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NovaGerar Landfill Gas to Energy Project Monitoring Plan

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1 DOCUMENT PURPOSE AND USE

This monitoring plan sets out a number of monitoring tasks in order to ensure that all aspects of projected greenhouse gas (GHG) emission reductions for the NovaGerar project are controlled and reported. This requires an ongoing monitoring of the project to ensure performance according to its design and that claimed Certified Emission Reductions (CERs) are actually achieved.

1.1 What is a monitoring plan?

The NovaGerar monitoring plan is a guidance document that provides the set of procedures for preparing key project indicators, tracking and monitoring the impacts of the NovaGerar project. The monitoring plan must be used throughout the crediting period of the project (2003-2023) to determine and provide documentation of the GHG emission impacts from the NovaGerar project.

The monitoring plan was prepared in September 2002 by EcoSecurities Ltd and last updated in December 2002. This monitoring plan monitors the requirement set out by the Kyoto Protocol that emissions reductions projects under the Clean Development Mechanism have real, measurable and long-term benefits and that the reductions in emissions are additional to any that would occur in the absence of the certified project activity.

International standards have not yet been finalised, however details from the Marrakech Accords and PDD requirements from the UNFCCC have been included wherever possible. The recently released CDM PDD requires all sources of greenhouse gas emissions to be monitored. The PDD does not require project developers to monitor other environmental and social impacts, but they have been included in the scope of this monitoring plan.

1.2 What is required by the monitoring plan?

Managers of the NovaGerar Project must maintain credible, transparent, and adequate data estimation, measurement, collection, and tracking systems to maintain the information required for an audit of an emission reduction project. These records and monitoring systems are needed to allow the selected Operational Entity to verify project performance as part of the verification and certification process, as required in international standards developed by the UNFCCC. This process also reinforces that CO_2 reductions are real and credible to the buyers of the Certified Emissions Reductions (CERs).

There are two significant emission reduction sources identified in the Baseline Study, methane combustion and displacement of grid electricity. Therefore emission reductions will be achieved through two means, firstly the combustion of methane in flares and electricity generators. Secondly emissions reductions will be achieved through avoided generation of fossil-fuel based

electricity in Southern Brazil due to the power generated by the NovaGerar project. Please note that the NoveGerar project will not be claiming emission reductions from the displacement of grid electricity, therefore these emission reductions will not be monitored within this monitoring plan. Methane is a highly potent greenhouse gas with a Global Warming Potential (GWP) 21 times that of carbon dioxide. The amount of methane combusted in flares and generators and the subsequent electric output are therefore the key activities to monitor.

The monitoring plan provides the requirements and instructions for:

- Calculating emission reductions
- Establishing and maintaining the appropriate monitoring systems for the CO_2 emissions reduction estimation;
- Preparing the necessary measurement and management operations;
- Assigning monitoring responsibilities to personnel;
- Data storage and filing system;
- Preparing for the requirements of an independent, third party audit and verification.

1.3 Who uses the monitoring plan?

NovaGerar will use this document as their guiding principle in monitoring of the project emissions and will strictly adhere to the guidelines set out in this monitoring plan. Strict adherence to the guidelines set out in this monitoring plan is necessary for the project managers and operators to successfully measure and track project impacts for audit purposes. The monitoring plan is designed to allow project managers and operators to meet currently accepted international auditing and verification requirements. This plan also aims to anticipate future international requirements that may be developed through the United Nations Framework Convention on Climate (UNFCCC) under Article 12 of the Kyoto Protocol for CDM projects. These requirements are yet to be finalised, however details of the Marrakech Accords and PDD requirements have been incorporated wherever possible.

1.4 Key definitions

The monitoring plan will use the following definitions of monitoring and verification.

- ***Monitoring:*** the systematic surveillance of the project's performance by measuring and recording performance-related indicators relevant in the context of the Kyoto Protocol (KP) and project agreements.
- ***Verification:*** the periodic ex-post auditing of monitoring results, the assessment of achieved emission reductions and of the project's continued conformance with all relevant project criteria by a selected Operational Entity.

2 PROJECT INFORMATION

2.1 Overview of project

NovaGerar is a joint venture between EcoSecurities, an environmental finance company which specialises in greenhouse gas (GHG) mitigation issues and S.A. Paulista a Brazilian civil engineering and construction firm based in the city of São Paulo, Brazil. S.A. Paulista's core business is in traditional heavy construction sectors such as highways, railways, airports, ports, industries and sanitation. S.A. Paulista also manages the largest domestic waste transfer station in South America (Transbordo Ponte Pequena) responsible for 60% of all domestic waste from São Paulo, a city with a population of more than 10 million people.

In 2001, SA Paulista was granted a 20-year concessional licence by the Empresa Municipal de Limpeza Urbana (EMLURB - Municipal Waste Collection Company, a government agency responsible for waste collection and disposal) to manage the Marambaia and Adrianopolis landfills (officially called 'Lixao de Marambaia' and 'Aterro Sanitario de Adrianopolis') in the state of Rio de Janeiro, and to explore the landfill gas potential of these sites. As part of this concessional agreement, SA Paulista is contractually obliged to decommission and rehabilitate the Lixao Marambaia site, which opened in 1986 and ceased operation in late 2002 with approximately 2 million tonnes of waste deposited. The Adrianopolis site will commence operation in early 2003 and it is anticipated that it will receive an average of 2,000 tonnes of municipal waste per day.

The objective of the NovaGerar joint venture is to explore the landfill gas collection and utilization activities of the landfills managed by SA Paulista. This will involve investing in a gas collection system, leachate drainage system and a modular electricity generation plant at each landfill site (with expected final total capacity of 12 MW), as well as a generator compound at each site. The generators will combust the methane in the landfill gas to produce electricity for export to the grid. Excess landfill gas, and all gas collected during periods when electricity is not produced, will be flared. Combustion and flaring combined reduce emissions of 11.8 million tonnes of CO_2 over the next 21 years. In addition, the project will lead to emission reductions attributable to the displacement of grid electricity, but these will not be claimed by NovaGerar.

The project is part of a large program initiated by the Municipality of Nova Iguaçú, of collection of urban waste in the municipality. When the program was initiated, 100,000 tonnes of waste were found in over 1,200 sites within the city. In a few months, the program managed to raise the waste collection rate to 90% of waste generated in the city, well above the national average of 50%. A selective waste collection system was initiated with community support, which covers 450 collection sites within the city of Nova Iguaçú. The program includes an environmental education

program, for which a conference room was built to accommodate workshops and lectures. The second phase of this program is based on the construction of a state-of-the-art Waste Treatment Plant, of which these landfills are a central component, together with units to treat hospital and construction waste, as well as a wastewater treatment plant. The program has already obtained the necessary environmental licenses from FEEMA (the state authority responsible), after a consultation and public audience process including representatives from the community and non-government organisations.

The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. Contaminated leachate and surface run-off from landfills can affect down-gradient ground and surface water quality consequently affecting the local environment. The uncontrolled release of landfill gas can also impact negatively on the health of the local environment and the local population and lead to risks of explosions in the local surroundings. By managing the Marambaia and Adrianopolis landfill sites properly the environmental health risks and the potential for explosions is greatly reduced. 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. Additionally, as a condition of the licence, NovaGerar will donate approximately 10% of the electricity generated on-site to the local municipal authority of Nova Iguaçu (where the project is located), to provide lighting for local schools, hospitals and other public buildings.

Economic benefits include the project acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity and better management of landfills throughout Brazil, which could be replicated across the region. The NovaGerar project will also play an important demonstration effect, illustrating the use of a new financial mechanism for funding of the renewable energy sector, i.e. the Clean Development Mechanism.

Please refer to the Brazil NovaGerar Landfill Gas to Electricity Project Design Document and Baseline Study for more information on the project, including detailed descriptions of the landfill site specifications, location and the technology used by the project.

2.2 Project Boundaries

The project boundaries define the technical extent to which the effects of the project must be measured, monitored and verified. These boundaries inform which environmental impacts arising as a result of the project should be monitored, the criteria used to judge adequate performance, and the design of indicators. The Marrakech Accords provide the following definition of project boundaries:

Paragraph 52: The project boundary shall encompass all anthropogenic sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

It is important to differentiate between boundaries that may be drawn around the 'without project' scenario (the continued uncontrolled release of landfill gas) and the 'with project' scenario (the collection and combustion of landfill gas to generate electricity). The project boundaries of the MP are drawn around the Marambaia and Adrianopolis landfill sites in the municipality of Nova Iguaçú, Rio de Janeiro.

To clarify the project boundaries, a full flow diagram is presented in Figure 1. The flow diagram comprises all possible elements of the landfill gas collection systems and the equipment for electricity generation. The project boundary encompasses landfill gas production, the capture and combustion of the gas for electricity, on-site use of the electricity generated and the export of the electricity to the Brazilian grid. The waste management activities associated with landfills e.g. transportation of the waste to the landfill site have been excluded. For further detail on all sources of on and off-site, direct and indirect emissions please refer to the Baseline Study for this project, prepared by EcoSecurities Ltd in December 2002.

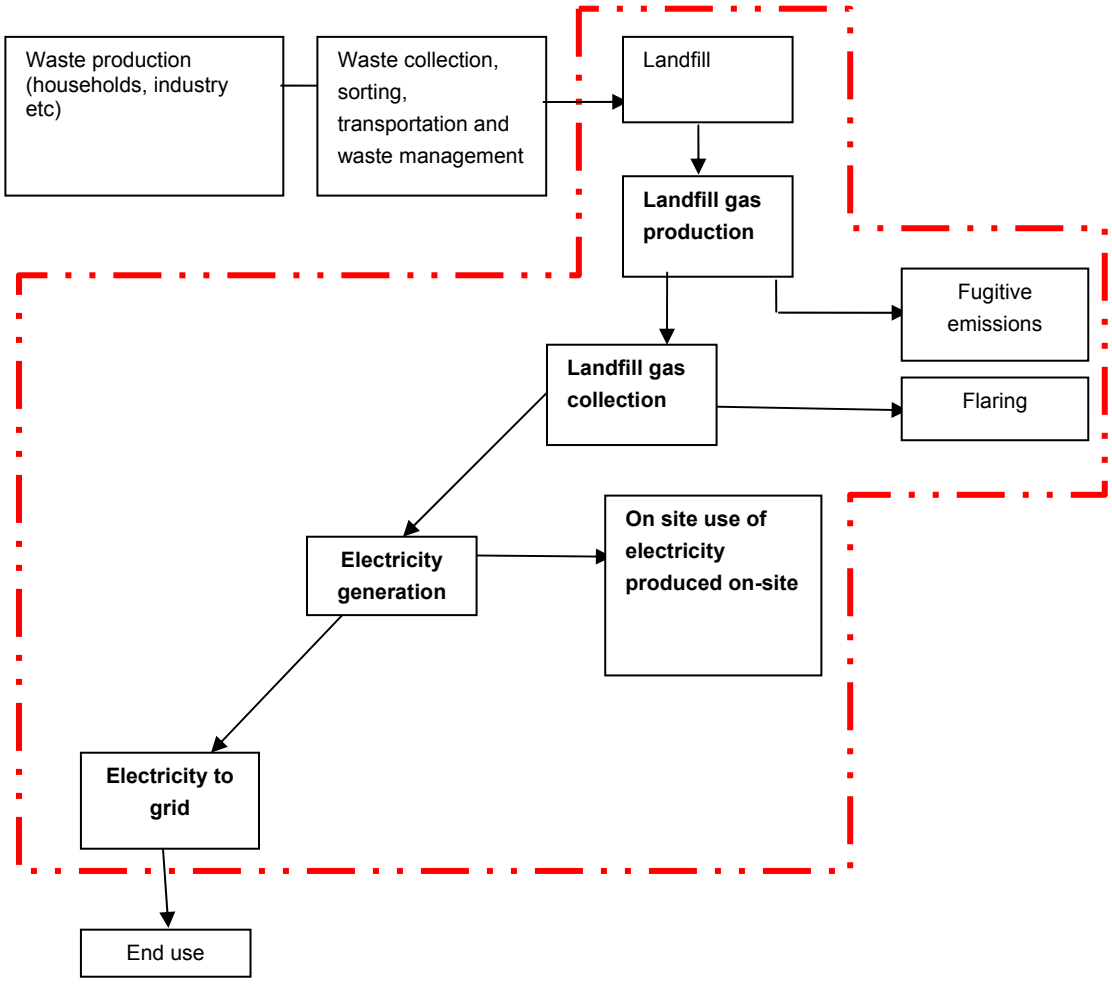

Figure 1: Flow chart of project boundaries

2.2.1 Summary of emission sources

Table 1 below contains a summary of the system and project boundaries for the NovaGerar project.

Table 1: Summary of system and project boundaries

Emissions	Project Scenario	Baseline Scenario
Direct on-site	Emissions associated with fugitive landfill gas emissions. EcoSecurities estimates that only 85% of LFG generated will be captured meaning the remaining 15% is released as fugitive emissions.	Uncontrolled release of 100% of landfill gas generated.
Direct off-site	Transportation of equipment to project site – excluded Use of electricity generated from landfill gas, reducing CO2 emissions in the electricity grid	None identified Emissions associated with use of grid electricity – in the interests of conservatism emission reductions arising from the displacement of more carbon intensive electricity will not be included in the projects volume of CERs
Indirect on-site	Emissions from electricity use for operation of lights and fans of on-site workshop – excluded, since it is carbon neutral Emissions from construction of the project – excluded as similar emissions would occur even if an alternative power generation project was constructed	–
Indirect off-site (or leakage)	Transport of waste to the landfill site(s) – excluded	Transport of waste to the landfill site(s) - excluded

2.3 Quantification of emission reductions

This section presents the methods for calculating CO_2 emission reductions. The emission reductions to be claimed from the project are potentially generated due to (a) methane combustion in flares and (b) methane combustion in generators.

Each element of emission reductions will require a separate monitoring and calculation process, as outlined in the sections below. The emission reduction calculations will be carried out separately for both the Marambaia and Adrianopolis sites.

2.3.1 Methane combustion in electricity generators

The bulk of landfill gas will be combusted in generators to produce electricity. The bulk of electricity will be sold to the Southern Brazilian grid, and a small proportion will be used on-site in running lights and fans in a maintenance workshop, and also operating the on-site leachate treatment facility. To calculate the emission reductions resulting from the generation of electricity monthly readings of electricity generated will be taken from meters owned by NovaGerar. These gross electricity production figures will then be multiplied by the generator heat rate (10,000 GJ/MWh) to give the total calorific input. Using the calorific value of methane (0.0357 GJ/m^3 CH_4) the amount of methane combusted can be calculated. This quantity of methane is then multiplied by the Global Warming Potential of methane (21) to give the total emission reductions due to combustion of methane for electricity generation (tCO_2e).

This emission reduction quantification is displayed diagrammatically overleaf:

STEP 1 – Methane combustion in electricity generators

Take the metered gross annual (aggregated from monthly readings) electricity produced by the NovaGerar project
(MWh)

⇩

Multiplied by generator heat rate
(GJ/MWh)

⇩

Total energy input
(GJ)

⇩

Convert GJ to equivalent tonnes of methane (using factors 0.0357 GJ/m^3 CH_4 and 0.000679 tCH_4/m^3CH_4)
(tonnes of CH_4)

⇩

Multiply by Global Warming Potential of methane (21)
(tCO_2e)

⇩

Annual CO_2 emissions displaced by the NovaGerar project through methane combustion to generate electricity
(tonnes CO_2 equivalent)

2.3.2 Methane combustion in flares

Excess gas will be flared at both the Marambaia and Adrianopolis landfill sites. Flaring will occur during periods of engine maintenance or low demand for electricity. Landfill gas will be channelled via flow meters which will measure the volume of landfill gas sent to the flares (m^3). This volume will then be multiplied by the methane fraction (50%) of the gas to calculate the volume of methane which has been sent to the flares. The volume of methane is then multiplied by the flare efficiency (98%) to give a net volume of methane burned in the flare. The volume of methane is then converted to the equivalent mass of methane using an appropriate conversion factor. From the baseline calculations workbook updated by EcoSecurities in December 2002 the following factor applies: 0.00067899 tonnes methane = 1 m^3 methane. The mass of methane burned in the flare is then multiplied by the Global Warming Potential of methane (21).

The CO_2 emission reductions from methane combustion in flares will be calculated on an annual basis as shown diagrammatically below:

STEP 2 – Methane combustion in flares

Volume of landfill gas channelled to flares (m^3)

Multiplied by methane fraction of landfill gas (50%)

Volume of methane combusted in flare (m^3)

Multiplied by flare efficiency (98 %)

Net volume of methane combusted in flare (m^3)

Multiplied by volume:mass conversion factor (0.00067899 tCH_4 = 1m^3 CH_4) (tonnes of methane)

Multiplied by Global Warming Potential of methane (21) (tonnes of CO_2 equivalent)

Annual emission reductions due to methane combustion in flares (tonnes of CO_2 equivalent)

(Results of Step 1 + Step 2) NOTE: For Marambaia site this result is further discounted by a factor of 20% for conservativeness

Total CERs generated by the project (tCO_2)

The total emission reductions (in tonnes of CO_2 equivalent) are the summation of results from Step 1 (Methane combustion in generators) and Step 2 (Methane combustion in flares). The sum is then discounted by 20% for the Marambaia site for conservativeness.

2.4 Monitoring period

The crediting period for the NovaGerar Landfill Gas to Energy project is 7 years, with up to 2 renewals, totalling 21 years, starting 1st of January 2003 and ending 31st December in 2023. At the end of each calendar year, monthly data will be aggregated into annual volumes of landfill gas sent to flares and annual amounts of electricity generated. The monitoring results will be audited and subsequent emission reductions will be verified on an annual basis (or in longer intervals if agreed between the project participants) by the selected Operational Entity.

2.5 Renewal of the Crediting Period and Time Boundary

In line with CDM modalities, the maximum crediting period of the project is 21 years, provided that the crediting period is renewed at the seven-year intervals. The renewal of the crediting period is subject to any modalities that may be adopted by the Executive Board and/or the UNFCCC Parties.

The baseline scenario is the continued uncontrolled release of landfill gas to the atmosphere, similarly to most landfills in Brazil (see NovaGerar Project Design Document for more discussion). The Brazilian Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. The implementation of environmental protection legislation in Brazil has a relatively long lead-time. In addition, historically in Brazil there also tends to be a gulf between stated regulations and actual practice with regards to the implementation of environmental protection legislation.

Prior to each periodic verification of the ERs, it will be determined whether regulatory changes have taken place that would require a certain level of flaring on even already operating landfills. An assessment is then made whether the ERs claimed from the Adrianapolis site should be discounted by a factor of X%, and whether the discount factor of 20% is still appropriate for the Marambaia site or whether it should be changed to 20% + X%. The discount factor of X% shall be proposed by NovaGerar and the appropriateness of the proposed factor reviewed and verified by the designated Operational Entity in the context of the periodic verification of the ERs.

In addition, after the first and second crediting periods, the consultant will also determine based on the control group below and other relevant information whether electricity generation has become the most attractive course of action. The table below contains a description of current practice at the 12 control group landfills.

Table 2: Brazilian Landfill Control Group

Landfill	*Waste in place (million of tons)*	*Waste deposition rate (tons/day)*	*Current flaring status*
Natal (RN)	8.0	450.0	No exhaust system, no flaring
Salvador (BA)	2.5	2500.0	Only natural exhaust system, no controlled flaring
São João landfill (SP)	17.0	6500.0	Only natural exhaust system, no controlled flaring
Cariacica (ES)	4.3	800.0	No exhaust system, no flaring
Marambaia (RJ)	3.0	1100.0	No exhaust system, no flaring
Guarulhos (SP)	3.5	1000.0	Only natural exhaust system, no controlled flaring
Itaquaquecetuba (SP)	2.0	2000.0	Only natural exhaust system, no controlled flaring
Maua (SP)	3.0	1500.0	Only natural exhaust system, no controlled flaring
Osasco (SP)	3.4	500.0	Only natural exhaust system, no controlled flaring
Florianópolis (SC)	1.2	350.0	Only natural exhaust system, no controlled flaring
Gravatai (RS)	4.3	1000.0	Only natural exhaust system, no controlled flaring
Joao Pessoa (PB)	2.8	400.0	No exhaust system, no flaring
Total	**55.0**	**18,100**	

3 MEASURING EMISSION REDUCTIONS

3.1 Data requirements for CO_2 emissions reduction monitoring

The following data will be monitored on both the Marambaia and Adrianopolis sites to enable accurate calculation of the emission reductions achieved.

3.1.1 Flow of landfill gas to flares

Flow meters owned by NovaGerar will record the volume of landfill gas sent to flares. Monthly records will be aggregated into an annual volume of landfill gas supplied to flares. Monthly figures will be recorded in the electronic workbook (please refer to Section 5.2).

3.1.2 Gross electricity produced

Gross project electricity generation will be monitored through the use of on site metering equipment at the substation. Monthly readings will be inputs into the electronic workbook (please refer to Section 5.2), and aggregated into annual figures.

Reliance on single meters may produce errors if the meter is not properly calibrated and checked periodically for accuracy. Therefore, meters will be subject to a regular maintenance regime (please refer to Section 3.3).

The monitoring process for emission reductions will be carried out in parallel with the monitoring activities for electricity generation and sales, but the records will be stored separately (refer to Table 6).

3.2 Methane-to-electricity conversion factors

In the electronic workbooks, as discussed in Section 5.2 a number of assumptions and conversion factors are used to convert electricity production to methane mitigation emission reductions. These factors and their sources appear in Table 3 below.

Table 3: List of constants used

Constant	Value	Reference
Calorific value of methane (GJ/m^3 CH_4)	0.0357	US EPA
Global warming potential of methane	21	UNFCCC
Density of methane (t/m^3)	0.00067899	US EPA

The calorific value, global warming potential and density of methane are all assumed to be constant therefore no quality assurance procedures will be implemented to check these values.

Table 4: List of variables used

Variable	**Value**	**Reference**
Fraction of methane in landfill gas (%)	50	EnerTech Consulting Engineers
Generator heat rate (GJ/MWh)	10,000	EnerG
Flare efficiency (%)	98	EnerG

The variables were derived from consulting and engineering companies and a technical consultant. The variables in the table above could be subject to change over time therefore quality assurance procedures will be implemented to periodically check the values are still correct. These procedures are outlined in Section 3.3 below.

The data to be collected in the monitoring process is summarized in Table 5 below as per the monitoring methodology AM0003 approved by the CDM executive board.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data variable	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)	For how long is archived data to be kept?	Comment
1	Flow of landfill gas to flares	M^3	m	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
2	Gross electricity produced	MWh	M	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
3	Generator heat rate	GJ/ MWh	M & C	Semi-annual determination of flare efficiency (if significant variation since last monitoring, monitoring repeated every month)	Semi-annually or more frequent depending on observed deviation from previous rating	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be used to test and, if necessary correct the generators' standard heat rate plate ratings*

4	Flare efficiency	%	M & C	Semi-annual determination of flare efficiency (if significant variation since last monitoring, monitoring repeated every month)	Semi-annually or more frequent depending on observed deviation from previous rating	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be used to test and, if necessary correct the flares' efficiency ratings.*
5	Methane fraction in LFG	%	M & C	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly.*

3.3 Quality Assurance

The EPC service providers for the NovaGerar project are EnerG, a UK based, specialist landfill gas to energy company. EnerG will be responsible for the operation of the engines and flares, as well as the maintenance of the gas collection system. The quality assurance practices they will be implementing are described below:

Daily Monitoring Records: On the larger more active sites EnerG site staff take daily gas field and engine readings and fax these to head office. These readings are then checked for any anomalies before being filed for future reference. At the smaller/older 300kW unit sites the readings are taken at weekly or other set periods depending on the activity and consistency of the gas field and engine operation. All engines have telemetry links back to a central computer at head office, which continually monitors the performance of the engine detecting problems and highlighting them for attention.

Gas Field Monitoring Records: Taken on a weekly basis or at periods to be determined. The Site Technician walks the gas field taking readings at each gas well and recording these on a form, which is then faxed to head office. These readings are then checked for any anomalies before being filed for future reference. Operators will determine at commencement of monitoring and thereafter annually whether the average methane fraction in the landfill gas has varied from the assumed value of 50%.

Routine Reminders for Site Technicians: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator go through this routine during site visits to ensure all aspects of the role are being performed. In addition paperwork due at head office is checked to ensure it has arrived. This includes monitoring records, oil sample reports and meter readings. Again the telemetry link records a lot of the data automatically.

Site Audits: The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator make regular site visits. 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 Works Notice: Following the Site Audit a 'Plant Outstanding Works Notice' is issued to the Site Technician 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. An example is attached in Appendix B.

Permit to Work Scheme: An example of the form completed before any work is carried out is attached in Appendix B. This is forwarded to head office and attached to the service records for each engine. The same form is used for any works associated with the gas field.

Service Sheets: EnerG carries out 750, 1500, and 3000 hour services on all 1MW engines followed by major servicing at 12,000 hours, and 500 and 1000 hours on the 300kW engines with a major service at 16,000 hours. Service sheets are completed for each service to ensure all aspects of the service are completed and recorded. An engineer is present at all major services and on earlier services if the site technician or management team feel this would be beneficial. Based on these services operators will determine whether the generator heat rate changes throughout the project life. It is anticipated that with such a rigorous maintenance the heat rate is likely to stay constant throughout the life of the engine. Further details on the engine maintenance programmes appear in Appendix A.

The table below summarizes the quality control and quality assurance procedures include in the monitoring methodology AM0003 approved by the CDM executive board and implemented in the context of the Project.

Data (Indicate table and ID number e.g. D.4-1; D.4-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D3 - 1	Low	Yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy
D3 - 2	Low	Yes	Meters will be subject to a regular maintenance and testing regime to ensure accuracy. Their readings will be double-checked by the electricity distribution company
D3 - 3	Low	Yes	Regular maintenance will ensure optimal operation of engines and generators. The heat rate used for calculation of ERs will be checked annually or more often if significant deviations from standard or previously used heat rate is observed.
D3 - 4	Low	Yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed.
D3 - 5	Low	Yes	Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy

4 SUSTAINABLE DEVELOPMENT MP

This Section of the MP establishes a protocol for monitoring and verifying the performance of the project with respect to sustainable development. Being a CDM activity, the NovaGerar project must meet the requirements of the Kyoto Protocol Art. 12 for CDM projects.

This sustainable development part of this MP seeks to ensure that the project meets expectations regarding its contribution to environmental and social sustainability over its lifetime. For this purpose, the MP identifies a set of performance indicators, as well as target values for these indicators, which the project is expected to meet or exceed.

4.1 Monitoring Sustainable Development

The MP compares the project's actual environmental and development performance, as measured by the indicators below, with the set target values and determines whether the targets have been reached. As long as the monitoring process shows that the projects performance meets these targets and if this is confirmed by the verifies, the project is automatically considered to be in compliance with the CDM's sustainable development objective – and so are the ERs generated by the project. If the host country sets targets for sustainable development and if the project's performance falls short of any of the set targets, it is the prerogative of the host Government to decide whether the project is still considered to meet the CDM's sustainable development objective. In the case of the NovaGerar project, the Brazilian Government has not set any sustainable development targets yet.

The following local environmental benefits have been identified from the project (also see Section 3.2 of the Baseline Study):

- The shut down of the largely unmanaged site of Marambaia is remediated and the environmental impacts from it reduced in the process;
- Capture and combustion of landfill gas reduces or eliminates toxic, odor and air quality impacts on the local community and environment;
- Collection and treatment of leachate reduces impacts on ground and surface water;
- Reforestation with native species around the Adrianopolis and Marambaia landfill suties and in the nearby ecological park will reduce the impact of the operations on biodiversity and loss of biomass and sequestered carbon;
- Marambaia clean up will provide conditions to the Municipality of Nova Iguacu to create an environmental protection area around the former dump site.

The direct social and development impact of the project are as follows (also see Section 3.2):

- Improved waste management practices and facilities;

- Significantly reduced or eliminated risk of explosions or fires;
- Employment during construction and operation;
- Improve of health conditions of landfill workers;
- Former scavengers will be integrated and formally employed;
- Labor conditions certified (ABRINQ);
- Capacity building seminars and training of workers, environmental agencies, students and governmental officials on environmentally correct and integrated waste management.

4.2 Monitoring, Recording and Reporting

The table below shows the worksheet for recording and reporting on sustainable development impacts. The first part records the expected developmental impacts during the construction phase of the project. It is expected that these targets for development impact will be met by the time of the initial verification for the project. The second part of the worksheet tries to document the impacts that sustain beyond the project construction phase.

Table 5: Sustainable Development Performance – Summary Sheet

Performance indicator	Description	Data collection responsibility	Measurement/ observation method or unit	Project expectations (unit)	Net perform-ance and compliance (unit, yes/no)
DURING PROJECT CONSTRUCTION PHASE					
Environmental					
Marambaia Remediation	Marambaia site will be remediated	NovaGerar	Desciptive	N/A	
Socio-Economic					
Job creation	Number of jobs created in the construction of Adrianapolis and remediation of Marambaia	NovaGerar	Numbers	200	
Job creation	Number of former scavengers absorbed and formal employment provided	NovaGerar	Numbers	Up to 10 (planned)	
AS A RESULT OF OPERATION OF THE PROJECT					
Environmental					

Ground water quality in Marambaia and Adrianopolis	Water quality improved due to leachate collection and treatment	NovaGerar	Water quality monitoring data provided by NovaGerar	Significant improvement of water quality in Marambaia, no pollution in Adrianopolis	
Native Forest restoration	Reforestation of degraded land and forest enrichment in secondary forests (Adr.) and reforestation of Marambaia site	NovaGerar	Reforestation plans	30 ha restored and 10 ha enriched	
Biodiversity	Restoration of native forests around Adrianopolis with positive impacts on fauna	NovaGerar	Fauna monitoring	Bird population monitored in Adrianopolis	
Socio-economic					
Job creation	Number of jobs created at the two landfill sites	NovaGerar	Numbers	70	
Job creation	Number of former scavengers absorbed	NovaGerar	Numbers	Up to 10	
Health care of workers	Improvement of health conditions by better working conditions	NovaGerar	Annual health controls	Improvement of health of former scavengers	
Working conditions	Abrinq certification for NovaIguacu waste disposal sites	NovaGerar	Abrinq certification maintained	Annual renewal	

Please note that the worksheet table shown in Figure 5.1 must be completed by the operator during the detailed design phase and must be reviewed by the verifier in the context of the initial verification.

5 MANAGEMENT OF PROJECT RELATED INFORMATION

This chapter provides information on record keeping of the data collected during monitoring. Record keeping is the most important exercise in relation to the monitoring process. Without accurate and efficient record keeping, project emission reductions cannot be verified. The sections below outline how project related records will be managed.

5.1 Proposed Information Management System for Emissions Reduction Monitoring

Overall responsibility for monitoring of greenhouse gas emissions reduction will lie with NovaGerar, Rio de Janeiro, Brazil. The following section sets out the procedures for tracking information from the primary source to the end-data calculations, in paper and electronic formats.

5.1.1 Structure of NovaGerar

Figure 4 shows the management structure of NovaGerar

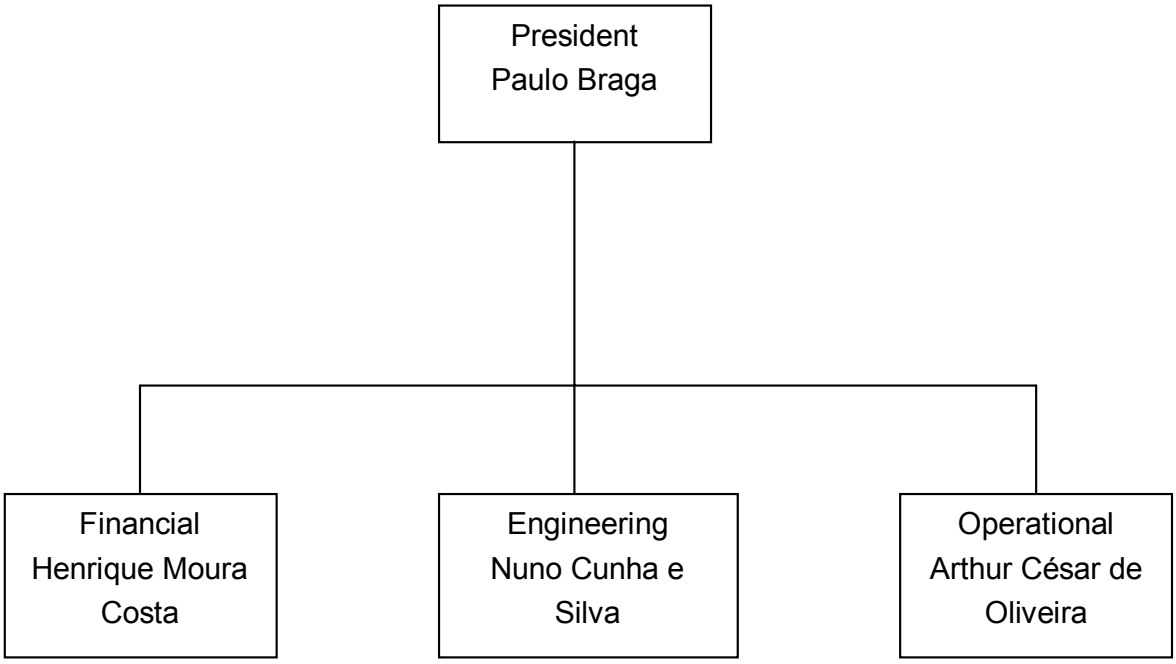

Figure 4: The management structure of NovaGerar

5.1.2 Paper-based and electronic documentation management

Physical documentation such as paper-based maps, diagrams, and feasibility studies, the baseline study and environmental impact statements will be collated in a central place, together with this monitoring plan. In order to facilitate verifiers' reference of relevant literature relating to

the NovaGerar project all project material and monitoring results will be indexed. A named person in the office of NovaGerar, Rio de Janeiro, Brazil, will store all paper-based information. This person is the person with ultimate responsibility for the emission reduction aspect of the NovaGerar Landfill Gas to Energy project – Nuno Cunha e Silva.

All electronic documentation also needs to be stored in a named location, and a second back-up copy kept in a different electronic location. Nuno Cunha e Silva in the office of NovaGerar, Rio de Janeiro, Brazil, will store this information.

Table 6 sets out the sets out the key documents relevant to monitoring and verification of the emissions reductions from the project.

Table 6: Data Storage Table

Document index reference number	Hard copy (H) or electronic copy (E)	Document title	General description of document	Individual or department submitting this information	Date entered	Document location	Back-up document location
DOC-001	H	Map	Map of the project	Engineering	08/2002	Novagerar Office	Novagerar LF
DOC-002	E	Baseline Sty	Baseline Study	Engineering	07/2002	Novagerar Office	Novagerar LF
DOC-003	E	Baseline Calc	Baseline Calculations	Engineering	07/2002	Novagerar Office	Novagerar LF
DOC-004	E	Monitoring Plan	Monitoring Plan	Engineering	09/2002	Novagerar Office	Novagerar LF
DOC-005	E	Monitoring WB	Monitoring Workbook	Engineering			
DOC-006	E	Host country	Host country approval documentation	Engineering		WorldBank	WorldBank
DOC-007	H	Monitoring Equip Maint	Monitoring Equipment Maintenance Report	Engineering			
DOC-008	H	Environmental/ social	Environmental and social impact statements	Engineering			
DOC-009	H	Records LFG flares	Records of volumes of LFG sent to flares (m^3)	Engineering			
DOC-010	E	Records electricity generated	Records of gross electricity generated on-site (MWh)	Engineering			
DOC-012	H	Calibration and maintenance records	Monthly meter calibration records and engine maintenance records as required	Engineering			
DOC-013	E	CO_2 Sign Off	Monthly CO_2 Sign Off	Engineering			
DOC-014	E	Electronic workbook	Electronic workbook: electricity and methane mitigation data & emissions reduction calculations	Engineering			
DOC-015	H	Verification	Records on verification of emission reductions	Engineering			
DOC-016	H	Stakeholder	Stakeholder comments	Engineering			
DOC-017	H	CER	Records on certified emission reductions	Engineering			
DOC-018	H	Management	Records on project management, including data collection and management systems	Engineering			
DOC-019	H	Gas field records	Operators of the gas field will take weekly measurements	Engineering			

As a result of likely project validation and verification requirements, a second copy of this material will be kept in an alternative location, as named in the table above.

5.2 NovaGerar CO_2 emissions calculation electronic workbook

The electronic workbook serves as the data estimation and management system for the project managers and operators. NovaGerar will develop a management system indicating:

- Which data is needed and its function;
- Who will be responsible for managing the data in NovaGerar;
- Who will be responsible for filling out the electronic workbook;
- Where the data is kept and how it is labelled;
- How often the data is generated.

The input to and output from the electronic worksheets is the only acceptable verification trail of CO_2 emission reduction estimation, data measurement and collection. The staff responsible for the monitoring of the project will complete the electronic worksheets on a monthly basis. The monthly worksheets are linked to an annual summary worksheet that will provide the total annual emission reductions.

For tracking, monitoring, and verification purposes, all of the annual CO_2 emission worksheets for both the Marambaia and Adrianopolis sites will be retained by the project monitors. The project staff that recorded the project emissions and the appropriate supervisor will sign off each month on this worksheet. Paper records of the officially signed monthly and annual worksheets will be kept.

The figure below shows the information which will be recorded each month.

Year	2003

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volume of landfill gas sent to flare (m3)												
Cumulative Total (m3)	0	0	0	0	0	0	0	0	0	0	0	0
Gross electricity generated (MWh)												
Cumulative Total (MWh)	0	0	0	0	0	0	0	0	0	0	0	0

Monthly entries are aggregated into annual figures, and emission reductions calculated and displayed on the same page in the tables below. The conversion factors and data used to calculate the emission reductions are also displayed on the same page.

Annual Emissions Reductions

Annual Volume of Landfill Gas Sent to Flares (m3)	0	
Annual Gross Electricity Produced (MWh)	0	
Annual ERs from flaring	#VALUE!	tonnes CO2
Annual ERs from electricity generation	0	tonnes CO2
Total Annual Emissions Reductions from project	#VALUE!	tonnes CO2
Emission Reductions after discount	#VALUE!	tonnes CO2
Net CERs created by the project	**#VALUE!**	**tonnes CO2**

Standard Conversions/Assumptions

Average Percentage of Methane in LFG	gas analyzer	
Generator Nameplate Rating	10,000	GJ/MWh
Calorific value of methane	0.0357	(GJ/m3 methane)
Tonnes of methane per m3 of methane	0.000679	(t/m3)
Tonnes of methane per GJ	0.01901933	(tCH4/GJ)
Discount to account for changes in Brazilian waste managemer	0%	
Flare efficiency	98%	
CEF of methane	21	(tCO2/tCH4)

The table below displays the quality control requirements. Each month the person entering the data will sign off that the data is correct.

Data Management	
	Date (dd/mm/yy)
Data input period	***dd/mm/yy - dd/mm/yy***
Completed by:	
Reviewed by:	

Each year operators will be required to verify the average methane content of the landfill gas, flare efficiency and generator heat rate based on records from the maintenance programme as described in Section 3.3, and sign off that the data is correct, as shown in the table below.

Year	2003						
Average methane content of LFG (%)	50%	Value inputted by:		dd/mm/yy	Reviewed by:	
Flare efficiency (%)	98%	Value inputted by:		dd/mm/yy	Reviewed by:	
Generator heat rate (GJ/MWh)	10,000	Value inputted by:		dd/mm/yy	Reviewed by:	

Workbooks will be completed each month for both the Marambaia and Adrianopolis sites. The sum of those results gives the total annual emission reductions for the NovaGerar project. These annual totals are then transferred to a master summary sheet, which appears overleaf.

Annual Emissions Reductions from Adrianopolis Landfill, Brazil

Year	Annual Emissions Reductions (tCO2)
2003	0
2004	0
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0
2019	0
2020	0
2021	0
2022	0
2023	0
Total over project lifetime	0

5.3 Back-up Information

Copies of electronic information will be stored away from the site of primary generation or use. This is primarily to ensure that copies are kept on a long-term basis (often longer than if it were to be kept for operational use alone), and to ensure that this information is not lost through periodic deletions or computer malfunctions.

All electronic data will be backed up on a monthly basis, and at each moment in time two electronic copies of each document will exist, and be kept in different locations. This information will be stored for a period of 2 years. For each document relevant for the monitoring process both an electronic (including back-up) and paper copy will be stored and archived. Table 4 above sets outwhere the collected information is kept. This information is aggregated to annual figures by the central information management systems.

6 VERIFICATION OF THE MONITORING RESULTS

The verification of the monitoring results of the NovaGerar project is a mandatory requirement for all CDM projects. The main objective of the verification is to independently verify that the project has achieved the claimed amount emission reductions. It is expected that the verification will be done on an annual basis. The World Bank as the Trustee of the World Bank Netherlands Clean Development Facility (WB NCDF) will be responsible for contracting an Operational Entity for carrying out the periodic verification.

This section of the Monitoring Plan outlines the auditing and verification procedures and prerequisites. It provides instructions on how the monitoring work undertaken by the project operator in line with this MP as well as project performance and compliance with CDM requirements will be verified.

6.1 The WB NCDF Audit and Verification Regime

The WB NCDF submits every project to third party validation and verification, which is conducted by an accredited CDM Operational Entity. WB NCDF expects that its auditors will seek accreditation under the Kyoto Protocol regime for providing these services as Operational Entities. The WB NCDF verification system for CDM projects consists of four activities:

Validation of project design: WB NCDF projects undergo validation of the project's design, baseline and MP against CDM requirements and modalities. Validation is a CDM requirement. WB NCDF will not implement a project unless a validator has confirmed that the project design is in compliance with all relevant CDM requirements. The validated MP for a project must be followed by the project operator. This MP can be adjusted or amended, if necessary, in order to improve consistency with its objectives, general concepts and project circumstances, subject to approval by the project verifier. A renewal of validation is not necessary in this case.

Initial audit and verification of project readiness: The WB NCDF requires that each WB NCDF project successfully completes an initial audit and verification process before the WB NCDF will accept emission reductions delivered by the project. While initial verification is not a CDM requirement, the WB NCDF regards it as an essential and the final step in the WB NCDF project preparation and implementation cycle. To prevent conflicts of interest, verification must not be conducted by the same firm and individuals that have provided validation services for the project. But the initial auditor / verifier can (and should) also provide subsequent verification services to the project. Initial verification provides an opportunity for verifiers to become familiar with the project, its context, the project operator and management.

The purpose of the initial audit and verification process is threefold:

- Ensure that the project has been implemented as planned, that the monitoring system is in place and that the project is ready to generate and record GHG emission reductions.
- Approve adjustments and amendments to the MP that may have become necessary during the detailed design and construction of the project.
- Assist meeting WB NCDF supervision obligations and clear the way for generation of high quality ERs.

During initial verification auditors are expected to do the following. They will:

- Familiarize themselves with the project and project circumstances,
- Introduce the project staff to the audit and verification process,
- Check whether the project has been implemented as planned,
- Check whether assumptions that have an impact on the monitoring and verification processes and its outcomes are still reasonable, in particular baseline assumptions,
- Confirm system readiness: that the MP has been implemented in the project's management and operational procedures and that all necessary monitoring elements are in place to ensure generation of verifiable emission reductions.

Periodic verification of emission reductions: All WB NCDF projects must undergo periodic audits and verification of emission reductions. This is a CDM requirement and the basis for issuance of Certified Emission Reductions (CERs) and for their value in the market place. Verification is arranged for by the WB NCDF and conducted at annual or longer intervals as appropriate for the project.

The purpose of periodic audits and verification is to confirm that:

- The project has achieved the ERs claimed for the verification period, in compliance with the methodology laid down in this MP.
- The operation of the project continues to be in compliance with all Kyoto Protocol, WB NCDF and host country requirements and modalities for CDM projects.
- The project maintains a high quality monitoring systems consistent with the MP.

As part of the periodic audit and verification process auditors are expected to:

- Review and audit relevant monitoring records and reports,
- Verify that the required measurements and observations have been made for all monitorable indicators in this MP,
- Check whether the MP methodology has been applied correctly and consistently
- Check whether achieved ERs have been computed correctly using the provided spreadsheets, and, if necessary, recalculate achieved ERs,
- Verify that all relevant MP and baseline assumptions are still valid,
- Verify that the management and monitoring system, including data handling, record keeping and reporting, is in place and remains adequate,
- Verify that the social and environmental targets in this MP have been met and that the project assists the host country in achieving sustainable development,

- Consult with the operator on the continued adequacy of the monitoring system and approve any modifications that need to be made to ensure a high quality monitoring operation.
- Undertake any other activities required by this MP, by the Kyoto Protocol requirements and modalities for the CDM, by the appropriate host country authorities or by professional auditing and verification standards and practice.

Verification concludes with a formal verification report. The report may include a statement that may permit the renewal of the project's crediting period in line with applicable CDM rules and modalities (yet to be developed).

Certification of emission reductions: A successfully completed verification process and the related verification report provide the basis for the issuance by the verifier of an emission reduction certificate. The certificate is a legally binding statement which confirms the (successful) verification report's conclusion that the project has achieved the stated quantity of ERs in compliance with all relevant criteria and requirements.

The certificate is issued by the verifier for the project only and it does not automatically constitute or create Certified Emission Reductions (CERs) in the sense of Art. 12 Kyoto Protocol. However, the verifier's certificate may be used by the WB NCDF and/or Brazilian authorities or authorized entities in the process of issuance and registration of CERs by the competent authority in line with applicable CDM and Kyoto Protocol modalities and procedures.

6.2 Auditing Criteria and Needs

Verification includes an audit of the project's output information and data and management systems on the basis of the following established criteria:

- Completeness
- Accuracy
- Coverage
- Risk Management Controls

Auditors / verifiers will request information (in the form of records and documentation) from the operator to determine if key performance indicators meet the objectives of the project as set out in this document. The operator is required to record all such indicators, and provide satisfactory documentation and an audit trail for verification purposes. The information that will be needed includes:

- Records on reported GHG emission reductions including the electronic spreadsheets / workbooks and supporting documentation (assumptions, data estimations, measurement methods, etc)
- Records on reported social and environmental performance as measured by indicators and targets laid down in this MP

- Records on project management, including monitoring, data collection and management systems

The audit process followed, as with other management systems, is interactive, iterative and participatory. The auditors will determine the credibility and accuracy of the reported performance through spot checks of data measurement and collection systems and interviews with the key project participants. It is necessary for all involved in an audit to understand the audit process and verification requirements.

6.3 Audit and Verification Process

Audits procedures used to verify CDM projects are similar to audits of other environmental management systems (ISO 14000, EMS) and should complement these established processes. Principle audit tools are spot check of documents and interview with participating organizations and individuals. Auditors/verifiers are generally free to apply any method that represents good auditing practice and internationally accepted standards. Auditors typically conduct risk-based spot checks, which are checks of the key parameters and systems with the highest risks for data measurement and collection problems. The planning and scheduling of audits and the verification process is covered in this section.

Audit preparation and requests for information: The auditor will familiarise himself with the project documentation, project reports, project requirements and expected project performance. The auditor will use this MP to prepare the audit process. She will make telephone contact with the operator, and if necessary, will request additional information from the operator, the WB NCDF and other project partners.

Development and delivery of an audit checklist: The auditor will develop a checklist to guide the audit process. The checklist will cover the key points of the audit. The checklist will be sent to the operator (auditee) accompanied by explanatory materials prior to a site visit.

The audit: A visit will be made to the site to undertake the audit. Audits on site require normally no more than two days. The audit time will be spend checking records and undertaking interviews with staff and other individual, which will allow the auditor to complete the audit checklist. These activities are the basis for completing the verification process and for preparing the verification report.

Audit and draft verification reports: The auditor will produce an audit report and a draft verification report, which summarizes the audit findings. The draft verification report will state the number of ERs achieved by the project and will point to areas of possible non-compliance if warranted. The report will also include conclusions on data quality, the projects monitoring and management and operational system, and other areas where corrective action may be required to come into compliance, improve performance or mitigate risks. The draft report will be submitted to the WB NCDF, a copy will be sent to the operator. Both parties will be given opportunity to

comment on the report. The operator will also have the opportunity to come into compliance, if necessary, by submitting the appropriate evidence or by taking corrective action.

Final verification report: The auditor will revise the draft report taking into consideration reviewers comments and further findings and issue the final verification report. If justified, the final verification report will conclude and explain that, within the verification period, the project has generated the stated quantity of ERs in compliance with all applicable CDM and other requirements. The final verification report is the basis for the issuance of a certificate by the verifier, which will state and confirm the conclusions of the report.

Non-compliance and dispute settlement: In the event of non-compliance findings, the auditee will be given sufficient time to demonstrated compliance. It is the responsibility of the verifier to ensure that dispute over any non-compliance issue is communicated clearly and that any attempt is made to resolve it. The verifier will have final decision over the process. The verifier will also provide guidance as appropriate on how identified deficiencies can be met so that the operator can come into compliance in the following period.

Audit and verification schedule: Audits and verification of the project will be conducted annually at first, then at intervals over the life of the project. The audit schedule will be determined by the WB NCDF in consultation with auditors and the project operator. Audit intervals will depend on audit outcomes and experience with the project's performance and compliance with the MP, the quality of its monitoring management and operational systems, and the type and number of corrective actions required by the verifier.

6.4 Roles and Responsibilities

Audit responsibilities are allocated between the project participants as follows:

The WB NCDF:

- The WB NCDF will make the arrangements for the audit and select a third party auditor/verifier in accordance with WB NCDF requirements and selection criteria
- It is the WB NCDF's obligation to ensure that the audit process is fair, that auditors/verifier are fully independent of the project operator and that and all possible conflicts of interests are avoided. The WB NCDF requires details of the experts to be used on the audit/verification team.
- The WB NCDF will facilitate the audit work and verification process and will work with the project participants to ensure co-operation.

Project operator, NovaGerar:

- The operator will prepare for the audit and verification process to the best of its abilities.
- They will facilitate the audit through providing auditors with all the required information, before, during, and, in the event of queries, after the audit.

- The operator will fully cooperate with the auditors and instruct staff and management to be available for interviews and respond honestly to all audit questions.
- It is the operator's contractual obligation and in its best interest to fully cooperate with auditors and verifier, since only successful verification will enable the delivery of ERs to the WB NCDF in fulfilment of its contract with the WB NCDF.

Auditor / verifier:

- The auditors for the project must be a professional organisations with a proven track record in environmental auditing and verification, an CDM accredited operational entity, and have experience with CDM projects and work in developing countries. The audit firm must guarantee professional work and assure the quality of the audit and verification team.
- The auditor / verifier must undertake the audit to the best of their professional ability. The auditor's responsibilities include to (a) provide the checklists and request for information in good time, (b) allow adequate time for sufficient review and preparation, (c) provide publishable reports in the agreed format, (d) work with the operator, host country authorities and WB NCDF as appropriate, (e) report on lessons learnt during the course of the project.

APPENDIX A – MAINTENANCE PROGRAMME

The maintenance programme for the generators is based on the standard Caterpillar recommended intervals and requirements. However the actual frequency is dependant on site conditions, particularly the quality of the landfill gas being used. The attached is an indication of the hours of operation that maintenance is required.

Table 7: Indicative Service Schedule

Hours of Operation	**Type of service**
Every 750 to 1,000 hours	Routine Service (see attached sheet)
Every 3,000 hours	3000 hour service (see attached sheet)
Every 12,000 to 18,000 hours	Top End Overhaul
Every 24,000 to 36,000 hours	Major Overhaul
Every 48,000 to 72,000 hours	Full Overhaul

The Overhauls typically consist of:

Top End Overhaul	**Full Overhaul**
Clean combustion space. Replace Cylinder Heads. Replace turbocharger cartridge. Renew T/C Exhaust bypass valve Cooling Water Pump Change	As for Major overhaul Replace pistons Replace camshaft bearings Replace lube oil pump
Major Overhaul	**Other Factors**
As for Top End Overhaul plus; Replace liners Replace piston rings Replace Large End Bearings Clean out Alternator and replace bearing Replace Main Bearings Replace crankshaft vibration damper. Replace crankshaft seals	At each of the above overhauls inspection and measurements of any bearing surface (including camshaft followers and cam lobes) will be made. Any anomalies will result in further inspections, which may lead to further works as required.

Maintenance includes regular lubricating oil analysis and combustion space inspection (using an endescope). This allows the maintenance schedule to be tailored to suit site conditions.

Maintenance can vary significantly as a direct result of the degree of contamination from Volatile Organic Compounds (VOC) and Hydrogen Sulphide, which can be present in the gas. During combustion, these form acids, which in turn can lead to corrosion. This can be dealt with by ensuring engine operating temperatures are maintained within acceptable limits and by selecting

a lubricating oil which neutralises acids. However, the additive used to provide this defence form combustion deposits that can lead to shortened maintenance periods.

The operator has then to make a compromise with the gas quality and lubricating oil selection in order to achieve the most cost effective maintenance frequency.

Constant inspection and analysis of operating parameters are required.

APPENDIX B – QUALITY ASSURANCE DOCUMENTATION

APPENDIX 3

GENERATOR SITE ROUTINE REMINDERS FOR SITE TECHNICIANS

INSPECTIONS TO BE CARRIED OUT DAILY

FILL OUT DAILY MONITORING SHEET AND INVESTIGATE ANY ANOMALIES
INSPECT ENGINE FOR LEAKS ETC AND RECTIFY
LISTEN TO ENGINE AND PLANT FOR ODD SOUNDS
EXAMINE COMPRESSOR, FOR WATER IN THE RESERVOIR,THAT IT HASN'T TRIPPED OFF, OR IS RUNNING TOO OFTEN ETC
CHECK WATER LEVEL IN SUMP.
CHECK AIR PUMP STROKES COUNTERS AND AIR EXHAUSTS FOR LEAKAGE
OIL LEVELS IN TOP UP TANKS
BLOW OUT DRAIN PIPEWORK FROM ENGINE DELIVERY PIPEWORK IF FITTED
FILL OUT SITE LOG BOOK WITH GAS QUALITY, KWH, AND NOTABLE EVENTS
GENERAL HOUSEKEEPING KEEP PLANT CLEAN AND TIDY
CHECK ANY TEMPORARY GAS FIELD CONNECTIONS

WEEKLY
CHECK COMPRESSOR OIL AND DRIVE BELTS
MONITOR GAS FIELD. DO THIS MORE FREQUENTLY IF THE SITE DEMANDS IT
CHECK PRESSURE DIFFERENTIAL ON GAS PLANT FILTERS
TAKE OIL SAMPLE AND SEND FOR ANALYSIS
CHECK CLEAN AND USED OIL TANK LEVELS
CHECK BATTERY ELECTROLYTE LEVELS

MONTHLY
SEND IN END OF MONTH METER READINGS & SIGNIFICANT SITE OCCURENCES
SEND IN TIME SHEETS
SEND IN EXPENSES
SEND ANY OTHER PAPERWORK EG PERMIT TO WORK OR SERVICE SHEETS.
SEND IN UP DATED OUTSTANDING JOBS LIST

ENER·G
NATURAL POWER

PROJECT OUTSTANDING WORKS NOTICE

LOG No:	
SITE:	Lune Power
DATE ISSUED:	4/10/00

No:	TASK:	DONE X
1	Fit Auto Drain to compressor.	
2	Clean up Oil Spill (Oil Sump Breather)	
3	Insulate Gasplant	
4	Support Oil Pipelines	
5	No1 Container front starting to rust.	
6	No1 gasline drain requires repair / refitting	

EXPECTED COMPLETION DATE:	
ACTUAL COMPLETION DATE:	
ADDITIONAL WORKS REPORT:	

SIGNED:	DATE:

ENTERED IN RECORD BOOK :	
SIGNED:	DATE:

THIS NOTICE IS NOT A METHOD STATEMENT
IT IS THE RESPONSIBILITY OF THE PERSON COMPLETING THE WORK TO IDENTIFY POSSIBLE HAZARDS AND RISKS INVOLVED AND TO TAKE THE APPROPRIATE ACTION BEFORE COMMENCING

APPENDIX 6

NATURAL POWER

CATERPILLAR G3516 ENGINE SERVICE/WORK STATEMENT

THIS DOCUMENT MUST BE COMPLETED AND RETURNED TO THE SERVICE DEPARTMENT AS SOON AS POSSIBLE.

PERMIT TO WORK MUST BE ISSUED BEFORE ANY WORK IS CARRIED OUT

SITE NAME					
DATE			ENGINE NO		
			ENGINEER/S		

SUITABLE PROTECTIVE CLOTHING MUST BE WORN WHERE APPROPRIATE!

ROUTINE SERVICE		FAULT RESPONSE		REMEDIAL WORK	
ENGINE HOURS		OIL HOURS		KW OUTPUT	
METER READING		COMMUNICATIONS		OIL PRESSURE	

CORRECT EQUIPMENT ISOLATION MUST BE CARRIED OUT PRIOR TO ANY WORK COMMENCING!

WORK INSTRUCTION FROM		POSITION	
PERMIT TO WORK NUMBER			

WORK UNDERTAKEN

VALVE CLEARANCES: INLET 0.51mm(.020") EXHAUST 1.27mm(.050")

CYLINDER	1	2	3	4	5	6	7	8
EXHAUST								
INLET								
CYLINDER	9	10	11	12	13	14	15	16
EXHAUST								
INLET								
VALVE								
INLET	COMPRESSION STROKE				EXHAUST STROKE			
EXHAUST	1-2-5-7-8-12-13-14				3-4-6-9-10-11-15-16			
WORK OUTSTANDING	1-2-3-4-5-6-8-9				7-10-11-12-13-14-15-16			

EQUIPMENT LEFT IN SAFE WORKING ORDER ON COMPLETION OF SERVICE/WORK

YES		SIGNED		POSITION	

EQUIPMENT LEFT SHUTDOWN/ISOLATED

YES		SIGNED		POSITION	
REASON:					

NATURAL POWER
CATERPILLAR G3516 ENGINE SERVICE INSTRUCTION

WARNING ENGINE IS EXTREMELY HOT!
PROTECTIVE CLOTHING/BOOTS/EAR-DEFENDERS MUST BE WORN DURING THIS OPERATION!

1 NOTE ENGINE kW OUTPUT IN RELATION TO THROTTLE POSITION. VISUALLY INSPECT THE ENGINE FOR ANY OIL/WATER AND GAS LEAKS. CHECK FOR ANY UNUSUAL NOISES/VIBRATIONS OR SMELLS.

2 STOP ENGINE USING NORMAL SHUTDOWN PROCEDURES.

3 WHEN THE ENGINE IS STOPPED:

A) ISOLATE ENGINE GAS SUPPLY VALVE. ATTACH ISOLATION WARNING SIGN TO VALVE.

B) ISOLATE AND LOCK OFF ENGINE BATTERY ISOLATOR. ATTACH ISOLATION WARNING SIGN TO ISOLATOR.

C) ISOLATE AND LOCK OFF ISOLATION CIRCUIT BREAKER. ATTACH ISOLATION WARNING SIGN TO BREAKER.

PROTECTIVE CLOTHING/BOOTS/DISPOSABLE LATEX GLOVES/EYE PROTECTION MUST BE WORN DURING THE NEXT OPERATION!

4 USING CORRECT EQUIPMENT TAKE AN OIL SAMPLE FROM THE DIPSTICK. (SUCTION PIPE SHOULD BE BETWEEN THE HIGH AND LOW LEVEL MARKS ON THE DIPSTICK).

5 DRAIN ENGINE/EXTENDED SUMP OIL WITH AUTO DRAIN EQUIPMENT ENSURING CORRECT VALVE SEQUENCE.

6 DRAIN OIL FILTER HOUSING. CHANGE OIL FILTERS (PUT A FILM OF CLEAN ENGINE OIL ON FILTER SEAL PRIOR TO FITTING). REPLACE FILTER HOUSING SEAL IF REQUIRED.

7 REFILL ENGINE/EXTENDED SUMP WITH CLEAN ENGINE OIL WITH AUTO FILL EQUIPMENT ENSURING CORRECT VALVE SEQUENCE. (ENSURE SUMP LEVEL IS TO MAXIMUM MARK ON DIPSTICK).

PROTECTIVE CLOTHING/BOOTS/DISPOSABLE LATEX GLOVES MUST BE WORN DURING THE NEXT OPERATION!

8 REMOVE ROCKER COVERS. DISCONNECT AND REMOVE IGNITION TRANSFORMERS. REMOVE SPARK PLUGS (NOTING THE COLOUR).

9 SET ENGINE VALVE CLEARANCES AS PER ENGINE SERVICE MANUAL RECORDING CLEARANCES ON SERVICE SHEET. RECORD TOP DECK MEASUREMENT.

10 CLEAN SPARK PLUGS WITH PLUG CLEANER. INSPECT PLUGS AND CHECK RESISTANCE FROM PLUG CONNECTOR TO CENTER ELECTRODE RESISTANCE SHOULD BE LESS THAN 20k OHMS (ENSURE CLEAN CONNECTIONS WHEN TESTING).
GAP SPARK PLUGS TO .012". VISUALLY INSPECT SPARK PLUGS. FIT NEW WASHER TO SPARK PLUG. THEN REFIT TORQUE 35lbft.

11 CLEAN AND INSPECT IGNITION TRANSFORMERS REPLACING SEALS IF OIL INGRESS IS EVIDENT. IF ANY PROBLEMS ARE APPARENT CHECK RESISTANCE FROM THE EXTENDER SPARK PLUG CONNECTOR TO THE GROUND SPRING. RESISTANCE SHOULD BE BETWEEN 8k AND 25k OHMS.
CHECK RESISTANCE FROM THE EXTENDER SPARK PLUG CONNECTOR TO EACH PIN OF THE TRANSFORMER PRIMARY CONNECTOR. RESISTANCE SHOULD BE GREATER THAN 20M OHMS.

M COOK 24/5/99 service sheet

APPENDIX J

NATURAL POWER LTD

BUCKDEN DAILY MONITORING RESULTS

Date							
	MON	TUE	WED	THUR	FRI	SAT	SUN
CH4%							
O2%							
CO2%							
Pump Pressure							
Pump vacuum							
Pump Hrs							
Compressor Hrs							
Flare Hrs							
GasFlow							
Bulk Oil Level							
KO Sump Level							
Export Kwh (Sub)							
	Date/Time			Date/Time			

Unit 671

Kw Output ND Meter							
Engine Hours							
Oil Pressure							
Oil Temp (out)							
Sump Level							
Topup Tank Level							
Oil Added							
CW Pressure							
CW Temp Inlet							
CW Temp Outlet							
Exh Temp Max							
Exh Temp Min							

Unit 958

Kw Output ND Meter							
Engine Hours							
Oil Pressure							
Oil Temp (out)							
Sump Level							
Topup Tank Level							
Oil Added							
CW Pressure							
CW Temp Inlet							
CW Temp Outlet							
Exh Temp Max							
Exh Temp Min							

APPENDIX I (CONT)

NATURAL POWER LIMITED
SEAMER MONITORING SUMMARY

DATE _____ NAME _____

GAS FIELD

Manifold	CH4	O2	CO2	Press	Action
A					
B					
C					

PUMP

CH4	O2	CO2	Press	Vac	Gas Flow

ENGINE

Gas press pump	
Gas pres engine 1	
Gas press engine 2	
Techjet gas 1	
Techjet gas 2	
KW output 1	
KW output 2	
Export kwh	

NOTES

APPENDIX 2

NATURAL POWER Ltd
SEAMER GAS FIELD MONITORING

Date

well number	CH4	O2	CO2	Mb	Valve	action
manifold A						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Mix						

Manifold B

1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Mix						

APPENDIX 5

ENER-G plc

NORGEN LAND FILL GAS LIMITED - NATURAL POWER LIMITED - CONTRACT HEAT & POWER LIMITED

PERMIT TO WORK NO. 5853

NATURE OF WORK: | **SITE**

REQUESTED BY:

ISSUERS INSTRUCTIONS:

RESPONSIBLE PERSON The precautions & isolations detailed here have been carried out and the equipment is safe to work on

Responsible Person: Name Sign. Date Time

PERMIT ACCEPTANCE As the person in charge of the work, I confirm that I have read and understand the permit conditions and that all those persons under my control have been made aware of the permit conditions and I accept this Permit to Work.

Name: Sign: Date Time

AUTHORISED ISSUER I am satisfied that the above isolations have been made and precautions taken and that the persons undertaking the work are aware of the conditions imposed by this Permit to Work and I authorise the work to proceed during the stated period

From Date: Time: To Date: Time:

Name: Sign: Date Time

PERMIT RE-ISSUE I confirm that all precautions and isolations are intact and it is safe to work on the equipment

	Day 1	Day2	Day 3	Day 4
Name				
Sign				
Date				
Time	to	to	to	to

WORK COMPLETION

WORK NOT* COMPLETED AND LEFT IN A SAFE CONDITION (Delete as necessary)

Name: Sign: Date Time

SANCTION TO TEST As the responsible person I have taken the precautions listed and checked that no conflict exists with any other permit. I authorise the equipment to be energised for testing.

Name: Sign: Date Time

RECOMMISSIONING As the responsible person I have checked the equipment is in a safe condition and can returned to service. I have checked that no conflict with other permits exists and have removed the isolations.

Name: Sign: Date Time

PERMIT TO WORK WITHDRAWN AND CANCELLED

WORK IS NOT* COMPLETED. NORMAL OPERATIONS MAY NOT* COMMENCE (Delete as necessary)

Name: Sign: Date Time