**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 03 - in effect as of: 28 July 2006**

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## SECTION A. General description of project activity

### A.1 Title of the project activity:

**Project title:** Madinah Landfill Gas Capture Project
**PDD Version:** 1.0
**PDD completion date:** 3 June 2010

**Revision History:**
Version 1.0: Submitted for validation

### A.2. Description of the project activity:

The Madinah Landfill Gas Capture Project is a new landfill gas (LFG) recovery project implemented at Yanboa old road landfill, 25km from Madinah city in the Kingdom of Saudi Arabia, for the purpose of reducing green house gases emissions into the atmosphere.

The site covers a total of 1.2 $km^2$ and can be divided into "old" and "new" landfilling areas. The old landfill operated without any proper waste disposal management system from 1985 and was closed in 2005. Total amount deposited is estimated at about 4.7 million tons municipal solid waste. The new landfill started operating in 2005 and is implemented and managed in compliance with guidelines of United States Environment Protection Agency subtitle D of the Resource Conservation and Recovery Act[1]. About 1Million tons waste have been deposited on the new landfill to date and daily input is 900 tons. Closure is expected in 2025. The waste processed by the project activity comprises municipal solid waste collected from households around Madinah region.

The scenario existing prior to the start of the project activity is that the waste is disposed on the landfill and gas generated by anaerobic decomposition of the biodegradable fraction of the waste is released into the atmosphere. Landfill gas contains a large amount of methane, a potent greenhouse gas with global warming potential 21 times higher than carbon dioxide.

The project scenario falls within sectoral scope 13 – Waste handling and disposal – and consists of the installation of a network of gas extraction wells and pipes on the landfill with the purpose of collecting and draining the gas to newly installed flares for destruction.

Through avoiding atmospheric release of the landfill gas the project leads to green house gas emissions reductions.

The baseline scenario is the same as the scenario existing prior to the start of the project activity mentioned above.

The project activity's contributions to sustainable development include:

- Introducing waste management good practice in the region as the project is first of its kind in Saudi Arabia
- Contributing to technology transfer as the equipment installed is not available in the Host Country and will be imported.
- Reducing the emissions of greenhouse gases to combat global climate change;

[1] http://www.epa.gov/compliance/resources/policies/incentives/auditing/apcol-rcrad.pdf

- Contributing to local economic development through employment creation;
- Improving air quality, reducing noxious odors as well as fire and explosion hazards

**A.3. Project participants:**

| Name of Party involved (*) (host) indicates a Host Party | Private and/or public entity(ies) project participants (*) (as applicable) | Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Kingdom of Saudi Arabia (host) | • Private entity: Environmental Construction For Contracting Business | No |
| Switzerland | • Private entity: Vitol S. A. | No |
| (*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required. | | |

Detailed contact information of the project participants is given in Annex I.

**A.4. Technical description of the project activity:**

**A.4.1. Location of the project activity:**

**A.4.1.1. Host Party(ies):**

Kingdom of Saudi Arabia

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

Hejaz region, Al Madinah province, western Saudi Arabia

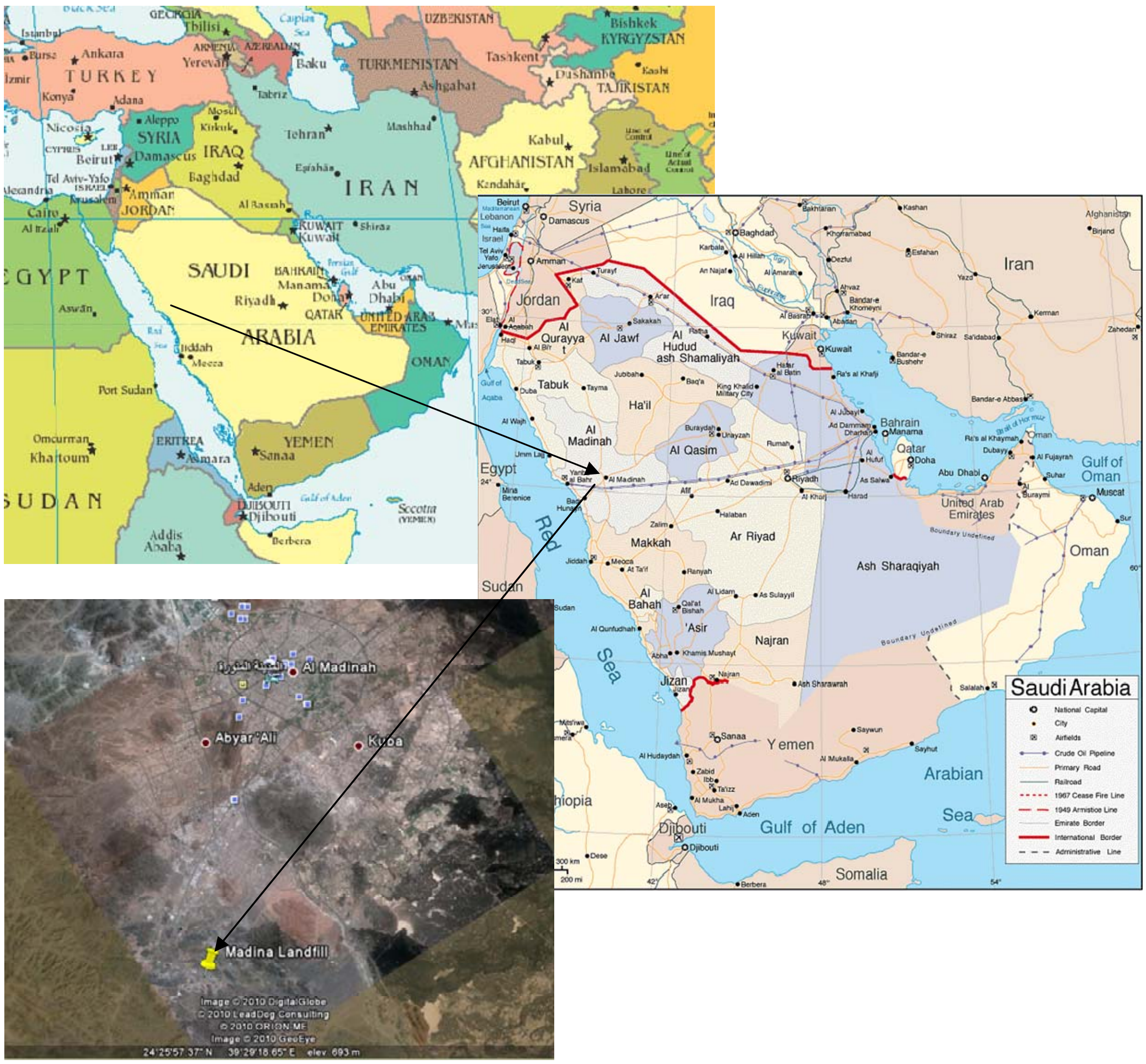
**A.4.1.3. City/Town/Community etc:**

Madinah, also transliterated as Medina, officially *al-Madīnah al-Munawwarah*

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

The proposed project activity will be carried out at the Madinah Landfill facility located on Yanbu-Medinah highway, 25 km southeast of Madinah. Approximate coordinates are 24°420’04.327” N, 39° 27’52.35” E. Figure A.1 shows the location of the project.

**Figure A.1 - Approximate Landfill Location (25km from centre of Madinah city)**




**A.4.2. Category(ies) of project activity:**

The proposed project activity falls within the following large scale project activity category:

- Sectoral Scope 13: Waste Handling and Disposal

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

The project will contribute to transfer landfill gas capture and destruction technology to the Host Country as equipments will be imported from the U.K and supplied by a company with in-depth experience in the design, manufacture, installation, operation and maintenance of such processes.

The scenario prior to the implementation of the project activity is the disposal of the waste on a landfill without capture of the landfill gas where decomposition of biodegradable fraction of the waste under anaerobic conditions leads to methane generation.

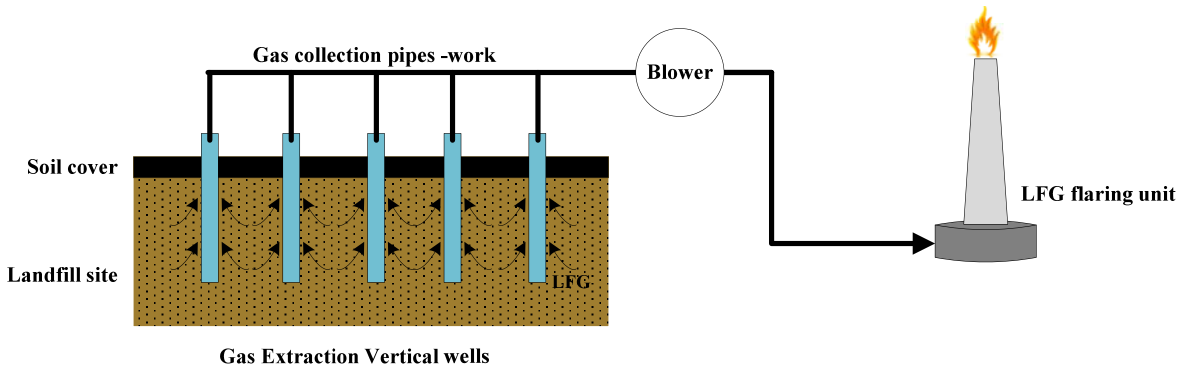
The equipment that is implemented in the project activity consists of gas extraction wells, gas collection pipe network, a set of UFU10-1000$m^3$/hr containerised gas plants and high temperature enclosed flares including fully automated flare control system, instrumentation, gas monitoring, data logger and telemetry for use in conjunctions with CDM requirements.

*Gas extraction and collection*
Vertical Gas extraction wells are constructed on the landfill site to extract the gas as it is produced. Wells are connected to gas collection High Density Polyethylene (HDPE) pipe network to collect and transport the gas from the wells to the extraction plant from where the gas is safely flared. A centrifugal blower is required to extract landfill gas from the wells and supply this to the flare unit. The blower creates lower pressure inside the wells than in the landfill, thereby sucking the gas from the landfill into the wells and from there to the extraction plant. Condensate knock-out pots are incorporated within the system to minimise condensate build-up and reduce the likelihood of pipe blockages, maximising the efficiency of the gas extraction system.

*Flaring system*
The project installs a set of UFU 10-1000 1000$m^3$/hour LFG utilisation plants with controlled combustion flare installed in 20 foot ISO container. Each plant mainly consists of:

- Inlet pipe including gas sampling port, temperature gauge, vacuum pressure gauge and switch and isolation valve;
- Inlet gas treatment assembly comprising a carbon steel condensate knockout pot hot dip galvanised to ISO 1460 and a filter with a 50 micron element;
- Landfill gas exhauster booster including outlet pressure gauge, outlet temperature gauge, outlet pressure switch; manufactured by Fans & Blowers 344 TSGX GX GAS BOOSTER 1000 mh@ 280 mbarg pressure lift. 304 stainless steel fan case, impeller, and pedestal as standard. The impeller is positively located with self-locking fittings. The gas booster is constructed, documented and certified to ATEX fan category 3G; 30 kW Eexn 400/3/60 ATEX Zone 2 Cat 3G; 14.15A Full Load Current
- Pilot gas train;
- Pressure control and burner gas train;
- 1000 $m^3$/h controlled combustion ground flare with cyclonic action burners.

**Figure A.2 LFG collection and flaring flow**




The baseline scenario is the same as the scenario existing prior to the start of the project activity mentioned above.

Baseline emissions source include $CH_4$ emissions from decomposition of waste at the landfill site and project emissions sources comprise $CO_2$ emissions from on-site fossil fuel consumption.

Monitoring equipments will comprise flow and electricity meters, temperature and pressure gauges, gas analyzer and plant records. See section B.7.1 for details

### A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The chosen crediting period is 21 years (broken down into three 7-year periods). The projection of emission reductions during first crediting period is presented in Table 1 below:

**Table A.1 Estimation of GHG emission reductions during first crediting period**

| **Years** | **Annual estimation of emission reductions in tonnes of $CO_2e$** |
|---|---|
| 2011 | 150,023 |
| 2012 | 146,744 |
| 2013 | 143,698 |
| 2014 | 140,867 |
| 2015 | 138,235 |
| 2016 | 135,786 |
| 2017 | 133,509 |
| **Total estimated reductions** (tonnes of $CO_2e$) | **988,862** |
| **Total number of the 1st crediting years** | 7 |
| **Annual average over the crediting period of estimated reductions** (tonnes of $CO_2e$) | **141,266** |

### A.4.5. Public funding of the project activity:

No public funding from Parties included in Annex I of the UNFCCC is involved in this project.

## SECTION B. Application of a baseline and monitoring methodology

### B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

Methodology ACM0001 (Version 11): *Consolidated baseline and monitoring methodology for landfill gas project activities*.

This methodology draws upon the following tools:

- Tool for the demonstration and assessment of additionality (Version 05.2)
- Tool to determine project emissions from flaring gases containing methane (Version 1)
- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (Version 04)
- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (version 02);
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (version 01)
- Combines tool to identify the baseline scenario and demonstrate additionality (Version 02.2)
- Tool to calculate the emission factor for an electricity system (Version 2)

For more information on the baseline and monitoring methodology we refer to the UNFCCC website: http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

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

This methodology ACM0001 (version 11) is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

(a) The captured gas is flared; and/or
(b) The captured gas is used to produce energy (e.g. electricity/thermal energy). Emission reductions can be claimed for thermal energy generation, only if the LFG displaces use of fossil fuel either in a boiler or in an air heater.
(c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodology AM0053.

As further explained in section B.4 the baseline scenario of the proposed project activity is the atmospheric release of the landfill gas and the project scenario is flaring of captured gas, which corresponds to the above mentioned situation (a).

Therefore, the approved consolidated baseline methodology ACM0001 is applicable.

### B.3. Description of the sources and gases included in the project boundary

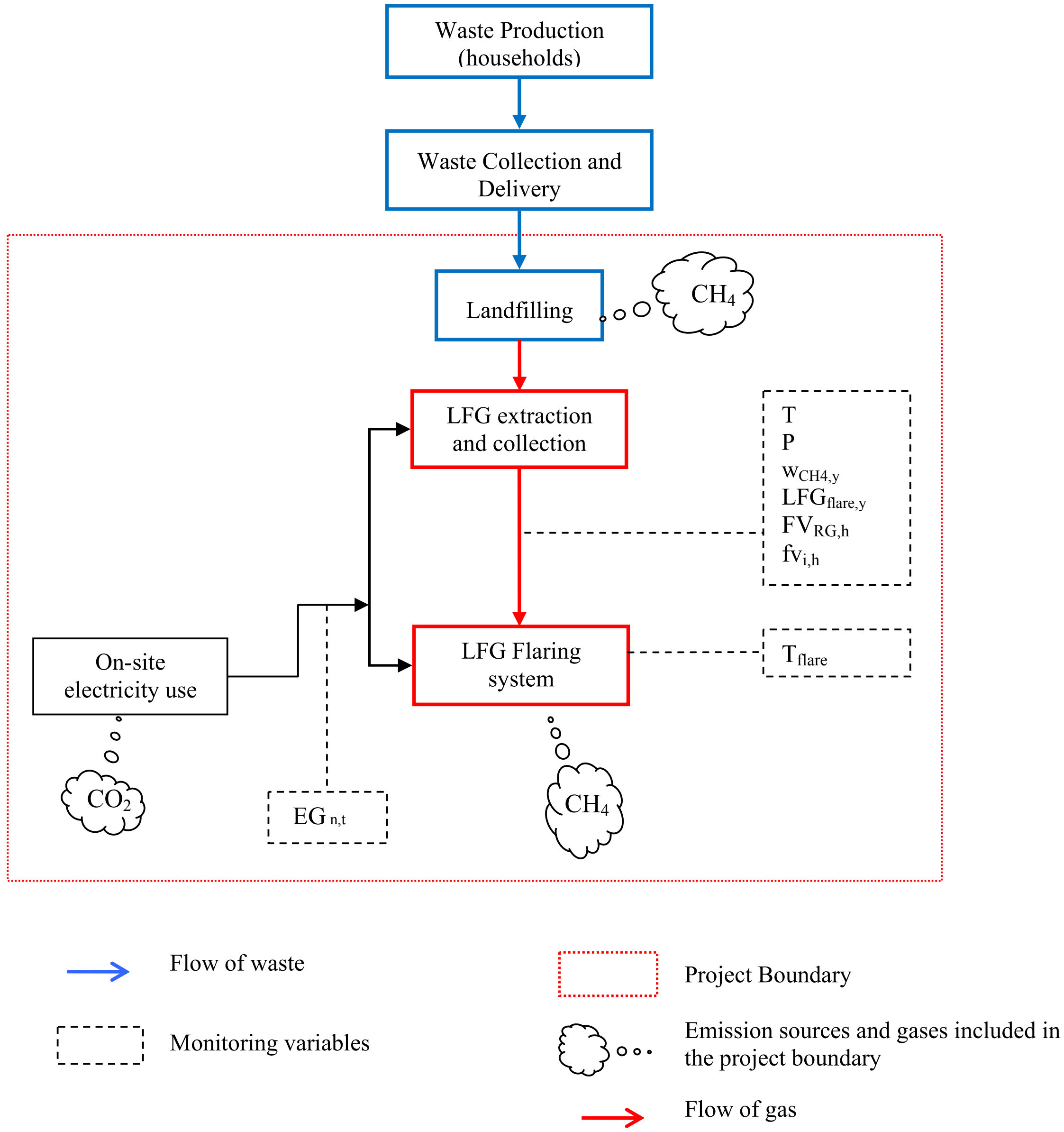
According to the consolidated baseline methodology ACM0001, the project boundary "is the site of the project activity where the gas is captured and destroyed/used". In this case, the project boundary is the landfill site.

**Table A.2 Summary of Gases and Sources Included in the Project Boundary**

| | Source | Gas | Included? | Justification / Explanation |
|---|---|---|---|---|
| **Baseline** | Emissions from decomposition of waste at the landfill site | $CH_4$ | Yes | The major source of emissions in the baseline |
| | | $CO_2$ | No | $CO_2$ emissions from the decomposition of organic waste are not accounted |
| | | $N_2O$ | No | $N_2O$ emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative. |
| | Emissions from electricity consumption | $CO_2$ | No | No electricity is 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. |
| | Emissions from thermal energy generation | $CO_2$ | No | No thermal energy generation is 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** | Project emissions from flaring the residual gas stream | $CO_2$ | No | Excluded for simplification. |
| | | $CH_4$ | Yes | This to reflect efficiency of combustion |
| | On-site fossil fuel consumption due to the project activity other than for electricity generation | $CO_2$ | No | The project does not consume fossil fuel other than for electricity use |
| | | $CH_4$ | 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 |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_20$ | No | Excluded for simplification. This emission source is assumed to be very small. |

Figure 3 shows the GHG emissions involved in the proposed project activity.

**Figure 3. Flow diagram of the project boundary**




**B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:**

In line with the methodology applied ACM0001 (version 11), the selection of the most plausible baseline scenario follows the below procedure:

Project participants should use Step 1 of the latest version of the "Tool for the demonstration and assessment of additionality", to identify all realistic and credible baseline alternatives. In doing so, relevant policies and regulations related to the management of landfill sites should be taken into account.

***Step 1. Identification of alternatives to the project activity consistent with current laws and regulations***

***Sub-step 1a: Define alternatives to the project activity***

In accordance with ACM0001 methodology, alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analyzed include:

LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity;

LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.

No energy is exported to a grid and/or to a nearby industry, or used on-site therefore alternatives for Power generation and heat generation in the absence of the project activity are not considered in the PDD.

***Sub-step 1b – Consistency with mandatory laws and regulations***

There are currently no legally-binding legal and regulatory requirements in the Kingdom of Saudi Arabia related to the management of solid waste.

All alternatives identified above are in compliance with mandatory applicable legal and regulatory requirements.

***Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable***

No energy is exported to a grid and/or to a nearby industry, or used on-site therefore step 2 is skipped.

***Step 3: Step 2 and/or Step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality" shall be used to assess which of these alternatives should be excluded from further consideration (e.g. alternatives facing prohibitive barriers or those clearly economically unattractive).***

Step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality" has been undertaken in Section B.5 of this PDD. In accordance with the Guidelines for completing the project design document (CDM-PDD) version 7, this section overlaps and will not be replicated. Please refer to section B.5.

***Step 4: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. The least emission alternative will be identified for each***

***component of the baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.***

As detailed in section B.5 of this PDD, only one credible and plausible alternative to the project scenario has been identified. Therefore, Step 4 is not undertaken.

The most plausible baseline scenario for the proposed Project is identified as LFG 2 “atmospheric release of the landfill gas” which is identical with the continuation of current situation in absence of the project.

**B.5. 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 (assessment and demonstration of additionality):**

The additionality of the project activity is demonstrated using the steps described in the ‘Tool for the demonstration and assessment of additionality’ (version 05.2). See UNFCC website:

http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf

***Step 1. Identification of alternatives to the project activity consistent with current laws and regulations***

***Sub-step 1a: Define alternatives to the project activity***

***Sub-step 1b – Consistency with mandatory laws and regulations***

Step 1 and Sub-steps 1a and 1b overlap with steps undertaken in section B.4 and will not be replicated here. Please refer to previous section for details

***Step 2. Investment analysis***

***Sub-step 2a: Determine appropriate analysis method***

The CDM project activity and the alternatives identified in step 1 generate no financial or economic benefits other than CDM related income. Therefore, in accordance with the above-mentioned Tool, simple cost analysis (Option I) is applied

***Sub-step 2b: Apply simple costs analysis***

Total capital expenditures related to the implementation of the proposed project have been estimated to be about 4.6 Millions USD. Alternative LFG 2, atmospheric release of the landfill gas, does not lead to any costs for the project entity and is consistent with mandatory laws and regulations. Therefore it is concluded that the proposed CDM project activity is more costly than at least one alternative.

***Step 3: Barrier Analysis***

***Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity:***

*Technological Barrier:*

The particular technology used in the proposed project activity is not available in the Host Country. The gas flaring equipment will have to be imported. This is evidence by the equipment contract that was signed between the project entity and UK supplier.

*Barrier due to prevailing practice*

The Madinah Landfill Gas Capture Project is the "first of its kind" in the Kingdom of Saudi Arabia. This is specifically mentioned in the Environmental Impact Assessment report which was prepared by independent third party name Mohammed Hussain Askari Environmental Consultancies and approved by Presidency of Meteorology and Environment of the Kingdom of Saudi Arabia.

***Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)***

*Alternative LFG1:* The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity. As mentioned in sub-step 2a, the project activity generates no financial or economic benefits other than CDM related income. Therefore, the proposed activity not implemented as a CDM project is not considered a plausible alternative.

*Alternative LFG2:* Atmospheric release of the landfill gas.
LFG2 represents the continuation of the current situation and the two identified barriers above would not prevent such alternative.

***Step 4. Common practice analysis***

As described in sub-step 3a above, the proposed project activity type has demonstrated to be first-of-its-kind therefore it has not diffused in the relevant sector and region. In accordance with the "Tool for the demonstration and assessment of additionality", the common practice analysis is skipped.

**Conclusion:**
As per sub-step 2a above, the project generate no financial or economic benefits other than CDM related income. Therefore, without revenues from the CDM the project participant which is a private entity would not have invested in the proposed project.
Besides, the project is the first of its kind in Saudi and the Municipality of Madinah has entered into a land lease agreement with the project entity provided that the project would be developed under Kyoto Protocol's Clean Development Mechanism, as specifically mentioned in land lease contract.
Finally, as the technology will be imported, revenues from the CDM will alleviate unacceptably high risk of equipment disrepair and malfunctioning or other underperformance through hiring international experts that will take charge of training labour to operate and maintain the technology. This is evidenced by employment contract between the project entity and international experts.

It can be concluded that CDM alleviate the identified barriers that prevent the proposed project activity from occurring, then the project is additional.

**Consideration of the incentive from the CDM in the decision to proceed with the project activity**

The starting date of the project activity is before the date of validation. As indicated in the table the incentive from the CDM was seriously considered in the decision to proceed with the project activity.

**Table B.2. CDM consideration timeline**

| Date | Key Events |
|---|---|
| *2007 Jan. 7th* | Project entity's business license is issued |
| *2008 Jul. 5th* | **Start of the project activity:** Lease contract is signed between the municipality of Madina Munawara and the project entity for the utilization of landfill gas at the Yanboa old road landfill where CDM is specifically mentioned. |
| *2008 Oct. 10th* | Signature of the equipment purchase contract |
| *2009 June* | Saudi Arabia notifies its DNA |
| *2009 Jun. 8th* | CDM consultant starts work |
| *2009 July* | EIA report is completed |
| *2010 Jan. 25th* | ERPA is signed |

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

**Baseline Emissions**

In accordance with the consolidated methodology ACM0001 (version 11), baseline emissions for the year *y* are calculated as:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \quad (1)$$

Where:

| | |
|---|---|
| $MD_{project,y}$ | The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($tCH_4$) 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 is 21 $tCO_2e/tCH_4$ |
| $EL_{LFG,y}$ | 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 onsite/offsite fossil fuel based captive power generation, during year y, in megawatt hours (MWh) |
| $CEF_{elec,BL,y}$ | $CO_2$ emissions intensity of the baseline source of electricity displaced, in $tCO_2e/MWh$. |
| $ET_{LFG,y}$ | The quantity of thermal energy produced utilising the landfill gas, which in the absence of the project activity would have been produced year y in TJ from onsite/offsite fossil fuel fired boiler, during the |
| $CEF_{ther,BL,y}$ | $CO_2$ emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in $tCO_2e/TJ$ |

$MD_{BL,y}$ is assumed to be zero as there are no regulatory requirements or contractual agreements concerning the capture and flaring of methane.

$EL_{LFG,y}$ and $CEF_{elec,BL,y}$ are assumed to be zero as no electricity will be produced.

$ET_{LFG,y}$ and $CEF_{ther,BL,y}$ are assumed to be zero as no thermal energy will be produced.

Therefore equation (1) can be simplified as follows:
$BE_y = MD_{project,y} * GWP_{CH4}$

$MD_{project,y}$ will be determined ex-post by metering the actual quantity of methane captured and destroyed once the project activity is operational. The consolidated methodology states that $MD_{project,y}$ should be calculated using the following equation

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y} \quad (2)$$

Where:

$MD_{flared, y}$ Quantity of methane destroyed by flaring ($tCH_4$)
$MD_{electricity, y}$ Quantity of methane destroyed by generation of electricity ($tCH_4$)
$MD_{thermal, y}$ Quantity of methane destroyed for the generation of thermal energy ($tCH_4$)
$MD_{PL, y}$ Quantity of methane sent to the pipeline for feeding to the natural gas distribution network

In this case, no electricity, thermal energy or direct supply of natural gas are provided and therefore the above equation can be simplified as:
$MD_{project,y} = MD_{flared,y}$

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (4)$$

Where:

$LFG_{flare,y}$ Quantity of landfill gas fed to the flare(s) during the year measured in cubic metres ($m^3$)
$PE_{flare,y}$ Project emissions from flaring of the residual gas stream in year y ($tCO_2e$) determined following the procedure described in the latest version of *"Tool to determine project emissions from flaring gases containing methane"*.
DCH4 Methane density expressed in tonnes of methane per cubic meter of methane (tCH4/m3CH4)
wCH4,y Average methane fraction of the landfill gas as measured4 during the year and expressed as a fraction (in m³ CH4/m³ LFG)
$GWP_{CH4}$ Global Warming Potential value for methane for the first commitment period is 21 tCO2e/tCH4

*Determination of project emissions from flaring of the residual gas stream in year y $PE_{flare,y}$* (STEP 7 of the Tool)

In line with the "Tool to determine project emissions from flaring gases containing methane", $PE_{flare, y}$ is determined based on the flare efficiency and the mass flow rate of methane in the residual gas stream that is flared. Flare efficiency depends on both the actual efficiency of combustion in the flare and the time that the flare is operating. The efficiency of combustion in the flare is calculated from the methane content in the exhaust gas of the flare, corrected for the air used in the combustion process, and the methane content in the residual gas.

Enclosed flare systems are employed by the project activity. According to the tool, there are two options for determining the flare efficiency for enclosed flares:

- To use a 90% default value. Continuous monitoring of compliance with the manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for this specific hour.
- Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

In both cases, if there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500ºC for any particular hour, it shall be assumed that during that hour the flare efficiency is zero.

The project entity has chosen to use the default value for the methane destruction efficiency.

As simplified approach and in accordance with monitoring methodology procedure of the *"Tool to determine project emissions from flaring gases containing methane"*, project participants will only measure the methane content of the residual gas and consider the remaining part as $N_2$. Consequently, project emissions from flaring are calculated as the sum of emissions from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows**:**

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000} \quad (3\text{-}1)$$

Where,

| Variable | SI Unit | Description |
|---|---|---|
| $PE_{flare,y}$ | $tCO_2e$ | Project emissions from flaring of the residual gas stream in year y |
| $TM_{RG,h}$ | kg/h | Mass flow rate of methane in the residual gas in the hour h |
| $\eta_{flare,h}$ | - | Flare efficiency in hour h |
| $GWP_{CH4}$ | $tCO_2e/tCH_4$ | Global Warming Potential of methane valid for the commitment period |

*Determination of methane mass flow rate in the residual gas on a dry basis* $TM_{RG,h}$ (STEP 5 of the Tool)

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60ºC), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \quad (3\text{-}2)$$

Where,

| Variable | SI Unit | Description |
|---|---|---|

| | | |
|---|---|---|
| $TM_{RG,h}$ | kg/h | Mass flow rate of methane in the residual gas in the hour h |
| $FV_{RG,h}$ | $M^3/h$ | Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h |
| $fv_{CH4,RG,h}$ | - | Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where I refers to methane). |
| $\rho_{CH4,n}$ | $kg/m^3$ | Density of methane at normal conditions (0.7168) |

*Determination of the hourly flare efficiency $\eta_{flare,h}$* (STEP 6 of the Tool)
The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

As the **use of the default value** for the flare efficiency has been chosen, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the temperature in the exhaust gas of the flare ($T_{flare}$) is below 500 °C for more than 20 minutes during the hour h.
- 50%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500 °C for more than 40 minutes during the hour h, but the manufacturers specifications on proper operation of the flare are not met at any point in time during the hour h.
- 90%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500 °C for more than 40 minutes during the hour h and the manufacturers specifications on proper operation of the flare are met continuously during the hour h.

***Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($MD_{project,y}$)***

The ex ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($MD_{project,y}$) will be done with the latest version of the approved *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site",* considering the following additional equation:

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4} \quad (4)$$

Where:

$BE_{CH4,\ SWDS,\ y}$ Methane generation from the landfill in the absence of the project activity at year y ($tCO_2e$) calculated as per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".

According to the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", the $BE_{CH4,SWDS}$,y is calculated as follows:

$$\mathbf{BE_{CH4,swds,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j})} \quad (5)$$

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 y ($tCO_2e$) |
| 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 |
| $GWP_{CH4}$ | Global Warming Potential (GWP) of methane, valid for the relevant commitment period |
| OX | Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) |
| F | Fraction of methane in the SWDS gas (volume fraction) (0.5) |
| $DOC_f$ | Fraction of degradable organic carbon (DOC) that can decompose |
| MCF | Methane correction factor |
| $W_{j,x}$ | Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons). Sampling to determine the different waste types is not necessary, the waste composition can be obtained from previous studies |
| $DOC_j$ | 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 crediting period: x will refer to the year since the landfill started receiving wastes [x runs from the first year of landfill operation (x = 1) to the year y for which avoided emissions are calculated (x = y) |
| y | Year for which methane emissions are calculated |

**Project Emissions**

ACM0001 (version 11) defines project emissions to be calculated using the following equation:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad (6)$$

Where:

| | | |
|---|---|---|
| $PE_{EC,y}$ | = | Emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{EC,y}$) will be calculated following the latest version of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. If in the baseline a part of LFG was captured then the electricity quantity used in calculation is electricity used in project activity net of that consumed in the baseline |
| $PE_{FC,j,y}$ | = | Emissions from consumption of heat in the project case. The project emissions from fossil fuel combustion ($PE_{FC,j,y}$) will be calculated following the latest version of “Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion”. For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the landfill, as well as any other on-site fuel combustion for the purposes of the project activity. If in the baseline part of a LFG was captured then the heat quantity used in calculation is fossil fuel used in project activity net of that consumed in the baseline. |

*Determination of $PE_{EC,y}$*

The proposed project installs a diesel generator for electricity generation on-site. Consequently, Scenario B “Electricity consumption from off-grid fossil fuel fired captive power plant” of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” applies and Option B2 is chosen: A value of 1.3tCO2/MWh is applied as the electricity consumption source is a project consumption source.

*Determination of* $PE_{FC,y}$

There is no consumption of heat in the project activity therefore $PE_{FC,y}=0$

**Leakage Emissions**

No leakage is taken into account under Methodology ACM0001 (version 11).

**Emission Reductions**

According to ACM0001 (version 11), emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad (9)$$

Where:
$ER_y$ Emission reductions in year y ($tCO_2e$)
$BE_y$ Baseline emissions in year y ($tCO_2e$)
$PE_y$ Project emissions in year y ($tCO_2e$)

### B.6.2. Data and parameters that are available at validation:

| **Data / Parameter:** | Regulatory requirements relating to landfill gas |
|---|---|
| Data unit: | - |
| Description: | Regulatory requirements relating to landfill gas |
| Source of data used: | Publicly available information of the host country's regulatory requirements relating to landfill gas |
| Value applied: | - |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | |
| Any comment: | The information though recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). Project participants should explain how regulations are translated into that amount of gas |

| **Data / Parameter:** | $MD_{BL,y}$ |
|---|---|
| Data unit: | $tCH_4$ |
| Description: | Amount of methane that would have been destroyed / combusted during year y in absence of the project due to regulatory and/or contractual requirement |
| Source of data used: | Project entity, Environmental Law of the Kingdom of Saudi Arabia |
| Value applied: | 0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | There is no methane destruction occurring at the landfill currently, only passive venting of methane to the atmosphere. In addition, there are no legal or contractual obligations to collect and flare landfill gas and therefore no methane would be destroyed / combusted in the absence of the project activity. |
| Any comment: | - |

| **Data / Parameter:** | $D_{CH4}$ |
|---|---|
| Data unit: | $tCH_4/m^3CH_4$ |
| Description: | Density of methane |
| Source of data used: | IPCC |
| Value applied: | 0.0007168 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Known value at Standard Temperature and Pressure (STP), i.e. 0 degrees Celsius and 1,013bar |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | $BE_{CH4,SWDS,y}$ |
| Data unit: | tCO2e |
| Description: | Methane generation from the landfill in the absence of the project activity in year y |
| Source of data used: | Calculated as per the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” (version. 4). |
| Value applied: | See section B.6.3 Table B.3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Used for ex-ante estimation of methane generation from the landfill in the absence of the project activity. |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | φ |
| Data unit: | - |
| Description: | Model correction factor to account for model uncertainties |
| Source of data used: | Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site |
| Value applied: | 0.9 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. 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. |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | OX |
| Data unit: | - |
| Description: | Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) |
| Source of data used: | IPCC 2006 Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.1 |
| Justification of the choice of data or description of measurement methods and procedures actually 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. 0.1 is applied in accordance with on-site conditions. |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | F |
| Data unit: | - |
| Description: | Fraction of methane in the SWDS gas (volume fraction) |
| Source of data used: | IPCC 2006 Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.5 |
| Justification of the | This factor reflects the fact that some degradable organic carbon does not |

| | |
|---|---|
| choice of data or description of measurement methods and procedures actually applied : | degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC. |
| Any comment: | - |

| **Data / Parameter:** | $DOC_f$ |
|---|---|
| Data unit: | - |
| Description: | Fraction of degradable organic carbon (DOC) that can decompose |
| Source of data used: | IPCC 2006 Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.5 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Default value of 0.5 is recommended by the IPCC |
| Any comment: | - |

| **Data / Parameter:** | MCF |
|---|---|
| Data unit: | - |
| Description: | Methane Correction Factor |
| Source of data used: | IPCC 2006 Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 1.0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Use the following values for MCF:<br>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) leveling of the waste;<br>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;<br>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;<br>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. |
| Any comment: | 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:** | $DOC_j$ |
|---|---|
| Data unit: | - |

| | |
|---|---|
| Description: | Fraction of degradable organic carbon (by weight) in the waste type j |
| Source of data used: | IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5) |
| Value applied: | Apply the following values for the different waste types *j*: (see table below) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | 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. In the case of empty fruit bunches (EFB), as their characteristics are similar to garden waste, the parameter value correspondent of garden shall be used. |
| Any comment: | - |

| Waste type *j* | $DOC_j$ (% 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 |

| | |
|---|---|
| **Data / Parameter:** | $k_j$ |
| Data unit: | - |
| Description: | Decay rate for the waste type j |
| Source of data used: | Inventories IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3) |
| Value applied: | The following default values for the different waste types *j* are applied: (see table below) |
| Justification of the choice of data or description of | As per project EIA stating: "The Madinah region is characterized in general by tropical dry to semi-dry climate". |

| **Waste type *j*** | | **Tropical (MAT＞20°C)** |
|---|---|---|
| | | Dry (MAP＜1000mm) |
| **Slowly degrading** | Pulp, paper cardboard (other than sludge), textiles | 0.045 |
| | Wood, wood products and straw | 0.025 |
| **Moderately degrading** | Other (non-food) organic putrescible garden and park waste | 0.065 |
| **Rapidly degrading** | Food, food waste, sewage sludge, beverages and tobacco | 0.085 |

NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.

| | |
|---|---|
| measurement methods and procedures actually applied : | |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | $GWP_{CH4}$ |
| Data unit: | $tCO_2e/tCH_4$ |
| Description: | Global Warming Potential (GWP) of methane, |
| Source of data used: | IPCC |
| Value applied | 21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | valid for the relevant commitment period |
| Any comment: | Shall be updated according to any future COP/MOP decisions |

**B.6.3 Ex-ante calculation of emission reductions:**

**Baseline emissions**

$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$
$BE_y = (MD_{project,y} - 0) * 21$

As per methodology, the ex ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($MD_{project,y}$) is done with the latest version of the approved *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site",* considering the following additional equation:

$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$

Besides, in accordance with methodology, the efficiency of the degassing system which will be installed in the project activity should be taken into account while estimating the *ex ante* estimation.

Consequently,

$BE_y = BE_{CH4,SWDS,y} * \eta_{degassing}$

Where:

$\eta_{degassing}$ = efficiency of the degassing system (70%)

The 70% value is considered appropriate as it has been estimated by international UK expert with extensive track record in landfill gas recovery system hired specifically by the project entity to supervise the implementation of the gas collection and flaring systems.

Accordingly, the calculations are presented in the below table:

**Table B.3. Calculation Landfill Methane Component of Baseline Emissions**

| Year | $BE_{CH4,SWDS,y}$ | $\eta_{degassing}$ | $BE_y$ |
|---|---|---|---|
| | **Landfill Methane Generation ($tCO_2e$)** | **Project LFG Collection Efficiency, (%)** | **$CH_4$ Destroyed Under Project Conditions ($tCO_2e$)** |
| 2011 | 215,115 | 70 | 150,581 |
| 2012 | 210,432 | 70 | 147,302 |
| 2013 | 206,080 | 70 | 144,256 |
| 2014 | 202,036 | 70 | 141,425 |
| 2015 | 198,275 | 70 | 138,793 |
| 2016 | 194,778 | 70 | 136,344 |
| 2017 | 191,524 | 70 | 134,067 |
| **Total** | **1,418,240** | | **992,768** |

**Project emissions**

$PE_y = PE_{EC,y}$

The project entity estimated 429.24MWh annually as internal consumption.

$PE_y$= 429.24 * 1.3 = **558 $tCO_2$/year**

**Emission Reduction**

$ER_y = BE_y – PE_y$

See section B.6.4 for a summary of the ex-ante estimation of emission reductions

### B.6.4 Summary of the ex-ante estimation of emission reductions:

**Table B.4. Summary of Ex Ante Estimation of Project Emission Reductio**

| Year | Estimation of baseline emissions (tonnes of $CO_2e$) | Project emissions from electricity consumption (tonnes of $CO_2e$) | Estimation of overall emission reductions (tonnes of $CO_2e$) |
|---|---|---|---|
| 2011 | 150,581 | 558 | 150,023 |
| 2012 | 147,302 | 558 | 146,744 |
| 2013 | 144,256 | 558 | 143,698 |
| 2014 | 141,425 | 558 | 140,867 |
| 2015 | 138,793 | 558 | 138,235 |

| | | | |
|---|---|---|---|
| 2016 | 136,344 | 558 | 135,786 |
| 2017 | 134,067 | 558 | 133,509 |
| **Total** | **992,768** | | **988,862** |

## B.7 Application of the monitoring methodology and description of the monitoring plan:

### B.7.1 Data and parameters monitored:

| **Data / Parameter:** | $LFG_{flare,y}$ |
|---|---|
| Data unit: | $m^3$ LFG |
| Description: | Amount of LFG captured in year y that is sent to the flare for combustion (at Normal Temperature and Pressure) |
| Source of data to be used: | Flow meter on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | Calculated using the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"* and assuming a collection efficiency of 70%. |
| Description of measurement methods and procedures to be applied: | Continuous measurement will be carried out by flow meter installed between the blower(s) and enclosed flare stack. |
| QA/QC procedures to be applied: | The flow meter(s) will be tested and calibrated periodically and in accordance with manufacturers specifications |
| Any comment: | - |

| **Data / Parameter:** | $w_{CH4,y}$ |
|---|---|
| Data unit: | $m^3CH_4$ / $m^3$LFG |
| Description: | Methane fraction of the landfill gas |
| Source of data to be used: | Gas analyzer on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | 0.5 as per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site". |
| Description of measurement methods and procedures to be applied: | The methane fraction of the landfill gas will be measured continuously by in-line gas analysers installed between the blower(s) and enclosed flare stack. Methane content will be measured on a wet basis. |
| QA/QC procedures to be applied: | The gas analyser will be calibrated periodically and in accordance with manufacturers specifications |
| Any comment: | - |

| **Data / Parameter:** | $fv_{i,h}$ |
|---|---|
| Data unit: | - |
| Description: | Volumetric fraction of component *i* in the residual gas in the hour *h* where *i*= $CH_4$ |
| Source of data to be used: | Continuous gas analyzer on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | - |

| | |
|---|---|
| Description of measurement methods and procedures to be applied: | Continuously |
| QA/QC procedures to be applied: | Periodically calibration will be carried out according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. |
| Any comment: | Remaining part of the residual gas is considered as $N_2$. |

| **Data / Parameter:** | $FV_{RG,h}$ |
|---|---|
| Data unit: | $m^3/h$ |
| Description: | Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h* |
| Source of data to be used: | Flow meter on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | - |
| Description of measurement methods and procedures to be applied: | Continuously. |
| QA/QC procedures to be applied: | Flow meters calibration will be carried out according to the manufacturer's recommendation. |
| Any comment: | - |

| **Data / Parameter:** | $T_{flare}$ |
|---|---|
| Data unit: | °C |
| Description: | Temperature in the exhaust gas of the flare |
| Source of data to be used: | Type N thermocouple on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | - |
| Description of measurement methods and procedures to be applied: | Flare temperature will be measured by a Type N thermocouple |
| QA/QC procedures to be applied: | The equipment will be maintained and calibrated in accordance with the manufacturers recommendations |
| Any comment: | - |

| **Data / Parameter:** | $FC_{i, j, y}$ |
|---|---|
| Data unit: | Mass or volume unit per year |
| Description: | Quantity of fuel type *i* combusted in process *j* during the year *y* |
| Source of data to be used: | Purchase invoices and/or metering (mass or volume) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | 100 tons, as estimated by project entity |
| Description of measurement methods and procedures to | Continuous monitoring |

| | |
|---|---|
| be applied: | |
| QA/QC procedures to be applied: | The amount of fuel will be derived from the paid fuel invoices |
| Any comment: | - |

| **Data / Parameter:** | $NCV_{fuel}$ |
|---|---|
| Data unit: | TJ/mass or volume units of fuel |
| Description: | Weighted average net calorific value of fuel (diesel) |
| Source of data to be used: | IPCC default value |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | 0.0433TJ/ton<br>IPCC default values at the upper limit of the uncertainty at a 95% confidence interval, |
| Description of measurement methods and procedures to be applied: | ex ante |
| QA/QC procedures to be applied: | - |
| Any comment: | - |

| **Data / Parameter:** | $EF_{CO2, i, y}$ |
|---|---|
| Data unit: | $tCO_2/TJ$ |
| Description: | Weighted average $CO_2$ emission factor of the fuel type *i* in year *y* |
| Source of data to be used: | IPCC default value |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | 74.8$tCO_2/TJ$<br>IPCC default values at the upper limit of the uncertainty at a 95% confidence interval. |
| Description of measurement methods and procedures to be applied: | ex ante |
| QA/QC procedures to be applied: | Any future revision of the IPCC guidelines should be taken into account |
| Any comment: | - |

| **Data / Parameter:** | T |
|---|---|
| Data unit: | K |
| Description: | Temperature the landfill gas to determine the density of methane in the LFG. |
| Source of data to be used: | Temperature gauge on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | - |
| Description of measurement methods and procedures to be applied: | Continuously |
| QA/QC procedures to be applied: | The equipment will be maintained and calibrated in accordance with the manufacturers recommendations |
| Any comment: | - |

| **Data / Parameter:** | P |
|---|---|
| Data unit: | Pa |
| Description: | Pressure of the landfill gas to determine the density of methane in the LFG. |
| Source of data to be used: | Pressure Gauge on-site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | - |
| Description of measurement methods and procedures to be applied: | Continuously |
| QA/QC procedures to be applied: | The equipment will be maintained and calibrated in accordance with the manufacturers recommendations |
| Any comment: | - |

| **Data / Parameter:** | $EG_{n,t}$ |
|---|---|
| Data unit: | MWh |
| Description: | Quantity of electricity generated in captive power plant *n* in the time period *t* |
| Source of data to be used: | On-site electricity meter located at each flare |
| Value of data applied for the purpose of calculating expected emission reductions in section B.6 | 429.24MWh annually |
| Description of measurement methods and procedures to be applied: | Meters readings will be logged on a daily basis |
| QA/QC procedures to be applied: | Meters will be calibrated periodically in accordance with manufacturer's requirements |
| Any comment: | - |

| **Data / Parameter:** | Regulatory requirements relating to landfill gas |
|---|---|
| Data unit: | - |
| Description: | Regulatory requirements relating to landfill gas |
| Source of data used: | Publicly available information of the host country's regulatory requirements relating to landfill gas |
| Value applied: | - |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | - |
| Any comment: | The information though recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). Project participants should explain how regulations are translated into that amount of gas |

**B.7.2 Description of the monitoring plan:**

**Operational and management structure for the monitoring of emission reductions**

The project entity will hold the overall responsibility for the on-site implementation of the monitoring plan under the guidance of the CDM consultant. A monitoring officer will be appointed by the general manager of the project entity. The monitoring officer will be selected from among the senior technical or managerial staff and will be responsible for carrying out the following tasks:

- Train operating staff about CDM monitoring requirements;
- Organize, supervise and verify metering, data logging and recording in strict accordance with parameters to be monitored and QA/QC procedures listed in section B.7.1;
- Ensure monitoring instruments comply with methodology requirements and are calibrated and maintained periodically according to applicable standards and accuracies and by officially accredited entity;
- Ensure methane fraction of the landfill gas and LFG flow are measured on same basis (either wet or dry).
- Collect and archive monitoring data, calibration reports, instruments specifications during the lifetime of the project activity;
- Keep track of daily operations and special events that could impact monitoring process;
- Transfer copies of the monitoring data to the CDM consultant;

The CDM consultant will provide support during the implementation of the monitoring plan and during verification of emission reductions. The following task will be carried out by the CDM consultant:

- Train monitoring officer on CDM monitoring requirements;
- Ensure monitoring plan is implemented on-site in strict accordance with methodology and with the description in the registered PDD at the start of the project activity or on the date the project is registered as CDM, whichever is later;
- Liaise regularly with the monitoring officer and collect monitoring data especially during the first months following the registration of the project as CDM;
- Perform plausibility checks
- Prepare periodic monitoring reports including calculations of emission reductions
- Support DOE during on-site verifications
- Support DOE during the preparation of the final monitoring reports and at request for issuance with the UNFCCC

**B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)**

Date of completion of the baseline study and monitoring methodology: 23/05/2010
Name of person determining the baseline study and the monitoring methodology:

Caspervandertak Consulting BV
Tel: +86-10-84505756 / Fax: +86-10-84505758

Christophe Assicot: christophe@cdmasia.org

Zhang Jing: carol@cdmasia.org

Caspervandertak Consulting BV is not project participant.

## SECTION C. Duration of the project activity / crediting period

### C.1 Duration of the project activity:

#### C.1.1. Starting date of the project activity:

5th July 2008
The date marks the signature of the lease contract between the municipality of Madina Munawara and the project entity for the utilization of landfill gas at the Yanboa old road landfill.

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

In excess of 21 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:

01/01/2011

##### C.2.1.2. Length of the first crediting period:

7 years

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

Not applicable

##### C.2.2.2. Length:

Not applicable

## SECTION D. Environmental impacts

### D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

An Environmental Impact Assessment Report was prepared by Mohammed Hussain Askari Environmental Consultancies and submitted to the Presidency of Meteorology and Environment of the Kingdom of Saudi Arabia in July 2009.

The report was prepared in strict accordance with the Implementing Regulations of the General Environment Law of the Kingdom of Saudi Arabia and including the requirements of the Presidency of Meteorology and Environment.

The main environmental impacts of the project activity were assessed through the following criteria: air quality, noise, soil and climate, underground water, geological features of the area, surrounding natural environment (flora and fauna), population activities and public health. The main findings and conclusion are summarized below:

*Impact on air quality*
The project primarily aims at improving the quality of air in the area and to reduce the environmental impact of gases generated from the decomposition of landfill waste since waste generates gases which are detrimental to the environment and cause the greenhouse effect phenomenon. In addition, the project is located in remote area and it is not expected that the project and the enclosed landfill gas flares will have an impact on the quality of air in the area.

*Noise*
The project is located in an area far away from any population centres, in the middle of the public landfill, and no noise will be generated, except for the transportation traffic and the workforce during the construction phase, and within the allowable limits in line with Saudi standards (less than 90 decibels).

*Impact on terrain, geology and climate*
The project has no substantial impact on the terrain and climate. The project plays a significant and influential role in reducing climatic changes through the suction and treatment of the generated gases generated and accumulated as a result of the decomposition of waste, and this reduces the emission of global greenhouse gases, particularly the methane gas. The project has no significant effects on the geology of the area, because the new project is only for setting up a gas collection network and the safe enclosed landfill gas flares for the disposal of gases.

*Impact on soil and water*
The project has no significant impact on soil and groundwater of the area because the new project is only for setting up a gas collection network and the safe enclosed landfill gas flares for the disposal of gases and has no relationship with or impact on soil or on underground water. The project has no anticipated impact on the quality of water in the area, because the landfill area is, in general, far away from any underground aquifers or water streams and surface waters.

*Surrounding environment and wildlife*
The area is classified in terms of bionomics as a dry desert region to an extreme dry region, and so it is classified as an area that is extremely poor in flora and fauna particularly the area of the old and new landfills.

*Social and cultural elements*
The social and cultural elements of the project in the area are negligible, because the site is located in the middle of Medina landfill and it is far away from population centres.

*Impact on public health*
The hazards of exposure to activity-related accidents are closely and directly related to the workforce of the project. However, this impact can be curbed by using skilled workers who are trained in these jobs, in addition to the use of occupational safety and health measures. On the other hand the workers in the site and all branches of the company/project are specialists, technicians and skilled workers who have passed a number of courses in occupational safety and health.

*Conclusion*
The general conclusion of this study is that the environmental impact of the project in view of compliance with the standards and measurements contained in the Implementing Regulations of the General Environment Law does not constitute pressure on the external environment or on the occupational safety of on public health.

**D.2. If environmental 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 undertaken in accordance with the procedures as required by the host Party:**

The environmental impacts of the project are not considered significant by the project participants and by the local authorities. No further measures are considered necessary.

## SECTION E. Stakeholders' comments

### E.1. Brief description how comments by local stakeholders have been invited and compiled:

Stakeholders have been consulted at several stages of the project's development. We describe in this section how comments have been invited and compiled while the results of the consultations are provided in section E.2.

At early stage, the project entity started discussion about the project with the Madinah Munawarah Municipality as main institutional stakeholder and entered into agreement July 5th 2008.

In addition, the project entity carried out a separate stakeholder consultation meeting near the project site on February 10th 2010 to confirm the impacts of the project on local stakeholders.

As described in the EIA report, "In the area of the project, there are no economic indicators or human activities. The general landfill is far from any human concentrations, by 8-10 kilometres, and there is nothing in the area of the project except a workers living quarters, while nearly 1-3 km there are some administrative blocks for Dallah Company. […] The nearest residential site to the landfill is Dallah Camp which is located around 5-7 kilometres to the north of the landfill". Dallah is the company responsible for waste collection in Madinah area and the main operator of the landfill.

Consequently, local stakeholders were identified as 1) the workers living in the Dallah Camp and 2) The Medinah Municipality.

Stakeholders were informed and consulted about the project by means of a questionnaire survey which included the following elements:

- An introduction of the project
- An introduction of the Clean Development Mechanism
- An explanation of the purpose of the stakeholder consultation process
- A set of questions to assess the impacts of the project

A report of the main comments and outcomes of the survey is provided in section E.2.

### E.2. Summary of the comments received:

As described in section E.1, a stakeholder consultation was held during which each participant expressed his or her opinion on the proposed project. The participants mainly commented on the project's impacts on the environment and on the local population – with particular comments concerning health impacts. No significant negative opinions were received. During the consultation stakeholders asked general questions about the CDM procedures. These comments have been omitted from the ones stated below.

A list of participants and overview of the main comments is provided below:

**Table E.1 List of stakeholders that filled the questionnaire survey**

| Stakeholders | | |
|---|---|---|
| **Name** | **Organization** | **Position / occupation** |
| Salah Abdullah Qadi | Madinah Municipality | Deputy Mayor |
| Ali Suleman Alawi | Madinah Municipality | General Manager Environmental Health |
| Mohammad Abdullah Slayhem | Madinah Municipality | Commercial Buildings Planning Dept. |
| Abdullah Wawi | Madinah Municipality | General Manager Cleaning Department |
| Mazen Rhedan | Madinah Municipality | Senior Engineer Project Execution Department |
| Jalal Ghouli | Madinah Municipality | Dep. General Manager Cleaning Dept. |
| Ayman Fahad Sraihi | Madinah Municipality | Secretary Deputy Mayor |
| Mohammad Hadram Sehli | Madinah Municipality | Manager Project Execution Department |
| Ahmed Syed Jsmail | Madinah Municipality | Officer bid department |
| Mohmmad Nasim AL-Dahlawi | Madinah Municipality | Advisor Deputy Mayor |
| Eng. Bandar Alalwain | Madinah Municipality | Manager of Landfills |
| Habir Fadeel Kabir | Dallah Camp | Follow-up Manager |
| En Abdo Hassan Algrpally | Dallah Camp | Operation Manager |
| Ali Deeb A. Rhman | Dallah Camp | HR |
| Abdullah Muhammed Alruheli | Dallah Camp | Charger |
| Abdullah Ahmed Jodah | Dallah Camp | Finance Manger |
| Essam Eldeen Abuzaid | Dallah Camp | Chief Accountant |
| Mr. Abdullah Y. Sindi | Dallah Camp | Deputy Project Manager |
| Abd. Glrohmmen Ali Mostofa | Dallah Camp | Technical support |

**Name:** Habir Fadeel Kabir
**Position / Affiliation:** Follow-up Manager Dallah Camp
**Comments:** I fully support this project because it reduces impacts on human health and it will lead to hygienic environment.

**Name:** Abdullah Muhammed Alruheli:
**Position / Affiliation:** Charger, Dallah Camp
**Comments:** I think this project will decrease waste gas into environment and also help fighting global warming.

**Name:** Essam Eldeen Abuzaid:
**Position / Affiliation:** Chief Accountant, Dallah Camp
**Comments:** It would be good if the gas was used rather than just flared.

**Name:** Ali Suleman Alawi
**Position / Affiliation:** General Manager Environmental Health, Madinah Municipality
**Comments:** The project is very good for the health of local citizens.

**Name:** Abdullah Wawi,
**Position / Affiliation:** General Manager Cleaning Department, Madinah Municipality
**Comments:** I hope other municipalities in the Kingdom of Saudi Arabia will consider similar sort of projects as well to ensure healthy lives of their citizens

**Name:** Mazen Rhedan
**Position / Affiliation:** Senior Engineer Project Execution Department, Madinah Municipality
**Comments:** This will ensure safe and healthy environment for our next generations.

**Results of the questionnaire survey:**
The results of the questionnaire surveys among project participants are presented in table E.2. The results of the questionnaire surveys show that all respondents fully support the project without any negative opinion towards the project.

**Table E.2 Results of questionnaire survey**

| Question | Investigation result | | |
|---|---|---|---|
| | Answer | Respondents | % |
| Do you agree the construction of the project activity will benefit local economy? | Yes | 20 | 100% |
| | No | 0 | 0 |
| | Not sure | 0 | 0 |
| Do you agree the construction of the project activity will benefit local environment? | Yes | 20 | 100% |
| | No | 0 | 0 |
| | Not sure | 0 | 0 |
| Do you agree the construction of the project activity will mitigate odour and improve life quality of local residents and on-site workers? | Yes | 20 | 100% |
| | No | 0 | 0 |
| | Not sure | 0 | 0 |
| Do you agree the construction of the project activity will reduce gas emission that causes global warming? | Yes | 20 | 100% |
| | No | 0 | 0 |
| | Not sure | 0 | 0 |
| Do you think the construction of the project activity can prevent hazardous constituents so as to potentially reduce impacts on the human health? | Yes | 20 | 100% |
| | No | 0 | 0 |
| | Not sure | 0 | 0 |
| Do you support the construction of the project activity? | Fully support | 20 | 100% |
| | Not support | 0 | 0 |
| | Not sure | 0 | 0 |

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

The comments received from the project participants through questionnaire survey were positive. Considering full support from local stakeholders, there is no need to make further adjustments to the design and implementation of the Project.

**Annex 1**

**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

**The project entity:**

| | |
|---|---|
| Organization: | Environmental Construction For Contracting Business |
| Street/P.O.Box: | Prince Majed Street, P.O. Box: 41943 |
| Building: | Al Bassam Center |
| City: | Jeddah |
| State/Region: | Al Makkatul Mukarramah |
| Postfix/ZIP: | Jeddah 21531 |
| Country: | Kingdom of Saudi Arabia |
| Telephone: | 00966 2 6726404, 00966 2 6721499 |
| FAX: | 00966 2 6721399 |
| E-Mail: | ceresjeddah@ceresgulf.com |
| URL: | www.ceresgulf.com |
| Represented by: | Syed Ehtesham Ul Haque |
| Title: | C.E.O |
| Salutation: | Mr. |
| Last Name: | Ul Haque |
| Middle Name: | Ehtesham |
| First Name: | Syed |
| Department: | administration |
| Mobile: | 0506472224 |
| Direct FAX: | 00966 2 6751094 |
| Direct tel: | 00966 2 6748273, 00966 2 6707948 |
| Personal E-Mail: | syed148@aol.com |

**The Purchasing Party:**

| | |
|---|---|
| Organization: | Vitol S.A. |
| Street/P.O.Box: | 28 Boulevard du Pont-d'Arve |
| Building: | |
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| Country: | Switzerland |
| Telephone: | +41 22 322 11 11 |
| FAX: | +41 22 800 23 74 |
| E-Mail: | dbf@vitol.com |
| URL: | www.vitol.com |
| Represented by: | David Fransen |
| Title: | Managing Director |
| Salutation: | Mr. |
| Last Name: | Fransen |
| Middle Name: | - |
| First Name: | David |
| Department: | |
| Mobile: | |
| Direct FAX: | +41 22 800 23 74 |
| Direct Tel: | +41 22 322 11 11 |
| Personal E-Mail: | |

## Annex 2

### INFORMATION REGARDING PUBLIC FUNDING

No public funding from Annex I parties are involved in this project.

# Annex 3

## BASELINE INFORMATION

***Waste amount***

The project entity indicated that around 288,000 tons of waste had been received on site between the opening of the landfill in September 2008 and December 2009. In 2010, an average of 1,500 tons per day is forecasted based on 360 days annually. From 2011, an average of 1,000 tons per day is expected to be land filled.

**Table 1. Waste treated in the landfill site**

| Area | Date of filling | Current Status | Waste in place (Million Tonnes) | Daily input (Tonnes Per Day) |
|---|---|---|---|---|
| Zone 1 | 1985 -1991 | Closed | 1.3 | 625 |
| Zone 2 | 1992-1998 | Closed | 1.5 | 667 |
| Zone 3 | 1999-2005 | Closed | 1.9 | 850 |
| Cell #1 | 2005-2010 | Active to 2010 | 1.0 | 900 |
| Cell #2 | 2010-2025 | 2010-to future | 1.7 | 900 (estimated) |

*Source: project entity*

***Waste composition***

**Table 2. Waste Composition**

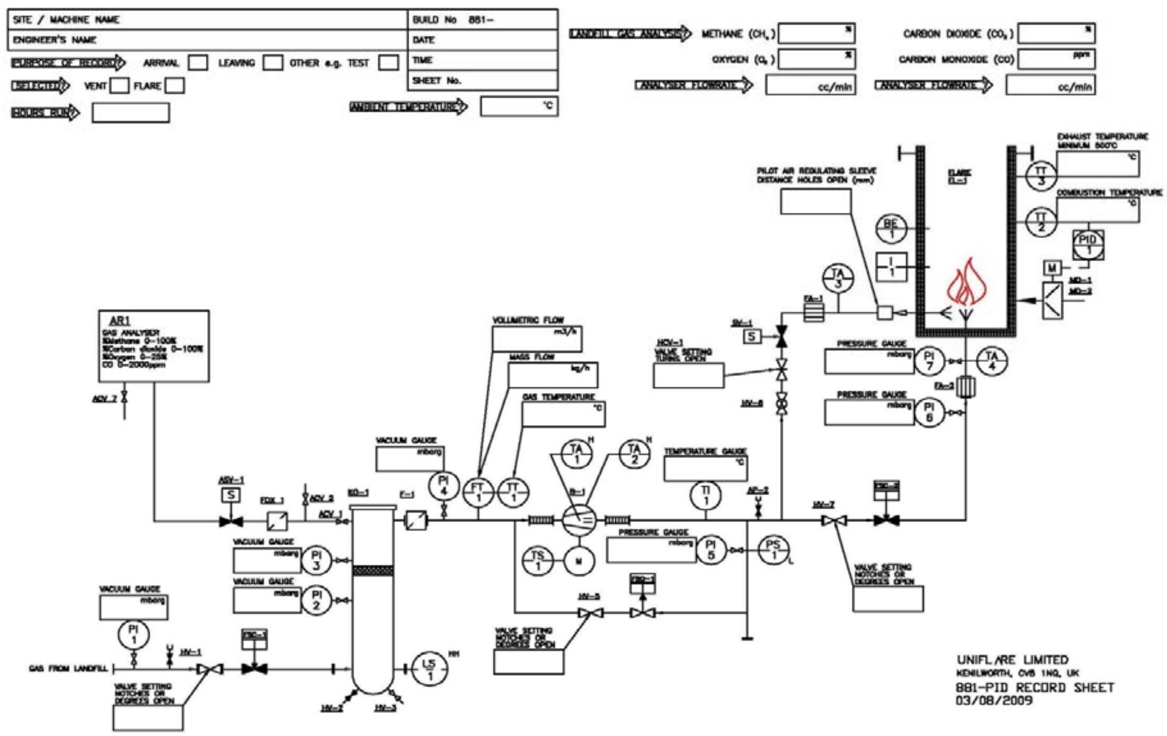
| Waste Type | % |
|---|---|
| Food waste | 41.1 |
| Paper/cardboard | 18 |
| Wood | 9.8 |
| Textiles | 2.9 |
| Rubber/leather | 0.6 |
| Plastic | 6.3 |
| Metal | 1.3 |
| Glass | 2.2 |
| Other | 5.4 |

*Source: IPCC 2006 Regional defaults, Middle East*

**Annex 4**
**Monitoring information**

The project installs remote data logging package for carbon credits, including Hi – Tech gas analyser for CH4, CO2 AND O2, Netrix Data Logging Package for carbon credit accreditation, digital flow meter.

Monitored parameters and location of the monitoring equipment:




Daily monitoring sheet template:

| Location | Flow rate of LFG (Nm3/h) (LFG $_{flare,y}$) | %CH4 (m3CH4/m3LFG) ($w_{CH4,y}$) | Temperature of landfill gas (T) (K) | Temperature in the exhaust gas of the flare ($^o$C) ($T_{flare}$) | Pressure of landfill gas (Pa) (P) |
|---|---|---|---|---|---|
| Flare # x (morning) | | | | | |
| Flare # x (afternoon) | | | | | |