy_3 = ET_y * CEF_{thermal, y} \qquad (13)$$

where:

PEy_3 estimated project emissions from fossil fuel (gasoline) / LFG used for electricity generation during the year y, tonnes CO_{2eq}

ETy quantity of gasoline / LFG used for own needs of the LFG flaring plant during the year y, TJ (please refer to the Annex 2 for details)

$CEF_{thermal, y}$ CO2 emissions intensity of gasoline / LFG, $CEF_{thermal, y}$ = 73,000kg/TJ for gasoline (This is conservative)[6]

The sum of the Project emission is equal to:

$$PE_y = PE_{y1} + PE_{y2} + PE_{y3} \qquad (14)$$

4. Emissions from construction works on installation of LFG collection system.

Since share of the construction emissions is less than 1% of the total baseline emissions, it can be neglected.

Results of calculation of the Project emission are given below. The table below shows that no LFG in the proposed project will be used for electricity generation. Only gasoline will be used for power supply.

Table 2 Results of calculation of the Project emission

Year	Methane not captured tonnes CO2e PE_{y1}	Methane not destroyed in Flare tonnes CO2e PE_{y2}	Emissions from Fossil Fuel use tonnes CO2e PE_{y3}	Project emission (flaring) tonnes CO2e PE_y
2009	52,858	12,333	93.5	65,284
2010	52,352	12,216	93.5	64,661
2011	51,693	12,062	93.5	63,849
2012	51,005	11,901	93.5	62,999

E.2. Estimated leakage:

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No leakage needs to be accounted for by ACM0001, version 09.

E.3. The sum of E.1. and E.2.:

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The sum of E.1 and E.2 is equal to:

$$PE_y = PE_{y1} + PE_{y2} + PE_{y3} \qquad (15)$$

For the results of the calculation of the project emission please refer to the Section E6.

[6] Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy), P.1.23, Table 1.4

E.4. Estimated baseline emissions:

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For calculation of baseline emissions two options are considered:

Since the LFG is flared in the project scenario, the GHG emissions in the scenario-without-project will come from decay of the whole amount of waste at Lviv landfill.

Estimation of baseline methane emissions into the atmosphere

The amount of methane release in the baseline scenario is estimated using Methodological tool "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (Version 04), Annex 10, EB 41".

Under this methodology the amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model. The model differentiates between the different types of waste *j* with respectively different decay rates k_j and different fractions of degradable organic carbon (DOC_j).

The model calculates the methane generation based on the actual (or estimated) waste streams $W_{j,x}$ disposed in years *x* with x = 1 to x = y, starting with the first year landfill started receiving wastes until the end of the year *y* (the year 2012), for which baseline emissions are calculated *for* years *x* with x = 1 to x = y.

Since in our case, no SWDS methane is captured and flared, combusted or used in another manner in the baseline scenario, the baseline emissions are not adjusted for the fraction of methane captured at the SWDS.

The amount of methane produced in the year *y* ($BE_{CH4,SWDS,y}$) is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right) \quad (16)$$

Where:

$BE_{CH4,SWDS,y}$ = Methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year (tCO_2e)

φ = Model correction factor to account for model uncertainties (0.9)

f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner (0 in our case)

GWP_{CH4} = Global Warming Potential (GWP) of methane, valid for the relevant commitment Period (21)

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) (0 in our case)

F = Fraction of methane in the SWDS gas (volume fraction) (0.5)

DOC_f = Fraction of degradable organic carbon (DOC) that can decompose (0.5)

MCF = Methane correction factor (0.8 in our case)

$W_{j,x}$ = Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tonnes)

DOC_j = Fraction of degradable organic carbon (by weight) in the waste type *j*

k_j = Decay rate for the waste type *j*

j = Waste type category (index)

x = Year during the period: x runs from the first year of the period (x = 1) to the year y for which avoided emissions are calculated (x = y)

y = Year for which methane emissions are calculated

Model correction factor to account for model uncertainties *(φ)*

Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results, therefore φ=0.9.

Fraction of methane captured at the SWDS and flared, combusted or used in another manner *(f)*

No methane capture is currently applied at the site, therefore f=0.

Oxidation factor *(OX)*

Oxidation factor reflects the amount of methane from SWDS that is oxidized in the soil or other material covering the waste. IPCC 2006 Guidelines for National Greenhouse Gas Inventories recommends the following values MCF(x) for the different types of dumps:

Data / parameter:	**OX**
Data unit:	-
Source of data:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value to be applied:	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites.

Since no oxidizing material is applied at Lviv landfill, value 0 was used in our case.

Fraction of methane in the SWDS gas *(F)*

This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Fraction of degradable organic carbon (DOC) that can decompose *(DOCf)*

IPCC 2006 Guidelines for National Greenhouse Gas Inventories recommends 0.5 value to be applied.

Methane correction factor *(MCF)*

The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

Data / parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	Use the following values for MCF: • 1.0 for **anaerobic managed solid waste disposal sites**. These 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 at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste. • 0.5 for **semi-aerobic managed solid waste disposal sites**. These must have controlled placement of waste and will include all of the following structures for

	introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system. • 0.8 for **unmanaged solid waste disposal sites – deep and/or with high water table**. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste. • 0.4 for **unmanaged-shallow solid waste disposal sites.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.

For the Lviv landfill, the MCF value of 1.0 was used.

Fraction of degradable organic carbon (by weight) in the waste type *j* (DOC_j)

The values for fraction of degradable organic carbon (by weight) for different types of waste *j* recommended by IPCC are given in the table below.

Data / parameter:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value to be applied	Apply the following values for the different waste types *j*:

Waste *j* type	**DOC_j (% wet waste)**	**DOC_j (% dry waste)**
Wood and wood products	43	50
Pulp, paper and cardboard (other than sludge)	40	44
Food, food waste, beverages and tobacco (other than sludge)	15	38
Textiles	24	30
Garden, yard and park waste	20	49
Glass, plastic, metal, other inert waste	0	0

If a waste type, prevented from disposal by the proposed CDM project activity, can not clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.

Data used for the calculations are based on the recommended data on waste content for Ukraine and Russia[7].

Decay rate for the waste type j (*k_j*)

The values for decay rate for different types of waste *j* recommended by IPCC are given in the table below.

Data / parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type *j*
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value to be applied	Apply the following default values for the different waste types *j:*

Waste type *j*		**Boreal and Temperate (MAT≤20°C)**		**Tropical (MAT>20°C)**	
		Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP< 1000mm)	Wet (MAP> 1000mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
	Wood, wood products and straw	0.02	0.03	0.025	0.035
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
Rapidly degrading	Food, food waste, beverages and tobacco (other than sludge)	0.06	0.185	0.085	0.40

NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET –

[7] Report: "On Results of the Lviv SW Landfill Pump-Testing"

	potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration. If a waste type, prevented from disposal by the proposed CDM project activity, cannot clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of *DOCj* and *kj* result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.

For the calculations for Lviv landfill following values for $\mathbf{k_j}$ were used:

Waste type *j*			**Temperate (MAT≤20°C)** Wet (MAP/PET >1)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	II, IV	0.06
	Wood, wood products and straw	III	0.03
Moderatel y degrading	Other (non-food) organic putrescible garden and park waste	V	0.10
Rapidly degrading	Food, food waste, beverages and tobacco (other than sludge)	I	0.185

Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tonnes) (*Wj,x)*

The annual amounts of waste disposed at Lviv landfill during the recent years are shown in Annex 2.

Summary of correction factors applied

Values of correction factors and other parameters used for calculation are summarized in the table below:

Factor	Value	Source of data
φ	0.9	"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"
f	0	Site situation
$GWPCH_4$	21	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
OX	0	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Site situation
F	0.5	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
DOCf	0.5	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
MCF(x)	0.8	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Site situation

For the Lviv project, the baseline emissions are calculated as follows.

Year	LFG - generated	Methane - generated		baseline emission
	1000 m3	tonnes CH4	tonnes CO2e	tonnes CO2e
2009	16,760	6,006	126,142	126,142
2010	23,732	8,505	178,614	178,614
2011	24,977	8,951	187,990	187,990
2012	26,247	9,406	197,544	197,544

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

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The baseline emissions, project emissions and emission reductions are summarized in the section E.6.

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

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The estimated results are expressed in the following table. The actual emission reductions generated by this project will be measured directly after the project is operational.

Year	**Estimated project emissions (tonnes of CO_2 equivalent)**	**Estimated leakage (tonnes of CO_2 equivalent)**	**Estimated baseline emissions (tonnes of CO_2 equivalent)**	**Estimated Emission Reductions** (tonnes of CO_2 equivalent)
2009	46,743	0	126,142	79,400

2010	66,181	0	178,614	112,434
2011	69,650	0	187,990	118,340
2012	73,185	0	197,544	124,359
Total (tonnes of CO_2 equivelent)	255,758	0	690,291	434,533

Numbers may not add due to rounding

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

Ministry for Environmental Protection of Ukraine approved the Project on 12/09/2006, to capture and utilize methane at the solid waste landfills in the city of Lviv.[8]

Implementation of the Project will make the landfill site a safe object of exploitation, normalize partly environmental conditions at the landfill and surrounding area, and also make an essential contribution to Ukraine's compliance with the requirements of UNFCCC on climate change.

Biogas collection and utilization system, apply at the Lviv SW landfill, reduces substantially negative impact on the air quality, both at local and global levels, as well as landfill gas emission into the atmosphere. Fire and explosion risks are also eliminated.

Implementation of the Lviv Landfill JI Project will eliminate anthropogenic impact on the environment, improve ecological situation, and bring environmental indexes to standard condition, which on the whole will have a positive effect on the living standards of people, living in the vicinity of the landfill site.

During phases of the project design and construction, the following key aspects will be addressed:

- Water Quality

1) LFG Condensate: The course of LFG pump and transportation and compression needs condensate to cool, and the condensate can be circularly used by the circular collection system. It will not impact environment.
2) Employee Living-Sewage: The sewage will be collected in a sewage tank, and will be transported to the sewage pool by excreta van. It will not impact environment.
3) Landfill Farm Leachate: The leachate of landfill farm will be collected by spray drain, and the spray drain will bring leachate to the leachate pool. Then the leachate will be pumped to the sewage farm. It will not impact environment.

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[8] Letter of Endorsement of the Joint Implementation Project

- Air Quality

This project flares LFG which is collected from the landfill farm, and it avoids uncontrolled releasing of LFG. Thus it reduces greenhouse gas and effluvium emitting to air, and mitigates the possible danger of fire or explosion. Besides a lot of CH_4 and CO_2, there is much volatile organic compound in LFG. By flaring the LFG, these substances will be converted into water and CO_2 and thus the side effects associated the gases can be avoided.

- Noise

There will be some increase in noise from the site. However, the equipment selected is state of the art and on a low noise grade.

- Visual Impacts

Most of the LFG collection system is under the landfill site, so it will bring little negative impact to visual landscape. The construction of the flaring equipment is well coordinated with the surrounding environment. It will not impact environment.

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

>>

The analysis above demonstrated that the project does not lead to significant negative environmental impacts. On the contrary, this project will promote local environment benefits and reduce greenhouse gases.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

Ukrainian legislation on conducting the EIA stipulates that for every EIA, a public stakeholder consultation process, during which the affected public is informed of the proposed and invited to provide comments.

The following public events were hosted by the Project Participants in the framework of a stakeholder consultation for the Lviv landfill Project:

1) Stakeholders meeting in The Velyki Grybovychy Local Council, April 2008.
2) Stakeholders meeting in The Lviv Regional Administration, May 2008.
3) Stakeholders meeting in The Lviv Regional Administration, June 16, 2008.

4) Stakeholders meeting in The Lviv City Council, June 19, 2008

No negative comments were received.

Annex 1

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Annex 2

BASELINE INFORMATION

Table A2.1 Annual waste input*

Year	Annual waste delivery (1000 tonnes)
1970	0
1971	3
1972	7
1973	10
1974	14
1975	17
1976	21
1977	24
1978	28
1979	31
1980	35
1981	38
1982	42
1983	45
1984	49
1985	52
1986	56
1987	59
1988	63
1989	66
1990	70
1991	73
1992	77

1993	80
1994	84
1995	87
1996	91
1997	94
1998	98
1999	101
2000	105
2001	108
2002	112
2003	115
2004	240
2005	230
2006	240
2007	250
2008	250
2009	250
2010	260
2011	260
2012	270
2013	250
2014	200

* Source: "On Results of the Lviv SW Landfill Pump-Testing" 2008
Note that waste volumes from 2004 to 2014 were provided in the report and historical amounts were extrapolated from total accumulated waste volumes in the report.

Annex 3

MONITORING PLAN

Summary of Monitoring Approach The monitoring will be carried out as described in Section D of this PDD, and in line with ACM0001. The basic approach is to monitor on a continuous basis the amount of methane destroyed through flaring and combustion. The main parameters to be monitored include:

- Total flow of captured landfill gas [Nm3]
- Landfill gas flow to flare and captive biogas generator [Nm3]
- LFG temperature [°C] and pressure [Pa]
- Methane content in the landfill gas [%]
- Flare operation time [h]
- Temperature of the flare exhaust gases [°C]
- O_2, CH_4 in the flare exhaust gas (for determining flare efficiency) [%]

Landfill gas flows and methane content will be determined on a continuous basis. The same applies for the flare operation time and the gross electricity production. The amount of flared methane will be calculated from the flow of landfill gas to the flare, the methane content of the gas, and the flare efficiency.

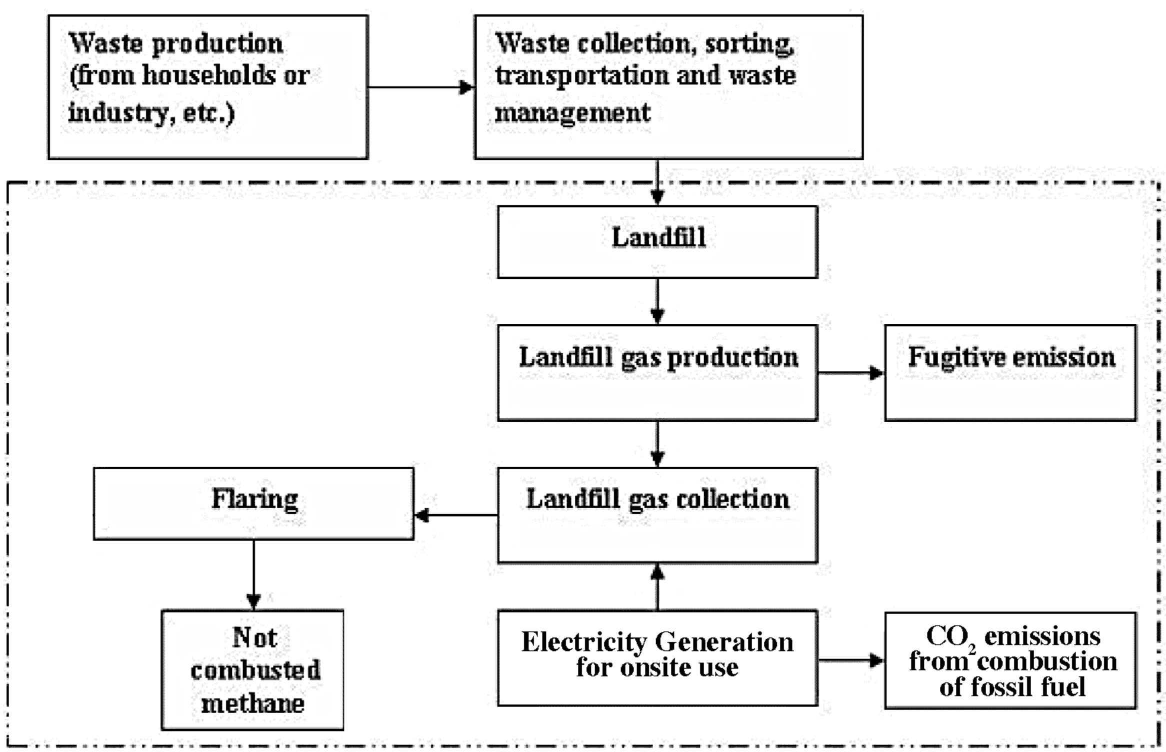

Table A3.1 Equipment used to monitor emissions reductions from the project activity

Equipment	Variables Monitored	Operational range	Calibration procedures	Parties responsible for operating equipment	Procedure in case of failure	Default value to use in case of failure	Comments
LFG flow meter	$LFG_{total,y}$, $LFG_{flare,y}$, $LFG_{electricity,y}$	+/- 1-2 %	Equipment will be calibrated annually after initial installation by the local accredited standardization and certification entity on site	Project Developer	Failure reported to equipment supplier and repairs carried out as per manufacturer's recommendations. If repair is not possible, equipment will be replaced as soon as possible. Failure events will be recorded in the site events log book.	The minimum amount required by the flare will be used in case of failure.	
Portable gas analyser	$PE_{flare,y}$ (O2, CH4 in the flare exhaust gas)	< 1%	Calibration of gas analysers should be carried out weekly	Project Developer	Failure reported to equipment supplier and repairs carried out as per manufacturer's recommendations. If repair is not possible, equipment will be replaced as soon as possible. Failure events will be recorded in the site events log book.	90% based on manufacturer's specifications	

Equipment	Variables Monitored	Operational range	Calibration procedures	Parties responsible for operating equipment	Procedure in case of failure	Default value to use in case of failure	Comments
Fixed Gas Analyser	$W_{CH4,\ y}$	+/- 2%	Calibration of gas analysers should be carried out weekly	Project Developer	Failure reported to equipment supplier and repairs carried out as per manufacturer's recommendations. If repair is not possible, equipment will be replaced as soon as possible. Failure events will be recorded in the site events log book.	The minimum concentration value required by the flare will be used in case of failure.	

The monitoring plan will be described in detail in an Operational Manual. It will be the responsibility of the site manager and undertaken by site staff responsible for the maintenance and care of the landfill gas collection system and flaring unit. The monitoring plan covers:

- responsibility of members of the monitoring team;
- QA/QC procedures;
- corrective action plans;
- maintenance plans; and
- monitoring schedules.

The site manager will ensure the measurements are recorded and calibration/maintenance actions are performed per schedule, review the results of the measurements, ensure proper records are kept and transmit data for archiving.

Project developer and project investor will perform quality assurance on the data and ensure archiving of the data for the specified period (crediting period plus two years). At the time of verification, training materials and information about the timing of completed trainings would be provided to the DOE.

The monitoring plan covers procedures for the systematic surveillance of the CDM Project Activity's performance by measuring and recording performance-related indicators relevant to the project or activity. The Plan includes:

- **Corrective Actions:** There will be quality assurance measures to handle and correct nonconformities in the implementation of the Project or this Monitoring Plan. In case such nonconformities are observed:
    - An analysis of the nonconformity and its causes will be carried out,
    - Appropriate corrective actions to eliminate the non-conformity and its causes will be identified, and
    - The implementation of corrective actions will be reported.
    - In the case that the gas engine generator fails to work for any reason, the blowers and flare will be shut down, that is, not run off the diesel engine. Therefore, in these cases, no ERUs will be claimed and no LFG will be vented.

- **Calibration of measurement equipment:** Calibration of measurement equipment will be defined and scheduled by the technology provider.

- **Operational Manual**: All the information about monitoring procedures and quality assurance measures will be included in an Operational Manual.

There will be a team that will cover all aspects of the monitoring. The team members will be responsible for collecting, reviewing, recording and archiving the data. There will be a JI Monitoring Manager who will quality check the team's work ensuring that the monitoring is performed correctly and on time. The manager will report monthly to project investor and developer about project performance and data. He/She will inform investor and project developer immediately in the event of nonconformance and technical problems. The manager will be the one of the main contacts for the verifier, DNA of Ukraine, and local authorities, during the crediting period.

A JI Project Team will be formed for monitoring purposes for the project activity. The project team comprises at least one representative of project investor, project developer, the chief engineer of the landfill, and the Carbon Monitoring Manager.

The monitoring tools that will be available to the team and the manager include:

- Operational Manual (see above) including procedures on what is to be monitored, frequency of the monitoring, equipment to be used, maintenance required on instrumentation, corrective actions, etc.
- This Project Design Document UNFCCC baseline and monitoring methodology
- Spreadsheets

The spreadsheets will serve as a registry of the all data collected by the different measuring equipments distributed all over the facilities. They will also be used to quantify ERs achieved by the projects activity during specific time periods through the use of auxiliary equations.

For the purposes of QA/QC and archiving data will be transmitted electronically to project investor and developer on a weekly basis as well as a reporting of any anomalies, equipment failures or any other causes of data loss. A final data quality check of the information will be made before an archived copy is created.