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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

- El Molle – Landfill gas (LFG) capture project.
- Version 010
- 12-03-2005

A.2. Description of the project activity:

El Molle landfill is an existing and operational landfill site. It is located 7 km far from Valparaiso city. The landfill site is suitable for municipal solid waste management and it is the most important landfill in the region. The landfill site belongs to the Valparaiso Municipality and was given under a 20 years public concession to **Gestión Integral de Residuos S.A.** (**GIRSA S.A.**), through contract number 4232 signed October 2nd, 2001 at a Chilean public notary. The landfill has been in operation since 1985 but **GIRSA S.A** has been landfilling only since the year of the contract, 2001. They will continue landfilling until 2021, year of the end of the contract.

Therefore, it will remain 16 years, since 2006, the year of this project start, to 2021, the year of the actual concession contract end.

The purpose of the El Molle landfill project is to install a highly efficient landfill gas collection system. This will involve investing in a gas collection system, airtight covering of the landfill and flaring equipment.

The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. The release of landfill gas can have a negative impact on the health of the local environment and the local population and lead to risks of explosions in the local surroundings. The project will also have a small, but positive impact on employment in the local area as a number of staff will need to be recruited to manage the landfill gas operations.

At the initial stage of the project, no electricity will be generated from the collected biogas. This is due to the high investment costs in power generation equipment and grid connection and the current low price of electricity. Another reason is the relatively low power capacity (3-5 MW)[1] that can be installed, and the uncertainty and variation in the actual production of biogas. The feasibility of electricity generation will be revisited once the project is fully operational.

The project is helping the Host Country fulfill its goal of promoting sustainable development. Specifically, the project:

- Increases employment opportunities in the area where the project is located;

[1] "Estudio de políticas de abatimiento de gas de efecto invernadero y desarrollo económico: sinérgias y desafíos en el sector de los rellenos sanitarios en el caso de Chile" Inter American Bank of Development, prepared by Bitrán & Asociados. Santiago, Chile. May 2003

- Uses clean and efficient technologies;
- Acts as a clean technology demonstration project;
- Optimizes the use of natural resources, avoids uncontrolled waste management.

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)
CHILE (host)	Gestión Integral de Residuos S.A (GIRSA S.A.) - Private	NO

Further contact information of Project participants is provided in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1.Host Party(ies):

Chile

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

Región V: So called *Región de Valparaíso*.

A.4.1.3.City/Town/Community etc:

Between the "Puchuncaví" *community* to the north and the "Rocas de Santo Domingo" *community* to the South.

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

El Molle landfill is located in *Sector Camino La Pólvora*, 7 km NE of Valparaiso city serving Valparaíso, Viña del Mar and Concón cities.

City	Current population [2] (inhabitants)
Viña del Mar	286,931
Valparaíso	275,982
Concón	32,273

[2] Census developed during the year 2002 by the Chilean National Institute of Statistics. INE, www.ine.cl

Geographically, the site is referred to the following coordinates,

Coordinates	
UTM (x,y)	**Geographic (long,lat)**
Limited to the North by,	
(19S 254,251.85W, 6,336,801.82S)	(W 71.63, S 33.07)
(19S 254,591.09W, 6,336,429.51S)	(W 71.62, S 33.08)
Limited to the South by,	
(19S 253,489.66W, 6,334,875.88S)	(W 71.64, S 33.09)
(19S 253,489.66W, 6,334,880.56S)	(W 71.64, S 33.09)

In the following figure, the physical location of El Molle landfill site is shown,

Fig. 1. El Molle Landfill site

El Molle landfill receives the total Valparaiso-Viña del Mar-Concón cities MSW (503 tones per day average). To the date, it accumulate 2,156,000 tones of MSW and it expect to receive another 4,465,000 tones in the next 16 years. The landfill has a surface of 96 hectares in total and the capacity has been calculated in 3,972,600 m^3 of domestic solid wastes and similar debris.

The landfill is divided in five cells. Two out of the five cells (Old Cell and Cell I) were totally filled and capped when **GIRSA S. A.** started to operate the landfill. **GIRSA S.A**, then continued to fill Cell II using the best available techniques of landfilling at the host country by successions of layers of waste covered with layers of filling material (a mix of sand, silt, clay and organic earth).

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

Sectoral Scope 13, Waste handling and disposal.

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

Landfill gas collection system:
State of the art gas collection technology will be used. This includes:

- Vertical wells used to extract gas;
- Optimal well spacing for maximun gas collection;
- Gas headers designed as a looping system in order to allow for partial or total loss of header function in one direction without losing gas system functionality, and
- Condensate extraction and storage systems designed at strategic low points throughout the gas system.

All efforts will be made to minimize the problems in condensate management.

Therefore, the LFG, which is produced naturally from the anaerobic decomposition of waste, is accumulated through a gas collection system of interconnected pipes throughout the landfill. This system is connected to wells, which are drilled to control the LFG and prevent it from migrating away from the landfill. The system then delivers the gas to a central flaring device where it is combusted to the atmosphere.

In addition, monitoring and control systems will be used to measure actual LFG flow and composition to reduce the intrusion of ambient air into the extraction wells and thus optimize the gas extraction.

The extraction wells, collection piping and blowers is expected to be installed in 2006, at the beginning of the crediting period. Thus, the collection efficiency would be improved from 6% [3] to 75% [4] in 2006 to the end of the lifetime of the equipment.

In this proposed project, LFG will be combusted with no energy conversion due to Chilean economic electricity circumstances. The financial analysis will be shown further in this document.

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 sector policies and circumstances:

[3] Baseline LFG collection efficiency found in the report "LFG Collection and Valorization at El Molle Landfill Site, Valparaíso, Chile" prepared by Biothermica Technologies Inc. Canada. July 2004.

[4] The cost increase to extract LFG up to approximately 75 percent of the actual LFG being generated is considered relatively linear in nature. However, to achieve very high recovery efficiencies, it may be necessary to employ a very tight grid of extraction wells/trenches and/or a synthetic cover system, which would result in major capital cost increases relative to the gain in LFG recovery. - *Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean The World Bank* – ESMAP – Section 2.6. Prepared by Conestoga-Rovers & Associates, Canada. January 2004.

The proposed project involves the collection and combustion of landfill gas that is currently released into the atmosphere, thus converting its methane content into CO_2 and reducing its greenhouse gas effect.

Currently, the methane generated at the landfill El Molle due to the MSW decomposition is released almost totally to the atmosphere (6% [3]). The permit for the El Molle landfill site operation does not specify the amount of methane produced by the landfill to be captured and destroyed.

The baseline scenario is defined as the most likely future scenario in the absence of the proposed CDM project activity. Thus, establishing this future scenario requires to follow all the steps below and comparing the most plausible courses of action according to the project circumstances. Based on this analysis (Section B below) the baseline scenario the concluding baseline scenario is the continued release into the atmosphere of majority of the LFG, which is the current case and common practice in Chile.

Furthermore, the financial analysis conducted clearly shows that implementation of this type of project is not the economically most attractive course of action. One top of this, the steps, found in Annex 1 "Tool for the demonstration and assessment of additionality" of the Approved consolidated baseline methodology ACM0001 "Consolidated baseline methodology for landfill gas project activities" were successfully fulfilled as shown in Section B.3. Thus, the project is not part of the baseline scenario and it can be concluded that the project is additional.

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

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2006	101,356
2007	110,921
2008	120,115
2009	128,752
2010	137,110
2011	145,004
2012	152,527
2013	159,770
2014	166,736
2015	173,422
2016	179,737
2017	185,867
2018	191,810
2019	197,568
2020	203,048
2021	208,341
Total estimated reductions (tonnes of CO_2 e)	2,562,085
Total number of crediting years	16
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	160,130

A.4.5. Public funding of the project activity:

The project will not receive any public funding from Parties included in Annex I of the UNFCCC, it is financed only with private capital.

SECTION B. Application of a baseline methodology

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

According to the UNFCCC's Drafting Group on Technical Issues text on CDM (Decision -/CP.7 Article 12, Paragraph 48) a project must select a baseline approach relevant with the activity.

The baseline approach adopted for El Molle project is option 48 (b) Marrakech text: The baseline is the scenario that represents "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

ACM001, the "consolidated baseline methodology for landfill gas project activities", has been applied to this project.

A justification of the method appropriateness given the project circumstances is given below.

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

The *Consolidated baseline methodology for landfill gas project activities* is applicable since the baseline is the scenario is either the partial or total atmospheric release of the gas and the project activity either flares or utilizes the captured gas.
The El Molle project involves the situation listed under a) in the baseline methodology, as the captured gas will only be flared in the project, and not used to produce electricity. The project baseline is the partial atmospheric release of the gas. The El Molle project thus meets the applicability requirements as described in the *consolidated methodology for landfill gas project activities.*

The selected approach from paragraph 48 of the CDM modalities and procedures in this methodology is: "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to invest". This approach is appropriate for this project activity as this project involves significant investment that would not have any financial return without CER revenues.

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

The consolidated methodology for landfill gas project activities provides instructions and a formula for calculating the emission reductions from a landfill project. Since the El Molle project only involves flaring, this formula can be simplified as follows,

$$\mathbf{ER_y = (MD_{\textit{project}\ y} - MD_{\textit{reg}\ y}) * GWP\_CH_4}$$

Where ER_y is the greenhouse gases emission reduction achieved by the project activity during the year y. These emission reductions are calculated as the difference between the amount of methane actually destroyed/combusted during the year y ($MD_{project\ y}$) and the amount of methane that would have been destroyed/combusted during the year y in the absence of the project activity ($MD_{reg\ y}$), times the approved Global Warming Potential of CH_4 (GWP_CH_4).

ER_y is measured in tones of CO_2 equivalents (tCO_2e). $MD_{project\ y}$ and $MD_{reg\ y}$ are measured in tones of methane (tCH_4). The approved Global Warming Potential of CH_4 (GWP CH_4) for the 1st commitment period is 21 (tCO_2e/tCH_4)

Since regulatory requirements have not specified the quantity of MD_{reg}, and "Adjustment Factor" (AF) for determining the baseline is used.

The percentage value for the adjustment Factor (AF)

Since 1980 El Molle landfill has been operating under the Sanitary resolutions numbers 02444 and 001681 granted by the Chilean Ministry of Health [5]. These resolutions include the sanitary and environmental requirements for the operation of this landfill. These regulations do not force **GIRSA S.A.** to capture and destroy any specific amount of landfill gas.

Since for the proposed project no "Adjustment Factor"(AF) is given/defined by the contract or law, it is necessary to determine it taking into account the project context. As said before, the regulations that apply to El Molle landfill do not include an obligation to capture and destroy the landfill gas. Currently, it has been estimated that at most 6% [6] is combusted at the landfill. It is expected that the collection and burning efficiency at the landfill could increase up to 75% [7] that would result in an adjustment factor of 8% [8].

Currently, the Chilean Ministry of Health is developing legislation at a national level that would also involve an obligation to capture and flare part of the landfill gas. The purpose of this obligation is to prevent the risks of explosions. This legislation is still at a draft stage and it has not been decided yet what percentage has to be flared. In the various discussions that have been held with stakeholders, percentages for the capture and flare obligation, varying from 10-20 percent, were mentioned.

However, under Chilean law, such new legislation could no apply to landfills that are already operating under an existing permit[9]. Since the current permit for El Molle is valid until 2020 approximately, the national regulation could not apply to the site before that date. The

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[5] www.minsal.cl

[6] Baseline LFG collection efficiency found in the report "LFG Collection and Valorization at El Molle Landfill Site, Valparaíso, Chile". Prepared by Biothermica Technologies Inc. Canada. July 2004.

[7] The cost increase to extract LFG up to approximately 75 percent of the actual LFG being generated is considered relatively linear in nature. However, to achieve very high recovery efficiencies, it may be necessary to employ a very tight grid of extraction wells/trenches and/or a synthetic cover system, which would result in major capital cost increases relative to the gain in LFG recovery. - *Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean The World Bank* – ESMAP – Section 2.6 - Prepared by Conestoga-Rovers & Associates, Canada. January 2004.

[8] AF= collection efficiency in the baseline / collection effiiciency in the project activity = 6% / 75 % = 8%

[9] "Estudio de políticas de abatimiento de gas de efecto invernadero y desarrollo económico: sinérgias y desafíos en el sector de los rellenos sanitarios en el caso de Chile" *Inter American Bank of Development*. Prepared by Bitrán & Asociados. Santiago, Chile. May 2003

legislation will not affect the El Molle baseline and adjustment factor during at least the first crediting period.

Having established the Adjustment Factor (AF), the amount of methane that would have been destroyed/combusted at El Molle landfill in the absence of the project activity ($MD_{reg\ y}$) is calculated as follows,

$$\mathbf{MD_{\mathit{reg}\ y} = MD_{\mathit{project}\ y} * AF\ (8\%^{8})}$$

As specified by the consolidated methodology, the ex ante emission reduction estimates are made by projecting the future GHG emissions of the landfill. The US EPA First Order Decay Model is used to perform these calculations. This projection is done using the MSW before and during the concession contract. The future tonnage to be landfill at El Molle is calculated using the estimated population growth projection for Chilean country (1.2% [10]), even though for Viña del Mar, Concón and Valparaíso cities the population growth shown in the past (Census 1992-2002 [11]) is almost ten times higher than the mentioned projection. Then, this value for population growth (1.2%) is conservative.

The actual emission reductions will be determined (ex post) by metering the actual quantity of methane captured and flared once the project activity is operational.

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:

Additionality determination is done by using the CDM "Tool for the demonstration and assessment of additionality".

Step 0. Preliminary screening based on the starting date of the project activity (Started after 1 January 2000 and prior to 31 December 2005)

The project is only expected to start it operation after it registration as a CDM project by the UNFCCC. In any case, as it will be demonstrated it the following steps, CDM revenue has been considered from the early stages of development of the project, and it is an integral part of the financial package of the project.

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

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

Alternative 1: The Business as Usual scenario. Although there is currently no controlled capture and destruction of methane at the El Molle landfill site, the BAU does take into account an estimated 6% of capture to comply with possible future regulations. The release of large part of the landfill gas to the atmosphere would continue.

Alternative 2: The landfill operator would invest in LFG collection equipment, power generation equipment and a grid connection to supply power to the Chilean grid.

[10] www.censo2002.cl/menu_superior/cuantos_somos/resultados_preliminares.htm

[11] www.conama.cl/portal/1255/article-26174.html

Alternative 3: The landfill operator would invest in a landfill gas collection system of a high effectiveness (the proposed project activity).

Other scenarios for a landfill might be:

- Utilization of the landfill gas to supply heat, steam or
- Upgrade the LFG to natural gas quality.

For El Molle the mentioned scenarios are not plausible, as the landfill is too small to make such utilization economically feasible. There is no industry to which heat or gas could be supplied nearby the landfill site. A connection to the natural gas grid and equipment to upgrade the LFG to natural quality are still too expensive to be competitive against the current compressed natural gas market prices at the host country.[12]

Sub-step 1b. Enforcement of applicable laws and regulations:

All three alternatives comply with the national and local regulations in the project location.

As explained under B.2, new legislation will not apply to El Molle, as it operates under an existing permit, and the BAU scenario is a scenario where EL Molle will meet all the permit requirements.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

According to the methodology for determination of additionality, option I should be used if the CDM project activity generates no financial or economic benefits other than CDM related income. Since this is the case for El Molle, the simple cost analysis will be used. To show that electricity production is not a viable baseline alternative, the benchmark analysis of option III will be used as well.

Sub-step 2b: Option I+III- simple cost analysis and application of benchmark analysis

Simple cost analysis

Alternative 3 (the proposed project activity) it represents extra investment in a effective gas collection system, airtight covering of the landfill, and flaring equipment.

The extra investment is expected to be US$ 3,100,800 and the costs for operation and maintenance is expected to be US$ 340,571 annually.

By investing in a gas capturing system El Molle will not generate any revenues in the absence of CDM.

[12] Facilities that process LFG to natural gas quality are rare. One study estimated that in 1994, only 4 per cent of LFG extracted for energy use in the US was being upgraded to natural gas quality (Berenyi, 1994). Investment in refining equipment is a key outlay, representing a large fixed cost. This cost can be justified if the price of natural gas sustains a per-unit profit on variable costs that covers the fixed cost. Given a low price of natural gas, a sustainable per-unit profit will be small. This means that upgrading LFG to natural gas will be economic only at very large landfills. - Methane Capture and Use - *Waste Management Workbook Australian Greenhouse Office*. Australia. 1997

Alternative 3 is therefore not an economically attractive scenario and not a realistic baseline scenario.

Benchmark analysis

The likelihood of Alternative 2, as opposed to the BAU scenario will be determined by comparing the IRR with the benchmark of the interest rate available to a local investor, i.e., as provided by local banks in Chile. An interest rate of 4% has been used in the analysis.

Sub-step 2c. Calculation and comparison of financial indicators (only applicable to options II and III):

The table below shows the financial analysis for Alternative 2. As shown, the project Internal Rate of Return (IRR) without carbon is -1 %. As the project IRR is negative [13], the Net Present Value (NPV)[14] will be negative at any interest rate and Alternative 2 is thus not a viable baseline alternative.

Net Present Value (US$)	-2,580,401
IRR (%)	-1%
Discount rate (%)	4%

Table 1. Financial results of Alternative 2 without carbon finance

Sub-step 2d. Sensitivity analysis (only applicable to options II and III):

It seems necessary to apply a sensitivity analysis to Alternative B by changing the following parameters in the financial analysis,

1. Increase in project revenues (price of electricity sold to the grid and CDM related income)
2. Reduction in project capital and running costs (operational and maintenance costs)

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 15%, and assessing what the impact on the project IRR would be (see table below). As can be seen, the project IRR remains very low [15] even in the case where these parameters change in favor of the project

Net Present Value (US$)	**IRR (%)**	**NPV (US$)**
Original	- 1%	- 2,580,401
Increase in project revenues	+3%	- 441,754
Reduction in project costs	+2%	- 1,174,114

[13] A negative IRR is possible in cases of negative NPV at no rate of return

[14] Net Present Value is the difference, if any, between the cost of an investment and the discounted present value of all anticipated future cash flows (positive and negative) to that investment. Generally, where NPV is positive, the investment is acceptable; where NPV is zero, the investment is marginal; and where NPV is negative, the investment is unacceptable.

[15] A number of projects have a positive IRR but net negative net present value. These are projects that will never see any economic viability in the private sector. A project with a negative NPV, i.e. projects that never pays back the initial investment, are common for social projects or programs undertaken by a national government, and it will cost, at a minimum, the NPV calculated.

Table 2. Financial results of the sensitivity analysis

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

To the date there has been limited development of landfill gas projects in the host country. At the moment there are only two other projects similar to this one, which at the moment is in the pipeline of the CDM project cycle. The projects mentioned are unreal and financially unattractive without the CER credits.

The current Chilean national legislation does not require that landfills active collect and dispose the LFG. So far, only a few landfills in Chile have been designed to collect and partially flare the gas generated. In the few cases where the gases are collected, this is done for safety reasons (to avoid explosions and fires), and it is often the case that the amounts effectively collected are very low. Investments done with this purpose is low and the technology used is very poor, with few exceptions.

Currently, only one landfill in Santiago is implementing a flaring system and a second one is installing a collecting system, but all over the country this is the case of less than three percent of the landfills.

In the proposed project's region (Region V), 11 landfills, among El Molle, are operating. None of them are operating with efficient (active) landfill gas flaring and capturing systems.

Stakeholders comments show real interest into imitate and deploy this technology to some other landfills in the host country, in the context of the CDM. However they are at a early stages of the mentioned initiative.

Sub-step 4b. Discuss any similar options that are occurring:

Where other similar projects are planned, these are all to be developed under the CDM. This does not call into question the claim that the El Molle project is financially unattractive without the CDM.

Step 5. Impact of CDM registration

As shown in step 2 above, the project is unlikely to move forward without the additional financial support from the CDM. As the project will generate 899,451 tones of CO_2e over the first seven year crediting period, the carbon revenues would be sufficient to make the project go ahead. Approval and registration as a CDM activity will thus alleviate the economic and financial hurdles.

According to the above analysis, the EL Molle gas capturing and flaring project, is not the baseline scenario.

If this CDM proposed project is successfully registered, a reinforced feedback, popularly known as "*snowball effect*" will occur since the registration would encourage future similar projects in Chile.

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

For the baseline determination, the project boundary is the physical site of the project activity where the gas is captured and destroyed.

In the following table, the direct on site, off site and indirect on and off site emissions are explained in the context of the project activity boundaries.

Emissions	Project Activity Scenario	Baseline Scenario
Direct on-site	Emission associated with fugitive landfill gas emissions. It has been estimated that 75%[16] of the landfill gas generated will be captured.	Emission associated with fugitive landfill gas emissions. It has been estimated that 6%[17] of the landfill gas generated will be captured.
Direct off-site	Transportation of equipment to project site *-excluded-*	None
Indirect on-site	Emissions from construction of the project (gas collection and flaring system). These emissions are excluded as they are not under control of the project developer and are insignificant (less than 1%) compared to the total emissions.	None
Indirect off-site	Transport of waste to landfill site. *–excluded-*	Transport of waste to landfill site. *–excluded-*

Table 3 . Direct and indirect on-site and off-site GHG emissions in the baseline scenario and project activity scenario

The emissions due to equipment transportation to landfill site and due to the improvement of the LFG collection and burning system at the landfill site, in the case of the project activity scenario, are insignificant (<1%) in contrast with the emission reductions.

[16] The cost increase to extract LFG up to approximately 75 percent of the actual LFG being generated is considered relatively linear in nature. However, to achieve very high recovery efficiencies, it may be necessary to employ a very tight grid of extraction wells/trenches and/or a synthetic cover system, which would result in major capital cost increases relative to the gain in LFG recovery. - *Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean The World Bank* – ESMAP – Section 2.6 - Prepared by Conestoga-Rovers & Associates, Canada. January 2004.

[17] Baseline LFG collection efficiency found in the report "LFG Collection and Valorization at El Molle Landfill Site, Valparaíso, Chile" Prepared by Biothermica Technologies Inc. Canada. July 2004.

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:

Mr. Francisco Acuña and Mrs. Valentina Villoria
Eratech Ltda. Chile (**NOT A PROJECT PARTICIPANT**)
Angamos 185. Oficina 34.
Reñaca, Viña del Mar.
Phone +56 32 83 2062
Email facuna@eratech.com
Web www.eratech.com

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:

Estimated at 01/04/2006 (d/m/y - starting date of the project activity is defined as the start of the improved gas capture system)

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

It estimated in 16 years, until the end of the actual concession's contract.

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:

01/04/2006

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period: NOT APLICABLE

C.2.2.1. Starting date:

C.2.2.2. Length:

SECTION D. Application of a monitoring methodology and plan

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

ACM0001 "Consolidated baseline methodology for landfill gas project activities"

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

The chosen methodology is to be used in conjunction with baseline methodology ACM001. The El Molle project involves the situation listed under a) in the monitoring methodology, as the captured gas will flared in the project. The project baseline is partial release to the atmosphere of the gas. The El Molle project thus meets the applicability requirements as described in the *consolidated monitoring methodology for landfill gas project activities.*

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

Option 2 is chosen here. See D.2.2.

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

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

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	Data	Source of	Data	Measured (m),	Recording	Proportion	How will the data be	Comment

(Please use numbers to ease cross-referencing to table D.3)	variable	data	unit	calculated (c), estimated (e),	frequency	of data to be monitored	archived? (electronic/ paper)	

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

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

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 (cross-referencing to table D.3)	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)	For how long is archived data kept?	Comment
1.	LFG Captured (LFG_{cap})	Flow meter	m^3	m	Continuous / Annually	100%	Electronic	Data will be archived during the crediting period and two years after it is over	Measured by a flow meter. Data to be aggregated monthly and yearly
2.	LFG Flared (LFG_{flared})	Equation	m^3	c	Annually	100%	Electronic		Measured by a flow meter. Data to be aggregated monthly and yearly.
3.	FE Flare/combustion efficiency, determined by the operation hours (2) and the methane content in the exhaust gas (1)	Chronometer Thermometer Gas quality analyser	%	m/c	(1) Continuously (2) quarterly, monthly if unstable	n/a	Electronic		FE = flare available hours*(100- % CH_4 exhaust gas)/total operating hours of the landfill (1) Periodic measurement of methane content of flare exhaust gas. (2) Continuous measurement of operation time of flare (e.g. with temperature)
4.	LFG composition (LFG_{comp})	Gas quality analyzer	m^3 CH_4/ m^3LFG	m	Continuous /annually	100%	Electronic		Preferably measured by continuous gas quality analyser.
5.	LFG temperature (LFG_{temp})	Thermometer	K	m	Continuous /annually	100%	Electronic		Measured to determine the density of methane DCH_4.
6.	LFG pressure (LFG_{press})	Barometer	Pa	m	Continuous /annually	100%	Electronic		Measured to determine the density of methane DCH_4.
7.	Total amount of electricity and/or other energy carriers used in the project for gas pumping and heat transport (not derived from the gas)	Energy-meter	MWh	m	Continuously	100%	Electronic		Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity
8.	CO_2 emission intensity of the electricity and/or other energy carriers in ID 7.	n/a	t CO_2 / MWh	c	Annually	100%	Electronic		Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity
9.	Adjustment factor (AF)	Equation	%	c	Annually	100 %	Electronic		Calculated as shown further below
10.	Regulatory mandate	Legal text	%	n/a	Annually	100%	Paper		-

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

In order to calculate the flaring efficiency, the following equation is used,

$$FE = \text{flare available hours} * (100 - \% CH_4)/\text{total operating hours of the landfill}$$

As well, to calculate the amount of landfill gas actually flared, the following equation is used,

$$LFG_{flared} = LFG_{cap} * FE/100$$

Where,

LFG_{flared}	Is the amount of LFG flared given in cubic meters per year [m^3LFG/year],
LFG_{cap}	Is the amount of LFG captured in year *y* given in cubic meters per year [m^3LFG/year],
FE	Is the efficiency of the flaring given as percentage [%]

Finally, to calculate the amount of methane destroyed in the project activity, the following equation is used,

$$MD_{project,y} = LFG_{flared} * LFG_{comp} * 16 * LFG_{press}/(R * LFG_{temp})$$

Where,

$MD_{projecty}$	Is the methane destroyed in the project activity during year *y*, given in tons of methane per year [t CH_4/year].
LFG_{flared}	Is the amount of LFG flared given in cubic meters per year [m^3LFG/year].
LFG_{comp}	Is the mean composition of methane in LFG captured in year *y* given in cubic meters of methane divided by cubic meters of LFG [m^3CH_4/m^3LFG].

LFG_{press}	Is the mean pressure for year *y* of the LFG given in Pascal [Pa].
LFG_{temp}	Is the mean temperature for year *y* of the LFG given in Kelvin [K].
R	Is the universal gas constant (8310000 [$Pa*m^3/(mol*k)$])
16	Molecular weight [g/mol]

D.2.3. Treatment of leakage in the monitoring plan NOT APPLICABLE

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

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

No leakage effects have been identified. The applicable monitoring methodology does not require leakage to be accounted for.

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.)

$$ER_y = (MD_{proectj,y} - MD_{reg,y}) * \text{GWP } CH_4$$

Where,

ERy	Is the emission reductions for year *y*, measured in tones of CO_2 equivalents [tCO_2e/y]
MD project,y	Is the methane destroyed/flared in year *y* with the project activity, measured in tones of methane [tCH_4/y]

MD reg,y	Is the methane destroyed/flared in year *y* without the project activity, measured in tones of methane [tCH_4/y]
GWP CH_4	Is the approved Global Warming Potential value for methane for the first commitment period, 21[tCO_2e/tCH_4]

As the project will not include thermal energy or electricity component, other terms of the equation, these terms are excluded from the overall equation.

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.
D.2.2.1.-1 (LFG Captured)	Low	Flow meters will be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-2 (LFG Flared)	Low	Flow meters will be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-3 (Flaring LFG efficiency)	Medium	Regular maintenance will ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values.
D.2.2.1.-4 (LFG composition)	Low	The gas analyzer should be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-5 (LFG temperature)	Low	Equipment will be held on maintenance periodically
D.2.2.1.-6 (LFG pressure)	Low	Equipment will be held on maintenance periodically
D.2.2.1.-7 (Total amount of electricity used in the project for gas pumping and heat transport)	Low	Energy-meter analyzers should be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-8 (CO_2 emission intensity of the electricity carriers in ID 7)	Low	The figure used was very conservative but will be under regular monitoring against the Chilean grid EF.
D.2.2.1-9 AF	Low	Linked to D.2.2.1-1 & D.2.2.1-10 QA/QC procedures
D.2.2.1-10 (Regulatory mandate)	Low	Since this is a given data, there is no place for uncertainty.

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

The project monitoring will be done by Mr. Pablo Asalgado, engineer, Director of El Molle and other 4 professionals at the landfill site.

Mr. Pablo Asalgado
GIRSA S.A.
Sector Camino La Pólvora.
Valparaíso, Chile.
Phone +56 32 23 2345
Email pasalgado@grupocam.cl
Web www.grupocam.cl

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

Mr. Francisco Acuña.
Eratech Ltda. Chile (**NOT PROJECT PARTICIPANT**)
Angamos 185. Oficina 34.
Reñaca, Viña del Mar.
Phone +56 32 83 2062
Email facuna@eratech.com
Web www.eratech.com

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

The source of emissions from the project is the combustion of landfill gas, converting methane into CO_2. As the methane is organic in nature these emissions are not counted as project emissions.

The emissions of the electricity consumption should be accounted as project emissions. By monitoring the electricity consumption of the gas extraction system and the CEF of Chile the emission can be determined. For now and estimate will be determinated.

It is assumed that the electricity capacity of the gas extraction unit is 80 HP. A CER of 1 kg CO_2/kWh will be used. With these assumptions it can be calculated that the annual emission from the electricity consumption is 522 CERs.

E.2. Estimated leakage:

No leakage has been identified and needs to be accounted for this methodology.

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

Not applicable.

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

The consolidated methodology for landfill projects uses an equation for calculating the amount of methane destroyed in the baseline scenario, as opposed to the amount of methane emitted in this scenario. We will use the convention established in the consolidated methodology and use this section to describe the amount of methane destroyed in the baseline scenario. The equation is as follows,

$$\mathbf{MD_{reg\ y} = MD_{project\ y} * AF}$$

Where,

$MD_{reg\ y}$	Is the amount of methane that would have been destroyed in the baseline scenario during year y [tCH_4/y].
$MD_{project\ y}$	Is the amount of methane actually destroyed in the project activity scenario during year y [tCH_4/y].
AF	Adjustment factor [%]

The methane destroyed by the project activity was estimated using the First Order Decay Model [18], using L_0 and *k* values appropriate for the landfill site as explained further below and assuming that 75% [19] of the landfill gas generated is collected by the gas collection system. In any case, as this project is merely for illustrational purposes because the actual emissions reductions will be monitored directly.

The AF value used for this project is 8% [20] (see section B.2 for the justification of this value).

The value for AF will be revisited at the beginning of each year and will be adjusted if affected by changes in national requirements or the El Molle permit.

In the case of the methane generation potential, L_o, it is calculated based on the IPCC Good Practice Guidelines, 1996, and the waste composition at El Molle landfill [21]. The waste composition at the landfill site is shown in the table below,

Landfilled Material	**%**
Organics	60
Paper	8
Cardboard	2
Plastics	6
Wood Residues	1
Rubber/tires	7
Textiles	4
Metals	1
Glass	1
Soil	6
Other	5
Total	**100**

Table 4. Landfill waste composition

[18] First-order kinetics method, also known as the Scholl Canyon model (IPCC, 1997). The Scholl-Canyon model is available in a packaged, user-friendly form as the *Landfill Air Emission Estimation Model*. The Model was developed by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, and can be downloaded for free at http://www.epa.gov/oar/oaqps/landfill.html.

[19] The cost increase to extract LFG up to approximately 75 percent of the actual LFG being generated is considered relatively linear in nature. However, to achieve very high recovery efficiencies, it may be necessary to employ a very tight grid of extraction wells/trenches and/or a synthetic cover system, which would result in major capital cost increases relative to the gain in LFG recovery. - *Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean The World Bank* – ESMAP – Section 2.6 - Prepared by Conestoga-Rovers & Associates, Canada. January 2004.

[20] AF= collection efficiency in the baseline / collection effiiciency in the project activity = 6% / 75 % = 8%

[21] Baseline waste composition found in the report "LFG Collection and Valorization at El Molle Landfill Site, Valparaíso, Chile" prepared by Biothermica Technologies Inc. Canada. July 2004.

It is corrected to 2005 conditions, and we can estimate the value with the following equation, given in (Gg CH_4/Gg MSW),

$$L_o = MFC \times DOC \times DOC_f \times F \times 16/12$$

Where,

MCF	0.80 (IPCC default value for deep, not controlled landfills)
DOC	0.1592 [Gg C/Gg MSW] (calculated as shown below)
DOC_f	0.77 (IPCC default value)
F	0.50 (IPCC default value)

Based on El Molle landfill site information, DOC is calculated as,

$$DOC = (0.40 \times A) + (0.17 \times B) + (0.15 \times C) + (0.30 \times D)$$

Where,

A	Fraction of paper, board and textile: 0.14
B	Fraction of garden waste: 0.06
C	Fraction of food residues: 0.6
D	Fraction of wood: 0.01

Resulting DOC equals to 0.1592 [Gg C/Gg MSW].

And thus,

$$L_o = 0.80 \times 0.1592 \times 0.77 \times 0.50 \times 16/12$$

$$L_o = 0.065 \text{ [Gg } CH_4 \text{ / Gg MSW]}$$

Considering a methane density of 0.000654 [t/m^3],

L_o results in 100 [$m^3 CH_4/t$ MSW].

In addition, the decay rate, *k*, has been taken from two reliable sources [22], [23]. Therefore, the decay rate used is 0.075. The mentioned value was used to run the First Order Decay Model [24].

[22] "Estudio de políticas de abatimiento de gas de efecto invernadero y desarrollo económico: sinérgias y desafíos en el sector de los rellenos sanitarios en el caso de Chile" Inter American Bank of Development. Prepared by Bitrán & Asociados. Santiago, Chile. May 2003. (Table 21. Region V)

[23] Ministery of Planification and Cooperation, Planification Division, Studies and Investment, Investment Department. "Metodología de Proyectos de Residuos Sólidos Domiciliarios y Asimilables". Chile. 2003.

[24] First-order kinetics method, also known as the Scholl Canyon model (IPCC, 1997). The Scholl-Canyon model is available in a packaged, user-friendly form as the *Landfill Air Emission Estimation Model*. The Model was developed by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, and can be downloaded for free at http://www.epa.gov/oar/oaqps/landfill.html.

In the following table the MSW accumulated since the landfill operation starting year (1985) to the end of the project activity is shown,

Year	MSW in place (t)
1985	107.400
1986	214.800
1987	322.300
1988	429.700
1989	537.100
1990	644.500
1991	751.900
1992	859.400
1993	966.800
1994	1.074.000
1995	1.182.000
1996	1.289.000
1997	1.396.000
1998	1.504.000
1999	1.611.000
2000	1.719.000
2001	1.826.000
2002	1.934.000
2003	2.037.000
2004	2.156.000
2005	2.394.000
2006	2.635.000
2007	2.878.000
2008	3.125.000
2009	3.375.000
2010	3.629.000
2011	3.885.000
2012	4.144.000
2013	4.407.000
2014	4.673.000
2015	4.942.000
2016	5.214.000
2017	5.489.000
2018	5.767.000
2019	6.049.000
2020	6.333.000
2021	6.621.000

Table 5. MSW in place per year

The Table below shows the destruction of methane that would have taken place in the baseline scenario (MD_{reg}) using the equations and values described above and the First Order decay model.

	Per year (average)	**7 years**	**16 years** [25]
$MD_{project}$ (tCH_4)	8,315	46,555	133,045
AF(%)	8	8	8 [26]
MD_{reg} (tCH_4)	665	3,724	10,644

[25] Projected deadline when the concession contract ends. After that, legally, the CERs cannot be claimed by GIRSA S.A. unless a concession contract extension will happen.

[26] AF = collection efficiency in the baseline / collection effiiciency in the project activity = 6% / 75 % = 8%. It will be check at the beginning of each crediting period.

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

The consolidated methodology for landfill project uses an equation for calculating the amount of methane destroyed in the project scenario, as opposed to the amount of methane emitted in this scenario. We will use the convention established in the consolidated methodology and use this section to describe the amount of methane destroyed in the project scenario. The equation is as follows,

The emission reductions were calculated not with baseline and project activity scenario emissions but using the amount of methane destroyed in each scenario. This is recommended by the approved consolidated baseline methodology used, ACM0001 "Consolidated baseline methodology for landfill gas project activities". Also, since in the project activity the data recorded would be the methane captured and flared, thus destroyed, it seems very appropriate to calculate the emission reductions using the methane captured and flared for each scenario.

$$MD_{project,y} = MD_{flared\,y}$$

Where,

$MD_{project,y}$ Amount of methane actually destroyed/combusted during the year y (tCH_4/y)
$MD_{flared\,y}$ Quantity of landfill gas flared during the year y (tCH_4/y)

The table below shows the emissions reductions taking place in the project scenario ($MD_{project}$) using the equations described above and the First Order decay model.

	Per year (average)	7 years	16 years [27]
LFG flare (m^3LFG)	25,948,125	145,275,000	415,170,000
WCH_4 (%)	50	50	50
DCH_4(tCH_4/ m^3CH_4)	0.000654	0.000654	0.000654
FE(%)	98	98	98
$MD_{project,} = MD_{flared}$ (tCH_4)	8,315	46,555	133,045

[27] Projected deadline when the concession contract ends. After that, legally, the CERs cannot be claimed by GIRSA S.A. unless a concession contract extension will happen.

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

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

Year	Estimation of project activity emission reductions (tonnes of CO_2)	Estimation of baseline emission reductions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2 e) [28]	Estimation of emission of the electricity used for biogas pumping and heat transport (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2006	110,737	8,859	0	522	101,356
2007	121,134	9,691	0	522	110,921
2008	131,127	10,490	0	522	120,115
2009	140,515	11,241	0	522	128,752
2010	149,600	11,968	0	522	137,110
2011	158,181	12,654	0	522	145,004
2012	166,357	13,309	0	522	152,527
2013	174,231	13,938	0	522	159,770
2014	181,802	14,544	0	522	166,736
2015	189,070	15,126	0	522	173,422
2016	195,934	15,675	0	522	179,737
2017	202,596	16,208	0	522	185,867
2018	209,057	16,725	0	522	191,810
2019	215,315	17,225	0	522	197,568
2020	221,271	17,702	0	522	203,048
2021	227,025	18,162	0	522	208,341
Total 7 year period (tonnes of CO_2 e)	977,651	78,212	0	3,654	895,785
Total 16 year period (tonnes of CO_2 e)	2,793,953	223,516	0	8,352	2,562,085

SECTION F. Environmental impacts

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

Although the Chilean Environmental Law was promulgated in 1995, its regulations were ratified on December 1997. El Molle Landfill's operations started in January, 1985. This means that for

[28] Under ACM0001 no leakage effects need to be accounted

the selection of this landfill no Environmental Impact Assessment was performed to determine if this specific location was most suitable as a landfill in Valparaiso area.

Later, after El Molle 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 "***Proyecto de cierre, sellado y reincersión de la celda número 2 vertedero El Molle***" and consists of a statement of the current environmental condition on site and presents a plan to adequate the procedures with the environmental law and its regulations.

The mentioned document was approved in November 6th, 2002 through resolution number 001681 granted by the Ministry of Health. Valparaiso – San Antonio communities.

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:

Not applicable. The El Molle project meets and goes beyond all local permit requirements.

SECTION G. Stakeholders' comments

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

Under the existing Chilean environmental legislation, the local DNA (CONAMA) calls for a Public Consultation Process (PCP) to identify concerns of the local stakeholders and response of the developer, as part of the EIA.

However, due to the technical & legal characteristics of the proposed CDM project activity (see section F.1), CONAMA did not considered necessary an open public consultation. In this case, what the common sense recommended, and it was done that way, was a focused public consultation, surveying the neighbors in the area of direct influence of the project and leaders or organized local groups in that same area.

Therefore the following independent PCP's activities was performed by the project developer:

a) 02 public announcements were performed in a regional newspaper.
b) Letters to all the public authorities and neighbors was sent explaining the project.
c) 02 public meetings were organized at the landfill site.

The PCP has been developed following crystal-clear procedures and tried to cover the interested parties and/or by those affected by the project.

G.2. Summary of the comments received:

In general, the perception of the project is positive and related health benefits regarding the recovering of the landfill gas are well recognized by local stakeholders. Other concerns about the project construction and operation are seen as solvable and not as key within their general concerns about the landfill itself.

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

The project developer will take the suggestions up and will inform the stakeholders regularly on the progress of the project at El Molle landfill site.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Gestión Integral de Residuos S.A. GIRSA S.A
Street/P.O.Box:	Sector Camino La Pólvora
Building:	
City:	Valparaíso
State/Region:	Región de Valparaíso. Región V
Postfix/ZIP:	
Country:	Chile
Telephone:	+56 32 23 2345
FAX:	+56 32 25 6139
E-Mail:	pasalgado@grupocam.cl
URL:	www.grupocam.cl
Represented by:	Mr. Pablo Asalgado
Title:	General Manager
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	+56 32 25 6139
Direct tel:	+56 32 23 2345
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any public funding.

Annex 3

BASELINE INFORMATION

Following the approved methodology AM0011, baseline emissions are, for reference only, determined *ex ante* by projecting the potential landfill gas volume at the site using a *First Order Decay model* (ref. section E.4).

A number of factors need to be taken into account using the First Order Decay model, such as physical aspects of the site, including type and quantity of waste actually deposited, waste density, percentage degradability of each fraction of solid waste and gas production rate within the waste mass.

The bulk density of the site is approximately 0.65 kg/m^3, the infilling history is known, the average depth of the site is known, the methane concentration of the gas is 50% and the collection efficiency is 75%.

For assessing the theoretical potential methane generation rate (L_o), it is assumed that each cubic meter of waste will produce 100 cubic meter of landfill gas over its lifetime.

BASELINE SUMMARY	
Year analysis was conducted	2005
Landfill data	
Country	Chile
Year started landfill operation	1985
Year finished operation (year of the end of the contract)	2021
Waste at the beginning of the project (tones)	2,394,000
Average daily waste rate (t/day)	326
Maximum flow of gas collected (m^3/h)	119
L_o (m^3CH_4/t MSW)	100
***k* (1/year)**	0.075
Methane content of landfill gas (%)	50
Baseline data	
Residual emission factor CH_4 to CO_2	0
Proportion of methane collected (%)	6
Adjustment factor (%)	8
Project date	
Date gas collection project starts (year)	2006
Proportion of methane collected (%)	75
Combustion effectiveness of Flare (%)	98

Annex 4

MONITORING PLAN

The project developers and operators (GIRSA S.A.) will oversee the development of the project and will periodically carry out internal audits, when required with external assistance, to assure that project activities are in compliance with monitoring and operational requirements.

GIRSA S.A. will adopt the instructions given in the MP and accomplish all activities related to the implementation of the procedures given in the Operational Manual (**OM**). The main responsibilities of the operator are related to:

• Data handling: maintaining an adequate system for collecting, recording and storing data according to the protocols determined in the Monitoring Plan, checking data quality, collection and record keeping procedures regularly;
• Reports: preparing periodic reports that include emission reductions generated, observations regarding Monitoring plan procedures;
• Training: assuring personnel training regarding the performance of the project activities and the Monitoring plan;
• Quality control and quality assurance: complying with quality control and quality assurance procedures to facilitate periodical audits and verification.

An Operational Manual (**OM**) to be produced by the developer of the project will include procedures for training, capacity building, proper handling and maintenance of equipment, emergency plans, and work conditions and security.

Quality control and quality assurance procedures

Regarding quality control and assurance procedures to be undertaken for the monitored data, the practices to be implemented in the context of the El Molle landfill gas project are as follows:

Monitoring:

The approved consolidated monitoring methodology ACM0001 “Consolidated monitoring methodology for landfill gas project activities” will be applied as is worked out in section D.2.

Monitoring records:

Daily readings of all field meters will be registered in either electronic form or on paper worksheets. Data collected will be entered in electronic worksheets and stored. Periodic controls of the field monitoring records will be carried out to check any deviation from the estimated CERs and according the Operational Manual for correction or future references.

Recommendations on system and procedures improvements will be presented. Periodic reports to evaluate performance and assist with performance management will be elaborated.

Equipment calibration and maintenance:

All meters and other sensors will be subject to regular maintenance and testing regime according to the technical specifications from the manufacturers to ensure accuracy and good performance.

Calibration of equipment will be performed periodically according to technical specifications and in agreement with recommendations given by suppliers.

It is the independent QA/QC-department that will ensure the implementation of proper maintenance and calibration.

Corrective actions:

Actions to handle and correct deviations from the Monitoring Plan and Operational Manual procedures will be implemented as these deviations are observed either by the operator or during internal audits. If necessary, technical meetings between the operator, the developer and the sponsor of the project will be held in order to define the corrective actions to be undertaken.

Site audits:

The authorities will make regular site audits to ensure that monitoring and operational procedures are being observed in accordance with the Monitoring Plan and the Operational Manual (**MP&OM**).

Training:

The operator personnel will be trained in equipment operation, data recording, reports writing, and operation, maintenance and emergency procedures in compliance with the Operational Manual.

Measuring Emissions from Flaring

The following steps describe how to estimate and record emission from flaring (see section D.2.2.1).

This is calculated by multiplying the volume of methane combusted by the flare, adjusted for flare efficiency, times the volume-to-mass conversion factor provided in the worksheet to be develop according with the MP&OM (e.g. methane density value corrected for temperature). To calculate methane input to-and destruction by the flare, data on flow to the flare and flare performance must be collected and monitored, as well.

Methane flow to the flare can be established based on the results of gas measuring. A flow meter installed at the flare facility measures and records all the biogas flow coming into the system in hourly basis. With the help of an electronic gas analyzer measurement of the methane content takes place. Gas analysis is performed to determine the amount of methane versus other impurities and gases to know its methane content (e.g. the fraction of CH_4 on a volume basis expressed in percentage) and it is required as an input for the engines adjusting and operation. Gas analysis is necessary at specified intervals throughout the project to maintain accurate and representative values for the landfill gas. This information should be recorded in the worksheet for audit and verification purposes.

Flare performance data: Flare performance data will be documented in the appropriate section of the worksheet. Maintenance records on flare performance data must be kept in the official set of all electronic spreadsheets.

Flare efficiency factor: A flare efficiency factor (e.g., 98% efficient) must be established (and entered into the worksheet) for the flare. The flare efficiency factor is the ratio of the actual methane emissions destroyed over the total methane emissions entering flare, expressed as a percentage. The undestroyed methane, in this example 2% of the methane sent to the flare, must be reported as project emissions.

Flare ignition sensor data: The operator must use a flare ignition meter to verify that the gas sent to the flare is being combusted. The sensor must be coupled with the flow meter. The flare sensor must be tested periodically to ensure proper function.