INITIAL AND FIRST PERIODIC JI MONITORING REPORT

Version 3.2
May 2010

CONTENTS

Annexes

SECTION A. General project activity information

A.1 Title of the project activity:
“Methane gas capture and electricity production at Kubratovo Wastewater Treatment, Sofia, Bulgaria”

A.2. JI registration number:
Not registered.
The present PDD has not been submitted to JISC for registration and the implementation procedure of this project is going under Track 1.

A.3. Short description of the project activity:
The project is both a methane emissions reduction and energy production project. Methane produced on the Kubratovo wastewater treatment plant will be captured in common methane tanks serving as a buffer and then supplied to the newly installed CHP gas engines for electricity and heat production, which in turn reduces both the plant’s electricity purchases from the grid and diesel fuel usage. Excess electricity will be supplied to the grid.
The main purpose of the project is to transform the existing low tech sludge treatment process at Kubratovo into a modern advanced treatment process matching the best sludge treatment practise available in Western Europe. This transformation will have a major effect on the environment through dramatically reducing the existing methane gas emissions at the plant and sludge disposal site while also reducing the volume of sludge (to as much as 50%) that needs to be transported to the landfill site, hence reducing GHG emissions from transportation as well (not included in GHG abatement calculations). This will proportionally extend the life of the landfill site.
The overall objective of the project is to provide an environmentally friendly sludge treatment process reducing methane and carbon dioxide emissions that – under a business-as-usual scenario – would have continued. Other objectives are:
- replace the traditional sludge drying beds and landfill options with mesophilic digestion of all primary and secondary sludge followed by mechanical dewatering (see Figure 1) in order to reduce GHG emissions;
- effectively mitigate odour problems from the existing treatment of sludge and sludge liquors through introduction of digestion and removal of sludge drying beds;
- production of fertiliser by mechanical dewatering of the digested stabilised sludge;
- production of electricity from utilisation of the biogas in CHP gas engines thereby reducing GHG emissions from electricity production from the grid.

Completion of this project will deliver the following key results:
- all primary and secondary sludge thickened and digested as per EU recommendations and guidelines;
- all biogas produced within the digestion process used for power and heat generation via CHP gas engines thus reducing on-site electricity purchases from the national grid;

- reduction in on-site fossil fuel usage as all site-heating requirements will be met by the CHP gas engines;
- all sludge stabilised and pathogen free.

Long term strategic reductions of GHG emissions will include:
- reduction in open release of CH_4 from open anaerobic sludge tanks and drying beds;
- reduction in open release of CH_4 from landfill disposal site;
- reduction in CO_2 emissions due to replacement of electricity production from fossil fuels;
- reduction in CO_2 emissions due to replacement of heat generation from fossil fuels.

The project will be implemented in two stages:
1. Erection of new digester system consisting of 4 digesters, 7,000 m^3 each designed, supplied and erected by PASSAVANT ROEDIGER Anlagenbau.
   For destroying of the methane a flaring system will be implemented, consisting of 2 x DN150 flares, type ZA1-..F2-0/N0 designed and manufactured by HEGWEIN GmbH, Germany.
2. Erection of 3 new co-generation sets GE JMS 320 GS-B.LC with 1063 kW electric capacity each and 1088 kW thermal capacity, for generation of electric and thermal energy by combusting biogas from digesters.

The digesters have been commissioned at the end of 2006 and started generating Early credits) on 01 January 2007 but due to some technical problems in the adjustment of the biological process the generation of biogas has been interrupted in the end of June 2007 and resumed during the first Kyoto crediting period on May,1st , 2008, so the first industrial quantities of biogas have been registered in May, 2008. The quantities of waste-water treated and biogas generated in the period 01.01.2008 – 31.04.2008 have not been considered in the calculation of the baseline and the project line which is a conservative approach.
The CHP has been commissioned and started generating electricity for plant's needs in November, 2009.

Following is a table with major dates for implementation of the different stages:

Stages of the project	Date of commissioning	Generation of ERs outside the Kyoto period	Start date of ERUs generation
Ist stage (digesters)	December,2006	01.01.2007-30.06.2007	01 May 2008
IInd stage (CHP)	25 Nov.2009		25 Nov.2009

Table 1: Implementation of the project

A.3.1 Connection of the project with the European law and Directives for waste treatment.

Apart from the obvious advantages that the project provides for greenhouse gas emissions abatement it has direct connection to the general requirements of the European Union for advanced treatment of municipal waste waters. The legal act that governs those requirements is the Sewage Sludge Directive 86/278/EEC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31986L0278:EN:HTML) and the Urban Waste Water Treatment Directive 91/271/EEC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0271:EN:HTML).

The Sewage Sludge Directive 86/278/EEC seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and man. To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing or grown, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge. The Directive also requires that sludge should be used in such a way that account is taken of the nutrient requirements of plants and that the quality of the soil and of the surface and groundwater is not impaired.

The main purpose of the project is to transform the existing low tech sludge treatment process at Kubratovo into a modern advanced treatment process matching the best sludge treatment practice available in Western Europe. This transformation will have a major effect on the environment through dramatically reducing the existing methane gas emissions at the plant and sludge disposal site while also reducing the volume of sludge (to as much as 50%) that needs to be transported to the landfill site, hence reducing GHG emissions from transportation as well (not included in GHG abatement calculations). Moreover, this will proportionally extend the life of the landfill site.

The following overall measures have been implemented by the project in order to achieve its goals, as well as to comply the European Directives for Waste Water and Sewage Sludge treatment:

- **Primary settling tanks**
  The refurbished digesters will be fed with a mixed sludge from the primary settlement tanks (see Figure 5) and the secondary sludge (surplus sludge) from the biological treatment unit. Mixing of the two will occur in the sludge mixing chamber where the mixing will produce a homogenised mixed sludge, which then will be pumped into the digesters.
- **Digesters for anaerobic sludge treatment**
  The anaerobic sludge treatment plant stabilises the sludge anaerobically. With this procedure the organic part of the sludge will be reduced which also effects a reduction on the dry solid mass of the total sludge. This process has a positive influence on the sizing of the sludge treatment units following digestion and also

on the properties of sludge regarding the ability to dewater and elimination of odour nuisance. The goal of anaerobic digestion is the stabilization of the sewage sludge in order to prevent odour nuisance and improve dewatering. As degradation of the volatile solids is an asymptotic and never ending process, a criterion is needed to define the required ratio of the VSS destruction.

After the process of digestion the sludge will be dewatered and afterwards transported to the landfill site. At the landfill site, the process of anaerobic digestion will continue as described in the PDD.

- **Raw Sludge Pumping Station**
  As part of the project 5 new raw sludge pumps will be installed in the existing raw sludge pumping station.
- **Sludge Circulation System**
  For heating up the raw sludge and maintaining the process temperature at mesophilic conditions (35℃), a new combined heating and sludge circulation system is provided within the basement of the new service building. 6 volute-casing pumps for dry well installation will be installed, whereas 4 pumps are in operation and 2 are standby for emergency case.
- **Heat Exchanger**
  The anaerobic digestion process will take place under mesophilic conditions, which means within a temperature range of about 33 and 37℃. The fresh incoming raw sludge has to be heated up to the required temperature conditions. Also the heat loss of the digester has to be compensated. For this purposes a double tube heat exchanger is installed for each digester.
  The mixture of raw sludge and seeding sludge is transported from the seeding mixer via the heat exchanger where the sludge is indirectly heated in the counter current flow with hot water. The heated sludge mixture is transported via the feeding line back into the digester.

A.4. Monitoring period:

- Monitoring period starting date(before Kyoto): 01.January.2007, 00.00 h
- Monitoring period closing date(before Kyoto): 31.December.2007, 24.00 h
- Monitoring period starting date(inside Kyoto): 01.January.2008, 00.00 h
- Monitoring period closing date(inside Kyoto): 31.December.2009, 24.00 h

A.5. Methodology applied to the project activity (incl. version number):

A.5.1. Baseline methodology: The "Guidance on criteria for baseline setting and monitoring", issued by the Joint Implementation Supervisory Committee allows using approved methodologies of the CDM or JI specific approach. The PDD, determined by Tuev Sued used a JI project specific approach to establish baseline scenario.

A.5.2. Monitoring methodology: A JI-specific monitoring approach was developed for this project in line with the "Guidance on criteria for baseline setting and monitoring". The resulting Monitoring Plan was determined as part of the determination process.

Baseline Monitoring Methodology
The emission reductions from Kubratovo WwTP JI Project are based on:

1. The difference in generation of methane in the "business as usual" baseline treatment of the wastewater and the sludge.
   The methodology for monitoring and the calculation of the emission reductions is based on metered inlet quantitiy of domestic waste-water entering the plant and its Biochemical Oxygen Demand (reduced), (BOD reduced) . The baseline monitoring of the GHG emissions is based on registering of the inlet quantity of domestic waste-water to the plant and the difference in BOD content in that waste-water at the plant inlet and after the digesters before the de-watering tanks.
2. Power generation of electricity and heat by new co-generation nits (CHP). The electricity power generation of Kubratovo WwTP JI Project displaces power generated by other dispatched power-plants in the Bulgarian National Grid.
   The heat recovery of the co-generation units displaces the heat generated by the old boilers that combusted fossil fuel (diesel fuel). The burners of those boilers are duel fuel so the diesel fuel will be used as a back-up fuel in case of emergency.
   The old steam boilers have been reconstructed for production of hot water only, using the existing duel fuel burners and combusting biogas.

The methodology for the monitoring and the calculation of the emission reductions due to electricity displacement is based on metered quantities of electricity generated by the co-generation units and the EF of the Bulgarian National Grid published by Bulgarian National Electric Company (NEC) for the crediting period.

Operational and monitoring obligations
The operator (Sofiyska voda) of the JI Project must fulfill certain operational and data collection obligations in order to ensure that sufficient information is available to calculate emission reductions in a transparent manner and to allow for a successful verification of these emission reductions.
The operator must integrate the monitoring requirements and the calculation of the emission reductions into the operational procedures for the operation of the digesters and co-generation units in the JI Project. In particular, the Operator has to install the electronic workbook. In order to avoid errors based on data transfer, maximum automation of the workbook is desired. The implementation of the monitoring system and the calculation of the emission reductions is subject to review and approval at the verification.

A.6. Status of implementation including time table for major project parts:

Activity	**Date**
JI Approval by owner	June , 2004
JI endorsement by the Host country	February 2005
Construction start	01 January 2006
Letter of Approval	August, 2007
Commissioning Ist stage (digesters)	December, 2006
Commissioning IInd stage (CHP)	25 Nov., 2009

Table 2: Status implementation-time table

The digester system has been built in the end of 2006 and started operation and generation of biogas within the monitored period on 01 January 2007.

A.7. Intended deviations or revisions to the registered PDD:

No deviations from the registered PDD have been made inside the project boundary.

A.8. Intended deviations or revisions to the registered monitoring plan

No deviations or revisions to the registered monitoring plan were made

Baseline emissions calculation									
ID	**Data type**	**Data variable**	**Data unit**	**Measured M Calculated C Estimated E**	**Recording frequency**	**Proportion of data to be monitored**	**Data recording**	**Archived data**	**Comments**
1.	Primary Settling tanks	$\mathbf{Q_{in,PST,y}}$; Flow-rate of domestic wastewater into the WwTP prior Primary Settling Tanks(PST) in the year y.	m^3	M	Continuously	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly by summarizing the readings of the four flow-meters mounted at the inlet of each Primary settling tank
2.	Drying beds	$\mathbf{BOD_{in,PST}}$, Biochemical oxygen demand concentration prior to Primary Settling Tanks (PST)	mgO_2/l	M/C	Weekly	100 %	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly
3.	Drying beds	$\mathbf{BOD_{in,DW}}$; Biochemical oxygen demand concentration	mgO_2/l	M/C	Weekly	100 %	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly

		prior Dewatering Unit							
4.	Drying beds	**$BOD_{in,Dig,y}$** ; Reduced biochemical oxygen demand (Total organic substance) at digesters inlet in the year y.	t	C	Yearly	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be monitored weekly but will be aggregated monthly and yearly
5.	Drying beds	**$SM_{DB,y}$** ; Methane emissions from drying beds in the year y	t	C	Yarly	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be monitored weekly but will be aggregated monthly and yearly
6.	Electricity generation	**$EG_{CHP,y,}$** ; Electricity generation by the CHP in the year y.	MWh	M	Continuous	100 %	Electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly.
7.	Electricity generation	**$EG_{grid,y}$** ; Electricity exported to the grid in the year y.	MWh	M	Continuous	100 %	Electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly.
8.	Heat generation	**$FR_{CHP,y}$** ; Biogas flow-rate to the CHP in the year y.	m^3	M/C	Continuous	100 %	Electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly.

9	Flare	**$FR_{Flare,y}$** ; Biogas flow-rate to the flare in the year y.	m^3	C	Continuous	100 %	Electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly.

Table 4: Baseline emissions calculations variables.

Project emissions calculation									
ID	**Data type**	**Data variable**	**Data unit**	**Measured M Calculated C Estimated E**	**Recording frequency**	**Proportion of data to be monitored**	**Data recording**	**Archived data**	**Comments**
10	Primary Settling tanks	**$Q_{in,PST,y}$** ; Flow-rate of domestic wastewater into the WwTP prior Primary Settling Tanks(PST) in the year y.	m^3	M	Continuously	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly by summarizing the readings of the four flow meters mounted at the inlet of each Primary settling tank
11	Digesters	**$BOD_{in,PST}$**, ; Biochemical oxygen demand concentration prior to Primary Settling Tanks (PST)	mgO_2/l	M/C	Weekly	100 %	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly
12	Digesters	**$BOD_{in,DW}$** ; Biochemical oxygen demand concentration	mgO_2/l	M/C	Weekly	100 %	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly

		after plant prior to Dewatering unit							
13	Digesters	**$BOD_{in,Dig,y}$** ; Reduced biochemical oxygen demand at digesters inlet (Total organic substance) at digesters inlet in the year y.	t	C	Yearly	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be monitored weekly but will be aggregated monthly and yearly
14	Digesters	**$FR_{Dig,y}$** ; Biogas flow-rate at digesters outlet in the year y.	m^3	M	Continuous	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly by summarizing the readings of the four flow-meters installed at each digester outlet. After installation of the new AWITE automatic gas analyzer and flow-meter system the data will be taken and recorded automatically.
15	Digesters	**$P_{CH4,Dig}$** ; Methane	%	M	Weekly	100 %	On paper	Two years after	Data will be

		concentration in biogas after digesters					and electronic	last Carbon Credit delivery (April 2013)	aggregated monthly and yearly. The data will be collected by portable gas analyzer MULTIWARN_II. After installation of the new AWITE automatic gas analyzer and flow-meter system the data will be taken and recorded automatically.
16	Digesters	**$Q_{CH4,y}$** ; Methane production by the digesters in the year y	t	C	Continuous	100 %	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly
17	Flare	**$T_{flare,y}$** ; Ignition in flare in the year y - duration	h	M	Continuous	100%	On paper and electronic	Two years after last Carbon Credit delivery (April 2013)	Data will be aggregated monthly and yearly.

Table 5: Project emissions calculations variable

A.9. Changes since last verification:

Not applicable

A.10. Person(s) responsible for the preparation and submission of the monitoring report:

1) Sofiyska voda
Dobromir Simidchiev
Director New Investments.
Contact:
Business park "Sofia"
Building 4ª, Mladost 4
1766 Sofia
e-mail: dsimidchiev@sofiyska
mobile: +359888 878 253

2) Global Carbon Bulgaria
Viktor Milkov
Senior JI Consultant
Contact:
"3 ushi" 6ª, floor 6,office 20
1301 Sofia
e-mail: milkov@global-carbon.com
mobile: +359 882 416 275

SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period stated in A.4.

The monitoring period stated in A.4 has been chosen because from 01 July 2009 on the measuring devices used to record the biogas flow-rate at digesters outlet and the portable gas analyzer used for measuring of the methane concentration in the biogas have been replaced with new automated computerized measuring system AWITE and a new central computerized monitoring and control system. During that period the CHP system has not been commissioned yet. The methane in the biogas generated has been combusted in the boilers to produce hot water and the excess biogas has been flared. No emission reductions will be claimed for the combusting of the biogas in the hot water boilers.

The control and monitoring system consists of Waste-water /sludge BOD part, biogas part and electricity generation part.

Measurement of the waste-water flow and Biochemichal Oxygen Demand (BOD),(reduced)
For the purpose of monitoring the emission reductions the following parameters are to be measured:

- Measuring of the waste-water flow-rate at plant inlet prior to Primary Settling Tanks (PST)
- Measuring of the BOD concentration in the inlet waste-water prior to Primary Settling Tanks (PST)
- Measuring of the BOD concentration in the outlet wastewater prior to Dewatering unit (DW)

Measurement of biogas production
For the purpose of monitoring the emission reductions the following parameters are to be measured:

- Measuring of the biogas quantity generated by the digesters
- Measuring of the CH_4 concentration in the biogas generated by the digesters

After commissioning of the digesters and until June,30,2009 (included) the biogas flow-rate has been measured by four flow-meters (one for each digester) specified in the original design made by Passavant-Roediger. Methane concentration has been measured by a portable gas-analyzer type MULTIWARN_II, ID No ARTH-2239. The plans were to replace that system with automatic gas-analyzer-flow-meter process analysis system AWITE with AwiFlex, Serie 7 gas analyzer and COMBIMASS eco-basic-bio EEx de flow-meter system. The system was integrated in a modern automatic controlling on-line, including high accuracy measuring instruments and sensors as well

as control and stop valves activated by remote drives. All data collected has been screened at the operator's desk in the control room. Afterwards the work parameters have been channeled to the central dispatching office for further review and storing.
The system monitors the followings parameters for the calculation of emission reductions:

- Biogas flow-rate;
- Methane concentration;

Measurement of electric and thermal energy displaced.
After commissioning of the CHP the electricity that has been imported from the grid will be replaced by electricity generated by the co-generation units. The excess energy will be exported to the grid. In case of emergency or insufficient generation by the CHP electricity will be imported from the national grid. According to Bulgarian law the commercial electric meter mounted at the point of connection to the grid will be two-directional and will measure the difference between the exported and imported electricity, i.e. the net electricity exported to the grid.
The thermal energy generated by the CHP will, if needed be supplemented by heating in the boilers using biogas as fuel or diesel fuel in emergency cases. The boilers are outside the project boundary and no emission reductions generated by them are envisaged.
The following parameters will be monitored:

- Biogas flow-rate to the CHP
- Biogas flow-rate to the boilers
- Electricity generated by the CHP
- Electricity exported to the grid (net)

B.1. Monitoring equipment:

The control and monitoring system can be divided into a waste-water part, biogas part and electrical part.

B.1.2. Table providing information on the equipment used (incl. manufacturer, type, serial number, date of installation, date of last calibration, information to specific uncertainty, need for changes and replacements):

Measuring equipment	Measured parameter, variable	Equipment producer and type	Serial number	Installation date	Date of latest calibration	Periodicity of calibration	Measurement error data	Comments
Flow-meter – primary settling tank No1 at plant inlet	Domestic waste-water flow	ABB-Germany, MAG-XM; DN=1400 mm; with magnetic flow-meter and converter	DM41F/ 000250	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to shipment.	n.a.	+/- 0.4% on flow-rate	The magnetic flow-meter is essentially maintenance free.
Flow-meter – primary settling tank No2 at plant	Domestic waste-water flow	ABB-Germany, MAG-XM;	DM41F/ 00251	2004	For the specified coordinati	n.a.	+/- 0.4% on flow-rate	The magnetic

inlet		DN=1400 mm; with magnetic flow-meter and converter			on (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to shipment.			flow-meter is essentially maintenance free.
Flow-meter – primary settling tank No3 at plant inlet	Domestic waste-water flow	ABB-Germany, MAG-XM; DN=1400 mm; with magnetic flow meter and converter	DM41F/ 000248	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored	n.a.	+/- 0.4% on flow-rate	The magnetic flow-meter is essentially maintenance free.

					calibration data) was installed prior to shipment.			
Flow-meter – primary settling tank No4 at plant inlet	Domestic waste-water flow	ABB-Germany, MAG-XM; DN=1400 mm; with magnetic flow-meter and converter	DM41F/ 000249	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to shipment.	n.a.	+/- 0.4% on flow-rate	The magnetic flow-meter is essentially maintenance free.
Laboratory equipment	BOD concentration	WTW, table oxymeter , Oxi 730	083109 58	2008	June, 2009	Once per year and at every change	+/- 1%	The calibrating is according internal

						of the electrode, after its regeneration or after change of membrane.		laboratory methodology based on EN ISO 25814 and ISO 5813. Before purchasing of the oxymeter the BOD concentration has been measured manually in the laboratory by titring
Portable gas analyzer	Concentration of methane in the biogas CO_2-0-100 v.% O_2-0-25 v.% H_2S-0-1000 ppm CO-0-2000 ppm CH_4-0-100 v.%	Draeger , MULTIWARN_II	ARTH-2239	2005	16.10.2009	6 months	+/- 1 v.%	The portable gas analyzer was used until the purchase of the Draeger X-am 7000 portable gas analyzer.
Multichannel	Concentration of	Draeger, X-	0158,	09.2008	12.2009	Before	Influence at IR CO_2:	The

portable gas analyzer	methane in the biogas CO_2-0-100 v.% O_2-0-25 v.% H_2S-0-1000 ppm CO-0-2000 ppm CH_4-0-100 v.%	am 7000	PFG - No 41300404			every measurement, with fresh air	<= +/- 0.07 v.% Influence at IR ExHC: <= 2	portable gas analyzer was used until erection of the new AWITE gas analyzer-flow-meter system and for back-up purposes
Biogas flow from Digester No1	Biogas at digester outlet P_G = 160-250 mbar T_G = 20 ^oC Qmax = 1900 Nm^3/h Tamb = 60^oC T= -55^oC to 200^oC U=14-28 V DC	ABB-Germany, Vortex meter EEx10v-1000	04FI91	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed	n.a.	<= +/-1 %	Gas line outlet Digester No 1, PN16/DN100 Dismantled in June 2009

					prior to shipment			
Biogas flow from Digester No2	Biogas at digester outlet P_G = 160-250 mbar T_G = 20 ^oC Qmax = 1900 Nm^3/h Tamb = 60^oC T= -55^oC to 200^oC U=14-28 V DC	ABB-Germany, Vortex meter EEx10v-1000	04FI92	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to shipment	n.a.	<= +/- 1%	Gas line outlet Digester No 2, PN16/DN100 Dismantled in June 2009
Biogas flow from Digester No3	Biogas at digester outlet P_G = 160-250 mbar T_G = 20 ^oC Qmax = 1900 Nm^3/h Tamb = 60^oC T= -55^oC to 200^oC U=14-28 V DC	ABB-Germany, Vortex meter EEx10v-1000	04FI93	2004	For the specified coordination (flow range, pulse, etc. are preset)	n.a.	<= +/- 1%	Gas line outlet Digester No 3, PN16/DN100 Dismantled in June

					and the external EEPROM (with the stored calibration data) was installed prior to shipment			2009
Biogas flow from Digester No4	Biogas at digester outlet P_G = 160-250 mbar T_G = 20 ^oC Qmax = 1900 Nm^3/h Tamb = 60^oC T= -55^oC to 200^oC U=14-28 V DC	ABB-Germany, Vortex meter EEx10v-1000	04FI94	2004	For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to	n.a.	<= +/- 1%	Gas line outlet Digester No 4, PN16/DN100 Dismantled in June 2009

					shipment			
Automatic gas analyzer, flow-meter system	Methane concentration in the biogas Methane – 0-100 Vol% Oxygen – 0-25 Vol% Carbon dioxide – 0-100 Vol% H_2S – 0-500 ppm Absolute pressure 0-1600 mbar	Draeger, Awite AwiFlex and AwiECO Series 07/Firmware 645	564_09	01 July 2009	13.11.2009	Six months	+/-1 % for Methane and Carbon Dioxide +/- 0.015 % for temperature	Before installation of the system the measurements have been done by vortex flow-meters Passavant-Roediger and portable gas analyzer MULTIWARN_II.
Automatic gas analyzer, flow-meter system	Biogas flow 24 V DC ; max. 3 W; IP 65 by EN 60529 -20 ^{o}C to +60 ^{o}C	Binder , Combimass eco basic switch bio EEx de Messsystems	IBExU05ATEX1068	01 July 2009	13.11.2009	Six months	+/-1%	The flow-meter is integral part of the AWITE automatic gas analyzer, flow-meter system.
Biogas flow-meter	Biogas flow to CHP							To be specified in

								the second phase after installation of the CHP units
Biogas flow-meter	Biogas flow to hot water boilers;	ELSTER, Turbine meter TRZ2/G100 00/PN10	830419 13	01.October .2008	October,2 008, factory calibrated	n.a.	Error – max. 0.29 % Measurement uncertainty – max.0.28 %	Will be used for reference needs only
Digital electric meter	Electricity generated by the CHP	Combined device "Integra 1630"; current transformer 200/5	Ser. No 21-091420; annunciator module LSB6R GB	July 2009	July 2009 – factory calibrated	4 years	+/- 0.5%	.
Digital electric meter	Electricity exported to the grid	ABB, AINRTAL-X; Current transformer HMO 110 110/V3//01/ V3//0.1 kV; Voltage transformer	Ser. No 023648 31	October 2009	October 2009, calibrated by NEC	4 years according to the regulation	+/- 0.5%	The commercial electric meter is property of the electric distribution company (NEC)

		TMO 126 4x200/5/5/5 A						

Table 6: List of metering equipment.

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B.1.3. Calibration procedures:

For Electricity meters:

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 6 years. Calibration procedures for meters are implemented in compliance with calibration methodology developed for National Electric Company. Manufacturer's warranty-36 months	Bulgarian Centre for Standardization and Metrology

For Flow-meters

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 6 months. Calibration procedures for meters are implemented in compliance with calibration methodology developed for Draeger Safety. Manufacturer's warranty-24 months	Draeger Safety Bulgaria ABB Bulgaria

For Gas analyzers, chemichal analyzers

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 6 months. Calibration procedures for meters are implemented in compliance with calibration methodology developed for Draeger Safety. Manufacturer's warranty-24 months	Draeger Safety Bulgaria Sofiyska voda company laboratory

B.1.4. Involvement of Third Parties:

Bulgarian Center of Metrology and Standardization (control of metering equipment).
Draeger Safety Bulgaria (control and metering equipment)

B.2. Data collection (accumulated data for the whole monitoring period):

B.2.1. List of fixed default values:

ID number	Fixed data	Source of data	Data unit	Value
18	**$EF_{el,y}$** ; Carbon emission factor of Bulgarian grid for the year y	See Annex 2 of PDD (See Table 8 of this MR)	tCO_2/MWh	Varries for each year in the crediting period. The most recent EF, if published by NEC will be used. See table bellow.
19	**EF_{losses}** , Losses in the grid	See PDD, section D. The data for losses in generation and distribution of electric energy for 2008, published by Bulgarian National Statistics Institute show common losses of the grid of 12.85% (http://www.nsi.bg/otrasal.php?otr=30&a1=175&a2=216#cont). So accepting 10% for the grid losses is a conservative approach.	%	10
20	**EF_{plant}** , Carbon emission factor of plant electricity consumption	Calculated on the base of grid emission factor **$EF_{el,y}$** (See Item 20 & Table 8 of this MR)	tCO_2/MWh	Varries for each year in the crediting period. The most recent EF, if published by NEC will be used
21	**Bo** ; Maximum methane producing	Rrevised IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5:Waste,p.5.17;	$tCH_4/tBOD$	0.60

	potential of the sludge	See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):		
22	**MCF_{DB}** ; Methane conversion factor of the baseline	IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 6:Waste, p.6.21; See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):	n.a.	0.7
23	MCF_{Lf} ; Methane conversion factor of the landfill	IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 6:Waste, p.6.21; See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):	n.a.	0.90
24	**HSR_{DB}** ; Ratio of organic waste that degrades in drying beds in the absence of the project	See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):	n.a.	1.0
25	**HSR_{LF} ;** Ratio of organic waste that degrades in the landfill	See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):	n.a.	0.01
26	**EF_{diesel}** ; Emission factor of the diesel fuel	2006 IPCC Guidelines for National GHG Inventories, V2: Energy, Table 1.2	$kgCO_2$ / GJ	73.30
27	**LHV_{diesel};** Low Heating Value of the diesel fuel	2006 IPCC Guidelines for National GHG Inventories, V2: Energy, Table 1.2	MJ/kg	43.00
28	**LHV_{CH4}**; Low Heating	2006 IPCC Guidelines for National GHG	MJ/kg	48.00

	Value of the methane	Inventories, V2: Energy, Table 1.2		
29	**$\eta_{th,CHP}$** , thermal coefficient of efficiency of the CHP	GE Jenbacher: Manufacturer's documentation		0.47
30	**LE_{Sys}**; Physical leakage emissions from the digesters system	See PDD, D.1.1.2.Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent)	%	5.0
31	**GWP_{CH4}**	*"IPCC Second Assessment: Climate Change 1995. A Report of the Intergovernmental Panel on Climate Change".*Bolin, B. *Et al. (1995). IPCC website*. http://www.ipcc.ch/pdf/climate-changes-1995/ipcc-2nd-assessment/2nd-assessment-en.pdf.	n.a.	21
32	**P_{CH4}** , specific weight of methane (density)	http://en.wikipedia.org/wiki/Methane	kg/m^3	0.717

Table 7: List of fixed data.

The following table presents the currently valid emission factors:
(http://www.moew.government.bg/recent_doc/climate/Baseline%20CEF%20Summary.pdf) of the Bulgarian National grid
(http://www.moew.government.bg/recent_doc/international/climate/carbon_emission_joint.pdf):

Description	Unit	**2008**	**2009**	**2010**	**2011**	**2012**

Official up-dated Carbon Emission Factor of Bulgarian National electric grid, $\mathbf{EF_{grid,y}}$	tCO2/MWh	1.006	0.888	0.850	0.834	0.791
Emission factor for plant internal consumption Of electricity generated by CHP (grid losses 10%), $\mathbf{EF_{plant,y}}$	tCO2/MWh	1.107	0.977	0.935	0.917	0.870

Table 8: Carbon emission factors of the Bulgarian National grid.

B.2.2. List of variables:

$\mathbf{Q_{in,PST,y}}$ **,** Flowrate of domestic waste-water into the WwTP prior Primary Settling Tanks (PST) in the year y	m^3
$\mathbf{BOD_{in,PST}}$, Biochemical oxygen demand concentration in waste-water prior to PST	mgO_2/l
$\mathbf{BOD_{in,DW}}$, Biochemical oxygen demand concentration in sludge prior to Dewatering unit	mgO_2/l
$\mathbf{BOD_{in,Dig,y}}$; Reduced biochemical oxygen demand (Total Organic Substance) at digesters inlet in the year y	t
$\mathbf{EG_{CHP,y}}$, Electricity generation by the CHP in the year y	MWh
$\mathbf{EG_{grid,y}}$, Electricity exported to the grid in the year y	MWh
$\mathbf{FR_{CHP,y}}$, Biogas flow-rate to the CHP in the year y	m^3
$\mathbf{FR_{Flare,y}}$ **,** Biogas flow-rate to the flare in the year y	m^3
$\mathbf{FR_{Dig,y}}$ **,** Biogas flow-rate at digesters outlet in the year y	m^3
$\mathbf{P_{CH4,Dig}}$ **,** Methane concentration in biogas after digesters	%
$\mathbf{Q_{CH4,dig,y}}$ **,** Methane production by the digesters in the year y	t

Table 9: List of variables.

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B.2.3. Data concerning GHG emissions by sources of the project activity :

Month/Year	Qin,PST	BODin,PST	BODin,DW	BODin,Dig , reduced	Biogas flow-rate outlet digesters, FRDig,	CH4 concentration in biogas, PCH4	Biogas flow-rate to CHP, FRCHP	Biogas flow-rate to boilers, FRboiler	Quantity of CH4 at outlet digesters, QCH4,dig	Quantity of CH4 to the CHP (with 5% sys.leakage), QCH4,CHP	Quantity of CH4 to the boilers (with 5% sys.leakage), QCH4,boiler	Electric energy, generated by the CHP, EGCHP	Electric energy, exported to the grid, EGGrid
	[m3]	*[mgO2/l]*	*[mgO2/l]*	*[t]*	*[m3]*	*[%]*	*[m3]*	*[m3]*	*[t]*	*[t]*	*[t]*	*[MWh]*	*[MWh]*
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.2007	11,357,367	88	17	808	379,580	62	0	0	169	0	0	0	0
2.2007	10,196,026	83	16	675	318,090	62	0	0	141	0	0	0	0
3.2007	10,698,047	98	20	837	294,130	62	0	0	131	0	0	0	0
4.2007	9,890,701	98	15	819	282,064	62	0	0	125	0	0	0	0
5.2007	12,676,785	94	18	963	244,529	62	0	0	109	0	0	0	0
6.2007	12,770,873	69	13	716	251,915	62	0	0	112	0	0	0	0
7.2007	0	0	0	0	0	0	0	0	0	0	0	0	0
8.2007	0	0	0	0	0	0	0	0	0	0	0	0	0
9.2007	0	0	0	0	0	0	0	0	0	0	0	0	0
10.2007	0	0	0	0	0	0	0	0	0	0	0	0	0

11.2007	0	0	0	0	0	0	0	0	0	0	0	0	0
12.2007	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for the period	**67,589,800**			**4,819**	**1,770,308**				**787**	**0**	**0**	**0**	**0**

Month/Year	Qin,PST	BODin,PST	BODin,DW	BODin,Dig , reduced	Biogas flow-rate outlet digesters, FRDig,	CH4 concentration in biogas, PCH4	Biogas flow-rate to CHP, FRCHP	Biogas flow-rate to boilers, FRboiler	Quantity of CH4 at outlet digesters, QCH4,dig	Quantity of CH4 to the CHP (with 5% sys.leakage), QCH4,CHP	Quantity of CH4 to the boilers (with 5% sys.leakage), QCH4,boiler	Electric energy, generated by the CHP, EGCHP	Electric energy, exported to the grid, EGGrid
	[m3]	*[mgO2/l]*	*[mgO2/l]*	*[t]*	*[m3]*	*[%]*	*[m3]*	*[m3]*	*[t]*	*[t]*	*[t]*	*[MWh]*	*[MWh]*
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***
1.2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2008	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2008	0	0	0	0	0	0	0	0	0	0	0	0	0
4.2008	0	0	0	0	0	0	0	0	0	0	0	0	0
5.2008	11,304,914	135	19	1,303	178,297	62	0	169,000	79	0	75	0	0
6.2008	11,970,709	117	22	1,138	282,133	66	0	165,000	134	0	78	0	0
7.2008	11,746,289	94	16	926	334,602	61	0	267,000	146	0	117	0	0

8.2008	11,261,936	103	15	992	355,059	61	0	245,000	155	0	107	0	0
9.2008	12,103,687	103	17	1,045	353,531	65	0	212,000	165	0	99	0	0
10.2008	11,951,904	106	13	1,109	521,786	67	0	189,000	251	0	91	0	0
11.2008	11,498,805	131	14	1,348	359,444	66	0	141,731	170	0	67	0	0
12.2008	11,781,801	116	15	1,197	290,509	66	0	193,975	137	0	92	0	0
Total for the period	**93,620,044**			**9,058**	**2,675,361**				**1,237**	**0**	**726**	**0**	**0**
1.2009	12,825,469	104	14	1,147	367,201	65	0	248,807	171	0	116	0	0
2.2009	11,669,073	99	14	991	134,439	65	0	129,009	63	0	60	0	0
3.2009	12,901,920	103	16	1,126	179,215	66	0	153,407	85	0	73	0	0
4.2009	11,840,683	104	15	1,047	324,101	64	0	138,279	149	0	63	0	0
5.2009	12,014,954	108	16	1,102	480,347	62	0	176,503	214	0	78	0	0
6.2009	11,383,892	118	15	1,171	481,620	65	0	167,072	224	0	78	0	0
7.2009	11,623,058	113	14	1,143	560,750	61	0	220,745	245	0	97	0	0
8.2009	11,486,109	140	15	1,428	612,747	61	0	200,016	268	0	87	0	0
9.2009	11,270,571	128	14	1,290	644,436	61	0	186,642	282	0	82	0	0
10.2009	12,098,414	78	14	776	703,160	62	0	177,219	313	0	79	0	0
11.2009	10,796,616	108	14	1,009	728,205	63	85,166	122,000	329	38	55	196	0

12.2009	12,185,208	106	18	1,068	698,310	63	579,079	110,200	315	262	50	1,331	0
Total for the period	**142,095,967**			**13,298**	**5,914,531**				**2,657**	**300**	**918**	**1,527**	**0**

Table 9: Data concerning emissions due to biogas production and utilisation.
Note 1: The industrial production of biogas in the first crediting period in the digesters started as of May, 01, 2008.
Note 2: The biogas flow to the hot water boilers is registered for auxiliary needs and for reference. No emission reductions will be claimed for replacing of fossil fuel in the boilers during the whole crediting period 2008 – 2012.

B.2.3.1. Additional information on formulas used in Table 9.

The data in Column 10 of Table 9 (respectively Column K in Excel file: "Data_flows_MR") are calculated as per **Formula (2)** in **Chapter 3.1….. Project emissions** of the present Monitoring Report and presents the quantity of methane content in the biogas $\mathbf{Q_{CH4,dig}}$. :

$$\mathbf{Q_{CH4,dig} = FR_{dig} \times P_{CH4} \times \rho_{CH4} / 1000} \qquad \mathbf{[t]} \qquad \mathbf{(2)}$$

Where:

$\mathbf{Q_{CH4,dig}}$ = quantity of methane at digesters outlet. T
$\mathbf{FR_{dig}}$ = flow-rate of the biogas at digesters outlet, m^3
$\mathbf{P_{CH4}}$ = concentration of methane in the biogas at digesters outlet, %
$\mathbf{\rho_{CH4}}$ = specific weight of methane, ISO conditions, kg/m^3

The data Column 12 of Table 9 (respectively Column M in Excel file: "Data_flows_MR") are calculated as per formula analogical to Formula (2) in Chapter 3.1:

$$\mathbf{Q_{CH4,boiler} = FR_{boiler} \times P_{CH4} \times \rho_{CH4} / 1000} \qquad \textbf{[t]}$$

Where:

$\mathbf{Q_{CH4,boiler}}$ = quantity of methane at digesters outlet. t
$\mathbf{FR_{dig}}$ = flow-rate of the biogas at digesters outlet, m^3
$\mathbf{P_{CH4}}$ = concentration of methane in the biogas at digesters outlet, %
$\mathbf{\rho_{CH4}}$ = specific weight of methane, ISO conditions, kg/m^3

The data in Column 12 is used for reference needs only because the boiler is outside the project boundaries and the emission reductions due to the combustion of the biogas are not claimed and counted.

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B.2.4. Data concerning GHG emissions by sources of the baseline :

Month/Year	Qin,PST	BODin,PST	BODin,DW	BODin,Dig , reduced
	[m3]	*[mgO2/l]*	*[mgO2/l]*	*[t]*
1	***2***	***3***	***4***	***5***
1.2007	11,357,367	88	17	808
2.2007	10,196,026	83	16	675
3.2007	10,698,047	98	20	837
4.2007	9,890,701	98	15	819
5.2007	12,676,785	94	18	963
6.2007	12,770,873	69	13	716
7.2007	0	0	0	0
8.2007	0	0	0	0
9.2007	0	0	0	0
10.2007	0	0	0	0
11.2007	0	0	0	0
12.2007	0	0	0	0
Total for the period	**67,589,800**			**4,819**

Month/Year	Qin,PST	BODin,PST	BODin,DW	BODin,Dig , reduced
	[m3]	*[mgO2/l]*	*[mgO2/l]*	*[t]*
1	***2***	***3***	***4***	***5***
1.2008	0	0	0	0
2.2008	0	0	0	0
3.2008	0	0	0	0
4.2008	0	0	0	0
5.2008	11,304,914	135	19	1,303
6.2008	11,970,709	117	22	1,138
7.2008	11,746,289	94	16	926
8.2008	11,261,936	103	15	992
9.2008	12,103,687	103	17	1,045
10.2008	11,951,904	106	13	1,109
11.2008	11,498,805	131	14	1,348
12.2008	11,781,801	116	15	1,197
Total for the period	**93,620,044**			**9,058**
1.2009	12,825,469	104	14	1,147
2.2009	11,669,073	99	14	991
3.2009	12,901,920	103	16	1,126
4.2009	11,840,683	104	15	1,047

5.2009	12,014,954	108	16	1,102
6.2009	11,383,892	118	15	1,171
7.2009	11,623,058	113	14	1,143
8.2009	11,486,109	140	15	1,428
9.2009	11,270,571	128	14	1,290
10.2009	12,098,414	78	14	776
11.2009	10,796,616	108	14	1,009
12.2009	12,185,208	106	18	1,068
Total for the period	**142,095,967**			**13,298**

Table 10: Data concerning emissions due to sludge treatment.

B.2.5. Data concerning leakage :

Not applicable.

B.2.6. Data concerning environmental impacts:

Not applicable.

B.3. Data processing and archiving (incl. Software used):

In the first period all data from the laboratory and different sections of the installation will be transferred in paper and electronic form to Process management dept (PM). And will be summarized in Excel sheets by the personnel in charge there. Primary data in electronic (Excel) and paper form as well as final Excel sheets will be archived at PM.
After implementation of the SCADA control and monitoring system all data from different meters and control rooms will be transmitted directly on screen at PM chief's office and will be treated by the staff of the department.

B.4. Special event log:

- Any special events which occurred should be listed here with date and details.

There were no special events.

SECTION C. Quality assurance and quality control measures

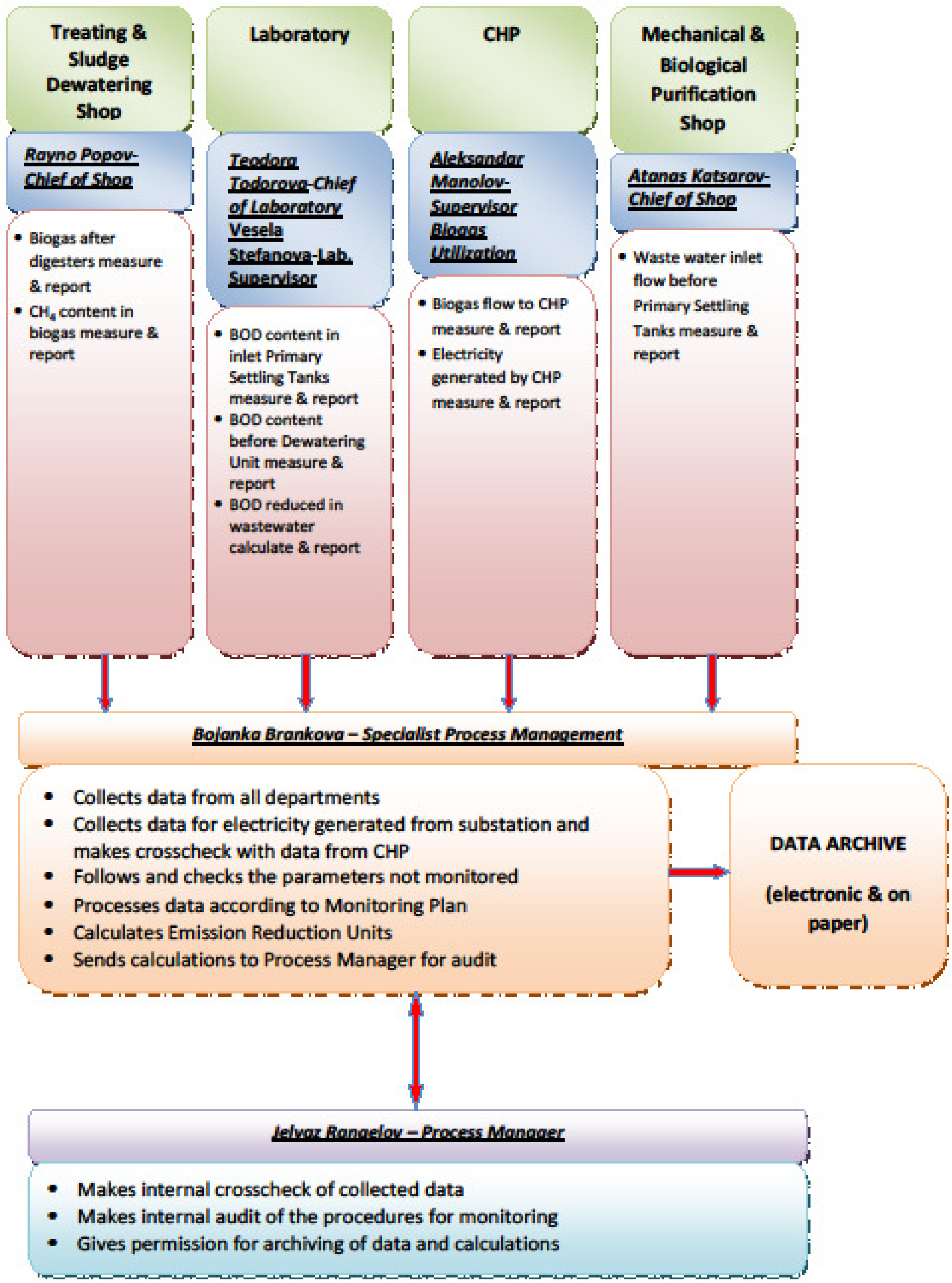
C.1. Documented procedures and management plan:

The Kubratovo WwTP is certified under ISO 14001:2004 by Bureau Veritas and has certificate No BG11843E/16 Dec.2008, valid until 18 Nov.2011.
The scope of services is:
"Management and maintenance of water supply and sewerage systems on the territory of Sofia Municipality. Water supply, sewerage and treatment of waste waters services on the territory of Sofia Municipality."
The Corporate Environmental Management System (EMS) Manual and copy of the ISO 14001:2004 certificate are attached in Annex 4 of the present document.

C.1.1. Roles and responsibilities:

The general project management will be implemented by Mr. Zhivko Cenov – Manager of Kubratovo WwTP through supervising and coordinating activities of his subordinates, such as head of laboratory, head of Process Management dept., head of accounting department, head of planning unit. During the daytime a group of mechanics who will be responsible for maintenance of all technological and measuring equipment as well as automation tools will be present on-site.
On-line information will be transmitted to the Process Management chief Mr. Zhelyaz Rangelov. His department will calculate finally emission reductions based on this data and will archive all data.
The personnel of Treating and Dewatering of the sludge shop, listing 26 people and headed by the Chief of shop Mr. Rayno Popov are authorized to take all measurements related to the generation of biogas.
The plant laboratory in the face of Mrs. Teodora Todorova and Mrs.Vesela Stefanova measure the BOD content in the wastewater at inlet of Primary settling tanks and before the Dewatering units and calculate the quantity of BOD reduced. The data is transferred to the Process Management dept. for further processing.
The roles and responsibilities of the people involved in the monitoring process are indicated in the following chart:

Flow chart with procedures for monitoring reporting and data flow



C.1.2. Trainings:

Trainings for different types of major equipment have been carried out by the suppliers and as part of the EPC contract which contains obligations in that respect that can be at the auditors team disposal at any time.
All executive and management personnel involved in operation and maintenance has been trained initially by the supplier of the basic equipment like:

- Digesters and auxiliary equipment – process management training
- CHP – operation and maintenance of the engines and electric generators & auxiliaries
- Biogas flares

In addition to the specific operational training and courses the members of all operating teams have passed training in more specific matters like working with inflammable and explosive gases, vessels under pressure and lifting equipment. The training and courses are conducted periodically on a regular base by authorised bodies.
The protocols for the trainings are included in the attached file 20100504_SD8_MR_SV_Training.rar
Copies of all protocols for trainings and courses are kept in the office of the Process Manager Mr. Jelyaz Rangelov.

C.2. Involvement of Third Parties:

- Calibration of some metering equipment is done by Bulgarian National Calibration Laboratory
- Draeger Safety Bulgaria.

C.3. Internal audits and control measures:

All metering equipment is controlled by the Instrument department. It makes periodical checking and calibration of metering equipment as per approved schedule.
The plant laboratory has its own certification and follows all calibration and measuring procedures according to EN ISO 25814 and ISO 5813
The procedure for periodic internal verification of data and GHG reductions calculation is the following:

> The internal audit is performed on a monthly basis by the Process Manager. After the specialist in Process Management dept. Mrs. Bojanka Brankova collects the data from the different department she makes the necessary calculations and aggregates the data where necessary according to the Monitoring plan. The data about CHP electricity production registered on the dedicated electric meter in the plant sub-

station is cross-checked with the data from the electric meters mounted at the CHP generators. Any discrepancy in the records is analyzed and dealt with. In case of abnormal differences between the readings the Chief of Instrument dept. have to be informed to check and if necessary replace the gauge.
Then all data is sent to the Process Manager who compares it with the data in his process computer run by a program that monitors all processes in the plant and the process computers running other processes not incorporated into the SCADA system that runs the plant.
The Process Manager cross-checks the calculations of the GHG reductions and in case everything is correct gives permission to the Process Management dept. specialist to save and archive all data and calculations.
At the end of the relevant monitoring period the data is aggregated and emission reductions are calculated after the same internal auditing procedure as in the monthly procedure.

C.4. Troubleshooting procedures:

The troubleshooting is made by maintenance mechanics or on-duty electrician/operator. The internal system requires that the broken meter has to be replaced in few hours by the Instrument department.
The Chief of Instrument dpt., M-r Lyuben Sotirov is in charge with the above activities.
The troubleshooting procedures concerning the commercial electric meters which are property of the electricity distributing company are according to the national standards for that kind of equipment, i.e. in max. 5 days the distributing company has to replace the meter. During that period the data is taken on a historical basis for a similar period of time.

SECTION D. Calculation of GHG emission reductions:

D.1. Description providing the formulas used:

Project emissions:

Physical leakage from the biogas system:

$$\mathbf{LE_{Sys,y} = 0.05 \times Q_{CH4,dig,y} \times GWP_{CH4}} \qquad [tCO_{2,e}] \qquad (1)$$

Where:

0.05 = the default value of the percentage of the physical leakages from the system accepted in the PDD
$LE_{Sys,y}$ = physical leakage from the sludge treatment and biogas system in the year y, $tCO_{2,e}$
$Q_{CH4,dig,y}$ = quantity of methane produced in the digesters in the year y, t
GWP_{CH4} = **21** = Global Warming Potential of Methane

$$\mathbf{Q_{CH4,dig} = FR_{dig} \times P_{CH4} \times \rho_{CH4} / 1000} \qquad [t] \qquad (2)$$

Where:

$Q_{CH4,dig}$ = quantity of methane at digesters outlet. T
FR_{dig} = flow-rate of the biogas at digesters outlet, m^3
P_{CH4} = concentration of methane in the biogas at digesters outlet, %
ρ_{CH4} = specific weight of methane, ISO conditions, kg/m^3

Emissions from the landfill:

$$\mathbf{SM_{Lf,y} = HSR_{Lf} \times TOS_y \times MCF_{Lf} \times Bo \times GWP_{CH4}} \qquad [tCO_{2,e}] \qquad (3)$$

Where:

$SM_{Lf,y}$ = project emissions from landfill application of the effluent sludge in the year y, tCO_2
HSR_{Lf} = **0.1** = default Ratio of organic waste that degrades in the landfill
TOS_y = **$BOD_{in,Dig.y}$** = Reduced Biochemical Oxygen Demand of the waste-water at digesters inlet in the year y, t
MCF_{Lf} = **0.9** = default Methane conversion factor of the landfill
Bo = **0.6** = maximum methane producing potential of the sludge, $tCH_4/tBOD$

$$\mathbf{BOD_{in.Dig} = Q_{in,PST} \times (BOD_{in,PST} - BOD_{in,DW}) \times 10^{-6}} \qquad [t] \qquad (4)$$

Where:

$Q_{in,PST,y}$ = inlet waste-water flow prior Primary Settling Tanks (PST) in the year y, t
$BOD_{in,PST}$ = biochemical oxygen demand prior PST, mgO_2/l
$BOD_{in,DW}$ = biochemical oxygen demand prior Dewatering unit (DW), mgO_2/l

Total Project emissions:

$$PE_y = SM_{Lf,y} + LE_{Sys,y} \quad [tCO_{2,e}] \quad (5)$$

Where:

PE_y = project emissions for the year y, $tCO_{2,e}$

<u>Baseline emission:</u>

<u>Emissions from methane from drying beds:</u>

$$SM_{DB,y} = HSR_{DB} \times TOS_y \times MCF_{DB} \times Bo \times GWP_{CH4} \quad [tCO_{2,e}] \quad (6)$$

and

$$SM_{CH4,DB,y} = HSR_{DB} \times TOS_y \times MCF_{DB} \times Bo \quad [tCH_4] \quad (6A)$$

where:

$SM_{DB,y}$ = total emissions due to methane generation from sludge in the drying beds in the year y, $tCO_{2,e}$;
HSR_{DB} = **1.0** = default ratio of organic waste that would degrade in the baseline drying beds accepted in the PDD;
TOS_y = **$BOD_{in,Dig,y}$** = total organic waste in tDC in the year y. For domestic streams, the DC (Degradable Organic Component) is the **BOD**, t
MCF_{DB} = **0.7** = default methane conversion factor accepted in the PDD.
Bo = **0.6** = default maximum methane producing potential of the sludge accepted in the PDD, tCH_4/tDC ($tCH_4/tBOD$)
$SM_{CH4,DB,y}$ = methane emissions from sludge in the drying bed in the year y, tCH_4

$$\mathbf{BOD_{in.Dig} = Q_{in,PST} \times (BOD_{in,PST} - BOD_{in,DW}) \times 10^{-6}} \quad \mathbf{[t]} \quad \mathbf{(7)}$$

Where:

$\mathbf{Q_{in,PST,y}}$ = inlet waste-water flow prior Primary Settling Tanks (PST) in the year y, t
$\mathbf{BOD_{in,PST}}$ = biochemical oxygen demand prior PST, mgO_2/l
$\mathbf{BOD_{in,DW}}$ = biochemical oxygen demand prior Dewatering unit (DW), mgO_2/l

Emissions from displaced electricity:

$$\mathbf{EE_{dis,y} = EG_{grid,y} \times EF_{grid,y} + (EG_{CHP,y} - EG_{grid,y}) \times EF_{grid,y} \times (1 + EF_{losses} / 100)} \quad \mathbf{[tCO_{2,e}]} \quad \mathbf{(8)}$$

Where:

$\mathbf{EE_{dis,y}}$ = emissions from displaced electricity in the year y, $tCO_{2,e}$
$\mathbf{EG_{grid,y}}$ = electricity exported to the grid in the year y, MWh
$\mathbf{EF_{grid,y}}$ = emission factor of the national grid in the year y, $tCO_{2,e}$ / MWh
$\mathbf{EG_{CHP,y}}$= electricity production of the CHP in the year y, MWh
$\mathbf{EF_{losses}}$ = losses in the national grid, %

Emissions from fuel switch and displaced thermal energy by the CHP:

$$\mathbf{EH_{av,y} = EH_{CHP,y}} \quad \mathbf{[tCO_{2,e}]} \quad \mathbf{(9)}$$

Where:

$\mathbf{EH_{av,y}}$ = emissions due to avoided combustion of fossil fuel in the year y, $tCO_{2,e}$
$\mathbf{EH_{CHP,y}}$ = emission due to avoided combustion of fossil fuel in the CHP in the year y, $tCO_{2,e}$

$$\mathbf{EH_{CHP,y} = Q_{CH4,CHP,y} \times \eta_{th,CHP} \times LHV_{CH4} \times EF_{diesel} / 1000} \quad \mathbf{[tCO_{2,e}]} \quad \mathbf{(10)}$$

Where:

$\mathbf{Q_{CH4,CHP,y}}$ = quantity of methane combusted in the CHP in the year y, t
$\mathbf{\eta_{th,CHP}}$ = thermal coefficient of efficiency of the CHP
$\mathbf{LHV_{CH4}}$ = low heating value of the methane, MJ/kg
$\mathbf{EF_{diesel}}$ **= emission factor of the diesel fuel, $kgCO_{2,e}/GJ$**

For conservativeness only the net quantity of displaced thermal energy is used to calculate the emissions from displaced fossil fuel.

Also for conservativeness and because the CHP has not been working during the whole monitored period, and though biogas has been combusted in the boilers for heat production, emission reductions for displacement of fossil fuel in the boilers are not claimed.

Total baseline emissions:

$$\mathbf{BE_y = SM_{DB,y} + EE_{dis,y} + EH_{dis,y}} \qquad [\mathbf{tCO_{2,e}}] \qquad \mathbf{(11)}$$

Where:

BE_y = baseline emissions in the year y,$tCO_{2,e}$

Emission reductions:

$$\mathbf{ER_y = BE_y – PE_y} \qquad [\mathbf{tCO_{2,e}}] \qquad \mathbf{(12)}$$

Where:

ER_y = emission reductions in the year y, $tCO_{2,e}$

D.2. Description and consideration of measurement uncertainties and error propagation:

All measurement uncertainties and error propagation are according to the passports of measuring equipment and the calibration certificates.

D.3. GHG emission reductions (referring to B.2. of this document):

D.3.1. Project emissions:

		2007	2008	2009
Project emissions (PE)	[tCO2e]	6,291	11,571	17,870
Total	[tCO2e]	6,291	29,440	

Table 11: Project emissions.

D.3.2. Baseline emissions:

		2007	2008	2009
Baseline emissions (BE)	[tCO2e]	42,504	79,892	118,344
Total	[tCO2e]	42,504	198,235	

Table 12: Baseline emissions.

D.3.3. Leakage:

Not applicable.

D.3.4. Summary of the emissions reductions during the monitoring period:

		2007	2008	2009
Emission reductions (ER)	[tCO2e]	36,212	68,321	100,474
Total	[tCO2e]	36,212	168,795	

Table 13: Emission reductions.

Annex 1

Definitions and acronyms

Acronyms and Abbreviations

ERU	EMISSION REDUCTION UNITS
CH_4	METHANE
CHP	COMBINED HEAT AND POWER
CO_2	CARBON DIOXIDE
BOD	BIOCHEMICAL OXYGEN DEMAND
TOS	TOTAL ORGANIC SUBSTANCE
GHG	GREENHOUSE GASES
GJ	GIGAJOULE
GWP	GLOBAL WARMING POTENTIAL
IPCC	INTERGOVERMENTAL PANEL ON CLIMATE CHANGE
MWH	MEGAWAT HOUR
PDD	PROJECT DESIGN DOCUMENT

Definitions

Baseline	The scenario that reasonably represents what would have happened to greenhouse gases in the absence of the proposed project, and covers emissions from all gases, sectors and source categories listed in Annex A of the Protocol and anthropogenic Removals by sinks, within the project boundary.
Emissions reductions	Emissions reductions generated by a JI project that have not undergone a verification or determination process as specified under the JI guidelines, but are contracted for purchase.
Global Warming Potential (GWP)	An index that compares the ability of greenhouse gases to absorb heat in the atmosphere in comparison to carbon dioxide. The index was established by the Intergovernmental Panel of Climate Change.
Greenhouse gas (GHG)	A gas that contributes to climate change. The greenhouse gases included in the Kyoto Protocol are: carbon dioxide (CO2),

	Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorcarbons (HFCs), Perfluorcarbons (PFCs) and Sulphurhexafluoride (SF_6).
Joint Implementation (JI)	Mechanism established under Article 6 of the Kyoto Protocol. JI provides Annex I countries or their companies the ability to jointly implement greenhouse gas emissions reduction or sequestration projects that generate Emissions Reduction Units.
Monitoring plan	Plan describing how monitoring of emission reductions will be undertaken. The monitoring plan forms a part of the Project Design Document (PDD).

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Annex 2

Technical drawings

Annex 3

Energy and material flowchart including metering positions

Annex 4

Excel tables for calculation of ERU

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