REPUBLIC OF GHANA

MINISTRY OF LOCAL GOVERNMENT AND RURAL DEVELOPMENT **MLGRD**

EMBASSY OF THE KINGDOM OF NETHERLANDS **EKN**

KOMENDA EDINA EGUAFO ABREM MUNICIPAL ASSEMBLY (KEEA)

GHANA NETHERLANDS WATER, SANITATION AND HYGYIENE (WASH) PROJECT

APPENDIX

Assessment of workability of plant designs, construction quality assurance, financial viability and facility operation and maintenance (O&M) management

for

Biomethanation Plant in Edina Essaman

WASTECARE

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JANUARY 2014

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Appendix A: Stakeholder Consultations and List of Persons Met

Global Renewal Energy Systems

A brief discussion was held with Prof. T.A. Coleman of Global Renewal Energy Systems who are the project designers/contractors for the KEEA Biomethanation Plant. This interaction took place at the project site. The issues which were hampering the timely and successful completion of the project from his point of view were as follows:

- Lack of cooperation by the municipal authority
- Delay in release of project funds
- Obstruction and interference of construction activities by the waste disposal activities which also occur at the project site.

The Design and Build Consultant believes that once all outstanding issues are resolved his company can complete the construction works within 4 – 6 weeks.

KEEA Municipal Assembly

A meeting was held with senior personnel of the KEEA Municipal Authority including the Municipal Chief Executive, Hon. Isaac K. Sam, at the conference room of the assembly in Elmina. Personnel from the engineering, planning, budget and audit departments were also present at the meeting. They admitted there had been difficulties due to strained relationships between the municipal assembly on one hand and the project contractor and the beneficiary community on the other hand. Issues that had been the source of conflict from their perspective included the following:

- Conflicting roles of Global Renewal Energy Systems as the designer/contractor/supervisor
- Payment schedules
- Contract terms including the measurement of completed works
- Work rate of the contractor
- Ownership of the project

The MCE also admitted the municipal assembly did not have the requisite technical expertise to supervise such liquid waste treatment systems. A follow up meeting was scheduled for 7th January 2014.

Beneficiary Communities

A meeting was held with Nana Kwesi Tandoh IV of The Edina Essaman Traditional Council at the Cape Coast Hotel lounge. Nana Tandoh was keen on the successful implementation of the project since it would be of immense benefit to the Edina Essaman community. Nana was not satisfied with the role being played by the KEEA Municipal Assembly for lack of transparency and failing to meet previous pledges to mitigate the environmental impacts arising from waste disposal activities at the Essaman dumpsite. Additionally they had failed to fully acquire the land demarcated for the waste disposal activities.

List of Participants

The list of participants at each of the stakeholder meetings is presented below.

Edina Essaman Project Site Meeting – 23rd December 2013 (11:16 – 11:46 GMT)

Name	Position	Organization
Prof. T.A. Coleman	Chief Executive	Global Renewal Energy Systems
Lukman Salifu	CEO/ Engineering Consultant	WasteCare Associates Ltd
James Afari	Financial Mgt Consultant	WasteCare Associates Ltd
Kodwo Keelson	Civil Engineering Consultant	WasteCare Associates Ltd
Delasi Amable	Team Leader	MDF

KEEA Conference Room Meeting - 23rd December 2013 (14:00 – 16:46 GMT)

Name	Position	Organization
Hon. Isaac Sam	Municipal Chief Executive	KEEA Municipal Assembly
Kwamena Adams	Internal Auditor	KEEA Municipal Assembly
Evelyn Arhin	Budget Analyst	KEEA Municipal Assembly
Z.A. Labaran	Planning Officer	KEEA Municipal Assembly
Felix Korankye Taylor	Engineer	KEEA Municipal Assembly
Kyei Agyeman Tabi	Engineer-Quantities	KEEA Municipal Assembly
Emmanuel Ofori	Engineer	KEEA Municipal Assembly
James G. Makame	Environmental Health Officer	KEEA Municipal Assembly
Lukman Salifu	CEO/ Engineering Consultant	WasteCare Associates Ltd
James Afari	Financial Mgt Consultant	WasteCare Associates Ltd
Kodwo Keelson	Civil Engineering Consultant	WasteCare Associates Ltd
Delasi Amable	Team Leader	MDF

Cape Coast Hotel Lounge Meeting - 23rd December 2013 (16:06 – 16:46 GMT)

Name	Position	Organization
Nana Kwesi Tandoh IV	Chief	Edina Essaman Traditional Area
Lukman Salifu	CEO/ Engineering Consultant	WasteCare Associates Ltd
James Afari	Financial Mgt Consultant	WasteCare Associates Ltd
Kodwo Keelson	Civil Engineering Consultant	WasteCare Associates Ltd
Delasi Amable	Team Leader	MDF

Minutes of Meeting, KEEA MA Mini Conference Room – 7th January 2014 (12:10 – 14:25 GMT)

Item	Description	Action By
1.	OPENING OF THE MEETING The meeting started at 12.15 am with opening prayer	Kurankyi Taylor
2.	MATTERS ARISING *Consultants' Draft Report* • Overview of Consultants' assignment • Presentation of interim findings – technical aspects • Presentation of interim findings – financial viability *Contractor/Designer's Response* • Contractor will provide detailed information on workability of choice of materials for liquid retaining tanks. • The Contractor will provide written responses on the absence of pre-treatment systems for the bio-conversion process. • Contractor to prepare as-built drawings for completed structures. *Ownership of the Project* • Nana Tandoh IV expresses dissatisfaction about the section of the draft report that described the KEEAMA as the owner of the project. In his view this is an error since the project was conceived by the Edina Essaman Traditional Council. Additionally, funding was also sourced by himself on behalf of the community. In his view the KEEAMA was just a facilitator of the process. • Mr. Lukman Salifu suggested that the issue of ownership would have to be settled by the sector ministry and the Netherlands Embassy. *Post-Construction O&M of the Facility* • MCE is of the view that since the KEEMA bears the cost of solid waste management services in the municipality it has a large stake in the ownership and management of the facility. • MCE proposed a PPP arrangement to manage the project after	 Lukman Salifu Kodwo Keelson James Afari Contractor MLGRD/EKN

	the construction is completed. • MCE acknowledges the role played by Nana Tandoh IV over the past 21 years and pledges to take this into consideration when a PPP management structure is worked out. *Completion of Works* • The MCE directed all the technical officers at the municipal assembly to ensure that the project is completed on schedule • Contractor gave assurances that outstanding works can be completed once the issue of timely release of funds is resolved. • Contractor is to be provide an update schedule for completing all outstanding costs	All KEEMA Works Dept Contractor Contractor
3.	NEXT MEETING No further meetings were fixed.	MCE
4.	CLOSURE OF MEETING The meeting ended at 14:25 am with a closing prayer	George Makame

Photographs

PARTICIPANTS LIST – MEETING OF 7TH JANUARY 2014

Name	Position	Organization
Hon. Isaac Sam	Municipal Chief Executive	KEEA Municipal Assembly
Alhaji Musah Issah	Municipal Coordinating Director	KEEA Municipal Assembly
Ernest Cudjoe	Municipal Finance Officer	KEEA Municipal Assembly
Evelyn Arhin	Municipal Budget Analyst	KEEA Municipal Assembly
Kwamena Adams	Internal Auditor	KEEA Municipal Assembly
Opon Tutu Paul	Municipal Public Health Engineer	KEEA Municipal Assembly
Felix Korankye Taylor	Municipal Engineer	KEEA Municipal Assembly
Kyei Agyeman Tabi	Engineer-Quantities	KEEA Municipal Assembly
Emmanuel Ofori	Engineer	KEEA Municipal Assembly
James Gmakame	Environmental Health Officer	KEEA Municipal Assembly
Solomon Agyekum	Procurement Officer	KEEA Municipal Assembly
Abdulai A. Hafez	ADPO	KEEA Municipal Assembly
Hudu Rafiatu Irene	ADPO	KEEA Municipal Assembly
Bertha Yankey	ADIIB	KEEA Municipal Assembly
Sampson Ansah	ADIIB	KEEA Municipal Assembly
Prof. T.A. Coleman	Chief Executive	Global Renewal Energy Ltd.
Nana Kwesi Tandoh IV	Chief of Edina Essaman	Edina Essaman Traditional Area
Ben Hansen Jnr.	Representative	Edina Essaman Community
Edward K. Amissah	Representative	Edina Essaman Community
Prof. T.A. Coleman	Chief Executive	Global Renewal Energy Ltd.
Lukman Salifu	CEO/ Engineering Consultant	WasteCare Associates Ltd
James Afari	Financial Mgt Consultant	WasteCare Associates Ltd
Kodwo Keelson	Civil Engineering Consultant	WasteCare Associates Ltd

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5. Kyei Agyemang Tabi James	Eng. - Quantities	0243215997		
6. Emmanuel Ofori	Engineer	0242549779		
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13 Nana Kwesi Tandoh IV	Chief of Edina Essaman	024 9394529	tandohiv@yahoo.com	
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15. J-A-Afari	WASTECARE LTD	0272746518	jaafarionico@yahoo.com	

NAME	DESIGNATION	PHONE NO	EMAIL ADDRESS	SIGNA
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19. Alhaji Mussah Issah	ADMIN	0244849616	mussahissah97@yahoo.in	
20. Bertha Tenkey	ADMIN	0249431357	berthayenkey@rocketmail.com	
21 Ansah Sampson	ADMIN	0240895538	ansahsampson@yahoo.com	

Appendix B: Outputs and By-products from Biomethanation Plant

Methane Gas

Input Data			
Description	**Symbol**	**Value**	**Unit**
Influent volume	$Q_{ww,d}$	**1825**	m^3/yr
Influent COD	$COD_{inflow,y}$	**0.02**	t/m^3
Removal Efficiency	$\eta_{COD,BL}$	**0.99**	-
Methane production capacity	$MCF_{ww,treatment,BL}$	**0.8**	-
Methane production capacity	$B_{o,ww}$	**0.21**	-
Model correction factor	UF_{BL}	**0.94**	-
Global warming potential for CH_4	GWP_{CH4}	**21**	-

Model Results			
Description	**Symbol**	**Value**	**Unit**
Baseline Methane Emission	$BE_{ww,treatment,y}$	**120.1**	tCO_2e
Methane production	-	**5.7**	tCH_4

Electricity

Input Data			
Description	**Value**	**Unit**	**Reference**
Density of methane	**0.717**	$kgCH4/Nm^3CH_4$	(Douglas et al., 2001)
Energy content of methane	**39.0**	MJ/Nm^3	(WasteCare, 2010)
Energy conversion factor	**0.2778**	KJ to Wh	(Tchobanoglous et al.,1985)
Gas engine efficiency	**30**	%	(WasteCare, 2010)

Model Results			
Description	**Value**	**Unit**	**Reference**
Methane production	**5.7**	tonnes/yr	-
	7,974	$m^{3/}yr$	-
	15.7	kg/d	
	21.8	m^3/d	-
Energy heating value	**311,001**	MJ	-
	86.4	MWh	-
Electricity generation potential	**25.9**	MWh/yr	-
	71.0	KWh/d	-

Digestate

Input Data		
Parameter	**Value**	**Unit**
Digestate Characterization		
TS content	2	%
TS concentration	20	kg/m^3
Flow Data		
Inflow	2.8	m^3/day
Losses	10	%
Outflow	2.5	m^3/day

Model Results		
Parameter	**Value**	**Unit**
Solid Digestate		
Daily Production	**50.0**	kg/day
Annual Production	**18.2**	tonnes/yr
Liquor		
Daily Production	**2.45**	m^3/day
Annual Production	**894**	m^3/yr

Appendix C: Edina Essaman Project Photo Gallery

23/12/2013

Signboard

Site access road

Site facilities

Coarse and fine aggregates

Cement blocks

Cement bricks

23/12/2013

Bioreactor 1

Bioreactor 2

Bioreactor 3

23/12/2013

Bioreactor 4

Excess Greywater Processing System

Hydro-Segregation tank

23/12/2013

Biological bed

Solar water purification tank

Reclaimed water tank

26/12/2013

Preparation of mortar mix

Bioreactor 3

Bioreactor 4

26/12/2014

Biological-bed filtration

Solar water purification tank

Reclaimed water tank

7/1/2014

Bioreactor 1

Bioreactor 2

Bioreactor 3

Bioreactor 4

Hydro-Segregation tank

7/1/2014

Biological bed

Solar water purification tank

Reclaimed water tank

7/1/2014

Appendix D: Works Progress

Summary

Description of Activity	Progress (%)
Preliminaries	55%
Bioconversion Plant	77%
Excess Gray Water Processing Plant	30%
Digested Residues Processing Plant	0%
Biogas Generator	0%
Autonomous Water Supply System	0%
Associated Works	0%

Preliminaries

BOQ Item No.	Description	Progress (%)
1/1	Movement to site and provision of site facilities	50%
1/2	Setting out works, tools and equipment	75%
1/3	Attendance by stakeholders on works	60%
1/4	Attendance during defects liability	0%
1/5	Site Occupancy, re-rendering, documentation, permits, site disinfection etc	60%
1/6	Site storage and security	5%
1/7	Instructional materials	0%
1/9	Insurance	100%
1/10	Handover	0%
1/11	Preliminary and post-construction stage contingencies	0%

Phase 2

BOQ Item No.	Description	Progress (%)
1B/1	Bioreactors (2 No.)	90%
1B/2	Hydro-segregation chamber	30%
1B/3	Entrance chamber (2 No.)	90%
1B/4	Hydraulic expansion chamber (2 No.)	90%
1C/1	Bio-bed	30%
1C/2	Solar water purification plant	30%
1C/4	Reclaimed water tank	30%
1G	External works	0%
14	Miscellaneous items	0%

Phase 3

BOQ Item No.	Description	Progress (%)
1B/1	Bioreactors (2 No.)	80%
1B/3	Entrance chamber (2 No.)	80%
1B/4	Hydraulic expansion chamber (2 No.)	75%
1B/5	Gas holder	0%
1D/1	Solar pasteurizer	0%
1D/2	Drying beds	0%
1B/6	Gas plant with compressor	0%
1G	External works	0%
14	Miscellaneous items	0%

Phase 4

BOQ Item No.	Description	Progress (%)
1E/1	Biogas generator	0%
IF/1	Autonomous water supply system	0%
1G/1	Sewage inspection works room	0%
1G/2	Plumbing and engineering installations	0%
1G/3	Electrical installations	0%
1G/4	Painting	0%
1G/5	External works	0%
11	Initial operation of facility	0%
14	Miscellaneous items	0%

As-built Dimensions

Bio-conversion Plant

Structure	Dimensions	Constructed Volume	Design Volume
Hydro-segregation chamber	Length = 3.2 m Breadth= 2.2 m Upstream depth = 0.68 m Downstream depth= 0.82 m	5.28 m^3	4.2 m^3

Excess Gray-water Plant

Structure	Dimensions	Constructed Volume	Design Volume
Bio-Bed	Length = 3.1 m Breadth = 2.2 m Depth = 0.98 m	6.68 m^3	3.6 m^3
Solar water purification plant	Length = 3.2 m Breadth = 1.8 m Depth = 1.1 m	6.33 m^3	5.4 m^3
Reclaimed water tank	Length = 3.8 m Breadth = 3.2 m Depth= 1.4 m	17.02 m^3	Not specified

Appendix E: Contractor's Revised Works Schedule

A. PHASE 2 SITE CONSTRUCTION WORKS PROGRAMMES, SCHEDULES AND COSTS

BOQ Page No	Item	Description	COST (GH¢)	TIME FRAME (WEEKS FROM DATE OFPHASE 2 FUNDS RELEASE)		
				WEEK S 1,2,3,4,5 (19.08/13 – 20/09/13)	WEEKS 6,7,8,9,10) 23/09/13 – 01/11/13)	
2	1B/1	Bioreactors (2 modules with total capacity 125 m3)	43,750			
2	1B/2	Hydro-segregation chamber	9,240			
2	1B/3	Entrance chambers (2 modules @ 1.8 m3)	630			
2	1B/4	Hydraulic expansion chambers (2 modules @1.8 m3)	630			
3	1C/1	Bio-bed (3.6 m3)	3,240			
3	1C/2	Solar water purification plant (5.4 m3)	5,940			
3	1C/3	Reclaimed water tank/pump	1,660			
4	1G	External works)	1,000			
5	13	Miscellaneous items	200			
5	12	Contingencies	1,000			
		Total	67,290			

B. PHASE 3 SITE CONSTRUCTION WORKS PROGRAMMES, SCHEDULES AND COSTS

BOQ Page No	Item	Description	COST (GH¢)	TIME FRAME (WEEKS FROM DATE OFPHASE 3 FUNDS RELEASE)		
				18/11/13 – 20.12/13	WEEKS 27/12/13 – 24/01/14	
2	1B/1	Bioreactors (next phase of either 2 modules with volume 62.5 m3 each or single module with volume 125 m3)	43,750			
2	1B/3	Entrance chambers (2 modules @ 1.8 m3)	630			
2	1B/4	Hydraulic expansion chamber (2 modules @ 1.8 m3)	630			
5	12	Contingencies	1,000			
5	13	Miscellaneous items	62			
		Total	46,072			

C. PHASE 4 SITE CONSTRUCTION WORKS PROGRAMMES, SCHEDULES AND COSTS

BOQ Page No	Item	Description	COST (GH¢)	TIME FRAME (WEEKS FROM DATE OFPHASE 4 FUNDS RELEASE)		
				31/01/14 -	21/02/14	
2	1D/1	Solar pasteurizer (4.8 m3)	5,280			
2	1B/5	Gas holder (4.6 m3)	5,520			
2	1D/2	Drying beds/packaging unit	2,000			
3	1B/6	Gas plant with compressor	4,500			
4	1G	External works	300			
5	13	Miscellaneous items	100			
4	1E/1	Biogas running electric generator plus housing, wiring etc	12,000			
4	1F/1	Autonomous water supply systems	15,000			
5	12	Contingencies	400			
5		Miscellaneous items	62			
		Total	45,162			

C. PHASE 5 SITE CONSTRUCTION WORKS PROGRAMMES, SCHEDULES AND COSTS

BOQ Page No	Item	Description	COST (GH¢)	TIME FRAME (WEEKS FROM DATE OFPHASE 5 FUNDS RELEASE) 24/02 – 15/03/2014		
4	1G/1	Sewage inspection/Workrooms	14,000			
4	1G/2	Plumbing and engineering installations	6,500			
4	1G/3	Electrical installations	2,000			
4	1G/4	Painting	2,500			
4	1G/5	External works	200			
5	11	Initial operation of facility	4,200			
5	12	Contingencies	283			
6		Miscellaneous items	62			
		TOTAL	29,745			

Appendix F: Contractor's Response to Draft Report

GLOBAL RENEWABLE ENERGY SERVICES

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COMMENTS ON WASTECARE ASSOCIATES CONSULTANTS' DRAFT REPORT ON BIOMETHANATION PLANT PROJECT AT EDINA ESSAMAN

The Draft Report by WasteCare Associates Consultancy team on the Biomethanation Plant project at Edina Essaman dwelt on a number of issues on which we provide our comments in the sequence of observations made in the main text of the report in order to clarify issues on various aspects of the project.

REPORT REF: Page 11 Section 3.1.1

1. Site Layout (Report Ref: Page 11 Section 3.1.1)

Drawing Dimensions

The report's observations about missing drawing dimensions are well taken. However we wish to mention that the overall sizes of the various system units are provided in the specifications and bill of quantities. In the drawings the detailed dimensions were left out to prevent confusion and repetitive re-drawings due to several shifts in the boundaries of the project site experienced at the beginning and in the process of project construction. Initially, the limits of the waste site were altered thrice by Komenda Edina Eguafo Abrem Municipal Assembly (KEEA MA). The waste site is in active use for the dumping of municipal sewage and solid waste by agents of the Assembly. Time and again we have had the occasion to face dumping of refuse within and very close to the area demarcated for the project by waste disposal agents and the need to modify the positions of the plant system units to accommodate the changes in the geometric alignment and orientations of the altered site area. Each alteration necessitated some modifications in the relative magnitudes of the plant systems dimensions in order to stay within the same overall sizes. Furthermore, the site as a landfill area has very fractious and unpredictable ground conditions compelling a review of plant systems positioning in the course of the project construction. These factors led us to defer the precise indications of various dimensions on the drawings while conforming generally to overall sizing of the units. The detailed dimensions will eventually be provided in the As-built drawings.

2. Excreta (Faecal Sludge) Inlet/Discharge Point (Report Ref Page 11 Section 3.1.2)

The inlet port referred to in the report is designed as part of the hydro-segregation tank which was originally intended to receive fresh sanitary water from a relatively small size flush- water closet system of a well organized public toilet facility which provides proper toilet materials for use by clients. For the present scale of the project, the volumetric daily load from this stream of waste water is expected to be less than 15% of inflow to the entire plant. The bulk of activated sewage from tankers constituting over 85% will be discharged directly into the bioreactors to avoid direct contact with humans. The discharge piping from the sanitary facility enters the inlet to the hydro-segregation tank where the waste water undergoes a two stage upward screening/filtration process. The settled sludge then enters the bioreactors while the supernatant fluid flows to the biological filtration bed. The first stage screening/filtration is expected to act as pre-treatment section to entrap extraneous materials for removal periodically. The design concept is to minimize human-to-sewage contact as much as possible and limit it to the periodic cleaning times. When need be, in line with the suggestion in the Report, another pre-treatment section for de-gritting and screening can be introduced in the entry section of the hydro-segregation tank.

3. Hydro-segregation Tank (Report Ref Page 11 Section 3.1.3
On account of the reasons explained above, in addition to the fact that the tank is a transient facility with hydraulic detention time of less than 3 hours for influent fluid, we consider the choice cement blocks with good coating of cement mortar plaster to be adequate and appropriate for the essential functions for the hydro-segregation chamber which include
   i. Separation of fresh sewage into two fractions: approximately 12 to 15% settled and 85 to 88% supernatant
   ii. Conduction of the separated fluids in two different directions: settled sludge to the bioreactors; supernatant to the filtration bed
   iii. Initiation of disinfection of influent sewage to reduce the propagation of sewage related vectors that can be harmful to humans and environment

The comment of the report on the use of concrete is noted possibly for larger plants with larger flows into the tank. The use of good cement plaster for the tank for the present scale of plant is expected to act as a compensatory measure in lieu of concrete.

4. Anaerobic Digesters
The report observes that the use of 125mm (5 inches) cement blocks at the base of the bioreactor dome is not appropriate as it may affect the structural integrity of the bioreactor in the medium and long terms. We however give assurance based on the mechanics of bioreactor design and over 25 years of construction history and experience that the use of the cement blocks presents no such problems to the structural integrity of the bioreactors.

A wide range of materials can be used for bioreactor construction, including laterite, (Ref. Annexure 1), hard and soft bricks, plastic balloons (Ref Annexure 2 & 3), clays, earth mortar, (all of these being much "weaker" than cement blocks in load bearing strength) as well as cement blocks, pavers, etc all with medium and long term durability. Over the past several years, a number of bioreactors constructed with cement blocks on the base levels have performed well without any problems arising from their use.

When cement blocks and cement pavers are used together as in the present construction, they are utilized on the basis of their mutual reciprocal complementarities. There are three main segments of the bioreactor: the base slab, the short foundation vertical cylindrical wall section which also contains the inlet and outlet gates into the bioreactor and the spherical wall dome. Cement blocks are about seven times faster to use on the vertical cylindrical section than cement pavers; on the other hand, cement pavers are about seven times faster to use on the spherical sections than cement blocks. The use of the two jointly in any construction is thus informed by their relative time factor advantages. From structural perspective, none of the two offers any comparative higher advantage for the durability of underground spherical bioreactors such as the ones being constructed for the present project. In either case our construction methods employ rich coating of cement plaster to enforce the structure to ensure very long term durability.

The technical reasons for the durability of underground spherical shell bioreactors irrespective of the materials for construction are rooted in the mechanics of the load bearing analysis of the bioreactor system which shows that whichever material is used in the foundation cylindrical wall or the dome sections, the load bearing requirements are far less than those which cement blocks or cement pavers ordinarily withstand for several decades in vertical rectangular structures. The analysis is depicted in Annexure 4 which can be briefly summed up as follows:

i. Any cement block component at position A experiences three main types of loading: from hydraulic pressure from the fluid contained in the reactor; from the external earth cover; and from the blocks above it.

ii. The fluid pressure load and earth cover loads effectively neutralize one another, leaving zero net force in the block (A)
iii. Only one or two layers (B) of the upper block have any significant loading effect on the block
iv. Beyond the third layer of upper blocks, the spherical contour becomes dominant. In the spherical region, the component of the weight of the block such as C having any effect of the lower block A is proportional to the cosine of the angle Ω between the gravitational line component of the weight and the line of action towards the block. This weight component reduces to zero as Ω increases to 90° at the highest location of the dome. The net effect is that the blocks in the foundation cylindrical section carry very insignificant load and thus cement blocks or any other fairly solid bodies over a wide range of strengths can sustain the spherical structure of the reactor dome for appreciably long periods.

5. Section 3.1.5 Gas Holder

The basis of the choice of gas holder size has already been communicated to WasteCare Associates by previous correspondence.

6. Section 3.1.6 Gas Plant

The gas plant will have standard gas storage cylinders into which gas from the gas holder will be pumped via a compressor. Biogas cleaning will be undertaken through the use of scrubbing agent in a scrubber pack.

7. Section 3.4 Autonomous Water Supply System

A description of the autonomous water supply scheme has been communicated to WasteCare Associates

8. Ref Page 15

The following corrections are to be made in the entries in the first table:

Item 9.1 Payments made so far: 167,037.77 to be corrected to 132,988
Item 9.4 Amount certified to date: 167,037.77 to be corrected to 132,988

9. Ref Page 17

The entries in Table 4.3 have not taken account of the fact that movable components of the hydro-segregation chamber, biobed, solar water purification plant and reclaimed water tank have deliberately not been installed due to site safety factors. A number of these were installed earlier on and were demonstrated as to their functional use during the site visit of Netherlands Embassy delegation in November 2013. The movable items were later deliberatively uninstalled by our team when they were discovered to be prone to tampering by persons who visit the waste site to scavenge for waste components. These items are being reserved for re-installation close to plant operations time when safety measures will have been put in place to ward off tampering etc.

10. Ref Pages 17 and 18

Tables 4.3 and 4.4 may be reviewed to reflect the revised works programmes schedules prepared and forwarded to KEEA MA and Netherlands Embassy late last year and, copies of which have been sent to WasteCare Associates by previous correspondence.

11. Ref Page 24

Section 5.5 Payments to Contractor
The amount of payment made so far to the Contractor is Gh¢ 132,988 instead of Gh¢167,037.27

12. Ref Page 24

Section 5.5 Value for Money
The observation in the report that the item listed in Table 5.6 need be revisited to take account of the following factors:

i. As mentioned in Section 9 supra, many portable and easily damageable plant unit parts that were earlier installed had to be removed to avoid being tampered with on the site by waste scavengers who visit the site in the absence of project workers. The re-installation of these items is being deliberately delayed till the time close to plant operation to ensure that they can be properly taken care of by plant operators These items which, due to lack of time and opportunity, have not yet been observed by the Consultants include black body radiator panels, and optical panels for the top surfaces and side linings of the **hydro-segregation chamber** and **solar water purification plant**; first and second stage upflow filtration/screening packs for hydro-segregation tank, **bio-bed** filtration media packs, hydraulic pump for the **reclaimed water collection tank**. Also included are items such as water vessels, hoses, earth working tools etc that have been procured under "movement to site", works done previously under " setting out" schedules etc. Logistical expenses covering various aspects of the project works have also to be taken into account in the assessment of the project.

Also attached as Annexure 5 to our comments is a list of samples of consultancy documents, including design services, on works undertaken in furtherance of the project over a period of several number of years.

Many of the items mentioned in the table include sub items that fall under the category of "intangible works" many of which have been accounted for in previous submissions to KEEA Municipal Assembly to show value for money. These submissions are exemplified by ATTACHMENT 6 (1 to 8)

The reckoning of the above named factors in the assessment is likely to lead to a revision of the comments of the report regarding value for money on the relevant aspects of the project.

13. Socio-economic benefits
We share the views expressed in the report on the benefits of the project to the community

14. Financial Viability
We have supplied to Watecare Associated further information on the gas and soil conditioner derivatives expected from the plant which are likely to further improve the potential financial viability of the project as analytically evaluated and predicted in the report.

ANNEXURE 1

Fig. 14: Household plants as tent plants (foil-covered pits) in the Ivory Coast.

2.4.2. The Ivory Coast

Apart from at the University of Abidjan there have been no government plants for the production of biogas.

In 1981 a biogas plant of 400 m³ volume was erected on a beef-farming station with slaughter-house and processing plant with the assistance of the GTZ, and taken into to operation in July 1982. This was a foil- covered pit model (see fig. 15 + 24). The plant was constructed in order to secure an electricity supply for the slaughter-house.

This system proved to bei technically very positive and as a result a distribution scheme for family plants, as foil-covered pits, was launched. In the meantime 60 ha- [illegible] been completed. The distribution scheme is being administrated by the Govern-[illegible] of the Ivory Coast in cooperation with the GTZ.

[illegible] Ivory Coast is a typical example to illustrate the fact that the installation of a [illegible] plant can lead to a biogas distribution programme for individual house-

2.4.3. The Philippines

In 1977, as a result of the oil price shock of 1973 the President d[illegible] tion of alternative sources of energy. By 1984 over 100 research [illegible] projects had been promoted by the government. The total numbe[illegible] nal biogas plants amounts to about 600 small-scale and 150 large[illegible]

Predominant in biogas development in The Philippines on accou[illegible] sive technical and economical success, are the Maya Farms where biogas is produced and used in the pork- processing plants connec[illegible] research facilities were maintained independent of any state suppo[illegible] the findings an abundancy of various types of plants were erecte[illegible] being operated as batch system. The majority are rectangular [illegible] with separate gas tanks which have been constructed as floatin[illegible] steel drums.

It is therefore not surprising that according to government polic[illegible] large-scale biogas plants has priority over every other renewab[illegible] whilst the distribution of small-scale plants on the village level [illegible] last place The Minister of Energy is of the opinion that the [illegible] plants has been concluded and that biogas development should [illegible] ferred to the private-economic sector.

The activities of private companies should be supported by [illegible] exemption from import duty on material and equipment. Th[illegible] judged very positively. A limitation is seen in the high inves[illegible] available for the financing of this.

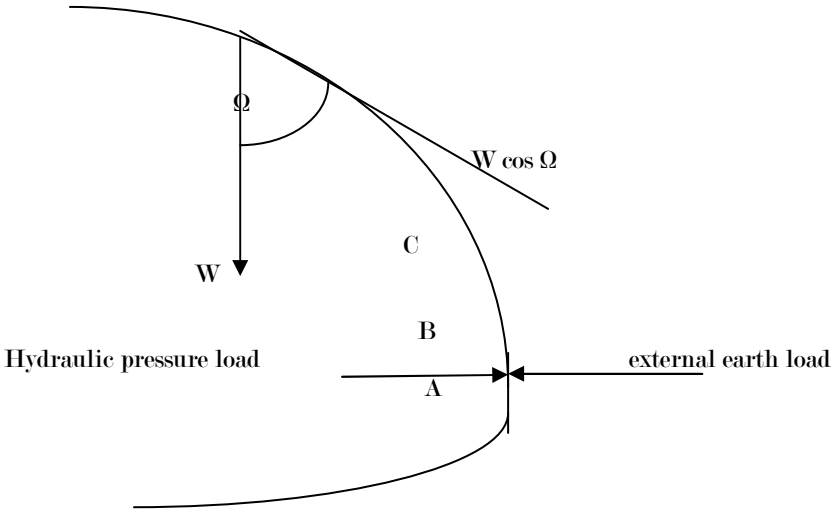
The majority of agricultural undertakings which produce [illegible] not have facilities for its effective utilization. Another d[illegible] this reason, to not only promote the integration of proc[illegible] but also, similar to the U.S.A., to control the delivery of [illegible] companies. As small-scale plants normally only substitut[illegible] e.g. wood, they are only of secondary importance withi[illegible]

[illegible] pit Construction

Source: Biogas- Community Plants Manual by Borda GTZ

ANNEXURES

ANNEXURE 4



ANNEXUE 5

The following items form sample part of project designs, draughts, drawings, and consultancy documentation undertaken by Global Renewable Energy Services for the project:

SR. NO	ITEM DESCRIPTION	COST (Gh¢)
1	DESIGN DRAWING TITLE: Solar Water Purification Unit (Version 1)	
2	DESIGN DRAWING TITLE Solar Pasteurizer	
3	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 2)	
4	DESIGN DRAWING TITLE Gas Holder	
5	DESIGN DRAWING TITLE Drying Bed	
6	DESIGN DRAWING TITLE Solar DESIGN DRAWING TITLE Pasteurizer (Version 2)	
7	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 3)	
8	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 4)	
9	**DESIGN DRAWING TITLE** Modern Biomethanation Sewage Treatment Plant For Edina Essaman	
10	**DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout	
11	**DESIGN DRAWING TITLE** Bioreactor Entrance/Exit Systems Section	
12	**DESIGN DRAWING TITLE** Biobed Views	
13	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility BIOCONVERSION PLANT	
14	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility BIOCONVERSION PLANT (Sectional Elevations)	

15	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility, Half Size Of 20-Seater Public Toilet Housing Unit)	
16	**DESIGN DRAWING TITLE** Workrooms	
17	**DESIGN DRAWING TITLE** Roof Plan (for work rooms)	
18	**DESIGN DRAWING TITLE** Foundation Plan (for work rooms)	
19	**DESIGN DRAWING TITLE** Ground Plan For work rooms)	
20	**DESIGN DRAWING TITLE** Sectional Elevation 2 of Back Wash Forced Convection Biobed (BWFCB)	

21	**DESIGN DRAWING TITLE** Edina Essaman Wash Biomethanation Plant Biobed Plan Preview	
22	**DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout (version 2)	
23	**DESIGN DRAWING TITLE** Bioreactor System – Elevations Schema	
24	**DESIGN DRAWING TITLE** Bioconversion Plant Section	
25	**DESIGN DRAWING TITLE** Sectional Elevation of 2 of Back Wash Forced Convection Biobed (BWFCB Version 2)	
26	**DESIGN DRAWING TITLE** **DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout (version 3)	
27	**DESIGN DRAWING TITLE** Hydro-Segregation Chamber	
28	**DESIGN DRAWING TITLE** Temporary Site Office	
29	**DESIGN DRAWING TITLE** Biobed Views (LARGE PRINT)	
30	**DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout (variant 3)	

31	**PROJECT CONSULTANCY DOCUMENT**: Design and Construction of Modern Municipal Sewage Treatment Plant at Edina Essaman: scope of works, facility descriptions, project design calculations, algorithmic programming, computational schemes, technical specifications, and cost specifications	
32	**PROJECT CONSULTANCY DOCUMEENT:** Design and Construction of Modern Municipal Sewage Treatment Plant at Edina Essaman: Project Bill of Quantities	
33	**PROJECT CONSULTANCY DOCUMENT**: Edina Essaman Sanitation and Solid Waste Management Improvement Project Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services July 2011	
34	**PROJECT CONSULTANCY DOCUMEN:** Edina Essaman Water Sanitation and Solid Waste Management Improvement Project Submitted to Ministry of Local Government and Rural Development and The Embassy of The Kingdom of The Netherlands by Edina Essaman Royal Stool and prepared by Global Renewable Energy Services August 2011	
35	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman Sanitation and Solid Waste Management Improvement Project Feasibility Report Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services July 2011	
36	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman Sanitation and Solid Waste Management Improvement Project Technical Proposal, Financial Proposal and Bill of Quantities Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services Feb 2012	
37	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman Sanitation and Municipal Waste Management Improvement Project. Project Technology, Design, Specifications and Plant Descriptions Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services. Feb 2012	
38	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman and Cape Coast Sanitation Municipal Waste Management and Ecological Improvement Project	

	Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services May 2012	
39	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman Sanitation and Municipal Waste Management Improvement Project Project Bill of Quantities Sept 2012	
40	**PROJECT CONSULTANCY DOCUMENT:** Edna Essaman Water and Sanitation Improvement Project. Project feasibility studies. Prepared by Global Renewable Energy Services Updated 6th September 2012	
41	**PROJECT CONSULTANCY DOCUMENT:** Edna Essaman Water and Sanitation Improvement Project. Project feasibility studies, descriptions and proposal. Updated 4th September 2012	
42	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman and Cape Coast Sanitation Municipal Waste Management and Ecological Improvement Project. Bill of Quantities Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services May 2012	
43	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman Sanitation and Municipal Waste Management Improvement Project Financial Analysis Sept 2012	
44	**PROJECT CONSULTANCY DOCUMENT**: Edina Essaman Sanitation, Municipal Waste Management and Ecological Improvement Project 60MW Inter district biomethanation waste to energy recycling facilities for environmental intermediation Project technology, design specifications and plant descriptions. Submitted to Edina Essaman Royal Stool By Global Renewable Energy Services. Updated May 2012	
45	**PROJECT CONSULTANCY DOCUMENT**: Edina Essaman Water and Sanitation Version 3 Bill of Quantities. Prepared by Global Renewable Energy Services. Updated November 2012	

ATTACHMENT 6 (1)

GLOBAL RENEWABLE ENERGY SERVICES

WORLD BANK CERTIFICATE OF RECOGNITION FOR POLLUTION-LESS WASTE-TO-ENERGY SANITARY FACILITIES

LOCAL TEL: 0244 449614; 0277 579481
INTERNATIONAL: +233 244 449614; +233 277 579481;
EMAIL: globalrenewableservices@gmail.com
ALT E-MAIL: genergies@yahoo.com

P. O. Box DC 549,
Dansoman,
Accra,
Ghana.

cleaner Safer world

July 10, 2013

The Municipal Chief Executive,
Komenda Edina Eguafo Abrem Municipal Assembly,
P. O. Box 29,
Elmina

Dear Chief Executive,
DESIGN AND CONSTRUCTION OF MODERN BIOMETHANATION MUNICIPAL SEWAGE TREATMENT PLANT AT EDINA ESSAMAN: SUBMISSION OF STATEMENT OF EXPENDITURE ON PROJECT WORK ESSENTIALS DISTINCT FROM SITE CONSTRUCTION WORKS

Sequel to the meeting of stakeholders of the above named project at KEEA Municipal Assembly premises and visit to the project site on Friday 28th June 2013, we deem it appropriate to submit to your office updated statement of expenditure on some project activities that are distinct from site works. The expenditure is itemized in the attached summary (Annexure I). The details are provided in Annexure II.

The expenditure on these activities totaling so far to the amount of Gh¢ 46,030.50 (Forty Six Thousand and Thirty Ghana Cedis, Fifty Ghana Pesewas) is to be added to the cost of the site works being evaluated by the Works Department of your Assembly to arrive at appropriate cost of works for the certification of Phase 1 of the project.

Yours sincerely,

GLOBAL RENEWABLE ENERGY SERVICES
P. O. BOX DC 549, DANSOMAN-ACCRA

EXECUTIVE DIRECTOR

Prof. Timothy Archibald Coleman
(Executive Director)
TEL: 0244 449614; 0277 579481
EMAIL: globalrenewableservices@gmail.com

CC:
The Embassy of the Kingdom of The Netherlands: ATTN Mrs. Elsie Appau (Elsie.Appau@minbuza.nl)
Nana Kwesi Tandoh IV, Chief of Edina Essaman and Gyasehen of Edina Traditional Council (tandohiv@yahoo.com)
The Coordinating Director (musahissah@yahoo.in)
The Head, Works Department, KEEA Municipal Assembly (taylorkurankyi@yahoo.com)
Municipal Development Planning Officer, KEEA (fuseinilabaran@yahoo.com)
Municipal Engineer, KEEA (opokutouch@yahoo.com

ATTACHMENT 6 (2)

ANNEXURE I

GLOBAL RENEWABLE ENERGY SERVICES P. O. BOX DC 549, DANSOMAN, ACCRA TEL: 0244 449614; EMAIL: globalrenewableservices@gmail.com

EDINA ESSAMAN WASH PROJECT – Ghana Netherlands WASH Programme

SUMMARY OF EXPENDITURE ON PROJECT WORKS ESSENTIALS EXCLUDING SITE STRUCTURAL CONSTRUCTION WORKS

SR. NO	ITEM DESCRIPTION	COST (Gh¢)
PART 1	PROJECT BONDS	1,840
PART 2	PROJECT DESIGNS, CONSULTANCY ETC	22,080
PART 3	SITE OCCUPANCY REQUIREMENTS	10,700
PART 4	PROJECT JOURNEYS (excluding subsistence allowances and project engineering works)	5,340
PART 5	PLANT TOOLS, EQUIPMENT, MATERIALS ETC	4,851
PART 6	SITE CLEARANCE AND DEMARCATION	1,140
PART 7	COURIER POSTAGES TO KEEA MCE PLUS LOGISTICS	79.5
	TOTAL	**46,030.5**

ATTACHMENT 6 (3)

ANNEXURE II

GLOBAL RENEWABLE ENERGY SERVICES P. O. BOX DC 549, DANSOMAN, ACCRA TEL: 0244 449614; EMAIL: globalrenewableservices@gmail.com

EDINA ESSAMAN WASH PROJECT – Ghana Netherlands WASH Programme

COST OF PROJECT WORK ESSENTIALS EXCLUDING SITE CONSTRUCTION WORKS – PROJECT PHASE 1

PROJECT: DESIGN AND CONSTRUCTION OF MODERN BIOMETHANATION SEWAGE TREATMENT PLANT AT EDINA ESSAMAN
NETHERLANDS WASH PROGRAMME

PART 1: PROJECT BONDS

	Performance Bond and Advance Mobilization Bond	1,800
	Funds transfers and logistics	40
	SUB TOTAL	1,840

PART 2: PROJECT DESIGNS, COMPUTATIONS, SCHEMA, CONSULTANCY DOCUMENTATION ETC FOR MANDATORY 60% OF ALL INCLUSIVE PROFESSIONAL FEES AT PRE-CONSTRUCTION STAGE OF PROJECT:

Settlement cost: Gh₵ 22,080

COST DESCRIPTION DETAILS:

The following items form sample part of project designs, draughts, drawings, and consultancy documentation and related costs:

SR. NO	ITEM DESCRIPTION	COST (Gh₵)
	DESIGN DRAWING TITLE: Solar Water Purification Unit (Version 1)	
2	DESIGN DRAWING TITLE Solar Pasteurizer	
3	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 2)	
4	DESIGN DRAWING TITLE Gas Holder	
5	DESIGN DRAWING TITLE Drying Bed	
6	DESIGN DRAWING TITLE Solar DESIGN DRAWING TITLE Pasteurizer (Version 2)	
7	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 3)	
8	DESIGN DRAWING TITLE Solar Water Purification Unit (Version 4)	
9	**DESIGN DRAWING TITLE** Modern Biomethanation Sewage Treatment Plant For Edina Essaman	
10	**DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout	

ATTACHMENT 6 (4)

11	**DESIGN DRAWING TITLE** Bioreactor Entrance/Exit Systems Section	
12	**DESIGN DRAWING TITLE** Biobed Views	
13	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility BIOCONVERSION PLANT	
14	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility BIOCONVERSION PLANT (Sectional Elevations)	
15	**DESIGN DRAWING TITLE** Biomethanation Waste-to-energy Hygienic Public Sanitary Facility, Half Size Of 20-Seater Public Toilet Housing Unit)	
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29	**DESIGN DRAWING TITLE** Biobed Views (LARGE PRINT)	
30	**DESIGN DRAWING TITLE** Sewage Treatment Plant Plan Layout (variant 3)	

PROJECT PROPOSALS, REVIEWS, SPECIFICATIONS - CONSULTANCY DOCUMENTS ETC

31	**PROJECT CONSULTANCY DOCUMENT**: Design and Construction of Modern Municipal Sewage Treatment Plant at Edina Essaman: scope of works, facility descriptions, project design calculations, algorithmic programming, computational schemes, technical specifications, and cost specifications	
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40	**PROJECT CONSULTANCY DOCUMENT:** Edna Essaman Water and Sanitation Improvement	

	Project. Project feasibility studies. Prepared by Global Renewable Energy Services Updated 6th September 2012	
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42	**PROJECT CONSULTANCY DOCUMENT:** Edina Essaman and Cape Coast Sanitation Municipal Waste Management and Ecological Improvement Project. Bill of Quantities Submitted to Edina Essaman Royal Stool by Global Renewable Energy Services May 2012	
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45	**PROJECT CONSULTANCY DOCUMENT**: Edina Essaman Water and Sanitation Version 3 Bill of Quantities. Prepared by Global Renewable Energy Services. Updated November 2012	
	SUB TOTAL COST	22,080

ATTACHMENT 6 (5)

PART 3: SITE OCCUANCY REQUIREMENTS

	SITE OCCUPANCY DOCUMENTATION, RE-RENDERING, ETC	Gh¢
1	Site plan processing and issuance	
2	Indenture/site use documentation processing	
3	Meetings and consultations	
4	Land use ceremonials	
5	Legal expenses	
6	Survey expenses	
7	Technical expenses	
8	Permits	
9	Journeys and allied logistical expenses	

10	Miscellaneous overheads	
	TOTAL COST	10,700

ATTACHMENT 6 (6)

PART 4: PROJECT JOURNEYS

1	Journey for site takeover by Chief Consultant	
1.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base- project site-Accra base plus local running: 190 km x 2	134
1.2	Transport dedicated utilization @ Gh¢ 220/d	220
1.3	DSA for Chief Consultant (p.a.)	p.a.
1.4	Road tolls	2
2	Journey for grader and works equipment arrangements etc 05/04/13	
2.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
2.2	Transport dedicated utilization @ Gh¢ 220/d	220
2.3	DSA for Chief Consultant (p.a.)	p.a.
2.4	Road tolls	2
3	Journey for site works by Chief Consultant and 2 Project Officers (Pos) Sunday 07/04/13	
3.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
3.2	Transport dedicated utilization @ Gh¢ 220/d	220
3.3	DSA for Chief Consultant (p.a.)	p.a.
3.4	DSA for 2 P.Os (p.a.)	p.a.
3.5	Project engineering works by CC and Pos (p.a.)	p.a.
3.6	Road tolls	2
4	Journey for works by Chief Consultant and Technical Artisan (TA) 10/04/13	
4.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
4.2	Transport dedicated utilization @ Gh¢ 220/d	220

4.3	DSA for Chief Consultant (p.a.)	p.a.
4.4	DSA for TA (P.a.)	p.a.
4.5	Project engineering works for CC and TA (p.a.)	p.a.
4.6	Road tolls	2
5	Journey for works set out by CC, 2 P.O.s and Tech. Artisan Saturday 13/04/13	
5.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 200 km x 2	134
5.2	Transport dedicated utilization @ Gh¢ 220/d	220
5.3	DSA for Chief Consultant (p.a.)	p.a.
5.4	DSA for 2 Pos (p.a.)	p.a.
5.5	DSA for TA (p.a.)	p.a.
5.6	Site engineering work for CC, 2 Pos and TA (p.a.)	p.a.
5.7	Road tolls	2

6	Project Journey by Chief Consultant on 16/04/13	
6.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base- project site-Accra base plus local running: 190 km x 2	134
6.2	Transport dedicated utilization @ Gh¢ 220/d	220
6.3	DSA for Chief Consultant (p.a.)	pa
6.4	Road tolls	2
7	Project Journey by Chief Consultant on 19/04/13	
7.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
7.2	Transport dedicated utilization @ Gh¢ 220/d	220
7.3	DSA for Chief Consultant (p.a.)	pa
7.4	Project engineering works by CC (p.a.)	pa
7.5	Road tolls	2
8	Journey for site works by Chief Consultant and Tech. Artisan 24/04/13	
8.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 200 km x 2	134

8.2	Transport dedicated utilization @ Gh¢ 220/d	220
8.3	DSA for Chief Consultant (p.a.)	pa
8.4	DSA for T.A. (p.a.)	pa
8.5	Project engineering works by CC and T.A. (p.a.)	pa.
8.6	Road tolls	2
9	Project Journey by CC on 26/04/13	
9.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
9.2	Transport dedicated utilization @ Gh¢ 220/d	220
9.3	DSA for Chief Consultant (p.a.)	p.a
9.4	DSA for TA (P.a.)	p.a.
9.5	Project engineering works for CC and TA (p.a.)	p.a.
9.6	Road tolls	2
10	Journey for works set out by CC on 30/04/13	
10.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
10.2	Transport dedicated utilization @ Gh¢ 220/d	220
10.3	DSA for Chief Consultant (p.a.)	p.a.
10.4	Site engineering work – CC	p.a.
10.5	Road tolls	2

11	Project Journey by Chief Consultant on 03/05/13	
11.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base- project site-Accra base plus local running: 190 km x 2	134
11.2	Transport dedicated utilization @ Gh¢ 220/d	220
11.3	DSA for Chief Consultant (p.a.)	pa
11.3	Project engineering – CC	p.a.
11.5	Road tolls	2
12	Journey for site works by Chief Consultant and Tech. Artisan 07/05/13	
12.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190	134

	km x 2	
12.2	Transport dedicated utilization @ Gh¢ 220/d	220
12.3	DSA for Chief Consultant (p.a.)	pa
12.4	DSA for T.A. (p.a.)	pa
12.5	Road tolls	2
13	Project journey by Chief Consultant for site meeting with KEEA supervision staff on Tuesday 14/05/13	
13.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
13.2	Transport dedicated utilization @ Gh¢ 220/d	220
13.3	DSA for Chief Consultant (p.a.)	pa
13.5	Road tolls	2
14	Project Journey by Chief Consultant on 30/05/13 for meeting with KEEA MCE, Technical and administrative Staff, etc at KEEA and for site visit	
14.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
14.2	Transport dedicated utilization @ Gh¢ 220/d	220
14.3	DSA for Chief Consultant (p.a.)	p.a
14.4	Road tolls	2
15	Project journey by Chief Consultant on Friday 28/06/13 for stakeholders meeting (Netherlands Embassy delegation, KEEA MCE, Tech/admin staff, Traditional Ruler and Elders of Edina Essaman, etc) at KEEA MA premises plus site visit	
15.1	Fuel: 6 km/li, Gh¢ 2.11/li, Accra base-project site-Accra base plus local running: 190 km x 2	134
15.2	Transport dedicated utilization @ Gh¢ 220/d	220
15.3	DSA for Chief Consultant (p.a.)	p.a.
15.4	Road tolls	2
	SUB TOTAL PROJECT JOURNEYS (Excluding DSAs etc)	5,340

Note: p.a.: pending addition

ATTACHMENT 6 (7

PART 5

PLANT WORKING TOOLS, EQUIPMENT, MATERIALS AND ACCESSORIES

1	Water hose: 2 rolls @ Gh¢ 65	130
2	Earth excavation tools: picks 5 nos. x Gh¢ 16, shovels 5 nos x Gh¢ 17, earth carriage vessels 6 nos x Gh¢ 5	195
3	Spirit level, tri square, ropes, pegs, iron rods, hammers, tools sets	150
4	Water storage vessels	240
5	Electric hydraulic pump plus accessories (not on site for safety reasons)	440
6	Power cutter (not on site for safety reasons)	190
7	Power drill (not on site for safety reasons)	180
8	Disinfectant pumping pack	35
9	Disinfectants	40
10	Cement: 23 bags @ Gh¢ 20 Carriage, conveyance etc	460 115
11	Sand and stones to site plus logistics etc	750
12	Blocks to site: 200 @ Gh¢ 1.6	320
13	Blocks packing, conveyance etc	90
14	Water to site plus carriage etc	290
15	Plywood: 12 nos. @ Gh¢ 15	180
16	2 x 6 wooden columns: 13 @ Gh¢ 14	182
17	Roofing sheets	120
18	Floor boards 12 nos @ Gh¢ 14	168
19	Battens	48
20	Nails, roof nails, locks, hinges etc	40
21	Carriage, conveyance, woodwork etc	488
	SUB TOTAL	4,851

ATTACHMENT 6 (8)

PART 6

SITE CLEARANCE and DEMARCATION: area 60m x 40 m: Gh¢ 1,140

PART 7: COURIER POSTAGES TO KEEA MCE

	EMS COURIER DISPATCHES TO KEEA MCE: 3 nos. x Gh¢ 6.5	19.5
	Logistics: 3 trips x Gh¢ 20	Gh¢ 60
	SUB TOTAL	Gh¢ 79.5

ATTACHMENT 6 (8)

SUMMARY OF EXPENDITURE ON PROJECT WORKS ESSENTIALS EXCLUDING SITE STRUCTURAL CONSTRUCTION WORKS

SR. NO	ITEM DESCRIPTION	COST (Gh¢)
PART 1	PROJECT BONDS	1,840
PART 2	PROJECT DESIGNS, CONSULTANCY ETC	22,080
PART 3	SITE OCCUPANCY REQUIREMENTS	10,700
PART 4	PROJECT JOURNEYS (excluding subsistence allowances and project engineering works)	5,340
PART 5	PLANT TOOLS, EQUIPMENT, MATERIALS ETC	4,851
PART 6	SITE CLEARANCE AND DEMARCATION	1,140
PART 7	COURIER POSTAGES TO KEEA MCE PLUS LOGISTICS	79.5
	TOTAL	46,030.5

The above expenses are to be added to the cost of project site works at the Edina Essaman waste disposal site under evaluation by the KEEA works Department Supervision Team described below.

SITE STRUCTURAL WORKS

The construction works undertaken at the site include the following:

1. Initial excavations for bioreactor first module of biometha nation plant
2. Initial work on hydro-segregation chamber of biomathanation plant
3. Initial work on bio-bed of biomethanation plant
4. Temporary site office and storage room
5. Works set out markings and demarcations for plant system and units

   The above named works are being evaluated by the Works Department of KEEA Municipal Assembly under Phase 1 of the project.

TURNKEY CONTRACTOR'S RESPONSE TO REQUEST FOR ADDITIONAL DESIGN INFORMATION ON GAS YIELDS, DIGESTATE VOLUME AND AUTONOMOUS WATER SUPPLY SYSTEM

1. **GAS VOLUME**

Estimated Gas volume generated per day for the $5m^3$ per day is approximately 26 m^3.

The basis of the gas rate is from approximately 1.9% solids contents of incoming sewage with about 70% volatile contents. On this basis, the gas rate of which the conversion range is approximately 0.3 to 0.4 is obtained as 26 m^3 per day. A fraction of this gas, approximately 10% may be stored in the gas holder for a day or two. The rest is to be compressed into gas storage cylinders at the gas plant or used for electric power production.

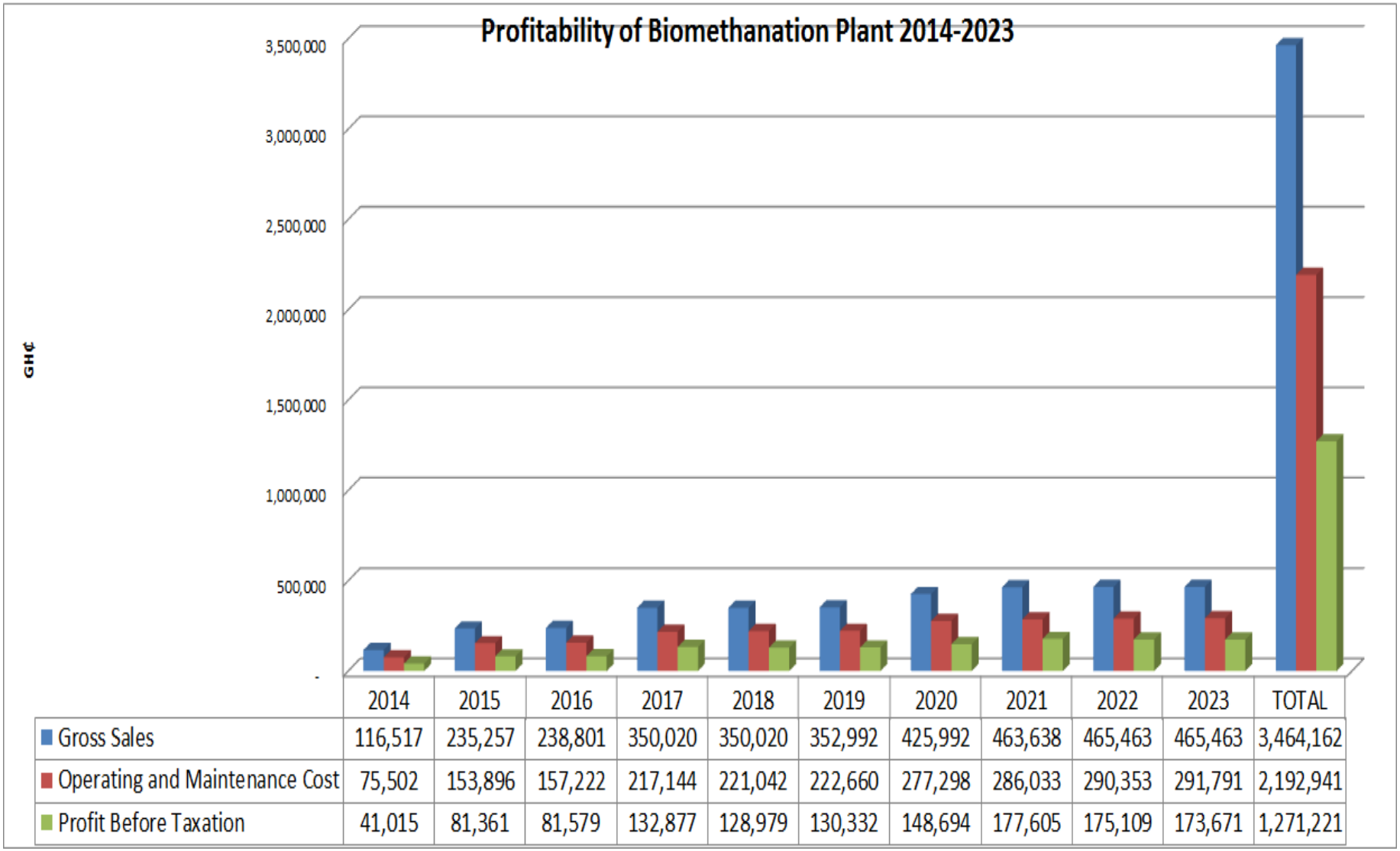
2. **DIGESTATE RATE**

   Expected daily outflow of digestate from the bioreactors is in the range of 3 to 4 m^3. After processing in the pasteurizer the estimated outflow will be in the range to 2 to 2.5 m^3 per day. This quantity may be made available as liquid fertilizer or mixed with 0.5 to 1 metric ton per day of organic binder and mixture dehumidified on the drying beds to produce between 2 and 3 metric tons per day of soil conditioner that can manually be packed in sacks.

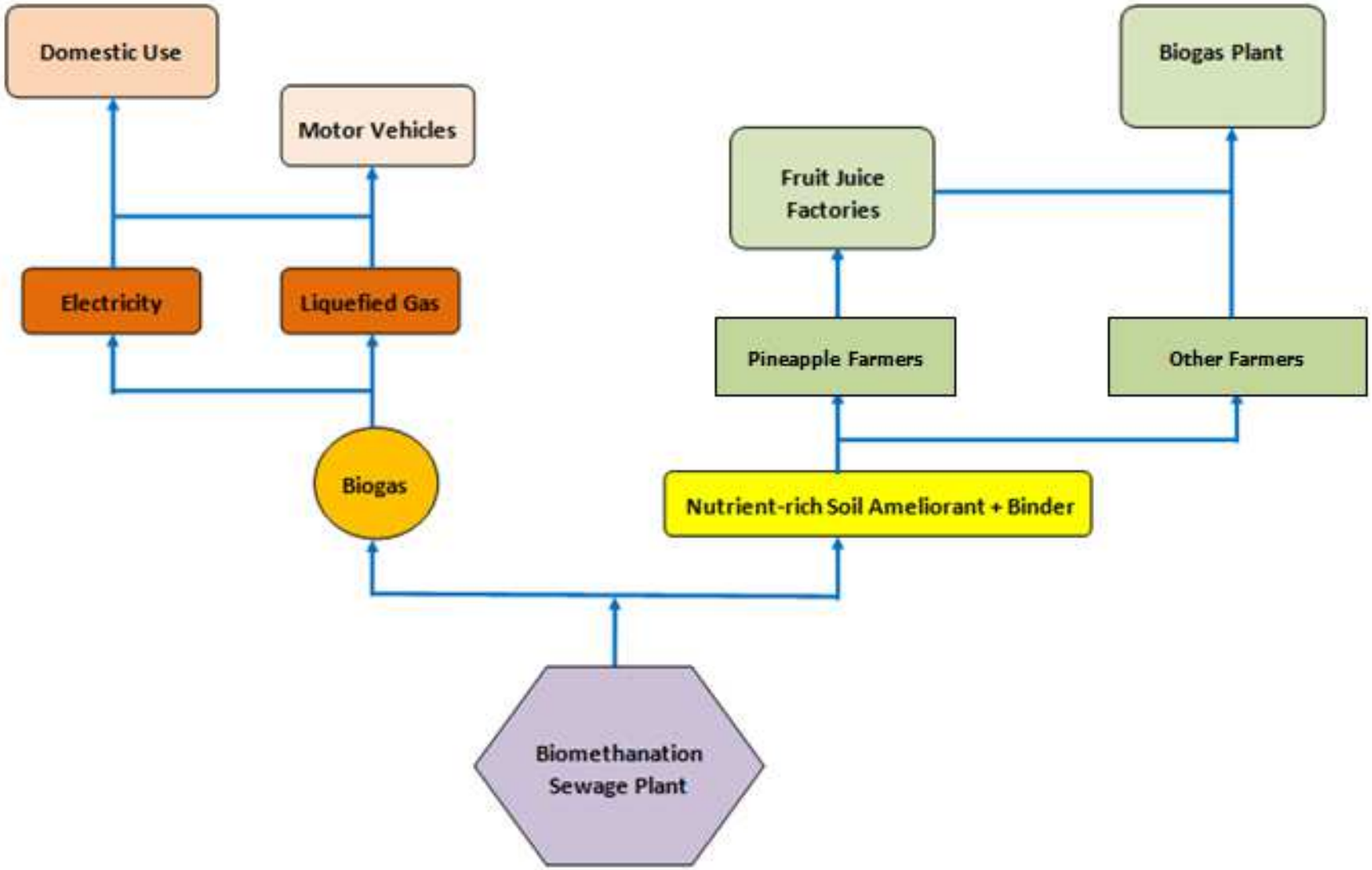
3. **AUTONOMOUS WATER SUPPLY**

   The autonomous water supply will be mainly from borehole source. Additionally a well with a good yield will be dug. The expected water yield from the borehole should be at least 2,000 gallons per day. Both the borehole and the well will be located on a land away from but safely close to the Biomethanation Plant at the waste site. Water from these sources will be pumped and stored in tanks at the location and will have fundamental outlets for fetching in portable vessels.

Appendix G Financial and Economic Viability of Expanded Plant



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	TOTAL
Gross Sales	116,517	235,257	238,801	350,020	350,020	352,992	425,992	463,638	465,463	465,463	3,464,162
Operating and Maintenance Cost	75,502	153,896	157,222	217,144	221,042	222,660	277,298	286,033	290,353	291,791	2,192,941
Profit Before Taxation	41,015	81,361	81,579	132,877	128,979	130,332	148,694	177,605	175,109	173,671	1,271,221


Domestic Use
Motor Vehicles
Biogas Plant
Fruit Juice Factories
Electricity
Liquefied Gas
Pineapple Farmers
Other Farmers
Biogas
Nutrient-rich Soil Ameliorant + Binder
Biomethanation Sewage Plant