CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

**Please note the 'Version 02' at the top of each page refers to the template used not the information contained in the document.

Changes to PDD since being posted on the internet for public consultation

A.3 Emacruz Waste management agency of the Municipality of Santa Cruz, owner of the landfill was been removed from the Project Participant list on 15/1/05.
C.1.1 construction dates were updated.
C.1.2 expected operational lifetime of project activity was corrected to be 30 years.
C.2.1.1 start date of the crediting period was updated.
C.2 was changed from '21 years (3 times 7)' to 'Initial registration period of 7 years with extension as per the CDM modalities and procedures' on 3/3/05.
Annex 1 Emacruz Waste Management Agency's details were removed from this section in accordance with their removal from A.3 on 15/1/05.

Annex 1 'Sevicos Urutibehety Para el Medio Ambiente' has been added as SUMA's full legal name on 1/1/05.

SECTION A. General description of project activity

A.1 Title of the project activity:

Santa Cruz landfill gas combustion project

A.2. Description of the project activity:

The main objective of the project activity is to capture methane from the existing compartment 6 and the new to be constructed compartment 7. In these compartments degrading municipal waste is producing large quantities of landfill gas. Landfill gas contains approximately 50% methane, which is a powerful greenhouse gas (GHG) contributing to the greenhouse effect. Furthermore methane is a flammable gas, the emission of methane creates a fire hazard on site. Thus, by capturing and combusting the landfill gas, global GHG emissions are reduced, local environmental impacts are mitigated and operational safety is increased.

The project activity consists of installing operating and maintaining a landfill gas extraction and flaring system at the Normandia landfill site in Santa Cruz, Bolivia.

Under the scope of the CDM project activity:

- the existing full compartment (Fosa) 6 will be equipped with a gas extraction system and flare. This will prevent the CH_4 originating from the organic waste component from being emitted to the atmosphere.
- the required new landfill will be equipped with a gas extraction system and flare system. This will prevent the CH_4 originating from the organic waste component from being emitted to the atmosphere.

The Normandia landfill site is operational since 1995 and currently consists of six compartments. Compartment number six is currently being filled. For the construction of compartment 7, a concession contract for the construction and operation of the waste management is awarded to SUMA, a Bolivian company. The landfill is owned by the municipality of Santa Cruz.

Compartment 7 will be equipped with an impermeable bottom liner, leachate collection and treatment system. For safety reason compartment 6 is equipped with passive atmospheric gas vents. It can be expected that compartment 7 would have been equipped with a comparable system. Compartment 7 complies with local technical, environmental and safety obligations.

Based on current national or state legislation in Bolivia, no landfill gas collection, flaring or other treatment is required.

The project activity will contribute to sustainable development in Bolivia in the following way:

- The odour nuisance in the surrounding areas will decrease
- The safety on the landfill will increase
- A significant percentage of the profit of the CDM project activity will be for the municipality of Santa Cruz. This will lead to a decrease in levy for the inhabitants of Santa Cruz for the solid waste management service.
- Knowledge transfer regarding waste management principles and gas extraction flaring.
- Catalytic function regarding other CDM landfill gas combustion projects.

A.3. Project participants:

1. Grontmij Climate & Energy, project developer, contact for CDM project
2. SUMA, operator of landfill

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Bolivia

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

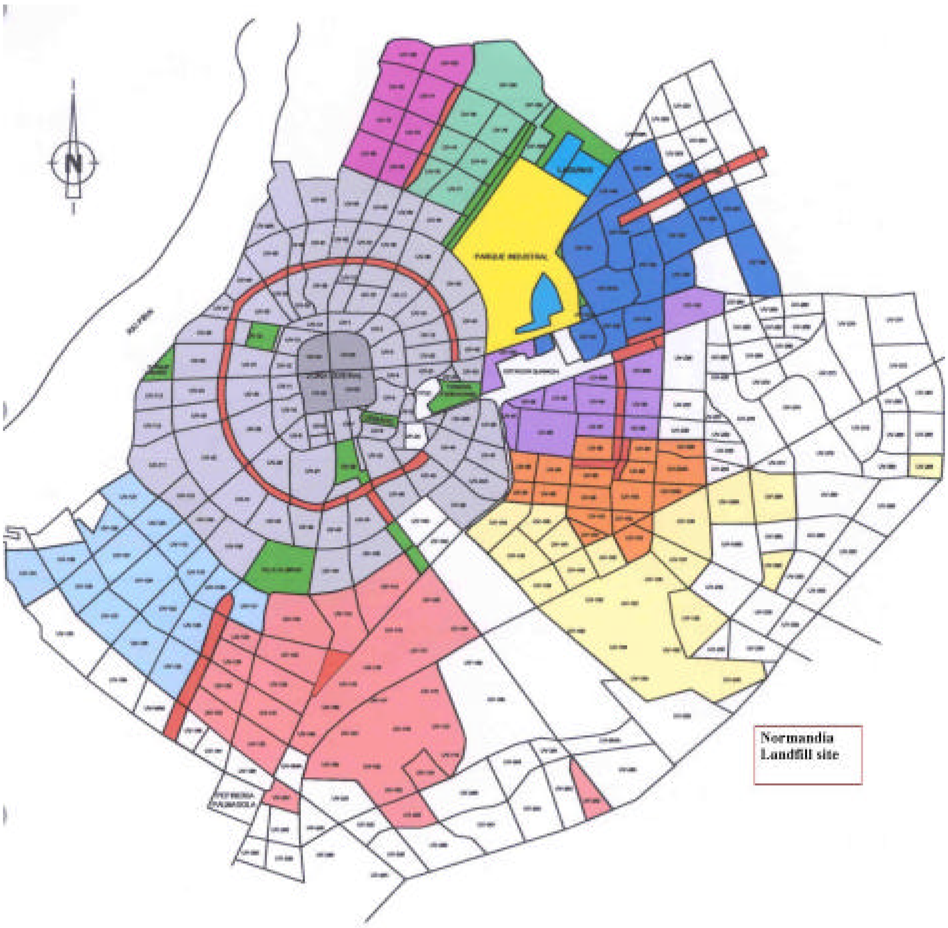
Santa Cruz

A.4.1.3. City/Town/Community etc:

Santa Cruz de la Sierra.
For the project, the municipality is represented by Emacruz, waste management agency of the Municipality of Santa Cruz and owner of the landfill.

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

Currently a landfill site (Normandia) is being used for the disposal of the municipal waste from the city of Santa Cruz. The current compartment is (almost) full, a new compartment is required. This new compartment will be built on the same site. The site is located approximately 15 km Southeast of the city centre.



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

Waste handling and disposal, sectoral scope 13.

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

Under the scope of the project activity a gas extraction and combustion installation will be installed. This installation consists of:

- Gas wells, these wells extract the gas from the landfill
- Gas collection and transportation pipes, these pipes collect and transport the extracted gas to the extraction plant.
- Gas extraction plant, this plant consists of a blower that creates a lower pressure inside the wells than in the landfill, thereby creating a driving force for the produced gas towards the gas wells.
- Flare, the extracted landfill gas will be combusted in a flare.
- Monitoring equipment: inline methane content analyser, flow meters, flare working hours.

The gas wells and gas collection and transport pipes will be designed, manufactured and installed locally. The gas extraction plant and flare will be manufactured in Europe and shipped to Bolivia for installation.

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

Landfill gas will be extracted from the existing compartment 6 and the new compartment 7.

Currently there is no legislation implemented in Bolivia that requires the installation of a gas extraction and combustion system. Furthermore in the concession contract for the construction and operation of compartment 7, that SUMA has won through a competitive bidding process, no contractual obligations are included to extract landfill gas. It can therefore be concluded that compartment 7 would not have been equipped with a gas extraction system if the CDM project activity is not implemented. All the gas which is extracted and combusted by the gas extraction system would otherwise have been emitted to the atmosphere.

Compartment 6 is currently equipped with passive atmospheric gas vents. Under the scope of the project these atmospheric gas vents will be upgraded to active gas wells and connected to the gas extraction system.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

For the project a crediting period of 21 (3 times 7) years is chosen. If the production of ER's starts in 2005, then a total ER production of 1.736.278 tCO_2e is calculated.

A.4.5. Public funding of the project activity:

No public funding from an annex I country is involved in the project

SECTION B. Application of a baseline methodology

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

The methodology used for this project is "Simplified financial analysis for landfill gas capture projectshttp://cdm.unfccc.int/UserManagement/FileStorage/AM0002.pdf" also known as AM0003.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

In the approved methodology the following applicability criteria are listed

1. The captured landfill gas is flared; or
2. The captured gas is used to generate electricity, but no emission reductions are claimed for displacing or avoiding electricity generation by other sources

It is not intended that under the scope of the project the extracted landfill gas will be utilised to generate electricity. The extracted landfill gas will be combusted using a flare. At this moment it is not economically feasible to generate electricity in Bolivia using landfill gas, due to the market price of power. If this changes, then production of electricity might become feasible.

B.2. Description of how the methodology is applied in the context of the project activity:

As a consequence of the project activity a landfill gas extraction plant will be installed, thereby extracting a large fraction of the total amount of LFG produced on the Normandia landfill site. The extracted LFG will be flared, thereby decreasing the emission.

Emission reductions

For determining the number of Emission Reductions (ERs) that will be produced by the project activity, the following text is taken from AM0003:

$$ER_y = (MDproject_y – MDbaseline_y) * GWP\_CH_4$$

The amount of methane destroyed in the absence of the project activity is the amount of landfill gas that would be flared or otherwise destroyed absent the project activity taking into account the effectiveness of the gas collection systems that would be imposed by regulatory or contractual requirements or similar circumstances at the time of inception of the project (the "Effectiveness Adjustment Factor" (EAF)).

$$MDbaseline_y = MDproject_y \times EAF$$

The default value for the Effectiveness Adjustment Factor (EAF) is 20%. Deviations from the default value can be proposed and justified based on project-specific considerations such as proposed new laws and regulations or enforcement of existing laws and regulations applicable at the project location.

The situation in Bolivia regarding legislation and practice regarding Landfillgas is reflected by the following:

- Legislation in Bolivia does not require landfillgas extraction and combustion
- Passive venting of landfillgas is the only measure related to landfillgas practiced in Bolivia on landfills for municipal solid waste. Landfillgas is not utilised, it is not actively extracted (i.e. by means of wells and a collection system) nor is it flared.
- Reduction of CH_4 emission by means of landfillgas capturing and combustion is not foreseen in the national plans of Bolivia as GHG mitigation measure.
- the projections as published by the Ministry of Sustainable Development and Planning and the Vice-ministry of Environment and Natural Resources, published in March 2003, do not foresee reductions of emission of landfillgas by means of flaring or otherwise
- no legislation is anticipated or in preparation requiring such practices

The default value of the Effectiveness Adjustment Factor (AEF) will therefor be set to 0% for the Santa Cruz landfill gas combustion project. This means that $MDbaseline_y$ is 0. This results in the following formula:

ERy = MDprojecty * GWP_CH4

ERy is the greenhouse gas emission reduction measured in tonnes of CO2 equivalents (tonnes CO2e). MDprojecty is the methane destroyed by the project activity measured in tonnes of methane. The approved Global Warming Potential value for methane for the first commitment period is 21 tonnes CO2e/tonne CH4. Thus, GWP_CH4 = 21 until December 31, 2012.

The methane destroyed by the project activity (MDprojecty) during a year is determined by monitoring the quantity of methane actually flared and used to generate electricity.

MDprojecty = MDflaredy + MDelectricityy

MDflaredy = LFG_y * F_CH4y * FE * D_CH4

Where LFG_y is the quantity of landfill gas flared during the year measured in cubic metres (m3), F_CH4_y is the methane fraction of the landfill gas as measured, FE is the flare efficiency (the fraction of the methane destroyed) expressed as a fraction, D_CH4 is the methane density expressed in tonnes per cubic metre at STP (t/Nm3). The density of methane can be calculated using the ideal gas law. The density of methane is 0,0007154 t/Nm3.

The extracted landfill gas will not be used to generate electricity, all landfill gas will be flared. The section in the approved methodology covering the methane which is combusted in the gas engines is therefore not applicable to the Santa Cruz landfill gas combustion project. Thus:

MDprojecty = LFGy * F_CH4y * FE * D_CH4

Baseline

In the "Manifiesto Ambiental" (MA issued by Interproyectos de Bolivia S.R.L., consultant on behalf of the Municipality of Santa Cruz) a declaration of the current on site environmental condition is given. Furthermore in the MA a plan to comply with the procedures of environmental law is outlined. The MA is written for all operations under the responsibility of EMACRUZ: Recollection, Transport, Sweeping, etc., and Final Disposal (Sanitary Landfill). This document can be regarded as the application for the environmental license for the operation of the Normandia landfill.

In relation to the landfill gas regulatory and contractual requirements, the "Plan de Adecuación y Seguimiento Ambiental" (PASA, a Plan to comply with all the requirements stated in the current legislation, part of the MA), gives the following recommendations to control air pollution:

- Burn the gas at all gas vents to prevent bad odors.
- Create a "Green Belt" around the site to prevent odors to reach the outside limits.
- Draft a monitoring gas program.
- Draft a monitoring program of particles that may be transported bay air.

Since these are recommendations only, these activities are not a requirement of the contract.

Annex 25 of the MA, Conclusions and Recommendations, gives an overview of all current operations of EMACRUZ and SUMA. The only recommendation related to the landfill gas reads:

"EMACRUZ deberá considerar la oportunidad de aprovechar adecuadamente los Créditos del Carbón, como previstos por el Convenio de Kyoto, en manera de realizar obras de captación de gases y de quema controlada de gas metano. Además, deberían estudiarse las posibilidades de implementar una planta termoeléctrica que aproveche el gas producido en vez de quemarlo directamente."

Which means:

EMACRUZ should consider the opportunity to take advantage of the Carbon Credits, as foreseen by the Kyoto Agreement, by building works to capture gases and to burn in a controlled manner the methane gas. Also, it should be studied the possibilities of implementing a thermoelectric plant to take advantage of the gas collected instead of burning it directly.

The applied value of the EAF (Effectiveness Adjustment Factor) is 0% for reasons as provided in the previous section. The EAF shall be revised at the start of each new crediting period.

Additionally
In AM0003 a stepwise approach is given that should be used to determine the baseline scenario of the proposed project activity.

Step 1: List of possible scenarios
The first step in determining the baseline scenario consists in assessing the options available to the landfill operator, including the proposed project activity. Only after full assessment of all possible scenarios it is possible to determine which of the scenarios is the most likely to occur in the absence of the project (baseline scenario).

The following three scenarios have been identified for the Normandia landfill site:

1. The contractual requirements of the concession contract between SUMA and the municipality of Santa Cruz, regarding the combustion of landfill gas, are met. In the concession contract no obligations are included.
2. A gas extraction installation and combustion installation (flaring) are installed;
3. A gas extraction installation and electricity generation units are installed.

Step 1b: Determining plausible scenarios
It can reasonably be assumed that scenario number 2 can be discharged without further evaluation, because this scenario only involves extra investments while not generating extra income. This is clearly not an economic attractive course of action and will therefore be discharged as likely scenario.

Step 2: Calculation of IRR for proposed project, excluding carbon credits
In scenario 3, extra income is generated through the sale of electricity to the grid. It is possible that the sale of electricity makes the investment in all the necessary equipment an economic attractive course of action, thereby becoming the baseline.

Investments necessary for the generation of electricity are:

- Active gas extraction system
- Gas engines and generator
- Grid connection

Revenues are generated through the sale of electricity.

The cashflow calculation spreadsheets provided with the PDD (appendix I) show that the IRR electricity without the sale of ER's results in an economically unfeasible IRR.

Step 3: Comparison of IRR with conservatively acceptable IRR

As demonstrated in the attached financial analysis (Annex 3) the third scenario will have an IRR of 5.2%. In the calculation some of the costs are not included (costs of finance, tax and rent for the use of the location). If all costs were considered then the IRR of the project would be negative. However, even without taking into account these costs the project can already be regarded as non feasible, while the average commercial loan rate in Bolivia is 10.8%.

Given that scenario 3 for Normandia landfill is economically unfeasible, it is concluded that the installation of a gas extraction and combustion facility on Normandia landfill is not an economically attractive course of action. It can therefore be discarded as a scenario, thereby making scenario 1 the baseline scenario.

<u>Step 4: Anticipated development of the baseline scenario</u>
The Ministry of Sustainable Development and Planning of Bolivia confirmed that no legislation is anticipated or prepared that will require the combustion of landfill gas. The legislation will be monitored and the AEF will be renewed after the first and second crediting period.

Leakage
No electricity will be produced under the scope of the Santa Cruz landfill gas combustion project. Therefore not enough electricity will be generated on site to power the gas extraction system. According to AM0003 the methodology to determine the leakage should be accounted for and should be determined as described in AM0002.

The gas extraction unit comprises (amongst others) of a blower, which uses electricity. This would not have been used in the absence of the CDM project activity. The electricity consumption of the blower will be regarded as leakage of the project. The leakage of the project activity will be calculated according to the formula:

$$EE_y = [(CH4_{flared,y} - CH4_{baseline,y})/CH4_{baseline,y}] * EP_y * EC_y/1000$$

The extraction of CH4 in the baseline is non existing. All electricity used by the blower is therefore used to extract landfill gas which would not have been used without the project activity. The correction factor which is included in the above mentioned formula does therefore not apply. The following formula will therefore be used to calculate the leakage for the Santa Cruz landfill gas combustion project:

$$EE_y = EP_y * EC_y/1000$$

Where EPy is the metered electricity use by the pumping equipment for the collection system during the year in kWh and ECy is the emissions coefficient for the electricity used measured in kg CO2e/kWh. The emissions coefficient needs to be estimated using an appropriate methodology given the source of the electricity supply.

Bolivia's electricity production is approximately 50 % hydro. The other 50% is generated using fossil fuels. It will be assumed that this fossil fuel is natural gas. These assumptions will be verified in a later stage. According to IPCC natural gas has a specific emission factor of 425 kg CO2/MWh. The specific emission of hydro power is 0 kg CO2 / MWh. The emission coefficient of the Bolivian electricity sector is therefore 213 kg CO2/MWh.

The ECy will be calculated annually using data published by 'Superintendencia Electricidad', the national regulatory agency of the Bolivian power sector. Published data on the fuel mix used to generate the consumed electricity will be used to annually calculate the emission coefficient.

B.3. 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:

The call for tender for the disposal of waste launched in 2003 by the municipality of Santa Cruz excluded the investment and operation of a gas extraction installation.

Financing the waste management sector in Santa Cruz is a problem. The levies which need to be collected by Emacruz for the waste management services provide problems due to the financial position of many households. Higher levies are therefor not collectable and on the other hand the legislation on municipal budgets prohibits the support of waste management from general municipal funds. Emacruz is therefor forced to restrict to the utmost the total costs of waste management.

SUMA is a company with a commercial objective. SUMA will therefore comply with the contractual requirements. The concession contract does not require the implementation of a landfill gas extraction plant. It can therefore be concluded that in the absence of the proposed project activity a gas extraction plant would not have been installed on the Normandia landfill site, all produced landfill gas would be emitted to the atmosphere.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project activity is defined as the extraction of landfill gas from fosa 6 and 7 by installation of a gas extraction and flaring system. In other words the construction and operation of the actual landfill is outside the scope of the project activity. All other activities of the waste management sector (e.g. waste collection and transfer) are also outside the scope of the project.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of completing the final draft of this baseline section *(DD/MM/YYYY)*:

September 2004

Name of person/entity determining the baseline:

Jeroen Bremmer / Erik Verveld
Grontmij Climate & Energy

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:

For this project it is estimated that construction activities start at 1/5/05

For this project it is estimated that the ER production starts at 1/7/05

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

30 years

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

Initial registration period of 7 years with extension as per the CDM modalities and procedures

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

1/7/05

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. Application of a monitoring methodology and plan

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

The methodology used for this project is "Simplified financial analysis for landfill gas capture projects", referred to as AM0003.

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

The following applicability criterion is included in the approved methodology AM0003:

This monitoring methodology can be used for project activities that reduce greenhouse gas emissions through landfill gas capture and destruction of the methane by flaring and/or generation of electricity. This methodology must be used in conjunction with the baseline methodology above.

The Santa Cruz landfill gas extraction project complies with the applicability criteria and can therefore be used.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

No data needs to be monitored to determine the amount of methane emitted from the project activity. All methane extracted and combusted is considered to be eligible for ER production. In other words all methane extracted and combusted would, in the absence of the project activity, be emitted. The emissions not released to the atmosphere can directly be monitored by metering the Nm3 of landfill gas captured and flared and by multiplying this by the concentration of methane in landfill gas. The monitoring of emission from the project activity is therefore not applicable. Therefore option 2 will be used for monitoring obligations.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Not applicable								

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 e.)

Not applicable

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-*	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? (electronic/ paper)	Comment

referencing to table D.3)								
Not applicable								

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Not applicable

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

The data, as described in AM0003, under ID numbers 2 and 3 are not included here, because this data is needed for determining the amount of landfill gas which is combusted using gas engines. In the baseline section of the PDD it is determined that in the absence of the proposed project activity no landfill gas would have been flared. Thereby making the monitoring obligations to determine the amount of methane flared in the baseline unnecessary.

All methane which is monitored as extracted and combusted from the Normandia landfill site is additional.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1 LFG_y	Amount of LFG to flares	[Nm^3]	m	continuously	100%	electronically Data is kept during project lifetime	Measured by a flow meter. Data will be aggregated monthly and yearly.

4 FE	Flare efficiency	%	m and c	Semi annual	n/a	Electronically Data is kept during life time of the project	Methane content of flare exhaust gases measured by sampling and analysing
5 F_CH4y	Methane fraction in LFG	%	m	Continuously	100%	Electronically Data is kept during lifetime of the project	Measured by continuous gas quality analyser
6	Annual Carbon dioxide equivalent avoided	Ton Co2e	c		n/a	Electronically Data is kept during lifetime of the project	

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

The flare efficiency is determined by analysing the exhaust gases of the flare twice a year. By dividing the amount of methane emitted by the flare and the amount sent to the flare the efficiency of the flare can be determined.

Flare efficiency = 1 – (amount of methane emitted by flare / amount of methane sent to flare)

By multiplying the total amount of methane sent to the flare with the flare efficiency, the amount of methane combusted by the flare is obtained.

The amount of landfill gas which is not captured by the landfill gas combustion installation and thus emitted cannot be monitored, because the emission takes place diffuse over the landfill. Only the amount of landfill gas which is collected and combusted can be monitored, because this is centralised and can thus be measured using a flow meter. The amount of methane which is not combusted due to inefficiency of the flare needs to be subtracted from the measured amount of collected methane.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
3.1	Electricity	Amount of electricity used by gas extraction unit	kWh	M	Continuous	100%	Daily : e	
3.2	Grid Emission factor	Average amount of CO2 emitted per generated kWh	Ton CO2e/ kWh	c	annual	Not applicable	paper	Emission factor will be calculated using data from electricity superintendence.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

The gas extraction unit comprises (amongst others) of a blower, which uses electricity. This would not have been used in the absence of the CDM project activity. The electricity usage of the blower will be regarded as leakage of the project. Calculating the leakage of the project activity will be done according to the formula:

$$EE_y = [(CH4_{flared,y} - CH4_{baseline,y})/CH4_{baseline,y}] * EP_y * EC_y/1000$$

The emission of CH4 in the baseline is non existing. All electricity used by the blower is therefore used to extract landfill gas which would not have been extracted without the project activity. The correction factor which is included in the above mentioned formula does therefore not apply. The following formula will be therefore be used to calculate the leakage for the Santa Cruz landfill gas combustion project:

$EE_y = EP_y * EC_y/1000$

Where EPy is the metered electricity use by the pumping equipment for the collection system during the year in kWh and ECy is the emissions coefficient for the electricity used measured in kg CO2e/kWh. The emissions coefficient needs to be estimated using an appropriate methodology given the source of the electricity supply.

The ECy will be calculated annually using data published by 'Superintendencia Electricidad', the national regulatory agency of the Bolivian power sector on the fuel mix for the generation of the consumed electricity

Bolivia's electricity production is approximately 50 % hydro. The other 50% is generated using fossil fuels. It will be assumed that this fossil fuel is natural gas. These assumptions will be verified in a later stage. According to IPCC natural gas has a specific emission factor of 425 kg CO2/MWh. The specific emission of hydro power is 0 kg CO2 / MWh. The emission coefficient of the Bolivian electricity sector is therefore 213 kg CO2/MWh.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

MDprojecty = LFGy * F_CH4y * FE * D_CH4

Where LFGy is the quantity of landfill gas flared during the year measured in cubic metres (m3), F_CH4y is the methane fraction of the landfill gas as measuredcontinuously, FE is the flare efficiency (the fraction of the methane destroyed) expressed as a fraction, D_CH4 is the methane density expressed in tonnes of methane per cubic metre of methane (tCH4/Nm3/CH4). The density of methane can be calculated using the general gas law of Boyle-Gay-Lussac. The calculated density of methane is 0,0007154 tCH4/Nm3 CH4.

The extracted landfill gas will not be used to generate electricity, all landfill gas will be flared. The section in the approved methodology covering the methane which is combusted in the gas engines is therefore not applicable to the Santa Cruz landfill gas combustion project. Thus:

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data ***(Indicate table and ID number e.g. 3.-1.; 3.2.)***	**Uncertainty level of data (High/Medium/Low)**	**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**
1 LFG_y	LOW	Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy

4 FE	LOW	Regular maintenance will ensure optimal operation of the flare. Flare efficiency will be checked semi annually by a certified laboratory.
5 F_CH4y	LOW	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy.
3.1 Electricity	LOW	The kWh meter will be subject to regular maintenance and testing regime to ensure accuracy.
3.2 Grid Emission Factor	LOW	Emission factor will be calculated using official data from Superintendencia Electricidad.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

Before the initial verification of the project activity, the following procedures need to developed and implemented:

- Establish and maintain data measurement, collection and record keeping systems for landfill gas collection and sustainable development indicators
- Quality assurance procedures for internal and external data acquistion
- Develop and establish management and operations system
- Procedures for storing and maintain records (paper trail)
- Training procedures to enable operational staff to meet the needs of this MP
- Procedures for calibration of monitoring equipment
- Procedures for maintenance of monitoring equipment
- Procedures for project performance review before submitted for verification
- Procedure for corrective actions to improve future monitoring and reporting.

D.5 Name of person/entity determining the monitoring methodology:

>> Date of completing the final draft of this baseline section *(DD/MM/YYYY)*:

September 2004

Name of person/entity determining the baseline:

Jeroen Bremmer / Erik Verveld
Grontmij Climate & Energy

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

For mathematical estimate of the LFG formation in time, various models can be used (Augenstein and Pacey, 1991; Farquhar and Rovers, 1973). The most important and widely applied modelling technique is the use of a first order decay model, in which the degradation of organic material for a landfill site, or specific waste amounts can be calc ulated.

- *First order model:*
Landfill gas formation in a certain amount of waste is assumed to decay exponentially in time. This first-order equation is described in numerous cases; e.g. Tabasaran (1987). Verschut et al (1991) correlates measurements on three landfills in terms of a first-order model, the model parameters thus obtained, being the basis of the Dutch estimate of methane emissions in The Netherlands (Van Amstel et al, 1992; Coops et al, 1995). Also the US-EPA LandGem model (Pelt et al, 1998) uses the first order equation.

$$A_t = z \cdot Q \cdot A_0 \cdot \left(1 - e^{-kt}\right)$$

where:
A_t = cumulative quantity of landfill gas produced [Nm^3]
k= decay constant [yr^{-1}]
t= time [years]
A_0=Amount of waste in place at year 0 [ton]
Q=Potential gas formation [m^3/kg]
?=formation factor [-]

The first order model has been adjusted for several reasons. Ehrig (1986) expanded the model with a term expressing the building-up of the methanogenic phase and Hoins (1986) introduced a temperature dependency. Hoeks (1983) described methanogenesis, assuming several fractions in the waste, all following their own first order degradation. This multi-phase model is so important, that it is described separately below.

- *Multi-phase model*
In the multi-phase model, a number of fractions are distinguished, in which landfill gas formation is described separately. Hoeks (1983) distinguished three phases: slow, moderate and fast degradable materials, but other subdivisions are possible, including the introduction of an inert fraction. The advantage of the multi-phase model is that the typical waste composition can be taken into account, since all types of waste contain typical fractions of slow, moderate and fast degradables. This results in a higher landfill gas production in the first years, and a prolongued formation at the end. In the intermediate years landfill gas formation is less than in the first-order model.
In the sizing of Dutch landfill gas projects, normally this multi-phase model is used. Scheepers and Van Zanten (1994) give a description of this use of the multi-phase model.

$$A_t = z \cdot Q \cdot \sum_{i=1}^{n} A_{0,i}\left(1-e^{-k_i t}\right)$$

where:
k_i= decay constant of fraction i [yr^{-1}]
t= time [years]
$A_{0,i}$=Amount of waste in place of fraction i at year 0 [ton]
Q=Potential gas formation [m^3/kg]
?=formation factor [-]

Grontmij uses its own dedicated computer model for gas estimations based on the theoretical multi-phase first-order model. It has been adapted to specific data and has been calibrated with data of real and long-term experience from numerous landfill gas extraction projects. The model incorporates the characteristics of different types of waste such as organic content, biodegradability and moisture content if available.

The following input data is used to calculate the landfill gas production:

Year	Growth	Waste brought (ton/year)
2000		231.076
2001		277.648
2002		300.456
2003		265.025
2004	4,8	277.747
2005	4,8	291.078
2006	4,8	305.050
2007	4,8	319.693
2008	4,8	335.038
2009	4,5	350.114
2010	4,5	365.870
2011	4,5	382.334
2012	4,5	399.539
2013	4,5	417.518

Table 1

According to waste analysis the waste in Santa Cruz has the following average composition:

Fractions	Percentage
Organic	58,1%
Paper/cardboard	5,7%
Glass	2,1%
Metal	2,1%
Plastic	9,8%
Textile	1,4%
Fines	10,5%
Goma	0,5%
Chemical waste	8,5%
Others (textile ceramics stone)	1,3%
Total	**100,0%**

Table 2

Using the Grontmij landfill gas production model, which is described above, the following landfill gas production estimations are calculated:

Year	Production Nm3/hr Fosa 6, ph1/4	Fosa 6 ph5	Fosa 7	TOTAL
2000	229,5	0,0	0,0	229,5
2001	622,4	0,0	0,0	622,4
2002	1027,7	0,0	0,0	1027,7
2003	1346,1	0,0	0,0	1346,1
2004	1320,0	275,9	0,0	1595,9
2005	1112,5	416,6	289,2	1818,3
2006	912,5	376,0	739,6	2028,1
2007	754,3	308,1	1169,1	2231,5
2008	633,6	249,8	1548,1	2431,5
2009	540,6	205,4	1883,2	2629,1
2010	467,0	172,0	2186,2	2825,3
2011	407,5	146,5	2467,4	3021,4
2012	358,4	126,4	2734,1	3218,8
2013	317,3	110,1	2991,3	3418,7
2014	282,5	96,7	2809,3	3188,5
2015	252,7	85,5	2384,0	2722,2
2016	227,2	76,0	1991,4	2294,6
2017	205,1	67,9	1677,7	1950,7
2018	185,9	61,0	1432,9	1679,7
2019	169,0	55,0	1239,4	1463,5
2020	154,2	49,8	1083,3	1287,3
2021	141,1	45,2	954,7	1141,0
2022	129,4	41,2	847,1	1017,8
2023	119,0	37,7	755,9	912,6
2024	109,6	34,6	678,0	822,2
2025	101,2	31,8	610,8	743,8

Table 3

These calculation show the total amount of landfill gas which is expected to be produced on the Normandia landfill fosa 6 and 7. However by installing a gas extraction system only part of the produced landfill gas will be captured and flared. The part which is not captured will be emitted to the atmosphere.

Based on experience with installing and operating gas extraction system on landfills it is expected that the following distribution between the amounts of captured and not captured landfill gas can be realised.

Year	Percentage captured	Percentage not captured	Amount of LFG captured [m3/h]	Amount of LFG not captured (project activity emission). [m3/h]
2005	52%	48%	945	872
2006	53%	47%	1076	951
2007	54%	46%	1202	1029

2008	55%	45%	1325	1106
2009	55%	45%	1446	1183
2010	55%	45%	1565	1259
2011	56%	44%	1684	1336
2012	56%	44%	1803	1415
2013	56%	44%	1922	1495
2014	64%	36%	2044	1144
2015	70%	30%	1905	816
2016	70%	30%	1606	688
2017	70%	30%	1365	585
2018	70%	30%	1175	503
2019	70%	30%	1024	439
2020	70%	30%	901	386
2021	70%	30%	798	342
2022	70%	30%	712	305
2023	70%	30%	638	273
2024	70%	30%	575	246
2025	90%	10%	669	74

Table 4

Another emission source is, not combusted methane emitted from the flare due to the inefficiency of the flare. The extraction and combustion system which will be installed for the Santa Cruz landfill gas combustion project will have an expected combustion efficiency of 99.9%. In other words, 0.1% of the captured Landfill gas is expected to be emitted uncombusted. By multiplying the total amount of extracted landfill gas with the percentage which will be emitted uncombusted, the amount of uncombusted methane can be obtained.

Year	Flare efficiency	Amount of uncombusted LFG [m3/h]	Emission ton CO2e/year
2005	99.9%	0,95	62
2006	99.9%	1,08	71
2007	99.9%	1,20	79
2008	99.9%	1,33	87
2009	99.9%	1,45	95
2010	99.9%	1,57	103
2011	99.9%	1,68	111
2012	99.9%	1,80	119
2013	99.9%	1,92	127
2014	99.9%	2,04	135
2015	99.9%	1,91	126
2016	99.9%	1,61	106
2017	99.9%	1,37	90
2018	99.9%	1,18	77
2019	99.9%	1,02	67
2020	99.9%	0,90	59
2021	99.9%	0,80	53
2022	99.9%	0,71	47
2023	99.9%	0,64	42
2024	99.9%	0,58	38
2025	99.9%	0,67	44

Table 5

The only source of project activity emission is the uncombusted methane.

E.2. Estimated leakage:

The electrical capacity of the blower which will be installed for the extraction of the landfill gas will have an expected electrical capacity of 7 kW. The capacity of this blower is 800 m^3/hour. This means that extracting 800 m^3 of landfill gas will require 7kWh of electric energy. This means that every m^3 of extracted Landfill gas will need 8.75 Wh of electrical energy to be extracted. By multiplying the electricity consumption per extracted m^3 of LFG with the total quantity of extracted LFG the total expected electricity consumption can be calculated.

Bolivia's electricity production is approximately 50 % hydro. The other 50% is generated using fossil fuels. It will be assumed that this fossil fuel is natural gas. These assumptions will be verified in a later stage. According to IPCC natural gas has a specific emission factor of 425 kg CO2/MWh. The specific emission of hydro power is 0 kg CO2 / MWh. The emission coefficient of the Bolivian electricity sector is therefore 213 kg CO2/MWh.

Year	Average LFG extraction [Nm^3/hr]	Electricity consumption [kWh]	CO2 emission (ton CO2)
2005	945,4	72.465	15
2006	1076,6	82.521	18
2007	1202,5	92.172	20
2008	1325,2	101.577	22
2009	1446,1	110.844	24
2010	1565,7	120.011	26
2011	1684,5	129.117	27
2012	1803,3	138.223	29
2013	1922,9	147.390	31
2014	2044,1	156.680	33
2015	1905,5	146.057	31
2016	1606,2	123.115	26
2017	1365,5	104.666	22
2018	1175,8	90.125	19
2019	1024,4	78.520	17
2020	901,1	69.069	15
2021	798,7	61.220	13
2022	712,4	54.605	12
2023	638,8	48.964	10
2024	575,5	44.112	9
2025	669,4	51.310	11
		2.022.763	430

Table 6

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

Year	GHG emissions from uncombusted methane [ton CO2e]	Leakage [ton CO2e]	Total
2005	62	15	77
2006	71	18	89
2007	79	20	99
2008	87	22	109
2009	95	24	119
2010	103	26	129
2011	111	27	138
2012	119	29	148
2013	127	31	158
2014	135	33	168
2015	126	31	157
2016	106	26	132
2017	90	22	112
2018	77	19	96
2019	67	17	84
2020	59	15	74
2021	53	13	66
2022	47	12	59
2023	42	10	52
2024	38	9	47
2025	44	11	55

Table 7

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

The anthropogenic emissions of the project activities are not consider relevant, because all the methane which is measured as being combusted is eligible as ER production. In this section the emissions which will be avoided will be calculated .

Year	Percentage captured	Amount of LFG captured [m3/h]	Amount of direct Emission Reductions
2005	52%	945	62.276
2006	53%	1076	70.908
2007	54%	1202	79.212
2008	55%	1325	87.318
2009	55%	1446	95.291
2010	55%	1565	103.134

2011	56%	1684	110.976
2012	56%	1803	118.818
2013	56%	1922	126.660
2014	64%	2044	134.700
2015	70%	1905	125.540
2016	70%	1606	105.835
2017	70%	1365	89.954
2018	70%	1175	77.433
2019	70%	1024	67.482
2020	70%	901	59.376
2021	70%	798	52.588
2022	70%	712	46.921
2023	70%	638	42.044
2024	70%	575	37.893
2025	90%	669	44.087

Table 8

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

Year	Direct emission reduction	Project activity emissions	Project activity emission reductions
2005	62.276	77	62.199
2006	70.908	89	70.819
2007	79.212	99	79.113
2008	87.318	109	87.209
2009	95.291	119	95.172
2010	103.134	129	103.005
2011	110.976	138	110.838
2012	118.818	148	118.670
2013	126.660	158	126.502
2014	134.700	168	134.532
2015	125.540	157	125.383
2016	105.835	132	105.703
2017	89.954	112	89.842
2018	77.433	96	77.337
2019	67.482	84	67.398
2020	59.376	74	59.302
2021	52.588	66	52.522
2022	46.921	59	46.862

2023	42.044	52	41.992
2024	37.893	47	37.846
2025	44.087	55	44.032
Total			1.736.278

Table 9

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

See table 7

SECTION F. Environmental impacts

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

Although the Bolivian Environmental Law was promulgated in 1992, its regulations were ratified on December 1995. The Normandía Landfill property was purchased in 1994, and the operations started in January, 1995. This means that for the selection of the Normandia landfill no Environmental Impact Assessment was written to determine if this specific location was most suitable as a landfill in Santa Cruz area.

Later, after Normandía had already been constructed, the before mentioned legislation on the field of environmental control and area-planning came into force. For certain classes of plants/facilities this new legislation required to make a kind of 'afterwards EIA', making an inventory of the environmental impact of the existing facility.

This document is called "Manifiesto Ambiental (MA)" and consists of a declaration of the current environmental condition on site and presents a plan to adequate the procedures with the environmental law and its regulations.

Title:	Manifiesto Ambiental, Empresa Municipal de Aseo de Santa Cruz – EMACRUZ.
Date:	Santa Cruz, Abril del 2003
Client:	Gobierno Municipal de Santa Cruz de la Sierra.
Consultant:	Interproyectos de Bolivia S.R.L.
Approving Agencies:	Prefectura del Departamento de Santa Cruz Ministerio de Desarrollo Sostenible y Planificación; Viceministerio de Medio Ambiente, Recursos Naturales, y Desarrollo Forestal; Dirección General de Impacto Ambiental, Calidad y servicios Ambientales.
Result:	Declaración de Adecuación Ambiental (Licencia Ambiental) Nº 070101-10-DAA-044-2003

F.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:

>>

SECTION G. Stakeholders' comments

>>

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

A general area-planning project was performed regarding the development of the district near the Normandia landfill site. Under the scope of that project the inhabitants of the nearby district were invited to give their views on the future development of the area.

Also, several meetings were held with the Municipality of Santa Cruz and with the Municipal Waste Management Company Ema Cruz of the city. Both organizations support the installation of a gas capture equipment on the Normandia Landfill. In addition to this, several public meetings have been organized with local media (radio, television and news papers) in order to explain the idea and purpose of the project activity.

Furthermore, stakeholders' comments were sought during the EIA process for the landfill site itself as this is a requirement under the EIA process.

No additional comments have been sought for the installation of the capture equipment as no adverse environmental or social impacts follow from this activity. The activity itself can be seen as a measurement limiting adverse environmental consequences to stakeholders.

G.2. Summary of the comments received:

Regarding the landfill site Normandia, the consultation as described in G.1 above resulted in the following comments.

- The stakeholders that gave their views on the Normandia landfill in the area did not want the Landfill to be relocated, but they required:
  1. That all environmental measures be taken so the health of the people in their district would not be affected,
  2. That the City Council build a park within the district, as an "environmental compensation", for the nuisance of living along the road that takes all Santa Cruz's solid waste to Normandia and for living near (3 Kms) the landfill.

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

Through the installation of a gas extraction system on the Normandia landfill site in Santa Cruz, the odour levels and air pollution in the surrounding areas will decrease. As a consequence of decreasing odour levels and air pollution, the living conditions and health situation for the people living in the surrounding areas will improve.

In the concession contract between Suma and the municipality of Santa Cruz, certain requirements were included as a result of the stakeholders comments:

- Leachate water treatment; this will decrease soil pollution, thereby contributing to the first requirement.
- For the collection of the waste more compactor trucks will be used. These trucks can transport more waste per trip. The amount of trips will therefore decrease, thereby decreasing the amount of traffic movements to and from the landfill.
- The waste collection trucks which are not equipped with a compacting unit, will be closely checked on the usage of nets to prevent waste from falling off.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The project activity will not receive public funding.

Annex 3

BASELINE INFORMATION

Assumptions

To be able to determine the electricity production of scenario 3, the following assumptions have been made:

1. The amount of landfill gas produced times the methane content (50%) results in the amount of methane extracted per hour. This is multiplied by the caloric value of methane (35.8 MJ/Nm3 of methane) and with the efficiency of the engines to obtain the amount of generated electricity.
2. The gas engine/generator set will be 600 kWe units.
3. The gas engine/generator sets will have an efficiency of 32%[1].
4. The gas engine/generator sets will have an availability of 90%. This is a value which is based on the experience with comparable installations.
5. An additional gas engine/generator will only be installed if enough landfill gas is produced to have the unit running at full load for at least five years.

In order to determine the financial feasibility the following data have been used:

1. Electricity prices: from contact with SUMA, it is concluded that the electricity paid for under a Power Purchase Agreement (PPA) yields $27 per MWh.
2. The investment costs of the gas extraction unit are based on quotations received from suppliers.
3. The investment of a gas engine / generator is $ 400.000 per 600 kW unit. This price is based on quotations received from suppliers for another comparable project.
4. The project development costs consist of the following:
   a. Drafting/negotiating Power Purchase Agreement $25.000
   b. Establishment JV (according to Bolivian law it is required to establish a PLC for the generation and sale of electricity to the public grid. $25.000
   c. Registration and qualification as electricity generator $20.000
   d. Drafting and negotiating Agreement municipality for the

[1] "Stortgaswinning en benutting in Nederland" (Landfill gas extraction and utilization in the Netherlands).

	usage of landfill	$ 10.000
e.	Acquiring Permits	$ 15.000
f.	Engineering	$ 120.000
g.	Financing	$ 35.000
	Total	$ 250.000

5. The grid connection will be a 2.5 MVA connection. The distance between the site and the closest grid connection is 3.000 meter. This grid is at a 29.4 kV level. It will be assumed that the power will be transformed on site to a 29.4 kV level and then transported to the grid. The grid connection will consist of:

    a. Transformer 400 V – 29.4 KV with a capacity of 3.000 KVA

    b. 3.000 meter of cable

    c. Switching station

    d. Local works

    These equipment and works are budgeted at $180.000.

6. Import duties; Bolivian import duties on capital goods are approximately 6%.

7. The installation of the gas extraction system is estimated under the local works at $100.000 in 2005 and $50.000 in 2007.

8. The annual O&M costs of the gas engines are estimated at 6% of the investment sum. The annual O&M costs of the gas extraction system are estimated at 5% of the investment sum. Typically for estimating purposes the O&M costs are assumed to be between 5 -10% of the investment sum. It can therefore be concluded that the O&M budget assumed here is conservative.

9. A contingencies budget is estimated at 10% of the total costs.

Annex 4

MONITORING PLAN

Monitoring Plan Santa Cruz Landfill Gas combustion Project

Table of Contents Monitoring Plan

INTRODUCTION

The project

This Monitoring Plan (MP) is written for the Santa Cruz landfill gas combustion project. Under the scope of this project landfill gas will be extracted and combusted from Normandia landfill site. On this landfill site the solid waste from the city of Santa Cruz, Bolivia is disposed. Currently the landfill comprises 6 compartments. Compartment number 6 is currently being filled. For the construction of the new compartment (number 7) a concession contract has been awarded to Suma, a Bolivian company. Under this concession contract Suma will finance, construct and operate compartment number 7. For these services Emacruz, the municipal institution responsible for waste collection and disposal, pays a gate fee to Suma.

In Bolivia there is no legal obligation to extract and combust landfill gas, nor does the concession contract require extraction and combustion of landfill gas. Under the scope of the CDM project activity a gas extraction and combustion facility will be installed. Thereby producing Emission Reductions (ER's).

Purpose of the MP

In the context of the Clean Development Mechanism (CDM) as defined in the Kyoto Protocol, monitoring describes the systematic surveillance of a project's performance by measuring and recording performance-related indicators relevant to the project or activity. Verification is the periodic auditing of monitoring results, the assessment of achieved emission reductions (ER's) and of the project's continued conformance with all relevant project criteria.

This document contains the Monitoring Plan (MP) for the Santa Cruz landfill gas combustion project. It describes the requirements for the collection, processing and auditing of data from the project for the purpose of calculating and verifying the ER's the project has produced.

Use of the MP

The MP is a working document that identifies key performance indicators and sets out the procedures for tracking, monitoring, calculating and verifying the impacts of the project.

This MP must be used for the planning and implementation of the project and during its operation. Adherence to the instructions in the MP is necessary to successfully measure and track the project's impacts and prepare for the periodic audit and verification process that will have to be undertaken to confirm the ER's achieved by the project.

The MP contains the requirements and instructions for:

- establishing and maintaining an appropriate monitoring system for the measuring and calculation of ER's;
- implementing the necessary measurement and management operations;
- preparing for independent, third party audits and verification of ER's.

The MP must be:

- adopted as key input into the detailed planning of the project, and
- included into the operational manuals of the project.

The data monitored, as per this MP, is to the extent possible in line with the kind of information routinely collected by the project operator. The MP can be updated and adjusted to meet operational requirements, provided such modifications are approved by the verifier during the process of initial or periodic verification.

CALCULATION OF EMISSION REDUCTIONS AND MONITORING OBLIGATIONS

The Santa Cruz landfill gas combustion project will be located on one location, namely the Normandia landfill site in the city of Santa Cruz, Bolivia. The landfill gas will be extracted from two compartments, the existing compartment number 6 and the new compartment number 7. These two compartments are neighboring each other. The landfill gas from these two compartments can therefore be extracted with one single gas extraction unit.

The emission reductions from the Santa Cruz landfill gas combustion Project results from:

- Avoided methane emissions due to collection, and flaring, and thus conversion to CO_2 of the methane in the landfill gas;

Name and reference of approved methodology applied to the project activity

The methodology used for this project is "Simplified Financial Analysis for Landfill Gas Capture Projects", referred to as AM0003.

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

The following applicability criterion is included in the approved methodology AM0003:

This monitoring methodology can be used for project activities that reduce greenhouse gas emissions through landfill gas capture and destruction of the methane by flaring and/or generation of electricity. This methodology must be used in conjunction with the baseline methodology above.

The Santa Cruz landfill gas extraction project complies with the applicability criteria and can therefore be used.

Basics of AM0003

According to the approved monitoring methodology AM0003, the following data needs to be monitored:

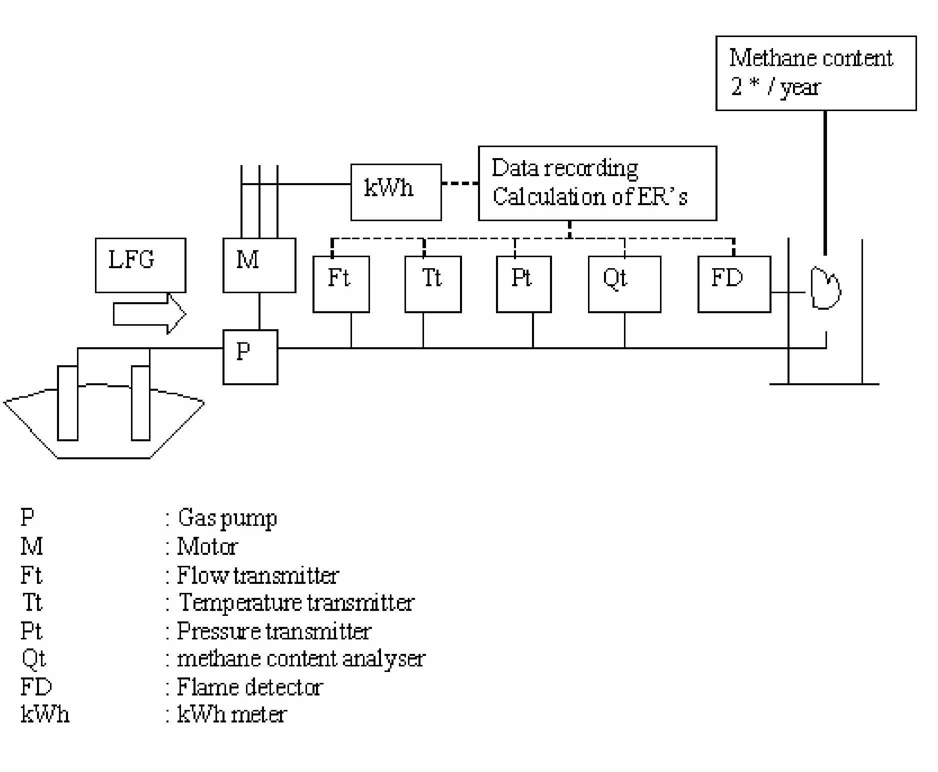
Methane collected and flared: As shown in Figure 1, the amount of methane actually flared will be determined by monitoring the:

- *amount of landfill gas collected (LFGy) [m3 - using a continuous flow meter]*
- *percentage of landfill gas that is methane (F_CH4y) [% - using a continuous analyser]*
- *flare working hours [hours - using a run time meter]*

In addition, the methane content of the flare emissions will be analysed quarterly to determine the flare efficiency (FE), the fraction of the methane destroyed.

Methane collected and used to generate electricity: The amount of methane used to generate electricity can be determined from the amount of electricity generated with the following monitored information:

- *The amount of electricity generated (EGy) [MWh metered];*
- *The heat rate of the electricity generator (HR) [GJ/MWh, determined through periodic*
- *testing];*
- *The energy content of methane (EC_CH4) [GJ/tCH4].*



Under the scope of the project no electricity will be generated. The section on methane collected and used to generate electricity is therefore not applicable for the Santa Cruz landfill gas combustion project.

Monitoring obligations

The project operator must implement the following data measurement and monitoring requirements for the key variables that determine the emission reductions from the combustion of methane:

- Total landfill gas flow extracted from gas wells: the gas flow will be measured continuously, together with temperature and pressure. With these data the amount of m^3 at standard pressure and temperature can be calculated (Nm^3). The monthly cummulative extracted amount of Landfill gas (in Nm^3) will be reported in the annual ER production report.

- Methane content of the LFG. This will be measured continuously, using a continues gas analyser. The average methane content per month will be calculated using this continues data. To corroborate the correct functioning of the inline analyser the methane content will also be measured daily using a handheld gasanaliser.
- The temperature in the flare of the installation. By monitoring of the temperature, the working hours of the flare can be monitored. Any gas flow measured during the time the flare was not burning will be subtracted when calculating the ER production.
- Methane content in the exhaust gases of the flare will be determined semi-annually, by means of sampling and analysis by a laboratory. The methane content of the past 6 months will be considered to be equal to the sample.

Calculation of the amount of ER's
The amount of extracted Nm^3 will be multiplied by the methane content of that time period. From this amount the amount of uncombusted methane will be subtracted.

The amount of ER's willl be calculated monthly on the basis of the continuously calculated and logged amounts of combusted methane in Nm^3:

- Calculate tons of combusted methane, by multiplying the volume of combusted methane (Nm^3) with the density of methane (= 0.0007154 t/Nm3)
- Obtain emission reductions by multiplying tons of combusted methane with the global warming potential of methane (GWP) (factor 21).

Leakage

No electricity will be produced under the scope of the Santa Cruz landfill gas combustion project. Therefore not enough electricity will be generated on site to power the gas extraction system. According to AM0003 the methodology to determine the leakage should be accounted for and should be determined as described in AM0002.

The gas extraction unit comprises (amongst others) a blower, which uses electricity. This would not have been used in the absence of the CDM project activity. The electricity consumption of the blower will be regarded as leakage of the project. The leakage of the project activity will be calculated according to the formula:

$$EE_y = [(CH4_{flared,y} – CH4_{baseline,y})/CH4_{baseline,y}] * EP_y * EC_y/1000$$

The extraction of CH4 in the baseline is non existing. All electricity used by the blower is therefore used to extract landfill gas which would not have been used without the project activity. The correction factor which is included in the above mentioned formula does therefore not apply. The following formula will therefore be used to calculate the leakage for the Santa Cruz landfill gas combustion project:

$$EE_y = EP_y * EC_y/1000$$

Where EPy is the metered electricity use by the pumping equipment for the collection system during the year in kWh and ECy is the emissions coefficient for the electricity used measured in kg CO2e/kWh. The emissions coefficient needs to be estimated using an appropriate methodology given the source of the electricity supply.

The emission factor of Bolivian is determined by determining the relative contribution of the different fuels and multiplies this by the specific emission factor for the specific energy carrier.

According IPCC the following specific emissions factors can be used:

- Coal : 1.000 kg CO_2 / MWh
- Oil : 550 kg CO_2 / MWh
- Natural gas/oil : 500 kg CO_2 / MWh
- Natural gas : 425 kg CO_2 / MWh
- Hydro : 0 kg CO_2 / MWh

Bolivia's electricity production is approximately 50 % hydro. The other 50% is generated using fossil fuels. It will be assumed that this fossil fuel is natural gas. These assumptions will be verified in a later stage. According to IPCC natural gas has a specific emission factor of 425 kg CO2/MWh. The specific emission of hydro power is 0 kg CO2 / MWh. The emission coefficient of the Bolivian electricity sector is therefore 213 kg CO2/MWh.

The ECy will be calculated annually using data published by 'Superintendencia Electricidad', the national regulatory agency of the Bolivian power sector. Published data on the fuel mix used to generate the consumed electricity will be used to annually calculate the emission coefficient.

SUSTAINABLE DEVELOPMENT MP

The MP compares the project's actual environmental and development performance as measured by indicators with the set target values and determines whether the targets have been achieved.

As long as the monitoring process shows that the project's performance meets the targets and if this is confirmed by the verifiers, the project is automatically considered to be in compliance with the CDM's sustainable development objectives.

The government of Bolivia has published the following sustainable development criteria for CDM projects in Bolivia.

Bolivia, as a host country, must certify that the activities of CDM projects contribute to its sustainable development. The CDM must be oriented to improve the quality of life of the population, especially the most impoverished segments.

The CDM must consider the following criteria in the design of activities for emissions reductions and/or uptake (sequestration) of GHG in proposed projects:

Environmental criteria

1. *Reductions of emissions from particulates and other elements that affect the quality of the local environment (indicators include levels of pollution avoided, improvement in the quality of environmental factors such as water, air, soil, etc.).*
2. *Sustainable use of local resources (indicators include the existence of a Management Plan, accomplishment of the goals of this Management Plan, maintenance or increase of local biodiversity, maintenance or increase of the population of local species, improvement in the management of soils, increased in the productivity of ecosystems).*
3. *Reduction of the local environmental pressure (indicators include pressure on biodiversity, pressure on water resources, on soil resources, reduction of natural disaster risks, increase of the resilience of local communities in relation to climate change, increase of capacities for adaptation to climate change).*
4. *Effects of environmental impacts on local health (indicators include index of toxicity of emissions, incidence of respiratory problems or other diseases caused by the environmental impacts of the project, etc.).*

Social criteria

5. *Improved quality of life for the members of local communities with regard to social variables (indicators include those on health, education, housing, employment).*
6. *Effects on poverty levels (indicators include increase in employment levels, increase of per capita income, percentage of the population living under the poverty line, other variables for quality of life and poverty).*
7. *Increase of equity levels (indicators include level of participation of local stakeholders, level of ethnic, generational and gender equity, levels of marginalization of social actors, distribution of benefits).*
8. *Respect of local cultures (indicators include integration of project activities with local stakeholders, appropriate adaptation by local or traditional cultures to the technology used, generation of local engineering and social capacities).*

Economic criteria

9. *Effects on the level of monetary income of local stakeholders (indicators include percentage of monetary income for service/remuneration of local stakeholders, percentage of investment used in services of Bolivian companies or agencies, etc.).*
10. *Effects on the levels of local production (indicators include rate of variation of local GDP, effects on levels of local prices).*
11. *Generation of new investment (indicators include creation of new investment consistent with the needs of local stakeholders, gross formation of fixed capital).*
12. *Effective transfer of technology (indicators include efficient technology in the use of natural resources, technology with a minimum negative impact on the environment than the one used traditionally).*

The Santa Cruz landfill gas combustion project will monitor the following sustainable development indicators.

Sustainable development indicator/criteria	Key data needs	Monitoring procedure
Job creation	Incremental number of jobs at landfill gas project	Employment records of the landfill gas extraction plant
Technology transfer	Succesfull implementation of new environmentally sound technology	Performance of landfill gas extraction plant
Environmental indicators		
Odour	Odour from the landfill	Reports from people living in surrounding areas
Safety	Incremental safety issues due to LFG landfill project	Number of fires on the landfillsite

The Santa Cruz Landfill gas combustion project will have a positive impact on items 1, 3, 4, 5 and 12 of the sustainable development criteria of the Bolivian government.

DEVELOPMENT OF SPECIFIC PROCEDURES

For a verifyable production of CER's certain procedures need to be developed and implemented. In this chapter the procedures, management systems and training which will be developed and implemented before the initial verification of the project are listed.

- Establish and maintain data measurement, collection and record keeping systems for landfill gas collection and sustainable development indicators
- Quality assurance procedures for internal and external data acquistion
- Develop and establish management and operations system
- Procedures for storing and maintain records (paper trail)
- Training procedures to enable operational staff to meet the needs of this MP
- Procedures for calibration of monitoring equipment
- Procedures for maintenance of monitoring equipment
- Procedures for project performance review before submitted for verification
- Procedure for corrective actions to improve future monitoring and reporting.