SECTION D. Application of a monitoring methodology and plan

Date of the revised monitoring plan: 15/02/2011.

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

The methodology applied to SJ is ACM0001 version 2, called "Consolidated baseline methodology for landfill gas project activities".

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

The applicability conditions for ACM0001 version 2 have already been considered under the baseline section of this PDD. In fact, SJ is a project activity undertaken with the purpose of capturing and flaring methane from landfill operations, and also using this methane as fuel for a power plant, generating electricity that will avoid fossil fuelled plants at the margin of the Brazilian electricity system, therefore causing a reduction in GHG emissions.

ACM0001 version 2 is therefore fully applicable to SJ.

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

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.)

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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.)

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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 *(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
1 LFG_{Total}	Total landfill gas captured	Flow meter to flares and powerhouse	Nm^3	M	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
2 LFG_{Flare}	Amount of landfill gas to flares	Flow meter to flares	Nm^3	M	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
3 $LFG_{Electricity}$	Amount of landfill gas to powerhouse	Flow meter to powerhouse	Nm^3	M	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
4 FE	Flare combustion efficiency. Determined by the operation hours (1) and the methane content in the exhaust gas (2)	Flare efficiency	%	M / C	(1) continuously, (2) quarterly, monthly if unstable	n/a	Electronic	(1) Continuous measurement of operation time of flare (e.g. with temperature). (2) Periodic measurement of methane content of flare exhaust gas. Data will be kept for two years after the end of the crediting period.
5 w_{CH4}	Methane fraction in the landfill gas	Continuous analyzes	$m^3 CH_4/m^3$ LFG	M	Continuous	100%	Electronic	Measured by continuous gas quality analyzer.
6	Regulatory requirements relating to landfill gas	Environmental legislation	Test	n/a	Annually	100%	Electronic	Biogás has a data base named "Green Solutions" which contains all the National Environmental Legislation applicable to the Project. The Green Solutions was developed and updated by a consultancy specialized in

	projects							Environmental Legislation.
7	Net quantity of electricity displaced during the year	Electricity meter	MWh	M	Continuous	100%	Electronic	The net quantity of electricity displaced will be measured by an electricity meter. Data will be kept for two years after the end of the crediting period.
8	CO_2 emission intensity of the electricity	Brazilian grid	tCO_2/MWh	C	Once at project start and then at each baseline renewal	100%	Electronic	CO_2 emission intensity of the electricity being generated by the grid will be determined through an approved baseline methodology, which is ACM0002 version 5. This data will be updated at the baseline renewal, in accordance with the considered methodology. Please refer to annex 3 – baseline determination, for how the emission factor will be determined. Data will be kept for two years after the end of the crediting period.
9	Electricity consumed from the diesel generator	Electricity-meter	MWh	M	Continuous	100%	Electronic	During the construction of the power house, SJ will consume electricity from a diesel generator. Data will be kept for two years after the end of the crediting period.
10	CO_2 emission intensity diesel generator	Tool to calculate project emissions from electricity consumption	tCO_2e/MWh	E	Every update of the tool.	100%	Electronic/Paper	The diesel CO_2 emission factor was adopted as a conservative default emission factor, based on the "*Tool to calculate project emissions from electricity consumption*".

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

The only source of project emissions from SJ will be the electricity consumption from a captive diesel generator during the construction of the power house. After the beginning of the power house's operation, SJ will generate no emissions since it will use project-generated electricity to operate the landfill gas project, including the pumping equipment for the collection system and energy required to transport heat.

D.2.3. Treatment of leakage in the monitoring plan

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

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
								No leakage under ACM0001 version 2.

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 under ACM0001 version 2.

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.)

Methane destruction:

$$ER = (MD_{project} - MD_{reg}) * GWP_{CH_4}$$

$$MD_{reg} = MD_{project} * AF$$

$$MD_{project} = MD_{flared} + MD_{electricity}$$

$$MD_{flared} = LFG_{flare} * w_{CH_4} * D_{CH_4} * FE$$

$$MD_{electricity} = LFG_{electricity} * w_{CH_4} * D_{CH_4}$$

ER are the emission reductions; $MD_{project}$ is the amount of methane actually destroyed/combusted during the year; MD_{reg} is the methane that would have been destroyed/combusted during a year in the absence of the project activity; GWP_{CH4} is the approved global warming potential value for methane (considered 21 throughout SJ's lifetime for the purpose of estimating emission reductions); EG is net quantity of electricity displaced; and $CEF_{electricity}$ is the CO_2 emissions intensity of the electricity displaced.

Considering there is no regulatory or contractual requirement determining MD_{reg}, an Effectiveness Adjustment Factor - EAF of 20% is used in SJ's case.

MD_{flared} is the quantity of methane destroyed by flaring (tCH_4), LFG_{flare} is the quantity of landfill gas flared during a year measured in normal cubic meters (Nm^3), w_{CH4} is the average methane fraction of the landfill gas as measured during a year and expressed as a fraction CH_4 volume per LFG volume, FE is the flare efficiency (the fraction of the methane destroyed) and D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4), measured at STP. This value is in fact 0.0007168 tCH_4/Nm^3CH_4.

$MD_{electricity}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity}$ is the quantity of landfill gas fed into electricity generator.

Electricity displacement: $ER_y = BE_{thermal,y} + BE_{electricity,y} - PE_y - L_y$ $BE_{thermal,y} = 0$ $PE = EF_{diesel\ generator} * EG_{diesel\ generator,\ y}$ $L_y = 0$ $BE_{electricity,y} = EF_{electricy} * EG_y$	*ERy:* are the emissions reductions of the electricity displacement part during the year y in tons of CO_2. *BEelectricity,y:* Are the baseline emissions due to displacement of electricity during the year y in tons of CO_2. *BEthermal,y:* Are the baseline emissions due to displacement of thermal energy during the year y in tons of CO_2. *PEy:* Are the project emissions during the year y in tons of CO_2. *Ly:* Are the leakage emissions during the year y in tons of CO_2.

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-3 LFG	Low	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
4 FE	Medium	Regular maintenance will ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values.
5 w_{CH4}	Low	The gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy.
7	Low	Electricity meter will be calibrated periodically to ensure accuracy.
9	Low	Electricity meter will be calibrated periodically to ensure accuracy.

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

Both the gas plant and the energy plant will have specific operators in charge of checking the gas flared, gas sent to engines, electricity generated and electricity dispatched. Such personnel are responsible for getting relevant information from both units monitoring systems. Monthly reports will consider the main factors as well as emission reductions calculated in accordance with this PDD.

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

ARCADIS Tetraplan is the entity determining the revision of the monitoring methodology. ARCADIS Tetraplan is not a participant in this project. Contact information:

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Annex 4

MONITORING PLAN

From the monitoring methodology, it could be seen that there are five main variables to be measured:

- Methane flow from the landfill
- Methane flow into flares
- Methane flow into powerhouse
- Methane content in the landfill gas
- Flares' efficiencies
- Electricity sent to the grid;

Electricity consumed from the diesel generator (during the construction of the power house) The degasifying unit of SJ will be installed with most up-to-date equipment to perform measures continually and allow for remote access to equipment and data. The system equipments will be connected through a Programmable Logic Control tool that will let operators quickly check the unit's main variables through a user-friendly interface. Through the PLC, users will have also access to continuously measured data, such as methane content in the landfill gas and the methane flows.

Methane flows:
There will be three flow meters installed for SJ operation: one in the main line straight after the blowers; one in the line to the flares and the last one in the line to the power house. All flow-meters will be the same model, likely the same used at Biogás other landfill gas to energy project: Instromet B.V SM-RI-X-K, which will be calibrated before entering in operation. The flow meters will be connected to the gas facilities PLC, and data will be recorded continuously. Moreover, the meters will be sealed, which prevent data manipulation.

Attached to each of the flow meters will be an electronic volume conversion device, which converts the volume measured by the flow meter to volume at 0^{o}C and 1,01325 bar, i.e., the STP. These devices will also be calibrated.

There are no national standards for the calibration of the flow-meters. However, a reference from the German National Calibration Institute obliges the recalibration of flow-meters every 10 years. Adopting a conservative approach, the flow-meters installed in SJ will be recalibrated every 5 years by a certified company/laboratory.

Methane content in LFG:
Methane content in the LFG is critical in SJ, since it will be the fuel to the powerhouse and therefore its concentration will lately determine the amount of electricity that can be generated. For measuring this information, SJ will count on a continuous analyzer (at its other project, Biogás has used a BINOS 100, manufactured by NUK, a German supplier). The analyzer will also be connected to the data system through the PLC, with information easily accessible through a desktop computer.

The calibration of the methane analyzer is be made weekly, with a standard gas certified by INMETRO (Brazilian National Metrology Institute). The calibration will follow a step-by-step internal procedure.

Flares' efficiencies:
SJ will be designed to ensure complete methane destruction at the installed flares. Nevertheless, complying with the monitoring methodology applied in this case, project owners will hire specialists to carry out exhaust gases analyses in order to determine if any methane is not being flared and, if so, how much of the gas is being released to the atmosphere.

Electricity sent to the grid:
Net Quantity of Electricity Generated at the powerhouse will be monitored both internally, by the meter installed at the output of the facility, and externally, at the electricity distributor sub-station. In both cases, the meters will be calibrated and will comply with regulatory standards for energy commercialization in Brazil.

The calibration of the electricity-meter will be made every 5 years by a certified company/laboratory.

Internally consumed energy:
During the construction of the power house, electricity consumed by Biogás will be supplied by a captive diesel generator, installed in the facility. An electricity meter will measure the amount of electricity consumed.

The diesel generator CO_2 emission factor was adopted based on a conservative value, according with the *"Tool to calculate project emissions from electricity consumption"*.

The calibration of the electricity-meter will be made every 5 years by a certified company/laboratory.

Biogás will generate monthly reports covering all such information, except for flares efficiencies, which will be determined on a less often basis. Such reports will be delivered to the verifier for means of writing the verification report. Some of the included information will be:

- Total energy generation
- Exported energy
- Internally consumed energy while the power house is not operating (monitored from the electricity meter connected to the diesel generator)
- Total extracted biogas
- Total biogas destroyed in flares
- Total biogas destroyed in engines
- Monthly average methane content in biogas
- Monthly average hourly extracted volumes of biogas
- Emission reductions from destroyed methane

The way these variables are displayed in the report can undergo minor changes in order to incorporate verification suggestions and/or needs.