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

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SECTION A. General description of project activity

A.1 Title of the project activity:

- Santa Marta Landfill Gas (LFG) Capture Project.
- Version 06
- 05/12/06

A.2. Description of the project activity:

Santa Marta landfill is an existing and operational landfill site. It is located 17 Km south of Santiago city. The site is suitable for municipal solid waste management and it is one of the most important landfills in the region. The landfill site belongs to Santiago Municipality and was given under a 20 years public concession to Consorcio Santa Marta S.A. (CSM), through contract number 3873/01 signed 2001 at a Chilean public notary. The landfill started its operation in 2002. Consorcio Santa Marta will continue landfilling until 2022, year of the end of the contract.

Therefore, the project will remain at least 16 years, since 2007, the estimated starting year of this project, to 2022, the year in which the current concession contract ends.

The purpose of the Santa Marta 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 operators will 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 uncertainty and the variation in the actual production of biogas. The feasibility of electricity generation will be revisited every three years once the project is fully operational.

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

- Increases employment opportunities in the area where the project is located;
- 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)	Consorcio Santa Marta 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.:

Metropolitan Region, Santiago of Chile, Talagante Province.

A.4.1.3.City/Town/Community etc:

Santiago of Chile, Talagante commune.

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

The project is located in the Metropolitan Region of Santiago, Chile's political and administrative capital. The Santa Marta Sanitary Landfill is located in the Province of Talagante, approximately 17 km south from Avenida General Velásquez with Las Margaritas, until the intersection of Route 5 South with Río Maipo, and 12.5 km west from this last intersection.

The sanitary landfill is located on a polygon of 296 hectares, according to the following geographic coordinates:

North : 6.268 km East : 332 km
North : 6.272 km East : 334 km

In the following figure, the physical location of Santa Marta landfill site is shown,

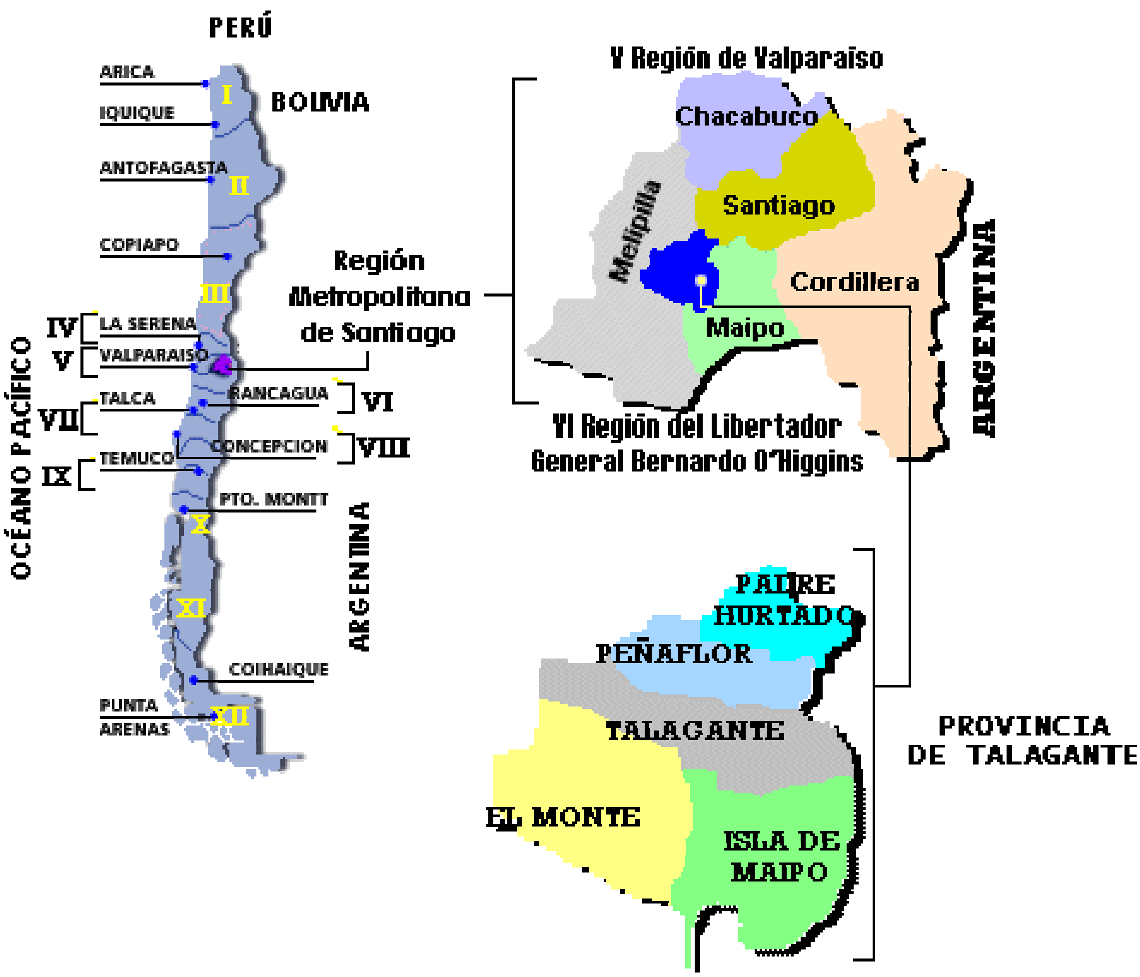

Fig. 1. Location of Santa Marta Landfill site

Santa Marta disposes of a contract with the company EMERES S.A., in charge of the collection, management and disposal of the municipal organic wastes of the Metropolitan region of Santiago. In virtue of this contract, the Santa Marta Landfill serves a population of around 1,200,000 inhabitants corresponding to the southern communes of Santiago: El Bosque, La Florida, La Granja, La Pintana, Lo Espejo, Macul, San Ramón, Puente Alto, Calera de Tango, San José de Maipo, Buin, Paine, Pirque and Talagante.

The total surface of the Sanitary Landfill is 296 Hectares and its useful life is 20 years. The total area destined to the final disposal of MSW is 77 Hectares, from which 11 Hectares have been already used, with an approximate medium height of 50 meters. Approximately 48,600 tonnes of wastes are received per month, which are domiciliary solid waste. To the date, 2,332,857 tonnes of MSW have been accumulated, and another 14,955,211 tonnes are expected to be received in the next 16 years.

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 the gas;
- Optimal well spacing for maximum gas collection;
- Gas headers designed as a looping system in order to allow a partial or total loss of header function in one direction without losing gas system functionality, and
- Condensate extraction 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 made of interconnected pipes throughout the landfill. This system is connected to wells, which are drilled to control and prevent the migration of the LFG. 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 the actual LFG flow and composition to reduce the intrusion of ambient air into the extraction wells and thus optimize the gas extraction.

The specific design of the LFG burning plant includes as system components:

1 Flaring plant:
- Flare of 12'', apt for biogas. Enclosed.
- 2 stain steel centrifugal extractors, direct actioning and explosion proof

1 measurement stage (Q,P,T, LFG composition)

3 devices for combustion and dissipation of the heat:
- Dimensions: 9.5 x 2.3 x 2.6 meters
- Axial fan
- Screen shaped burner with automatic start. Every burner counts on:
  - 3 screens of 5.2 Mkcal/h
  - Flare detector
  - Chimney thermicaly isolated for evacuation of burnt gases
  - Total installed capacity: 15 Mkcal/h
  - Type of Burner: mixture made in nozzle and air vein with an ample rank of operation (turn down > 1-10 each)
  - Homogeneous mixture of gas-air
  - Controler: : LANDYS&GYR LFL 1.322 (or equivalent)
  - Start: direct and with safety control

2 control electrical panels

1 control room for data adquisition and monitoring

1 room for the analizer

The Combustion efficiency given by the manufacturer is as follows (the actual efficiency will be monitored during the project activity):

CH_4	>98% for Biogás (Q> 800 N/m^3/h)
NOx	<100 ppm (1 ppm per MKcal/h)
HCl	Traces
SO_2	number of moles equivalent to income number of moles of S
Particules	<5 mg/Nm^3
% O_2	up to 2%

The installation will be carried out during 2006, before the beginning of the crediting period. The expected efficiency of the capture system will be at least 65%[1].

In the proposed project activity, the LFG will be combusted with no energy conversion, since the electricity generation from Santa Marta Landfill is not an attractive alternative, due to the current Chilean electricity situation. The financial analysis for such an alternative 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:

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 potential.

Currently, almost all the methane generated at Santa Marta landfill due to the MSW decomposition is released to the atmosphere. The operation permit for the Santa Marta landfill site, specifies the little amount of landfill gas that has to be captured and destroyed. The Chilean Commission of Environment (CONAMA), in charge of the regulations and permissions for the national sanitary landfills, has established through the Resolution of Environmental Qualification RCA 509/2005, an obligation to capture and destroy a determined small amount of LFG per year (see table 2 in section B.2), the accomplishment of such obligation will lead to the burning of a total amount of **751,751 tCO_2e** in the following 16 years of the landfill operation, while the implementation of the proposed CDM project activity will greatly increase that amount leading to a total burning of LFG representing **6,712,426 tCO_2e** in those years.

The project proposed here has the purpose to capture and burn at least 65% (see footnote 1) of the LFG generated in the landfill, which makes it additional to the requirements imposed by the regional and national authorities, since there is no legal nor contractual obligation for the installation and implementation of the new extended capture and flaring plant.

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

[1] 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. **In order to be conservative a reduction of 10% respect to this 75% has been used in the estimation of the LFG capture.**

comparing the most plausible courses of action according to the project circumstances. Based on this analysis (Section B below) the concluding baseline scenario is the continued release into the atmosphere of the majority of the LFG, which is the current case and the common practice in Chile.

Furthermore, the financial analysis here conducted, clearly shows that the implementation of this type of project is not the economically most attractive course of action. On 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:

Table 1. Estimated amount of emission reductions

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2007	152,042
2008	185,390
2009	218,082
2010	249,726
2011	280,446
2012	310,338
2013	339,574
Total estimated reductions (tonnes of CO2 e)	1,735,598
Total number of crediting years	7 (renewable)
Annual average over the crediting period of estimated reductions (tonnes of CO2 e)	247,943

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 Santa Marta Landfill 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".

ACM0001 "Consolidated baseline methodology for landfill gas project activities" Version 04, 28 July 2006, has been applied to this project.

A justification of the choice of the methodology 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 to projects where the baseline scenario is either the partial or the total atmospheric release of the gas, and the project activity either flares or utilizes the captured gas.

Santa Marta project involves the situation listed under a) in the applicability section of the ACM0001, as in the project scenario the captured gas will only be flared, and not used to produce electricity. The project baseline is the partial atmospheric release of the gas. The proposed 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 CERs 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, as given in page 2 of the ACM0001.Ver 04.

$$ER_y = (MD_{project\ y} - MD_{reg\ y}) * GWP\_CH_4 + EL_y * CEF_{electricity,y} + ET_y * CEF_{thermal,y}$$

and

$$El_y = EL_{EX,LFG,y} - EL_{IMP,y}$$

where:

ER_y emission reductions of the project activity in year y (tCO_2e);

$MD_{project,\,y}$	quantity of methane destroyed at year *y* (tCH_4);
$MD_{reg,\,y}$	methane that would have been destroyed during the year *y* in the absence of the project (tCH_4);
GWP_{CH4}	Global Warming Potential of Methane (tCO_2e/tCH_4);
$EL_{EX,\,LGFG}$	net quantity of electricity exported during year y, produced using landfill gas (MWh).
EL_{IMP}	net incremental electricity imported, defined as difference of project imports less any electricity in the baseline, to meet the project requirements (MWh);
$CEF_{electricity}$	CO_2 emissions intensity of the electricity displaced (tCO_2e/MWh);
ET_y	incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline use during project, for energy requirement on site under project activity during the year y (TJ);
$CEF_{thermal}$	CO_2 emissions intensity of the fuel used to generate thermal/mechanical energy,

The approved Global Warming Potential of CH_4 (GWP CH_4) for the 1st commitment period is 21 (tCO_2e/tCH_4).

Santa Marta Landfill Gas Project only involves flaring and it will not involve generation of electricity or thermal energy from the captured landfill gas. The small amount of electricity taken from the national grid in order to cover the landfill operation requirements, will be taken into account and then, the simplified formula to apply in Santa Marta is as follows:

$$ER_y = (MD_{project\ y} - MD_{reg\ y}) * GWP\_CH_4 - EL_{IMP} * CEF_{electricity,y}$$

Regarding the quantity of methane to be destroyed due to the project activity, it is important to note that regulatory requirements exists for Santa Marta landfill, specifying the quantity of LFG that is mandatory to burn every year.

Then, following the methodology ACM0001, Ver. 04, pag 2: *"In the case where the $MD_{reg,y}$ is given/defined as a quantity that quantity will be used."* the proposed project will use the data of the regulated amount of gas that has to be burnt by law in the baseline scenario. The values for the MD_{reg} are obtained from the values of LFG that is obligatory to burn, as established by the Resolution of Environmental Qualification RCA 509/2005. MD_{reg} will be calculated from those values, following the formula presented in section D.2.4., using the monitored temperature and composition of the generated LFG.

Table 2. Amount of LFG to be burnt in the baseline

Year	Obligatory burning of LFG(m^3/year), from RCA 509/2005
2007	2,959,000
2008	3,506,000
2009	4,047,000
2010	4,583,000
2011	5,114,000
2012	5,643,000
2013	6,161,000
2014	6,670,000
2015	7,170,000
2016	7,662,000
2017	8,147,000
2018	8,626,000

2019	9,099,000
2020	9,566,000
2021	10,030,000
2022	10,490,000

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 not apply to landfills that are already operating under an existing permit[2]. Since the current permit for Santa Marta is valid until 2022, the national regulation could not apply to the site before that date. The legislation will not affect Santa Marta baseline during at least the first crediting period. Regarding the current permit for Santa Marta operation, any change that this might face in the future will be monitored and taken into account as a change in the baseline for the calculation of the emission reductions.

As specified by the consolidated methodology, the ex-ante estimation of the emission reductions are made by projecting the future GHG emissions of the landfill. The US EPA LANGEM[3] (First Order Decay Model) has been used to perform these calculations. This projection is done using the estimated amount of MSW before and during the concession contract. The future tonnage to be disposed at Santa Marta Landfill was calculated by Consorcio Santa Marta and approved by the Chilean National Environmental Commission (CONAMA).

The actual emission reductions will be determined (ex post) by metering the actual quantity of total landfill gas captured and the amount of landfill gas flared, once the project activity is operational. From these measurements the total amount of methane destroyed is calculated and compared with the amount that would have been flared in the absence of the project activity.

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 its 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

[2] "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

[3] A last version of the Landfill Gas Emission Model (LANDGEM) is available in a packaged, user-friendly form from the US-EPA Technology Transfer Network Clean Air Technology Center as the Landfill GAS Emission Model. The Model can be downloaded for free at http://www.epa.gov/ttn/catc/products.html#software

current laws and regulations

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

Alternative 1: The Business as Usual scenario. This alternative corresponds to the capture and flaring of a small amount of LFG generated at Santa Marta as regulated by CONAMA.

Alternative 2: The landfill operator would invest in LFG collection equipment, power generation equipment and a grid connection to supply power to the Chilean national grid (Sistema Nacional Interconectado, SIC).

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 sale to the natural gas grid,

For Santa Marta Landfill these two lasts scenarios are not plausible. There is no industry to which heat or gas could be supplied nearby the landfill site, and a connection to the natural gas grid and the 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[4].

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 Santa Marta, as it operates under an existing permit, and the business as usual scenario is a scenario where Santa Marta will meet all the permit requirements.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

According to the methodology, for the 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 Santa Marta, 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

The capture and flaring system to be installed at Santa Marta will be implemented in different gradual phases in accordance with the management plan of the landfill site and the increase of the generation of LFG. There is no technical or economical justification for the implementation in advance of any

[4] 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

capture and flaring system able to cover all the crediting period. Thus, cost simple analysis has been carried out for a project that will cover at least the first 3 years of operation. The investment in the capture and flaring system was determined following the Landfill Gas to Energy Project Development Handbook US-EPA 1996, taken the most conservative range from the recommended interval of default values[5].

Alternative 3 (the proposed project activity) represents extra investment respect to the Alternative 1 (BAU and compliance with regulations). The investment in an effective gas collection system, airtight covering of the landfill, and flaring equipment will amount to an extra US$ 2,036,244 when compared with the minimal investment required to fully comply with regulations and safety. The extra costs for the operation and maintenance in Alternative 3, compared to Alternative 1, are expected to be US$ 75,947 annually.

Besides, by investing in a gas capturing system Santa Marta will not generate any revenues in the absence of CDM. Alternative 3 is therefore not an economically attractive scenario and thus it is not a realistic baseline scenario.

Benchmark analysis

The likelihood of Alternative 2, as opposed to the business as usual 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. The current Chilean law[6], establishes a fixed discount rate or return rate of 10% annual, on investments in electrical generation, transmission and distribution.

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) is -1.7 %, for the most conservative recommended default values. As the project IRR is negative[7], the Net Present Value (NPV)[8] will be negative at any interest rate and Alternative 2 is thus not a viable baseline alternative.

Table 3. Financial results of Alternative 2 without carbon finance

Net Present Value (US$)	- 799.991
IRR (%)	-1,7%
Discount rate (%)	10%

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

It seems necessary to apply a sensitivity analysis to Alternative 2 by changing the following parameters in the financial analysis,

[5] Landfill gas to Energy Project, Development Handbook, Landfill Methane, Outreach Program, US-EPA, 1996.
[6] Chilean Law "Ley General de Servicios Eléctricos", D.F.L. Nº 1/82, Art. 100, (d) and Art. 106, number 3 www.cne.cl/normativas/f_normelec.html
[7] A negative IRR is possible in cases of negative NPV at no rate of return
[8] 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.

1. Increase (10%) in project revenues (price of electricity[9])
2. Reduction (10%) in the operational and maintenance costs of the project.
3. Increase (10%) in project revenues (price of electricity sold to the grid) and Reduction (10%) in the operational and maintenance costs of the project.

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 10%, and assessing what the impact on the project IRR would be (see table below). As it can be seen, the project IRR remains very low, in all the analyzed cases, which makes the project unattractive for investors[10].

Table 4. Financial results of the sensitivity analysis

Nº	Net Present Value (US$)	IRR (%)
	Original	-1,7%
1	Increase (10%) in project revenues (electricity price)	0,1%
2	Reduction in project costs (10%)	0,2%
3	Increase (10%) in project revenues (electricity price) and Reduction in project costs (10%)	2,2%

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 three other projects similar to this one, all of them developed under the CDM framework and already registered as CDM projects. The projects mentioned would not be possible without the CERs revenues.

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. The implementation of a collecting system for the LFG only occurs in three percent of the Chilean landfills.

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

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

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[9] Energy National Commission of Chile (CNE). The energy price used here for the calculations has been 28,9 (USA cent / kWh) , which corresponds to the average price in the last 10 years (1995-2005). www.cne.cl/estadisticas/nacionales/electricidad/f_precio.html

[10] According to the "Superintendencia de Bancos e Instituciones Financieras", the current interest rate for credit operations in Chile is 8,08%. See http://www.sbif.cl/sbifweb/servlet/InfoFinanciera?indice=4.2.1&FECHA=1/12/2006

Where other similar projects are planned, these are all to be developed under the CDM. This fact corroborates the claim that Santa Marta 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 around 1,735,599 CERs 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 Santa Marta LFG capturing and flaring project, is not the baseline scenario.

The successful registration of this project as CDM will encourage the development of other 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 boundary.

Table 5 . Direct and indirect on-site and off-site GHG emissions in the baseline scenario and project activity scenario

Emissions	Project Activity Scenario	Baseline Scenario
Direct on-site	a-Emissions associated with fugitive landfill gas emissions. It has been estimated that 65%[11] of the landfill gas generated will be captured.	a-Emissions associated with fugitive landfill gas emissions. Just a small amount of the landfill gas generated would be captured.
Direct off-site	a-Emissions associated with consumption of electricity from the national grid b-Transportation of equipment to project site *-excluded-*	a-Emissions associated with consumption of electricity from the national grid. As a conservative measure these are taken as zero in the calculations. b-None

[11] See footnote 1.

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-*

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.

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:

DEUMAN Ltda (NOT A PROJECT PARTICIPANT)
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The baseline study was completed on 08/03/2006

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 01/01/2007. This is just an estimation for the starting date of the project activity. It will commence as soon as Registration occurs and the construction works finish.

Before any decission was made about the implementation of the project, project developers carried out a public tender process, through which companies interested in the purchase of the CERs to be generated by Santa Marta CDM Project were invited for the submission of their offers. The tender was published on the 27th November 2005 in the national Chilean newspaper "El Mercurio".

The tender finished on December the 23th,with the election of ENDESA ESPAÑA as the buyer of the CERs to be generated by the project. The 14th March 2006, an Emission Reduction Purchase Agreement was signed with ENDESA.

The investment in the technology to be used by the project was contracted the 26th of July of 2006, after a tender process started the 2nd of February of 2006.

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

It is 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:

15/02/2007. This is just an estimation for the date of the begining of the project. Monitoring and Crediting period will start as soon as the project is implemented and registered as CDM.

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

Not Applicable

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:

ACM0001 "Consolidated monitoring methodology for landfill gas project activities" Version 04, 28 July 2006, has been applied to this project.

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 the baseline methodology ACM0001. Santa Marta project involves the situation listed under a) in the monitoring methodology, as the captured gas will be flared in the project. The project baseline is partial release to the atmosphere of the LFG gas. The 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.)

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-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)	Comment

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).

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? (elec./ paper)	For how long is archived data kept?	Comment
1.1 $LFG_{captured,y}$	Amount of landfill gas captured	Flow meter	m^3	m	Continuous	100%	Electronic	Data will be archived during the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly.
1.2 $LFG_{flared,y}$	Amount of landfill gas flared	Flow meter	m^3	m	Continuous	100%	Electronic		Measured by a flow meter. Data to be aggregated monthly and yearly. As the methodology states in page 7*: In the case where LFG is just flared, one flow meter can be used provided that the meter used is calibrated periodically by an officially accredited entity*. Therefore in Santa Marta Project one flow meter will be used for both $LFG_{captured,y}$ and $LFG_{flared,y}$
2. FE	Flare/combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2)	(1)Chronometer Thermometer (2)Gas quality analyser of accreditted entity.	%	m/c	(1) Continuously (2) yearly, with the first measurement to be made at the time of installation	n/a	Electronic		FE = flare available hours*(100- % CH_4 exhaust gas)/total operating hours of the landfill The acreditted entity will be either SGS-Environmental in its Canada Headquarters or Gas Valpo in Chile , who is currently under their accreditation procedures with the Chilean National Institution for Normalization
3. $w_{CH4,y}$	Methane fraction in the landfill gas	Gas quality analyzer	m^3 CH_4/ m^3LFG	m	Continuous	100%	Electronic		Measured by continuous gas quality analyser.
4. T	LFG temperature	Thermometer	K	m	Continuous	100%	Electronic		Measured to determine the density of methane DCH_4.
5. p	LFG pressure	Barometer	Pa	m	Continuous	100%	Electronic		Measured to determine the density of methane DCH_4.
6. EL_{IMP}	Total amount of electricity imported to meet project requirements	Energy-meter	MWh	m	Continuously	100%	Electronic		Required to determine CO2 emissions from use of electricity. The electricity imported in the baseline is not monitored and conservatovly taken as zero.
7. CEF $_{electricity,y}$	CO_2 emission intensity of the electricity imported.	Data from the Chilean National Comission of Energy	t CO_2 e / MWh	c	As specified in AMS I.D	100%	Electronic		Required to determine CO_2 emissions from use of electricity. In order to be conservative the Emision Factor of the Chilean Grid feeding the landfill has been taken as 1 tCO_2/MWh, as explained in D.2.2.2. The official values from the Chilean National Comission of Energy will be monitored in order to assure continuation of conservativeness.
8.	Regulatory requirements relating to landfill gas projects in Chile and the Region	Legal text	Text	n/a	Annually	100 %	Paper	Data will be archived during the crediting period and two years after	The information will be used to assure compliance with regulations and aditionality of the claimed emission reductions.
9.	Compliancy with Environmental Regulations	CONAMA	n/a	n/a	As specified in RCA	100%	Paper and electronic	Data will be archived during the crediting period and two years after	The indicators of compliancy with environmental regulations are given in the RCA 509/2005. Compliancy with this RCA as well as with any future changes and/or additions to the RCA will be monitored.

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

Since there is no burning of fossil fuels in the baseline or the project scenario, the only project emissions to account for are the emissions due to electricity consumption by the capture and flaring equipment at the project site. These emissions correspond to $EL_{IMP,y}$ times $CEF_{electricity,y}$. $EL_{IMP,y}$ is defined as the net incremental electricity imported, which is represented by the difference of project imports less any electricity consumption in the baseline to meet the project requirements (in MWh) for year y and $CEF_{electricity,y}$ is the CO_2 emissions intensity of the electricity used or displaced, in tCO_2e/MWh, in year y.

In order to be conservative, it will be assumed that the imports of electricity to meet the regulatory requirements in the baseline are null. The amount of electricity needed to operate the LFG capture and flaring plant (that includes the needs to comply with the regulatory requirements) will be obtained by direct monitoring, using electricity meters at the entrance of the capture and flaring plant.

For determining the $CEF_{electricity,y}$ factor, ACM0001 methodology established that it can be estimated using the Approved methodology for small scale projects AMSI.D, if the capacity is within the small scale threshold values, when grid electricity is used or displaced. Since the project meets the small scale threshold values AMSI.D has been used to calculate $CEF_{electricity,y}$ considering:

- The average of the "approximate operating margin" and the "build margin", where:
  - The "approximate operating margin" is the weighted average emission (in kg CO_{2eq}/kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;
  - The "build margin" has been chosen to be the weighted average emissions (in kg CO_{2eq}/kWh) of recent capacity additions to the system, based on the most recent information available on plants already built, for the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

In view of the fact that Santa Marta will buy the electricity required from the Chilean Interconnected Central System (SIC), the calculations were made for this system based on data given by the National Commission of Energy (CNE) regarding all generating sources serving the system. The results are as follows:

Operational Margin	0.5809
Buil Margin	0.3589
Average	0.4699

Hence, the SIC emission factor ($CEF_{electricity,y}$) is obtained as 0.4699 tCO_2e / MWh[12].

In order to be conservative regarding the project emissions, the emission factor of Chilean grid will be taken as 1 tCO_2/MWh, and the official values from the Chilean National Comission of Energy will be monitored in order to assure continuation of conservativeness.

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.)

[12] This value was also approved by the CNE and is publicly available through the study: Desarrollo de un Instrumento para el Fortalecimiento de la Operación del Mecanismo de Desarrollo Limpio en Chile para Proyectos del Sector Energía, at http://www.cne.cl/archivos_bajar/GuiaMDL.pdf

Santa Marta Landfill Gas Project only involves flaring and it will not involve generation of electricity or thermal energy from the captured landfill gas. The small amount of electricity taken from the national grid in order to cover the project activity operation requirement will be taken into account and then, the simplified formula to be applied in Santa Marta, as explained in paragraph B.2., is the following:

$$ER_y = (MD_{project\ y} - MD_{reg\ y}) * GWP\_CH_4 - EL_{IMP} * CEF_{electricity,y}$$

where:

ER_y	emission reductions of the project activity in year *y* (tCO_2e);
$MD_{project,\ y}$	quantity of methane destroyed at year *y* (tCH_4);
$MD_{reg,\ y}$	methane that would have been destroyed during the year *y* in the absence of the project (tCH_4);
GWP_{CH4}	Global Warming Potential of Methane (tCO_2e/tCH_4);
EL_{IMP}	net incremental electricity imported, defined as difference of project imports less any electricity in the baseline, to meet the project requirements (MWh);
$CEF_{electricity}$	CO_2 emissions intensity of the electricity displaced (tCO_2e/MWh);

The approved Global Warming Potential of CH_4 (GWP CH_4) for the 1st commitment period is 21 (tCO_2e/tCH_4).

Following the methodology, the methane destroyed by the project activity ($MD_{project,y}$) during a year “y” is determined by measuring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable, and the total quantity of methane captured. In Santa Marta Project, there is no generation of electrical or thermal energy, and then:

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

The methane flared $MD_{flared,y}$ (t CH_4),will be calculated from $LFG_{flared,y}$, as follows:

$$MD_{flared,y} = LFG_{flared,\ y} * w_{CH4,y} * D_{CH4} * FE$$

Where:

D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH4), at the monitored temperature and pressure (T,p) and considering that at standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH4/m3CH4.

$w_{CH4,y}$ cubic meters of methane divided by cubic meters of LFG [m^3CH_4/m^3LFG].

FE is calculated as product of (i) fraction of time the gas is combusted in the flare; and (ii) the efficiency of the flaring process.

Efficiency of the flaring process is defined as fraction of methane completely oxidized by the flaring process, and in order to obtain it the exhaust gas will be regularly analyzed, (yearly as stated in the methodology for enclosed flares), by an accredited entity.

To calculate the amount of methane that would have been destroyed by regulations, in the absence of the project activity, the following equation is used, using the measurements of , $w_{CH4,y}$, T , p

$$MD_{reg,y} = LFG_{reg} * w_{CH4,y} * D_{CH4}$$

Where,

$MD_{reg,,y}$	Is the methane that would have been destroyed during year *y*, in absence of the project activity, given in tonnes of methane per year [tCH_4/year].
LFG_{reg}	Is the amount of LFG that is obligatory to burn every year as listed in Table 2 of paragraph B.2., in cubic meters per year [m^3LFG/year].
$w_{CH4,y}$	cubic meters of methane divided by cubic meters of LFG [m^3CH_4/m^3LFG].
D_{CH4}	density of methane at measured temperature **T** and pressure **p**

EL_{IMP} and $CEF_{electricity,y}$ are calculated as explained in paragraph D.2.2.2 above.

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.-1.1 ($LFG_{captured}$)	Low	Flow meters will be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-1.2 (LFG_{Flared})	Low	Flow meters will be subject to regular maintenance and testing regime to ensure accuracy
D.2.2.1.-2 (FE)	Medium	Flares will be maintained and tested regularly, and operated according as per specifications prescribed by the manufacturer.
D.2.2.1.-3 (W_{CH4})	Low	The gas analyzer should be subject to regular maintenance and testing regime to ensure accuracy and calibrated annually
D.2.2.1.-4 (T)	Low	Equipment will be held on maintenance periodically and calibrated annually
D.2.2.1.-5 (p)	Low	Equipment will be held on maintenance periodically and calibrated annually
D.2.2.1.-6 (EL_{IMP})	Low	Energy-meter analyzers should be subject to regular maintenance and testing regime to ensure accuracy, and calibrated annually
D.2.2.1.-7 ($CEF_{electricity,y}$)	Low	The figure used was very conservative but will be under regular monitoring against the Chilean grid EF.
D.2.2.1.-8	Low	Legal text
D.2.2.1.-9	Low	Regulations Text

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 developers and operators (Consorcio Santa Marta) 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.

The specific structure and methods of the monitoring plan is given in Annex 4.

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

The baseline study was completed on 08/04/2006 by:

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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

As explained in paragraph D.2.2.2., since there is no burning of fossil fuels in the baseline or the project scenario, the only project emissions to account for are the emissions of the electricity consumption by the capture and flaring plant at the project site.

For the writing of this PDD the electricity consumption to meet the project requirements has been estimated in a conservative way, focusing on the installation of a capture and flaring system of 200 HP, working with a conservative load factor of 50%, which means an annual total consumption of 654 MWh at the project plant.

Thus, the annual CO_2e emission due to the electricity consumption, taking the conservative $\boldsymbol{CEF}_{electricity,y}$ equal to 1 tCO_2e / MWh , as presented in paragraph D.2.2.2), would be 654 tCO_2 per year. Actual electricity consumption will be monitored in order to calculate this value for every year during the crediting period.

E.2. Estimated leakage:

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

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

Since there is no leakage: E.1 + E.2 = E.1

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

Santa Marta regulations establish the amount of LFG to be burn every year (LFG_{reg}) as shown in Table 2.

From those values the amount of methane that would have been destroyed without the project activity can be calculated using the equations given in paragraph D.2.4 above.

Table 6 below shows the destruction of methane that would take place in the baseline scenario, in the absence of the proposed CDM project (MD_{reg}), using the existing regulations for Santa Marta Landfill.

Table 6. Amount of LFG burnt in the baseline, and estimated MD_{reg}

Year	Obligatory burning of LFG as appear in RCA 509/2005 (m3/year)	MD_{reg} (t CH_4/year)
2007	2,959,000	967.59
2008	3,506,000	1,146.46
2009	4,047,000	1,323.37
2010	4,583,000	1,498.64
2011	5,114,000	1,672.28
2012	5,643,000	1,845.26

2013	6,161,000	2,014.65
2014	6,670,000	2,181.09
2015	7,170,000	2,344.59
2016	7,662,000	2,505.47
2017	8,147,000	2,664.07
2018	8,626,000	2,820.70
2019	9,099,000	2,975.37
2020	9,566,000	3,128.08
2021	10,030,000	3,279.81
2022	10,490,000	3,430.23

The MD_{reg} values given in the table above have been calculated using a methane density of 0.00065 tCH_4/m^3, and an average 50% of methane in the LFG. This density has been calculated supposing an average temperature of 25ºC and an average pressure of 1,013 bar, using Gay-Lussac Law, and taking the data given in the methodology ACM0001: "*At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168* tCH_4/m^3CH_4"*.*

The actual composition of the gas generated by the landfill as well as its temperature and pressure, will be monitored and obtained during operation to calculate the actual values of the methane density and thus MD_{reg}, following the formula given in D.2.4.

The value for LFG_{reg} will be revisited at the beginning of each year and will be adjusted if affected by changes in national requirements or Santa Marta permit.

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.

Thus, 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-Version 04. "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 destroyed in each scenario.

For the writing of this PDD, the methane to be destroyed by the project activity has been estimated using the Landfill Gas Emission Model [13], using L_o and k values appropriate for the landfill site as explained further below and assuming that 65%[14] of the landfill gas generated is collected by the gas collection system. In any case, these calculations are for illustrational purposes, since the actual emissions reductions will be monitored directly.

[13] See footnote 3
[14] See footnote 1

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 Santa Marta landfill[15]. The waste composition at the landfill site is shown in the Table 7 below,

Table 7. Santa Marta Landfill waste composition

Landfilled Material	%
Food Organics	42.29
Paper & cardboard	21.85
Plastics	14.09
Wood Residues	0
Leather	0
Textiles	5.04
Metals	2.46
Glass	2.12
Other	12.15
Total	**100**

We can estimate the value for Lo with the following equation, given in (Gg CH_4/Gg MSW),

$$L_o = MFC \text{ x } DOC \text{ x } DOC_f \text{ x } F \text{ X } 16/12$$

Where,

MCF	0.80 (IPCC default value for deep, not controlled landfills)
DOC	0.172 [Gg C/Gg MSW] (calculated as shown below)
DOC_f	0.77 (IPCC default value)
F	0.50 (IPCC default value)

Based on Santa Marta landfill site information, DOC is calculated as,

$$DOC = (0.40 \text{ x } A) + (0.17 \text{ x } B) + (0.15 \text{ x } C) + (0.30 \text{ x } D)$$

Where,

A	Fraction of paper, board and textile: 0.2689
B	Fraction of garden waste: 0
C	Fraction of food residues: 0,4229
D	Fraction of wood

Resulting that DOC equals to 0.171 [Gg C/Gg MSW].

And thus,

$$L_o = 0.80 \text{ x } 0.171 \text{ x } 0.77 \text{ x } 0.50 \text{ x } 16/12$$

$$L_o = 0.0702 \text{ [Gg } CH_4 \text{ / Gg MSW]}$$

Considering a methane density of 0.00065 [t/m^3],

[15]"Composicion de RSU en la Región Metropolitana", EMERES, 2000.

L_o results in 107.4 [m^3CH_4/t MSW], but with the aim of being conservative a value of 100 [m^3CH_4/t MSW] will be used for L_o.

In addition, the decay rate, *k*, has been taken from two reliable sources [16],[17]. Therefore, the decay rate used was 0.075.

The following Table 8 shows the MSW annually disposed since the landfill started its operation in 2002, as well as the projections of waste to be received annually till the end of its lifetime,

Table 8. MSW at Santa Marta Landfill

Year	WASTE disposed (t/year)
2002	387.193
2003	561.405
2004	661.451
2005	722.808
2006	751.720
2007	781.789
2008	813.060
2009	837.452
2010	862.576
2011	888.453
2012	915.106
2013	933.409
2014	952.077
2015	971.118
2016	990.541
2017	1.010.351
2018	1.030.559
2019	1.051.170
2020	1.072.193
2021	1.093.637
2022	1.115.510
TOTAL	**18.403.578**

The use of the Landfill Gas Emission Model, (referenced in footnote 3) with the mentioned inputs for Lo, k and the given amount of tonnes of MSW per year, has given the following estimated results for the generation of LFG at Santa Marta Landfill:

[16] "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)

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

Table 9. Output from Landgem Model

Year	Waste-In-Place (t)	OUTPUT Landgem Model (m^3LFG/year)
2007	3,084,577	39,553,003
2008	3,866,366	48,035,330
2009	4,679,426	56,358,358
2010	5,516,878	64,433,812
2011	6,379,454	72,290,200
2012	7,267,907	79,954,273
2013	8,183,013	87,451,183
2014	9,116,422	94,671,889
2015	10,068,499	101,641,641
2016	11,039,617	108,383,983
2017	12,030,158	114,920,889
2018	13,040,509	121,272,816
2019	14,071,068	127,458,904
2020	15,122,238	133,496,980
2021	16,194,431	139,403,717
2022	17,288,068	145,194,711

Table 10 below shows the methane destroyed in the project scenario ($MD_{project}$) using the equations described above and the Landgem model, and assuming that 65% of the LFG generated in the landfill is flared.

Table 10. Methane destroyed in the project scenario

	Per year (average)	First 7 years	First 16 years [18]
LFG flare (m^3LFG)	62,339,944	291,249,503	997,439,097
WCH_4 (%)	50	50	50
DCH_4(tCH_4/ m^3CH_4)	0.00065	0.00065	0.00065
FE(%)[19]	98	98	98
$MD_{project,} = MD_{flared}$ (tCH_4)	19,977	93,334	319,639

Finally, the following table summarized the estimated results,

[18] 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.

[19] This value (98%) was given by the flaring plant manufacturer and is used to estimate the potential emissions reductions presented in this PDD. The actual FE value will be monitored after the implementation of the project as stablished in table D.2.2.1.

Table 11. Estimated results

	Per year (average)	First 7 years	First 16 years [20]
$MD_{project}$ (tCH_4)	19,977	93,334	319,639
MD_{reg} (tCH_4)	2,237	10,468	35,798

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

As mentioned in paragraph E.5, it is recommended by the approved consolidated baseline methodology used, ACM0001-Version 04. "Consolidated baseline methodology for landfill gas project activities", for the emission reductions to be calculated not with baseline and project activity scenario emissions but using the amount of methane destroyed in each scenario. Therefore it seems appropriate to calculate the emission reductions using the methane destroyed in each scenario. The table below shows the estimations of the methane destroyed in the baseline scenario in tCO_2 equivalent per year (Estimation of Baseline emission Reductions) and the estimation of the methane to be destroyed in the project scenario in tCO_2 equivalent per year (Estimation of Project activity Emission Reductions).

The actual emissions reductions generated by the project will be measured directly during the operational time of the project.

Year	Estimation of project activity Emission reductions (tonnes of CO_2e/año)	Estimation of baseline emission reductions (tonnes of CO_2e/year)	Estimation of leakage (tonnes of CO_2 e) [21]	Estimation of emission of the electricity used for biogas pumping (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2007	173,016	20,319	0	654	152,042
2008	210,120	24,076	0	654	185,390
2009	246,527	27,791	0	654	218,082
2010	281,851	31,471	0	654	249,726
2011	316,218	35,118	0	654	280,446
2012	349,742	38,750	0	654	310,338
2013	382,536	42,308	0	654	339,574
2014	414,121	45,803	0	654	367,664
2015	444,609	49,236	0	654	394,719
2016	474,102	52,615	0	654	420,833
2017	502,696	55,945	0	654	446,097
2018	530,481	59,235	0	654	470,592
2019	557,541	62,483	0	654	494,404
2020	583,953	65,690	0	654	517,609
2021	609,791	68,876	0	654	540,261
2022	635,122	72,035	0	654	562,433
TOTAL 16 years	6,712,426	751,751	0	10,464	5,950,211

In order to be conservative, the emissions due to the amount of electricity from the national grid used in the baseline scenario has been considered as zero.

[20] Projected deadline when the concession contract ends. After that, legally, the CERs cannot be claimed by Consorcio Santa Marta, unless a concession contract extension happens.

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

SECTION F. Environmental impacts

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

As established by the Chilean environmental regulations, Santa Marta Landfill presented the Environmental Impact Study to the Environmental Chilean Comission (CONAMA), and was approved in the year 2001.

After that, Santa Marta Consortium (CSM) obtained the permit for the operation of the landfill, with the positive resolution RCA 433/2001 de CONAMA RM. In 2005 CSM obtained the positive resolution for the management of the landfill gas generated at Santa Marta Landfill site, as established in the RCA Resolución Exenta Nº 509/2005.

As a consequence of the burning of the landfill gas there will be emissions of local pollutants as: PM10, SO_2, NO_2, CO, and volatile hydrocarbons. All these pollutants would also be emitted in the absence of the project activity, although in some minor quantity. The RCA establishes the actions to take by Consortio Santa Marta in order to compensate these emissions if they get to go beyond certain values also given in the resolution.

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. Santa Marta 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:

Regarding the operation of the Landfill, as part of the Santa Marta Landfill Environmental Impact Evaluation (EIA), and following the current Chilean Environmental Legislation, CONAMA (which is also the Chilean DNA) called for a Public Consultation Process (PCP) to identify concerns of the local stakeholders. The results of that process were taken in due account during the phase of developing the EIA.

Regarding the proposed CDM Project "Capture and Burning of Biogas at Santa Marta Landfill", Santa Marta Consortium carried out a public participation process, with the aim of informing the community about the implementation of the Project as well as giving response to their potential concerns. A summary of the Process is given below:

1. **Information about the Project at a national level**: Santa Marta Consortium informed the national community about the Project through the publication in the national press "La Nación", the 28th of March 2006. In such publication information was given about the phases of the Project, the benefits for the community as well as for the local and global environment. The publication also informed about the fulfilment of the environmental Chilean rules by the project, and invited the population to submit any queries or comments.
2. **Information about the Project at a local level:** Santa Marta Consortium informed the local community about the Project, through the posting of 12 certificated letters to a local representative sample which covered the geographical area influenced by the project, Lonquen Community. The letters, sent the 15th of March 2006, also informed about the

fulfilment of the environmental Chilean rules by the project, and invited the local population to submit any queries or comments. The information about the project was also broadcasted through the local and regional radio waves and invited the population to submit any queries or comments.

G.2. Summary of the comments received:

The Committee of Social Help of the Community of Lonquén ("Comité de Ayuda Social de Santa Teresa de Lonquén"), is an entity created by and for the community. It represents the local population of Lonquén (which is the bigger area affected by the activity of Santa Marta Landfill) and they are in constant and fluent communication with the local population that they represent. Meetings are held in a regular bases and there is an easy and friendly way for the inhabitants to contact them in any matter affecting the community.

Regarding the proposed CDM project activity, the President of the committee, Ana María Loyola, and the Treasurer of the Committee, Patricia Candia, held several meetings with representatives of Consortium Santa Marta(CSM) with the aim being informed about the proposed CDM Project, and also informing the CSM about the opinions and suggestions of the local community affected by the project. A summary of those meetings is presented below:

1st Meeting hold the 2nd of January 2006 in Santa Marta facilities.

The Committee of Social Help of Lonquén (CSHL) is extensively informed by CSM about the Landfill gas Capture Project to be implemented in Santa Marta, about the benefits that the project will have on the community regarding environmental and odour issues, and the requirements established by the CONAMA Resolution RCA 509/2005 for CSM regarding compensatory measures for the mitigation of local pollutants.

CSHL informs of their aim of keeping the local community informed and agrees in the elaboration of a programme for informing the community. They also proposed the implementation of an environmental project to be developed in the community.

2nd Meeting hold the 10th March 2006 in Santa Marta facilities:

CSHL presents their proposals regarding the Information programme, which included:

- Broadcasting of the information regarding the implementation of the CDM Project by the CSHL to the local population.
- Direct information about the project by CSM to CSHL.
- Consultation to the local population for the feasibility of projects in direct benefit for the community
- Request for Support in the construction and implementation of an "Ecological Kinder garden" for children between 0 and 4 years old, from the less favoured families in the area, where they could have assistance and education.

CSM agrees in the meeting to the proposals regarding the information programme and the construction of the "Ecological Kindergarden".

3rd Meeting hold the 29th of May in Santa Marta facilities:

CSLH reports about all the actions taken regarding the information to the local population. Other issues regarding the promotion of the tourism in the area are also discussed.
In Lonquén, the 19th of June of 2006, the CSLH hold a Directive Meeting with the local population were the neighbours were largely explained about the CDM project to be developed at Santa Marta

Landfill, known by the locals as “Proyecto Biogas Kioto”, and informed of the ways to express their doubts or queries on the subject.

After that, and as a result of this information campaign, the President of the committee, Ana María Loyola, sent a letter to Consortium Santa Marta, expressing her satisfaction about the amount and quality of information received from CSM regarding the CDM project activity at Santa Marta, and informing that the information was passed to the local population, who have been also trained for the detection of any odour related to Santa Marta Activity. The President shows also her satisfaction about the visits that the neighbours have been able to make to Santa Marta Landfill, where they have been explained all the activities carried out at the site.

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

The project developers have maintained close communication with the local community, as shown in paragraph G.2. The community has been fully informed and their comments addressed trough the Committee of Social Help of Lonquén (CSHL), including the project for the construction of the “Ecological Kinder garden”, and the visits to the landfill site by the inhabitants of the influenced area.

The communication with stakeholders will continue open during the lifetime of the project activity and project developers will take due account of any suggestions and/or comments that could been received in the future by the population. At the same time the developer will inform the stakeholders regularly on the progress of the CDM Project at Santa Marta landfill site.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Consorcio Santa Marta S.A.
Street/P.O.BOX:	Avenida General Velásquez 8990, San Bernardo
Building:	
City:	Santiago
State/Region:	Metropolitana
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Country:	Chile
Telephone:	(56-2) 8541323
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E-Mail:	rbernstein@csmarta.cl
URL:	www.csmarta.cl
Represented by:	Rodolfo Bernstein
Title:	Ingeniero
Title:	
Last Name:	Bernstein
Middle Name:	
First Name:	Rodolfo
Department:	
Mobile:	
Direct FAX:	(56-2) 8543574
Direct tel:	
Personal E-Mail:	rbernstein@csmarta.cl

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any public funding.

Annex 3

BASELINE INFORMATION

Following the approved consolidated methodology ACM0001, 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.5).

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 methane 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 65%.

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, and k will be taken as 0.075, as they have been estimated and justified in section E.5.

BASELINE SUMMARY	
Year analysis was conducted	2006
Landfill data	
Country	Chile
Year started landfill operation	2002
Year finished operation (year of the end of the contract)	2022
Waste at the beginning of the project (tonnes)[22]	3,084,577
Average projected daily waste rate (t/day)	2,401
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
Amount of captured methane (annual average) tCH4/year	2,237
Project data	
Date gas collection project starts (year)	2007[23]
Amount of capture methane (annual average) tCH4/year	19,977
Combustion effectiveness of Flare (%)	98

[22] This is an approximate value of the amount of waste to have in the landfill at the beginning of the CDM project activity.

[23] This is just an estimation for the year of the begining of the project. Monitoring will start as soon as the project is implemented and registered as CDM.

Annex 4

MONITORING PLAN

1) ACRONYMS:

Consorcio Santa Marta S.A. (General Manager: Mr. Rodolfo Bernstein): CSM

Data acquisition team (Team manager Mr. Brunsley Oscar Elliot): DAT

Data processing, reporting and storage team (Team manager Mr. Pedro Rivas): DRST

Quality assurance team (Team manager Mrs. Andrea Viglino): QAT

Flare and monitoring provider – ASD Consultores: ASD

PDD Developer & Consultant – Deuman Consultores: Deuman

2) GENERAL APPROACH:

As stated in the PDD, the following variables need to be measured in order to determine and account for emission reductions:

• The amount of landfill gas being sent to flares;
• The amount of methane in the landfill gas;
• The flares' efficiencies.
• The pressure of the landfill gas;
• The temperature of the landfill gas; and
• The consumption of electricity from the grid.

Except from the flare efficiency, all other data need to be monitored continuously, through meters or analyzers. The flare efficiency will be measured continuously (by the operating hours of the flare and by the average temperature of the combustion chamber) and annually through the percentage of methane in the flue-gas. Considering that the CSM facility have computer-based equipment and generate continuous data, such equipment will be used for generating data relevant for the annual emission reduction verification report.

2) DATA TO BE COLLECTED OR USED TO MONITOR EMISSIONS REDUCTIONS

The data to be collected are given in table D.2.2.1, of this PDD.

Equipment used to monitor emissions reductions:

Equipment	Variables Monitored	Brand	Calibration procedures	Maintenance procedures	Parties responsible for operating equipment	Procedure in case of failure
Volumetric Flow Meter	1. LFG_{flare}	Yokogawa DY150	Equipment will be calibrated by YEW Chile each 12 months after initial installation	According with the manufacturer manual	DAT	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.
Thermocouple	2. P 3. T	Yokogawa EJA510A (P) PTA-006 (T)	Equipment will be calibrated by YEW Chile each 12 months after initial installation	According with the manufacturer manual	DAT	1) Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. 2) Repeat procedure within one month and if not possible contact other external company.
Fixed Gas Analyzer	4. W_{CH4}	Nova 4170MN4X	Equipment will be calibrated by manufacturer each 12 months after initial installation	According with the manufacturer manual	DAT	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.
Electricity meters	5. Electricity consumed	ENTES MPR-53S MERLIN GERIN X/5A	Equipment will be checked monthly by the Chief Engineer	According with the manufacturer manual	DAT	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.

Operational procedures and responsibilities for monitoring and quality assurance of emissions reductions (E = responsible for executing, R = responsible for overseeing and assuring quality, I = to be informed)

Task		*DAT*	*DRST*	*QAT*
Collect Data		E	R	
Enter data into Spreadsheet		E	R	
Make monthly and verification reports	I	R	E	I
Archive data & reports		E	E	I
Calibration/Maintenance, rectify faults		E	R	I

The management structures that will be implemented in the context of this project are as follows:

Personnel:

DAT will establish a qualified person that will be responsible of monitoring the LFG exploitation in the landfill and centralizing all the relevant data.
DAT will commit at least one site staff for daily data monitoring and storage. This will be the direct counterpart of the QAT representative for the monitoring component of the project.

Training:

The training for a proper data collection and report processing for variables with ID number 1 to 5 in table D.2.2.1 will be performed by ASD. The training for a proper data collection and report processing for variables with ID number 6 to 9 in table D.2.2.1 will be performed by Deuman.

Monitoring Records:

The DAT will record all data related to the landfill in relevant hardcopy and electronic files (at least 03 copies). Transmission of these data to DRST will be made on weekly basis. QAT will check for any anomalies before storing the data. In case any anomaly is found, the data of the corresponding week will not be used for verification of emission reductions.

Gas Field Monitoring Records:

The DAT will check the gas wells on weekly basis, taking readings at each gas well and recording these on a form. These readings are then checked for any anomalies before being filled at the landfill site, and transmitted to DRST & QAT. Gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

Flaring Monitoring Records:

The DAT will check the flaring equipment on weekly basis, taking readings and recording it on a form. These readings are then checked for any anomalies before being filed at the landfill site, and transmitted to DRST & QAT. Flare inspections will also observe occurrence of any unintended fugitive emissions of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

Routine Reminders for Site Technicians:

Site DAT Technicians will be supplied with a reminder list to guide them through their daily, weekly, and monthly routine. Apart from frequent contacts with DRST, the DAT landfill engineering manager and QAT representative will go through this routine during site visits to ensure all aspects of the role are being performed. In addition data archived are to be checked to ensure they are appropriately maintained. This includes all data to be monitored, as well as wells and flares monitoring records, meter readings, etc. In addition to ensuring the site routines are being performed, any additional training needs are assessed and an audit is taken of any outstanding task on site.

Outstanding Work Notice:

Following the Site Audit a 'Plant Outstanding Works Notice' is issued to each CSM personnel listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

Service Sheets:

Service sheets will be completed for each service to ensure all aspects of the service are completed and recorded. Based on these service sheets operators will ensure an optimum exploitation of the LFG system.

Calibration of measurement equipment:

Calibration of measurement equipment will be defined and scheduled by DAT/QAT according to table B and performed by accredited entities. If during the calibration procedure the equipment is found not to have worked properly, the data concerning the period from the last calibration will not be used and the concerning data will be stadistically analized in order to use conservative approppiate data according to internationally recognized rules.

Internal audits:

In order to have a suitable, adequate, and effective Monitoring Plan, internal audit will be conducted. Its objective will be to ensure that the Monitoring Plan functions as intended, and that it identifies weak links in the system as well as potential opportunities for improvement. The internal audit acts as a feedback mechanism for the top management; it can give top management, and other interested parties (DAT, DRST, & QAT), assurance that the Monitoring Plan meets the requirements of The United Nations Framework Convention on Climate Change (UNFCCC). How the internal audit process is managed is a key factor to ensuring the effectiveness of the Monitoring Plan.

The internal audit programme will focus on those processes and areas where past history indicates that problems have occurred, or where problems are likely to be ongoing, and/or are likely to occur (because of the nature of the processes themselves). These problems may result from issues such as human factors, measurement sensitivity, changes in the work environment, etc.

The audit frequency will be established using a risk based approach, in order to ensure the effective and efficient use of resources. This should also ensure that the inherent risks of audit failure in the audit process, and to audit outcomes, are minimised. Past audit results will be utilized in the planning of future internal audits.

The internal audits will be conducted by the QAT.

Corrective Actions:

The quality assurance measures to be conducted by the QAT include procedures to handle and correct non-conformities in the implementation of the Project or this Monitoring Plan.

In case such non conformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by the DAT and DRST.
- The landfill management will make a decision, on appropriate corrective actions to eliminate the non-conformity and its causes.
- Corrective actions are implemented and reported back to CSM/QAT/DRST.

All the information about monitoring plant and quality assurance measures described above will be included in the Operational Manual, which would have been prepared and edited by DAT and validated by DRST & QAT prior to the signature of CSM management team. The Operational Manual will include procedures for training, capacity building, proper handling and maintenance of equipment & emergency plans.

Values to use in case of failure:

Should any failure found to have occurred in any meter or data adquisition equipment during monitoring or calibration, all the previous concerning results would be stadistically analized in order to use conservative approppiate data according to internationally recognized rules.

3) DATA REPORTING:

Sample of weekly report – Form A:

Date	Time (minutes)	Pressure (bar)	Temperature (°C)	CH_4 (%)	Flow (m^3/h)	Flow (Nm^3/h)	CH_4 (t)

Sample of weekly report – Form B:

Date	Time (minutes)	Valve A (ON/OFF)	Valve B (ON/OFF)	Valve C (ON/OFF)	Flare 1 (°C)	Flare 2 (°C)	Flare 3 (°C)

Sample of monthly report

Date	Time (h/month)	Flow (Nm^3/month)	Gross CH_4 (t/month)	Flare Efficiency %	Net CH_4 (t/month)	Energy (Wh/month)

4) DATA STORAGE:

PC Consultants	PC on flare site	DAT	DRST	QAT
monthly	monthly	Up to 2 years after verification		