

OUTSIDE FRONT COVER

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 15 Report: Final Report
Public Version (No Confidential Version Issued)**

Presented to Study Grantee IDEA:



and to funding agency:



United States Trade and Development Agency (USTDA) by:

CAMBRIDGE Project Development Inc.

November 24, 2011

USTDA Delivery and Mailing Address:

United States Trade and Development Agency
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The contents of this Task 15 Report are listed below. Please note that the feasibility study terms of reference (TOR) stipulate that this Task 15 report contain all Task 1 through 14 reports, in addition to an Executive Summary. Therefore, the complete interim reports from Tasks 1 through 14 are included in this final report.

Contents of Task 15 Report

Section (Task No.)	Section Title (Task Title)
	Executive Summary
1	Infrastructure Assessment at Site
2	Power Demand & Electrical Market
3	Fuel Supply and Ash Disposal
4	Technical Configuration & Preliminary Design
5	Preliminary Cost Estimates
6	Preliminary Environmental Analysis
7	U.S. Sources of Supply
8	Financial Evaluation
9	Project Risk Assessment
10	Regulatory Framework
11	Development Impact
12	Off-Take Agreements
13	Implementation Plan
14	Investment Memorandum

Executive Summary

1. A waste-derived energy recovery project at the CIS El Guacal site is considered both technically and financial feasible. The recommended technical configuration is a widely proven landfill gas to energy (LFGE) system that utilizes combustible methane generated from the decomposition of municipal solid wastes placed in the CIS El Guacal landfill cells. Use of any other available technical configuration involves unacceptably high technical risk, or requires a significant increase in the scalehouse tipping fee at CIS El Guacal, which is currently on the order of USD\$ 11. EVAS, the landfill owner, has emphasized that any increase in the scalehouse tipping fee would be unacceptable to CIS El Guacal users and to the served communities.

The following technical configurations have been carefully evaluated during this feasibility study, and have been eliminated as a result of technical risk (typically poor or non-existent commercial track record) or requirement for a much higher tipping fee at the CIS El Guacal:

- Combustion (good commercial track record but requires much higher tipping fee)
 - Mass Burn
 - Refuse-Derived Fuel
 - Gasification and Pyrolysis (lack of commercial track record and require much higher tipping fee)
 - In-Vessel Gasification
 - Plasma Arc Gasification
 - Biological and Chemical (lack of commercial track record and require much higher tipping fee)
 - Anaerobic Digestion
 - Chemical Decomposition.
2. The CIS El Guacal site is appropriate for such an LFGE project, as a result of the following favorable factors:
 - a. The site has a reliable waste intake of 900 tons per day at current levels. Projected tonnage is for 900 tons per day intake beginning in 2011, with a 1.5% annual growth rate for at least 20 years.
 - b. Approximately 90% of the waste intake to the site is committed under long term contractual arrangements or delivered by EVAS, the owner and operator of the site. Even the remaining 10% of the site waste intake is unlikely to be diverted, since use

of the nearest alternative landfill at La Pradera requires an approximately 70 kilometer transport from the southern Aburrá Valley (the area from which most of the delivered tonnage to the CIS El Guacal originates) that includes transiting the dense road traffic of the central Medellín metropolitan area.

- c. The site offers adequate landfill airspace capacity of approximately 25 years for the existing North Cell (currently active) together with the planned Central Cell (next cell to commence operations), with an additional 25 years of airspace capacity provided by the planned South Cell. Therefore, the site offers approximately 50 years of airspace capacity.
 - d. The site can be connected to the national grid for power export through construction of a new 44 kV line from the CIS El Guacal to one of three candidate existing substations (San Antonio de Prado, Ebéjico, or San Cristóbal). The specific substation will be selected during project implementation through a connection study. EPM is the only distribution company in the area, and EPM will build and operate the new 44 kV line and the transformers at both ends of the new line.
 - e. The site operates under an existing environmental license issued by the regional environmental authority Corantioquia. The existing environmental license includes permission to collect landfill gas and combust it through an existing flare. It is concluded, therefore, that permitting for the new LFGE facility would be straightforward and would require only a modification of the existing environmental license through Corantioquia (not through the national government's Ministry of Environment, Housing, and Territorial Development). The LFGE facility will only modify the means of combustion, while collecting gas in the same manner as is currently accomplished.
3. The recommended technical configuration calls for the use of internal combustion engines designed to combust landfill gas. These engines are integrated with generators, and each combination of engine-generator is termed a "module". Each module would have a capacity of 1.6 MW each, and modules are available in prefabricated permanent housings. The number of modules installed would be:
- a. Two modules (Modules A and B) would be installed in Year 1 (total installed capacity of 3.2 MW).
 - b. A third module (Module C) would be installed in Year 4 (total installed capacity of 4.8 MW) and a fourth module (Module D) would be installed in Year 12 (maximum installed capacity of 6.4 MW).
 - c. In order to realize the projected power generation levels, EVAS and its contractors, as landfill operators, must continue to consistently pursue the recently begun landfill operational improvements, including minimization of the exposed waste

working face, use of frequent soil cover, and prompt removal of any leachate accumulations within the landfill cells.

- d. **Figure A-1** below presents projections of the key performance parameters of the recommended facility.

Figure A-1: Landfill Gas Generation and Projected Plant Capacity

Year: Sequential	Active Cell	Power Plant Generation (MW)	Total Installed Engines @ 1.6 MW Capacity Each (units installed)	Total Installed Plant Capacity (MW)	Annual Power Sold (kWh)
Base	North Cell	Base	Base	Base	Base
1		2.0	2.0	3.2	17,520,000
2		2.8	2.0	3.2	24,528,000
3		3.2	2.0	3.2	28,032,000
4		3.4	3.0	4.8	29,784,000
5	Central Cell	3.6	3.0	4.8	31,536,000
6		3.7	3.0	4.8	32,412,000
7		3.8	3.0	4.8	33,288,000
8		4.0	3.0	4.8	35,040,000
9		4.2	3.0	4.8	36,792,000
10		4.3	3.0	4.8	37,668,000
11		4.5	3.0	4.8	39,420,000
12		4.7	4.0	6.4	41,172,000
13		4.9	4.0	6.4	42,924,000
14		5.0	4.0	6.4	43,800,000
15		5.2	4.0	6.4	45,552,000
16		5.4	4.0	6.4	47,304,000
17		5.6	4.0	6.4	49,056,000
18		5.1	4.0	6.4	44,676,000
19		4.0	4.0	6.4	35,040,000
20		3.2	4.0	6.4	28,032,000

Figure A-18 (from Task 4) below shows a typical LFGE internal combustion engine-generator set and typical pre-fabricated enclosures for the generator sets. **Figure D-1** (from Task 4) below presents the overall process flow for an LFGE installation.



Figure A-18: Typical Landfill Gas Engine-Generator Set and Pre-Fabricated Enclosures

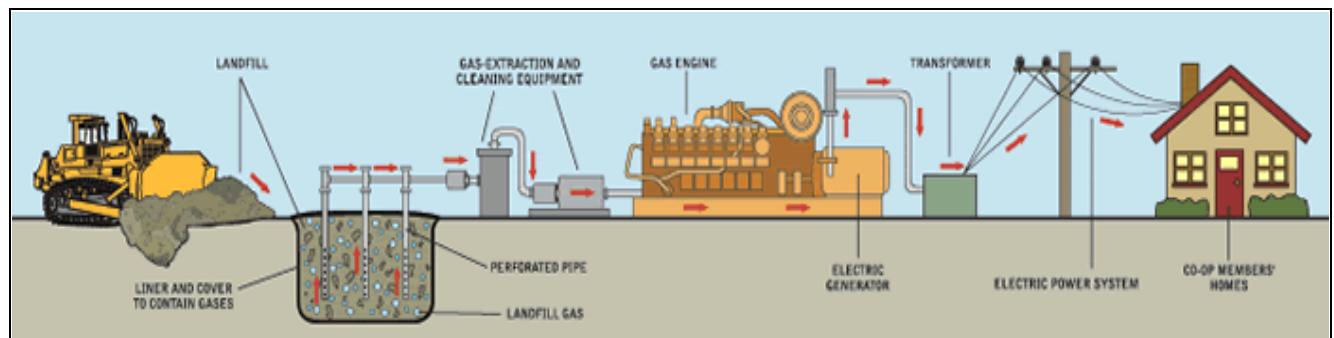


Figure D-1: Landfill Gas to Energy Process Flow

4. As an independent generating facility with capacity of less than 20 MW, the new LFGE facility is guaranteed, under the innovative Sistema Interconectado Nacional (SIN), to be able to sell 100% of the power generated into the national grid. The new LFGE facility will have the option of selling to the Spot Market or to a specific power customer under contract (generally with a 1 to 2 year contract term). Based on historical review of pricing, it is recommended that the new LFGE facility sell power to the Spot Market, at least initially. Power sales pricing under contracts have been historically slightly lower than Spot Market prices; a new facility may also want to take advantage of the added flexibility offered by the Spot Market (no minimum export level required), especially during the first year of operations, during which it may be difficult to guarantee a minimum generation level under a client contract.
5. It is anticipated that a new special-purpose company (a new company or "NEWCO") will be formed to implement the project and operate the new LFGE facility. As an independent generating facility owned by public entities (it is assumed that the NEWCO will be owned by a combination of IDEA, EVAS, and EMGEA), the facility will be exempt from sales tax.
6. Key financial indicators for the recommended LFGE facility are:
 - a. In this study, the power sales price for the LFGE facility is projected at USD\$ 0.0705 per kilowatt-hour (kWh) average in 2011 dollars for sales to the Spot Market.
 - b. Total capital investment is projected at USD\$ 15.2 Million and is composed of:
 - i. Tranche 1 (2011 through 2020 or Year 1 through Year 9): USD\$ 11.0 Million
 - ii. Tranche 2 (2021 through 2031 or Year 10 through Year 20): USD\$ 4.2 Million
 - c. Net Income as a percent of revenue varies as follows:
 - i. Average of 19.5% from Year 1 through Year 9
 - ii. Average of 28.4% from Year 10 through Year 20
 - d. Internal Rate of Return (IRR) on equity averages as follows:
 - i. 12.3% from Year 1 through Year 20
 - e. **Figure F-2** (originally presented in Task 8 and updated here) below presents projected cash flows for the project.

Figure F-2: Cash Flow Projection / Cuadro F-2: Proyecciones de Flujo de Caja

	2012	2013	2014	2015	2016	2017	2018	2019	2020		
	1	2	3	4	5	6	7	8	9		
Operating Activities/ Actividades Operacionales											
Cash Received / Flujo de Caja Recibido											
Power Sales Revenue / Ventas de Energía	\$ 1,235,160	\$ 1,729,224	\$ 1,976,256	\$ 2,099,772	\$ 2,223,288	\$ 2,285,046	\$ 2,346,804	\$ 2,470,320	\$ 2,593,836		
Total Cash Received/Recibido	\$ 1,235,160	\$ 1,729,224	\$ 1,976,256	\$ 2,099,772	\$ 2,223,288	\$ 2,285,046	\$ 2,346,804	\$ 2,470,320	\$ 2,593,836		
Cash Used / Consumo de Caja											
Operations Expense / Costos Operacionales	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936		
Total Cash Used / Consumo	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936		
Net / Neto	\$ 743,497	\$ 1,072,537	\$ 1,237,057	\$ 1,319,317	\$ 1,225,120	\$ 1,266,250	\$ 1,307,380	\$ 1,389,640	\$ 1,471,900		
Investing Activities / Actividades de Inversión											
Cash Received / Flujo de Caja Recibido											
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Cash Used / Consumo de Caja											
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Used / Consumo	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908						
Net / Neto	\$ (7,190,289)	\$ (55,599)	\$ (2,775,599)	\$ (55,599)	\$ (70,908)						
Financing Activities/Actividades de Financiamiento											
Cash Received / Flujo de Caja Recibido											
Contributed Equity / Equity Contribuido	\$ 4,419,683	\$ 55,599	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Bank Loan / Préstamo Bancario	\$ 2,770,606	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Received/Recibido	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908						
Cash Used / Consumo de Caja											
Interest Paid / Intereses	\$ 193,942	\$ 178,440	\$ 352,949	\$ 317,628	\$ 282,990	\$ 247,855	\$ 212,224	\$ 176,097	\$ 139,473		
Principal Payment / Repembolso de Capital	\$ 277,061	\$ 282,620	\$ 560,180	\$ 565,740	\$ 572,831	\$ 579,922	\$ 587,013	\$ 594,104	\$ 601,194		
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Total Cash Used / Consumo	\$ 471,003	\$ 461,061	\$ 913,129	\$ 889,368	\$ 855,821	\$ 827,777	\$ 799,237	\$ 770,200	\$ 740,658		
Net / Neto	\$ 6,719,286	\$ (405,462)	\$ 1,862,470	\$ (827,769)	\$ (784,912)	\$ (756,869)	\$ (728,328)	\$ (699,292)	\$ (669,759)		
Taxes and Fees Activities/Actividades Tributarias											
Cash Received / Flujo de Caja Recibido											
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Total Cash Received/Recibido	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Cash Used / Consumo de Caja											
ICA Municipal Tax / Impuesto ICA Municipal	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655		
Sales Tax / Impuesto Sobre la Renta	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Total Cash Used / Consumo	\$ 198,282	\$ 277,332	\$ 316,857	\$ 336,948	\$ 356,710	\$ 366,592	\$ 376,473	\$ 396,235	\$ 415,998		
Net / Neto	\$ (656)	\$ (656)	\$ (656)	\$ (984)							
Net Increase/(Decrease) in Cash held	\$ 271,838	\$ 610,820	\$ 323,272	\$ 434,964	\$ 368,315	\$ 437,489	\$ 507,159	\$ 618,456	\$ 730,249		
(Aumento o Decreimiento en Balance de Caja)											
Cash Balance	\$ 271,838	\$ 882,658	\$ 1,205,929	\$ 1,640,894	\$ 2,009,209	\$ 2,446,698	\$ 2,953,857	\$ 3,572,313	\$ 4,302,562		
(Balance de Caja)											
Free Cash Flow / Flujo de Caja Libre	\$ (6,447,448)	\$ 1,016,282	\$ (1,539,198)	\$ 1,262,734	\$ 1,153,228	\$ 1,194,358	\$ 1,235,488	\$ 1,317,748	\$ 1,400,008		
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	10	11	12	13	14	15	16	17	18	19	20
Operating Activities/ Actividades Operacionales											
Cash Received / Flujo de Caja Recibido											
Power Sales Revenue / Ventas de Energía	\$ 2,655,594	\$ 2,779,110	\$ 2,902,626	\$ 3,026,142	\$ 3,087,900	\$ 3,211,416	\$ 3,334,932	\$ 3,458,448	\$ 3,149,658	\$ 2,473,320	\$ 1,976,256
Total Cash Received/Recibido	\$ 2,655,594	\$ 2,779,110	\$ 2,902,626	\$ 3,026,142	\$ 3,087,900	\$ 3,211,416	\$ 3,334,932	\$ 3,458,448	\$ 3,149,658	\$ 2,473,320	\$ 1,976,256
Cash Used / Consumo de Caja											
Operations Expense / Costos Operacionales	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Total Cash Used / Consumo	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Net / Neto	\$ 1,513,030	\$ 1,595,290	\$ 1,677,550	\$ 1,759,810	\$ 1,800,940	\$ 1,883,200	\$ 1,965,460	\$ 2,047,720	\$ 1,842,070	\$ 1,389,640	\$ 1,060,600
Investing Activities / Actividades de Inversión											
Cash Received / Flujo de Caja Recibido											
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Cash Used / Consumo de Caja											
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Used / Consumo	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908							
Net / Neto	\$ (795,561)	\$ (70,908)	\$ (2,790,908)	\$ (70,908)							
Financing Activities/Actividades de Financiamiento											
Cash Received / Flujo de Caja Recibido											
Contributed Equity / Equity Contribuido	\$ 1,689,858	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Bank Loan / Préstamo Bancario	\$ (894,297)	\$ 70,908	\$ 2,790,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Received/Recibido	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908							
Cash Used / Consumo de Caja											
Interest Paid / Intereses	\$ (62,601)	\$ 4,964	\$ (1,035)	\$ 146,294	\$ 134,118	\$ 121,834	\$ 109,550	\$ 97,267	\$ 84,983	\$ 72,700	\$ 60,416
Principal Payment / Reembolso de Capital	\$ 511,765	\$ 241,795	\$ 151,326	\$ 244,857	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 342,908
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Used / Consumo	\$ 449,164	\$ 246,758	\$ 514,291	\$ 391,151	\$ 380,505	\$ 368,222	\$ 355,938	\$ 343,655	\$ 331,371	\$ 318,088	\$ 403,325
Net / Neto	\$ 346,397	\$ (175,850)	\$ 2,276,617	\$ (320,242)	\$ (309,597)	\$ (297,131)	\$ (285,030)	\$ (272,746)	\$ (260,463)	\$ (248,179)	\$ (332,416)
Taxes and Fees Activities/Actividades Tributarias											
Cash Received / Flujo de Caja Recibido											
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 553,352	\$ 503,945	\$ 395,251	\$ 316,201
Total Cash Received/Recibido	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 553,352	\$ 503,945	\$ 395,251	\$ 316,201
Cash Used / Consumo de Caja											
ICA Municipal Tax / Impuesto ICA Municipal	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Sales Tax / Impuesto Sobre la Renta</											

7. Based on meetings held during September 2011 with IDEA and EVAS, it has been anticipated that the project will be implemented on a "Turnkey" basis (one direct contractor to the NEWCO). Therefore, proposals would be requested from suppliers for Tranche 1 (which operates Year 1 through Year 20) for the selected single contractor to accomplish the following Turnkey services, also called an EPC (Engineering-Procurement-Construction) scope of work:
 - a. Engineering (including detailed design)
 - b. Procurement (including logistics for importation and in-country transport of the equipment)
 - c. Construction (includes civil works and equipment installation)
 - d. Subcontracting local contractors for civil, electrical, etc. scopes of work
 - e. Guarantee performance of the entire system.
8. The following **Figure A-2** (from Task 9) presents a Project Implementation Plan target schedule:

Figure A-2: Project Implementation Plan Target Schedule

Sequential and Calendar Months													
1	2	3	4	5	6	7	8	9	10	11	12	13	
2011		2012											
NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	
Feasibility Study Completed													
Business Aspects													
Negotiate Contracts													
Negotiate Financing													
Permitting and Licenses													
Complete Applications													
Regulatory Review													
EPM Scope of Work													
Interconnection Study													
Negotiations with EPM													
EPM Installs 44 kV Line + Transformers													
Turnkey EPC Contract													
Prepare Request for Proposals													
Proponents Prepare Responses													
Evaluate Responses and Award													
Detailed Design													
Purchase Order and Deliver Equipment													
Install Modules and Auxiliary Equipment													
Testing and Startup													
Begin Power Sales													

9. It is recommended that Turnkey proposals be requested from engine-generator manufacturers directly. The alternative of requesting proposals from consulting firms could result in higher capital costs, and the guarantee of engine-generator set performance stems from the manufacturer in any case. The following suppliers with applicable manufacturing facilities in the United States should be in a position to submit proposals for an EPC Turnkey scope of work for the project:
 - a. Caterpillar, Inc. (Indiana)
 - b. Cummins Inc. (Indiana)
 - c. Curtis Engine & Equipment Inc. (Maryland)
 - d. GE Waukesha (Wisconsin) (subsidiary of General Electric).
10. It is estimated that approximately 85% of the capital investment will be sourced from U.S. companies, as detailed in **Figure A-2** (updated from Task 7) below:
 - a. USD\$ 13.0 Million or 85% of USD\$ 15.2 Million total capital investment.

Figure A-2: Estimated US Sourcing

Tranche 1	Estimated Sourcing			Percent US
	Local	US		
LFG Collection System	\$ 576,936	\$ 115,387	\$ 461,549	80%
LFG Power Generation System	\$ 8,160,000	\$ 408,000	\$ 7,752,000	95%
Civil Works	\$ 100,000	\$ 100,000	\$ -	0%
Project Soft Costs	\$ 678,592	\$ 271,437	\$ 407,155	60%
Contingency	\$ 916,099	\$ 274,830	\$ 641,269	70%
Working Capital	\$ 617,580	\$ 555,822	\$ 61,758	10%
Total Tranche 1	\$ 11,049,207	\$ 1,725,475	\$ 9,323,731	84%

Tranche 2	Estimated Sourcing			Percent US
	Local	US		
LFG Collection System	\$ 779,992	\$ 155,998	\$ 623,994	80%
LFG Power Generation System	\$ 2,720,000	\$ 136,000	\$ 2,584,000	95%
Civil Works	\$ -	\$ -	\$ -	0%
Project Soft Costs	\$ 308,363	\$ 123,345	\$ 185,018	60%
Contingency	\$ 416,290	\$ 124,887	\$ 291,403	70%
Working Capital	\$ -	\$ -	\$ -	10%
Total Tranche 2	\$ 4,224,645	\$ 540,230	\$ 3,684,414	87%

Total Capital Investment	\$ 15,273,851	\$ 2,265,706	\$ 13,008,145	85%
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11. The new LFGE facility will generate significant carbon emissions reductions by replacing fossil fuels that would otherwise be used to generate the same amount of electricity. The existing landfill gas collection and flaring system (installed and operated by GreenGas under contract to EVAS) already claims carbon credits by avoiding landfill gas methane emissions that would otherwise be produced. Since it appears that the Kyoto Protocol is unlikely to be replaced in 2012, it is not clear how readily it will be possible to sell carbon credits for monetary amounts in the future. Therefore, all financial projections exclude any revenue from sales of carbon credits.
12. A complete financial model in Excel format has been provided to IDEA, and key financial projection sheets from this model in final form are presented in Section F of the report for Task 14-Investment Memorandum.

END OF EXECUTIVE SUMMARY

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

Task 1 Report

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

**CAMBRIDGE
Project Development Inc.**

and its subcontractors:

EnerconAmerica Inc.

Quality & Evolution S. A.

July 07, 2011

A. Overview of Task 1

Task 1 Requirements from TOR

The Terms of Reference (TOR) under which this present Feasibility Study is being conducted begins with the following description of the content of the Task 1 Report:

“Contractor shall assess the existing infrastructure at the designated Project site at the El Guacal landfill, and collect and analyze data related to the national electricity transmission grid, water supply, sewage, and waste-water treatment and other infrastructure for the purpose of confirming the selected site as a suitable location for the new WTE plant from economical, ecological, and technical standpoints.”

As a result, and in order to ensure that all stipulated areas are covered, this Task 1 Report is organized into the following Sections, as shown below in **Figure A-1**:

Figure A-1: Contents of Task 1 Report

Section	Section Title
A	Overview of Task 1
B	Stakeholder Expectations
C	Waste Supply Tonnages
D	Landfill Airspace Available
E	Geotechnical Aspects
F	Transportation Infrastructure / Traffic and Access Roads
G	Utility Grid Conditions
H	Water and Wastewater Aspects
I	Ecological and Regulatory Aspects
J	Task 1 Conclusions

While Sections C through I are stipulated in the TOR as required for Task 1, Cambridge has added Sections A, B, and J to provide additional basis and framework for downstream Tasks 2 through 15.

Pre-Visit and Kickoff Visit Meetings

Figures A-2 and A-3 below present the meetings and interviews accomplished during the Pre-Visit and Kickoff Initial Visit, respectively. These visits were essential and preparatory not only to commencing Task 1, but also all subsequent tasks.

Figure A-2: Agenda Completed: Pre-Visit 11 May -12 May 2011

TIME	WEDNESDAY 11	THURSDAY 12
7:30		Visit to CIS El Guacal LF and Waste Mgt. Center
8:00		
8:30		
9:00	Preliminary Meeting with Mr. Santiago Piedrahita Location: IDEA	Location: CIS El Guacal
9:30		
10:00		
10:30		
11:00		
11:30		
12:00 - 14:00		
14:30	Meeting with IDEA General Manager Location: IDEA	Meeting with EVAS General Manager Location: EVAS
15:00		
15:30		
16:00		Pre-Visit Conclusions
16:30		
17:00		Location: IDEA

Notes:

IDEA General Manager:

Sr. Francisco Beltrán Montoya

Deputy Manager for International Business and Cooperation:

Sr. Santiago Piedrahita Tabares

IDEA Primary Contacts:

Sr. Pablo Jaramillo Vasco, Sra. Mónica López Correa

EVAS Primary Contacts:

Sr. Jhon Henry Laverde B., Gerente Mercadeo y Proyectos

Sr. S. Saldarriaga, Gerente General

Cambridge Project Team for Pre-Visit:

Leonard N. Enriquez and Mauricio Mikan

Figure A-3: Agenda Completed: Initial (Kickoff) Visit 24 May - 26 May 2011

	TUESDAY 24	WEDNESDAY 25	THURSDAY 26
7:30			
8:00			
8:30			
9:00			
9:30	<p>Visit to El Guacal LF / Location: El Guacal (Tour & Work Session) /</p> <p><u>Participants:</u></p> <p>-Mr. Carlos Mejía, EVAS; - IDEA Team; - Cambridge Project Team (L. Enriquez, A. Enriquez, M. Mikan, S. Gutner, W. Uchdorf, J. Blanco, G. Sanclemente, W. Serbetci)</p>	<p>Meeting with Mr. Rodolfo Atehortua of EMGEA / Location: EMGEA</p> <p>-IDEA Team -Cambridge Project Team</p>	
10:00			
10:30		<p>Meeting with Corantioquia / Location: Corantioquia Offices /</p> <p><u>Participants:</u></p> <p>-Cambridge Project Team (M. Mikan; G. Sanclemente; J. Blanco in document collection) - Corantioquia Participants: Jorge Emilio Angel Robledo / Subdirector de Calidad Ambiental Alvaro González / Area Jurídica Gustavo Parra / Dirección Territorial Aburrá Sur Andrés Perilla / Dirección Territorial Aburrá Sur</p>	<p>Meeting with Heliconia Municipality</p> <p><u>Participants:</u></p> <p>-Cambridge Project Team (M. Mikan; G. Sanclemente) - Heliconia Municipality Participants: Walter David Rodríguez / Secretario de Planeación Ana Arenas / Directora UMATA (Unidad Municipal de Asistencia Técnica Agropecuaria)</p>
11:00			<p>EPM Meeting / Location: EPM</p> <p><u>Participants:</u></p> <p>EPM: Diego Humberto Montoya; Rene Alberto Castrillón; - IDEA Team; - Cambridge Project Team (L. Enriquez, W. Uchdorf, W. Serbetci)</p>
11:30			<p>EVAS Meeting / Location: IDEA</p> <p><u>Participants:</u></p> <p>EVAS: Mr. Jhon Henry Laverde; Ms. Girgesa Mesa - IDEA Team; - Cambridge Project Team (L. Enriquez, W. Uchdorf, W. Serbetci)</p>

(Continuation of Figure A-3 from previous page)			
14:00		Meeting with Mr. Ramón León of XM / Location: Holiday Inn Express Hotel / Participants: - IDEA Team; - Cambridge Project Team	Meeting with Mr. Jorge Luis Rodríguez, Consultant (Ex Isagen) / Location: IDEA / <u>Participants:</u> -IDEA Project Team; - Cambridge Project Team (L. Enriquez, W. Uchdorf, W. Serbetci, M. Mikan)
14:30			
15:00			
15:30		Meeting with Mr. Juan Felipe González of ARGOS Cement Mfg. / Location: ARGOS Offices / <u>Participants:</u> - IDEA Project Team; - Cambridge Project Team	IDEA Wrap-Up Working Session/ Location: IDEA / Participants: - IDEA Project Team; Cambridge Project Team (L. Enriquez, W. Uchdorf, W. Serbetci, M. Mikan)
16:00			
16:30			
17:00			
17:30			

Subsequent Tasks

The Tasks following Task 1 shown below in **Figure A-3** are anticipated to be eligible for commencement of drafting immediately following Task 1:

Figure A-3: Subsequent Tasks

Task	Task Description
1	Infrastructure Assessment at Site
2	Power Demand and Electricity Market
3	Fuel Supply and Ash Disposal Strategies
4	Technical Configuration & Preliminary Design
10	Regulatory Framework

B. Stakeholder Expectations

Stakeholders

The key Stakeholders preliminarily identified during Task 1 are listed below. This list of key Stakeholders will be finalized during Task 2-Power Demand and Electricity Market:

- **IDEA (Instituto para el Desarrollo de Antioquia):** a public sector corporation with the mission of promoting, facilitating, and financing projects with high impact on the economic, social, financial, administrative, and institutional development of the Department of Antioquia in the strategic areas of Banking, Infrastructure, Energy, Mining, and Reforestation. IDEA also provides consulting services and other support to entities developing such projects. IDEA is the grantee under this present Feasibility Study funded by USTDA (United States Trade Development Agency.)
- **EVAS S.A. ESP (EVAS):** A public sector corporation owned and controlled by the Municipality of Envigado. EVAS is the owner and operator of the CIS El Guacal facility, although Subcontracts have been let for various significant operations at CIS El Guacal for activities such as North Cell operations, Material Recovery Facility (MRF) labor, and gas extraction and flaring. Gas extraction and flaring are accomplished under a contract between EVAS and private firm **GreenGas**.
- **New Company (NEWCO):** This newly established entity would have as its scope to Finance / Design / Build / Own / Operate (FDBOO) the new energy recovery facility. It is anticipated that the NEWCO would be owned by IDEA and by EVAS as shareholders in percentages to be determined by IDEA and EVAS.
- **EMGEA (Empresa de Generación y Promoción de Energía de Antioquia):** Within the Colombian national electric power system (Sistema de Interconexión Nacional or "SIN"), registered Generating Companies only are permitted to sell power into the SIN. EMGEA is a sister public sector corporation to IDEA, with 37.5% of the shares of EMGEA held by IDEA.
- **XM:** XM is an entity that, among other activities, administers the SIN in terms of matching demand and load. A detailed discussion of the SIN, XM's role, and other aspects of the SIN are presented under Task 2. It is noted here that our entire discussion is applicable to power generating projects of capacity 20 MW or less. Above 20 MW capacity, significantly different requirements and business arrangements are required under the SIN.
- **Empresas Públicas de Medellín (EPM):** EPM is the entity responsible for distribution of electric power within the Medellín region, including the area surrounding the CIS El Guacal facility. Any power export from the CIS El Guacal facility will flow through a line installed and operated by EPM.

- **United States Trade and Development Agency (USTDA)** is funding this present Feasibility Study through a grant to IDEA. USTDA is not anticipated to remain long term as a direct commercial participant in the Project. However, we understand that the expectation of USTDA is for the project to **maximize the use of United States-sourced equipment and services during the implementation of the Project.**

IDEA and EMGEA Expectations

IDEA and EMGEA have had significant success in promoting independent power generation projects, especially with regard to hydroelectric projects in the region. Based on interviews with IDEA and EMGEA's top management, Cambridge believes the key expectations for the CIS El Guacal energy recovery project are:

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining, and readily financeable. Since IDEA is likely to provide part of the required equity and debt financing and other parties may provide remaining financing requirements, IDEA has the expectation that the project will be readily financeable.
- **Energy Generation:** The energy recovery facility must export energy in some form. Ideally, the project will generate power long term for sales into the national grid (SIN). This expectation fits with the "Energy" strategic category being pursued by IDEA.
- **Social Development Impact:** In line with its mission, IDEA intends for the Project to increase the supply of economical energy into the SIN as well as providing high-skilled and other jobs to the local community. Both of these features will support regional and national social development. It is noted here that installation of a new 44 kV line from one of three EPM candidate substations to CIS El Guacal will be a significant improvement, in itself, to the power supply infrastructure in the area.
- **Technical Risk:** IDEA expects the energy recovery facility to incorporate in its design only commercially proven technologies.

EVAS Expectations

As owner and operator of the CIS El Guacal site and a likely shareholder in the NEWCO, EVAS is expected to share all of the expectations of IDEA described above. In addition, some specific expectations of EVAS management are:

- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee of approximately US\$ 11 per ton. EVAS management has been emphatic in indicating that it will be politically difficult to increase the current tipping fee.

- **Compatibility with Existing Subcontracts** in force at the site, including:
 - Interaseo North Cell operations and waste delivery agreement;
 - GreenGas gas extraction and flaring agreement;
 - MRF Labor contract with RECIMED.

Municipality of Heliconia Expectations

The Municipality of Heliconia basically supports the Project as an environmental enhancement to the CIS El Guacal facility, and requested that its staff be kept abreast of project development. During the interview, the municipality indicated that it hopes the additional attention brought to the CIS El Guacal facility by the Project will lead to resolution of the following pre-existing issues unrelated to the energy recovery Project:

- It is noted here, as reported by EVAS, that the Municipality of Heliconia currently receives a Host Fee of approximately US\$ 1.00 per ton of waste delivered. Heliconia expressed a desire to realize an additional Host Fee with regard to Hazardous Wastes planned to be received at the CIS El Guacal facility for disposal in a small, specialized, cell separated from the main landfill cells.
- Intermittent discharges of leachate into the nearby Los Morros water course ("Quebrada Los Morros").
- Intermittent donations of compost material to the municipality are reported to be less frequent than originally agreed.

Since electric power generated at the new facility will be exported to the national grid, and power supplies to Heliconia itself are reported to be adequate, it can be said that the Project will not necessarily have an impact on energy supplies in the immediate area

Corantioquia Expectations

Corantioquia is the environmental regulatory agency with direct responsibility for compliance of the CIS El Guacal facility with environmental standards.

With regard to solid waste management at the regional level, Corantioquia officials reported that the agency's policy is to support regional solid waste disposal projects versus smaller local landfills. Some five waste disposal projects are in discussion stages for the entire Department of Antioquia, but only one of these is considered viable. As a result, Corantioquia considers that CIS El Guacal will continue as the primary landfill for the southwestern area of Antioquia for the foreseeable future.

Corantioquia expectations are that the Project will, directly or indirectly:

- Lead to increased compliance with requirements by the facility, particularly with regard to waste separation, optimization of leachate treatment, and extension of landfill cell life;
- Support better tracking by Corantioquia of the overall operations of the CIS.

Some of these issues would not be directly related to an energy recovery project.

Stakeholders Expectations Conclusions

Key expectations identified from Stakeholders during Task 1 are:

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining and readily financeable.
- **Energy Generation:** The energy recovery facility must export energy in some form. Ideally, the Project will generate power long term for sales into the national grid (SIN).
- **Social Development Impact:** In line with its mission, IDEA intends for the Project to increase the supply of locally-generated, economical energy into the SIN as well as providing high-skilled and other jobs to the local community.
- **Low Technical Risk:** IDEA stipulates that the energy recovery facility should incorporate in its design only commercially proven technologies.
- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee at the scalehouse of approximately US\$ 11 per ton.
- **Compatibility with Existing Subcontracts** in force at the site, including:
 - Interaseo North Cell operations and waste delivery agreement;
 - GreenGas gas extraction and flaring agreement;
 - MRF Labor contract with RECIMED.
- **Keeping Municipality of Heliconia Abreast of Project Development:** The municipality basically supports the Project as an environmental enhancement of the Site, and wishes to be kept abreast of Project development.
- **Corantioquia:** The environmental agency generally supports the Project, and hopes that it will lead to increased compliance by the CIS El Guacal facility with regard to leachate treatment, and extension of landfill cell life. Some of these issues would not be directly related to an energy recovery project.

- **USTDA / United States-Sourced Equipment and Services:** The Project implementation should maximize the use of U.S.-sourced equipment and services during its implementation.

C. Waste Supply

Current Waste Supply

As shown in **Figure C-1** below, CIS El Guacal currently receives, on a full annual basis in calendar year 2010, approximately 640 to 650 tons per day (TPD) of mixed municipal solid waste (MSW). These 650 TPD are delivered by the following collection entities:

- Interaseo (private hauler)
- Enviaseo (Municipality of Envigado waste collection agency)
- EVM (Empresas Varias de Medellín, the Municipality of Medellín collection agency)
- Up to 12 other nearby smaller municipalities and communities.

In addition, approximately 100 TPD of Source-Separated Organics (SSO) are delivered to CIS El Guacal by specific organic waste generators. This is a select, source-separated waste stream (which includes those agricultural waste accessible to the CIS) that is, according to CIS management, already fully utilized for production of a compost soil amendment product. Therefore, the remainder of this discussion involves only the 650 TPD of MSW, which is the only unutilized waste stream that is available for energy recovery.

Figure C-1: Received MSW Tonnages

Year	Tons per Annum	Calendar Days in Time Period	Tons per Calendar Day
2006	32,655	273.8	119
2007	110,063	365.0	302
2008	168,762	365.0	462
2009	224,603	365.0	615
2010	233,897	365.0	641
2011 Year to Date	74,647	121.7	614

Source: EVAS records from CD provided 26 May 2011

Figure C-2 below shows the current 2011 rate of waste supply split out by source.

Interaseo is a large local private hauling company that has a waste delivery contract with EVAS and is required to dispose of a minimum of 400 tons per day at CIS El Guacal. The waste delivered by Interaseo represents 62% of the total waste received at the CIS El Guacal. **The Interaseo contract is in its second year of a 15-year term, so that this waste stream is contractually assured for 13 more years.** It is noted here that Interaseo also, under the same contract with EVAS, operates the currently active North Cell of the landfill.

Figure C-2: Current MSW Supply

Source	TPD [a]	TPA [b]	Percentage
Enviaseo	180	65,700	28%
Interaseo	400	146,000	62%
EVM & Others	70	25,550	10%
Total	650	237,250	100%
[a]Tons per Day			
[b] Tons per Annum (Rounded from 2010 Full Year Data)			

Source: EVAS Management Interviews

Enviaseo is the municipal waste hauling agency for the municipality of Envigado and is therefore the sister agency of EVAS for waste collections. The waste delivered by Enviaseo represents 28% of all the waste received at CIS El Guacal. Since EVAS itself is owned by the Municipality of Envigado and the CIS El Guacal is owned and operated by EVAS, **this is considered internal, and therefore long term committed waste supply**

These two sources of waste, Interaseo and Enviaseo, together deliver 90% of all the waste received at CIS El Guacal. **Therefore, 90% of the waste stream being delivered to CIS El Guacal is considered a committed, long term source of waste.** Stability of waste supply is always a fundamental factor in establishing feasibility and in obtaining financing of solid waste infrastructure projects.

EVM (Empresas Varias de Medellín) is the waste collection agency for the municipality of Medellín. Although Medellín encourages EVM to dispose at the La Pradera Landfill located some 40 km by road from the center of Medellín (please see **Figure C-3** below), EVM utilizes CIS El Guacal for some its routes in the southern areas of Medellín. The EVM tonnage is not considered committed long term tonnage supply to CIS El Guacal.

EVM and haulers from a number of nearby smaller municipalities deliver approximately 10% of the total waste delivered to CIS El Guacal.

Potentially Competing Landfills

In order to provide a general orientation of the region and metropolitan area, including municipal boundaries, **Figure C-3** is provided below.

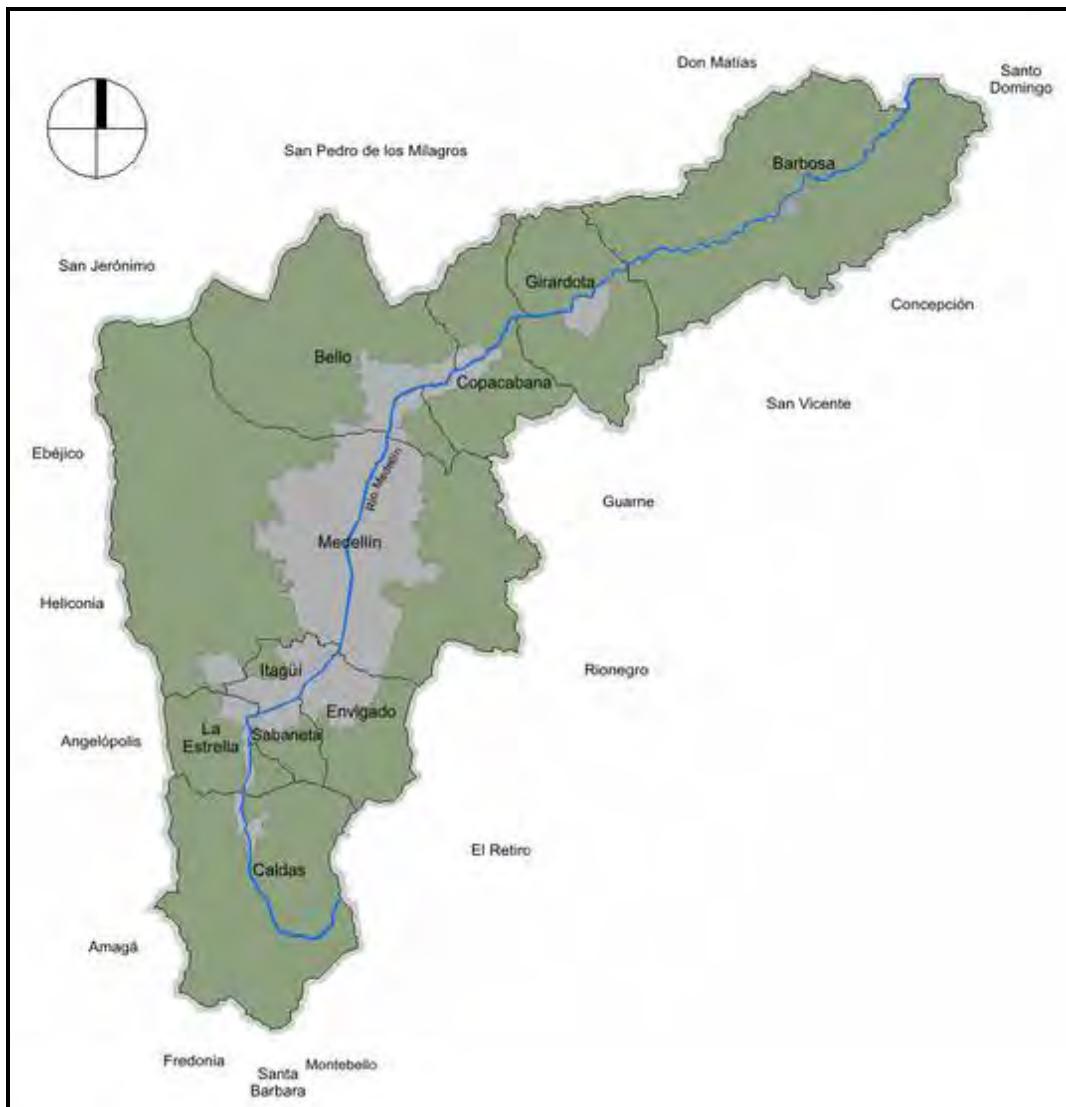


Figure C-3: Metropolitan Area and Municipal Boundaries

In addition to having 90% of its MSW supply delivered under long term contractual commitments, it is considered that the logistics of the geographical situation provide additional assurance that the 10% of tonnages not currently under long term delivery commitment are unlikely to flow elsewhere.

As shown in **Figure C-4**, the La Pradera landfill, as a theoretically potentially competing landfill, is located in the far Northeast of the region, while CIS El Guacal is located on the western side of the Aburrá valley, in the Southwest-Central part of the region. The orange perimeter shown in Figure C-4 is the approximate “Wasteshed” for CIS El Guacal, with its straight border within the main Aburrá valley representing the approximate division of collection routes between the municipalities of Envigado and Medellín. (As noted above, even some Municipality of Medellín (EVM) waste is delivered to CIS El Guacal to save transport time for EVM collection vehicles.)

For MSW to “leak” from the CIS El Guacal Wasteshed to the La Pradera Landfill would require transport of waste from the northern edge of the CIS El Guacal Wasteshed a considerable road distance approximately 70 km. Transport along approximately half, or about 35 km, of this total road distance is impeded, at least during much of the day, by the dense urban traffic of central areas of Medellín itself.

It is not clear that the La Pradera landfill site can be readily expanded beyond the currently active cell, and there are significant impact issues with surrounding communities (article from de "El Colombiano" newspaper: 02 July 2011) and a new site is being discussed. A new candidate site is being discussed, but may be located even further from the urban area.

Other logistical and cost considerations are:

- The current tipping fee at the gate at La Pradera is approximately \$15 per ton, while the current tipping fee at CIS El Guacal is approximately US\$ 11 per ton.
- Interaseo waste is delivered to CIS El Guacal:
 - Directly from waste collected within the CIS El Guacal Wasteshed;
 - Transferred by tractor-trailer from the Caldas Transfer Station (Southeast of Aburrá valley);
 - Transferred by tractor-trailer from the Bello Transfer Station (Northwest of Aburrá valley); it is noted here that the Bello Transfer Station is closer by road to the La Pradera Landfill, but Interaseo delivers waste from the Bello Transfer Station to CIS El Guacal in order to meet its contractual commitment of delivering 400 TPD.

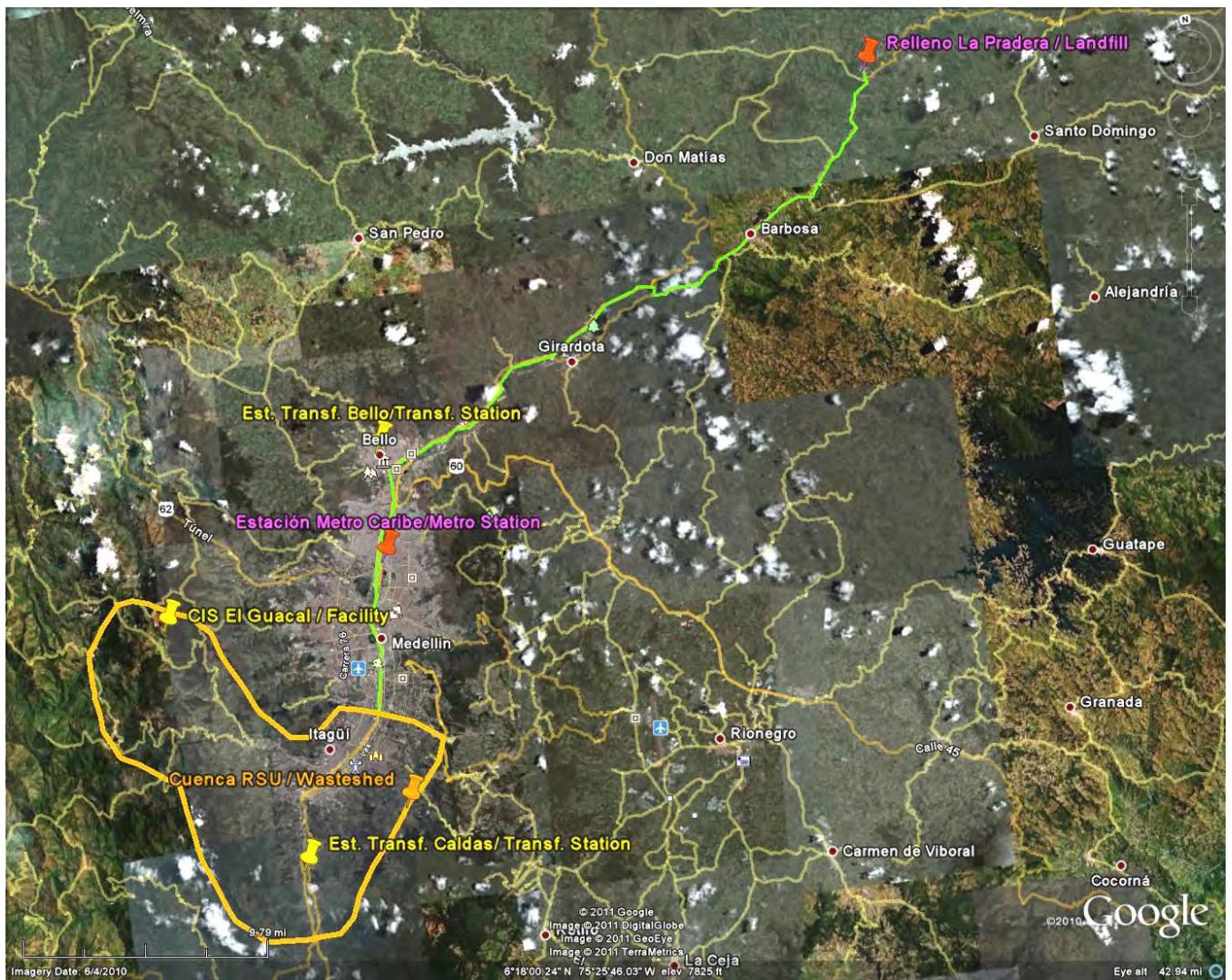


Figure C-4: Alternative Landfill (La Pradera), Bello Transfer Station, Caldas Transfer Station, Caribe Metro Station, and Approximate CIS El Guacal Wasteshed ("Cuenca RSU")

Potential Effect of Waste by Rail Project

Rehabilitation and reconstruction of the old, disused rail line from Medellín to areas northeast of the metropolitan area is a project that is in advanced planning stages. This line would be designated as "El Sistema Férreo Multipropósito del Valle de Aburrá" (The Multi-Purpose Rail System for the Aburrá Valley.) This new rail system would be built and operated by the Medellín Metro organization, which operates the large existing Metro, or urban rapid transit system. In addition to providing passenger transportation from the Aburrá valley to the northeastern portions of Antioquia, the new system is planned so as to allow the transportation of waste from central Medellín to the La Pradera Landfill. The

waste to rail transfer station is planned to be built near the existing "Caribe" Metro station (please see Figure C-4 above.)

The new rail system would transport the 1800 to 1900 TPD of MSW that originate primarily in the north and central Aburrá valley toward the La Pradera landfill. The new system is not designed to attract MSW tonnages from the south of the valley (from the CIS El Guacal Wasteshed):

- The Caribe waste by rail transfer station would be located some 10 km by road north of the approximate border of the CIS El Guacal Wasteshed, a heavily transited route that would cause serious delays to a collection vehicle originating in the southern Wasteshed;
- Cambridge has direct, detailed experience with two waste by rail projects in the United States (one in Florida and one in New Jersey.) A collection vehicle from the CIS El Guacal Wasteshed would encounter a tipping cost at the Caribe waste by rail transfer station on the order of US\$ 34 per ton = US\$ 8 per ton for Caribe transfer + US\$ 5 for actual rail transport + US\$ 6 for unloading transfer on arrival at La Pradera + US\$ 15 gate tipping fee at La Pradera landfill. This cost of US\$ 34 per ton compares to the US\$ 11 per ton tipping fee at the gate of the CIS El Guacal. **It is unlikely that this cost will be intensively subsidized with the sole purpose of attracting southern valley tonnages to La Pradera, given that this landfill is already well utilized with 1800 to 1900 TPD intake, and that La Pradera may have important limitations to its expansion.**

As a result, it is concluded that:

- The new waste by rail system has the potential to address the significant existing challenges in transporting waste from the center and north of the Aburrá Valley to the La Pradera Landfill;
- The costs involved in waste by rail make it unlikely that the 10% of the MSW supply to CIS El Guacal that is not committed long term will be attracted to the new waste by rail system; and
- Even if the contract with Interaseo is not renewed in 2024, costs involved make it unlikely that Interaseo waste tonnages will be attracted by the new waste by rail system.

Historical and Projected Waste Supply

Figure C-5 below shows MSW tonnages delivered to the facility to date. It is noted that 2006 was a partial year of operations, with only 274 calendar days. Highlighted year 2010 is the Base historical (actual) year. All years 2011 through 2020 are projected at a 1.5% annual growth rate.

Figure C-5: Historical and Projected MSW Supply

Year	Tons per Annum	Tons per Day
2006	32,655	119
2007	110,063	302
2008	168,762	462
2009	224,603	615
2010	233,897	641
2011	237,405	650
2012	240,967	660
2013	244,581	670
2014	248,250	680
2015	251,973	690
2016	255,753	701
2017	259,589	711
2018	263,483	722
2019	267,435	733
2020	271,447	744

EVAS management estimates the 1.5% annual growth rate of MSW deliveries, and Cambridge considers that this is a reasonably conservative growth rate, considering that MSW deliveries grew versus previous year by 4.1% in 2010 and 3.3% in 2009.

Another point of reference for waste supply growth is population trending in the Wasteshed. It is known from Cambridge experience worldwide that waste tonnage growth is a direct function of population growth and per capita income growth. **Figure C-6** below shows that the EVAS projected growth rate of 1.5% is reasonable, since a 1.5% annual growth is between the projected growth rate 2011-2020 of the major municipalities in the Wasteshed (1.7%) and the overall projected growth rate 2011-2020 of the Antioquia Department overall (1.3%). Any change in per capita income (if positive) would be additional to the growth in waste tonnage caused by population growth.

**Figure C-6: Projected Population for Major Wasteshed Municipalities
and for Department of Antioquia 2011-2020**

Municipality	Population 2011	Population 2020	Population Change	Percentage Change	Years in Projection Period	Percentage Annual Average Change
Envigado	202,354	249,046	46,692	23.1%	9	2.6%
Caldas	74,069	82,227	8,158	11.0%	9	1.2%
Heliconia	6,209	5,837	-372	-6.0%	9	-0.7%
Itagüí	255,345	282,792	27,447	10.7%	9	1.2%
La Estrella	58,422	67,259	8,837	15.1%	9	1.7%
Sabaneta	48,998	55,220	6,222	12.7%	9	1.4%
Sub-Total	645,397	742,381	96,984	15.0%	9	1.7%
Antioquia [b]	6,143,809	6,845,093	701,284	11.4%	9	1.3%

[a]Source:DANE: "Estimate and projection of national, departmental, and municipal populations by gender, age quintiles, and ages from zero to 26 for 1985-2020"
 "DANE" is the Departamento Administrativo Nacional de Estadística (National Administrative Department for Statistics.)

[b] Entire Department of Antioquia

EVAS management emphasizes that increasing tipping fees at either landfill would be greatly impeded by political considerations. The lower tip fee of approximately US\$ 11 per ton at CIS El Guacal compares favorably to the US\$ 15 per ton at La Pradera.

Waste Supply Conclusions

Task 1 Section C Conclusions:

- Of the 650 TPD current delivery rate for MSW, 90% is assured under long term commitments, with Interaseo's contractually committed delivery tonnage of 400 TPD assured for 13 more years (through 2024);
- Even after 2024, Interaseo's current 400 TPD tonnage is likely to continue to be delivered to CIS El Guacal, given the distance to the La Pradera Landfill or its even more distant successor, as a result of the long transport time or transfer cost involved;
- Even the 10% of CIS El Guacal tonnage currently delivered by primarily smaller municipalities in the CIS El Guacal Wasteshed are unlikely to "leak" to distant La Pradera Landfill or its even more distant successor as a result of the required long transport time or transfer cost involved;
- The siting and permitting of a competing landfill closer to the CIS El Guacal Wasteshed is considered difficult, given the demographic, environmental, and agricultural sensitivities of any site selected; the extreme distance of the La Pradera landfill;

As a general conclusion, the MSW waste supply to CIS El Guacal is highly unlikely to drop below approximately 650 TPD (the current delivery rate) for the foreseeable future.

D. Landfill Airspace Available

Capacity Calculations

The entire property covers 384 hectares, of which 52 hectares are set aside for the major waste disposal cells. The large surrounding buffer area of approximately 300 hectares provides a large buffer area that many landfills would like to have.

The main landfill disposal areas are divided into North, Central, and South cells. Estimated total capacities and capacity consumed through December 2010 are presented in **Figure D-1**:

Figure D-1: Landfill Capacity and Capacity Consumed

Cell	Area (ha)	Estimated Capacity (Tons) [a], [b]	Capacity Consumed To December 2010 (Tons) [b]
North	5	2,000,000	769,980
Central	22	5,600,000	-
Sub-Total [a]	27	7,600,000	769,980
South [c]	25	6,400,000	-
Total	52	14,000,000	769,980

Notes:

[a] Total Currently Permitted: Source: EVAS from: [Assessment Report / CIS El Guacal Landfill / SCS Eng. for USEPA / July 2010](#)

[b] Source: EVAS from "Antecedentes" document received May 2011.

[c] EVAS indicates has not to date calculated a capacity for the South Cell.

The figure calculated here is conceptual and intended only to provide a sense of magnitude.

[d] All capacities are based on a density of 1.1 tons per cubic meter, as assumed by EVAS. Cambridge considers this to be a reasonable density assumption. To obtain cubic meters (volume), the above tonnage numbers (mass) should be divided by 1.1. According to EVAS, actual operational density over 1.1 tons/m³ has been achieved in the North Cell.

EVAS records indicate that North Cell has received an additional 76,647 tons from January through May 2011. **Figure D-2** below shows that significant capacity remains, which would provide sufficient airspace, without any additional diversion, for a total of approximately 50 years, divided as follows:

1. 5 more years for currently active North Cell;
2. 21 more years for undeveloped Center Cell;
3. A total of $5 + 21 = 26$ years of Permitted Capacity for North and Central cells;
4. A total of approximately 51 years including undeveloped and as yet not permitted South Cell.

Figure D-2: Landfill Capacity Remaining

Cell	Estimated Remaining Capacity (Tons)	Projected Disposal Rate (TPA) [d], [e]	Est. Remaining Disposal Period (Years)
North	1,230,020	244,635	5
Central	5,600,000	263,541	21
Sub-Total [a]	6,830,020		26
South [c]	6,400,000	263,541	24
Total	13,230,020		51

Notes:

[a] Source: EVAS from: [Assessment Report / CIS El Guacal Landfill / SCS Eng. for USEPA / July 2010](#)

[b] Total Currently Permitted: Source: EVAS from "Antecedentes" document received May 2011.

[c] From our data research, EVAS has not to date calculated a capacity for the South Cell.

The figure calculated here is conceptual and intended only to provide a sense of magnitude.

[d] Average projected tonnage intake 2011-2015 (please see Section C of this Task 1 Report.)

[e] Average projected tonnage intake 2016-2020 (please see Section C of this Task 1 Report.)

It is noted here that some technical configurations of energy recovery facilities, such as incineration, could divert significant volumes from disposal in the landfill cells. This diversion would extend the useful life of the cells significantly.

Site Landfill Airspace Available Conclusions

Even with no additional diversion (beyond that provided by the existing recycling plant), the currently permitted North and Central cells provide approximately 26 years of available disposal airspace. This is considered more than adequate to accommodate any residues that might be generated by an energy recovery facility (such as ash.)

There is no landfill airspace limitation that would preclude implementation of an energy recovery facility at the CIS El Guacal site.

E. Geotechnical Aspects

General Location

There are a number of potential sites for an energy recovery plant available within the perimeter of the overall CIS El Guacal facility, but the discussion below focuses on candidate locations adjacent to existing landfill cells, recycling plant, gas extraction plant and access roads.

Larger Footprint Plant Candidate Locations

Two candidate locations for positioning a larger footprint waste processing and energy recovery facility would be located either on one or both of the following adjacent plots of land within the CIS. Please see **Figure E-1** below. These two candidate plots of land are directly accessible from the internal access road that runs from the Scalehouse along the East edge of the North Cell to the existing Material Recovery Facility (MRF) and further on to the Composting Area:

- a) The “**Flat Cut Lot**” of approximately 1.5 hectares in area cut out of the mountainside just adjacent to the existing Composting Area. The Flat Cut Lot floor is undisturbed virgin ground exposed after the excavation cut of the mountainside; and
- b) The “**Stockpile Lot**” of approximately 4.0 hectares located adjacent to the Flat Cut Lot. The soil excavated to create the currently active North Cell has been stockpiled and compacted by bulldozers to the West of the North Cell, creating a flat, artificial hill with a level area spanning approximately 4.0 hectares. This stockpile pile stands at about 9.0 meters higher elevation than the adjacent 1.5 hectare “Flat Cut Lot”.

A larger footprint plant configuration would likely include elements such as a Fuel Preparation “Front End” plus an Energy Recovery “Back End.” Such plants with intake capacities in the range of 650 TPD of MSW will typically require footprints on the order of 3.2 to 6.5 hectares, including dedicated roads. The two candidate lots identified total approximately 5.5 hectares, which is enough surface area for even the largest likely larger footprint plant configuration.



Figure E-1: Potential Larger Footprint Plant Locations at CIS El Guacal

Smaller Footprint Plant Candidate Locations

For a smaller footprint energy recovery plant, such as a Gas Engine-Generator configuration, an area near the existing GreenGas contractor's gas extraction/gas flare installation would be adequate. Soil loading for such a facility would be significantly lower than for a larger footprint facility. Please see **Figure E-2: Existing Landfill Gas Extraction/Gas Flare Installation (GreenGas)**

It is estimated that the following approximate footprint areas would be required for smaller-footprint configuration such as a typical Landfill Gas Engine-Generator configuration:

- a) Two (2) Gas Engine-Generator modules (Module A + Module B) of approximately 1.6 MW, each (total 3.2 MW) capacity to utilize Landfill Gas from the currently active North Cell. Accounting for compressor and LFG treatment system space requirements and the service corridors:

$$2 \text{ Modules} \times 4 \text{ m} \times 15 \text{ m} = 120 \text{ m}^2;$$

and

- b) Two (2) Gas Engine-Generator modules (Modules C + Module D) of approximately 1.6MW, each (total 3.2 MW) to utilize Landfill Gas from the planned Central Cell. Accounting for compressor and LFG treatment system space requirements and the service corridors:

$$2 \text{ Modules} \times 4 \text{ m} \times 15 \text{ m} = 120 \text{ m}^2;$$

- c) Expansion area to accommodate two (2) additional potential future Gas-Engine Modules (Module E + Module F):

$$2 \text{ Modules} \times 4 \text{ m} \times 15 \text{ m} = 120 \text{ m}^2;$$

The total footprint area calculated above for 6 Modules would be:

$$3 \times 120 \text{ m}^2 \times 1.2 \text{ factor for cover building and access} = 432 \text{ m}^2$$

This estimate will be further defined during Task 4.

The weight of the concrete slab for the Landfill Gas Engine-Generator configuration needs to be approximately three times the weight of the Engine-Generator sets to absorb the dynamic loads. Typical slab thickness would be 16 to 32 centimeters (6 inches -12 inches) above grade and 45 to 60 cm (18 to 24 inches) below grade at 4000psi (28 day) concrete strength. This design will be further defined during Task 4.



Figure E-2: Existing Landfill Gas Extraction/Gas Flare Installation (GreenGas)

Site Geological Profile and Seismic Activity

The lithological formations commonly found across the country date back from Paleozoic to pre-Cretaceous periods, the metamorphic rock formation being the most prominent one. The country is divided into three seismic zones along a northeast to southwest region parallel to the Bucaramanga fault zone into Ecuador. These zones are designated as High Seismic Hazard, Intermediate Seismic Hazard and Low Seismic Hazard. Please see **Figure E-3** below.

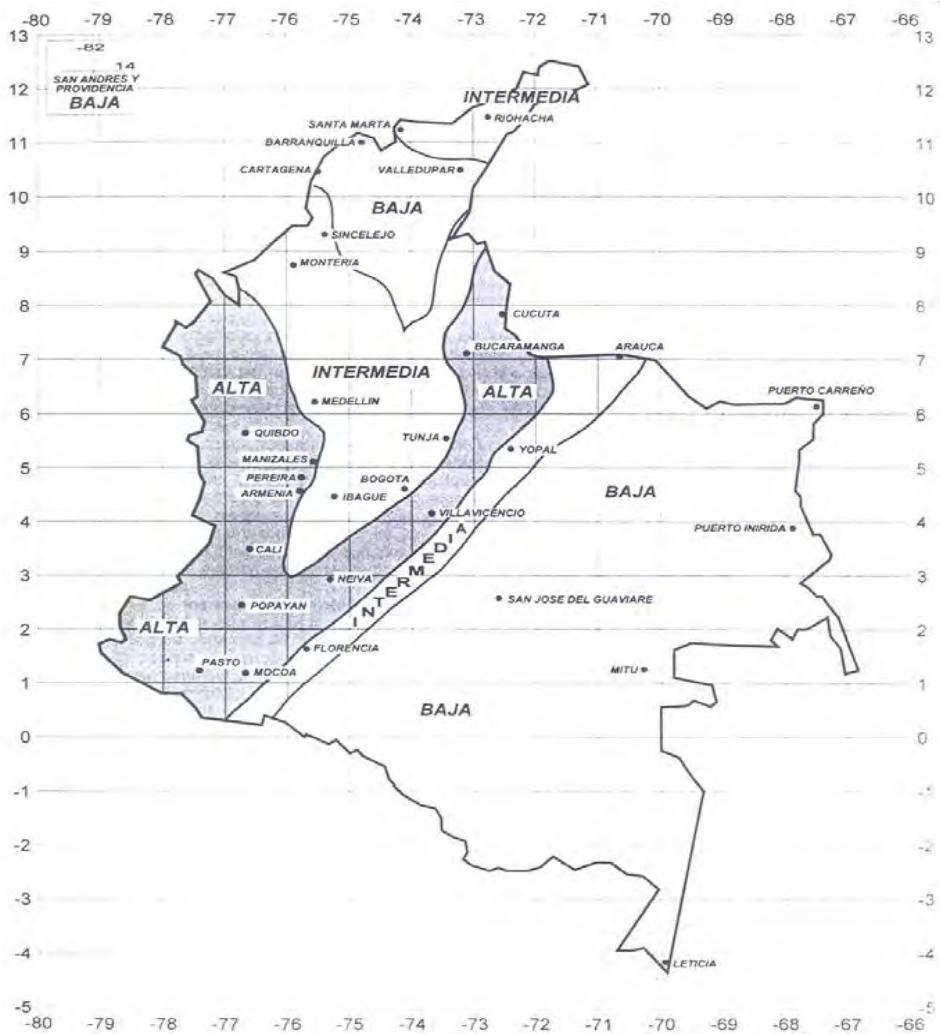


Figure E-3: Seismic Map of Colombia

(Source: "Normas Colombianas de Diseño y Construcción Sismo Resistentes", 1998 or "Colombian Standards for Earthquake Resistant Design and Construction", 1998)

Based on this source, "Normas Colombianas de Diseño y Construcción Sismo Resistentes" 1998, the CIS El Guacal Landfill site is located in the Intermediate Seismic Hazard Zone and almost at the delineation line with the High Seismic Hazard Zone. Thus the site is subject to Effective (vertical and horizontal) Peak Acceleration factors (Aa) of 0.20-0.25. Please see **Figure E-4** below.

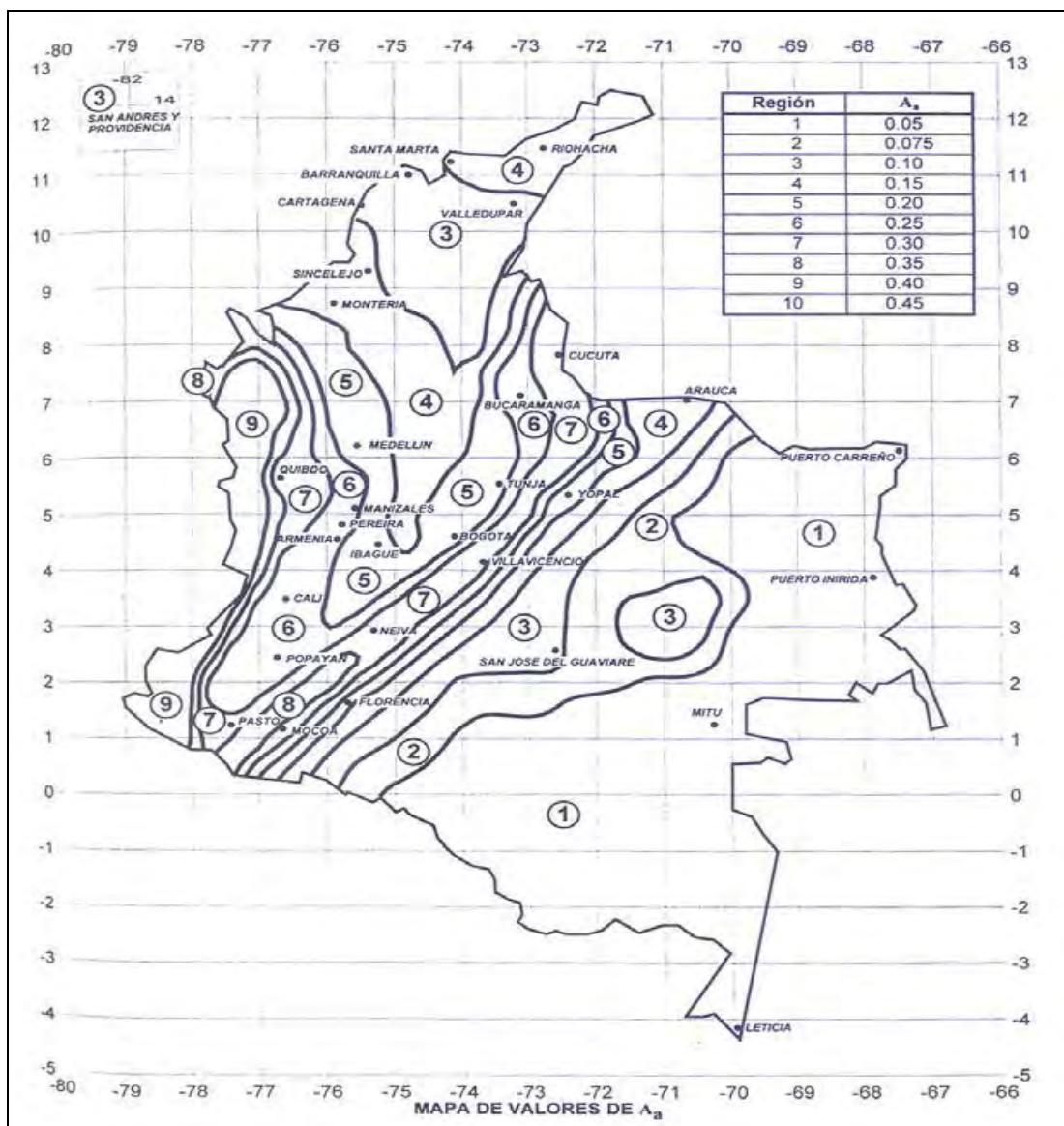


Figure E-4: Effective Peak Acceleration Factors (A_a)

(Source: "Normas Colombianas de Diseño y Construcción Sismo Resistentes", 1998 or "Colombian Standards for Earthquake Resistant Design and Construction", 1998)

Once the IBC (International Building Code) Site coefficients are confirmed by the geotechnical field studies, to be accomplished during the implementation phase of the Project, all critical plant foundations will need to be designed to withstand these peak acceleration factors.

Site Geotechnical Conclusions

It is concluded that the CIS El Guacal site offers adequate available:

1. Footprint area for a larger footprint plant configuration (up to 5.5 hectares);
2. Footprint area for a smaller footprint plant configuration (up to 432 m²); and
3. Soil and seismic conditions for various candidate plant foundation designs, subject to the results of the geotechnical field studies to be described in Task 4.

There is no evident geotechnical aspect that would preclude an energy recovery facility from being built at the CIS El Guacal site.

F. Transportation Aspects / Traffic and Access Roads

The CIS El Guacal facility has private internal access roads within the site, which are unpaved but in fair condition. The internal roads are fairly normal for a landfill and waste recycling facility context. These internal roads are not considered an obstacle to construction of an energy recovery facility.

The road to CIS El Guacal connects the town of San Antonio de Prado with the Municipality of Heliconia. Please see Figure F-1. The exit to CIS El Guacal is approximately 17 kilometers before Heliconia itself, and some 16 kilometers from San Antonio de Prado. The waste collection trucks currently pass through the Municipality of San Antonio, a congested urban area. The truck traffic affects this population negatively.



Figure F-1: Routes to CIS El Guacal

Note: Yellow lines indicate existing roads.

On an average day, there are approximately 65 trucks that travel this route to the landfill, which is not a high traffic level. However, the road is narrow (2 lanes in most locations and 1 lane in a number of locations) and is in poor condition. The road has many unpaved sections and requires continuous corrective and preventive maintenance. Despite frequent landslides and other events, no waste delivery interruptions of any significance were reported by the EVAS landfill management team.

The Municipality of Medellín, in whose jurisdiction is located the town of San Antonio de Prado, has been considering two options to bypass San Antonio and thereby minimize or avoid the passage of waste collection trucks through the town. The two options shown in Figure F-2 are:

1. The construction of a bypass through San José. The bypass would add 6.1 kilometers to the overall route.
2. The construction of an alternative named the Doña María. This alternative route runs parallel to the Doña María water course. The Doña María alternative would have a length of 9.9 kilometers as a route from Itagüí connecting to the existing road to El Guacal after San Antonio. The disadvantage with the Doña María route is that the ground is unstable in many sections.

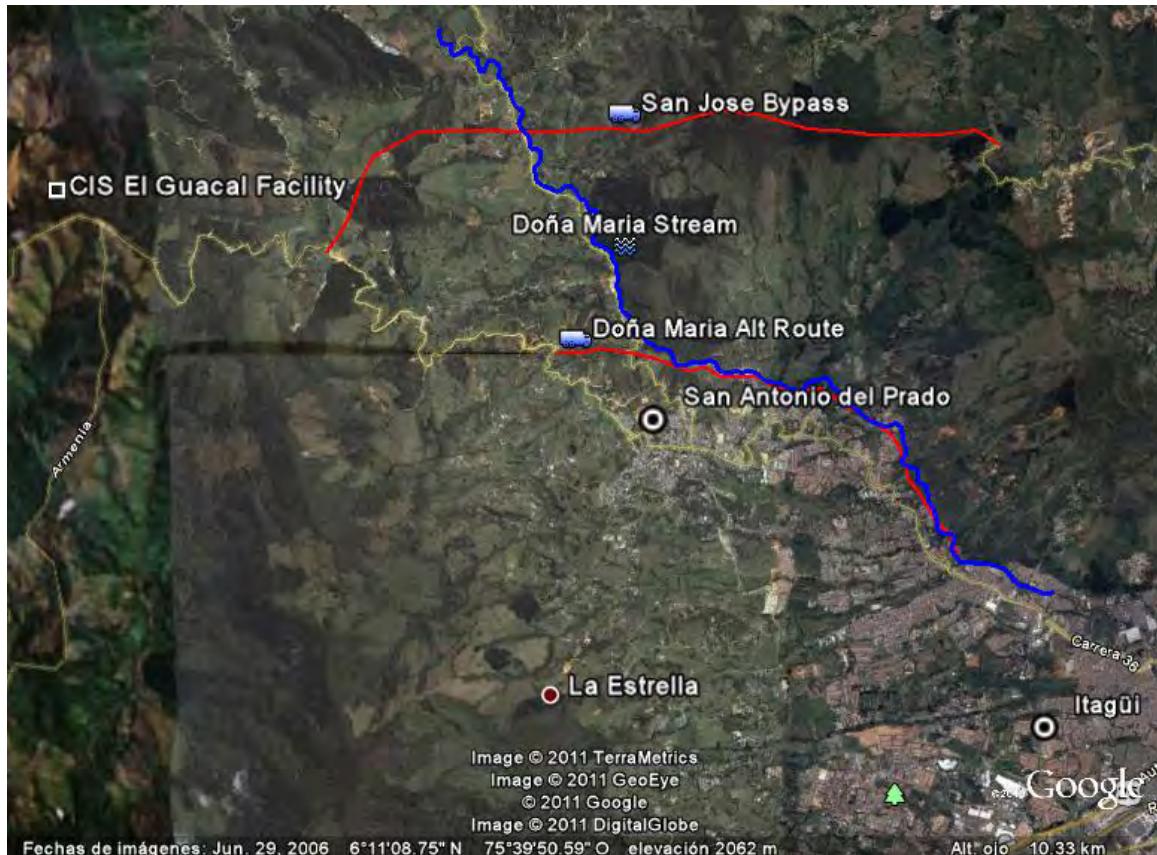


Figure F-2: Alternative Routes: San José Bypass and Doña María Bypass

Note: Yellow lines indicate existing roads and red lines indicate routes under evaluation.

The municipality of Medellín does not consider that it should be solely responsible for the financing of either alternative because the municipalities of Envigado and Itagüí would also benefit from the construction of the roads. Therefore, the projects have not been budgeted as yet by the Medellín city administration.

Site Transportation Aspects Conclusions

Although two alternate routes are under discussion which would reduce traffic impacts to San Antonio de Prado, it is not clear that construction of these routes will occur within the medium or even long term. Therefore, the CIS El Guacal facility is likely to remain dependent on the current road from San Antonio de Prado for the foreseeable future.

Although the current road from San Antonio de Prado requires continuous repairs, impedes traffic flow, and has significant negative impacts to San Antonio de Prado itself, the EVAS landfill management team and the annual waste delivery tonnages clearly indicate that no significant interruptions in waste deliveries have occurred. An energy recovery facility would not increase traffic to the CIS El Guacal facility, since the current waste supply is adequate (please see Section C of this Task 1 Report.) The internal roads are in fair condition, and fairly typical of waste management facility contexts in various parts of the world.

There is no evident transportation obstacle that would preclude construction of an energy recovery facility at the CIS El Guacal facility.

G. Utility Grid Conditions

Within the Sistema de Interconexión Nacional (SIN), the national electricity grid system, operating companies are classified as either "Generation", "Transmission", or "Distribution" companies. The 220 kV (kilo volt) to 500 kV range of line voltage is considered as "Transmission" voltage and all line voltages less than 220 kV are considered as "Distribution" voltage. The Distribution Company in the CIS El Guacal area is Empresas Públicas de Medellín (EPM).

Cambridge meetings with EPM engineers at EPM head office in Medellín 26 May 2011 confirmed that the existing 13.2 kV distribution line at site already has a high loading factor and cannot, under any circumstances, support additional loads such as that which might be exported by any type of energy recovery facility located at CIS El Guacal. EPM engineers have confirmed that the optimum means of exporting any power generated at the CIS El Guacal would be via a new 44 KV distribution line from the landfill to one of three alternative substations. This line will be designed to handle up to 20 MW of export capacity from the CIS El Guacal site. Alternative connections as proposed in EPM's 29 June 2011 email to Cambridge are:

- San Antonio de Prado Substation at 10.3 km connection length;
- San Cristobal Substation at 6.8 km connection length; and
- Ebéjico Substation at 10.4 km connection length.

EPM will propose the following scope of work and associated pricing during the accomplishment of this Study:

1. Step-Up Transformers at CIS El Guacal (new local Sub-Station);
2. 44 kV line from CIS El Guacal to one of the three alternative substations;
3. Step-Up Transformer 110 kV: 44kV at the existing Substation at one of the alternative substations.

The substation alternative will be selected during project implementation, which includes detailed design.

Depending on the Technical Configuration to be selected in Task 4, electric power is likely to be generated at one of two different voltage levels (13.8 kV from a typical energy recovery steam turbine generator and 4.16 kV at a typical energy recovery gas engine generator.) Therefore, either a 44 kV: 13.8 kV step-up transformers or 44 kV: 4.16 kV step-up transformers would be located at CIS El Guacal would boost the voltage up, respectively, for export to the grid.

EPM is willing to provide these step-up transformers (both at CIS El Guacal and at one of the alternative substations) and the 44 kV distribution line from CIS El Guacal to one of the alternative substations and

factor the leveled cost into a power distribution agreement as part of a distribution charge per kWh exported from CIS El Guacal. This charge will be incorporated into the Task 5 Preliminary Cost Estimates effort.

Site Utility Grid Conclusions

It is concluded that utility grid conditions at the CIS El Guacal site require installation of a 44 kV line to San Antonio de Prado. This line will be designed and built by EPM to accommodate up to 20 MW of export capacity. In addition, step-up transformers (step up to 44 kV) will be required at CIS El Guacal, as well as to one of three alternative existing substations. The cost of this new line and the various step-up transformers will be spread out over time and over kWh exported.

There is no evident site utility grid condition that would preclude an energy recovery facility from being built at El Guacal.

H. Water and Wastewater Aspects

Wastewater

The only significant volume of wastewater present at the site is leachate (water that has come into contact with MSW or other wastes.) Corantioquia has indicated that the facility has suffered from overflows of leachate from its treatment system into the nearby Los Morros creek. Corantioquia reports that the leachate treatment system, including a large pond, is designed for a maximum volume of 1 l/s (liters per second), while leachate volumes during the rainy season have reached the range of 10.0 to 25.0 l/s.

The El Guacal landfill began operating in April 2006. EVAS took over operations of the Site in 2008. The previous operator began filling the currently active North Cell from the upper section downward, which is an unusual sequence. This has caused a number of operational problems, including the creation of a very large exposed working face, which in turn generates excessive amounts of leachate (rain water that has come into contact with waste.) The steep slope so created makes it difficult to keep temporary cover materials such as tarps in place. Finally, the large exposed work face promotes loss of landfill gas to the atmosphere, limiting the amount extracted.

EVAS has begun to address this issue by beginning to cover the upper sections of the in-place waste, and reducing the slope of the waste by beginning to deposit increasing amounts of waste in the lower areas of the North Cell.

These measures, if fully implemented, should significantly limit the amount of leachate generated during the remaining approximately 5 years of North Cell life. This is the optimum way to address the existing overload on the leachate treatment system, since a very large expanded treatment pond surface area or a very large leachate evaporation system would be required to treat the current (abnormal) volumes of leachate.

Water Availability

Depending on the technical configuration for the energy recovery facility to be selected during Task 4, the water demand from such a plant could range from zero to 75 m³ / day (intermediate demand case) to 400 m³ per day (high demand case.)

Significant amounts of groundwater are not accessible at any practical depth. The nearby Los Morros creek has a total available volume of 7.0 l/s (approximately 600 m³ per day.) Of this, only a negligible amount is used by the existing CIS El Guacal facility. This means that even under a high demand case of 400 m³ per day, the Los Morros creek would satisfy the plant's demand.

If there was a desire to limit the amount of water drawn from the Los Morros creek, leachate could be treated on-site to supplement the water available. We estimate leachate flow for a typical working face of 1.0 hectare (a much smaller working face area than the current one) to be on the order of 100 m³ per day (1.2 l/s).

Conclusions

There is no obstacle related to water supply or wastewater that would preclude implementation of an energy recovery facility.

I. Ecological and Regulatory Aspects

Current Status

The CIS El Guacal facility holds Environmental License No. 7529 issued January 12, 2005, which covers both the construction phase and operation of the landfill in an initial volume of 200 tons per day. Subsequently, by Resolution 3968 of March 2007, the authorized volume of disposal to the facility was expanded to 400 tons per day, imposing additional obligations related to the solid waste recycling plant. In December 2007, by Resolution 4389, the authorized volume of waste was further expanded to 740 tons per day, covering the facility's current disposal level of approximately 650 TPD. The current license does not include treatment of hazardous materials, meaning that hazardous waste that goes into the landfill is sent directly to the special waste cell now under construction. The environmental permit has a term of 24 years until 2029.

According to Corantioquia, the facility has a leachate treatment system with capacity to treat a maximum flow of 1.0 l/s but there have been levels of 10.0 to 25.0 l/s during rainy season, causing overflows and consequent pollution to the "Quebrada de Los Morros" stream.

In addition, Corantioquia reports that a number of routine periodic reports have not been submitted in a timely manner. This has resulted in the initiation by the environmental authority (Corantioquia) of a sanction process and in the imposition of preventive measures (Resolution 5742 of November 2010). This process is currently undergoing a phase of final imposition of sanctions. Of the various reports that the CIS El Guacal should present periodically to Corantioquia, the only one that is reportedly being presented regularly but incompletely is the surface water report.

According to Corantioquia officials, one of the possible sanctions to be imposed is to not authorize the development of new projects in the landfill until it meets all the obligations imposed by Corantioquia in various administrative acts. **However, it is reasonable to assume that CIS El Guacal would be able to enter into satisfactory compliance prior to the implementation phase of the Project, since neither routine reporting compliance nor leachate volume reduction compliance should require any significant capital investment or fundamental adjustment to operations.** Most importantly, Corantioquia emphasized its general position of support for an energy recovery project at the CIS El Guacal site.

Regarding leachate volume reduction, Cambridge agrees that current efforts by EVAS to correct the unusual top-to-bottom fill pattern initiated by the previous operator in the North Cell will lead to a much smaller uncovered working face, which will lead to a drastically reduced leachate volume.

Environmental and Regulatory Aspects Relevant to an Energy Recovery Project

In Task 10 the specific types of licenses, permits or approvals required, permissible limits and applicable standards, competent authority and its relationship with the licenses and permits that currently cover the operation of the landfill will be confirmed.

Nevertheless, at this point the following general requirements that could frame a permitting effort can be listed:

1. Requirement for environmental licensing: The Regulatory Decree 2820 of 2010 Title VIII of Law 99 of 1993 on environmental permits establishes the types of projects subject to environmental licensing and the competent authority for the processing of that license. In Task 10, there will be discussed in detail the various options and categories established by the Decree and its applicability to the energy recovery project in order to determine if the project would require an environmental license and the applicable regulatory agency. It is important to clarify that if the project requires an environmental license, the process would also include all permits and authorizations for the use of natural resources.

2. Air Emission Permit: The regulations relating to air quality and air emissions permits are as follows: Decree 610 of 2010, which regulates air quality and intake standards; Decree 909 of 2008, which regulates air emissions permits and permitted contaminant limits; and Resolution 058 of 2002 which establishes the standards and maximum permitted emission limits for incinerators and solid waste crematoria. No specific regulation exists that cover emissions standards from flaring landfill gas; typically these activities are generally controlled within the environmental license. However a landfill gas to energy project will have to comply with the emissions standards applicable to burners of Decree 909 of 2008.

3. Discharge Permits: Decree 3930 of 2010 partially amended by Decree 4728, 2010, regulates direct discharges to water and contains the standards on dumping permits and permissible limits for contaminants. This aspect should be covered by the CIS El Guacal's existing permit.

4. Water Concession: Decree 1541 of 1978 regulates water concessions in all the activities that derive from water sources. If the energy recovery project requires higher volumes of water than the currently available ones at the CIS El Guacal, the regulations related to additional water capture will have to be analyzed. Currently, the landfill captures water from the "Los Morros" stream.

5. Special waste disposal: Decree 2309 of 1986 regulates handling, collection and disposal of special waste including sludge and ash.

6. POT (Plan de Ordenamiento Territorial/Land Use Plan): The current POT expires in 2012 and, with the support of the National University of Colombia, is currently undergoing an information-gathering phase for updating. The CIS meets the requirements of the POT, regarding land use. In

the case that some form of construction of an energy recovery plant or civil work is necessary, the POT permits will have to be consulted and the compatibility of land use with this type of projects will have to be verified. In addition, it will be necessary to take into account the requirements and licenses stipulated by the municipality for construction phase.

In accordance with Decree 2820 of 2010, the energy recovery project could, under some circumstances, be classified as a "use of virtually polluting alternative energy sources" project, in which case, the processing of license would be done through the Ministry of Environment, Housing and Territorial Development. However, Corantioquia's officials raised the possibility that the energy recovery project can be presented as one to improve the operation of the landfill in order to maintain Corantioquia's jurisdiction. To do so, Corantioquia would make the consultations directly with the Ministry of Environment, once the project is presented to this entity.

Ecological and Regulatory Aspects Conclusions

The key environmental regulatory agency, Corantioquia is supportive of an energy recovery Project to be built at the site. There is in place an adequate regulatory framework that would guide permitting efforts.

It is concluded that no unmanageable regulatory or ecological obstacle exists that would preclude implementation of an energy recovery facility at the CIS El Guacal site.

J. Task 1 Conclusions

General Conclusion

Based on a detailed review of extensive documentation, together with detailed interviews with project stakeholders, the Cambridge Project Team has determined that there are no obstacles related to the infrastructure of the site (or other aspects of the site addressed in this Task 1) that would preclude the implementation of an energy recovery facility at the CIS El Guacal.

Key Conclusions by Task 1 Section

B. Stakeholder Expectations

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining and readily financeable.
- **Energy Generation:** The energy recovery facility must export energy in some form. Ideally, the Project will generate power long term for sales into the national grid (SIN).
- **Social Development Impact:** In line with its mission, IDEA intends for the Project to increase the supply of locally-generated, economical energy into the SIN as well as providing jobs to the local community.
- **Low Technical Risk:** IDEA expects the energy recovery facility to incorporate in its design only commercially proven technologies.
- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee of approximately US\$ 11 per ton.
- **Compatibility with Existing Subcontracts** in force at the site.
- **Keeping Municipality of Heliconia Abreast of Project Development:** The municipality supports the project and wishes to remain up to date on its development.
- **Corantioquia:** The environmental agency supports the Project and hopes it will lead to additional compliance with existing requirements.
- **USTDA: United States-Sourced Equipment and Services:** The Project implementation should maximize the use of U.S.-sourced equipment and services during its implementation.

C. Site Waste Supply

The MSW waste supply to CIS El Guacal is highly unlikely to drop below approximately 650 TPD (the current delivery rate) for the foreseeable future.

D. Landfill Airspace Available

There is no landfill airspace limitation that would preclude implementation of an energy recovery facility at the CIS El Guacal site.

E. Geotechnical Aspects

There is no evident geotechnical aspect that would preclude an energy recovery facility from being built at the CIS El Guacal site.

F. Transportation Aspects / Traffic and Access Roads

There is no transportation or road access obstacle that would preclude construction of an energy recovery facility at the CIS El Guacal facility.

G. Utility Grid Conditions

There is no evident site utility grid condition that would preclude the construction of an energy recovery facility at the CIS El Guacal facility.

H. Water and Wastewater Aspects

There is no obstacle related to water supply or wastewater management that would preclude implementation of an energy recovery facility.

I. Ecological and Regulatory Aspects

No unmanageable regulatory or ecological obstacle exists that would preclude implementation of an energy recovery facility at the CIS El Guacal site.

END OF TASK 1 REPORT

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 2 Report:
Power Demand and Electricity Market**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

**CAMBRIDGE
Project Development Inc.**

in association with:

EnerconAmerica Inc.

18 August 2011

The contents of this Task 2 Report are listed below:

Task 2 Report Contents

Section	Title
A	The Colombian Electricity Market and Key Players
B	Tax Exemptions
C	Spot Market vs. Power Purchase Agreements
D	Likely Power Sales Pricing to be Achieved
E	Power Sales Model
F	Plant Internal Power Consumption
G	Generation Cost Including Capital Recovery
H	Conclusions

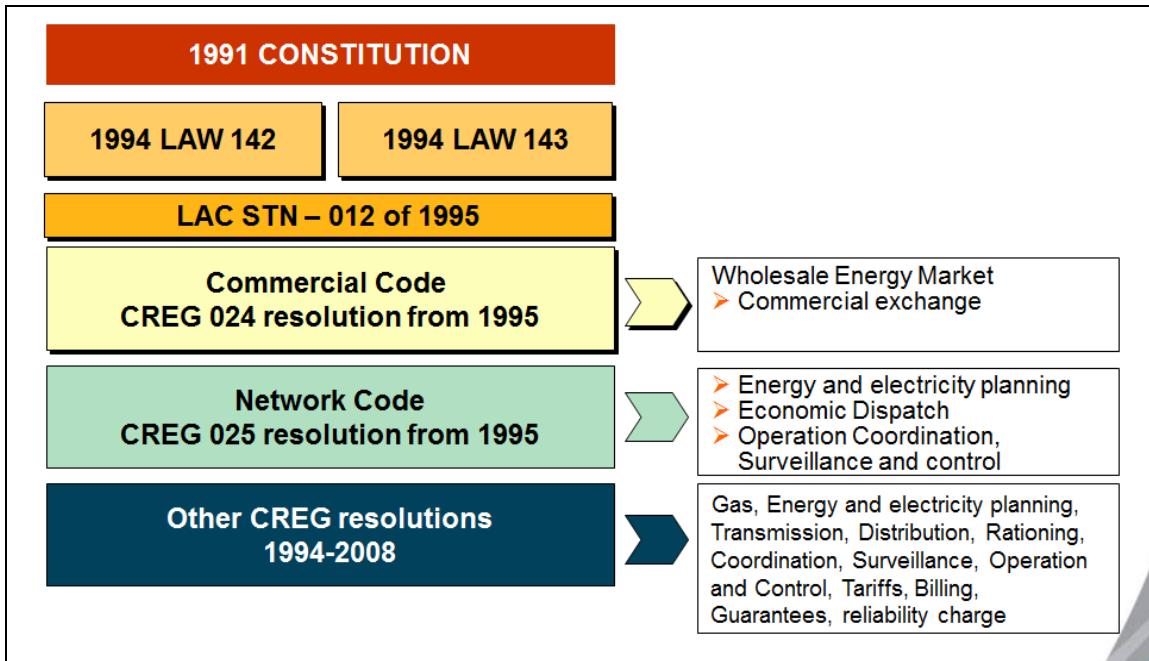
A. The Colombian Electricity Market and Significant Participants

Policy and Regulation

Colombia has had a liberalized energy market since 1995. The sector is characterized by an unbundled Generation, Transmission, Distribution, and Commercialization framework. **The liberalized energy market has resulted in much better matching of power production and demand than that which prevailed previously. The liberalized market has also proven successful in encouraging the establishment and long term operations of numerous independent producers.**

The legal and regulatory structure of the Colombian energy market is based primarily on Laws 142 (Public Services Law) and 143 (Electricity Law) of 1994. See **Figure A-1** below.

Figure A-1: Regulatory Framework



The **Ministry of Mines and Energy** is the leading policy and regulatory institution in Colombia's energy sector. Within the Ministry, the **Unit for Mining and Energy Planning** (or "Unidad de Planeación Minero Energética" or UPME) is responsible for the study of future energy requirements and supply situations, as well as for drawing up the National Energy Plan and Expansion Plan.

The **Regulatory Commission for Gas and Energy (CREG)** is in charge of regulating the market for the efficient and reliable supply of energy. It defines tariff structures for consumers and guarantees free network access, transmission charges, and standards for the wholesale market. Among others, CREG is responsible for providing regulations that ensure the rights of consumers, the inclusion of environmental and socially sustainable principles, improved coverage, and financial sustainability for participating entities.

Administration and Operation of the Market

Please see **Figure A-2** below, for an illustration of the market structure and flow of transactions.

XM (Compañía de Expertos en Mercados S.A. ESP) is a subsidiary of **ISA** (Interconexión Eléctrica S.A.), and is in charge of:

- Operating and coordinating the overall National Interconnection System (**SIN**)
- Administering the electric power commercial settlement mechanism in the Wholesale Market
- Settling and clearing of charges for use of the SIN's grids
- Handling all Spot Market transactions (invoicing and payments) between Generators and the Spot Market.

The centralized administration and operation provided by XM has been a key element in the successful matching of power production with demand within this complex and geographically distributed market.

Currently, there are 28 pure Trading (commercializing) companies; 22 Distribution and Trading companies, 9 companies that operate Transmission lines, and 11 Integrated (Generation + Distribution + Trading + Transmission) companies in the Colombian market.

Transmission

In Colombia, **all voltages above 220 kV are considered as "Transmission" voltages and those below 220 kV are considered "Distribution" voltages**. The Transmission voltage levels in the SIN are either 500 kV or 220 kV.

ISA is the largest of the nine Transmission companies. The other sizeable Transmission companies are EEB, TRANSELCA and DISTASA (Source: World Bank, www.worldbank.org).

Generators do not generally have any direct commercial relationship with Transmission companies, since the generators do not follow the power sold physically once it leaves the generator's facility.

Distribution and Trading

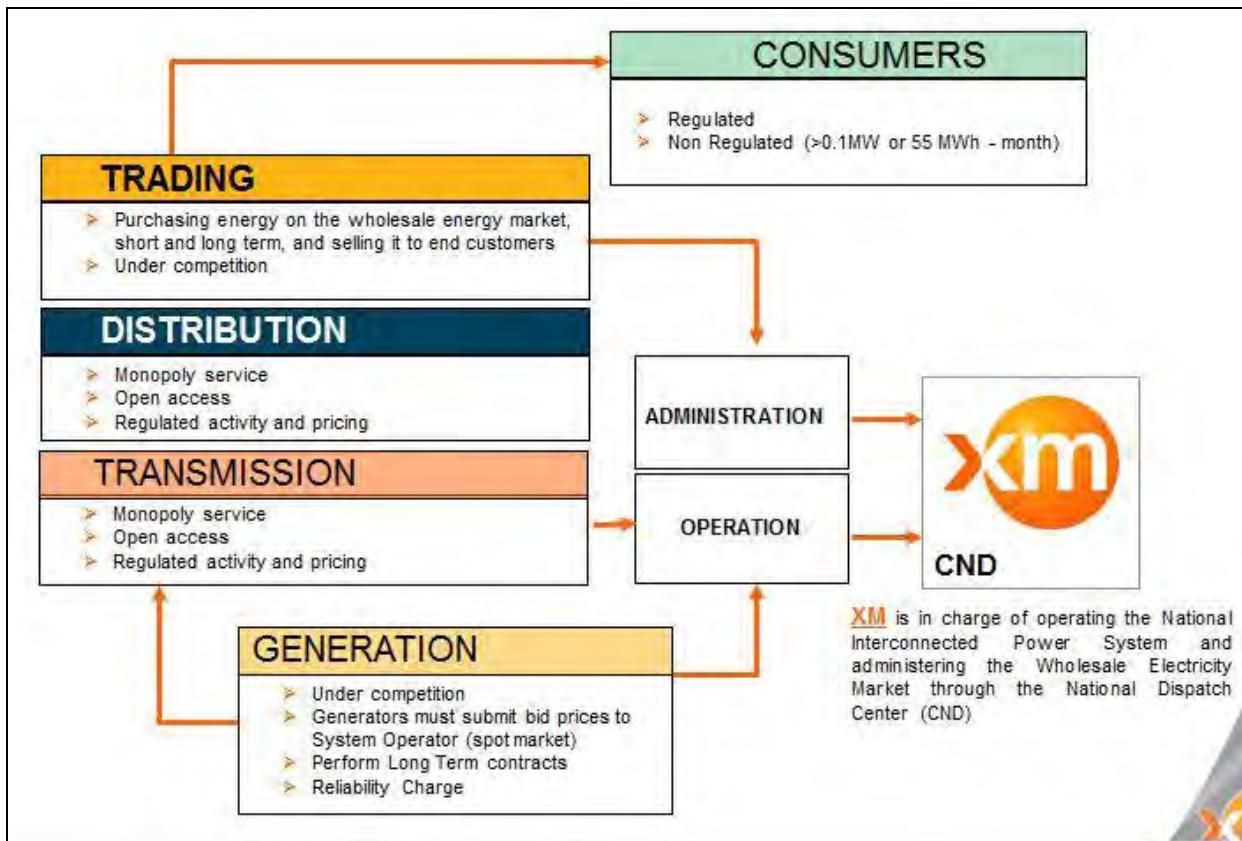
The three largest participants in Distribution are Unión Fenosa (with Electrocosta and Electrocaribe), Endesa (in Bogotá) and Empresas Públicas de Medellín* (EPM) (Source: Ministerio de Minas y Energía, www.minminas.gov.co). **EPM is the sole Distribution company for the CIS El Guacal area.**

The Distribution network consists of 115 kV, 13.8 kV and 44 kV lines. Consumers who have contracts with Generators are billed by their local Trader ("Comercializador"), which buys the power wholesale from the local Distributor. Large customers who purchase more than 55 MWh of power qualify for the **Unregulated User** consumer status and have the option of signing one year (or more), fixed price contracts.

Traders are involved only when Generators have contracts with specific clients, in which case the Trader handles all transactions between the Generator and the contract client.

Please see Section E below, in which appears a more detailed discussion of the flow of sales transactions.

Figure A-2: Market Structure



B. Tax Exemptions

Sales Tax

Current regulations do not provide incentives for use of renewable energy sources such as biomass (an important constituent of MSW on a percentage basis) or landfill gas.

However, tax breaks offered to “Public Entities” would be applicable. The ownership of the proposed power generation facilities is anticipated to be a combination of the following public entities:

- IDEA
- Municipality of Envigado, probably through EVAS
- EMGEA

As a result, the public sector nature of the new generating company would qualify it for a sales tax exemption. Reference is made to Articles 19, 22, and 598 of the Tax Statute ("Estatuto Tributario").

Value Added Tax

The project should qualify for an exemption on Value Added Tax or ("IVA" or "Impuesto al Valor Agregado") on certain specialized equipment purchased or imported for the project. Reference is made to Articles 428 and 424-5 of the Tax Statute ("Estatuto Tributario"). It is necessary to apply for a certification from the Ministerio de Ambiente, Vivienda y Desarrollo Territorial de Colombia (MAVDT) in order to qualify for this exemption.

C. Spot Market vs. Power Purchase Agreements

Spot Market prices over the 1997-2009 timeframe show on average a 20% fluctuation around the mean price, as shown in **Figure C-1** below.

Figure C-1: Electricity Price Variations between 1997 and 2009
(USD / Colombian Peso as of December 2009)

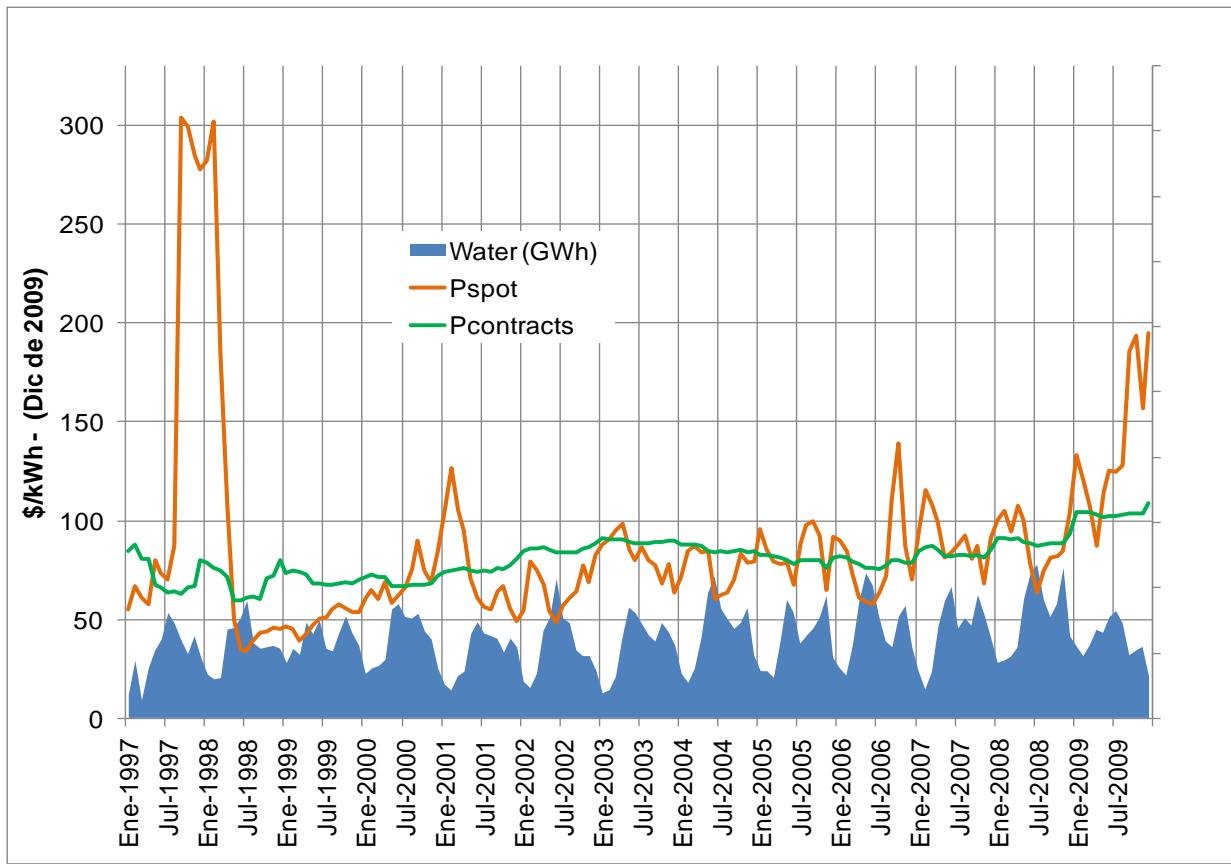


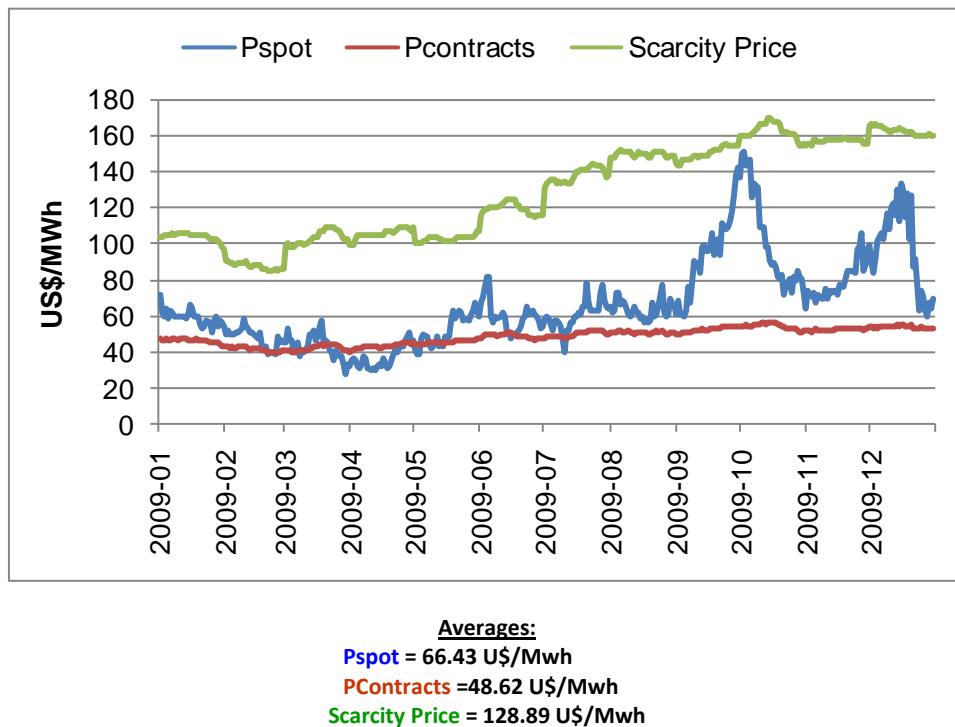
Figure C-1 indicates that over the long term, the Spot Market prices lead the contract prices. Also, please see **Figure C-2** below. (Please note that USD\$ 100.00 / MWh is equivalent to USD\$ 0.10000 / kWh or ten cents per kWh). This price comparison reveals that in 2009, as calculated by XM:

- The Spot Market price which averaged at **USD\$ 0.06643 /kWh**; and
- The contract (Power Purchase Agreement) price averaged **USD\$ 0.04862 /kWh**.

At one point, in October 2010, the Spot Market prices exceeded even the scarcity price level average of USD\$ 0.1289 / kWh, reaching approximately USD\$0.1500 / kWh. **There do not appear to be any**

"downside events" that offset such peaks by dropping the Spot Market price below the annual average.

Figure C-2: Comparison of Spot Market and Contract Prices in 2009



(The Scarcity Price is paid to larger producers for use of reserve capacity during periods of low hydroelectric production.)

Based on the following factors:

- The **average historical price advantage provided by the Spot Market**;
- A contract will probably contain delivery guarantees with associated penalties, which could be problematic in early operational stages; and
- The fact that the SIN system, as currently structured, guarantees that all power from a small producer can be sold into the Spot Market (**there is no risk that available power from the project will not find a buyer** in the Spot Market at any given time),

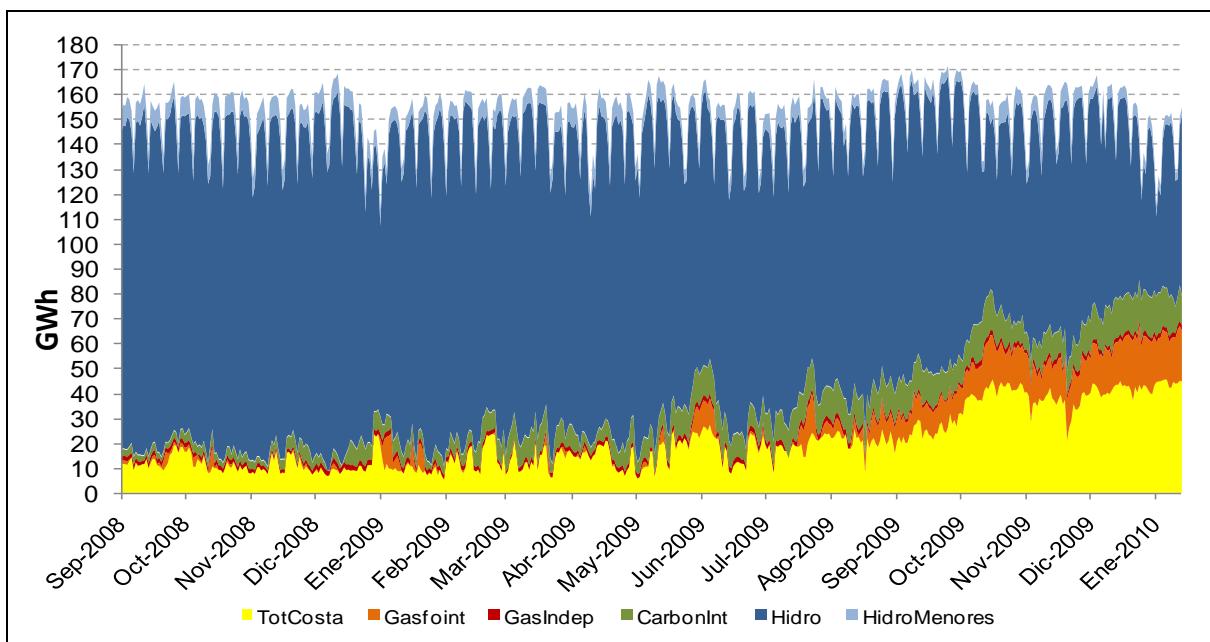
In conclusion, we recommend that the project initiate operations under the Spot Market option. Once the project is in operation, if markedly different price tendencies (for example, a sustained increase in contracted pricing) are detected, the project can always enter into a Power Purchase Contract, even for a limited period of time (for example, a contract with duration of one year.)

D. Likely Power Sales Pricing to be Achieved

During the rainy season, the share of hydropower is typically around 80% and the share of the thermal power is 20% of the total production. The dry season is normally between July and January. In the last dry season (2009-2010), these trended toward a level of approximately 50% / 50% each. See **Figure D-1 below.**

During El Niño events such as that as experienced in 2001 (an overall drying event), the share of hydropower tends to further diminish.

Figure D-1: Fluctuating Share of Hydro and Thermal Power Production



The abundance of hydropower, despite its capacity fluctuations between the wet to dry seasons, contributes to stability for electricity in Colombia. Thermal power, which is seen primarily as a reserve resource, tends to provide some cushioning effect for electricity prices when hydropower is strained during the dry season of the year. In addition, the tax incentive offered to small generators less than 10 MW is likely to encourage new IPPs (Independent Power Producers) to come online. Colombia, as a net exporter of electricity, is in a position to divert the Spot Market electricity exports to the domestic market in case of unexpected power shortages. **All these drivers support the concept that, despite seasonal fluctuations, the supply side of the electricity market will be able to count on stable pricing in the long term.**

In the light of the market drivers discussed above, we project the annual price (in constant dollars) of electricity for the next 10 years as shown in **Figure D-1** below:

Figure D-1: Power Pricing and Seasonality

(in constant US Dollars)

USD\$ / kWh	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
C-Wet Season	.050	.050	.050	.050	.055	.055	.055	.055	.055	.055
C-Dry Season	.060	.060	.060	.060	.065	.065	.065	.065	.065	.065
SP-Wet Season	.060	.060	.060	.060	.065	.065	.065	.065	.065	.065
SP-Dry Season	.075	.075	.075	.075	.080	.080	.080	.080	.080	.080
C-Contract Prices					SP-Spot Market Prices					

Since a recommendation is made in Section C for the project to begin operations under a Spot Market concept, **the economic calculations in Task 4 will assume an overall representative annual average power sales price of USD\$ 0.070 /kWh** (in constant dollars and before any effect of tax exemptions.)

E. Power Sales Model

Figure E-1 below illustrates the anticipated power sales model, as well as commercial relationships between the key entities involved in the project.

As discussed above in Section B, it is anticipated that the company that will operate the project will qualify as a “Generator” on behalf of an IDEA, EVAS and EMGEA partnership. The Generator will export power into the grid as measured at the CIS El Guacal substation.

EPM’s “Distribution” unit will provide and maintain ownership of the on-site step-up transformers, the new 44 kV Distribution line and the 110kV:44kV step-up transformer at the one of the three nearby candidate substations (San Antonio de Prado, Ebéjico, or San Cristóbal). **From this point on, the Generator does not follow the physical movement of power through the Distribution or Transmission lines.**

The three main commercial options for power sales are:

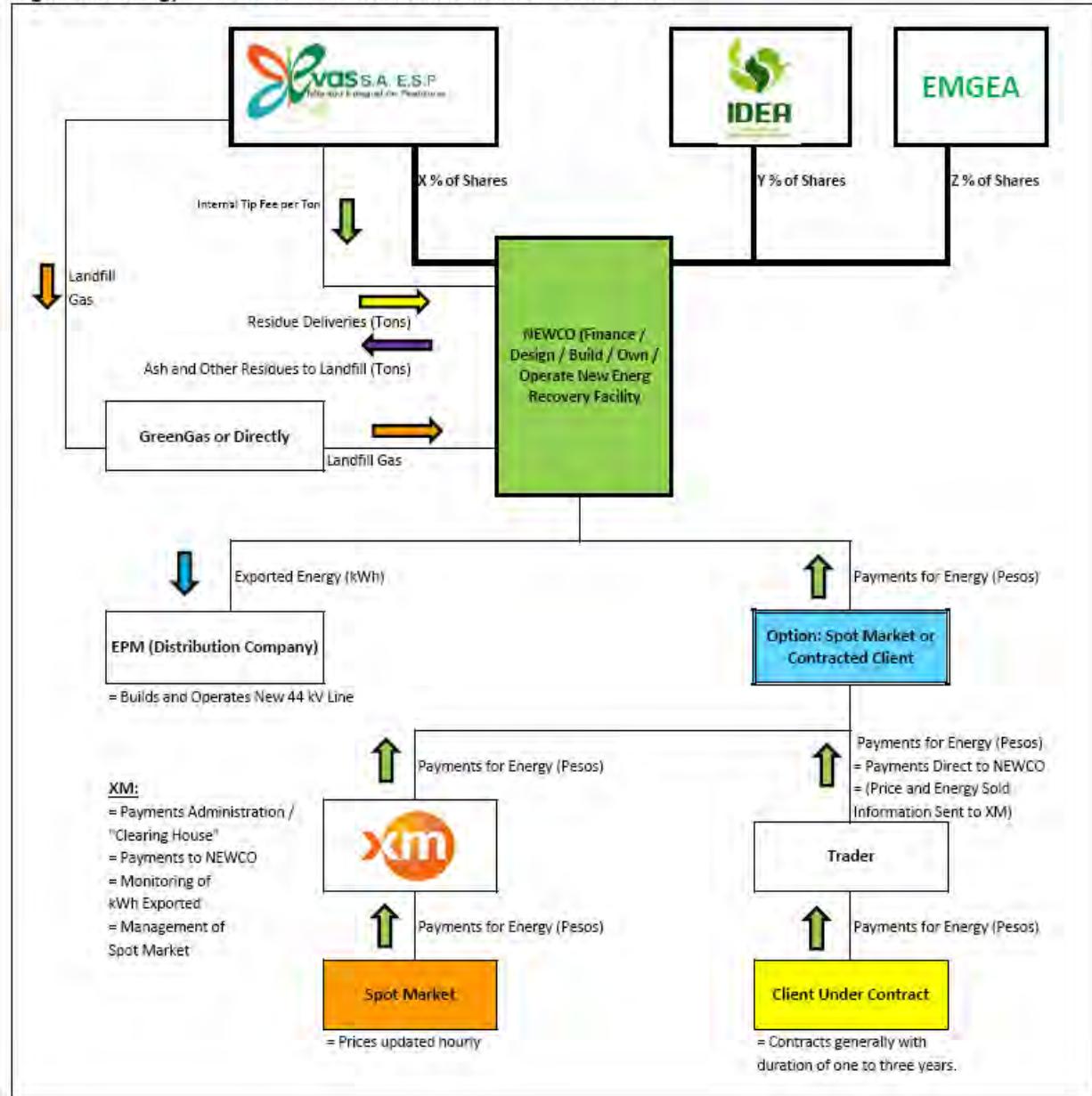
- Sales to the Spot Market
- Sales by contract to a specific client
- A combination of partial sales to the spot market and partial sales by contract to a specific client. (A specific amount of power is committed to the contract, and amounts above that are sold to the Spot Market).

If the mechanism of contract sales is chosen, it will be necessary to select a Trader to handle the transactions for power sales to the final client. In this case, payments flow from the client through the Trader and on to the Generator. Under this mechanism, XM does not handle transactions, but the Generator is required to send information on kWh exported and prices obtained to XM under the power sales contract. This information is used by XM in its function as administrator of the wholesale market.

It is possible for a Generator to register as a Trader, but various requirements are stipulated, including various guarantees and permissions, which imply a significant effort. **If the Generator were to export from only one relatively small plant (as in the case of the project), it is probable that it would be more economical to utilize an external Trader.**

If it is decided to sell to the Spot Market, it is not necessary to involve a Trader, and XM directly handles such transactions, including making payments to the Generator according to the Spot Market prices (which are updated hourly).

Figure E-1: Energy Sales Business Model and Relations Between Entities



F. Plant Internal Power Consumption

The potential energy recovery facilities that could be built at the landfill site will require low voltage electricity to power numerous pieces of internal equipment. Such power used internally is termed here as "Plant Internal Power Consumption."

Typically, a potential Waste to Energy (WTE) plant would consume around 12 % of the gross power generated. The major power consumers in this case are the boiler fans and various pumps, including feed water, condensate and the circulating water pumps. Since it is likely that a "Front End" fuel preparation MRF will be required prior to combustion, the power consumption of such a Front End process could be on the order of 3% of the gross power generation. Therefore, a WTE plant would internally consume on the order of 15% of the gross power generated, and likely have available for export on the order of 85% of the gross power generated. An example for a 9.0 MW gross power generation, net power export capacity would be:

$$9.0 \text{ MW} \times 85\% = 7.6 \text{ MW}$$

A 3.2 MW gross generation Landfill Gas (LFG) plant consisting of two (for example, Caterpillar 3520 model) motor-generator sets would require about 160 kW of auxiliary power consumption at the blowers and the compressors, resulting in net export capacity of:

$$3.2 \text{ MW} - 0.16 \text{ MW} = 3.04 \text{ MW}.$$

It is noted here that SIN Total Daily Demand = 160 Giga Watt Hours or 160 Billion Watt Hours, while, for example an energy recovery facility at 10 MW export capacity would export 240,000,000 Watt Hours per day (or 0.15% of total SIN demand).

Therefore, an energy recovery facility at the CIS El Guacal with power export below 20 MW would not be of sufficient size to have a market-wide effect on the SIN system, whether with regard to pricing or to interconnection operations.

G. Generation Cost Including Capital Recovery

Similar to the Payback Period and Internal Rate of Return analyses, the **Levelized Energy Cost (LEC) Analysis** is an effective method of determining the economic viability of a proposed power plant. LEC is the cost electricity must be generated at to break even. It is an economic assessment of the cost of the energy-generating system including all the costs over its lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital and incentive factors such tipping fees and subsidies. LEC is later compared to the sales price to determine viability or profitability, and is formulated as:

$$LEC = \frac{\sum_{t=1}^n \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^n \frac{E_t}{(1+r)^t}}$$

Where:

- LEC = Average lifetime leveled electricity generation cost (in dollars per kWh or MWh generated)
- I_t = Investment expenditures (net of subsidies) in the year t
- M_t = Operations and maintenance expenditures in the year t
- F_t = Fuel expenditures (negative if a tipping fee) in the year t
- E_t = Electricity Generation in the year t in kWh or MWh
- r = Discount rate
- n = Life of the system, typically 20-25 years.

The LEC and other financial indices will be utilized in subsequent financial evaluations during this feasibility study.

H. Conclusions

It is concluded that the proposed energy recovery facility that could be built at the CIS El Guacal site:

- Would not encounter any legal or commercial obstacles in selling the generated power to the national grid either at Spot Market prices or via Power Purchase Contracts;
- **Can utilize the SIN system, which provides a well proven sales model used by numerous other independent power producers;** this model would involve, primarily: the project (as Generator), an EPM unit as the only Distributor in the project area, a Trader (if a decision is made to enter into a power contract), and access to the vigorous Spot Market at all times.
- **Can count on the ability to sell 100% of available power at all times, under the SIN.** This is an enormous advantage and incentive for independent power projects under the SIN system that is not generally available in most countries.
- **Should initiate operations under the Spot Market,** as higher long term average prices have historically been achieved (it is noted here that **the SIN system guarantees that all power from small producers will find a buyer at all times**); if any difficulties are encountered in selling to the Spot Market (which are not expected), the project can always enter into a Power Purchase Contract subsequently;
- **Would, as a facility exporting 20 MW or less, not have sufficient size to have a market-wide effect** on the SIN system, whether with regard to pricing or interconnection operations;
- Would be able to take advantage of tax exemptions:
 - On power sales revenue tax as a Generator facility owned and operated by public sector entities; and
 - Potentially on Value Added Tax or ("IVA" in Spanish) on certain specialized equipment purchased for the project.
- **Can anticipate a basic power sales price (as sold to the Spot Market) averaging approximately US\$ 0.070/kWh** (in constant dollars excluding inflation and tax incentive effects), based on market history; this annual average is not anticipated to vary significantly over the project life because supply is likely to remain well balanced with demand under the SIN system (given the various incentives for new generators to enter the market);

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 3 Report:
Waste Supply and Ash Management**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

22 August, 2011

The contents of this Task 3 Report are listed below:

Task 3 Report Contents

Section	Title
A	Waste Supply and Logistics
B	Previous Waste Characterization Studies
C	Characterization Study Procedure
D	Ash Management
E	Conclusions

A. Waste Supply and Logistics

A1. Committed Waste Fuel Supply

As described in detail in the Task 1 report (Section C-Waste Supply), two sources of waste, Interaseo and Enviaseo, together deliver 90% of all the waste received at CIS El Guacal. **Therefore, as discussed below, 90% of the waste stream being delivered to CIS El Guacal is considered a committed, long term source of waste:**

- Enviaseo is the municipal waste collection agency for the municipality of Envigado. The waste delivered by Enviaseo represents 28% of all the MSW (Municipal Solid Waste) received at CIS El Guacal. Since EVAS itself is owned by the Municipality of Envigado and the CIS El Guacal is owned and operated by EVAS, this flow is considered internal, and therefore considered as a waste supply committed for the long term.
- Interaseo is a large local private waste collection company that has a current waste delivery contract with EVAS and is required to dispose of a minimum of 400 tons per day at CIS El Guacal. The waste delivered by Interaseo represents 62% of the total waste received at the CIS El Guacal. The Interaseo contract is in its second year of a 15-year term, so that this waste stream is contractually assured for 13 more years from 2011.

The remaining 10% of the MSW flow that is not delivered by Enviaseo or by Interaseo is delivered primarily by the following municipalities:

- Medellín (Southern areas)
- Itagüí
- Caldas
- La Estrella
- Sabaneta
- Heliconia.

This 10% flow out of the total flow is delivered under short term agreements with these municipalities, but as described in the Task 1 Report (Section C-Waste Supply), there are excessive distances involved for these municipalities to feasibly access the alternative landfill of La Pradera in the Northeast region of Antioquia.

Note: The following Sub-Sections A2 through A5 respond to specific topics stipulated to be covered in the Terms of Reference under this present Task 3.

A2. New Potential MSW Supply

The potential for attracting new MSW fuel supplies is currently very limited. The waste that is not disposed of at the CIS El Guacal originates primarily from the northern Aburrá Valley and is disposed of at La Pradera. No market factors are seen that would change this (Please see Task 1 Report). El Guacal's tip fee, \$11 per ton, is less than that of La Pradera, \$15 per ton, and the difference in tip fee (advantage for CIS El Guacal) does not currently attract larger quantities of waste.

A3. New Potential Agricultural Waste Supply

In addition to the 650 TPD of MSW discussed above, CIS El Guacal currently receives an estimated 100 tons per day of Source Separated Organic (SSO) waste, which includes all the agricultural waste that can be economically delivered to the facility. The agricultural waste is processed at the composting facility together with the overall SSO. Compost, once matured, is currently sold as a soil amendment. It is not possible to attract additional agricultural waste (as postulated in the Terms of Reference) without adding an economic incentive (a negative tip fee, or payment to haulers or generators, at the CIS scalehouse.) This is contrary to the EVAS position described in Task 1 that the current tip fee structure should not be changed.

A4. Special Handling Waste as a Potential Fuel

Special Handling and Hazardous Wastes are to be disposed in the specially designed special waste cell currently under construction at CIS El Guacal. While some of this waste may be combustible, it is not anticipated that an energy recovery facility would utilize any of it because:

- Such waste may require special air emissions control equipment;
- Residues, such as ash or other residues from such wastes should not be mixed with ash or other residues from normal MSW, as it may render such residues unfit for disposal in a landfill designed for MSW;
- There is sufficient MSW to supply an energy recovery facility without incurring environmental risk from air emissions from special handling wastes or mixing of ash or residues from special handling wastes.

A5. Logistics and Transportation Infrastructure

The volume of waste that will be delivered to an energy recovery facility at the CIS El Guacal will continue to be the same quantity currently delivered to the landfill within the projected growth

rate discussed in the Task 1 Report. As concluded in Task 1, the transportation infrastructure should not pose as an obstacle that would restrict the construction of an energy recovery facility at the CIS El Guacal facility.

B. Previous Waste Characterization Studies

B1. RECIMED Study

A study was conducted in February 2011 by Precooperativa Multiactiva de Recicladores de Medellin (RECIMED) to evaluate the potential for upgrading the quantity and quality of materials recovered at the CIS El Guacal MRF.

Sampling of garbage collection routes was conducted by RECIMED during January 17, 18, 19 and 21, 2011. Please **Figure B-1** below. Although the sampling and characterization effort was fairly rigorous, the effort was narrowly focused on those routes that are normally sent to the MRF because they are believed to contain a maximum concentration of recyclable materials. Consequently, the great majority of the material that enters through the CIS El Guacal scalehouse was not characterized. Therefore, the RECIMED study is not directly useful as a characterization of the totality of all the waste entering the CIS El Guacal site. **However, the RECIMED study does provide a potentially useful sub-categorization of plastics within the recyclables. This sub-categorization of plastics may be of use in subsequent Feasibility Study tasks.**

Figure B-1: RECIMED Study: Average of Routes Sampled

Material Type	Weight (Kg)	Plastic Only (Kg)	Percent of Plastic
Office Paper	6.9		
Kraft	0.7		
Cardboard	3.9		
Other Paper	1.1		
Plastic Bags (HDPE and LDPE)	33.3	33.3	69.3%
Sacks	6.7		
Glass, clear	14.5		
Glass, brown	0.3		
Glass, plane	0.3		
Aluminum	0.6		
Newsprint	2.7		
Plastic Bottles (PET)	13.5	13.5	28.0%
Plastic Bottles Green (PET)	0.2	0.2	0.5%
Plastic Bottles Brown (PET)	0.6	0.6	1.2%
PET as Percent of All Plastic			29.6%
Plastics Bottles Oil (HDPE)	0.5	0.5	1.1%
Cellulose Material	15.3		
Debris	0.4		
Ferrous	5.9		
Tetrapak	0.2		
Total	104.6	48.14	100.0%

Notes:

- [a] Recycling Numbers for each type of plastic (resin) are: PET = #1; HDPE = #2; LDPE = # 4.
- [b] While Figure B-1 does not provide a breakout of the category of "Plastic Bags", which are normally made of LDPE (Low Density Polyethylene) or HDPE (High Density Polyethylene), we believe that a 50% LDPE / 50% HDPE breakout would be representative.

B2. Previous Waste Characterization Studies: Total MSW Stream

At least three previous studies have characterized the totality of waste entering the CIS El Guacal site. This excludes the RECIMED study discussed in Section B above, which was not designed to sample the totality of MSW entering the site, but rather the concentration recyclables within a pre-selected set of truck routes. The three study results are summarized below in **Figure B-2**:

Figure B-2: Results of Previous Waste Composition Studies

	EVAS Antecedentes Document	EVAS / SCS Engineers for USEPA	EVAS / ARES Ltda.
Source:	[a]	[b]	[c]
Food / Organics	54.30%	55.00%	55.00%
Plastics	10.40%	12.20%	14.00%
Paper / Cardboard	9.30%	10.00%	10.00%
Yard Waste	7.10%	2.00%	0.00%
Rubble	5.40%	6.30%	0.00%
Glass / Ceramics	4.70%	5.50%	0.00%
Rubber, Hoses, Bones	3.20%	0.00%	0.00%
Textiles	2.10%	0.60%	0.00%
Metals	1.70%	2.00%	2.00%
Wood	1.60%	0.40%	0.00%
Unusable	0.02%	0.00%	15.00%
Others	0.00%	6.00%	4.00%
Total	100%	100%	100%

Sources:

[a] EVAS from University of Antioquia/CORANTIOQUIA/Enviaseo Study; CIS El Guacal 2008

[b] SCS Engineers for EVAS; Methane to Market (Landfill Gas) Assessment Report, page 8;

[c] Definitional Mission; from ARES Ltda. to EVAS Table 2, Page 54: 2005.

These three studies show very little variability in waste composition. The waste stream entering the CIS El Guacal facility appears reasonable and consistent across the three studies, as it presents a much higher organic fraction than seen in North America, where kitchen sink food disposal is common, and pre-processed, highly packaged foods are widely used.

Fractions shown for plastics, paper and card board, and other components appear reasonable, based on our experience. In the "Table 2" study, the "Unusable" category of 15.0% appears to have been a composite of inert and other unusable components separated in the other two studies, including Rubble and Glass and Ceramics.

B3. Selected Waste Fuel Characterization

As discussed in Section B2 above, the waste entering the CIS El Guacal has been analyzed in at least three previous waste characterization studies. The composition of the waste is very similar in each of the three studies. Because of its detailed breakout, we have selected the EVAS Antecedentes 2008 (Enviaseo / CORANTIOQUIA / University of Antioquia) results, as shown below in **Figure B-3**. This selected study is used as the point of reference for the remainder of this feasibility study:

Figure B-3: Selected Waste Composition

	EVAS from Enviaseo /CORANTIOQUIA / Univ. of Antioquia Study 2008
Food / Organics	54.30%
Plastics	10.40%
Paper / Cardboard	9.30%
Yard Waste	7.10%
Rubble	5.40%
Glass / Ceramics	4.70%
Rubber / Bones	3.20%
Textiles	2.10%
Metals	1.70%
Wood	1.60%
Other	0.20%
Total	100.0%

However, while Figure B-3 represents the totality of waste entering the CIS El Guacal, it is unlikely that any energy recovery process involving combustion, gasification, pyrolysis, or similar technologies would be able to efficiently absorb this high-organics raw MSW stream without preprocessing (or "Front End" processing). **Therefore, we develop here an estimated**

composition for the waste after typical Front End processing has taken place. Typical Front End operations, in downstream order, are:

1. Removal of oversize items, such as large metal items for recycling or large rubble items that could damage machinery;
2. Bag Opening (mechanical and manual);
3. Screening, typically over a 10.0 cm screen opening, including removal of most of the Organic and inert fractions as "Unders" falling down through the screen openings, followed by the following steps on the Unders stream only:
 - a. Magnetic removal of smaller metal items;
 - b. Potentially manual removal of plastic bottle caps from the Unders stream;
 - c. Disposal of Unders in a landfill cell or use for anaerobic digestion.
4. The fraction that does not fall through the screen openings is often termed "Overs"; Overs usually contain a high concentration of paper, cardboard, and plastics (including plastic bags and plastic containers), and therefore have much more potential for energy recovery than the raw waste prior to Front End processing.

In order to characterize the Unders and the Overs fractions that result from such processing, we have performed the calculations presented in **Figure B-4** and **Figure B-5** below.

Figure B-4: Intake MSW and Unders Composition

Category	Intake MSW			Unders
	A	B	B1 = B * A	B2 = B1 / ΣB2
	Percent by Weight	Front End Removal Rate	Unweighted Composition	Composition
Food Waste	54.3%	90.0%	48.9%	76.0%
Plastics	10.4%	2.5%	0.3%	0.4%
Paper / Cardboard	9.3%	2.5%	0.2%	0.4%
Garden Waste	7.1%	35.0%	2.5%	3.9%
Rubble	5.4%	70.0%	3.8%	5.9%
Glass / Ceramics	4.7%	90.0%	4.2%	6.6%
Rubber/Hoses/Bones	3.2%	90.0%	2.9%	4.5%
Textiles	2.1%	1.0%	0.0%	0.0%
Metals	1.7%	80.0%	1.4%	2.1%
Wood	1.6%	2.5%	0.0%	0.1%
Other	0.2%	90.0%	0.2%	0.3%
Total	100.0%		64.3%	100.0%

Figure B-5: Overs Composition and Heating Value

Category	overs	overs		
	C=A*(1-B)	D = C / ΣC	E	F = D * E
	Unweighted Composition	Weighted Composition	LHV	Average LHV
Food Waste	5.4%	15.2%	6,000	914
Plastics	10.1%	28.4%	25,622	7,285
Paper / Cardboard	9.1%	25.4%	11,977	3,045
Garden Waste	4.6%	12.9%	6,280	813
Rubble	1.6%	4.5%	-	-
Glass / Ceramics	0.5%	1.3%	-	-
Rubber/Hoses/Bones	0.3%	0.9%	-	-
Textiles	2.1%	5.8%	10,880	634
Metals	0.3%	1.0%	-	-
Wood	1.6%	4.4%	11,680	511
Other	0.0%	0.1%	-	-
Total	35.7%	100.0%		13,202

In Figure B-4, the calculation develops the composition of the Unders fraction after screening and other Front End processing. Figure B-4 shows, as highlighted at the bottom of the figure, that **the Unders fraction will represent approximately 64.3% of the weight of all the intake waste** that enters the process, leaving only 35.7% of the waste as Overs, which is characterized in Figure B-5. This relatively large Unders fraction is expected, since the primary goal of screening is to remove the high moisture organics and the inert fractions (glass, ceramic, rubble, metals). The Unders fraction is calculated by multiplying the typical process removal rate times the intake waste composition for each category, as shown by the formulas inserted at the top of each column, also highlighted.

In Figure B-5, the **Overs fraction of 35.7%** (as highlighted at the bottom of the figure) of the intake waste is characterized with regard to composition and with regard to Lower Heating Value or LHV. **It is this Overs fraction of 35.7% that is normally utilized for energy recovery.** LHV represents the heat released when the waste is combusted, net of the waste needed to evaporate the moisture in the waste. Therefore, LHV represents the net amount of energy that is available in the process for energy generation. It is noted here that the Higher Heating Value, or HHV, includes the heat lost in evaporating the original moisture in the material. At Cambridge, we prefer the use of LHV, as it better represents the net amount of energy available for utilization.

Key characteristics of the Overs fraction are:

- Very high combustible fraction of over 60.5%, made up primarily of 28.4% Plastic, 25.4% Paper and Cardboard, 4.6% Garden Waste, and 2.1% Textiles;
- Based on the Cambridge data base of LHV values for individual waste components (column E in Figure B-5), the overall LHV heating value of the Overs fraction is calculated (please see column F = D * E) as being approximately 13,202 kilo Joules per kilogram (kJ / kg), as highlighted in the lower right hand corner of the figure; **this is a sufficient value to support normal combustion without addition of supplemental fuels;**
- **In tonnage, the Overs fraction of 37.5% available for energy recovery represents, for the current intake tonnage of 650 tons per day:**

$$650 \text{ tons per day} \times 35.7\% = 232 \text{ tons per day}$$

The waste characterizations developed in this Section B will be used in the technology evaluations and economic calculations of Task 4.

C. Characterization Study Procedure

Below is a Characterization Study Procedure prepared by Cambridge. This procedure should be read and followed sequentially, starting with Sub-Section C1 and ending with Sub-Section C6:

C1. Purpose

The waste composition studies accomplished previously are extremely consistent in terms of results, and a field waste composition study is not required.

However, the Terms of Reference requires that Cambridge "...provide the Grantee (in this case IDEA) with a clear set of parameters for a defined trial period of sorting and classifying of the wastes..."

Therefore, we are providing the following Characterization Study Procedure, which could be used to guide a future potential waste study, if such were desired.

C2. Sampling of Incoming Loads at the Scale

An average number of 65 trucks total per day at 10 tons payload each discharge at the CIS El Guacal. A number of 4 to 5 trucks must be weighed and randomly sampled daily (26 trucks in total for a week-long study, where each week consists of 6 days from Monday through Saturday). This represents a total sample during one week of $26 / 390 = 6.6\%$. In practice, in order to obtain this sample, approximately every 4th truck should be sampled.

In addition to the net weight, the delivering company, origin of the material (geographical area) and date/time shall be recorded.

C3. Quartering of Each Truck Load

Each selected truck shall discharge at the designated area onto a covered concrete floor. This area must be sheltered, as no rain shall be allowed to increase the moisture content of the samples. This area shall be clean and shall be kept clean continuously from all previously obtained samples.

A wheel loader shall mix and quarter each truck load, discarding three quarters. The remaining quarter shall be piled up into a cone shaped form and quartered again.

Assuming a truckload of 10 tons, the steps for each load will be:

1. Input 10 tons per truck; quartering to 2.5 tons. The remaining 7.5 tons shall be put onto a dump body truck using a wheel loader and be dumped at the landfill, or fed into the existing MRF.
2. The 2.5 tons are then quartered to 625 kg;
3. The 625 kg are then quartered to 150 kg which shall be subject to remaining steps; the remaining 475 kg not used shall be removed to the landfill;
4. Spread out the 150 kg and open all closed garbage bags at this point;
5. The sample of about 150 kg shall then be divided into two equal parts of 75 kg each. **One 75 kg sample will be used for Material Type Characterization (please see section C4 below), and the other 75 kg sample shall be used for the Particle Size Characterization (please see section C5 below).**

C4. Material Type Characterization

For this step, sufficient containers should be obtained, so that each Material Type category will have dedicated to it one or more containers, clearly labeled with the name of each Material Type. Containers may be clean (new) oil drums with closeable covers, or large, closeable recyclable material bags.

One 75 kg sample shall be analyzed immediately after being available and shall be separated manually into these 14 Material Types for each Material Type:

1. Plastic
2. Paper
3. Cardboard
4. Textiles
5. Glass and Ceramics
6. Rock / Concrete (including Rubble)
7. Shoes/Leather
8. Electric/Electronics

9. Metals Fe
10. Metals non-Fe
11. Food
12. Rubber (including Tires)
13. Yard Waste
14. Other and Unidentifiable.

At the end of the week, the total material classified into Material Types (and stored in containers) will be:

- 75 kg x 26 Truck Loads = 1,950 kg.

All 14 categories shall be weighed and recorded, subtracting the weight of the container. The **average** weight of each of the Material Type Categories will be approximately:

- 1,950 kg / 14 Material Type Categories = 139 kg per Material Type Category

The Material Type Category samples may be discarded at the end of the week. The total number of data points from the Material Type Category characterization will be:

- 1 Data Point (weight in kg) per Material Type Category x 14 Material Type Categories Types = 14 Data Points.

C5. Particle Size Characterization

For this step, sufficient containers should also be obtained, so that each Particle Size category will have dedicated to it one or more containers, clearly labeled with the name of each Particle Size category. Containers may be clean (new) oil drums with closeable covers, or large, closeable recyclable material bags.

It is noted here that a trommel (a rotating perforated drum screen) fitted with the various interchangeable size screens can be used for particle size differentiation if mechanical sorting is desired. Alternatively, wire mesh of different opening sizes can be attached to wooden frames to make an economical but effective manual sorting tool.

The 75 kg sample shall be thoroughly vibrated (manually or mechanically) over screens of different perforation sizes as shown in the bullet points below:

1. >100mm
2. 50 mm to 100 mm

3. 25 mm to 50 mm
4. < 25 mm.

Each fraction shall be deposited into one or more containers for each Particle Size fraction and retained until the end of the week. Each Particle Size Category is weighed at the end of the week, ensuring that the container weight is subtracted from the total weight.

The total amount of material that will be sampled for Particle Size is:

- 75 kg per Truck Load x 26 Truck Loads = 1,950 kg.

The average weight of each Particle Size fraction shall be:

- 1,950 kg / 4 Particle Size Categories = 488 kg per Particle Size Category.

The 4 Particle Size Category samples should be weighed at the end of the week and the following data points recorded:

- 4 Particle Size Categories x 1 Data Point (weight in kg) per Category = 4 Data Points.

The material in the Particle Size containers shall be retained after weighing until the end of the week in covered containers to allow for preparation for the Laboratory Analysis step, and for the Laboratory Analysis step itself to take place as follows:

C6. Laboratory Analysis

The material in each Particle Size category, after weighing, should be dumped to the floor, mixed, and quartered twice (divided into an eighth). This will result in an average sample weight of:

- 488 kg per Particle Size Category / 8 = 61 kg.

It may be advisable, or requested by the laboratory, to shred some of the larger-size Particle Size Category samples before sending them to the laboratory.

The laboratory will quarter each sample into fractions, each averaging:

- 61 kg / 4 = 15.3 kg.

For each sample, the resulting quarters will be used as follows:

- Quarter 1: Laboratory keeps for future reference.
- Quarter 2: Undergoes Tests A through E
- Quarter 3: Undergoes Tests A through E

- Quarter 4: Undergoes Tests A through E.

Laboratory Tests A through E are:

- A. Weight on Arrival
- B. Moisture content
- C. Higher Heating value (calorimeter)
- D. Lower Heating Value (calorimeter)
- E. Ash Content.

Therefore, the laboratory will be reporting:

- 4 Particle Size Categories x 3 Quarters Tested per Sample x 5 Lab Tests = 60 Data Points.

END OF PROCEDURE

D. Ash Management

D1. WTE Ash and Energy Conversion Char

Ash residues are generated by waste-to-energy (WTE) facilities, which combust Municipal Solid Waste (MSW) within a carefully monitored and controlled process. The following are the two main types of Ash that are generated:

- **Bottom Ash**, composed of relatively heavy ash, is discharged after the waste has progressed down the stoker. Bottom Ash (residues, carbon, metallic objects) usually represents on the order of 30% of the weight of the original MSW (and on the order of 10% of the volume of the original MSW.)
- **Fly Ash** is lighter Ash that is carried by combustion gases through the furnace, boiler and Air Quality Control System (AQCS). It is primarily collected within the AQCS. Fly Ash usually represents on the order of 1% to 3% of the weight of the original MSW.

In the United States (with over 90 WTE facilities currently in operation), Bottom Ash and Fly Ash are combined within the WTE facility, resulting in an Ash that can be safely disposed in a conventional lined landfill cell. In Europe (with over 400 WTE facilities in operation), Bottom Ash and Fly Ash are usually collected separately, resulting in a Bottom Ash that can be disposed in a conventional lined landfill cell, but at the same time generating a Fly Ash that, primarily because of high metals concentrations, must be disposed in a special waste or hazardous waste cell.

It is anticipated that any WTE facility to be built at the CIS El Guacal facility will be designed to comply with United States standards and practices, and will therefore collect Bottom Ash and Fly Ash as one material stream. Therefore, it should be acceptable to landfill the Ash from a WTE facility in the conventional lined landfill cell already built at the CIS El Guacal site.

Normal metals and other components that will be present in MSW Ash are listed below:

- Chromium
- Copper
- Arsenic
- Lead
- Cadmium
- Zinc
- Manganese
- Mercury

Leaching into soil of lead, cadmium, and mercury from WTE Ash are of particular concerns around the world. These metals and other components are derived from various materials present in MSW, including the following:

- Household batteries
- Inks and dyes
- Metal-based paints (including mercury-based paints)
- Weather-resistant and insect-resistant wood.

Non-combustion technologies such as gasification or pyrolysis (in which MSW is chemically degraded by external heat within an atmosphere without sufficient oxygen to support combustion) produce a "Char" material. This Char material will have contained within it metals concentrations similar to those in combustion Ash.

The remainder of this discussion is focused on Ash, but the same statements can be made about Char residues.

D2. Ash Storage and Handling

Ash typically falls off the combustion grate or stoker and falls into a conveyor submerged in water. The water extinguishes any remaining combustion and cools off the ash to facilitate further handling. Such a conveyor normally moves the Ash to a small storage bunker within the facility. A small fixed crane normally loads the Ash onto a dump-type truck, which moves the Ash to the landfill working face. **Outdoor or uncovered storage of Ash outside a lined landfill cell is never recommended because of contaminant leaching concerns.**

D3. Utilization of Ash Demand for Ash for Agricultural and Other Purposes

The Terms of Reference require this Feasibility Study to determine if there is a potential for use of ash as an agricultural soil amendment.

Waste to Energy facilities worldwide virtually always dispose of Ash in lined cells, primarily to prevent leaching of metals and other components from the Ash into ground water.

Ash (or Char) derived from MSW has never been utilized on any significant scale as a soil amendment because of concerns with metals and other components leaching into the soil. Old unlined landfills from the 1940's through the 1970's that contain incinerator Ash require multi-million dollar cleanup projects to protect surrounding communities. Metals build up over time in soils after multiple applications, and eventually, a public health hazard is created. **Therefore,**

farmers and landowners worldwide reject disposal of MSW Ash on their lands. There is no reason to believe that farmers or landowners in Colombia would take a differing position.

There has been limited experience in Europe with the use of Ash as road base material (in which the deposited Ash is protected from exposure to rainwater by asphalt above it.) Nevertheless, use of Ash as a road base material has also been greatly limited worldwide by concerns about metals and other components leaching into the soil. Groundwater that flows horizontally would not be prevented from contacting and leaching the Ash by the asphalt roadway above the Ash.

Cambridge concludes that Ash or Char from an energy recovery facility at the CIS El Guacal could not be safely or reliably used as a soil amendment or as road base material.

Ash is typically an economical cover material, because it is inert and odorless and has already been moved from the WTE facility to the working face of the landfill and only requires spreading as cover material. **The Ash generated at a CIS El Guacal facility could be used as cover material at the landfill or simply disposed of in the lined landfill cells.** Virgin soil cover material must often be excavated with heavy equipment, where such excavation work would be additional to the work of moving the Ash to the working face.

E. Conclusions

Task 3 conclusions are listed below:

- As discussed in Task 1, at least 90% of the waste supply to the CIS El Guacal is committed long term, and the remaining 10% is unlikely to be diverted because of geographic and logistical factors.
- At least three characterization studies of the totality of the waste arriving at the CIS El Guacal have been accomplished, with extremely good consistency observed in the results; therefore, these characterizations can be used as a reference point for subsequent evaluations during this feasibility study.
- The RECIMED study was not a random study of the totality of the incoming waste, but was rather a characterization of a sub-set of waste loads pre-selected for having high recyclables; however, the RECIMED study does provide insight into the distribution of types of plastics (among the seven commonly used plastic resins) present within the overall plastics fraction of the waste.
- The waste characterizations developed in Section B above for incoming raw MSW and for MSW that has been submitted to a "Front End" fuel preparation process will be used in evaluations that follow during this feasibility study.
- The calorific value calculated in Section B above for the MSW fraction remaining after passing through a fuel preparation "Front End" process is 13,202 kJ / kg (kilo Joules per kilogram), a value that can sustain combustion without supplemental fuels. A number of plants in the world incinerate and generate power with MSW in the range of 10,000 to 13,000 kJ / kg.
- The MSW remaining after the fuel preparation Front End process is calculated in Section B to be approximately 37.5% of intake MSW. For the current intake rate of 650 tons per day, these 37.5% fraction would be the equivalent of 232 tons per day. This fraction of 37.5% represents the MSW that would be available for an energy recovery process at the "Back End" of a plant.
- In compliance with the Terms of Reference for this feasibility study, a waste characterization study procedure is provided here in the event that a desire arises in the future to conduct an additional study.
- Ash or Char from an energy recovery facility at the CIS El Guacal cannot be safely or reliably used as a soil amendment or as road base material because of their very high potential to leach contaminants, especially heavy metals. These residues must be landfilled in the CIS El Guacal lined landfill cell. Such material can be utilized in the landfill cell as cover material.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 4 Report:
Technical Configuration and
Preliminary Design**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

04 October, 2011

The contents of this Task 4 Report are listed below:

Task 4 Report Contents

Section	Title
A	Candidate Technical Configurations
B	Economic Performance of Technical Configurations
C	Selection of Primary Energy Equipment
D	Selected Technical Configuration
E	Conclusions

A. Candidate Technical Configurations

A1. Candidate Technical Configurations

Processes designed to recover energy derived from municipal solid wastes (MSW) can be classified into the following categories, which correspond to Sub-Sections in this Section A:

- **A2. Combustion**
 - Mass Burn
 - Refuse-Derived Fuel
- **A3. Gasification and Pyrolysis**
 - In-Vessel Gasification
 - Plasma Arc Gasification
- **A4. Biological and Chemical**
 - Anaerobic Digestion
 - Chemical
- **A5. Landfill Gas to Energy**

Section A6. Evaluation of Technical Configurations consists of a comparative evaluation of the technical configurations discussed in Sections A2 through A5.

We have endeavored to establish a common basis for comparison of technologies, in which a number of elements are held constant:

- Projection for total MSW intake to the CIS El Guacal Facility (developed in Task 1);
- Waste split of total MSW intake between MSW Overs and MSW Overs fraction and Unders fraction after a Front End fuel preparation process (developed in Task 3). As defined in Task 3, the Unders fraction is that portion of the MSW that passes by gravity through openings in a processing screen, while the Overs fraction is that portion of the MSW that is too large to pass through the screen openings.

These fundamental assumptions are described again briefly below:

As established in Task 1, it is unlikely that the MSW tonnage intake to the CIS El Guacal facility will ever drop below 650 tons per day. In addition, it was established in Task 1 that the EVAS projection for growth rate of 1.5% annually is reasonable, considering the waste shed's population growth rate. The overall tonnage intake is projected below in **Figure A-1**. Figure A-1 also shows a calculation for the required capacity of the planned energy recovery facility:

- In base year 2010, an average of 641 tons per day MSW intake;
- Plants are usually designed with sufficient capacity to avoid the need for an expansion before 10 years; MSW intake in 10 years (in 2020) is projected at 750 tons per day.

Therefore:

- The Front End capacity must be on the order of **750 tons per day** (total MSW intake);
- The Back End (energy recovery process) capacity must be **270 tons per day** (approximately 35.7% of the total MSW intake as Overs); and
- The resulting Unders (containing the majority of organics and moisture) will be on the order of **480 tons per day** (approximately 64.3% of the total MSW intake as Unders).

For each candidate technical configuration, this Section A assesses the **technical risk** involved with implementation of the subject technology at the CIS El Guacal site.

"**Technical Risk**" is defined here as the probability that a plant utilizing any one of the subject technologies will operate with an availability well below 80% as a result of (a) equipment failures; or (b) inability to produce power or by-products in quantity or quality required by markets. For example, Anaerobic Digestion (AD) plants may operate at a reasonable reliability, but post-AD organics residuals have often been found to contain significant heavy metals concentrations and have therefore required landfilling or use as landfill cover material.

**Figure A-1: Projected MSW Supply
and Energy Recovery Plant Required Intake Capacity**

Calendar Year	Sequential Year	Intake MSW TPY	Intake MSW TPD	Overs Fraction		Unders Fraction	
				Percent of MSW Intake	TPD to Energy Recovery	Percent of MSW Intake	Unders Fraction TPD
2006		32,655	119				
2007		110,063	302				
2008		168,762	462				
2009		224,603	615				
2010	Base	233,897	641	35.7%	229	64.3%	412
2011	1	237,405	650	35.7%	232	64.3%	418
2012	2	240,967	660	35.7%	236	64.3%	424
2013	3	244,581	670	35.7%	239	64.3%	431
2014	4	248,250	680	35.7%	243	64.3%	437
2015	5	251,973	690	35.7%	246	64.3%	444
2016	6	255,753	701	35.7%	250	64.3%	451
2017	7	259,589	711	35.7%	254	64.3%	457
2018	8	263,483	722	35.7%	258	64.3%	464
2019	9	267,435	733	35.7%	262	64.3%	471
2020	10	271,447	744	35.7%	266	64.3%	478
				Front End TPD		Energy Recovery in TPD	Unders in TPD
Plant Design Capacity				750		270	
							480

A2. Combustion

Combustion has as its foremost objective the reduction of the original volume of MSW. At the same time, the waste is stabilized and sterilized. This is especially important where development of new landfill capacity is not practical. Energy recovery is a secondary feature that allows reduction of the net tip fee required by combustion facilities. Generally, "incineration" is taken to mean combustion without energy recovery (as was practiced until the 1970's in North America), while "Waste to Energy" or "WTE" is accepted to mean combustion with energy recovery. Combustion without energy recovery is not common today, since the cost of the energy recovery equipment (such as steam turbine-generators) is small compared to the power sales revenue achieved.

Combustion technologies are divided into the following subcategories:

- **Mass Burn:** Direct combustion of virtually unprocessed MSW); and
- **Refuse Derived Fuel (RDF):** Combustion of a processed fuel (usually shredded and screened) prepared from incoming raw MSW.

WTE has an extensive track record worldwide, as discussed further below in this Section A. **Over 500 facilities are in commercial operations in North America and Europe**, while Asia has dozens of facilities in commercial operations. Information on WTE and other waste treatment plants in Asia has not been compiled, to our knowledge, in a comprehensive way, and data from Asia has often been inconsistent or contradictory. In Latin America, there are no WTE facilities in operation to our knowledge. Therefore, in this evaluation, we focus on the extensive experience in North America (United States and Canada) and Europe.

A2.1 Mass Burn

Modern Mass Burn technology evolved in the late 1970's and is worldwide the most favored Waste to Energy (WTE) technology. Approximately 90% of the WTE plants in North America utilize a Mass Burn design, while most of the rest utilize Refuse-Derived Fuel, or RDF, as discussed below in subsection A2.2. Mass Burn waterwall systems are typically large, field-erected systems consisting of integrated furnace and boiler arrangements. The boiler section is positioned above the grate furnace area in order to maximize the capture of hot gases from the combustion taking place on the grate. Waste is charged from a feed chute into the furnace onto a combustion grate system by a hydraulic piston located near the bottom of the chute. The grate consists of thick metal transverse sections, some of which oscillate to move the MSW down slope across the grate surface. **Figure A-2** illustrates an advanced design Mass Burn grate system.

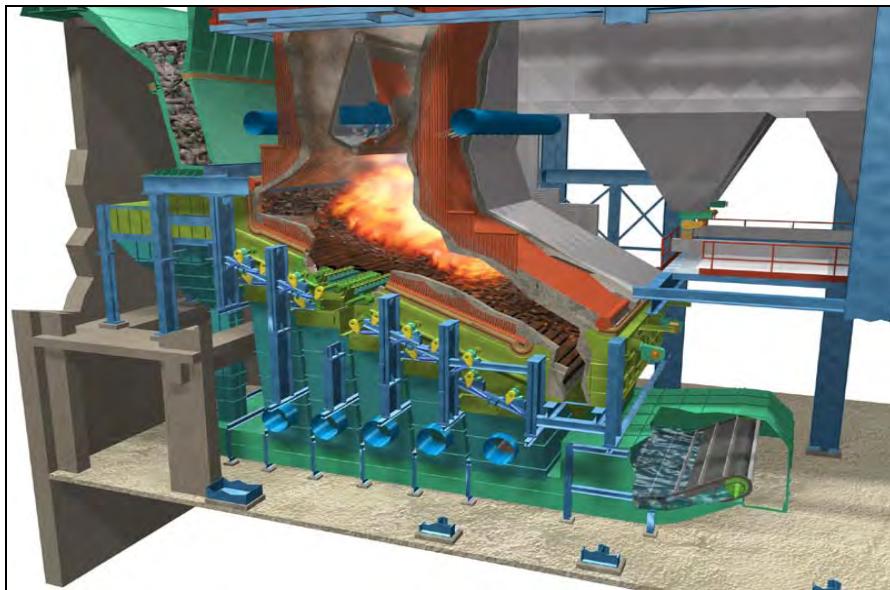


Figure A-2: WTE Mass Burn Grate System

Hot gases from combustion rise up from the grate and then pass over various heat exchange tubing sections in the boiler, from which steam is generated. This steam is ducted to the turbine-generator unit, where the steam turns the turbine. The turbine in turn rotates the generator, producing electric power.

The flue gases leaving the boiler have enough remaining energy to pre-heat the water for the boiler and the combustion air prior to combustion. This water is circulated back from the turbine toward the boiler. Combustion air is ducted into the furnace from below and above the grate.

Figure A-3 shows a side view of a modern Mass Burn grate and furnace (yellow) and boiler system.

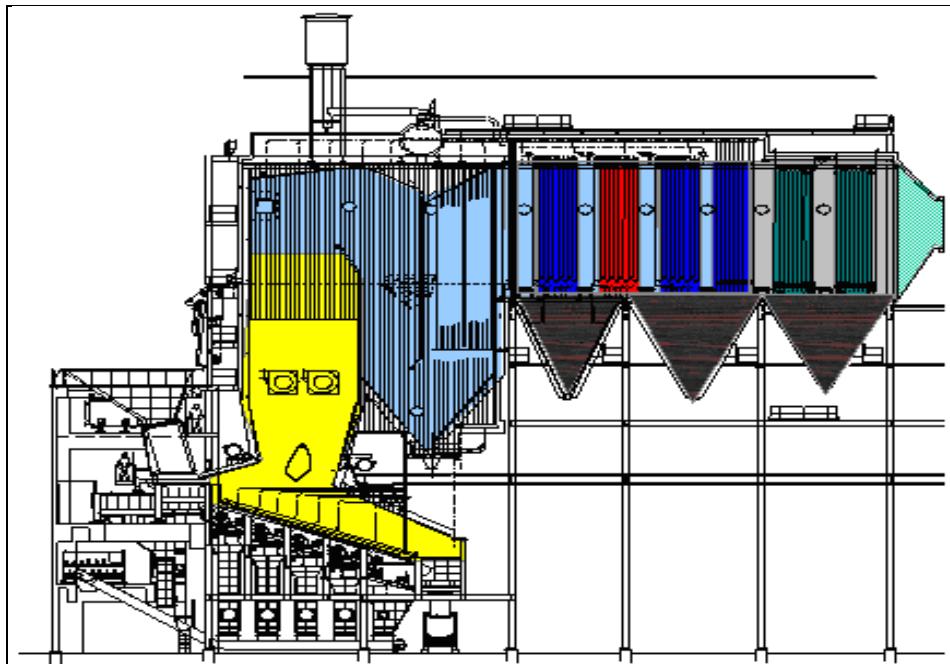


Figure A-3: WTE Mass Burn Grate Furnace (yellow) and Boiler Arrangement

Ash from the combustion grate falls off the grate and into a conveyor submerged in water. This quenching both cools the material and prevents dusting from the ash falling off the grate. Ash removed from the grate in this manner is called bottom ash. Ferrous metals and sometimes aluminum are recovered from the ash.

The air quality control system (AQCS) is design to clean the flue gases, is very large and can often represent 25% to 30% of the capital investment for a WTE plant. A number of flue gas cleaning systems are available. Modern WTE plants in North America and Europe routinely meet the following strict emissions standards:

- USEPA Standards (each state's standards may be more, but not less, stringent than USEPA standards); or
- European Union Standards.

There are many companies involved with the development of a Mass Burn facility. A large percentage of the equipment and systems are similar to conventional power plant equipment (such as a coal-fired power plant), and many suppliers are available. However, usually a single "turn-key" contractor is hired to engineer, procure, and construct ("EPC") build the plant.

A2.2 Refuse-Derived Fuel

Refuse-Derived Fuel (RDF) plants are similar to Mass Burn plants, but the combustion process is preceded by a fuel preparation process, in which the waste is homogenized and its heating value is increased. This is accomplished typically by shredding and screening the waste material. In this manner, a much more uniform particle size is obtained, and the organic fraction is removed. The organic fraction usually retains most of the moisture content and most of the inert components such as glass.

In the case of CIS El Guacal waste, as documented in Task 3, virtually any type of energy recovery process would require an RDF-type Front End preparation system to improve the quality of the MSW. **Figure A-4** below shows photographs of unprocessed MSW and RDF.



Figure A-4: Unprocessed MSW (left) and RDF (right) Ready for Combustion

Key characteristics of the Overs fraction (RDF) for the CIS El Guacal MSW, as shown in **Figure A-5** and **Figure A-6** below (and as developed in Task 3) are:

- High combustible fraction of over 60.5%, made up primarily of 28.4% Plastic, 25.4% Paper and Cardboard, 4.6% Garden Waste, and 2.1% Textiles;
- The overall LHV heating value of the Overs fraction as calculated in Task 3 as approximately 13,202 kilo Joules per kilogram (kJ / kg); this is a sufficient value to support normal combustion without addition of supplemental fuels.

Based on the good combustion characteristics of the Overs fraction and the extensive commercial operating experience worldwide, the technical risk involved with a combustion technical configuration for CIS El Guacal is considered "Low".

Figure A-5: Intake MSW and Unders Composition

	Intake MSW			Unders
	A	B	B1 = B * A	B2 = B1 / ΣB2
	Percent by Weight	Front End Removal Rate	Unweighted Composition	Composition
Category	Est. %	Est. %	Est. %	Est. %
Food Waste	54.3%	90.0%	48.9%	76.0%
Plastics	10.4%	2.5%	0.3%	0.4%
Paper / Cardboard	9.3%	2.5%	0.2%	0.4%
Garden Waste	7.1%	35.0%	2.5%	3.9%
Rubble	5.4%	70.0%	3.8%	5.9%
Glass / Ceramics	4.7%	90.0%	4.2%	6.6%
Rubber/Hoses/Bones	3.2%	90.0%	2.9%	4.5%
Textiles	2.1%	1.0%	0.0%	0.0%
Metals	1.7%	80.0%	1.4%	2.1%
Wood	1.6%	2.5%	0.0%	0.1%
Other	0.2%	90.0%	0.2%	0.3%
Total	100.0%		64.3%	100.0%

Figure A-6: Overs Composition and Heating Value

	Overs		Overs	
	C=A*(1-B)	D = C / ΣC	E	F = D * E
	Unweighted Composition	Weighted Composition	LHV	Average LHV
Category	Est. %	Est. %	kJ/kg	kJ/kg
Food Waste	5.4%	15.2%	6,000	914
Plastics	10.1%	28.4%	25,622	7,285
Paper / Cardboard	9.1%	25.4%	11,977	3,045
Garden Waste	4.6%	12.9%	6,280	813
Rubble	1.6%	4.5%	-	-
Glass / Ceramics	0.5%	1.3%	-	-
Rubber/Hoses/Bones	0.3%	0.9%	-	-
Textiles	2.1%	5.8%	10,880	634
Metals	0.3%	1.0%	-	-
Wood	1.6%	4.4%	11,680	511
Other	0.0%	0.1%	-	-
Total	35.7%	100.0%		13,202

A3. Gasification and Pyrolysis

This Subsection A3 deals with the following major forms of gasification:

- **In-Vessel Gasification;** and
- **Plasma Arc Gasification.**

A3.1 In-Vessel Gasification

Gasification generates a synthesis gas (sometimes called "syngas") by placing a carbon-base feedstock into a chamber with minimal amounts of oxygen while the chamber is heated from the outside. **The lack of oxygen prevents the material from combusting, but the heat causes a number of components in the feedstock to be released as gasses.** Syngas is usually a mixture of:

- Hydrogen
- Methane
- Carbon monoxide
- Carbon dioxide
- Water as steam
- Volatile components derived from the feedstock.

Once the syngas is released, it can be utilized, usually after a gas cleaning process, by one or a combination of the following steps:

- Combustion of the syngas (such as in a heat recovery boiler or in an internal combustion engine); or
- Converted to a liquid fuel that can be combusted separately.

The gasification process has been used for industrial purposes for over 100 years, but the only large scale commercially successful applications have used **homogeneous** feedstocks such as:

- Coal or peat (a partially decomposed plant material with some remaining calorific value)
- Wood chips or other biomass.

Pyrolysis is one of the steps in an overall gasification process, although it is often designated as a separate technology. The overall process of in vessel gasification, which includes pyrolysis, is described below:

1. **Dehydration** around 100 degrees Centigrade, in which the water (H_2O) in the feedstock is emitted as a steam (and becomes available for Steps 4 and 5 described below);
2. **Pyrolysis** at around 200 to 300 degrees Centigrade, in which volatile components

(hydrogen, tars, and other hydrocarbons) are released from the feedstock as gaseous products. For a homogeneous feedstock, this results in a large weight reduction in the feedstock material. The residual of the feedstock remaining after pyrolysis is called a "char".

3. **Oxidation** of carbon compounds in the char combines carbon with oxygen to make carbon dioxide: $C + O_2 \rightarrow CO_2$. Oxidation is often minimized, since CO_2 is not available for subsequent steps and is an inert component of the syngas. Temperature and pressure continue to be increased through steps 4 and 5.
4. **Hydrogen (H_2)** is generated when most of the remaining carbon in the char reacts with water as steam (from Step 1 or introduced externally) to produce carbon monoxide and hydrogen: $C + H_2O \rightarrow H_2 + CO$. Hydrogen is one of the combustible components in the syngas.
5. **Methane (CH_4)** gas is generated if the hydrogen and carbon monoxide from Step 4 are further reacted as: $CO + 3H_2 \rightarrow CH_4 + H_2O$ or if carbon in the char reacts as: $C + 2H_2 \rightarrow CH_4$. Methane, of course, is another potentially combustible component in the syngas.

As a result of these chemical reactions, syngas may contain widely varying amounts of carbon monoxide, carbon dioxide, hydrogen, water, methane, and volatiles in various proportions. **With a very heterogeneous feedstock such as MSW, many components of which react at different temperatures and pressures, obtaining a uniform desired syngas composition is extremely challenging.**

Cambridge industry monitoring indicates that **there is no commercial operational record for gasification systems processing truly mixed MSW.**

A specific process apparently representative of the worldwide experience with gasification systems is the process developed by European company Thermoselect. In the late 1990's, Thermoselect developed a medium-large scale (approximately 685 tons per day design capacity) facility in Karlsruhe, Germany.

An important economic concern with gasification processes such as the Thermoselect process continues to be the energy balance (energy in compared to energy out in usable form). A significant amount of energy is required to heat the gasification chamber from the outside. Gasification promoters claim that the syngas produced is enough to both:

- Generate electricity (for example, in an internal combustion engine); and
- Be burned to heat the gasification chamber from the outside in.

At Karlsruhe, the Thermoselect process reportedly consumed significant quantities of natural gas (which was purchased at significant cost) in order to achieve targeted gasification and other process requirements [a].

The Karlsruhe facility opened for operations in 2002. However, none of the three processing lines ever reached full commercial operational status. The facility was shut down in 2004 due to technical and commercial difficulties and is no longer in operation [b]. The approximately \$500 Million capital investment is reported to have been lost as a write-off.



Figure A-7: Thermoselect Karlsruhe Gasification Plant after Shutdown in 2004

The original Thermoselect pilot plant in Fondotoce, Italy, has been shut down since the mid 1990's. Thermoselect often cites its Chiba, Japan plant as being a gasification plant in commercial operations with mixed MSW. However, a long time Cambridge industry contact who visited the Chiba plant observed that its infeed pit was, on the day of the visit, stocked with source-separated plastics, rather than truly mixed MSW.

[a] Source: Fränkische Landeszeitung, "Natural Gas Use Should Be Halved This Year [Erdgas-Verbrauch soll dieses Jahr halbiert werden]," 29 January 2003.

[b] Süddeutsche Zeitung [Munich, Germany], "The End for Thermoselect [Aus für Thermoselect]", 05 March 2004; and: Frankfurter Allgemeine Zeitung [Frankfurt, Germany], "No Future for Thermoselect" [Keine Zukunft für Thermoselect]", 03 March 2004.

A type of gasification process that has been advanced in recent years is **Plastic to Oil** pyrolysis. In this type of process, the syngas is converted to a liquid product reportedly equivalent in many characteristics to crude petroleum. This product may be sold to a refinery, or refined further on-site. An optional "mini-refinery" at the back end of the plant is designed to refine the petroleum equivalent product into the various normal products obtained from crude petroleum, including diesel, kerosene, gasoline, and lubricants. The AGILYX pilot plant in Oregon, United States has reportedly sold such oil-like products successfully for some time. However, while the AGILYX process is promising, a number of projects are planned, and the technology has recently attracted large amounts of development capital, **we cannot classify it as a commercially proven technology.** The Oregon pilot plant is the only one we are aware of that has so far actually operated. A technical issue is how well the product will work with various combinations of the seven plastic resin types. A commercial issue is cost and availability of source-separated plastics, whose value as recyclable increases with oil prices.

It is concluded that gasification or pyrolysis of mixed MSW has not been proven commercially, as manifested by:

- **The lack in North America or Europe of any commercially operating gasification or pyrolysis plants** using mixed MSW as a feedstock, and;
- **At least two major plant shutdown failures** in Europe recorded in recent years:
 - Thermoselect Karlsruhe: approximately 685 tons per day design capacity (shut down 2004); approximately \$500 Million capital investment lost [a]; and
 - Thermolyse in Arras, France: approximately 125 tons per day design capacity (shut down 2009) approximately \$36 Million capital investment lost [b].

The technical risk involved with an in-vessel gasification project for CIS El Guacal is considered "High".

[a] Source: Süddeutsche Zeitung, "The End for Thermoselect [Aus für Thermoselect]", 05 Marzo 2004; and: Frankfurter Allgemeine Zeitung, "No Future for Thermoselect" [Keine Zukunft für Thermoselect]", 03 March 2004.

[b] Source: La Voix du Nord (La Voice of Northern France), "Le traitement des déchets par thermolyse à Arras n'aura duré que quatre ans" ("Waste Treatment by Thermolyse in Arras Lasted only Four Years"), 04 February 2009.

A3.2 Plasma Arc Gasification

Plasma, referred to as the "fourth state of matter" (after solid, liquid, and gas states), is a very high temperature, highly ionized (electrically charged) gas capable of conducting electrical current. Examples of plasma in nature include lightning and gas at the surface of the sun. Plasma technology has a long history (outside the solid waste industry) of development and has evolved into a valuable tool for engineers and scientists who need to use very high temperatures for new process applications.

Man-made plasma is formed by passing an electrical discharge through a gas such as air or oxygen (O_2). The interaction of the gas with the electric arc dissociates the gas into electrons and ions, and causes its temperature to increase significantly, often exceeding 6,000 °C, nearly as hot as the sun's surface.

Figure A-8 shows a plasma torch schematic, and **Figure A-9** shows a photograph of a plasma torch being used to generate plasma.

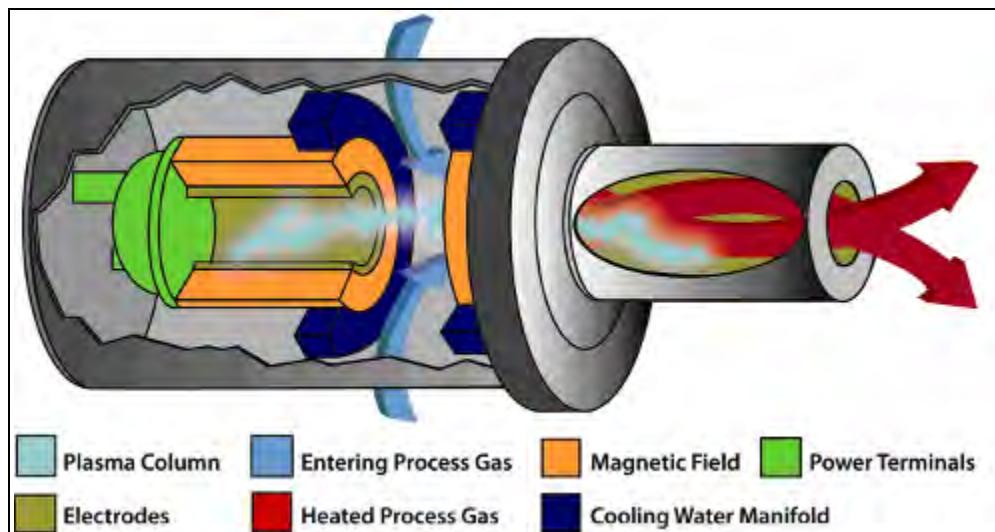


Figure A-8: Plasma Torch Schematic



Figure A-9: Plasma Torch in Operation

The heated and ionized plasma gas is then used to treat the feedstock. **Figure A-10** shows a waste treatment reactor with plasma torches at the bottom of the reactor. Plasma arc converts select waste streams to slag.

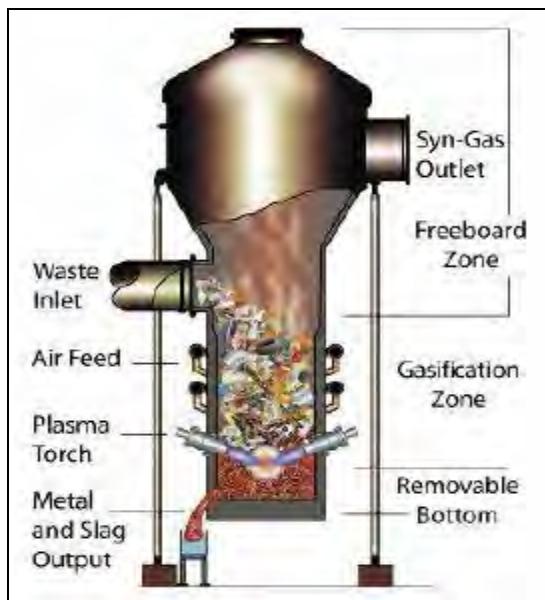


Figure A-10: Plasma Reactor with Torch at Bottom of Reactor

As illustrated in Figure A-10, the feedstock emits a syngas after being exposed to the plasma arcs emitted by the torches. The syngas can be used as a fuel for energy recovery in a separate process.

The molten residue from the gasification process is typically discharged to a water bath and quenched to form a glassy, slag material slag that may be reusable, depending on market availability.

Experimentation with MSW gasification using plasma arc has been ongoing since the 1980s, with a number of pilot-scale projects, but **no commercial scale operations in continuous use**.

Plasma MSW gasification developers include Geoplasma of Georgia, USA and Plasco Energy Group of Canada.

Geoplasma has obtained from Florida environmental regulators a permit to build a plasma arc waste treatment facility in St. Lucie County, Florida, but construction has not begun as of mid 2011. The sizing of this facility was reduced during development from 3,000 tons per day to 200 tons per day. Solid waste industry observers are monitoring this project closely, as it is the one project that may be closest to entering a commercial production stage.

Plasco of Canada indicates that it has two pilot plants, one in Ottawa and one in Spain. Plasco also has other projects in various stages of development, but none in commercial operations.

Plasma arcs are powerful enough to have been used to break down metals (and therefore certainly have enough power to destroy MSW), but the remaining primary issues are:

- How much of the large amount of energy input can be recovered; and
- How consistent can the quality of the syngas be long term.

The technical risk involved with a plasma arc gasification project for CIS El Guacal is considered "High".

A4. Biological and Chemical

Biological-chemical waste treatment technologies are generally low temperature operations that require a biodegradable feedstock. Many can accept high moisture content materials. For the purposes of this study, biological-chemical processes described are:

- Anaerobic Digestion (AD), a biological process; and
- Acid Hydrolysis (AH), a chemical process.

A4.1 Anaerobic Digestion

After MSW undergoes a Front End RDF-type preparation process, the Overs fraction is usually utilized as RDF in a conventional WTE combustion plant. **This means that anaerobic (without oxygen) digestion is not a full waste disposal technology, but a technology that relies on working together with other waste treatment technologies.**

Figure A-11 illustrates a typical process flow for an anaerobic digestion system, and **Figure A-12** shows the large anaerobic digestion containers (reactors) required for the relatively long anaerobic process resident times.

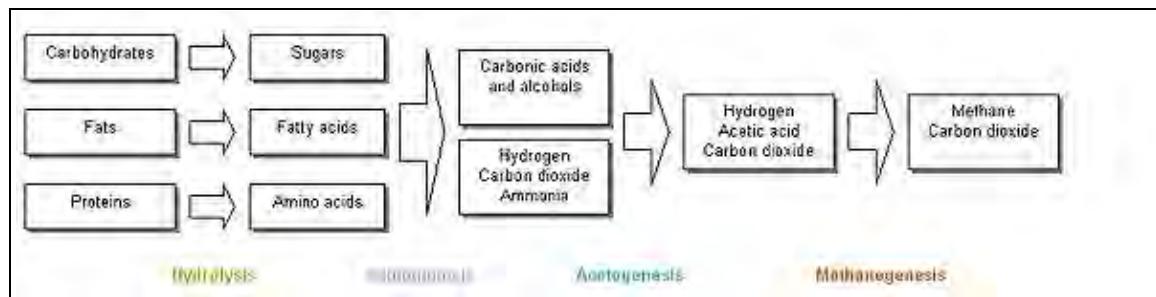


Figure A-11: Anaerobic Digestion Typical Process Flow



Figure A-12: Anaerobic Digestion Containers (Reactors)

The biogas produced during anaerobic digestion requires cleanup and can be used in a separate energy recovery process. **The generation and use of biogas in anaerobic digestion is analogous to similar processes in the generation and utilization of landfill gas, as described in Subsection A5 below.**

As of 2008, there were 26 plants in Europe (and 1 plant in Canada) processing mixed MSW (please see www.iaea-biogas.net.)

While there are a significant number of AD plants operating commercially primarily in Europe, the technology is highly dependent on separate operations that:

- Are subject to market acceptance of the large Unders (organics) fraction as a soil amendment compost, even though such material has often been landfilled after being rejected by markets in various parts of the world for having contaminants including heavy metals; and
- Burn the large Overs (combustible) fraction in a separate RDF combustion plant that may be subject to increases or decreases in supply from other sources.

Therefore, the technical risk of an anaerobic digestion project at CIS El Guacal is considered "Medium-High".

A4.2 Acid Hydrolysis

Chemical approaches to waste treatment have focused on chemical conversion of cellulose materials present in MSW to ethanol and simultaneously achieving a landfilled volume reduction. Chemical treatments typically require an RDF-type process to prepare wastes for chemical processing. **Again, as in the case of plastic to oil and anaerobic digestion, chemical conversion cannot be used alone and must be used in conjunction with other technologies in**

order to deal with the entire MSW stream.

Acid hydrolysis appears to be the only chemical waste treatment process that has undergone pilot plant experience for any prolonged period of time.

Masada Resource Group LLC, with offices in Alabama, offers a proprietary process called the CES OxyNol Hydrolysis Process. This process uses a sequence of material preparation, acid hydrolysis, fermentation and distillation to convert the cellulose fraction to sugars. The sugars are further processed in a fluidized-bed gasifier for acid separation. A key issue remains the actual amount of residue (components other than cellulose) from the process that must be combusted or landfilled.

We are not aware of any chemical conversion facilities using mixed MSW as a feedstock on a commercial basis. Therefore, the technical risk of a chemical waste treatment project at CIS El Guacal is considered "High".

A5. Landfill Gas to Energy

Landfill Gas to Energy (LFGE) is a full-cycle waste treatment and energy recovery technology, in that it includes:

- **Final disposal and decomposition of waste** in a lined landfill cell, with significant volume reduction from biological degradation; and
- **Significant energy recovery** (primarily as electricity generation available for export).

A modern landfill will have the following features, which are already available at CIS El Guacal:

- Lined landfill cell;
- Leachate collection system;
- Landfill gas collection and flaring system.

LFGE takes advantage of the landfill gas already being flared and converts it to electricity.

LFGE has a very large commercial operations record comparable to combustion. Commercial plants in North America and Europe are estimated to number at least:

- Combustion: **522 commercial plants**; and
- Landfill Gas to Energy: **480 commercial plants**.

Landfill gas is typically on the order of 50% methane (which is burned to recover energy) and 50% carbon dioxide and other gases. Landfilled MSW decomposition begins soon after placement of waste in a landfill cell, but the speed of decomposition through various phases (which are the same phases as those illustrated for anaerobic digestion in Figure A-11 above and reproduced as **Figure A-13** below) is accelerated to the extent that the waste is:

- **High in organics** (as is the case at CIS El Guacal); and
- **High moisture content and exposure to rainfall** (as is the case at CIS El Guacal).

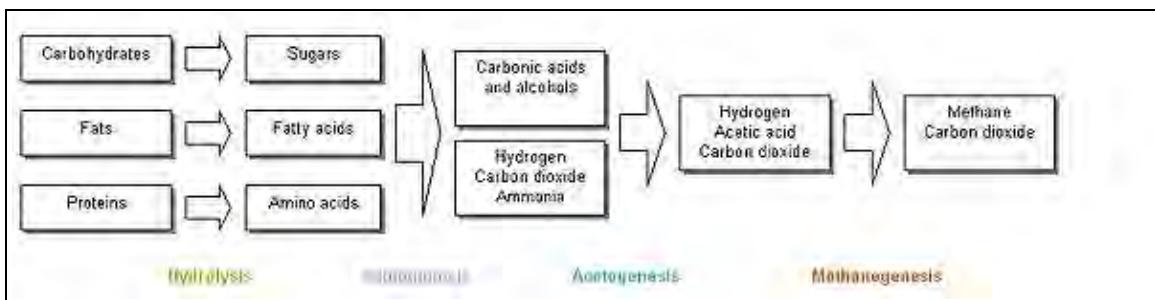


Figure A-13: Phases in Landfill Gas Generation

Figure A-14 shows a profile of landfill gas generation for a given amount of MSW as a function of the number of years after placement of the MSW in a cell. Figure A-14 also shows that a large amount of landfill gas is available as soon as 2 years after placement of waste in the cell, reaches a peak at approximately 5 to 6 years after placement, and continues to generate gas in significant quantities for an additional 15 or more years.

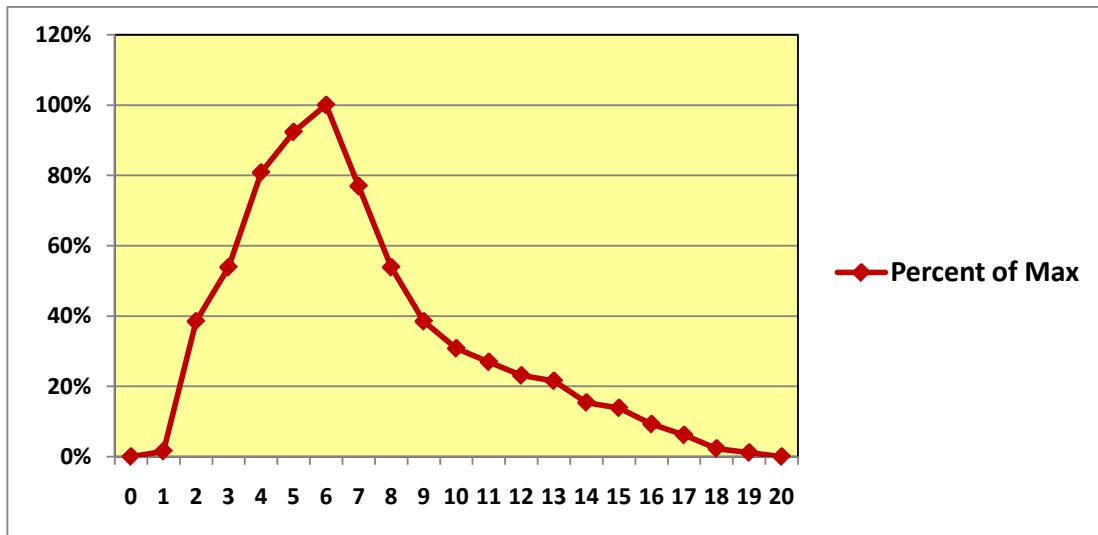


Figure A-14: Landfill Gas Generation as Percent of Maximum vs. Years after MSW Placement

Source: [Handbook of Solid Waste Management](#); Table 14.7; Tchobanoglou and Kreith; 2002

Figure A-15 shows the design of a typical gas extraction well.

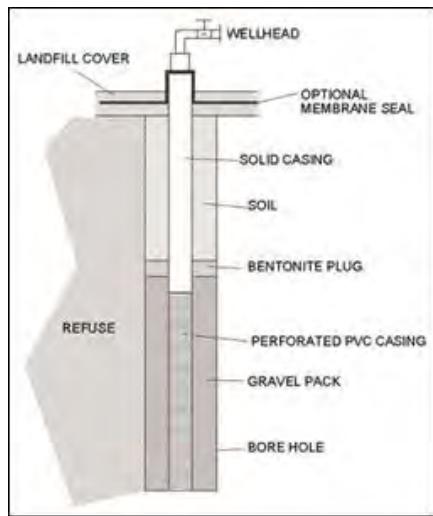


Figure A-15: Typical Landfill Gas Extraction Well Design

Figure A-16 shows a typical landfill gas collection system layout on a landfill.

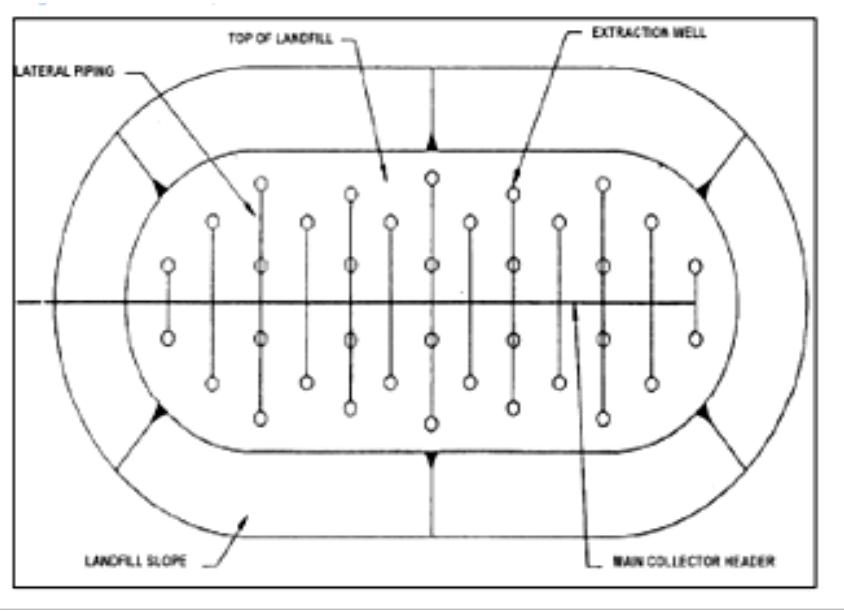


Figure A-16: Typical Landfill Gas Extraction Layout on a Landfill

Landfill gas extracted from the landfill waste mass is suctioned through piping to a station located away from the landfill waste mass. At this point, the landfill gas may be simply flared

without energy recovery (as is currently accomplished at the CIS El Guacal site). However, if LFGE energy recovery is implemented, the gas continues to one of two types of devices that utilize the gas as a fuel and then turn generators to produce electricity:

- Internal combustion engine + generator; or
- Turbine + generator.

While internal combustion engines have higher maintenance costs than turbines, **by far the most common system used worldwide is the internal combustion engine + generator.** For example, of the 368 United States landfill gas projects registered in the USEPA Landfill Methane Outreach Program (LMOP), 279, or 76%, utilize internal combustion engines. Primary reasons for this are:

- Internal combustion engines are much less sensitive to fluctuations in gas flow, which can drastically reduce the efficiency of turbines;
- Lower capital cost per installed MW capacity than turbines; and
- More "modular" or flexible, so that engines can be added or removed to the facility as gas flow varies over the years.

Figure A-17 shows a typical landfill gas flaring station. It is recommended that the existing flare at the CIS El Guacal be retained for use during maintenance downtime for the engine-generator sets.



Figure A-17: Typical Landfill Gas Flare Station

Figure A-18 shows a typical LFGE internal combustion engine-generator set and typical pre-fabricated enclosures for the generator sets.



Figure A-18: Typical Landfill Gas Engine-Generator Set and Pre-Fabricated Enclosures

Figure A-19 shows a typical LFGE internal combustion engine-generator set installed inside a building, without the use of pre-fabricated enclosures.



Figure A-19: Typical Landfill Gas Engine-Generator Sets Installed inside a Building

As a result of the extensive commercial experience with at least 480 landfill gas to energy projects operating commercially in North America and Europe, in numerous climactic zones and with various compositions of waste, a **landfill gas to energy project is deemed to represent a "Low" technical risk for the CIS El Guacal.**

A6. Evaluation of Technical Configurations

Certain overall guiding principles were used to narrow the field of technologies to be evaluated further. Therefore technology must:

- Have a substantial **commercial track record of processing mixed municipal solid waste (MSW)**; and
- **Do not require an increase in the gate tip fee** at El Guacal (currently approximately \$11.00 per ton).

These fundamental criteria are driven by the following Shareholders' expectations established in Task 1:

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining and readily financeable (IDEA and EVAS).
- **Energy Generation:** The energy recovery facility must export energy in some form. Ideally, the Project will generate power long term for sales into the national grid (IDEA).
- **Low Technical Risk / Commercially Proven:** IDEA expects the energy recovery facility to incorporate in its design only commercially proven technologies.
- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee of approximately US\$ 11 per ton (EVAS).
- **Net environmental benefit:** The plant should have a very light additional environmental impact, combined with significant environmental benefits (IDEA).

Figure A-20 shows the technical risk comparison of the technical configuration options discussed in Subsection A1 through A5 above. For each option, we have also shown sample plants from each technology that we believe illustrate the developmental status of each option.

		Commercial Plants			Pilot Plants	Closed Plants	
	Overall Technology and Examples of Specific Plants	North America	Europe	Total	N. America + Europe	N. America + Europe	Technical Risk
Combustion							
Mass Burn and RDF	OVERALL	91	431	522	0	2	LOW
Gasification and Pyrolysis							
In-Vessel Gasification	OVERALL	0	0	0	Unknown	Unknown	HIGH
Closed:	Thermoselect/ Karlsruhe/Ger.	0	0	0	0	2	
	Thermolyse/ Arras, France	0	0	0	0	1	
Plasma Arc Gasification	OVERALL	0	0	0	Unknown	Unknown	HIGH
Planned, not built:	Geoplasma / USA	0	0	0	0	0	
	Plasco / Ottawa / Canada	0	0	0	1	1	
Plastic to Oil	OVERALL	0	0	0	Unknown	Unknown	HIGH
Pilot Plant Only:	AGILYX / Oregon USA	0	0	0	1	0	
Biological and Chemical							
Anaerobic Digestion	OVERALL	1	27	28	Unknown	Unknown	MEDIUM-HIGH
	Cröburn / Leipzig /Ger.	0	1	1	Unknown	Unknown	
Landfill Gas to Energy	OVERALL	380	100	480	0	0	LOW

Figure A-20: Technical Options: Commercial Record and Technical Risk

As defined at the beginning of this Section A:

"**Technical Risk**" is defined as the probability that a plant utilizing the subject technology will operate with an availability well below 80% as a result of (a) equipment failures; or (b) inability to produce power or by-products in quantity or quality required by markets. For example, Anaerobic Digestion (AD) plants may operate at a reasonable reliability, but post-AD organics residuals have often been found to contain significant heavy metals concentrations and have therefore required landfilling or use as landfill cover material.

Based on the evaluation criteria and shareholders' expectations listed above in this Subsection A6, and the technology descriptions in Subsection A2 through A5 above, **we have excluded the following candidate technological configurations:**

- **A3. Gasification and Pyrolysis: No Commercial Track Record / "High" Level of Technical Risk**
 - In-Vessel Gasification
 - Plasma Arc Gasification
- **A4. Biological and Chemical**
 - Anaerobic Digestion: Limited Commercial Record in Europe / Obstacles in Finding Outlets for Compost Product / "Medium-High" Level of Technical Risk
 - Acid Hydrolysis: No Commercial Track Record / "High" Level of Technical Risk

We have retained for further consideration the following technical configurations:

- **A2. Combustion: Extensive Commercial Record / "Low" Level of Technical Risk**
 - Mass Burn
 - Refuse-Derived Fuel
- **A5. Landfill Gas to Energy: Extensive Commercial Record / "Low" Level of Technical Risk**

We believe that some point in the future, a technology currently in developmental (non-commercial) status may mature to the point where it is commercially proven. **However, we do not recommend in this feasibility study that CIS El Guacal become the first or second**

commercial scale plant built with one of these developmental technologies, considering the technical risk and uncertainty with regard to operational success that is involved.

B. Economic Performance of Technical Configurations

Even though a number of the technical configuration options have been eliminated in Section A above based on the level of technical risk, we have included all the options (except Chemical treatment, which has virtually no economic or operational information available) in **Figure B-1**. Figure B-1 also shows an estimated capital investment for each technical configuration, and an estimated debt service per ton is also calculated.

Figure B-2 presents a calculation of the scale house "break even" tipping fee based on the following standard formula, which is shown on a per ton of MSW intake basis:

Power Sales Revenue

- **Debt Service (Principal + Interest) Expense**
- **Operations and Maintenance ("O&M") Expense**
- = **Tipping Fee Required**

Figure B-2 also shows tipping fees estimated for specific plants that are examples of each technology option.

Even though all technical options potentially could generate carbon credits for sale, we do not include such revenues in determining each option's feasibility because of the uncertainty surrounding the Kyoto protocol, which expires in 2012. The Kyoto protocol has served to date as the primary driver of carbon credits markets. If the Kyoto protocol is not replaced after 2012, this market for carbon credits will become voluntarily driven and demand for credits will likely diminish significantly.

On this basis, the following minimum break-even tipping fees per ton would be required for each technology option, given sizing of the plant for CIS El Guacal design basis (750 tons per day MSW intake and 270 tons per day available as Back End energy recovery):

- **Combustion (Retained until now on a "Low" technical risk basis)**
 - Mass Burn: **\$43**
 - Refuse-Derived Fuel: **\$40**
- **Gasification and Pyrolysis (Excluded previously on a "High" technical risk basis)**
 - In-Vessel Gasification: **\$232**
 - Plasma Arc Gasification: **\$232**
- **Biological and Chemical**

- Anaerobic Digestion (**Retained until now on a "Medium-High" technical risk basis**): \$47
- Acid Hydrolysis (**Excluded previously on a "High" technical risk basis / economics not calculable as a result of lack of information**)
- **Landfill Gas to Energy (Retained previously on a technical risk basis): negative tip fee of \$2.60;** this positive value indicates that the LFGE project at CIS El Guacal is **profitable in itself and does not require any support from the existing CIS El Guacal tipping fee of approximately \$11 per ton.**

As shown above and in Figure B-2, **all technology options except Landfill Gas to Energy would be excluded from further consideration on the basis of the scale house tipping fee required.**

We refer here to key shareholders' expectations established in Task 1:

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining and readily financeable (IDEA and EVAS).
- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee of approximately US\$ 11 per ton (EVAS).

Therefore, the selected option is landfill gas to energy, based on extensive commercial operating record and economic feasibility.

For the landfill gas to energy technical configuration, as the selected technical configuration, greater budget detail is provided in Task 5, and financial modeling is provided in Task 8.

Figure B-1: Capital Investment and Debt Service per Ton for Technical Configurations

	Specific Plant: EL GUACAL SIZING or Example Plant	Capital Investment										Technical Risk [e]
		Front End Preparation Process [a]			Back End Energy Recovery [f]			Total Plant			Debt Service per Ton Intake [d]	
		Plant Design TPD	Capital per TPD	Sub-Total	Plant Design TPD	Capital per TPD	Sub-Total	Total Capital	Annual Debt Service [d]	Debt Service per Ton Intake [d]	Technical Risk [e]	
Combustion												
Mass Burn	EL GUACAL Sizing	750	\$ 80,000	\$ 60,000,000	270	\$ 500,000	\$ 135,000,000	\$ 195,000,000	\$ 13,804,965	\$ 56	LOW	
	Palm Beach County Expansion		None / Not Applicable		3000	\$ 220,000	\$ 660,000,000	\$ 660,000,000	\$ 46,724,498	\$ 47		
RDF	EL GUACAL Sizing	750	\$ 80,000	\$ 60,000,000	270	\$ 450,000	\$ 121,500,000	\$ 181,500,000	\$ 12,849,237	\$ 52	LOW	
	Miami-Dade County RDF	3000	\$ 70,000	\$ 210,000,000	2400	\$ 150,000	\$ 360,000,000	\$ 570,000,000	\$ 40,352,976	\$ 41		
Gasification and Pyrolysis												
In-Vessel Gasification	EL GUACAL Sizing		None / Not Applicable		750	\$ 773,333	\$ 580,000,000	\$ 580,000,000	\$ 41,060,923	\$ 167	HIGH	
	Thermoselect/Karlsruhe/Ger.		None / Not Applicable		685	\$ 846,800	\$ 580,000,000	\$ 580,000,000	\$ 41,060,923	\$ 182		
	Thermolyse/Arras, France		None / Not Applicable		125	\$ 290,000	\$ 36,250,000	\$ 36,250,000	\$ 2,566,308	\$ 62		
Plasma Arc Gasification	EL GUACAL Sizing		None / Not Applicable		750	\$ 600,000	\$ 580,000,000	\$ 580,000,000	\$ 41,060,923	\$ 167	HIGH	
	Geoplasma /St. Lucie FL / USA		None / Not Applicable		200	\$ 600,000	\$ 120,000,000	\$ 120,000,000	\$ 8,495,363	\$ 129		
Plastic to Oil	EL GUACAL Sizing	750	\$ 80,000	\$ 60,000,000	73	\$ 350,000	\$ 25,620,000	\$ 85,620,000	\$ 6,061,442	\$ 25	HIGH	
Biological and Chemical												
MBT with Anaerobic Digestion	EL GUACAL Sizing [c]	750	\$ 80,000	\$ 60,000,000	270	\$ 500,000	\$ 135,000,000	\$ 195,000,000	\$ 13,804,965	\$ 56	MEDIUM-HIGH	
	MBT Cröbern/Ger. [b]	920	\$ 107,174	\$ 98,600,000	460	\$ 400,000	\$ 184,000,000	\$ 282,600,000	\$ 20,006,581	\$ 66		
Landfill Gas to Energy	EL GUACAL Sizing		None / Not Applicable		750	\$ 17,078	\$ 12,808,572	\$ 12,808,572	\$ 917,875	\$ 4	LOW	

Notes

- [a] Front end raw MSW preparation process.
- [b] RDF to energy recovery as 30% of raw MSW intake, similar to other German MBT plants (e.g. MBT Hanover). Energy recovery portion shows RDF type energy recovery for RDF produced.
- [c] Back end (energy recovery capital calculation) added to overall project cost to make comparison to other technologies possible, since basic front end plant does not dispose of RDF.
- [d] Principal + interest annual payments estimated assuming: 20 Year loan period @ 75% debt @ 7.0% annual interest rate; average debt service over 23 years from 2011 until South Cell becomes active in 2033 except for Landfill Gas to Energy @ 10 year Loan Period with 60% debt @ 7.0% annual interest rate.
- [e] "Technical Risk" is an assessment of the probability that a plant utilizing the subject technology will operate with a reliability well below 80% as a result of (a) equipment failures; or (b) inability to produce power or by-products in quantity or quality required by markets. For example, Aerobic Digestion plants may operate at a reasonable reliability, but post-AD organics residuals have often been found to contain significant heavy metals concentrations and have therefore required landfilling or use as landfill cover material.
- [f] Includes Air Quality Control System capital investment.)

Figure B-2: Economic Performance Comparison of Technical Configurations

Specific Plant: El GUACAL-SIZING or Example Plant	Front End		Energy Recovery and Air Quality Control System							Total Plant			Technical Risk
	A1	A2	B	C	D	E	F=CFDPE	G=E/C	H	I	K=M-H-J		
	Plant Design TPD	Plant Design TPY	Plant Design TPD	Plant Design TPY	Power Sales kWh/Ton to Energy Recovery [a]	Power Sales Price per kWh [b]	Power Sales per Year [c]	Power Sales Per Ton [e]	Debt Service per Ton Intake [d]	O&M Cost per Ton [f]	Net Tip Fee Required to Break Even [h]		
Combustion													
Mass Burn	EL GUACAL	750	246,375	270	68,895	650	\$ 0.0812	\$ 4,681,320	\$ 53	\$ 56	\$ 40	(\$41.83)	LOW
	Palm Beach County Expansion			3000	965,500	650	\$ 0.0812	\$ 52,014,600	\$ 53	\$ 47	\$ 33	(\$28.12)	
RDF	EL GUACAL	750	246,375	270	246,375	600	\$ 0.0812	\$ 12,000,300	\$ 49	\$ 51	\$ 37	(\$40.27)	LOW
	Miami-Dade County RDF	3000	965,500	2400	965,500	600	\$ 0.0812	\$ 48,012,500	\$ 49	\$ 41	\$ 29	(\$21.15)	
Gasification and Pyrolysis													
In-Vessel Gasification	EL GUACAL			750	246,375	650	\$ 0.0812	\$ 18,000,670	\$ 53	\$ 167	\$ 118	(\$231.59)	HIGH
	Thermoselect / Karlsruhe, GDR			685	225,000	650	\$ 0.0812	\$ 11,875,500	\$ 53	\$ 182	\$ 129	(\$258.60)	
	Thermolyse / Anras, France			125	41,083	650	\$ 0.0812	\$ 2,167,279	\$ 53	\$ 62	\$ 44	(\$53.05)	
Plasma Arc Gasification	EL GUACAL			750	246,375	650	\$ 0.0812	\$ 18,000,670	\$ 53	\$ 167	\$ 118	(\$231.59)	HIGH
Plastic to Oil [c]	EL GUACAL	750	246,375	73	24,046	Not Applicable	\$ 368,940	\$ 15	\$ 25	\$ 17	(\$26.59)	HIGH	
MBT with Anaerobic Digestion	EL GUACAL	750	246,375	270	68,895	600	\$ 0.0812	\$ 4,681,320	\$ 49	\$ 56	\$ 40	(\$46.83)	MEDIUM-HIGH
Landfill Gas to Energy [d]	EL GUACAL			750	246,375	Not Applicable	\$ 0.0812	\$ 2,080,500	\$ 8	\$ 6	\$ 2	\$2.00	LOW

Notes to Figure B-2:

[a] Good net power export per ton for Mass Burn (650 kWh/Ton) or RDF (600 kWh/Ton); assumed for Gasification and MBT. Plastic to Oil revenue column under Note [c] below.

[b] Please see Task 3 Report for historical analysis of power sales pricing averaging US\$ 0.0812. In addition, this column includes cash flow effect of 10% sales tax exemption (Task 3): \$0.0700 * 1.16 = \$0.0812.

[c] Landfill Gas Power Sales is revenue average over 23 years until South Cell becomes active.

[d] Please see Figure B-1.

[e] Plastic to Oil Column "P" or "Power Sales Revenue per Year": 750 TPD Raw MSW * 12.2% Plastic * 10% Recovery = 73 TPD Plastic; (73 TPD Plastic / 5.20 Tons plastic per barrel of oil) * \$20 per barrel.

[f] Annual O&M = 3% of Total Capital as representative for all technologies other than landfill gas to energy.

[g] Negative values in this column mean that negative value shown must be paid at scalehouse as tip fee in order to break even.

C. Selection of Primary Energy Equipment

As discussed in Section A, internal combustion engines are by the most widely used energy recovery systems for landfill gas to energy projects and are recommended for the CIS El Guacal application.

Landfill gas to energy internal combustion engines are sold with an integrated generator, as well as all required instrumentation and control, and are available in a number sizes, typically from 0.54 MW to 3.0 MW and higher. Such engines are sized according to the landfill gas flow anticipated for the facility.

We believe that the 2010 USEPA-LMOP assessment report of landfill gas to energy potential at the CIS El Guacal site is a well-founded basis for identifying the potential gas flows that could be generated from the North Cell and the Central Cell. This 2010 study included field measurements of gas quantity and quality from two existing gas extraction wells already installed on the North Cell.

The model equation used in the USEPA-LMOP 2010 study, and in other models, to calculate landfill gas generation is a linear function of waste tonnage in place in the landfill cell:

- Landfill Gas Cubic Meters Produced per Year =
- $2 k * L_o * M * (e^{(-kt)})$
- Where:
 - L_o = methane generation potential (cubic meters/ton)
 - k = refuse decay rate (1 / the number of years required to biodegrade completely)
 - M = mass of waste in place (tons) in any given year
 - t = age of waste in years in any given year.

However, we have noted that the projection of tonnage in place in each cell may be too high as a result of estimating that annual tonnage would increase to over 900 tons per day between 2010 and 2011 in the USEPA-LMOP 2010 study, whereas we have determined, as established in Task 1 and Task 3 from CIS El Guacal scale house tonnage records, that a large sudden increase did not occur in that time period. Rather, tonnage has remained in the range of 650 tons per day during the early months of 2011, as of the development of Task 3. Therefore, we have adjusted the anticipated landfill gas flow projections linearly (since the model equation is a linear function of the variable M if all other variables remaining unchanged). This adjustment and projection of several variables are shown in **Figure C-1**. The adjusted projection represents an average of 79% of the original tonnage in place (as well as landfill gas production) projection in the 2010 USEPA-LMOP study.

If, in fact, the intake tonnage does increase to the level projected in the 2010 USEPA-LMOP study (as appears to be beginning to occur during June and July 2011), then this will represent a major economic benefit to the project. In this way, the projections and models of this present feasibility study may be considered as conservative ones.

As shown in Figure C-1, columns G, G1, and G2, two engines of 1.6 MW capacity each would be sufficient from 2011 through 2020 (year highlighted) for an installed capacity of:

- **2 Engines x 1.6 MW per Engine = 3.2 MW.**

The sizing of 1.6 MW per engine allows for reliability redundancy of two engines during the first 10 years of operations.

In 2020, a third engine would be added, for an installed capacity of:

- **3 Engines x 1.6 MW per Engine = 4.8 MW.**

After 2020, three engines provide sufficient capacity to reach the 4.3 MW peak generation level projected in Figure C-1 for the year 2029, without having oversized the equipment.

In the event that tonnage flows reach the levels projected in the USEPA-LMOP 2010 study (as shown in columns D, D1, and D2 in Figure C-1) and continue as projected through 2020, a fourth engine, for a total capacity as follows of can be added modularly quite readily:

- **4 engines x 1.6 MW per Engine = 6.4 MW.**

We do wish to emphasize here that the successful capture of landfill gas at the projected levels is entirely dependent on the completeness with which the following operational practices are followed over the years:

- Daily and intermediate cover application (to prevent methane emissions to the atmosphere); the CIS El Guacal has initiated an aggressive soil daily and intermediate cover program as of the time of this writing);
- Active working face with exposed waste should be minimized (this will also greatly reduce leachate generation);
- Effective leachate removal system to prevent leachate buildup in the cell, which can suppress gas production in the part of the waste mass that is water saturated.

Figure C-1: Landfill Gas Generation and Projected Plant Capacity

Year:Sequential	Cell Status	Year: Calendar	Disposal Rate (tons/day)	Disposal Rate (tons/yr)	A	B	C = A / B	Projection Adjustment	Maximum Recovery Scenario [a]			Adjusted Projection		
					Waste In-Place (tons) per Cambridge Projection	Waste In-Place (tons) per USEPA 2010 Study		D	D1	D2	G = C * D	G1	G2	
1	North Cell Active	2011	650	237,405	1,007,385	1,238,080	81%	1.5	2.0	3.2	1.2	2.0	3.2	
2		2012	660	240,967	1,248,352	1,576,480	79%	2.0	2.0	3.2	1.6	2.0	3.2	
3		2013	670	244,581	1,492,933	1,919,980	78%	2.8	2.0	3.2	2.2	2.0	3.2	
4		2014	680	248,250	1,741,183	2,268,680	77%	3.2	3.0	4.8	2.5	2.0	3.2	
5		2015	690	251,973	1,993,156	2,622,580	76%	3.4	3.0	4.8	2.6	2.0	3.2	
6	Central Cell Active	2016	700	255,753	2,248,909	2,981,780	75%	3.6	3.0	4.8	2.7	2.0	3.2	
7		2017	711	259,589	2,508,497	3,346,380	75%	3.7	3.0	4.8	2.8	2.0	3.2	
8		2018	722	263,483	2,771,980	3,716,480	75%	3.8	3.0	4.8	2.8	2.0	3.2	
9		2019	732	267,435	3,039,415	4,092,180	74%	4.0	3.0	4.8	3.0	2.0	3.2	
10		2020	743	271,446	3,310,862	4,473,480	74%	4.2	3.0	4.8	3.1	3.0	4.8	
11		2021	754	275,518	3,586,380	4,860,480	74%	4.3	3.0	4.8	3.2	3.0	4.8	
12		2022	766	279,651	3,866,031	5,253,280	74%	4.5	3.0	4.8	3.3	3.0	4.8	
13		2023	777	283,846	4,149,876	5,651,980	73%	4.7	4.0	6.4	3.5	3.0	4.8	
14		2024	789	288,103	4,437,980	6,056,680	73%	4.9	4.0	6.4	3.6	3.0	4.8	
15		2025	801	292,425	4,730,405	6,467,480	73%	5.0	4.0	6.4	3.7	3.0	4.8	
16		2026	813	296,811	5,027,216	6,884,480	73%	5.2	4.0	6.4	3.8	3.0	4.8	
17		2027	825	301,263	5,328,480	7,307,780	73%	5.4	4.0	6.4	3.9	3.0	4.8	
18		2028	837	305,782	5,634,262	7,400,000	76%	5.6	4.0	6.4	4.3	3.0	4.8	
19		2029	850	310,369	5,944,631	7,400,000	80%	5.1	4.0	6.4	4.1	3.0	4.8	
20		2030	863	315,025	6,259,656	7,400,000	85%	4.0	4.0	6.4	3.4	3.0	4.8	
21		2031	876	319,750	6,579,406	7,400,000	89%	3.2	4.0	6.4	2.8	3.0	4.8	
22		2032	889	324,546	6,903,952	7,400,000	93%	2.6	4.0	6.4	2.4	3.0	4.8	
23		2033	902	329,415	7,233,367	7,400,000	98%	2.2	4.0	6.4	2.2	3.0	4.8	
24		2034	916	334,356	7,567,723	7,400,000	102%	1.9	4.0	6.4	1.9	3.0	4.8	
25	South Cell Active	2035												
Average over 24 year period until South Cell becomes active:								3.8	3.4	5.4	2.9			

D. Selected Technical Configuration

This Section D presents a preliminary conceptual design as described through the following Subsections, which correspond to components of the Terms of Reference (TOR):

- D1. Process Flow
- D2. Time Schedule and Procurement Plans
- D3. Environmental Benefits
- D4. Energy Efficiency and Electrical Capacity
- D5. General Plot Plan

Financial modeling of the landfill gas to energy option is presented in Task 8, and capital as well as operations and maintenance budgets are provided in Task 5.

D1. Process Flow

Figure D-1 illustrates the flow of the Landfill Gas to Energy (LFGE) process in sequence:

1. LFG collection within the landfill cell and piping to gas extraction and cleaning equipment.
2. Gas extraction (by means of a blower) of gas and cleaning equipment (removal of moisture and undesirable gas components). Gas is then conducted to engine-generator.
3. Engine combusts cleaned gas and turns its integral generator. Power output flows to step-up transformer (step up from 13.8 kV to 44 kV in the case of CIS El Guacal).
4. Transformer exports stepped up power to the local transmission line.

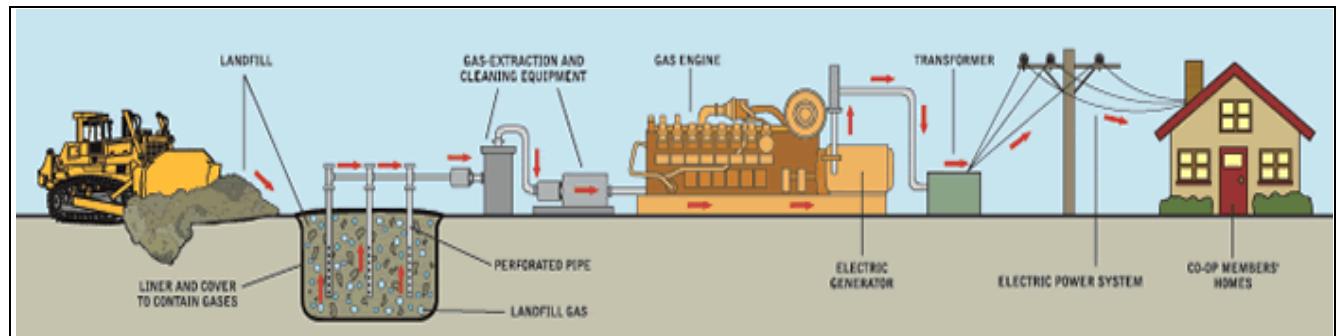


Figure D-1: Landfill Gas to Energy Process Flow

D2. Time Schedule and Procurement Plans

Figure D-2 shows a preliminary schedule for implementation of the project, beginning with completion of this present feasibility study. Sequential months are shown in the event that implementation activities do not begin immediately after completion of this present feasibility study. Implementation activities are classified into three categories:

- **Business Aspects:** Negotiation of contractual arrangements between stakeholders, including IDEA, EVAS, EMGEA, power traders (for spot market sales), and potentially Green Gas. In parallel, financing arrangements are finalized with financing institutions;
- **Permitting and Licenses:** Preparation of applications for any permits or licenses, including modifications of existing permits or licenses. Applications are followed by processing of the applications by environmental authorities.
- **EPM Scope:** after the connection study is completed, negotiations for EPM's scope are finalized, and EPM procures and installs the 44 kV line, the step-up transformer at CIS El Guacal, and the step-up transformer at the existing San Antonio de Prado substation;
- **Turnkey EPC Contract:** The request for proposals (RFP) is prepared based on the findings of this feasibility study. After a competitive bid process, a turnkey Engineering-Procurement-Construction (EPC) contractor is selected and the EPC contract is finalized before detailed design, construction of the concrete slab(s) is (are) completed, purchase order and delivery of equipment (including the engine-generators), equipment is installed, and the entire system of two engine-generator sets is tested and started up. The EPC contractor must guarantee performance of the overall system.

Total duration of implementation activities is projected as approximately 12 months, based on a high level of sponsorship by the stakeholders.

Installation of the landfill gas collection wells in the North Cell is filled is not shown, since this activity is already underway by GreenGas under contract to EVAS, and the number of wells in place by the time the power generation system starts up will be enough to initiate commercial power export.

Figure D-2: Preliminary Project Implementation Schedule

Sequential and Calendar Months													
1	2	3	4	5	6	7	8	9	10	11	12	13	
2011		2012											
NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	
Feasibility Study Completed													
Business Aspects													
Negotiate Contracts													
Negotiate Financing													
Permitting and Licenses													
Complete Applications													
Regulatory Review													
EPM Scope of Work													
Interconnection Study													
Negotiations with EPM													
EPM Installs 44 kV Line + Transformers													
Turnkey EPC Contract													
Prepare Request for Proposals													
Proponents Prepare Responses													
Evaluate Responses and Award													
Detailed Design													
Purchase Order and Deliver Equipment													
Install Modules and Auxiliary Equipment													
Testing and Startup													
Begin Power Sales													

D3. Environmental Benefits

Landfill gas to energy is considered an important part of the effort to reduce greenhouse gas emissions globally. It is estimated that 25% of all man-made methane emissions originate in landfills without adequate landfill gas collection systems.

Landfill gas to energy projects reduce greenhouse gas emissions under two independent mechanisms:

- Landfill methane emissions avoided; and
- Fossil fuels combustion avoided by the electric power generated.

Each carbon credit is the equivalent of one ton of CO₂ emissions avoided. Each ton of methane emissions avoided has the global warming potential of 21 tons of CO₂ emissions avoided.

Figure D-3 shows the potential carbon credits for the CIS El Guacal project. However, it should be noted that the landfill gas methane emissions avoided during North Cell operations are already being claimed by the existing gas flaring operation. In Figure D-3, "CO_{2e}" means CO₂ equivalent of the tons of methane emissions avoided.

Subsequently, when Central Cell enters operations, it may be possible for the landfill gas to energy project to claim carbon credits from landfill methane emissions avoidance obtained through installation of the gas collection system.

Figure D-3: Total Potential Carbon Credit Generation

Year: Sequential	Cell Status	Year: Calendar	Methane Emissions Reductions Estimates		Avoided Fossil Fuel	Total Carbon Credits
			(tons CH4/yr)	(tons CO2e/yr)	(tons CO2e/yr)	(tons CO2e/yr)
1	North Cell Active	2011	1,138	23,881	7,372	31,253
2		2012	3,004	63,082	9,337	72,419
3		2013	4,116	86,436	12,286	98,722
4		2014	4,679	98,245	13,760	112,005
5		2015	4,952	103,991	14,252	118,243
6	Central Cell Active	2016	5,144	108,023	14,473	122,496
7		2017	5,276	110,795	14,473	125,268
8		2018	5,443	114,313	15,235	129,548
9		2019	5,634	118,319	15,726	134,045
10		2020	5,841	122,657	16,217	138,874
11		2021	6,059	127,224	16,709	143,933
12		2022	6,284	131,961	17,200	149,161
13		2023	6,516	136,833	17,692	154,525
14		2024	6,754	141,821	18,675	160,496
15		2025	6,996	146,911	18,675	165,586
16		2026	7,243	152,100	19,657	171,757
17		2027	7,494	157,382	20,149	177,531
18		2028	8,104	170,181	21,623	191,804
19		2029	7,832	164,474	21,132	185,606
20		2030	6,428	134,983	17,200	152,183
21		2031	5,377	112,917	14,252	127,169
22		2032	4,607	96,743	12,286	109,029
23		2033	4,036	84,761	10,182	94,943
24		2034	3,607	75,754	9,337	85,091
25	South Cell Active	2035				
			5,523	115,991	15,329	127,775

Notes:

[a] USEPA LMOP Emissions Reductions and Environmental and Energy Benefits for Landfill Gas to Energy Projects; Excel Model ifge_benefitscalc.

D4. Energy Efficiency and Electrical Capacity

The proposed engine-generator sets utilize landfill gas as fuel and do not require any supplemental fuel to function. The "fuel handling system" (as mentioned in the Terms of Reference) for the selected technical configuration is the piping from the landfill cell to the gas cleaning equipment and then continues on to the engine-generator modules.

Energy efficiency (**the percentage of the total energy in the fuel that is actually converted to electrical energy**) for the landfill gas to energy process can be calculated directly from the published "**heat rate**" for any given model of engine-generator set. The heat rate for landfill gas engine-generator sets is usually expressed as the fuel heat energy needed to produce one kilowatt-hour (kWh). The USEPA-LMOP 2010 study uses a heat rate of 10,800 BTU (British Thermal Units) per kWh produced. One kWh represents 3,412 BTU. Therefore, we can express the energy efficiency of a typical landfill gas to energy engine-generator set as:

- Energy OUT / Energy IN = 3,412 BTU / 10,800 BTU = **31.6%**

This is a normal level of efficiency for an internal combustion engine, and such efficiency values will vary only slightly with the specific model of engine-generator set acquired. The approximately 70% of the fuel energy lost is made up of heat emitted to the surrounding environment and energy losses resulting from thermodynamic effects.

Electrical generation capacity of the plant is projected for 2011 through 2034 in Figure C-1 above and varies from 1.2 MW in projection year 2011 to 4.3 MW in 2028 back down to 1.9 MW in 2034.

D5. General Plot Plan

D5.1 General Plot Plan

As discussed above in Section C, it is recommended that the project be implemented as follows:

- Initially, and for the first 9 years as projected, in Figure C-1 above, with two engine-generator sets of 1.6 MW each. Each engine-generator set with its gas cleaning equipment and generator are termed a "module." Hence, during the first 9 years, only Module A and Module B are in operation.
- In year 10 (calendar year 2020) as projected in Figure C-1, a third module of 1.6 MW capacity, Module C, is installed. These three modules are projected to be sufficient to landfill gas flow through year 24 (calendar year 2034), unless waste intake tonnage increases to the level projected in the USEPA-LMOP 2010 study (reaching 900 TPD during 2011).
- In the event that tonnage levels increase to the levels projected in the USEPA-LMOP 2010 study, a fourth Module D of 1.6 MW capacity can be added.

Therefore, it is recommend that:

- Acquisition of modules supplied complete with pre-fabricated enclosures for each set based on the modular flexibility achieved. Constructing a conventional building for housing the modules will be higher in capital cost and may require modifications in the building as modules are added or removed over time.
- Construction of a single concrete slab or three individual concrete slabs on which Modules A, B, and C can be installed. During detailed design (during the project implementation phase), the desirability of separate slabs for each module should be considered, depending on the design of the engine-generators acquired.
- Reservation of a footprint space (but no slab construction as yet) for a Module D if needed in the future.

Figure D-5 provides a general plot plan for installation of the project equipment.

The concrete slab(s) for Modules A, B, and C should be, with final design to be finalized during detailed design and dependent on dimensions and loading from the specific generator sets acquired:

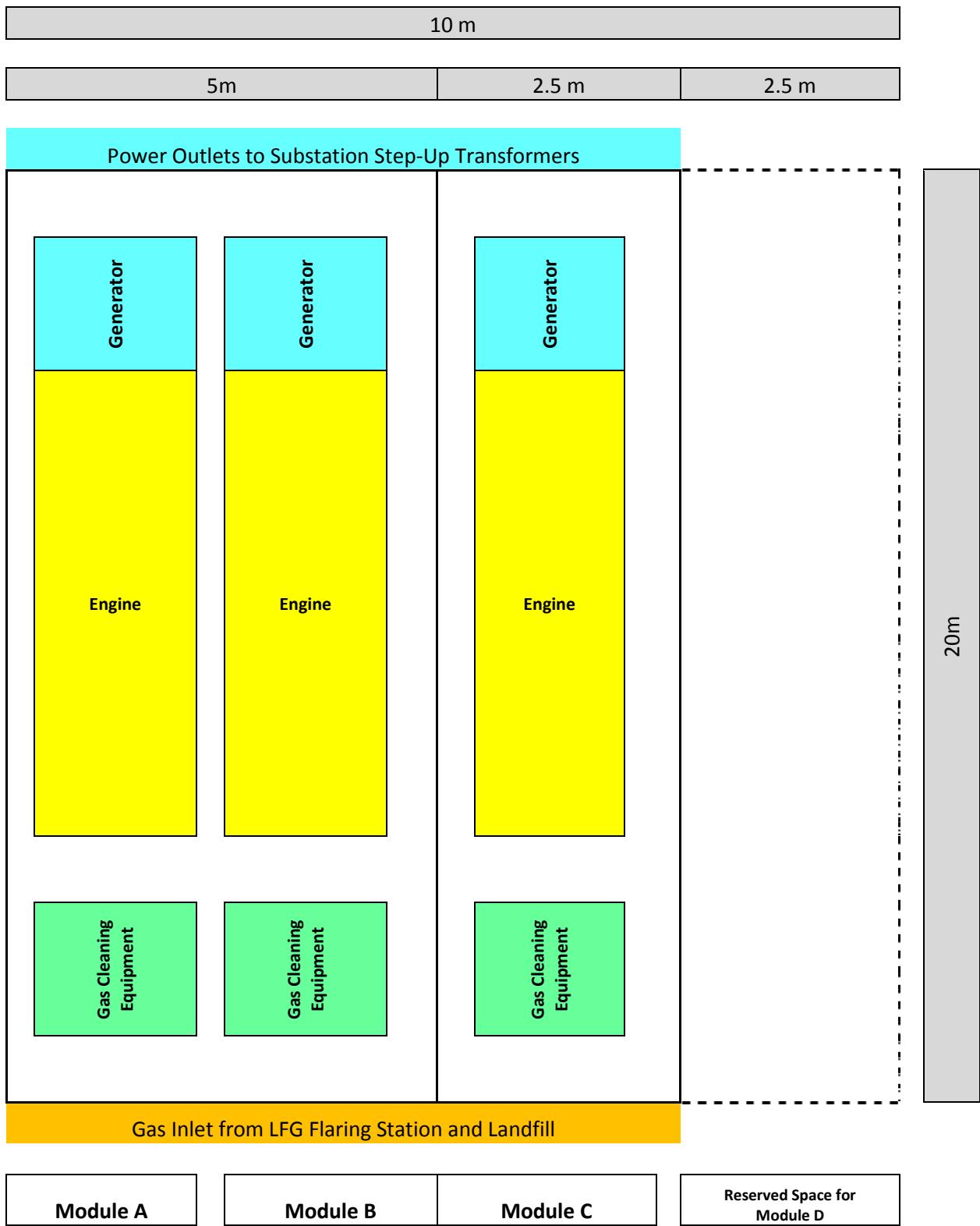
- Approximately 7.5 meters x 20 meters = 150 square meters total footprint area for three modules including end and side access ways.
- The weight of the concrete slab(s) for the Landfill Gas Engine-Generator configuration needs to be approximately three times the weight of the Engine-Generator sets to absorb the dynamic loads. Typical slab thickness would be 16 to 32 centimeters (6

inches -12 inches)) above grade and 45 to 60 cm (18 to 24 inches) below grade at 4000 psi (28 day) concrete strength.

The following **auxiliary systems** are delivered with the engine-generator sets and the pre-fabricated housings:

- Instrumentation and Control
- Fire Detection and Suppression.

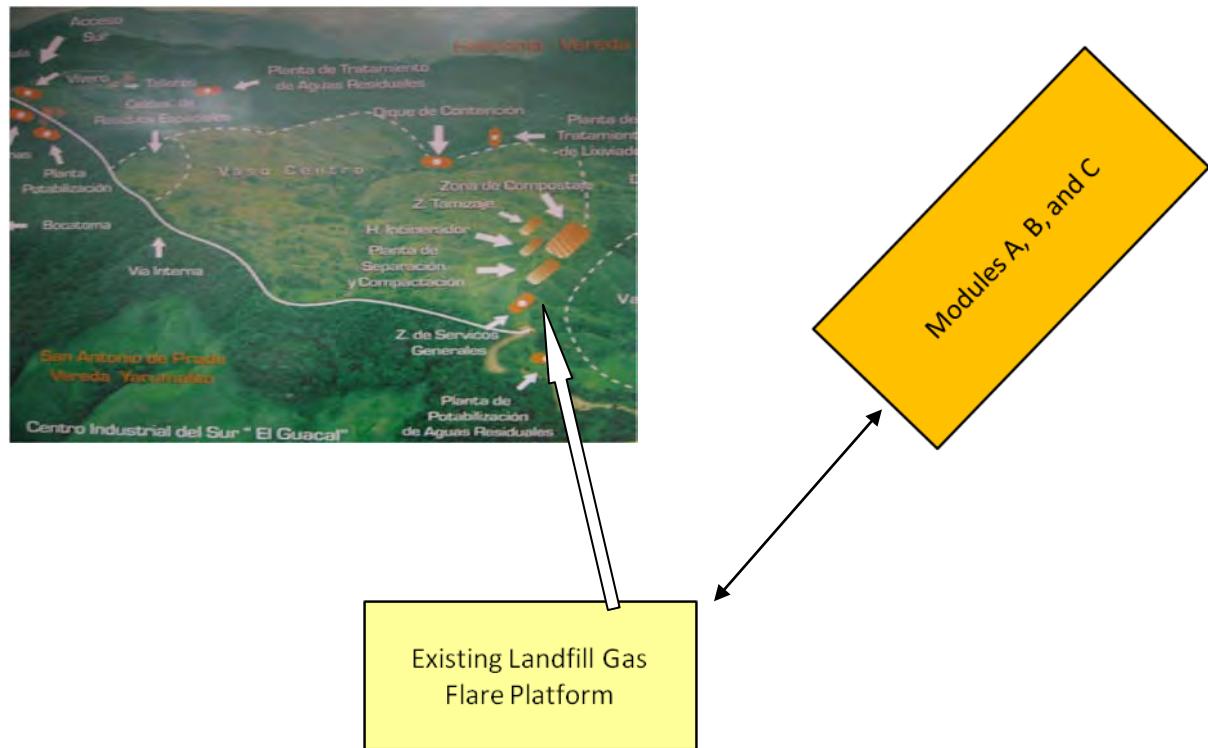
Figure D-5: General Plot Plan



D5.2 Recommended Location On-Site

Figure D-6 shows the location selected during discussions with EVAS representatives, including the general location on the site and the location relative to the existing gas flare platform. The location of the slab that will accommodate Modules A, B, and C is slanted at approximately 45 degrees to the long axis of the existing landfill gas flare platform. This slanting is required in order to avoid footprint conflict with the cut hillside to the Northeast of the existing landfill gas flare platform. The edge of the slab accommodating Modules A, B, and C is positioned at least 6 meters from the edge of the existing landfill gas flare platform for fire safety reasons. The 6 meter separation is shown as a double-headed arrow in Figure D-6.

Figure D-6: Recommended Location On-Site



D5.3 Interface Points for Connection to the Power Grid

The power outlets from the engine-generator sets should be connected to the new CIS El Guacal substation (a fenced concrete slab accommodating the transformer to step up from 13.8 kV coming from the engine-generators to 44 kV as the transmission line voltage), whose location will be selected during the "interconnection study" detailed design during implementation phase by consultants for use by EPM. However, the new substation should be located as closely as possible to the engine-generator sets in order to minimize the need for cabling.

E. Conclusions

We refer here to the following Shareholders' expectations established in Task 1:

- **Profitability:** The energy recovery facility must be profitable, economically self-sustaining and readily financeable (IDEA and EVAS).
- **Energy Generation:** The energy recovery facility must export energy in some form. Ideally, the Project will generate power long term for sales into the national grid (IDEA).
- **Low Technical Risk / Commercially Proven:** IDEA expects the energy recovery facility to incorporate in its design only commercially proven technologies.
- **Tipping Fee Continuity:** The new energy recovery project economics should not require an increase in the current tipping fee of approximately US\$ 11 per ton (EVAS).
- **Net environmental benefit:** The plant should have a very light additional environmental impact, combined with significant environmental benefits (IDEA).

These key shareholders' expectations have been used in identifying Landfill Gas to Energy as the selected technical configuration. Key elements of this selection process are:

- We believe that at some point in the future, a technology that is today in developmental (non-commercial) status may mature to the point where they are commercially proven. However, we **do not recommend that CIS El Guacal be among the first commercial scale plants built with one of these developmental technologies.**
- As a result of the extensive commercial experience with at least 480 landfill gas to energy projects operating commercially in North America and Europe, in numerous climactic zones and with various compositions of waste, landfill gas to energy projects, especially **landfill gas to electricity projects utilizing engine-generator sets, are deemed to represent a "Low" technical risk for the CIS El Guacal.**
- If the Kyoto protocol is not replaced after 2012, the carbon credits market is expected to be substantially diminished. The Kyoto protocol has created specific financial incentives for industrial emitters of greenhouse gas emissions to purchase carbon credits to offset their physical emissions. Therefore, **carbon credit revenues are not relied upon in evaluating the economics of each option.**
- **Landfill Gas to Energy requires a capital investment of less than \$15 Million over 10 years,** compared to investments of over \$100 Million for most other technical configurations.

- **The Landfill Gas to Energy project is profitable** and makes a cash flow contribution to the overall CIS El Guacal facility without requiring any subsidy from the existing tipping fee of approximately \$11 per ton.

Other conclusions reached during this Task 4 effort that should be considered are:

- It is recommended that the existing flare at the CIS El Guacal be retained for use during maintenance downtime for the engine-generator sets.
- Two engines of 1.6 MW capacity each would be sufficient from 2011 through 2020 (first 10 years of operations) for an installed capacity during this period of:
 - **2 Engines x 1.6 MW per Engine Each = 3.2 MW.**
- The sizing of 1.6 MW per engine allows for reliability redundancy of two engines during the first 10 years of operations. Larger engines (for example with 1.8 MW capacity each) would have a higher cost and the extra capacity would not be utilized during most of the first 10 years of operations.
- In 2020, a third engine would be added, for an installed capacity of:
 - **3 Engines x 1.6 MW per Engine Each = 4.8 MW.**
- After 2020, three engines provide sufficient capacity to reach the 4.3 MW peak generation level projected in Figure C-1 for the year 2029, without having oversize the equipment.
- In the event that tonnage flows reach the levels projected in the USEPA-LMOP 2010 study (as shown in columns D, D1, and D2 in Figure C-1), a fourth engine, for a total capacity as follows can be modularly added at a later point quite readily:
 - **4 engines x 1.6 MW per Engine Each = 6.4 MW.**
- We do wish to emphasize here that the successful capture of landfill gas (and the associated power generation) at the projected levels is **entirely dependent on the completeness with which the following operational practices are followed over the years:**
 - Daily and intermediate soil cover application (to prevent methane loss to the atmosphere); the CIS El Guacal had initiated an aggressive daily and intermediate soil cover program as of the time of this writing);
 - Active working face with exposed waste should be minimized (this will also greatly reduce leachate generation);

- Effective leachate removal system to prevent leachate buildup in the cell, which can suppress gas production in the part of the waste mass that is water saturated; and
- **Total duration of project implementation activities is projected as approximately 12 months**, based on a high level of sponsorship by the stakeholders.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

Task 5 Report: Preliminary Cost Estimates

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

20 September 2011

The contents of this Task 5 Report are listed below:

Task 5 Report Contents

A	Capital Cost Estimates
B	Operating Cost Estimates
C	Summary

A. Capital Cost Estimates

The total capital cost estimate for the landfill gas facility at El Guacal landfill is approximately USD \$13.9 Million USD or \$25 Billion Colombian Pesos, at an exchange rate of COP\$ 1800 per U.S. Dollar. The Terms of Reference (TOR) for this feasibility study requires that this Task 5 express preliminary cost estimates in dollars as well as in Colombian pesos. **Figure A-1** calculates capital cost ("capex") estimates for the project and is divided into the North Cell and Central Cell portions of the landfill gas to energy project. The major line items in Figure A-1 are:

- Landfill Gas (LFG) Collection System
- LFG Power Generation System
- Civil Works
- Soft Costs (Design, Permitting, Legal, Financing Costs)
- Contingency

A1. Landfill Gas Collection System

The LFG Collection System is the network of wells and piping that are installed in the landfill throughout the operating life of the landfill. This system remains in place permanently and operates for a prolonged period of years after the landfill is deactivated. The collection system normally includes a blower that is used to withdraw the landfill gas from the landfill and feed it into the gas cleaning equipment upstream of the engine-generator. Figure A-1 uses a standard industry cost per acre or hectare calculation to determine the cost of installing the gas collection system throughout the life of the landfill cells. The industry cost factor used to calculate the capital cost of a LFG collection system is compatible with the factor published by the United States Environmental Protection Agency (USEPA) Landfill Methane Outreach Program (LMOP). The cost per acre or hectare amount includes:

- Installation Expense
- Equipment and Materials Expense

At CIS El Guacal in the North Cell, a system of gas collection is currently being installed. EVAS confirms that approximately 30% of the collection system in the North Cell is already installed. Therefore, Figure A-1 reflects a deduction toward the future capital investment of the system under the new project. The Central Cell has not been constructed and is not in operation, so that the cost estimate for the collection system is for the entire collection system in the Central Cell.

A2. LFG Power Generation System

The LFG Power Generation System in Figure A-1 is the largest capital expense, because it consists of plant equipment (engine, generator, gas cleaning equipment, control equipment, etc.). The industry cost factor of USD \$1,700 USD per kW installed capacity is used to estimate the total capital cost for the power generation system.

A3. Civil Works

Civil works is made up primarily construction costs associated with the concrete slabs and site preparation for the LFG facility and transmission equipment, especially a resistant concrete slab. A cost factor of USD\$ 1000 per square meter is used, based on our recent experience.

A4. Soft Costs

The soft costs for the project include:

- Legal Fees
- Permitting Costs
- Financing Fees
- Consulting Fees

The estimate of indirect costs (soft costs) as a percent of direct costs as shown in Figure A1 is based on our experience with a number of projects of similar magnitude. In general, we find that soft costs represent on the order of 10% to 15% of the direct (or "hard") costs.

A5. TOR Itemization of the Capital Cost Estimate

The Terms of Reference (TOR) require that the capital cost estimate be itemized into a list of line items specified in the TOR. This break down is presented in **Figure A-2**.

Figure A-1: Calculation bases for Capital Investment (Capex)

North Cell							
LFG Collection System	Acres	Hectares	Capex/Acre	Capex/Hectare	Total Wells	Total Capex USD	Total Capex Pesos
	12.4	5.0	\$ 30,000	\$ 74,131		\$ 370,657	\$ 667,183,446
	Acres	Hectares	Wells/Acre	Wells/Hectare			
	12.4	5.0	1.0	2.5		12.4	
LFG Power Generation System	Engines	MW [a]	kW [a]	Capex/kW [c]		Total Capex	Total Capex
	2.0	3.2	3200.0	\$ 1,700		\$ 5,440,000	\$ 9,792,000,000
Civil Works	Square Meters	Capex/m ²				\$ 75,000	\$ 135,000,000
	75.0	\$ 1,000.00					
Less LFG Collection System Already Installed in North Cell				30.0%		\$ (111,197)	\$ (200,155,034)
					Hard Costs Sub-Total	\$ 5,774,460	\$ 10,394,028,412
Project Soft Costs [b]				15.0%		\$ 866,169	\$ 1,559,104,262
					North Cell Total	\$ 6,640,629	\$ 11,953,132,674
Central Cell							
LFG Collection System	Acres	Hectares	Cost/Acre	Cost/Hectare	Total Wells	Total Capex USD	Total Capex
	54.4	22.0	\$ 30,000	\$ 74,131		\$ 1,630,893	\$ 2,935,607,160
	Acres	22	Wells/Acre	Wells/Hectare			
	54.4	22.0	1.0	2.5		54.4	
LFG Power Generation System	Engines [c]	MW [a]	kW [a]	Capex/kW [c]		Total Capex	Total Capex
	1.0	1.6	1600.0	\$ 1,700		\$ 2,720,000	\$ 4,896,000,000
					Hard Costs Sub-Total	\$ 4,350,893	\$ 7,831,607,160
Project Soft Costs [b]				15.0%		\$ 652,634	\$ 1,174,741,074
					South Cell Total	\$ 5,003,527	\$ 9,006,348,234
		Engines	MW	Contingency on Capital	10%	\$ 1,164,416	\$ 2,095,948,091
Project Total Capital	3.0	4.8				\$ 12,808,572	\$ 23,055,428,999
		Months	Avg. Power Sales / Month [d]				
Working Capital	6.0	\$ 174,000				\$ 1,043,999	\$ 1,879,198,345
Project Grand Total						\$ 13,852,571	\$ 24,934,627,344

[a] Installed generating capacity .

[b] Design, financing, legal, permitting, shipping and related costs.

[c] Additional engines for Central Cell.

[d] Average over 24 years of operations.

Figure A-2: Total Basic Capital Cost Estimate

	USD	Pesos [h]
	\$ 13,852,571	\$ 24,934,627,344
CAPEX Breakdown:	\$ %	\$
> Architectural and engineering design	\$ 692,629	5.0% \$ 1,246,731,367
> Primary energy equipment (boilers, turbines, and gas piston engines with generator sets)	\$ 5,541,028	40.0% \$ 9,973,850,938
> Auxiliary energy equipment	[b]	0.0% \$ -
> Transformers, switchgear and other electro-technical equipment	\$ 415,577	3.0% \$ 748,038,820
> Fuel-handling system and ash disposal system (Gas collection System)	\$ 4,155,771	30.0% \$ 7,480,388,203
> Automated control and communications system	[b]	0.0% \$ -
> Water-treatment, water-supply and sewage systems	[a]	0.0% \$ -
> Fire-protection system	[b]	0.0% \$ -
> Buildings and structures	[b]	0.0% \$ -
> Plot preparation	\$ 138,526	1.0% \$ 249,346,273
> Connection to the local district heating (DH) network and pipeline	[a]	0.0% \$ -
> Upgrading the local DH network	[a]	0.0% \$ -
> Connection to the national electricity grid (SIN)	[d]	0.0% \$ -
> Permitting and licensing fees	\$ 415,577	3.0% \$ 748,038,820
> Financing costs	\$ 207,789	1.5% \$ 374,019,410
> Certified Emissions Reductions (CERS) under the Clean Development mechanism (CDM) Registration	[c]	0.0% \$ -
> Real estate, concession and easement costs	[a]	0.0% \$ -
> Legal Fees	\$ 138,526	1.0% \$ 249,346,273
> Taxes	[e]	0.0% \$ -
> Cost for Colombian National Government special tax zone certification	[e]	0.0% \$ -
> Inspection and special consultants	\$ 69,263	0.5% \$ 124,673,137
> Commissioning, startup, and spare parts	[b]	0.0% \$ -
> Environmental protection measures	\$ 138,526	1.0% \$ 249,346,273
> Freight	\$ 277,051	2.0% \$ 498,692,547
> Construction	\$ 138,526	1.0% \$ 249,346,273
> Verification Costs	\$ 69,263	0.5% \$ 124,673,137
> Personnel training	\$ 69,263	0.5% \$ 124,673,137
> Contingency	\$ 1,385,257	10.0% \$ 2,493,462,734
TOTAL CAPITAL EXPENSE	\$ 13,852,571	100.0% \$ 24,934,627,344
[a] Not applicable to selected technology configuration		
[b] Price included in primary energy equipment		
[c] Kyoto Protocol Expires in 2012 and may not be replaced		
[d] Amortized over time by EPM		
[e] The project is exempt from numerous taxes and duties. Any applicable taxes or duties would be paid from the contingency amount.		
[f] Colombian Pesos per USD = \$1800		

B. Operating Cost Estimates

The operating costs for a LFG generation facility are well documented in industry literature, and are calculated for the case of the CIS El Guacal facility below in **Figure B-1**. The USEPA Landfill Methane Outreach Program (LMOP) includes industry standards for operations and maintenance (O&M) costs for an LFG to electricity facility, on which we based the following factors:

- **LFG Collection System O&M:** Total number of gas wells per cell x USD \$2,318 per well per year; and
- **LFG Power Generation System O&M:** Power generation kW capacity x USD \$180 per kW per year.

Figure B-1: Bases for Calculation of Operations and Maintenance Cost (O&M)

North Cell						USD	Pesos
LFG Collection System	Total Wells	O&M/Well/Yr	Wells O&M/Yr	Blower O&M	Flare O&M	Total O&M / Yr	Total O&M / Yr
	12.4	\$ 2,318	\$ 28,633	\$ 45,835	\$ 4,635	\$ 79,103	\$ 142,385,921
LFG Power Generation System	Engines	MW [a]	kW [a]	O&M/kW [c]		Total O&M / Yr	Total O&M / Yr
	2.0	3.2	3200.0	\$ 180		\$ 576,000	\$ 1,036,800,000
					North Cell Total	\$ 655,103	\$ 1,179,185,921
Central Cell						USD	Pesos
LFG Collection System	Total Wells	O&M/Well/Yr	Wells O&M/Yr	Blower O&M	Flare O&M	Total O&M / Yr	Total O&M / Yr
	54.4	\$ 2,318	\$ 125,986	\$ 45,835	\$ 4,635	\$ 176,456	\$ 317,621,653
LFG Power Generation System	Engines [b]	MW [a]	kW [a]	O&M/kW [c]		Total O&M / Yr	Total O&M / Yr
	1.0	1.6	1600.0	\$ 180		\$ 288,000	\$ 518,400,000
					Central Cell Total	\$ 464,456	\$ 836,021,653
Project Total (North Cell + Central Cell)						\$ 1,119,560	\$ 2,015,207,574

[a] Installed generating capacity .

[b] Additional engines for Central Cell.

[c] USEPA LMOP LFG Project Development Handbook; Chapter 3.

C. Summary

The **capital cost estimate** for the LFGE Facility is:

- **Total** **\$13.8 Million**

This amount is planned to be invested in two segments, or "tranches":

- **Tranche 1 (in Year 1):** **\$ 9.4 Million**
- **Tranche 2 (in Year 10):** **\$ 4.4 Million.**

Tranche 1 includes 2 generation modules and 70% of the collection system for North Cell.

Tranche 2 includes 1 additional generation module and 100% of the collection system for Central Cell.

A detailed use of capital over time is provided in the financial modeling in Task 8.

The estimate of **operations and maintenance (O&M) costs** for the LFG Facility are:

- **Total Annual Maximum:** **\$1.1 Million**

This annual amount is budgeted over time as a function of kWh produced as follows:

- **From Year 1 to Year 9:** **from \$300 Thousand increasing to \$800 Thousand**
- **From Year 10 to Year 18:** **from \$900 Thousand to \$1.1 Million.**
- **From Year 18 to Year 20:** **from \$1.0 Million to \$950 Thousand.**

The period during which the capital investment takes place is from year 1 to year 20, when the Central Cell gas collection system is completed. However, the gas collection systems in the North Cell and the Central Cell will require operations and maintenance for a period after installation of their gas systems is completed. The projection of operational costs over the years is detailed in Task 8.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 6 Report:
Preliminary Environmental Analysis**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

in association with:

Quality & Evolution S.A.

October 20, 2011

The contents of this Task 6 Report are listed below:

Task 6 Report Contents

Section	Title
A	Environmental Impacts
B	Applicable Regulations
C	Carbon Credits
D	Conclusions

A. Environmental Impacts

The technical configuration selected in Task 4 for the energy recovery project consists of the generation of electric power through utilization of thermal energy from combustion of biogas captured in the site landfill. This gas is the product of biological decomposition of organic materials in the waste deposited in the landfill. The existing gas flare will be retained as a backup mechanism during repairs or shutdowns of the landfill gas to energy (LFGE) system.

The project equipment will be housed in up to four equal sized modules of 1.6 MW generating capacity each. Modules will be brought online gradually, as landfill gas flow increases over time, and greater generating capacity is required.

Below are described the types of impacts that the project could potentially originate.

A1. Net Water Use and Water Balance

The landfill gas cleaning equipment includes controls for metering the flow of landfill gas entering the treatment system. Landfill gas is composed of methane (CH_4), carbon dioxide (CO_2), and traces of other gases such as water vapor, hydrogen sulfide (H_2S), nitrogen, hydrogen, and oxygen. In addition, siloxanes, chemical commonly used in household detergents and shampoos, are normally present.

Gas cleaning consists of various methods for removing these non-methane compounds. None of the gas cleaning methods calls for a net consumption of water. Gas cleaning equipment generally requires only power consumption as an input. Removed components often form a gel type non-hazardous residue in small quantities, which can be disposed in the landfill. Gas cleaning equipment does not generate any liquid discharges that must be managed separately.

A2. Atmospheric Emissions

The project's atmospheric emissions would not increase the greenhouse gas (GHG) emissions generated currently by the gas flaring operation. On the contrary, with gas cleaning equipment installed, a reduction in emissions is foreseen. Sulfur (as present in hydrogen sulfide) should be reduced through gas cleaning, and optimization of gas combustion (higher destruction efficiency of methane) through greater removal of carbon dioxide and water vapor) will reduce methane emissions below present levels.

A3. Noise

The noise from the power generating modules originates primarily with the engine, the exhaust flow, and to a lesser extent, from the gas blower that feeds the power generating equipment. Higher gas flow, power generation, and greater load on the engines generally increase noise levels.

From our research and experience, the noise level from internal combustion engines of this type varies between 95 and 115 dB (decibels), and it has been observed that noise levels from gas-fired internal combustion engines are lower than for internal combustion engines utilizing liquid diesel fuels. The noise levels from engines are generally similar among engine manufacturers, since allowable noise level standards must be met by all manufacturers.

The noise level should increase, as would be expected, as the number of modules is increased. However, the increase is not linear with the number of engines (not additive of each engine's noise level), as shown in **Figure A-1**.

Figure A-1: Increase in Noise Level as a Function of Number of Modules

Number of Modules	Increase in Noise Level	Human Perception of Increase
1	Base Noise Level for One Module	-
2	+ 3 dB	Barely Noticeable
4	+ 6 dB	Clearly Noticeable
10	+ 10 dB	Double the Noise Level

Source: <http://www.generatornoise.com>

Based on the foregoing, the noise levels **within** the prefabricated structures are anticipated to be between 90 and 109 dB with one module in operation, and in the range between 96 and 115 dB with four modules in operation. These values should be validated during detailed design and final equipment selection.

The national standard for noise emissions and environmental noise is Resolution 0627 of 2006 from the Ministry of Environment, Housing, and Territorial Development. In Article 9 are defined the maximum permissible noise emissions, expressed in perceived decibels (dB(A)), as presented in **Figure A-2** below.

**Figure A-2: Maximum Permissible Levels of Noise Emission Standards Expressed in Decibels
Db(A)**

Sector	Subsector	Maximum Permissible Levels of Noise Emission Standards (dB(A))	
		Day	Night
Sector A. Tranquility and Silence	Hospitals, libraries, day-care centers, sanatoriums, geriatric centers.	55	50
Sector B. Tranquility and Moderate Noise	Residential areas or areas exclusively designed for housing development, hotels and lodging.	65	55
	Universities, colleges, schools, study and research centers.		
	Parks in urban areas different than outdoor mechanical parks.		
Sector C. Restricted Intermediate Noise	Permitted industrial areas: industry in general, port areas, industrial parks, free zones.	75	75
	Permitted commercial areas: shopping centers, shops, stores or commercial facilities, mechanic workshops, sports and recreation centers, gyms, restaurants, bars, taverns, night clubs, bingo, casinos.	70	60
	Permitted office use areas.	65	55
	Permitted institutional use areas.		
	Areas for other related use: outdoor mechanical parks, areas for outdoor public entertainment.	80	75
Sector D. Suburban or Rural Area. Tranquility and Moderate Noise	Suburban residential area.	55	50
	Rural inhabited area intended for farming.		
	Recreation and rest areas: natural parks and reserves.		

Nevertheless, the CIS El Guacal is located in a rural or suburban zone, so that the applicable norms would be those applicable to this type of zone. In this case, the noise emissions at the boundaries of the site should not exceed 55 dB(A) during daylight hours, and should not exceed 50 dB(A) during nighttime hours.

Given that the above noise levels are those inside the prefabricated module structures, the noise levels outside the prefabricated structures, will not exceed the allowable noise levels for either workers or neighbors of the site. Workers temporarily entering the prefabricated structures while the generating equipment is operating should wear ear protection.

Landfill gas powered internal combustion engines are used in hundreds of landfill projects worldwide, without impact on workers or neighbors.

A4. Solid Waste

Residues from the gas cleaning equipment will be disposed in the main landfill, since neither the filters or activated carbon (which could be used for removal of sulfur compounds, carbon dioxide, water, or siloxanes) constitute a hazardous waste or special handling waste. These chemical components do not fit within the definition of such wastes, as defined in Law 1252 of 2008 of the Congress of the Republic of Colombia, Decree 4741 of 2005 from the Ministry of Environment, Housing, and Territorial Development, and Resolution 2309 of 1986 from the Ministry of Social Protection of Colombia.

B. Applicable Regulation

According to Decree 2820 of 2010 from the Ministry of Environment, Housing, and Territorial Development, through which environmental licenses are regulated in Colombia, only those projects require an environmental license through the Ministry of the Environment, Housing, and Territorial Development that could be classified in any of the following categories:

- (a) Construction and operation of generating power plants with installed capacity above 100 MW;
- (b) Projects over 3 MW installed capacity that explore or utilize sources of alternative energy that are virtually contaminating;
- (c) Projects that require installation of transmission lines in the national interconnected system with substation voltages equal to or greater than 220 kV.

Considering that the project does not fall within any of the categories stipulated under Decree 2820 of 2010 from the Ministry of Environment, Housing, and Territorial Development, it is concluded that the project does require an environmental license. This means that the permitting of the project may be processed through Corantioquia, and not through the Ministry of Environment, Housing, and Territorial Development.

In the remainder of this section, we analyze the permits for utilization of natural resources that should be process through Corantioquia, and the relation with the existing environmental license that authorizes operation of the landfill and other activities being accomplished within the site.

B1. Environmental License for the Centro Industrial Sur (CIS) El Guacal

Through Resolution 7529 of 12 January 2005, Corantioquia issued to EVAS an environmental license for construction and operation of the CIS El Guacal, which must comply with all provisions of the environmental management plan, to mitigate, prevent, correct, and compensate environmental effects of the existing project.

Considering that the landfill gas energy recovery project does not require modification of the landfill conditions recognized within the current environmental license, it is concluded that the new project does not require a modification of the environmental license.

Decree 2820 of 2010 from the Ministry of Environment, Housing, and Territorial Development mentions reasons for which environmental licenses must be modified:

1. When the holder of the environmental license proposes to modify the project, works, or activity in a manner in which environmental impacts additional to those identified in the existing license will be generated.
2. When the issuance of the existing license did not contemplate the use, utilization, or impact on renewable natural resources necessary or sufficient for the proper development and operation of the project.
3. When it is proposed to change the conditions of use, utilization, or impact on a renewable natural resource in a manner that generates a greater impact on these resources than that impact that is recognized in the existing license.
4. When the owner of the project, works, or activity proposes to increase or reduce the licensed land area or to expand the licensed area into adjacent zones.
5. When the proposed project, works, or activity changes the applicable environmental authority as a result of a change in operational volume, depth, production, voltage level, or other characteristics of the project.
6. When, as a result of monitoring, the authority identifies environmental impacts additional to those identified in the environmental studies used to issue the existing license.
7. When the subject land areas covered by the existing license are not applicable and these subject areas are returned to the environmental authority by the license holder.
8. When it is proposed that the existing license be merged with another environmental license.

Considering these regulatory provisions and that the activity, rather than generate greater environmental impacts, will improve landfill operational conditions and diminish environmental impacts, it is considered that the existing license will not require modification.

As a result, it is recommended that:

- Advise Corantioquia regarding the implementation of the landfill gas energy recovery project, ensuring, beforehand, that EVAS has been able to reach compliance with the obligations imposed by Corantioquia recent administrative actions; according to Corantioquia personnel, no new activities will be authorized until each and every activity in the environmental management plan has been implemented. It is important to note that Corantioquia, through Resolution 5742 of 04 November 2010, imposed preventive measures on EVAS, based on non-compliance with measures and obligations stipulated in the existing environmental license.

- Present the project as an improvement and optimization of the existing landfill, in order to avoid potential incompatibilities with the land use defined in the Territorial Land Use Plan of the municipality of Heliconia (Esquema de Ordenamiento Territorial del municipio de Heliconia). This plan establishes that the Monteadentro sector (including the Chorrera trail) is ratified as a site or place in which solid waste handling and disposal may be accomplished as part of the CIS El Guacal project. As a result, if the new project is presented as an independent energy recovery project, there could arise an incompatibility with the land use already defined by the municipality.

B2. Atmospheric Emissions Permitting

Currently the landfill has a generic atmospheric emissions permit, which addresses the various activities conducted there. Decree 948 of 1995 from the Presidency of the Republic of Colombia, which regulates the issuance of emissions permits, establishes in its Article 73 those cases in which an atmospheric emissions permit is required, among them item k) "Operation of Thermolectric Plants". However, there are exceptions, as defined in the fourth and fifth paragraphs:

- **Fourth Paragraph:** Expansions or modifications of facilities that have an atmospheric emissions permit; when the proposed technical specifications or technical characteristics, architectural characteristics, or urban characteristics introduce substantial changes to the emissions conditions or the dispersion of emitted contaminating substances, or when the proposed changes have the effect of adding new contaminants to existing emissions, or increase the amount of these, will require a modification of the existing permit.
- **Fifth Paragraph:** (Paragraph added by Article 3 of Decree 1697 of 1997; text follows): Boilers or furnaces that utilize natural gas or liquified petroleum gas, in an industrial or commercial establishment, for the operation of thermal power plants with boilers, turbines or motors, do not require an atmospheric emissions permit.

As a result of the above, there would be two possibilities under which it would not be necessary to obtain an emissions permit:

- That the energy recovery project does not invoke changes that are significant or substantial to the emissions or dispersion conditions for contaminants currently emitted by the existing landfill gas capture and flaring system; or
- That the landfill gas produced by the landfill is considered similar to natural gas, and as a result, its utilization would coincide with the definition in the fifth transcribed paragraph, thereby being exempted from the need to obtain an emissions permit.

Nevertheless, it is important the EVAS present the project to Corantioquia and make a detailed description of the project and the technology that will be used, with the intent of avoiding the stipulation by the environmental agency that no environmental permit be needed additional to the existing ones.

C. Carbon Credits

In this section, we present an estimate of the reduction in Green House Gas emissions and the generation of carbon credits resulting from the landfill gas energy recovery project at CIS El Guacal. It is important to note that a clean development mechanism (CDM) registered and operating at the landfill, which is the flaring of the landfill gas. This existing project is claiming carbon credits for avoidance of methane emissions, which, without the flaring project, would be emitted to the atmosphere. As a result, the new energy recovery project cannot claim these methane emission credits, but the new project can claim those credits arising from the power generation fossil fuel emissions avoided, which are proportionate to the power exported to the national grid.

C1. Calculation of Carbon Credits

In order to estimate the value of the carbon credits generated, the plant generation in MWh for a period of 20 years (2012-2031) is projected in **Figure C-1**.

The implemented emission factor for the entire Sistema Interconectado Nacional (SIN) or National Interconnected System, as generated by the Energy and Mining Planning Unit for greenhouse gas emissions from power generation (please see Resolution 180947 of 2010 from the Ministry of Mines and Energy) is 0.2849 tons CO₂e/MWh. It is assumed that this factor remains stable over the analysis period (2011-2035). The notation "CO₂e" represents the equivalent (hence the use of the letter "e" in the notation) tons of carbon dioxide avoided.

Figure C-1: Fossil Fuel Avoidance Carbon Credits

Año	Plant Generation Capacity (MW)	Annual Energy Production (MWh/año)	Avoided Emissions (ton CO2e/yr)
		B=A*8760 hours/year	C=B*0.2849 tons CO2e/MWh
2011	1.5	Base	Base
2012	1.88	16,469	4,692
2013	2.51	21,988	6,264
2014	2.78	24,353	6,938
2015	2.88	25,229	7,188
2016	2.99	26,192	7,462
2017	3.03	26,543	7,562
2018	3.07	26,893	7,662
2019	3.2	28,032	7,986
2020	3.33	29,171	8,311
2021	3.38	29,609	8,436
2022	3.51	30,748	8,760
2023	3.64	31,886	9,084
2024	3.78	33,113	9,434
2025	3.84	33,638	9,583
2026	3.97	34,777	9,908
2027	4.11	36,004	10,258
2028	4.44	38,894	11,081
2029	4.26	37,318	10,632
2030	3.51	30,748	8,760
2031	2.94	25,754	7,337
			167,339

The results presented in Figure C-1 show that the carbon credits generated at the end of 20 years would total **167 thousand tons of CO₂e**. This represents an annual average of 8,350 carbon credits annually. The price of carbon credits is variable and is determined by supply and demand. It is important to note that in December 2012 the first period of the Kyoto Protocol will expire. As a result, at the time of preparation of this study, the carbon credit market conditions that will prevail after 2012 are unknown.

C2. Potential for Generating Carbon Credits under the Kyoto Protocol Clean Development Mechanism

To determine if the energy recovery project can generate carbon credits under the Clean Development Mechanism (CDM) of the Kyoto Protocol, it is necessary to consider that a registered and validated CDM project for EVAS contractor GreenGas already exists for the flaring of landfill gas. In this sense, the energy recovery project would modify the existing registered project, and, as such, it is necessary to determine if it is possible to modify the existing gas flaring project in order to install the energy recovery modules.

According to the methodologies and procedures established for CDM projects by the UNFCCC (United Nations Framework Convention on Climate Change), it is not possible to have two independent CDM projects in this case, since the GreenGas flaring operation would be replaced by the internal combustion engines. By definition, the limits of the project are established considering the equipment and activities under the control of the participants. In this case, GreenGas would lose "control" of the equipment in which the destruction of the methane from landfill gas takes place. In conclusion, the only alternative would be to "modify" the existing project registered previously by GreenGas by adding to the project the energy recovery equipment and activities.

The CDM rules contemplate a procedure for evaluating the changes that the verifying entity observes in the process of verification, with respect to the Project Design Document (PDD) previously registered. The procedure for notification and approval of the changes to the activities of the project are established in Annex 66 of session 48 of the CDM Executive Council. This procedure establishes that the appropriate agency for notification of changes to the Executive Council is the Designated Operating Entity (DOE) contracted by the existing project participants (GreenGas and EVAS) for the CDM verification of the project. Said DOE, before sending the report on the issuance of credits, should evaluate in the first place if the change (in this case the replacement of the gas flare with energy recovery equipment) impacts any of the following aspects:

- To what extent the new equipment is additional to the existing equipment ("Additionality")
- Scale of the Project

- Applicability of the methodology of the baseline and monitoring of the project under which the project was registered.

Accordingly, there are two alternatives:

- **Alternative 1:** If, in the judgment of the DOE, the change does not impact any of the above listed aspects, the DOE will notify the Executive Council. Within 10 business day after receipt of such notice, the Secretariat prepares an evaluation of the notification, informing the Chairperson of the Executive Council whether the changes are acceptable and whether the issuance of credits is authorized. In this case, the PDD should be modified to include the changes and published to serve as a basis for subsequent verifications. In the event that the Secretariat does not consider the changes acceptable, the case will be considered by the Executive Council during its next session.
- **Alternative 2:** If, in the judgment of the DOE, the change impacts any of the above listed aspects, the DOE sends a request for approval of changes to the Executive Council. Said request is evaluated by a member of the Registration and Issuance Team, who evaluates the request and sends a report to the Executive Council. The Executive Council will decide whether to approve the request for issuance of credits, limit the amount of credits to issue, or not approve the issuance of credits for the project.

The modifications that the energy recovery project would bring about to the project previously registered by GreenGas could affect the additionality of the project, and as a result Alternative 2 as described above would follow, since the power generation equipment would replace the gas flare as the primary means of methane destruction.

For this reason, it is necessary to take into account the participation and approval of GreenGas for the modification of the existing CMD project.

D. Conclusions

- The landfill gas energy recovery project at the CIS El Guacal does not have major environmental impacts that negatively affect the community, the workforce, or the environment in general.
- Because of the characteristics of the energy recovery project, it should not be necessary to obtain an Environmental License from the Ministry of Environment, Housing, and Territorial Development, nor a modification of the existing Environmental License through Corantioquia. Nevertheless, it is important that EVAS present the project to Corantioquia and submit a detailed description of the project, with the intent that Corantioquia arrives at a clear understanding of the project and does not determine that additional environmental permitting is required for the project.
- It is necessary for EVAS to enter into compliance with conditions recently stipulated by Corantioquia and notified by means of Resolution 5742 issued by Corantioquia on November 4, 2010, in order to correct certain unfavorable conditions identified in the landfill.
- It is suggested that the energy recovery project be presented as an improvement activity and an optimization of the existing landfill, in order to avoid potential incompatibilities with the municipality of Heliconia Land Use Plan.
- The energy recovery project constitutes a modification of the CDM gas flaring project already registered jointly by GreenGas and through a Designated Operating Entity (DOE); therefore, it is necessary to follow the procedures for such a modification, if the energy recovery project is to claim carbon credits for fossil fuel avoidance.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

Task 7 Report: U.S. Sources of Supply

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

October 12, 2011

The contents of this Task 7 Report are listed below:

Task 7 Report Contents

Section	Title
A	U.S. Sources of Supply
B	Conclusions

A. U.S. Sources of Supply

A1. Supply Scope

The selected technical configuration is to divert landfill gas from the existing flare to utilize this gas as a fuel in internal combustion engines with integral generators in modules of 1.6 MW each. The existing landfill gas flare will be left in place as a backup during engine-generator maintenance down time.

The project would be implemented in two phases, labeled here and in Task 8 as "tranches" of capital investment:

1. **Tranche 1** beginning in 2011 (sequential Year 1): Electrical generation system consisting of 2 modules of 1.6 MW each.
2. **Tranche 2** beginning in 2020 (sequential Year 10): One additional module of 1.6 MW.

Please note that Task 8 contains a detailed projection of capital use over time.

Figure A-1 presents estimates of the percentage of the capital investment that would come from US sources. **Approximately USD\$ 10.5 Million of the total capital investment ("capex") estimate of USD\$ 13.0 Million would be sourced from the United States.** This estimate may be slightly modified during the remaining tasks of this feasibility study. The amounts in Figure A-1 exclude working capital, since the eventual use or sourcing of working capital is not known beforehand.

As was observed in Task 4, the implementation of Tranche 2 could be accelerated if the CIS El Guacal MSW intake tonnage increases beyond the minimum tonnages projected in Task 3. An increase from 650 TPD to approximately 900 TPD has been observed during the months of June and July 2011, during the preparation of the Task 3 report. To date, this feasibility study has been based on the conservative position that intake MSW tonnage will not decrease below 650 TPD as a minimum. EVAS believes that tonnage intake henceforth will remain at least at 900 TPD. A sustained increase to the level of 900 TPD would be an important economic boost to the project, since the production of landfill gas (and the generation of electricity) would increase by approximately 25%. This "Base Case" and this "High Case" are dealt with in Task 8.

For Tranche 1, the scope of work (but not the capital investment estimate) excludes the landfill gas collection system, which is currently being installed by a contractor to EVAS (in this case, GreenGas). Therefore, Tranche 1 should include the following major systems:

- **Piping from the area of the existing flare to the landfill gas cleaning equipment**
- **Landfill gas cleaning equipment**
- **Engine-generator sets or modules**

- Electrical connection from the modules to the step-up transformer at the new CIS El Guacal substation.

Figure A-1: Estimated US Sourcing

Tranche 1	Estimated Sourcing			
	Local	US	Percent US	
LFG Collection System	\$ 688,643	\$ 137,729	\$ 550,914	80%
LFG Power Generation System	\$ 5,440,000	\$ 272,000	\$ 5,168,000	95%
Civil Works	\$ 75,000	\$ 75,000	\$ -	0%
Project Soft Costs	\$ 1,012,535	\$ 405,014	\$ 607,521	60%
Contingency	\$ 556,894	\$ 167,068	\$ 389,826	70%
Working Capital	\$ 1,043,999	\$ 939,599	\$ 104,400	10%
Total Tranche 1	\$ 8,817,071	\$ 1,996,410	\$ 6,820,661	77%

Tranche 2	Estimated Sourcing			
	Local	US	Percent US	
LFG Collection System	\$ 944,201	\$ 188,840	\$ 755,361	80%
LFG Power Generation System	\$ 2,720,000	\$ 136,000	\$ 2,584,000	95%
Civil Works	\$ -	\$ -	\$ -	0%
Project Soft Costs	\$ -	\$ -	\$ -	60%
Contingency	\$ 556,894	\$ 167,068	\$ 389,826	70%
Working Capital	\$ -	\$ -	\$ -	10%
Total Tranche 2	\$ 4,221,096	\$ 491,909	\$ 3,729,187	88%

Total CAPEX	\$ 13,038,167	\$ 2,488,319	\$ 10,549,848	81%
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In meetings with IDEA and EVAS, it has been anticipated that the project will be implemented on a "Turnkey" basis (one direct contractor). Therefore, proposals would be requested from suppliers for Tranche 1 for the selected single contractor to accomplish the following Turnkey services, also called an EPC (Engineering-Procurement-Construction) scope of work:

- Engineering (including detailed design)
- Procurement (including logistics for importation and in-country transport of the equipment)
- Construction (includes civil works and equipment installation).

Other project features are:

- Consistent with the goals of USTDA to maximize the participation by United States suppliers, proposals will be requested only from U.S. suppliers.
- The EPC Turnkey contractor will probably utilize local subcontractors for the civil works of the project.
- It should be required that the EPC Turnkey contractor guarantee the performance of the system once it is installed. The performance of the system is confirmed during several weeks of testing near the end of the EPC scope.

For the Turnkey project mode, there are two types of providers that could provide the required scope:

- Consulting / engineering firms; or
- Primary equipment (engine-generator sets or modules) suppliers (manufacturers).

We recommend that proposals for a single EPC contractor be requested from primary equipment suppliers rather than from consulting / engineering firms. The reasons for this recommendation are:

- The primary equipment will account for a high percentage of the capital investment in Tranche 1 (and Tranche 2). Consulting/engineering firms are very likely to add a margin to the cost of the primary equipment additional to the margin normally added by the primary equipment manufacturer (since the consulting/engineering firm becomes a middle man provider). This could significantly increase the cost of the project.
- Primary equipment suppliers have direct control over equipment performance, and as such would have a tendency to provide more rigorous performance guarantees.

A2. U.S. Suppliers

Figure A-2 presents the four U.S. suppliers of primary equipment (engine-generator sets or modules), as well as contact information for each company. These suppliers should be in a position to submit proposals for an EPC Turnkey scope of work for the project:

- **Caterpillar, Inc. (Indiana)**
- **Cummins Inc. (Indiana)**
- **Curtis Engine & Equipment Inc. (Maryland)**
- **GE Waukesha (Wisconsin)** (subsidiary of General Electric)

Other suppliers with offices in the United States exist, but their manufacturing facilities are outside the U.S. **It is recommended that during implementation, proposals be requested from those suppliers listed in Figure A-2.**

Figure A-2: United States-Based Primary Equipment Manufacturers

Company	Name	Title	Contact Information		
			Email	Phone	Fax
Caterpillar, Inc.	Tom Lee	Senior Product Consultant	leej@cat.com	Phone: 765-448-5552	Fax: 765-448-5985
Cummins Inc.	Curt Chesler	Account Manager	Curt.Chesler@cummins.com	Phone: 702-399-2339	Fax: 702-399-2614
Curtis Engine & Equipment Inc.	Tony Janotta	Sales Engineer	Jannotta.tony@curtisengine.com	Phone: 410-536-1203	Fax: 240-209-0776
GE Waukesha Gas Engines	Aaron P. Trexler	Product Line Leader	aaron.trexler@ge.com	Phone: 262-549-2995	Fax: 262-650-5650

B. Conclusions

- In meetings with IDEA and EVAS, it has been anticipated that the project will be implemented on a "Turnkey" basis (one direct contractor). Therefore, proposals would be requested from suppliers for Tranche 1 to accomplish the following Turnkey services, also called an EPC (Engineering-Procurement-Construction) scope of work:
 - Engineering (including detailed design)
 - Procurement (including logistics for importation and transport of the equipment)
 - Construction (includes civil works and equipment installation).
- Other project features are:
 - Consistent with the goals of USTDA to maximize the participation by United States suppliers, proposals will be requested only from U.S. suppliers.
 - The EPC Turnkey contractor will probably utilize local subcontractors for the civil works of the project.
 - It should be required that the EPC Turnkey contractor guarantee the performance of the system once it is installed. The performance of the system is confirmed during several weeks of testing near the end of the EPC scope.
- Approximately USD\$ 10.5 Million, of the overall Tranche 1 and Tranche 2 total capital investment ("capex") of USD\$ 13.0 Million would be sourced from the United States. This estimate may be slightly modified during the remaining tasks of this feasibility study, with the final estimate appearing in the final report.
- We recommend that proposals be requested from primary equipment suppliers. The reasons for this recommendation are:
 - The primary equipment will account for approximately 90% of the capital investment in Tranche 1, since Tranche 1 will exclude the landfill gas collection system.
 - Consulting firms may have a tendency to add a margin to the cost of the primary equipment higher than the margin that would be added by the primary equipment manufacturer.
 - Primary equipment suppliers have direct control over equipment performance, and as such would have a tendency to provide more rigorous performance guarantees.
- The following suppliers with applicable manufacturing facilities in the United States should be in a position to submit proposals for an EPC Turnkey scope of work for the project:

- Caterpillar, Inc. (Indiana)
- Cummins Inc. (Indiana)
- Curtis Engine & Equipment Inc. (Maryland)
- GE Waukesha (Wisconsin) (subsidiary of General Electric).

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 8 Report:
Financial Evaluation**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

20 October, 2011

The contents of this Task 8 Report are listed below:

Task 8 Report Contents

Section	Title
A	Projection Basis: Base Case and High Case
B	Investment Cost
C	Financing Assumptions
D	Operating Cost
E	Revenue
F	Cash Flow
G	Profitability Analysis
H	Conclusions

Please note that all monetary amounts presented in this Task 8 Report are presented in United States dollars, unless designated as Colombian pesos in specific instances.

A. Projection Basis: Base Case and High Case

As discussed in Tasks 1, 3, and 4, tonnage supply to the CIS El Guacal landfill is reliable over the long term and unlikely to drop below 650 tons per day and likely to increase over time at a rate of approximately 1.5 percent per year.

During the initial months of 2011 through May 2011, tonnage intake was on the order of 650 tons per day. However, during June, July, and August 2011, during the preparation of this study, EVAS reports that tonnage intake has increased to the level of approximately 900 tons per day.

EVAS reported in September that this recent increase has been achieved as a result of discussions with CIS El Guacal landfill users, in which one or more users have been persuaded to maximize their deliveries under their existing contractual agreements. This recent sudden increase in tonnage is a positive economic development for the Landfill Gas to Energy (LFGE) project at the CIS El Guacal, as explained in this Task 8.

In summary, we believe that:

- The recent increase to the 900 TPD level is likely, but not assured, to continue over the long term.
- Since we do not have complete certainty that the increase to the 900 TPD level will in fact continue over the long term, we believe there is some probability that deliveries could return to the 650 TPD level observed during 2010 and the first five months of 2011.

Therefore, we believe that this Task 8 financial evaluation should consider the following two cases:

- **Base Case (this can be considered a "low" case):** 650 TPD in 2011 and increasing by 1.5% annually thereafter; and
- **High Case:** 900 TPD in 2011 and increasing by 1.5% annually thereafter.

The USEPA-LMOP 2010 study, based on EVAS projections, in effect projects the High Case for deliveries of MSW to the CIS El Guacal.

In the High Case, significantly more landfill gas is generated, on the order of 25% more per year, since tonnage in place is approximately 25% more than in the Base Case. This requires, as explained below:

- Earlier investments for some project components;
- The addition of a fourth module during the 20 year financial projection horizon; and
- Generation of significantly more power (and therefore power sales revenue) each year.

Figure A-1 (based on Figure C-1 from Task 4) shows the two cases and their effect on power generation requirements. The main points of comparison between the two cases, which are incorporated into the financial models in this Task 8, are:

- **Module D (fourth Module):** Installed in Year 13 (High Case) instead of never (Base Case); the year in which Module D (fourth module is installed in Year 13 for High Case only) is highlighted in aqua in Figure A-1;
- **Module C (third module):** Module C is installed in both cases in Year 10 and is highlighted in yellow on Figure A-1;
- **North Cell depleted in Year 4 (High Case) instead of Year 5 (Base Case):** This means that the investment for the LFG collection system for Central Cell begins in Year 4 (High Case) instead of Year 5 (Base Case).

Figure A-1: Projected Power Generation: Base Case and High Case

Year: Sequential Year	Active Cell	Year: Calendar	Disposal Rate (tons/day)	Disposal Rate (tons/yr)	A	B	Projection Adjustment	High Case			Base Case		
								USEPA-LMOP 2010 Study Max Recovery Scenario			Cambridge Adjusted Projection from Task 4		
								D	D1	D2	G = C * D	G1	G2
1	North Cell	2011	650	237,405	1,007,385	1,238,080	81%	1.5	2.0	3.2	1.2	2.0	3.2
2		2012	660	240,967	1,248,352	1,576,480	79%	2.0	2.0	3.2	1.6	2.0	3.2
3		2013	670	244,581	1,492,933	1,919,980	78%	2.8	2.0	3.2	2.2	2.0	3.2
4		2014	680	248,250	1,741,183	2,268,680	77%	3.2	3.0	4.8	2.5	2.0	3.2
5		2015	690	251,973	1,993,156	2,622,580	76%	3.4	3.0	4.8	2.6	2.0	3.2
6		2016	700	255,753	2,248,909	2,981,780	75%	3.6	3.0	4.8	2.7	2.0	3.2
7		2017	711	259,589	2,508,497	3,346,380	75%	3.7	3.0	4.8	2.8	2.0	3.2
8		2018	722	263,483	2,771,980	3,716,480	75%	3.8	3.0	4.8	2.8	2.0	3.2
9		2019	732	267,435	3,039,415	4,092,180	74%	4.0	3.0	4.8	3.0	2.0	3.2
10		2020	743	271,446	3,310,862	4,473,480	74%	4.2	3.0	4.8	3.1	3.0	4.8
11	Central Cell	2021	754	275,518	3,586,380	4,860,480	74%	4.3	3.0	4.8	3.2	3.0	4.8
12		2022	766	279,651	3,866,031	5,253,280	74%	4.5	3.0	4.8	3.3	3.0	4.8
13		2023	777	283,846	4,149,876	5,651,980	73%	4.7	4.0	6.4	3.5	3.0	4.8
14		2024	789	288,103	4,437,980	6,056,880	73%	4.9	4.0	6.4	3.6	3.0	4.8
15		2025	801	292,425	4,730,405	6,467,480	73%	5.0	4.0	6.4	3.7	3.0	4.8
16		2026	813	296,811	5,027,216	6,884,480	73%	5.2	4.0	6.4	3.8	3.0	4.8
17		2027	825	301,263	5,328,480	7,307,780	73%	5.4	4.0	6.4	3.9	3.0	4.8
18		2028	837	305,782	5,634,262	7,400,000	76%	5.6	4.0	6.4	4.3	3.0	4.8
19		2029	850	310,369	5,944,631	7,400,000	80%	5.1	4.0	6.4	4.1	3.0	4.8
20		2030	863	315,025	6,259,656	7,400,000	85%	4.0	4.0	6.4	3.4	3.0	4.8

B. Investment Cost

The investment cost estimate for the LFG Facility at CIS El Guacal was developed in Task 5-Preliminary Cost Estimates on the basis of per kW, per hectare, and other proven industry cost factors.

Please note that the Terms of Reference for Task 8 require financial projections to a time horizon of 10 years. For this Task 8, we have provided financial projections through 20 years. It is also noted that Central Cell would likely be depleted at some point around Year 23, so that the projections provided in this Task 8 are well within the useful life of Central Cell.

B1. Base Case

Figure B-1 presents the use of that capital investment estimate over time for the Base Case and over the two Tranches described in Task 5.

- **Tranche 1:** Installation of the remaining landfill gas collection system in North Cell and installation of the first two power generation modules (Modules A and B).
- **Tranche 2:** Installation of the landfill gas collection system in Central Cell and installation of the third power generation module (Module C), as well as potentially the installation of the fourth power generation module (Module D).

The Base Case total capital investment is estimated at USD\$ 13,295,676 and is composed of:

- **Tranche 1:** USD\$ 8.8 Million
- **Tranche 2:** USD\$ 4.5 Million

The **Tranche 1** capital investment estimate includes the following major components:

- **The first two LFGE modules (Modules A and B)** are acquired at an investment of: USD\$ 2.7 Million x 2 = USD\$ 5.4 Million in Year 1.
- **The completion of the (approximately 70%) remaining installation of the LFGE Collection System in the currently active North Cell** (beginning in Year 1 and continuing through Year 4 at an investment of approximately USD\$ 65 thousand per year). We have included the installation of the remaining part of the LFG Collection System in the North Cell in the capital investment estimate, even though this work is already contracted to GreenGas by EVAS and is underway. We feel that we are assuming a conservative perspective in this Task 8 financial evaluation by including the installation of the remaining LFG Collection System in the North Cell, even though this cost element would have occurred even if no energy recovery were implemented and gas flaring alone were to continue.

- USD\$ 577 Thousand of the **Soft Costs** (design, permitting, legal, financing costs, etc.) occurs in Year 1 to support implementation of Tranche 1.
- USD\$ 435 Thousand of the **Soft Costs** occurs in Year 5 to support implementation of Tranche 2.

The **Tranche 2** capital investment estimate includes the following major components:

- **A third (Module C)** is acquired at an investment of: USD\$ 2.7 Million in Year 10.
- **The installation of the LFG Collection System in Central Cell** beginning in Year 5 and continuing through Year 20 at an investment of approximately USD\$ 85 Thousand per year. Again, by including the LFG Collection System in the Tranche 2 capital investment estimate, we believe we are creating a conservative cost basis for this Task 8 financial evaluation, since it is virtually assured that the LFG Collection System would be installed in Central Cell even if no energy recovery project were implemented and flaring alone were to continue.

Figure B-1: Capital Investment and Use Over Time

Base Case

B2. High Case

Figure B-2 presents the use of that capital investment estimate over time for the High Case and over the two Tranches described in Task 5.

The High Case total capital investment is estimated at USD\$ 16.0 Million and is composed of:

- **Tranche 1:** USD\$ 8.8 Million
- **Tranche 2:** USD\$ 7.2 Million

The **Tranche 1** capital investment estimate use over time of USD\$ 7.2 Million for the High Case is similar to the Tranche 1 capital investment for the Base Case, but with the following difference:

- The completion of the (approximately 70%) remaining installation of the LFGE Collection System in the currently active North Cell begins in Year 1 and **continues only through Year 3 (instead of through Year 4 for the Base Case).**
- USD\$ 577 Thousand of the **Soft Costs** (design, permitting, legal, financing costs, etc.) occurs in Year 1 to support implementation of Tranche 1.
- USD\$ 435 Thousand of the **Soft Costs** occurs in Year 4 (instead of Year 5 for the Base Case) to support implementation of Tranche 2.
- **A fourth module (Module D) is acquired in Year 13 at an investment of USD\$ 2.7 Million.**

The capital investment amounts in Figures B-1 and B-2 are inputs to the financial projections shown in the remaining sections of this Task 8.

Figure B-2: Capital Investment and Use Over Time

High Case

C. Financing Assumptions

The capital repayment and interest payment projections are shown in **Figure C-1** for the Base Case and in **Figure C-2** for the High Case. The basic assumptions used for the financing and investment costs for the project, as discussed in mid September with IDEA and EVAS representatives, are:

- **Annual Interest Rate:** 7.0%
- **Equity Percentage:** 40% / **Debt Percentage:** 60%
- **Principal Repayment Period:** 10 years / **Loan Period:** 10 Years
- **Base Case Total Capital Investment:** USD \$13,295,676 made up of:
 - **Tranche 1:** USD\$ 8,817,071
 - **Tranche 2:** USD\$ 4,478,605.
- **High Case Total Capital Investment:** USD \$16,036,648 made up of:
 - **Tranche 1:** USD \$8,838,043
 - **Tranche 2:** USD \$7,198,605.

Based on meetings conducted with IDEA and EVAS during September 2011, we conclude that there exist various mechanisms and financing sources within Colombia that may be utilized to fund the project in a manner analogous to the manner in which previous energy projects sponsored by IDEA have been financed. However, in the event that it is determined that sources outside Colombia would be attractive, we present the following institutions, which have recently expressed their conceptual interest to Cambridge toward financing of renewable energy projects such as landfill gas to energy projects:

- International Finance Corporation (IFC) (part of the World Bank Group)
- Inter-American Development Bank (IADB)
- Overseas Private Investment Corporation (OPIC)
- United States Export Import Bank (EXIMBANK)
- European Investment Bank (EIB)

Figure C-1: Interest and Principal Payments

Base Case

	Tranche 1								
	1 2012	2 2013	3 2014	4 2015	5 2016	6 2017	7 2018	8 2019	9 2020
Capital Use	\$ 7,758,205	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Less Equity Use (40% Equity)	\$ 3,526,829	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Loan Facility Use in Specific Year	\$ 4,231,376	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Principal Payment	\$ 423,138	\$ 429,624	\$ 436,111	\$ 442,597	\$ 494,690	\$ 503,273	\$ 511,857	\$ 520,441	\$ 529,024
Interest Payment	\$ 296,196	\$ 271,117	\$ 245,584	\$ 219,597	\$ 225,080	\$ 196,460	\$ 167,240	\$ 137,418	\$ 106,996
Loan Balance	\$ 3,808,238	\$ 3,443,479	\$ 3,072,234	\$ 2,694,502	\$ 2,720,738	\$ 2,303,301	\$ 1,877,280	\$ 1,442,676	\$ 999,488
Total	\$ 719,334	\$ 700,741	\$ 688,181	\$ 655,708	\$ 719,770	\$ 699,734	\$ 679,097	\$ 657,859	\$ 636,020

	Tranche 2											
	10 2021	11 2022	12 2023	13 2024	14 2025	15 2026	16 2027	17 2028	18 2029	19 2030	20 2031	Total
Capital Use	\$ 3,362,731	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 8,817,071
Less Equity Use (40% Equity)	\$ 1,791,442	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,526,829
Loan Facility Use in Specific Year	\$ 1,571,289	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 5,290,243
Principal Payment	\$ 686,153	\$ 271,599	\$ 273,696	\$ 275,793	\$ 277,891	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382	\$ 4,290,754
Interest Payment	\$ 109,990	\$ 6,009	\$ 131,924	\$ 105,770	\$ 92,473	\$ 79,029	\$ 68,631	\$ 58,233	\$ 47,835	\$ 37,437	\$ 27,038	\$ 1,865,688
Loan Balance	\$ 1,884,624	\$ 1,698,861	\$ 1,511,002	\$ 1,321,044	\$ 1,128,990	\$ 980,445	\$ 831,900	\$ 683,355	\$ 534,809	\$ 386,264	\$ 386,264	\$ 22,361,937
Total	\$ 796,143	\$ 277,608	\$ 405,620	\$ 381,564	\$ 370,364	\$ 313,411	\$ 303,013	\$ 292,615	\$ 282,217	\$ 271,818	\$ 112,875	\$ 6,156,443

Figure C-2: Interest and Principal Payments

High Case

	Tranche 1								
	1 2012	2 2013	3 2014	4 2015	5 2016	6 2017	7 2018	8 2019	9 2020
Capital Use	\$ 7,758,205	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Less Equity Use (40% Equity)	\$ 3,535,217	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Loan Facility Use in Specific Year	\$ 4,222,987	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Principal Payment	\$ 422,299	\$ 428,785	\$ 435,272	\$ 487,364	\$ 495,948	\$ 504,532	\$ 513,115	\$ 521,699	\$ 530,283
Interest Payment	\$ 295,609	\$ 270,589	\$ 245,114	\$ 251,110	\$ 223,003	\$ 194,295	\$ 164,987	\$ 135,077	\$ 104,567
Loan Balance	\$ 3,800,689	\$ 3,436,769	\$ 3,066,362	\$ 3,099,923	\$ 2,689,812	\$ 2,271,117	\$ 1,843,838	\$ 1,407,975	\$ 963,529
Total	\$ 717,908	\$ 699,374	\$ 732,479	\$ 686,382	\$ 718,951	\$ 698,827	\$ 678,102	\$ 656,776	\$ 634,849

	Tranche 2											
	10 2021	11 2022	12 2023	13 2024	14 2025	15 2026	16 2027	17 2028	18 2029	19 2030	20 2031	Total
Capital Use	\$ 3,362,731	\$ 85,836	\$ 85,836	\$ 2,805,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 8,838,043
Less Equity Use (40% Equity)	\$ 2,879,442	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,535,217
Loan Facility Use in Specific Year	\$ 483,289	\$ 85,836	\$ 85,836	\$ 2,805,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 5,302,826
Principal Payment	\$ 578,611	\$ 164,896	\$ 166,993	\$ 441,091	\$ 397,582	\$ 397,582	\$ 397,582	\$ 397,582	\$ 397,582	\$ 397,582	\$ 397,582	\$ 4,339,296
Interest Payment	\$ 33,830	\$ 6,009	\$ 60,774	\$ 49,559	\$ 215,091	\$ 193,269	\$ 171,447	\$ 149,625	\$ 127,803	\$ 105,981	\$ 84,158	\$ 1,884,352
Loan Balance	\$ 868,207	\$ 789,147	\$ 707,990	\$ 3,072,736	\$ 2,760,990	\$ 2,449,245	\$ 2,137,500	\$ 1,825,755	\$ 1,514,009	\$ 1,202,264	\$ 930,264	\$ 22,580,013
Total	\$ 612,442	\$ 170,905	\$ 227,768	\$ 490,650	\$ 612,673	\$ 590,851	\$ 569,029	\$ 547,207	\$ 525,385	\$ 503,562	\$ 441,995	\$ 6,223,648

D. Operating Cost

The Operations and Maintenance (O&M) Costs presented in **Figure D-1** (Base Case) and in **Figure D-2** (High Case) below lists 4 line items:

- **LFG Collection System Tranche 1:** this O&M cost is associated with the gas collection wells, piping, and extraction blower for the North Cell. The period for operating North Cell collection system is 20 years. The LFG Collection System O&M costs are calculated on a per well basis as described in Task 5.
- **LFG Collection System Tranche 2:** this O&M cost begins in Year 5 in the Base Case (Year 4 for the High Case) when the new Central Cell begins to receive waste and collect gas. The LFG Collection System O&M costs are calculated on a per well basis as described in Task 5.
- **LFG Power Generation System:** this O&M cost is a variable cost that increases with power production and decrease as production is reduced. Power generation is higher in the High Case, so that this O&M cost is correspondingly higher than in the Base Case.
- **EPM Transmission Line Charge:** this cost item pays EPM for use of the new 44 kV transmission line and the new step-up transformers at the CIS El Guacal and at an existing EPM substation to be selected during the Connection Study required by EPM. This EPM charge is estimated as \$0.003 per kWh based on our experience with previous projects; our understanding is that this cannot be confirmed until the Connection Study is accomplished during project implementation.

Figure D-1: Operations and Maintenance Expense

Base Case

	Sequential Year		1	2	3	4	5	6	7	8	9
	Calendar Year		2012	2013	2014	2015	2016	2017	2018	2019	2020
LFG Collection System Tranche 1	\$ 1,582,066		\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103
LFG Collection System Tranche 2	\$ 2,823,304					\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456
LFG Power Generation System	\$ 11,287,854		\$ 285,070	\$ 391,899	\$ 442,073	\$ 465,119	\$ 488,732	\$ 499,244	\$ 510,169	\$ 534,771	\$ 559,522
EPM Transmission Line Charge	\$ 1,648,027		\$ 41,620	\$ 57,217	\$ 64,543	\$ 67,907	\$ 71,355	\$ 72,890	\$ 74,485	\$ 78,077	\$ 81,690
TOTAL	\$ 17,341,250										
	Annual Total		\$ 405,793	\$ 528,220	\$ 585,719	\$ 612,130	\$ 815,647	\$ 827,693	\$ 840,214	\$ 868,407	\$ 896,772

	Sequential Year		10	11	12	13	14	15	16	17	18	19	20
	Calendar Year		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
LFG Collection System Tranche 1	\$ 1,582,066		\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103
LFG Collection System Tranche 2	\$ 2,823,304		\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456
LFG Power Generation System	\$ 14,868,000		\$ 571,108	\$ 596,101	\$ 621,162	\$ 646,278	\$ 658,273	\$ 683,490	\$ 708,735	\$ 767,478	\$ 737,456	\$ 609,048	\$ 512,127
EPM Transmission Line Charge	\$ 2,170,728		\$ 83,382	\$ 87,031	\$ 90,690	\$ 94,357	\$ 96,108	\$ 99,790	\$ 103,475	\$ 112,052	\$ 107,669	\$ 88,921	\$ 74,771
TOTAL	\$ 21,444,097												
	Annual Total		\$ 910,049	\$ 938,691	\$ 967,411	\$ 996,194	\$ 1,009,940	\$ 1,038,839	\$ 1,067,771	\$ 1,135,089	\$ 1,100,684	\$ 953,528	\$ 842,457

Figure D-2: Operations and Maintenance Expense

High Case

	Sequential Year		1	2	3	4	5	6	7	8	9
	Calendar Year		2012	2013	2014	2015	2016	2017	2018	2019	2020
LFG Collection System Tranche 1	\$ 1,582,066		\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103
LFG Collection System Tranche 2	\$ 2,823,304					\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456
LFG Power Generation System	\$ 14,868,000		\$ 360,000	\$ 504,000	\$ 576,000	\$ 612,000	\$ 648,000	\$ 666,000	\$ 684,000	\$ 720,000	\$ 756,000
EPM Transmission Line Charge	\$ 2,170,728		\$ 52,560	\$ 73,584	\$ 84,096	\$ 89,352	\$ 94,608	\$ 97,236	\$ 99,864	\$ 105,120	\$ 110,376
TOTAL	\$ 21,444,097										
	Annual Total		\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936

	Sequential Year		10	11	12	13	14	15	16	17	18	19	20
	Calendar Year		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
LFG Collection System Tranche 1	\$ 1,582,066		\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103
LFG Collection System Tranche 2	\$ 2,823,304		\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456
LFG Power Generation System	\$ 14,868,000		\$ 774,000	\$ 810,000	\$ 846,000	\$ 882,000	\$ 900,000	\$ 936,000	\$ 972,000	\$ 1,008,000	\$ 918,000	\$ 720,000	\$ 576,000
EPM Transmission Line Charge	\$ 2,170,728		\$ 113,004	\$ 118,260	\$ 123,516	\$ 128,772	\$ 131,400	\$ 136,656	\$ 141,912	\$ 147,168	\$ 134,028	\$ 105,120	\$ 84,096
TOTAL	\$ 21,444,097												
	Annual Total		\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656

E. Revenue

The revenue for the LFG Facility at El Guacal will be derived solely from power sales. As observed in previous tasks, it is not clear that any carbon credits sales will be realized, since the Kyoto Protocol expires in 2012 and may not be replaced.

The power sales price used to calculate power sales revenue is USD \$0.0700 per kWh sold. This average annual pricing was calculated in Task 2 based on spot market information provided by XM S.A. E.S.P.

Revenue for the LFGE project is shown reflected in the following figures in the remainder of the report:

- **F-1: Cash Flow Projection (Base Case)**
- **F-2: Cash Flow Projection (High Case)**
- **G-1: Income Statement (Base Case)**
- **G-2: Income Statement (High Case)**

F. Cash Flow

The Cash Flow section is divided into the following subsections:

F.1 Cash Flow Statement

F.2 Balance Sheet

F.1 Cash Flow Statement

The Cash Flow Statement presented in **Figure F-1** is for the Base Case scenario and in **Figure F-2** is for a High Case scenario, based on 4 business activities:

- **Operating Activities:** includes revenue and operating and maintenance costs.
- **Investing Activities:** includes proceeds from loans or equity sold, selling of capital assets or acquisition of capital and civil improvements.
- **Financing Activities:** includes equity and debt financing, interest payments, principal payments, return on contributed equity, and dividends.
- **Taxes and Fees Activities:** includes any tax credits that maybe available to the project and any tax payments the project will have to pay.

The Cash Balance at the end of each year is an important amount in determining whether or not the project is feasible. The average cash balances at the end of the first 5 years under each scenario are:

- **Base Case:** USD\$ 1,264,561
- **High Case:** USD\$ 1,997,435

The project under both cases maintains a positive cash balance at the end of each operating year, which reflects the basic feasibility of the project throughout the projection horizon of 20 years.

Internal Rate of Return (IRR) on equity averages as follows:

- **Base Case**
 - **Tranche 1:** 9 % from Year 1 through Year 9.
 - **Tranche 1 and 2:** 16 % from Year 10 through Year 20.

- **High Case**
 - **Tranche 1:** 18 % from Year 1 through Year 9
 - **Tranche 1 and 2:** 22 % from Year 10 through Year 20.

F.2 Balance Sheet

Figure F-3 (Base Case) and **Figure F-4** (High Case) show a Balance Sheet position of the project at the end of Year 1, as required by the Terms of Reference.

Figure F-1: Cash Flow Projection / Cuadro F-1: Flujo de Caja Proyectado
Base Case / Caso Básico

	2012	2013	2014	2015	2016	2017	2018	2019	2020
	1	2	3	4	5	6	7	8	9
Operating Activities/ Actividades Operacionales									
Cash Received / Flujo de Caja Recibido									
Power Sales Revenue / Ventas de Energía	\$ 971,138	\$ 1,335,069	\$ 1,505,994	\$ 1,584,505	\$ 1,664,949	\$ 1,700,757	\$ 1,737,977	\$ 1,821,786	\$ 1,906,106
Total Cash Received/Recibido	\$ 971,138	\$ 1,335,069	\$ 1,505,994	\$ 1,584,505	\$ 1,664,949	\$ 1,700,757	\$ 1,737,977	\$ 1,821,786	\$ 1,906,106
Cash Used / Consumo de Caja									
Operations Expense / Costos Operacionales	\$ 405,793	\$ 528,220	\$ 585,719	\$ 612,130	\$ 815,647	\$ 827,693	\$ 840,214	\$ 868,407	\$ 896,772
Total Cash Used / Consumo	\$ 405,793	\$ 528,220	\$ 585,719	\$ 612,130	\$ 815,647	\$ 827,693	\$ 840,214	\$ 868,407	\$ 896,772
Net / Neto	\$ 565,344	\$ 806,850	\$ 926,276	\$ 972,375	\$ 849,301	\$ 873,064	\$ 897,763	\$ 953,379	\$ 1,009,333
Investing Activities / Actividades de Inversión									
Cash Received / Flujo de Caja Recibido									
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Cash Used / Consumo de Caja									
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 6,714,206	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Total Cash Used / Consumo	\$ 6,714,206	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Net / Neto	\$ (6,714,206)	\$ (64,865)	\$ (64,865)	\$ (64,865)	\$ (520,926)	\$ (85,836)	\$ (85,836)	\$ (85,836)	\$ (85,836)
Financing Activities/Actividades de Financiamiento									
Cash Received / Flujo de Caja Recibido									
Contributed Equity / Equity Contribuido	\$ 3,526,829	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Bank Loan / Préstamo Bancario	\$ 4,231,376	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Total Cash Received/Recibido	\$ 7,758,205	\$ 64,865	\$ 64,865	\$ 64,865	\$ 520,926	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Cash Used / Consumo de Caja									
Interest Paid / Intereses	\$ 296,196	\$ 271,117	\$ 245,584	\$ 219,597	\$ 225,080	\$ 196,460	\$ 167,240	\$ 137,418	\$ 106,996
Principal Payment / Reembolso de Capital	\$ 423,138	\$ 429,624	\$ 442,597	\$ 436,111	\$ 494,690	\$ 503,273	\$ 511,857	\$ 520,441	\$ 529,024
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Used / Consumo	\$ 719,334	\$ 700,741	\$ 688,181	\$ 655,708	\$ 719,770	\$ 699,734	\$ 679,097	\$ 657,859	\$ 636,020
Net / Neto	\$ 7,038,871	\$ (635,876)	\$ (623,316)	\$ (590,842)	\$ (198,844)	\$ (613,897)	\$ (593,260)	\$ (572,022)	\$ (550,184)
Taxes and Fees Activities/Actividades Tributarias									
Cash Received / Flujo de Caja Recibido									
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 155,382	\$ 213,611	\$ 240,959	\$ 253,521	\$ 266,392	\$ 272,121	\$ 278,076	\$ 291,486	\$ 304,977
Total Cash Received/Recibido	\$ 155,382	\$ 213,611	\$ 240,959	\$ 253,521	\$ 266,392	\$ 272,121	\$ 278,076	\$ 291,486	\$ 304,977
Cash Used / Consumo de Caja									
ICA Municipal Tax / Impuesto ICA Municipal	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Sales Tax / Impuesto Sobre la Renta	\$ 155,382	\$ 213,611	\$ 240,959	\$ 253,521	\$ 266,392	\$ 272,121	\$ 278,076	\$ 291,486	\$ 304,977
Total Cash Used / Consumo	\$ 156,038	\$ 214,267	\$ 241,615	\$ 254,505	\$ 267,376	\$ 273,105	\$ 279,061	\$ 292,470	\$ 305,961
Net / Neto	\$ (656)	\$ (656)	\$ (656)	\$ (984)					
Net Increase/(Decrease) in Cash held	\$ 889,353	\$ 105,452	\$ 231,438	\$ 315,684	\$ 128,548	\$ 172,346	\$ 217,682	\$ 294,536	\$ 372,329
(Aumento o Decreto en Balance de Caja)									
Cash Balance	\$ 889,353	\$ 994,806	\$ 1,226,244	\$ 1,541,928	\$ 1,670,475	\$ 1,842,821	\$ 2,050,504	\$ 2,355,040	\$ 2,727,369
(Balance de Caja)									

Avg.	Prom.	9%	25%	3%	7%	9%	4%	5%	6%	8%	11%
IRR / Tasa de Retorno Interno		9%	25%	3%	7%	9%	4%	5%	6%	8%	11%

IRR Tranche 1 / Tasa de Retorno Interno Fase 1

IRR Tranche 1 + 2 / Tasa de Retorno Interno Fase 1 + 2

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	10	11	12	13	14	15	16	17	18	19	20
Operating Activities/ Actividades Operacionales											
Cash Received / Flujo de Caja Recibido											
Power Sales Revenue / Ventas de Energía	\$ 1,906,106	\$ 1,945,574	\$ 2,030,717	\$ 2,116,092	\$ 2,201,653	\$ 2,242,515	\$ 2,328,423	\$ 2,414,425	\$ 2,614,541	\$ 2,512,265	\$ 2,074,822
Total Cash Received/Recibido	\$ 1,906,106	\$ 1,945,574	\$ 2,030,717	\$ 2,116,092	\$ 2,201,653	\$ 2,242,515	\$ 2,328,423	\$ 2,414,425	\$ 2,614,541	\$ 2,512,265	\$ 2,074,822
Cash Used / Consumo de Caja											
Operations Expense / Costos Operacionales	\$ 910,049	\$ 938,691	\$ 967,411	\$ 996,194	\$ 1,009,940	\$ 1,038,839	\$ 1,067,771	\$ 1,135,089	\$ 1,100,684	\$ 953,528	\$ 842,457
Total Cash Used / Consumo	\$ 910,049	\$ 938,691	\$ 967,411	\$ 996,194	\$ 1,009,940	\$ 1,038,839	\$ 1,067,771	\$ 1,135,089	\$ 1,100,684	\$ 953,528	\$ 842,457
Net / Neto	\$ 996,056	\$ 1,006,882	\$ 1,063,306	\$ 1,119,898	\$ 1,191,713	\$ 1,203,676	\$ 1,260,653	\$ 1,279,336	\$ 1,513,857	\$ 1,558,737	\$ 1,232,365
Investing Activities / Actividades de Inversión											
Cash Received / Flujo de Caja Recibido											
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Cash Used / Consumo de Caja											
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 3,362,731	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Total Cash Used / Consumo	\$ 3,362,731	\$ 85,836									
Net / Neto	\$ (3,362,731)	\$ (85,836)									
Financing Activities/Actividades de Financiamiento											
Cash Received / Flujo de Caja Recibido											
Contributed Equity / Equity Contribuido	\$ 1,791,442	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Bank Loan / Préstamo Bancario	\$ 1,571,289	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836	\$ 85,836
Total Cash Received/Recibido	\$ 3,362,731	\$ 85,836									
Cash Used / Consumo de Caja											
Interest Paid / Intereses	\$ 6,009	\$ 109,990	\$ 131,924	\$ 105,770	\$ 92,473	\$ 79,029	\$ 68,631	\$ 58,233	\$ 47,835	\$ 37,437	\$ 27,038
Principal Payment / Reembolso de Capital	\$ 271,599	\$ 686,153	\$ 273,696	\$ 275,793	\$ 277,891	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382	\$ 234,382
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Used / Consumo	\$ 277,608	\$ 796,143	\$ 405,620	\$ 381,564	\$ 370,364	\$ 313,411	\$ 303,013	\$ 292,615	\$ 282,217	\$ 271,818	\$ 112,875
Net / Neto	\$ 3,085,123	\$ (710,307)	\$ (319,784)	\$ (295,727)	\$ (284,527)	\$ (227,575)	\$ (217,176)	\$ (206,778)	\$ (196,380)	\$ (185,982)	\$ (27,038)
Taxes and Fees Activities/Actividades Tributarias											
Cash Received / Flujo de Caja Recibido											
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 304,977	\$ 311,292									

Figure F-2: Cash Flow Projection / Cuadro F-1: Flujo de Caja Proyectado

	Avg.	Prom.
IRR / Tasa de Retorno Interno	0%	
IRR Tranche 1 / Tasa de Retorno Interno Fase 1	-16%	-17%
IRR Tranche 1 / Tasa de Retorno Interno Fase 2 + 3 + 4 + 5	-26%	-27%
IRR Tranche 1 / Tasa de Retorno Interno Fase 6 + 7 + 8 + 9	-32%	-32%
IRR Tranche 1 / Tasa de Retorno Interno Fase 10 + 11 + 12	-34%	-34%
IRR Tranche 1 / Tasa de Retorno Interno Fase 13 + 14 + 15	-35%	-35%
IRR Tranche 1 / Tasa de Retorno Interno Fase 16 + 17 + 18	-39%	-39%
IRR Tranche 1 / Tasa de Retorno Interno Fase 19 + 20 + 21	-40%	-40%
IRR Tranche 1 / Tasa de Retorno Interno Fase 22 + 23 + 24	-42%	-42%
IRR Tranche 1 / Tasa de Retorno Interno Fase 25 + 26 + 27	-43%	-43%
IRR Tranche 1 / Tasa de Retorno Interno Fase 28 + 29 + 30	-44%	-44%
IRR Tranche 1 / Tasa de Retorno Interno Fase 31 + 32 + 33	-45%	-45%
IRR Tranche 1 / Tasa de Retorno Interno Fase 34 + 35 + 36	-46%	-46%
IRR Tranche 1 / Tasa de Retorno Interno Fase 37 + 38 + 39	-47%	-47%
IRR Tranche 1 / Tasa de Retorno Interno Fase 40 + 41 + 42	-48%	-48%
IRR Tranche 1 / Tasa de Retorno Interno Fase 43 + 44 + 45	-49%	-49%
IRR Tranche 1 / Tasa de Retorno Interno Fase 46 + 47 + 48	-50%	-50%
IRR Tranche 1 / Tasa de Retorno Interno Fase 49 + 50 + 51	-51%	-51%
IRR Tranche 1 / Tasa de Retorno Interno Fase 52 + 53 + 54	-52%	-52%
IRR Tranche 1 / Tasa de Retorno Interno Fase 55 + 56 + 57	-53%	-53%
IRR Tranche 1 / Tasa de Retorno Interno Fase 58 + 59 + 60	-54%	-54%
IRR Tranche 1 / Tasa de Retorno Interno Fase 61 + 62 + 63	-55%	-55%
IRR Tranche 1 / Tasa de Retorno Interno Fase 64 + 65 + 66	-56%	-56%
IRR Tranche 1 / Tasa de Retorno Interno Fase 67 + 68 + 69	-57%	-57%
IRR Tranche 1 / Tasa de Retorno Interno Fase 70 + 71 + 72	-58%	-58%
IRR Tranche 1 / Tasa de Retorno Interno Fase 73 + 74 + 75	-59%	-59%
IRR Tranche 1 / Tasa de Retorno Interno Fase 76 + 77 + 78	-60%	-60%
IRR Tranche 1 / Tasa de Retorno Interno Fase 79 + 80 + 81	-61%	-61%
IRR Tranche 1 / Tasa de Retorno Interno Fase 82 + 83 + 84	-62%	-62%
IRR Tranche 1 / Tasa de Retorno Interno Fase 85 + 86 + 87	-63%	-63%
IRR Tranche 1 / Tasa de Retorno Interno Fase 88 + 89 + 90	-64%	-64%
IRR Tranche 1 / Tasa de Retorno Interno Fase 91 + 92 + 93	-65%	-65%
IRR Tranche 1 / Tasa de Retorno Interno Fase 94 + 95 + 96	-66%	-66%
IRR Tranche 1 / Tasa de Retorno Interno Fase 97 + 98 + 99	-67%	-67%
IRR Tranche 1 / Tasa de Retorno Interno Fase 100 + 101 + 102	-68%	-68%
IRR Tranche 1 / Tasa de Retorno Interno Fase 103 + 104 + 105	-69%	-69%
IRR Tranche 1 / Tasa de Retorno Interno Fase 106 + 107 + 108	-70%	-70%
IRR Tranche 1 / Tasa de Retorno Interno Fase 109 + 110 + 111	-71%	-71%
IRR Tranche 1 / Tasa de Retorno Interno Fase 112 + 113 + 114	-72%	-72%
IRR Tranche 1 / Tasa de Retorno Interno Fase 115 + 116 + 117	-73%	-73%
IRR Tranche 1 / Tasa de Retorno Interno Fase 118 + 119 + 120	-74%	-74%
IRR Tranche 1 / Tasa de Retorno Interno Fase 121 + 122 + 123	-75%	-75%
IRR Tranche 1 / Tasa de Retorno Interno Fase 124 + 125 + 126	-76%	-76%
IRR Tranche 1 / Tasa de Retorno Interno Fase 127 + 128 + 129	-77%	-77%
IRR Tranche 1 / Tasa de Retorno Interno Fase 130 + 131 + 132	-78%	-78%
IRR Tranche 1 / Tasa de Retorno Interno Fase 133 + 134 + 135	-79%	-79%
IRR Tranche 1 / Tasa de Retorno Interno Fase 136 + 137 + 138	-80%	-80%
IRR Tranche 1 / Tasa de Retorno Interno Fase 139 + 140 + 141	-81%	-81%
IRR Tranche 1 / Tasa de Retorno Interno Fase 142 + 143 + 144	-82%	-82%
IRR Tranche 1 / Tasa de Retorno Interno Fase 145 + 146 + 147	-83%	-83%
IRR Tranche 1 / Tasa de Retorno Interno Fase 148 + 149 + 150	-84%	-84%
IRR Tranche 1 / Tasa de Retorno Interno Fase 151 + 152 + 153	-85%	-85%
IRR Tranche 1 / Tasa de Retorno Interno Fase 154 + 155 + 156	-86%	-86%
IRR Tranche 1 / Tasa de Retorno Interno Fase 157 + 158 + 159	-87%	-87%
IRR Tranche 1 / Tasa de Retorno Interno Fase 160 + 161 + 162	-88%	-88%
IRR Tranche 1 / Tasa de Retorno Interno Fase 163 + 164 + 165	-89%	-89%
IRR Tranche 1 / Tasa de Retorno Interno Fase 166 + 167 + 168	-90%	-90%
IRR Tranche 1 / Tasa de Retorno Interno Fase 169 + 170 + 171	-91%	-91%
IRR Tranche 1 / Tasa de Retorno Interno Fase 172 + 173 + 174	-92%	-92%
IRR Tranche 1 / Tasa de Retorno Interno Fase 175 + 176 + 177	-93%	-93%
IRR Tranche 1 / Tasa de Retorno Interno Fase 178 + 179 + 180	-94%	-94%
IRR Tranche 1 / Tasa de Retorno Interno Fase 181 + 182 + 183	-95%	-95%
IRR Tranche 1 / Tasa de Retorno Interno Fase 184 + 185 + 186	-96%	-96%
IRR Tranche 1 / Tasa de Retorno Interno Fase 187 + 188 + 189	-97%	-97%
IRR Tranche 1 / Tasa de Retorno Interno Fase 190 + 191 + 192	-98%	-98%
IRR Tranche 1 / Tasa de Retorno Interno Fase 193 + 194 + 195	-99%	-99%
IRR Tranche 1 / Tasa de Retorno Interno Fase 196 + 197 + 198	-100%	-100%

Figure F-3: Balance Sheet for Base Case at End of Year 1

<u>Balance Sheet</u>		<u>31 December</u>
<u>Assets / Activos</u>		
Current assets / Activos actuales		
Cash / Caja	741,552	
Accounts Receivable / Cuentas por cobrar	-	
Civil Improvements and Equipment / Obra Civil y Equipos	6,714,208	
Total Assets / Total Activos	7,455,757	
<u>Liabilities & Shareholder's Equity / Pasivos y Capital de Accionistas</u>		
Current liabilities / Pasivos actuales		
Accounts Payable and Accrued Liabilities / Cuentas por Pagar y Pasivos Acumulados	-	
Dividend payable/ Dividendos por Pagar	-	
Amounts due to Affiliated Companies	-	
Taxes Payable / Impuestos Pagables	-	
	-	
Long Term Liabilities / Pasivos a Largo Plazo		
Shareholders Loans / Préstamos de Accionistas	-	
Long Term Portion of Bank Loan / Porción a largo plazo del préstamo bancario	3,808,238	
Total Liabilities / Total Pasivos	3,808,238	
Shareholders Equity / Capital de Contratistas		
Shareholders Equity / Capital de Contratistas	3,647,519	
Total Shareholders Equity / Capital de Accionistas	3,647,519	
Total Long term Liabilities and Shareholders Equity / Pasivos a Largo Plazo & Capital de Accionistas	7,455,757	

Figure F-4: Balance Sheet for High Case at End of Year 1

<u>Balance Sheet</u>	
<u>31 December</u>	
<u>Assets / Activos</u>	
Current assets / Activos actuales	
Cash / Caja	856,712
Accounts Receivable / Cuentas por cobrar	-
Civil Improvements and Equipment / Obra Civil y Equipos	6,714,206
Total Assets / Total Activos	7,570,917
<u>Liabilities & Shareholder's Equity / Pasivos y Capital de Accionistas</u>	
Current liabilities / Pasivos actuales	
Accounts Payable and Accrued Liabilities / Cuentas por Pagar y Pasivos Acumulados	-
Dividend payable/ Dividendos por Pagar	-
Amounts due to Affiliated Companies	-
Taxes Payable / Impuestos Pagables	-
Long Term Liabilities / Pasivos a Largo Plazo	
Shareholders Loans / Préstamos de Accionistas	-
Long Term Portion of Bank Loan / Porción a largo plazo del préstamo bancario	3,800,689
Total Liabilities / Total Pasivos	3,800,689
Shareholders Equity / Capital de Contratistas	
Shareholders Equity / Capital de Contratistas	3,770,229
Total Shareholders Equity / Capital de Accionistas	3,770,229
Total Long term Liabilities and Shareholders Equity / Pasivos a Largo Plazo & Capital de Aacionistas	7,570,917

G. Profitability Analysis

The Income Statements in **Figure G-1** (Base Case) and **Figure G-2** (High Case) present net income projections from the LFGE Plant. As discussed previously:

- Power production is a function of gas flow and gas flow is a function of tons in place.
- The Base Case takes a conservative estimate of the total tons in place in both the North Cell and Central Cell.
- The High Case calculates waste at the rates that are arriving at the landfill in mid 2011 (approximately 900 TPD with further annual growth long term of 1.5%).

While profitability can be considered satisfactory for the Base Case scenario, it is even more favorable, as can be anticipated, for the High Case scenario.

The Income Statements for both scenarios show a favorable EBITDA (Earnings before interest, tax, depreciation, and amortization), as well as other ratios reflecting **favorable** performance of the LFGE project.

EBITDA varies as follows:

- **Base Case**
 - USD\$ 563,344 to USD \$ 1,009,333 from Year 1 through Year 9.
 - USD\$ 1.0 Million to USD\$ 1.2 Million from Year 10 through Year 20.
- **High Case**
 - USD\$ 734,737 to USD\$ 1.5 Million from Year 1 through Year 9
 - USD\$ 1.0 Million to USD \$ 1.4 Million from Year 10 through Year 20

Net Income as a percent of revenue varies as follows:

- **Base Case**
 - -18% to 24% from Year 1 through Year 9
 - 12% to 26% from Year 10 through Year 20
- **High Case**
 - -0.3% to 35% from Year 1 through Year 9
 - 25% to 8% from Year 10 through Year 20

Figure G-1: Pro-Forma Income Statement / Cuadro G-1 Cálculo de Ingresos Netos

Base Case / Caso Básico

	2012 1	2013 2	2014 3	2015 4	2016 5	2017 6	2018 7	2019 8	2020 9
Revenue / Ventas									
Power Sales (Ventas de Electricidad)									
Total Revenue	\$ 971,138	\$ 1,335,069	\$ 1,505,994	\$ 1,584,505	\$ 1,664,949	\$ 1,700,757	\$ 1,737,977	\$ 1,821,786	\$ 1,906,106
Expenses / Costos									
Operations Expense (Costos Operacionales)	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Collection System (Sistema de Recolección)	\$ 285,070	\$ 391,899	\$ 442,073	\$ 465,119	\$ 488,732	\$ 499,244	\$ 510,169	\$ 534,771	\$ 559,522
LFG Power Generation System (Sistema de Generación)	\$ 41,620	\$ 57,217	\$ 64,543	\$ 67,907	\$ 71,355	\$ 72,890	\$ 74,485	\$ 78,077	\$ 81,690
EPM Charges (Pagos a EPM por Interconexión)									
Sub-Total	\$ 405,793	\$ 528,220	\$ 585,719	\$ 612,130	\$ 815,647	\$ 827,693	\$ 840,214	\$ 868,407	\$ 896,772
Interest Expense (Pago de Intereses)									
Interest Expense (Pago de Intereses)	\$ 296,196	\$ 271,117	\$ 245,584	\$ 219,597	\$ 225,080	\$ 196,460	\$ 167,240	\$ 137,418	\$ 106,996
Sub-Total	\$ 296,196	\$ 271,117	\$ 245,584	\$ 219,597	\$ 225,080	\$ 196,460	\$ 167,240	\$ 137,418	\$ 106,996
Years (Años)									
Depreciation / Depreciación									
Tranche 1 / Fase 1	20.0	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854
Tranche 2 / Fase 2	20.0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854
Total Expense	\$ 1,142,843	\$ 1,240,190	\$ 1,272,156	\$ 1,272,580	\$ 1,481,581	\$ 1,465,007	\$ 1,448,307	\$ 1,446,679	\$ 1,444,622
Taxes / Impuestos									
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (155,382)	\$ (213,611)	\$ (240,959)	\$ (253,521)	\$ (266,392)	\$ (272,121)	\$ (278,076)	\$ (291,486)
Sales Tax (Exención)	16.0%	\$ 155,382	\$ 213,611	\$ 240,959	\$ 253,521	\$ 266,392	\$ 272,121	\$ 278,076	\$ 291,486
Sub-Total	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Net Income (Ingresos Netos)	\$ (172,362)	\$ 94,223	\$ 233,182	\$ 310,941	\$ 182,384	\$ 234,766	\$ 288,686	\$ 374,123	\$ 460,500
Percent of Revenue (Porcentaje de Ventas)	-17.7%	7.1%	15.5%	19.6%	11.0%	13.8%	16.6%	20.5%	24.2%
EBITDA [b]	\$ 565,344	\$ 806,850	\$ 920,276	\$ 972,375	\$ 849,301	\$ 873,064	\$ 897,763	\$ 953,379	\$ 1,009,333

	2021 10	2022 11	2023 12	2024 13	2025 14	2026 15	2027 16	2028 17	2029 18	2030 19	2031 20
Revenue / Ventas											
Power Sales (Ventas de Electricidad)											
Total Revenue	\$ 1,906,106	\$ 1,945,574	\$ 2,030,717	\$ 2,116,092	\$ 2,201,653	\$ 2,242,515	\$ 2,328,423	\$ 2,414,425	\$ 2,614,541	\$ 2,512,265	\$ 2,074,822
Expenses / Costos											
Operations Expense (Costos Operacionales)	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Collection System (Sistema de Recolección)	\$ 571,108	\$ 596,101	\$ 621,162	\$ 646,278	\$ 658,273	\$ 683,490	\$ 708,735	\$ 767,478	\$ 737,456	\$ 609,948	\$ 512,127
LFG Power Generation System (Sistema de Generación)	\$ 83,382	\$ 87,031	\$ 90,690	\$ 94,357	\$ 96,108	\$ 99,790	\$ 103,475	\$ 112,052	\$ 107,669	\$ 88,921	\$ 74,771
EPM Charges (Pagos a EPM por Interconexión)											
Sub-Total	\$ 910,049	\$ 938,691	\$ 967,411	\$ 996,194	\$ 1,009,940	\$ 1,038,839	\$ 1,067,771	\$ 1,135,089	\$ 1,100,684	\$ 953,528	\$ 842,457
Interest Expense (Pago de Intereses)											
Interest Expense (Pago de Intereses)	\$ 109,990	\$ 6,009	\$ 131,924	\$ 105,770	\$ 92,473	\$ 79,029	\$ 68,631	\$ 58,233	\$ 47,835	\$ 37,437	\$ 27,038
Sub-Total	\$ 109,990	\$ 6,009	\$ 131,924	\$ 105,770	\$ 92,473	\$ 79,029	\$ 68,631	\$ 58,233	\$ 47,835	\$ 37,437	\$ 27,038
Years (Años)											
Depreciation / Depreciación											
Tranche 1 / Fase 1	20.0	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854	\$ 440,854
Tranche 2 / Fase 2	20.0	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930	\$ 223,930
Total	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784	\$ 664,784
Total Expense	\$ 1,684,823	\$ 6,009	\$ 1,764,119	\$ 1,766,748	\$ 1,767,197	\$ 1,782,653	\$ 1,801,185	\$ 1,858,106	\$ 1,813,303	\$ 1,655,749	\$ 1,534,279
Taxes / Impuestos											
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (304,977)	\$ (311,292)	\$ (324,915)	\$ (338,575)	\$ (352,265)	\$ (358,802)	\$ (372,548)	\$ (386,308)	\$ (418,327)	\$ (401,962)
Sales Tax (Exención)	16.0%	\$ 304,977	\$ 311,292	\$ 324,915	\$ 338,575	\$ 352,265	\$ 358,802	\$ 372,548	\$ 386,308	\$ 418,327	\$ 401,962
Sub-Total	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Net Income (Ingresos Netos)	\$ 220,298	\$ 335,106	\$ 265,614	\$ 348,032	\$ 433,144	\$ 458,550	\$ 525,925	\$ 555,007	\$ 799,926	\$ 855,204	\$ 539,231
Percent of Revenue (Porcentaje de Ventas)	11.6%	17.2%	13.1%	16.4%	19.7%	20.4%	22.6%	23.0%	30.6%	34.0%	26.0%
EBITDA [b]	\$ 996,056	\$ 1,006,882	\$ 1,063,306	\$ 1,119,898	\$ 1,191,713	\$ 1,203,676	\$ 1,260,653	\$ 1,279,336	\$ 1,513,857	\$ 1,558,737	\$ 1,232,365

Notes / Notas

[a] Please see Task 11, / Favor ver Tarea 11.

[b] EBITDA = Earnings before interest, taxes, depreciation & amortization. / EBITDA = Ingresos antes de pagarse intereses, impuestos, depreciación & amortización.

Figure G-2: Pro-Forma Income Statement / Cálculo de Ingresos Netos
High Case / Caso Alto

	2012	2013	2014	2015	2016	2017	2018	2019	2020
	1	2	3	4	5	6	7	8	9
Revenue									
Power Sales (Ventas de Electricidad)									
Total Revenue	\$ 1,226,400	\$ 1,716,960	\$ 1,962,240	\$ 2,084,880	\$ 2,207,520	\$ 2,268,840	\$ 2,330,160	\$ 2,452,800	\$ 2,575,440
Expenses									
Operations Expense (Costos Operacionales)									
LFG Collection System (Sistema de Recolección)	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Power Generation System (Sistema de Generación)	\$ 360,000	\$ 504,000	\$ 576,000	\$ 612,000	\$ 648,000	\$ 666,000	\$ 684,000	\$ 720,000	\$ 756,000
EPM Charges (Pagos a EPM por Interconexión)	\$ 52,560	\$ 73,584	\$ 84,096	\$ 89,352	\$ 94,608	\$ 97,236	\$ 99,864	\$ 105,120	\$ 110,376
Sub-Total	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936
Interest Expense (Pago de Intereses)									
Interest Expense (Pago de Intereses)	\$ 295,609	\$ 270,589	\$ 245,114	\$ 251,110	\$ 223,003	\$ 194,295	\$ 164,987	\$ 135,077	\$ 104,567
Sub-Total	\$ 295,609	\$ 270,589	\$ 245,114	\$ 251,110	\$ 223,003	\$ 194,295	\$ 164,987	\$ 135,077	\$ 104,567
Years (Años)									
Depreciation / Depreciación									
Tranche 1 / Fase 1	20.0	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902
Tranche 2 / Fase 2	20.0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902
Total Expense	\$ 1,229,175	\$ 1,369,178	\$ 1,426,216	\$ 1,473,468	\$ 1,663,073	\$ 1,654,993	\$ 1,646,313	\$ 1,657,659	\$ 1,668,405
Taxes									
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (196,224)	\$ (274,714)	\$ (313,958)	\$ (333,581)	\$ (353,203)	\$ (363,014)	\$ (372,826)	\$ (392,448)
Sales Tax (Exención)	16.0%	\$ 196,224	\$ 274,714	\$ 313,958	\$ 333,581	\$ 353,203	\$ 363,014	\$ 372,826	\$ 392,448
Sub-Total	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Net Income (Ingresos Netos)	\$ (3,431)	\$ 347,126	\$ 535,368	\$ 610,428	\$ 543,463	\$ 612,863	\$ 682,863	\$ 794,157	\$ 906,051
Percent of Revenue (Porcentaje de Ventas)	-0.3%	20.2%	27.3%	29.3%	24.6%	27.0%	29.3%	32.4%	35.2%
EBITDA [b]	\$ 734,737	\$ 1,060,273	\$ 1,223,041	\$ 1,304,425	\$ 1,209,352	\$ 1,250,044	\$ 1,290,736	\$ 1,372,120	\$ 1,453,504

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	10	11	12	13	14	15	16	17	18	19	20
Revenue											
Power Sales (Ventas de Electricidad)											
Total Revenue	\$ 2,636,760	\$ 2,759,400	\$ 2,882,040	\$ 3,004,680	\$ 3,066,000	\$ 3,188,640	\$ 3,311,280	\$ 3,433,920	\$ 3,127,320	\$ 2,452,800	\$ 1,962,240
Expenses											
Operations Expense (Costos Operacionales)											
LFG Collection System (Sistema de Recolección)	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Power Generation System (Sistema de Generación)	\$ 774,000	\$ 810,000	\$ 846,000	\$ 882,000	\$ 900,000	\$ 936,000	\$ 972,000	\$ 1,008,000	\$ 918,000	\$ 720,000	\$ 576,000
EPM Charges (Pagos a EPM por Interconexión)	\$ 113,004	\$ 118,260	\$ 123,516	\$ 128,772	\$ 131,400	\$ 136,656	\$ 141,912	\$ 147,168	\$ 134,028	\$ 105,120	\$ 84,096
Sub-Total	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Interest Expense (Pago de Intereses)											
Interest Expense (Pago de Intereses)	\$ 33,830	\$ 6,009	\$ 60,774	\$ 49,559	\$ 215,091	\$ 193,269	\$ 171,447	\$ 149,625	\$ 127,803	\$ 105,981	\$ 84,158
Sub-Total	\$ 33,830	\$ 6,009	\$ 60,774	\$ 49,559	\$ 215,091	\$ 193,269	\$ 171,447	\$ 149,625	\$ 127,803	\$ 105,981	\$ 84,158
Years (Años)											
Depreciation / Depreciación											
Tranche 1 / Fase 1	20.0	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902	\$ 441,902
Tranche 2 / Fase 2	20.0	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930	\$ 359,930
Total	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832	\$ 801,832
Total Expense	\$ 1,978,226	\$ -	\$ 2,087,683	\$ 2,117,723	\$ 2,303,884	\$ 2,323,317	\$ 2,342,751	\$ 2,362,185	\$ 2,237,223	\$ 1,988,493	\$ 1,801,647
Taxes											
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (421,882)	\$ (441,504)	\$ (461,126)	\$ (480,749)	\$ (490,560)	\$ (510,182)	\$ (529,805)	\$ (549,427)	\$ (500,371)	\$ (392,448)
Sales Tax (Exención)	16.0%	\$ 421,882	\$ 441,504	\$ 461,126	\$ 480,749	\$ 490,560	\$ 510,182	\$ 529,805	\$ 549,427	\$ 500,371	\$ 392,448
Sub-Total	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Net Income (Ingresos Netos)	\$ 657,549	\$ 766,755	\$ 793,373	\$ 885,644	\$ 760,004	\$ 864,010	\$ 967,216	\$ 1,070,423	\$ 888,785	\$ 462,995	\$ 159,281
Percent of Revenue (Porcentaje de Ventas)	24.9%	27.8%	27.5%	29.5%	24.8%	27.1%	29.2%	31.2%	28.4%	18.9%	8.1%
EBITDA [b]	\$ 1,494,196	\$ 1,575,580	\$ 1,656,964	\$ 1,738,348	\$ 1,779,040	\$ 1,860,424	\$ 1,941,808	\$ 2,023,192	\$ 1,819,732	\$ 1,372,120	\$ 1,046,584

Notes / Notas

[a]. Please see Task 11. / Favor ver Tarea 11.

[b] EBITDA = Earnings before interest, taxes, depreciation & amortization. / EBITDA = Ingresos antes de pagarse intereses, impuestos, depreciación & amortización.

H. Conclusions

H1. Capital Investment

The Base Case total capital investment is projected at USD\$ 13.3 Million is composed of:

- Tranche 1: USD\$ 8.8 Million
- Tranche 2: USD\$ 4.5 Million

The High Case total capital investment is projected at USD\$ 16.0 Million and is composed of:

- Tranche 1: USD\$ 8.8 Million
- Tranche 2: USD\$ 7.2 Million

H2. Financing Assumptions

The basic assumptions used for the financing and investment costs for the project, as discussed in mid September with IDEA and EVAS representatives, are:

- **Annual Interest Rate:** 7.0%
- **Equity Percentage:** 40% / **Debt Percentage:** 60%
- **Principal Repayment Period:** 10 years / **Loan Period:** 10 Years
- **Base Case Total Capital Investment:** USD \$13,295,676 made up of:
 - **Tranche 1:** USD\$ 8,817,071
 - **Tranche 2:** USD\$ 4,478,605.
- **High Case Total Capital Investment:** USD \$16,036,648 made up of:
 - **Tranche 1:** USD \$8,838,043
 - **Tranche 2:** USD \$7,198,605.

Based on meetings conducted with IDEA and EVAS during September 2011, we conclude that there exist various mechanisms and financing sources within Colombia that may be utilized to fund the project in a manner analogous to the manner in which previous energy projects sponsored by IDEA have been financed. However, in the event that it is determined that sources outside Colombia would be attractive, we present the following institutions, which have recently expressed their conceptual

interest to Cambridge toward financing of renewable energy projects such as landfill gas to energy projects:

- International Finance Corporation (IFC) (part of the World Bank Group)
- Inter-American Development Bank (IADB)
- Overseas Private Investment Corporation (OPIC)
- United States Export Import Bank (EXIMBANK)
- European Investment Bank (EIB)

H3. Cash Flow

The Cash Balance at the end of each year is an important amount in determining whether or not the project is feasible. The average cash balances at the end of the first 5 years under each scenario are:

- **Base Case:** \$1,246,561
- **High Case:** \$1,997,435

The project under both cases maintains a positive cash balance at the end of each operating year, which reflects the basic feasibility of the project throughout the projection horizon of 20 years.

Internal Rate of Return (IRR) on equity averages as follows:

- **Base Case**
 - **Tranche 1:** 9% from Year 1 through Year 9
 - **Tranche 1 and 2:** 16 % from Year 10 through Year 20
- **High Case**
 - **Tranche 1:** 18% from Year 1 through Year 9
 - **Tranche 1 and 2:** 22 % from Year 10 through Year 20.

H4. Profitability Analysis

While profitability can be considered satisfactory for the Base Case scenario, it is significantly more favorable, as can be anticipated, for the High Case scenario.

The Income Statements for both scenarios show a favorable EBITDA (Earnings before interest, tax, depreciation, and amortization), as well as other ratios reflecting favorable performance of the LFGE project.

Net Income as a percent of revenue varies as follows:

- **Base Case**
 - -18% to 24% from Year 1 through Year 9
 - 12% to 26% from Year 10 through Year 20
- **High Case**
 - -0.3% to 35% from Year 1 through Year 9
 - 25% to 8 % from Year 10 through Year 20

H5. Summary Conclusions

The landfill gas to energy (LFGE) project is feasible, both technically and financially for the CIS El Guacal facility. The levels of technical and financial risk are considered manageable and more than acceptable. We believe that, in light of recent tonnage trends observed during mid 2011, the most likely scenario will be closer to the High Case than to the Base Case.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

Task 9 Report: Project Risk Assessment

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

September 22, 2011

The contents of this Task 9 Report are listed below:

Task 9 Report Contents

Section	Title
A	Risk Matrix
B	Conclusions

A. Risk Matrix

The project risks derive directly from the project implementation activities, which are illustrated in **Figure A-1** below (this schedule is based on the preliminary project schedule illustrated in Task 4, Section D):

Figure A-1: Preliminary Project Implementation Schedule

Sequential and Calendar Months												
1	2	3	4	5	6	7	8	9	10	11	12	13
2011		2012										
NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Feasibility Study Completed												
Business Aspects												
Negotiate Contracts												
Negotiate Financing												
Permitting and Licenses												
Complete Applications												
Regulatory Review												
EPM Scope of Work												
Interconnection Study												
Negotiations with EPM												
EPM Installs 44 kV Line + Transformers												
Turnkey EPC Contract												
Prepare Request for Proposals												
Proponents Prepare Responses												
Evaluate Responses and Award												
Detailed Design												
Purchase Order and Deliver Equipment												
Install Modules and Auxiliary Equipment												
Testing and Startup												
Begin Power Sales												

Figure A-2 presents an evaluation of the risks implicit in each implementation activity. No "High" risks are identified in any of the activities, with the majority of the activities deemed to have a "Low" risk. The risks identified are generally manageable, primarily through sufficient executive sponsorship from the stakeholders' organizations, especially from IDEA as probable project leader.

Figure A-2: Project Risk Matrix

Risks			Probability		Risk Mitigation		Comments
Activity	Primary Risk	Secondary Risk	Primary Risk	Secondary Risk	Primary Risk	Secondary Risk	
Business Aspects							
Negotiate Contracts among stakeholders	Failure to come to an agreement.	Non-obvious obstacles contained in agreement.	Low	Low	Executive level sponsorship by stakeholder organizations.	Effective expert and legal review of draft contracts	Risk is considered "Low" for all risks, considering high level of interest and executive sponsorship demonstrated by stakeholders during Feasibility Study. Stakeholders have extensive experience with power sales projects.
Negotiate Financing	Failure to find acceptable financing.	None	Low	None	Access to a range of financing options.	None	Risk is considered "Low", considering large number of similar LFGE projects financed in medium-income countries in recent years. IDEA has significant experience in financing projects of this size and larger.
Permitting and Licenses							
Complete Applications	Takes longer than planned.	None	Low	None	Effective consultant support.	None	Risk is considered "Low", considering generally supportive position of regulatory agencies observed during Feasibility Study.
Regulatory Review	Regulatory review denies a needed permit or license.	None	Medium-Low	None	Close interaction with regulatory agencies.	None	Generally, the pace and progress of a regulatory review is not readily predictable. However, the project schedule has a time margin of 4 months after the scheduled completion of the regulatory review.
EPM Scope							
Complete Interconnection Study	Takes longer than planned.	None	Low	Low	Close interaction with EPM staff.	None	EPM staff appears to be very familiar with the existing and planned interconnection network.
EPM Negotiations	Failure to come to an agreement.	None	Low	None	Executive level sponsorship by EPM and IDEA.	None	Risk is considered "Low", since this is a standard type of agreement for EPM.
EPM Install 44 kV Line + Substations	Takes longer than planned.	None	Medium-Low	None	Close interaction with EPM staff.	None	Risk is "Medium-Low" since line may cross several properties.
Turnkey EPC Contract							
Prepare RFP	Takes longer than planned.	None	Low	None	Executive level sponsorship by IDEA.	None	Self-explanatory.
Proponents Prepare Responses	Low response to RFP.	None	Low	None	Clear and effective RFP content.	None	Self-explanatory.
Evaluate Responses and Award	Takes longer than planned.	None	Low	None	Executive level sponsorship by IDEA.	None	Self-explanatory.
Complete Detailed Design	Takes longer than planned.	None	Low	None	Selection of experienced EPC Contractor.	None	Self-explanatory.
Order and Deliver Equipment	Takes longer than planned.	None	Low	None	Selection of experienced EPC Contractor.	None	Special attention to shipping and logistics with regard to importation as well as to in-country transport is required.
Install Engine Generators	Takes longer than planned.	None	Low	None	Selection of experienced EPC Contractor.	None	Self-explanatory.
Startup and Testing	Takes longer than planned.	None	Low	None	Selection of experienced EPC Contractor.	None	Self-explanatory.
Begin Power Export	Operational Costs higher than planned.	Landfill produces less gas than planned.	Low	Low	Effective Feasibility Study.	Consistent landfill operations practices.	Self-explanatory.

B. Conclusions

No unusual risks are identified in the project Risk Matrix (Figure A-2). During this feasibility study, a widely proven technical configuration has been selected. This creates a fundamental basis that mitigates most of the normal risks encountered during the implementation phase.

All the detected risks are manageable with sufficient application of the following mitigating factors listed in Figure A-2:

- Executive sponsorship from all stakeholders, especially from IDEA as probable project leader.
- Access to a wide selection of financing options.
- Review of draft agreements by experts with experience in management and contracting for these types of projects, and by legal advisors.
- Effective support from environmental and permitting consultants.
- Close interaction with regulatory agencies granting permits.
- Close interaction with EPM staff regarding the 44 kV line and the transformers.
- Clear and complete request for proposals (RFP) document.
- Selection of an experienced EPC (Engineering-Procurement-Construction) Turnkey contractor.
- Quality detailed design.
- Consistent operational practices in the landfill.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 10 Report:
Regulatory Framework**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

in association with:

Quality & Evolution S. A.

06 August 2011

The content of this Task 10 report is presented in the table below:

Task 10 Report Contents

Section	Title
A	Regulatory Context
B	Environmental License
C	Atmospheric Emissions
D	Discharges
E	Water Use
F	Disposal of Residues
G	Mechanisms for Public Participation
H	Energy Generation Regulations
I	Municipal Regulation and Land Use Planning
J	Conclusions

Attached to this Task 10 report is **Annex 1**, which contains copies of laws and regulations key to the regulatory framework.

A. Regulatory Context

In order to define the regulatory framework for the project, two options are considered preliminarily for the recovery of energy derived from municipal solid waste (MSW):

- Combustion of landfill gas (LFG); and
- Combustion of the MSW.

These options constitute a representative range of technical configurations that are used here to define the regulatory framework for the project. For example, gasification has aspects in common with both of these representative options, since gasification includes combustion of a gas derived from MSW in the gasification chamber, and at the same time produces a char that shares many characteristics with ash produced from direct combustion.

It is important to note that **independently of the option or technical configuration selected**, taking into account the consultations accomplished during interviews with personnel from the Directorate of Licenses, Permits, and Environmental Processing of the **MAVDT** ("Ministerio de Ambiente, Vivienda y Desarrollo Territorial de Colombia" or Ministry of Environment, Housing, and Territorial Development of Colombia) and in conformance with article 8 numeral 4 of decree 2820 of 2010, the project should be classified as a "**Proyecto de Exploración y Uso de Fuentes de Energía Alternativa Virtualmente Contaminantes** (or **Project of Exploration and Use of Virtually Contaminating Alternative Energy Sources**) with an installed capacity greater than **3 MW**". This important classification of the project has been made by regulators interviewed during this study, and is further examined in Section B below.

This classification applies to combustion of MSW or combustion of LFG, given that the legal definition of Alternative Energy or Non-Conventional Sources of Energy is in Law 697 of 2001, in which LFG is classified as a gaseous fuel derived from biomass. In this context, we present this analysis of the applicable regulatory framework from environmental, energy, and territorial development (land use).

This initial classification of the project has been given by the MAVDT personnel interviewed. Considering that in the country there are no similar projects utilizing Waste to Energy, this initial classification is, according to the MAVDT, the closest applicable categorization. This initial classification dictates that the applicable authority is MAVDT.

However, during the implementation phase of the project, at the initiation of the permitting process, the project can present a Right of Petition ("Derecho de Petición") containing a detailed description of the project. MAVDT will then officially validate or change the classification of the project. Based on this review by MAVDT, it is possible that MAVDT will delegate to CORANTIOQUIA the regulation of the project.

B. Environmental License

Environmental Licensing Regulations

In conformance with article 49 from Title VIII of Law 99 of 1993, the execution of works, the establishment of industries, or the development of any activity which, according to the law and its regulations could produce: a serious degradation of renewable natural resources or of the environment; or cause significant or negative changes in the landscape will require an Environmental License or "**Licencia Ambiental**". The currently applicable decree is decree 2820 of August 5, 2010, which regulates by means of which Title VIII of Law 99 of 1993, which provides that only those projects, works, or activities included in the 8th and 9th articles of the decree, and that are processed before the MAVDT or that are processed before the Autonomous Regional Corporations (such as CORANTIOQUIA) will require an environmental license.

Additionally, the decree establishes that the Environmental License is unique; that is to say that the Environmental License implicitly authorizes the various permits, authorizations, and concessions for the use and utilization of renewable natural resources that are necessary during the useful life of the project. In other terms, **the Environmental License is a condition precedent for the exercise of rights that stem from separate permits, authorizations, concessions, contracts, and licenses issued by authorities other than environmental authorities.**

Environmental License Processing

In order to obtain an Environmental License, the process to be followed is defined in decree 2820 of 2010 and consists of the following steps:

- Submittal of application;
- Determination of the authority on the need for an Environmental Diagnostic of Alternatives;
- Beginning of processing;
- Submittal of the Environmental Impact Assessment;
- Technical and legal evaluation of the project for which a license is sought;
- Final decision on the application (a resolution that awards or denies the Environmental License.)

Modification of Environmental Licenses

Modification of an Environmental License is possible when the requested changes continue to be within the scope of the authority that initially issued the current license, in this case CORANTIOQUIA.

For this project, however, the modification of the Environmental License would not apply, independent of the technical configuration selected, since the project is:

- Considered by MAVDT, in discussions to date, a "**Proyecto de Exploración y Uso de Fuentes de Energía Alternativa Virtualmente Contaminantes** (or **Project of Exploration and Use of Virtually Contaminating Alternative Energy Sources**); and
- Will probably have an installed capacity greater than 3 MW.

Therefore, the process would involve obtaining a new Environmental License processed through MAVDT, and not a modification of the current Environmental License.

It is clarified here that even though the current Environmental License, issued by CORANTIOQUIA through Resolution 7529 of January 2005 allows combustion of LFG, the fact that a LFG combustion plant would generate energy over 3 MW would put the project into this category that requires a new Environmental License (according to determinations made by regulators during interviews for this study.)

Charge for Evaluation and Monitoring Services

Article 96 of Law 633 of 2000 authorizes environmental authorities to charge for evaluation and monitoring services for Environmental Licenses, permits, concessions, authorizations, and other environmental control and management documents. This article 96 establishes limits for charges for projects, works, and other activities whose capital value is equal to or greater than 2115 minimum monthly salaries ("Salarios Mínimos Mensuales" or SMMV.) For 2011, the minimum monthly salary averaged US\$ 310 equivalent, so that 2,115 SMMV's would be an amount in pesos equivalent to:

$$2115 \times \text{US\$ } 310 = \text{US\$ } 655,650.$$

That is, if the project capital value is over US\$ 655,650, then it will be subject to a processing charge that will be determined by the MAVDT at the time, according to criteria provided for in Law 633 of 2000. If the project were to have a value below that amount, the processing charge would be defined according to the rate scale provided for in Resolution 1280 of 2010 from the MAVDT. On the MAVDT web page (www.minambiente.gov.co) the form for payment to the MAVDT is provided.

Environmental License Requirements and Applicable Regulations

The Directorate of Licenses, Permits, and Environmental Licenses of the MAVDT **recommends that once the technical configuration for the project is selected, a request for information be submitted so that the MAVDT can pronounce officially regarding the process to be followed, and the competent authority for the process**, taking into account that the raw materials for the project is solid waste, for which the current license has been issued by CORANTIOQUIA. Nevertheless, the Directorate will conduct internal consultations with the Directorate of Sustainable Sectoral Development, in order to provide clarity on the subject.

Permits, Authorizations, and Concessions for the Use and Utilization of Renewable Natural Resources

For the processing of permits (which are different and subsidiary to the Environmental License itself), the renewable natural resources that will be utilized in development of the project should be identified. Regulations require that a copy of the Environmental Impact Statement be filed with CORANTIOQUIA.

In the following sections are analyzed in detail the permits required and the applicable regulations. These permits are those related to:

- Atmospheric emissions;
- Discharges;
- Water Use; and
- Waste Disposal.

C. Atmospheric Emissions

Regulations for Fixed Point Source Atmospheric Emissions

Applicable regulations establish the norms and standards for acceptable pollutant emissions for fixed point sources under Resolution 909 of 2008, as modified by Resolution 1309 of 2010. Currently, the existing landfill holds a permit for generic atmospheric emissions, which covers various activities (including the combustion of landfill gas currently accomplished). This permit would need to be modified or amplified if activities are implemented that would produce new emissions from energy recovery. **It is possible that combustion of landfill gas for energy would not create emissions additional to those currently existing.**

Applicable Emissions Standards

Resolution 909 of 2008 from MAVDT sets forth the acceptable emissions levels for air pollutants for fixed point sources.

In the event that the selected technical option includes heat recovery from MSW, it is necessary to identify the specific technology to determine if the activity will be considered as one of the following:

- External combustion regulated by the provisions of Chapters III or VII of Resolution 909 of 2008, for combustion of MSW (it is unlikely that an option involving external combustion of MSW would be selected);
- Thermal powerplant operated with a solid fuel regulated by the provisions of Chapter V of Resolution 909 of 2008. For the current project, if a combustion option is selected, it is probable that it would involve internal combustion, in which case the provisions of Chapter V would apply.

If landfill gas combustion is selected, the provisions of Chapter V of Resolution 909 of 2008 for combustion of gaseous fuel would apply.

D. Discharges

It is not anticipated that the project will generate liquid discharges additional to volumes of leachate currently generated, since the project does not imply use of MSW additional to those tonnages received today.

However, discharge regulations are discussed here in the event that some type of new discharge were to be generated.

Regulations Applicable to Discharges

Decree 3930 of 2010 establishes the provisions related to the uses, regulation, and discharges of water resources to the soil and to storm sewers. In relation to the norm for discharges, decree 4828 of 2010 establishes the parameters and the maximum allowable limits for discharges to surface waters, marine waters, public sewer systems, and to soils. In October 2011 the term will expire for MAVDT to establish the standards for point discharges. These new norms will have to be taken into account at the time that any discharge permit is applied for.

Discharge Permit Included in the Current Environmental License

The Environmental License issued by CORANTIOQUIA in 2005, through Resolution 7529, awards to the CIS El Guacal a permit for liquid discharges for waste water, both domestic and industrial (this latter referring to leachates). It is important to note that currently, the applicable decree is 3930 of 2010, based on which any modification of this permit should be applied for, in the event that the project were to generate additional liquid discharges.

E. Water Use

It is noted here that any energy recovery plant employing a steam boiler will likely require water flows additional to those currently authorized. A landfill gas combustion energy recovery facility is not likely to require flows additional to those currently authorized.

Applicable Water Use Regulations

The applicable regulations for the use of surface waters is Law Decree 2811 of 1974 and its regulatory Decree 1541 of 1978. These require that prior to use of water resources, a water concession must be obtained. At the same time, these decrees provide for the obligation to construct necessary capture works which guarantee that only the watershed actually conceded by the environmental authority will be used. Additionally, in Colombia there is established the obligation to pay for the use of water. This obligation is set forth in Decree 0155 of 2004, which established the procedure for water charges.

Current Watershed Concession

CORANTIOQUIA issued a concession through Resolution 7529 of 2005 to the CIS El Guacal of 2.8 l/s, distributed as follows: 0.23 l/s for domestic use and 1.95 l/s for industrial use. The source of these flows is not named, but is shown to have a minimum flow of 5.5 l/s. It is this source on which catchment works should be included in the Environmental Impact Statement. This concession was issued for a period of 10 years, and requires payment for utilization of water while stipulating that no more than the stated water flow can be used without prior approval of CORANTIOQUIA.

F. Disposal of Residues

In Colombia, there is no specific regulation for the disposal of residues forthcoming from an energy generation process (such as ash or gasification char). These residues are considered to be included as solid waste in general, and a characterization of such ashes should be accomplished in order to determine the applicable final disposal regulation.

In case such residues are utilized as inputs to soil amendment products, the fertilizer and soil conditioning regulations adopted through Resolution 150 of 2003 of the Colombian Agricultural Institute (or "Instituto Colombiano Agropecuario" or ICA). These regulations apply to fertilizers and soil conditioners, as well as to raw materials used to prepare them. In addition, amendments are considered inorganic soil conditioners, and as a result they are regulated under Colombian Technical Standard 5167. It is not anticipated combustion residues (such as ash) or from gasification or plasma arc (such as char) will be usable as soil amendments (please see Task 3 Report's section on ash handling.)

Authorization of the Landfill for Disposal of Ashes

After a review of Resolution 7529 of 2005, through which the current Environmental License was issued to the CIS El Guacal, no reference was found to disposal of ash in the landfill. As a result, authorization must be sought to allow for such.

The current Environmental License does not authorize disposal of ash, as a result of which it will be necessary to:

- Apply for modification of the existing license through CORANTIOQUIA, or
- Include such a request for authorization in the application for the new Environmental License to be processed through MAVDT. This is likely to occur if the project is considered a new project independent of the landfill.

G. Mechanisms for Public Participation

Citizen participation is the process through which citizens take on the commitment to work for a solution of public issues using existing participation mechanisms, thereby exercising those rights provided for by these same mechanisms.

Said participation mechanisms can be divided into three types:

- Obtaining of information;
- Participation in the environmental permitting process;
- Participation in the administration of justice in the case of environmental impacts.

It is important to take into account these public participation mechanisms during the permitting process in order to avoid administrative or legal processes that could affect implementation of the project. Specific public participation can take various forms, including: Petitioning; Environmental Journal entries; Public Audience; Complaints Filing; Stewardship Action; Community Actions; Group Actions; Compliance Actions.

H. Energy Generation Regulations

In a meeting with Mr. Omar Orlando Serrano Sánchez, Advisor to the CREG (Energy and Gas Regulatory Commission) during which the discussion considered that initial estimates that the energy recovery project will be able to generate power in the range of 3 MW to 20 MW, the following considerations were put forward with regard to classification of the project:

- According to CREG Resolution 086 of 1996, generation from a Small Plant ("**Planta Menor**") is generation from a plant with less than 20 MW capacity, operated by a generating company, marginal producer, or independent power producer that markets such energy to third parties. In the case of vertically integrated companies, to supply totally or partially their respective markets. The Planta Menor category excludes the self-generator ("Autogenerador") category.
- The project cannot be considered as an Self-Generator ("**Autogenerador**"), since CREG Resolution 084 of 1996 stipulates that in this category are classified those individual or corporate entities that produce electricity exclusively for their own needs and cannot sell partially or totally their energy to third parties, except when an energy rationing situation has been declared.
- The project cannot also be considered as a Cogenerator ("**Cogenerador**"), since the issuance of Resolution 005 of 2010, this classification applies to an individual or to a corporate entity that has a combined electrical energy and thermal energy production as an integral part of its productive activity. The project would not generate power for an internal process, and 100% of the available energy would be sold to the grid.
- According to CREG Resolution 086 of 1996, a Marginal Producer ("**Productor Marginal**") or an Independent Producer ("**Productor Independiente**") is an individual or corporate entity that wishes to use its own resources to produce goods and services inherent to the mission of the public service entities for itself, or for other entities in exchange for any type of remuneration, or for free to those that have an economic link to the entity. Article 16 of Law 142 of 1994 is clear in stipulating that the fact that an entity is a marginal producer, independent producer, or generates power for private use does not imply that the acts and contracts of that producer will be subject to legal requirements different from those applicable to acts and contracts of a public service enterprise that provide similar services. Therefore, an entity that sells electricity, whether a public service enterprise or a marginal producer or an independent producer, with regard to power supply acts or contracts, will be subject to the same requirements.

According to the above, the project cannot be considered an Autogenerator or a Cogenerator, and the project meets the regulatory stipulations as a Smaller Plant. If the

project were considered a Marginal Producer or an Independent Producer, the same requirements as would be applied to any other power producer.

Requirements for Supply and Sale of Energy to the Grid

It is noted here that under Resolution CREG-131 of 1998, **Regulated Users** are those users whose consumption is less than 55 MWh per month, on average, or one that has an installed capacity of less than 0.1 MW. Most homes and smaller businesses are Regulated Users. **Unregulated Users** are those with energy consumption above 55 MWh on average and who choose to be classified as Unregulated Users.

Small Plants ("Plantas Menores") with Net Capacity Under 10 MW

These plants shall not have access to the Central Dispatch, and as a result, do not participate in the wholesale electricity market. Power sold from such facilities can be commercialized, taking into account the following guidelines:

- Energy generated by a Small Plant may be sold to a Trader that supplies the **Regulated Market** (made up of **Regulated Users**) directly and without public bids, as long as there is no economic link between the buyer and the seller. In this case, the sales price shall be strictly and exclusively the Spot Market Price ("Precio en la Bolsa Energía") at any given hours, less one peso legal currency (\$1.00) per kWh indexed per CREG Resolution CREG-005 of 2001.
- Energy generated by a Smaller Plant may be offered to a trader that deals with the **Regulated Market** by participating in public bids published by the users. In this case, as provided in Resolution CREG-020 of 1996, the award must be made on the basis of price.
- The energy generated by a Smaller Plant may be sold at prices freely agreed to between seller and buyer to the following entities: Generators, or Traders who deal exclusively to **Unregulated Users**.

Smaller Plants with Capacity Between 10 MW and 20 MW

These plants may opt for accessing Central Dispatch, in which case they participate in the Wholesale Market. If this option is chosen, such plants will need to comply with applicable regulations.

If such plants do not participate in Central Dispatch, then the energy generated may be commercialized as follows:

- Energy generated by a Small Plant may be sold to a Trader that supplies the Regulated Market directly and without public bids, as long as there is no economic link between the buyer and the seller. In this case, the sales price shall be strictly and exclusively the

Spot Market Price ("Precio en la Bolsa Energía") at any given hours, less one peso legal currency (\$1.00) per kWh indexed per CREG Resolution CREG-005 of 2001.

- Energy generated by a Smaller Plant may be offered to a trader that deals with the Regulated Market by participating in public bids published by the users. In this case, as provided in Resolution CREG-020 of 1996, the award must be made on the basis of price.
- The energy generated by a Smaller Plant may be sold at prices freely agreed to between seller and buyer to the following entities: Generators, or Traders who deal exclusively with Unregulated Users.

I. Municipal Regulation and Land Use Planning

Compatibility with Land Use in Compliance with the Heliconia Land Use Plan

Considering that the location where the project would be built is an area that is already developed and is dedicated, according to the Land Use Plan ('Esquema de Ordenamiento Territorial' or "EOT"), to disposal of solid waste, there is not, preliminarily, any incompatibility between the project and the land use defined in this local document. Nevertheless, during project implementation, the project team should conduct a detailed review of the EOT (in its current version at that time) to identify those requirements, licenses, or permits stipulated by the municipality for execution of the project.

J. Conclusions Task 1

It is estimated that the total duration of the following permitting processes would be approximately 8 months, keeping in mind that other activities (such as detailed design) may be conducted in parallel or partially in parallel during the project implementation period:

- Environmental License (process is illustrated in **Figure J-1** below);
- Specific Permits:
 - Atmospheric Emissions
 - Discharges
 - Water Use
 - Residues Disposal
 - Verification of Compatibility with Heliconia Land Use Plan (EOT)
- Registration of the project into the electricity market. The project is anticipated to be classified as a **Small Plant ("Planta Menor")**.

It is concluded that no major regulatory obstacle is in place that would hamper project implementation or subsequent power sales.

Figure J-1: Environmental License Schedule

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8
Environmental License*								
Application filing	■							
Determination by the Authority of the need for an Environmental Diagnostic of Alternatives		■	■					
Filing of the Environmental Diagnostic of Alternatives (EDA)			■					
Notice of Initiation of the EDA Process				■				
Evaluation of the EDA and selection of the alternative on which the Environmental Impact Statement (EIS) should be based				■	■	■		
Filing of the EIS				■		■		
Issuance of Notice of Initiation of the Environmental License process		■				■		
Environmental authority's request to other authorities or entities with regard to technical concepts or relevant information			■	■		■	■	
Response to the environmental authority's request				■	■	■	■	
Additional information request to applicant					■	■	■	
Applicant submittal of additional information						■		■
Issuance of notice of completeness of file to support decision						■		
Issuance of Environmental License approval or denial						■	■	■

(Figure J-1 Continued from previous page)

* Environmental License is unique; that is to say that the Environmental License implicitly authorizes the various permits, authorizations, and concessions for the use and utilization of renewable natural resources that are necessary during the useful life of the project

Project Registration within Electricity Market																				
Submittal of forms and registration format to the General Directorate of the UPME, identifying the phase in which the project should be registered (Pre-Feasibility, Feasibility, or Definitive Project)																				
Project registration with the UPME																				

Key

Applicant responsibility		
Authority responsibility		
Responsiblity of other authority or entity		
Applicant responsibility in the event of request for additional information		
Authority responsibility in the event of request for additional information		
Responsiblity of other authority or entity in the event of request for additional information		

Annex 1: Key Laws and Regulation

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Por el cual se reglamenta el Título VIII de la Ley 99 de 1993 sobre licencias ambientales.

Título II

Competencia y exigibilidad de la licencia ambiental

Artículo 8º. Competencia del Ministerio de Ambiente, Vivienda y Desarrollo Territorial. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial, otorgará o negará de manera privativa la licencia ambiental para los siguientes proyectos, obras o actividades:

1. En el sector hidrocarburos:

- a) Las actividades de exploración sísmica que requieran la construcción de vías para el tránsito vehicular y las actividades de exploración sísmica en las áreas marinas del territorio nacional cuando se realicen en profundidades inferiores a 200 metros;
- b) Los proyectos de perforación exploratoria por fuera de campos de producción de hidrocarburos existentes, de acuerdo con el área de interés que declare el peticionario;
- c) La explotación de hidrocarburos que incluye, la perforación de los pozos de cualquier tipo, la construcción de instalaciones propias de la actividad, las obras complementarias incluidas el transporte interno de fluidos del campo por ductos, el almacenamiento interno, vías internas y demás infraestructuras asociada y conexa;
- d) El transporte y conducción de hidrocarburos líquidos y gaseosos que se desarrolle por fuera de los campos de explotación que impliquen la construcción y montaje de infraestructura de líneas de conducción con diámetros iguales o superiores a 6 pulgadas (15.24 cm), incluyendo estaciones de bombeo y/o reducción de presión y la correspondiente infraestructura de almacenamiento y control de flujo; salvo aquellas actividades relacionadas con la distribución de gas natural de uso domiciliario, comercial o industrial;
- e) Los terminales de entrega y estaciones de transferencia de hidrocarburos líquidos, entendidos como la infraestructura de almacenamiento asociada al transporte de hidrocarburos y sus productos y derivados por ductos;
- f) La construcción y operación de refinerías y los desarrollos petroquímicos que formen parte de un complejo de refinación;

2. En el sector minero:

La explotación minera de:

- a) Carbón: Cuando la explotación proyectada sea mayor o igual a 800.000 ton/año;
- b) Materiales de construcción y arcillas o minerales industriales no metálicos: Cuando la producción proyectada sea mayor o igual a 600.000 ton/año para las arcillas o mayor o igual a 250.000 m³/año para otros materiales de construcción o para minerales industriales no metálicos;
- c) Minerales metálicos y piedras preciosas y semipreciosas: Cuando la remoción total de material útil y estéril proyectada sea mayor o igual a 2.000.000 de ton/año;
- d) Otros minerales y materiales: Cuando la explotación de mineral proyectada sea mayor o igual a 1.000.000 ton/año.

3. La construcción de presas, represas o embalses, cualquiera sea su destinación con capacidad mayor de 200 millones de metros cúbicos de agua.

4. En el sector eléctrico:

a) La construcción y operación de centrales generadoras de energía eléctrica con capacidad instalada igual o superior a 100 MW;

b) Los proyectos de exploración y uso de fuentes de energía alternativa virtualmente contaminantes con capacidad instalada superior a 3MW;

c) El tendido de las líneas de transmisión del Sistema Nacional de Interconexión Eléctrica, compuesto por el conjunto de líneas con sus correspondientes módulos de conexión (subestaciones) que se proyecte operen a tensiones iguales o superiores a 220 KV. 5. Los proyectos para la generación de energía nuclear.

6. En el sector marítimo y portuario:

a) La construcción o ampliación y operación de puertos marítimos de gran calado;

b) Los dragados de profundización de los canales de acceso a puertos marítimos de gran calado y los de mantenimiento cuyo volumen sea superior a 1000.000 de m³/año;

c) La estabilización de playas y de entradas costeras.

7. La construcción y operación de aeropuertos internacionales y de nuevas pistas en los mismos.

8. Ejecución de obras públicas:

8.1. Proyectos de la red vial nacional referidos a:

a) La construcción de carreteras, incluyendo puentes y demás infraestructura asociada a la misma;

b) La construcción de segundas calzadas;

c) La construcción de túneles con sus accesos;

8.2 Ejecución de proyectos en la red fluvial nacional referidos a:

a) La construcción y operación de puertos públicos;

b) Rectificación de cauces, cierre de brazos, meandros y madreviejas;

c) La construcción de espolones;

d) Desviación de cauces en la red fluvial;

e) Los dragados de profundización en canales navegables y en áreas de deltas;

- 8.3. La construcción de vías férreas y/o variantes de la red férrea nacional tanto pública como privada;
- 8.4. La construcción de obras marítimas duras (rompeolas, espolones, construcción de diques) y de regeneración de dunas y playas;
9. La construcción y operación de distritos de riego y/o de drenaje con coberturas superiores a 20.000 hectáreas;
10. La producción de pesticidas y la importación de los mismos en los siguientes casos:
- a) Pesticidas o plaguicidas para uso agrícola, con excepción de los plaguicidas de origen biológico elaborados con base en extractos naturales. La importación de plaguicidas químicos de uso agrícolas se ajustará al procedimiento establecido en la Decisión Andina 436 de 1998, o la norma que la modifique o sustituya;
 - b) Pesticidas o plaguicidas veterinarios, con excepción de aquellos de uso tópico para mascotas y los accesorios de uso externo tales como orejeras, collares, narigueras, etc.;
 - c) Pesticidas o Plaguicidas para uso en salud pública;
 - d) Pesticidas o plaguicidas para uso industrial;
 - e) Pesticidas o plaguicidas de uso doméstico, con excepción de aquellos plaguicidas para uso doméstico en presentación o empaque individual.
11. La importación y/o producción de aquellas sustancias, materiales o productos sujetos a controles por virtud de tratados, convenios y protocolos internacionales de carácter ambiental, salvo en aquellos casos en que dichas normas indiquen una autorización especial para el efecto. Tratándose de Organismos Vivos Modificados - OVM, para lo cual se aplicará en su evaluación y pronunciamiento únicamente el procedimiento establecido en la Ley 740 de 2002, y en sus decretos reglamentarios o las normas que lo modifiquen sustituyan o deroguen.
12. Los proyectos que afecten las Áreas del Sistema de Parques Nacionales Naturales:
- a) Los proyectos, obras o actividades que afecten las áreas del Sistema de Parques Nacionales Naturales por realizarse al interior de estas, en el marco de las actividades allí permitidas;
 - b) Los proyectos, obras o actividades señalados en los artículos 8° y 9° del presente decreto, localizados en las zonas amortiguadoras del Sistema de Parques Nacionales Naturales previamente determinadas, siempre y cuando sean compatibles con el Plan de Manejo Ambiental de dichas zonas.
13. Los proyectos, obras o actividades a realizarse al interior de las áreas protegidas públicas nacionales de que trata el Decreto 2372 del 1° de julio de 2010, distintos a los enunciados en el numeral anterior, siempre que el uso sea permitido de acuerdo a la categoría de manejo respectiva e impliquen la construcción de infraestructura en las zonas de uso sostenible y general de uso público, o se trate de proyectos de agroindustria, a excepción de las unidades habitacionales, siempre que su desarrollo sea compatible con los usos definidos.

14. Los proyectos que adelanten las Corporaciones Autónomas Regionales a que hace referencia el inciso segundo del numeral 19 del artículo 31 de la Ley 99 de 1993.

15. Los proyectos que requieran traspaso de una cuenca a otra con corrientes de agua que excedan de 2 m³/seg durante los períodos de mínimo caudal.

16. La introducción al país de parentales, especies, subespecies, razas, híbridos o variedades foráneas con fines de cultivo, levante, control biológico, reproducción y/o comercialización, para establecerse o implantarse en medios naturales o artificiales, que puedan afectar la estabilidad de los ecosistemas o de la vida silvestre.

La Licencia Ambiental contemplará la fase de investigación o experimental y la fase comercial. La fase de investigación involucra las etapas de importación del pie parental y de material vegetal para la propagación, la instalación o construcción del zoocriadero o vivero y las actividades de investigación o experimentación del proyecto. Para autorizar la fase comercial se requerirá modificación de la Licencia Ambiental.

Parágrafo 1º. Para los proyectos de hidrocarburos en donde el área de interés de explotación corresponda al área de interés de exploración previamente licenciada, el interesado podrá solicitar la modificación de la licencia de exploración para realizar las actividades de explotación. En este caso se aplicará lo dispuesto en el artículo 4º del presente decreto.

Parágrafo 2º. En lo que respecta al numeral 12 del presente decreto, previamente a la decisión sobre la licencia ambiental, el Ministerio de Ambiente, Vivienda y Desarrollo Territorial contará con el concepto de la Unidad Administrativa Especial del Sistema de Parques Nacionales Naturales.

Los senderos de interpretación, los utilizados para investigación y para ejercer acciones de control y vigilancia, así como los proyectos, obras o actividades adelantadas para cumplir las funciones de administración de las áreas protegidas que estén previstas en el plan de manejo correspondiente, no requerirán Licencia Ambiental.

Parágrafo 3º. Los zoocriaderos de especies foráneas a los que se refiere el numeral 16 del presente artículo, no podrán adelantar actividades comerciales con individuos introducidos, ni con su producción, en ninguno de sus estadios biológicos, a menos que el Ministerio de Ambiente, Vivienda y Desarrollo Territorial los haya autorizado como predio proveedores y solamente cuando dichos especímenes se destinen a establecimientos legalmente autorizados para su manejo en ciclo cerrado.

Parágrafo 4º. No se podrá autorizar la introducción al país de parentales de especies, subespecies, razas o variedades foráneas que hayan sido declaradas como invasoras o potencialmente invasoras por el Ministerio de Ambiente, Vivienda y Desarrollo Territorial con el soporte técnico y científico de los Institutos de Investigación Científica Territorial con el soporte técnico y científico de los Institutos de Investigación Científica vinculados al Ministerio.

Parágrafo 5º. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial, podrá señalar mediante resolución motivada las especies foráneas, que hayan sido introducidas irregularmente al país y puedan ser objeto de actividades de cría en ciclo cerrado. Lo anterior sin perjuicio de la imposición de las medidas preventivas y sancionatorias a que haya lugar.

Artículo 9º. Competencia de las Corporaciones Autónomas Regionales. Las Corporaciones Autónomas Regionales, las de Desarrollo Sostenible, los Grandes Centros Urbanos y las autoridades ambientales creadas mediante la Ley 768 de 2002, otorgarán o negarán la licencia ambiental para los siguientes proyectos, obras o actividades, que se ejecuten en el área de su jurisdicción.

1. En el sector minero

La explotación minera de:

- a) Carbón: Cuando la explotación proyectada sea menor a 800.000 ton/año;
- b) Materiales de construcción y arcillas o minerales industriales no metálicos: Cuando la producción proyectada de mineral sea menor a 600.000 ton/año para arcillas o menor a 250.000 m³/año para otros materiales de construcción o para minerales industriales no metálicos;
- c) Minerales metálicos, piedras preciosas y semipreciosas: Cuando la remoción total de material útil y estéril proyectada sea menor a 2.000.000 de ton/año;
- d) Otros minerales y materiales: Cuando la explotación de mineral proyectada sea menor a 1.000.000 ton/año.

2. Siderúrgicas, cementeras y plantas concreteras fijas cuya producción de concreto sea superior a 10.000m³/mes.

3. La construcción de presas, represas o embalses con capacidad igual o inferior a 200 millones de metros cúbicos de agua.

4. En el sector eléctrico:

a) La construcción y operación de centrales generadoras con una capacidad mayor o igual a 10 y menor de 100 MW, diferentes a las centrales generadoras de energía a partir del recurso hídrico;

b) El tendido de líneas del sistema de transmisión conformado por el conjunto de líneas con sus equipos asociados, que operan a tensiones menores de 220 KV y que no pertenecen a un sistema de distribución local;

c) La construcción y operación de centrales generadoras de energía a partir del recurso hídrico con una capacidad menor a 100 MW; exceptuando las pequeñas hidroeléctricas destinadas a operar en Zonas No Interconectadas (ZNI) y cuya capacidad sea igual o menor a 10 MW;

5. En el sector marítimo y portuario:

a) La construcción, ampliación y operación de puertos marítimos que no sean de gran calado;

b) Los dragados de profundización de los canales de acceso a los puertos que no sean considerados como de gran calado;

c) La ejecución de obras privadas relacionadas con la construcción de obras duras (rompeolas, espolones, construcción de diques) y de regeneración de dunas y playas.

6. La construcción y operación de aeropuertos del nivel nacional y de nuevas pistas en los mismos.

7. Proyectos en la red vial secundaria y terciaria:

- a) La construcción de carreteras; incluyendo puentes y demás infraestructura asociada a la misma;
- b) La construcción de nuevas calzadas;
- c) La construcción de túneles con sus accesos.

8. Ejecución de obras de carácter privado en la red fluvial nacional:

- a) La construcción y operación de puertos;
- b) Rectificación de cauces, cierre de brazos, meandros y madreviejas;
- c) La construcción de espolones;
- d) Desviación de cauces en la red fluvial;
- e) Los dragados de profundización en canales y en áreas de deltas.

9. La construcción de vías férreas de carácter regional y/o variantes de estas tanto públicas como privadas.

10. La construcción y operación de instalaciones cuyo objeto sea el almacenamiento, aprovechamiento, recuperación y/o disposición final de residuos o desechos peligrosos, y la construcción y operación de rellenos de seguridad para residuos hospitalarios en los casos en que la normatividad sobre la materia lo permita.

11. La construcción y operación de instalaciones cuyo objeto sea el almacenamiento, tratamiento, aprovechamiento (recuperación/reciclado) y/o disposición final de Residuos de Aparatos Eléctricos y Electrónicos (RAEE) y de residuos de pilas y/o acumuladores.

Las actividades de reparación y reacondicionamiento de aparatos eléctricos y electrónicos usados no requieren de licencia ambiental.

12. La construcción y operación de plantas cuyo objeto sea el aprovechamiento y valorización de residuos sólidos orgánicos biodegradables mayores o iguales a 20.000 toneladas/año.

13. La construcción y operación de rellenos sanitarios; no obstante la operación únicamente podrá ser adelantada por las personas señaladas en el artículo 15 de la Ley 142 de 1994.

14. La construcción y operación de sistemas de tratamiento de aguas residuales que sirvan a poblaciones iguales o superiores a 200.000 habitantes.

15. La industria manufacturera para la fabricación de:

- a) Sustancias químicas básicas de origen mineral;

- b) Alcoholes;
 - c) Ácidos inorgánicos y sus compuestos oxigenados;
16. Los proyectos cuyo objeto sea el almacenamiento de sustancias peligrosas, con excepción de los hidrocarburos.
17. La construcción y operación de distritos de riego y/o drenaje para áreas mayores o iguales a 5.000 hectáreas e inferiores o iguales a 20.000 hectáreas.
18. Los proyectos que requieran trasvase de una cuenca a otra de corrientes de agua igual o inferior a 2 m³/seg. Durante los períodos de mínimo caudal.
19. La caza comercial y el establecimiento de zoocriaderos con fines comerciales.
20. Los proyectos, obras o actividades a realizarse al interior de las áreas protegidas públicas regionales, de que trata el Decreto 2372 del 1º de julio de 2010, siempre que el uso sea permitido de acuerdo a la categoría de manejo respectiva e impliquen la construcción de infraestructura en las zonas de uso sostenible y general de uso público, o se trate de proyectos de agroindustria, a excepción de las unidades habitacionales, siempre que su desarrollo sea compatible con los usos definidos.

Parágrafo 1º. Las Corporaciones Autónomas Regionales ejercerán la competencia a que se refiere el numeral 5 del presente artículo, sin perjuicio de las competencias que corresponden a otras autoridades ambientales sobre las aguas marítimas, terrenos de bajamar y playas.

Así mismo, dichas autoridades deberán en los casos contemplados en los literales b) y c) del citado numeral, solicitar concepto al Invemar sobre los posibles impactos ambientales en los ecosistemas marinos y costeros que pueda generar el proyecto, obra o actividad objeto de licenciamiento ambiental.

Parágrafo 2º. Para los efectos del numeral 19 del presente artículo, la licencia ambiental contemplará las fases experimental y comercial. La fase experimental incluye las actividades de caza de fomento, construcción o instalación del zoocriadero y las actividades de investigación del proyecto. Para autorizar la fase comercial se requerirá modificación de la licencia ambiental previamente otorgada para la fase experimental.

Cuando las actividades de caza de fomento se lleven a cabo fuera del área de jurisdicción de la entidad competente para otorgar la licencia ambiental, la autoridad ambiental con jurisdicción en el área de distribución del recurso deberá expedir un permiso de caza de fomento de conformidad con lo establecido en la normatividad vigente. De igual forma, no se podrá autorizar la caza comercial de individuos de especies sobre las cuales exista veda o prohibición.

Parágrafo 3º. Las Corporaciones Autónomas Regionales solamente podrán otorgar licencias ambientales para el establecimiento de zoocriaderos con fines comerciales de especies exóticas en ciclo cerrado, para tal efecto, el pie parental deberá provenir de un zoocriadero con fines comerciales que cuente con licencia ambiental y se encuentre debidamente autorizado como predio proveedor.

Parágrafo 4º. Cuando de acuerdo con las funciones señaladas en la ley, la licencia ambiental para la construcción y operación para los proyectos, obras o actividades de que trata este artículo, sea solicitada por las Corporaciones Autónomas Regionales, las de Desarrollo sostenible y las autoridades ambientales a que se refiere el artículo 66 de la Ley 99 de 1993 y el artículo 13 de la Ley 768 de 2002, esta será de competencia del Ministerio de Ambiente, Vivienda y Desarrollo Territorial.

Así mismo, cuando las mencionadas autoridades, manifiesten conflicto para el otorgamiento de una licencia ambiental, el Ministerio de Ambiente, Vivienda y Desarrollo Territorial podrá asumir la competencia del licenciamiento ambiental del proyecto, en virtud de lo dispuesto en el numeral 31 del artículo 5º de la citada ley.

Parágrafo 5º. Las Corporaciones Autónomas Regionales y demás autoridades ambientales no tendrán las competencias señaladas en el presente artículo, cuando los proyectos, obras o actividades formen parte de un proyecto cuya licencia ambiental sea de competencia privativa del Ministerio de Ambiente, Vivienda y Desarrollo Territorial.

Título IV **Procedimiento para la obtención de la licencia ambiental**

Artículo 23º. De la evaluación del Diagnóstico Ambiental de Alternativas - DAA. En los casos contemplados en el artículo 18 del presente decreto, se surtirá el siguiente procedimiento:

1. El interesado en obtener licencia ambiental deberá formular petición por escrito dirigida a la autoridad ambiental competente, en la cual solicitará que se determine si el proyecto, obra o actividad requiere o no de la elaboración y presentación de Diagnóstico Ambiental de Alternativas - DAA, adjuntando para el efecto, la descripción, el objetivo y alcance del proyecto y su localización mediante coordenadas y planos.

Dentro de los quince (15) días hábiles siguientes a la radicación de la solicitud, la autoridad ambiental se pronunciará, mediante oficio acerca de la necesidad de presentar o no DAA, adjuntando los términos de referencia para elaboración del DAA o del EIA según el caso.

2. En caso de requerir DAA, el interesado deberá radicar el estudio de que trata el artículo 19 del presente decreto, junto con una copia del documento de identificación y el certificado de existencia y representación legal, en caso de ser persona jurídica. Recibida la anterior información, la autoridad ambiental competente dentro de los cinco (5) días siguientes a su presentación dictará un acto administrativo de inicio de trámite de evaluación de Diagnóstico Ambiental de Alternativas, DAA, auto que será publicado en los términos del artículo 70 de la Ley 99 de 1993.

Para proyectos hidroeléctricos, se deberá presentar copia del registro correspondiente expedido por la Unidad de Planeación Minero Energética (UPME); así mismo la autoridad ambiental competente solicitará a esta entidad concepto técnico relativo al potencial energético de las diferentes alternativas. En este caso se suspenderán los términos que tiene la autoridad ambiental para decidir, mientras dicha entidad realiza el respectivo pronunciamiento.

3. Ejecutoriado el auto de inicio de trámite, la autoridad ambiental competente en un plazo de treinta (30) días hábiles, evaluará el DAA y elegirá la alternativa sobre la cual deberá elaborarse el

correspondiente Estudio de Impacto Ambiental y fijará los términos de referencia respectivos, mediante acto administrativo que se publicará en los términos del artículo 71 de la Ley 99 de 1993.

Artículo 24º. De la solicitud de licencia ambiental y sus requisitos. En los casos en que no se requiera pronunciamiento sobre la exigibilidad del Diagnóstico Ambiental de Alternativas (DAA) o una vez surtido dicho procedimiento, el interesado en obtener Licencia Ambiental deberá radicar ante la autoridad ambiental competente, el Estudio de Impacto Ambiental de que trata el artículo 21 del presente decreto y anexar la siguiente documentación:

1. Formulario Único de Licencia Ambiental.
2. Plano de localización del proyecto, obra o actividad, con base en la cartografía del Instituto Geográfico Agustín Codazzi (IGAC)
3. Costo estimado de inversión y operación del proyecto.
4. Poder debidamente otorgado cuando se actúe por medio de apoderado.
5. Constancia de pago para la prestación del servicio de evaluación de la licencia ambiental. Para las solicitudes radicadas ante el Ministerio de Ambiente, Vivienda y Desarrollo Territorial, se deberá realizar la autoliquidación previo a la presentación de la solicitud de licencia ambiental.
6. Documento de identificación o certificado de existencia y representación legal, en caso de personas jurídicas.
7. Certificado del Ministerio del Interior y de Justicia sobre presencia o no de comunidades étnicas en el área de influencia del proyecto.
8. Certificado del Incoder sobre la existencia o no de territorios legalmente titulados a resguardos indígenas o títulos colectivos pertenecientes a comunidades afrocolombianas en el área de influencia del proyecto.
9. Copia de la radicación ante el Instituto Colombiano de Arqueología e Historia, ICANH, del Programa de Arqueología Preventiva, en los casos en que sea exigible dicho programa de conformidad con la Ley 1185 de 2008;

Parágrafo 1º. Los interesados en la ejecución de proyectos mineros deberán allegar copia del título minero y/o el contrato de concesión minera debidamente otorgado e inscrito en el Registro Minero Nacional. Así mismo los interesados en la ejecución de proyectos de hidrocarburos deberán allegar copia del contrato respectivo.

Parágrafo 2º. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial dentro de los tres (3) meses siguientes a la publicación del presente decreto, actualizará el Formato Único Nacional de Solicitud de Licencia Ambiental.

Parágrafo 3º. Una vez, entre en operación la Ventanilla Integral de Trámites Ambientales en Línea (VITAL) de que trata el artículo 46, se indicará la documentación que deberá ser adjuntada o diligenciada a través de dicho aplicativo.

Parágrafo 4º. Cuando se trate de proyectos, obras o actividades de competencia del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, el peticionario deberá igualmente radicar una copia del Estudio de Impacto Ambiental ante las respectivas autoridades ambientales regionales. De la anterior radicación se deberá allegar constancia al Ministerio en el momento de la solicitud de Licencia Ambiental.

Parágrafo 5º. Las solicitudes de Licencia Ambiental para proyectos de explotación minera de carbón, deberán incluir los estudios sobre las condiciones del modo de transporte desde el sitio de explotación de carbón hasta el puerto de embarque del mismo, de acuerdo con lo establecido en el Decreto 3083 de 2007 o la norma que lo modifique o sustituya.

Artículo 25º. De la evaluación del estudio de impacto ambiental. Una vez realizada la solicitud de Licencia Ambiental se surtirá el siguiente procedimiento:

1. A partir de la fecha de radicación del Estudio de Impacto Ambiental con el lleno de los requisitos establecidos para el efecto en los artículos 21 y 24 del presente decreto, la autoridad ambiental competente, contará con cinco (5) días hábiles para expedir el auto de inicio de trámite de Licencia Ambiental el cual deberá publicarse en los términos del artículo 70 de la Ley 99 de 1993.

2. Ejecutoriado el auto de inicio de trámite, dentro de los quince (15) días hábiles siguientes la autoridad ambiental, solicitará a otras autoridades o entidades los conceptos técnicos o informaciones pertinentes, que deben ser remitidos en un plazo no superior a veinte (20) días hábiles, contados desde la fecha de radicación de la comunicación correspondiente.

3. Recibida la información o vencido el término de requerimiento de informaciones a otras autoridades o entidades, la autoridad ambiental podrá solicitar al interesado dentro de los veinte (20) días hábiles siguientes mediante el correspondiente acto administrativo, la información adicional que se considere pertinente. En este caso se suspenderán los términos que tiene la autoridad para decidir de conformidad con lo establecido en el artículo 12 y 13 del C.C.A. (Código Contencioso Administrativo – Decreto 1 de 1984).

4. Allegada la información por parte del interesado, la autoridad ambiental en un término de cinco (5) días hábiles expedirá el auto de trámite que declare reunida toda la información requerida para decidir.

Así mismo, el interesado podrá hasta antes de la expedición del citado auto, aportar nuevos documentos o informaciones relacionados con el proyecto, obra o actividad, caso en el cual los plazos y términos que tiene la autoridad para decidir comenzarán a contarse desde la ejecutoria del auto que da inicio al trámite siempre y cuando dicha información implique una nueva visita de evaluación o un nuevo requerimiento por parte de la autoridad ambiental a cargo.

5. La autoridad ambiental competente decidirá la viabilidad del proyecto, obra o actividad, en un término no mayor a veinticinco (25) días hábiles, contados a partir de la expedición del auto que declare reunida la información, la cual será publicada en los términos del artículo 71 de la Ley 99 de 1993.

6. Contra la resolución por la cual se otorga o se niega la Licencia Ambiental procede el recurso de reposición ante la misma autoridad ambiental que profirió el acto.

Parágrafo 1º. Al efectuar el cobro del servicio de evaluación, las autoridades ambientales tendrán en cuenta el sistema y método de cálculo establecido en el artículo 96 de la Ley 633 de 2000 y sus normas reglamentarias.

Parágrafo 2º. Cuando se trate de proyectos, obras o actividades de competencia del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, la autoridad o autoridades ambientales con jurisdicción en el área del proyecto en donde se pretenda hacer uso y/o aprovechamiento de los recursos naturales renovables tendrán un término máximo de treinta (30) días hábiles, contados a partir de la radicación del Estudio de Impacto Ambiental por parte del usuario, para emitir el respectivo concepto sobre los mismos y enviarlo al Ministerio.

Así mismo, y en el evento en que se haya hecho requerimiento de información adicional sobre el uso y/o aprovechamiento de los recursos naturales renovables, las autoridades ambientales de que trata el presente parágrafo deberán en un término máximo de quince (15) días hábiles, contados a partir de la radicación de la información adicional por parte del interesado, emitir el correspondiente concepto técnico sobre los mismos.

Una vez vencido el término antes indicado sin que las autoridades se hayan pronunciado el Ministerio procederá a pronunciarse en la licencia ambiental.

Parágrafo 3º. En el evento en que durante el trámite de licenciamiento ambiental se solicite o sea necesaria la celebración de una audiencia pública ambiental de conformidad con lo establecido en el artículo 72 de la Ley 99 de 1993 y el Decreto 330 de 2007 o la norma que lo modifique o sustituya, se suspenderán los términos que tiene la autoridad del edicto a través del cual se convoca la audiencia pública hasta el día de su celebración.

Artículo 26º. Superposición de proyectos. La autoridad ambiental competente podrá otorgar licencia ambiental a proyectos cuyas áreas se superpongan con proyectos licenciados, siempre y cuando el interesado en el proyecto a licenciar demuestre que estos pueden coexistir e identifique además, el manejo y la responsabilidad individual de los impactos ambientales generados en el área superpuesta. Para el efecto el interesado en el proyecto a licenciar deberá informar a la autoridad ambiental sobre la superposición, quien a su vez, deberá comunicar tal situación al titular de la licencia ambiental objeto de superposición con el fin de que conozca dicha situación y pueda pronunciarse al respecto en los términos de ley.

Artículo 27º. De las Corporaciones Autónomas de Desarrollo Sostenible. En desarrollo de lo dispuesto en los artículos 34, 35 y 36 de la Ley 99 de 1993, para el otorgamiento de las licencias ambientales relativas a explotaciones mineras y de construcción de infraestructura vial, las Corporaciones Autónomas de Desarrollo Sostenible, a que hacen referencia los citados artículos, deberán de manera previa al otorgamiento enviar al Ministerio de Ambiente, Vivienda y Desarrollo Territorial, el proyecto de acto administrativo que decida sobre la viabilidad del proyecto, junto con el concepto técnico y el acta en donde se pone en conocimiento del Consejo Directivo el proyecto.

El Ministerio en un término máximo de veinte (20) días hábiles contados a partir de su radicación, deberá emitir el correspondiente concepto de aprobación del proyecto para que sea tenido en cuenta por parte de la autoridad ambiental.

Una vez emitido el mencionado concepto, la autoridad ambiental competente deberá decidir sobre la viabilidad del proyecto en los términos de lo dispuesto en los numerales 5 y 6 del artículo 25 del presente decreto.

Artículo 28º. Contenido de la licencia ambiental. El acto administrativo en virtud del cual se otorga una licencia ambiental contendrá:

1. La identificación de la persona natural o jurídica, pública o privada a quién se autoriza la ejecución o desarrollo de un proyecto, obra o actividad, indicando el nombre o razón la ejecución o desarrollo de un proyecto, obra o actividad, indicando el nombre o razón social, documento de identidad y domicilio.
2. El objeto general y localización del proyecto, obra o actividad.
3. Un resumen de las consideraciones y motivaciones de orden ambiental que han sido tenidas en cuenta para el otorgamiento de la licencia ambiental.
4. Lista de las diferentes actividades y obras que se autorizan con la licencia ambiental.
5. Los recursos naturales renovables que se autoriza utilizar, aprovechar y/o afectar, así mismo las condiciones, prohibiciones y requisitos de su uso.
6. Los requisitos, condiciones y obligaciones adicionales al Plan de Manejo Ambiental presentado que debe cumplir el beneficiario de la licencia ambiental durante la construcción, operación, mantenimiento, desmantelamiento y abandono y/o terminación del proyecto, obra o actividad.
7. La obligatoriedad de publicar el acto administrativo, conforme al artículo 71 de la Ley 99 de 1993.
8. Las demás que estime la autoridad ambiental competente.

LEY 697 DE 2001 (OCTUBRE 3 DE 2001) – CONGRESO DE LA REPÚBLICA DE COLOMBIA

Mediante la cual se fomenta el uso racional y eficiente de la energía, se promueve la utilización de energías alternativas y se dictan otras disposiciones.

Artículo 3º. Definiciones. Para efectos de interpretar y aplicar la presente ley se entiende por

9. Fuentes no convencionales de energía: Para efectos de la presente ley son fuentes no convencionales de energía, aquellas fuentes de energía disponibles a nivel mundial que son ambientalmente sostenibles, pero que en el país no son empleadas o son utilizadas de manera marginal y no se comercializan ampliamente.

13. Biomasa: Es cualquier tipo de materia orgánica que ha tenido su origen inmediato como consecuencia de un proceso biológico y toda materia vegetal originada por el proceso de fotosíntesis, así como de los procesos metabólicos de los organismos heterótrofos.

Artículo 10º. El Gobierno Nacional a través de los programas que se diseñen, incentivará y promoverá a las empresas que importen o produzcan piezas, calentadores, paneles solares, generadores de biogás, motores eólicos, y/o cualquier otra tecnología o producto que use como fuente total o parcial las energías no convencionales, ya sea con destino a la venta directa al público o a la producción de otros implementos, orientados en forma específica a proyectos en el campo URE, de acuerdo a las normas legales vigentes.

LEY 99 DE 1993 (DICIEMBRE 22 DE 1993) – CONGRESO DE LA REPÚBLICA DE COLOMBIA

Por la cual se crea el Ministerio del Medio Ambiente, se reordena el Sector Público encargado de la gestión y conservación del medio ambiente y los recursos naturales renovables, se organiza el Sistema Nacional Ambiental, SINA, y se dictan otras disposiciones.

Título VIII De las licencias ambientales

Artículo 49º. De la Obligatoriedad de la Licencia Ambiental. La ejecución de obras, el establecimiento de industrias o el desarrollo de cualquier actividad, que de acuerdo con la ley y los reglamentos, pueda producir deterioro grave a los recursos naturales renovables o al medio ambiente o introducir modificaciones considerables o notorias al paisaje requerirán de una Licencia Ambiental.

LEY 633 DE 2000 (DICIEMBRE 29 DE 2000) – CONGRESO DE LA REPÚBLICA DE COLOMBIA

Por la cual se expiden normas en materia tributaria, se dictan disposiciones sobre el tratamiento a los fondos obligatorios para la vivienda de interés social y se introducen normas para fortalecer las finanzas de la Rama Judicial.

Capítulo V Otras disposiciones

Artículo 96º. Tarifa de las licencias ambientales y otros instrumentos de control y manejo ambiental. Modifícase el artículo 28 de la Ley 344 de 1996, el cual quedará así:

“Artículo 28º. Las autoridades ambientales cobrarán los servicios de evaluación y los servicios de seguimiento de la licencia ambiental, permisos, concesiones, autorizaciones y demás instrumentos de control y manejo ambiental establecidos en la ley y los reglamentos.

Los costos por concepto de cobro de los citados servicios que sean cobrados por el Ministerio del Medio Ambiente entrarán a una subcuenta especial del Fonam y serán utilizados para sufragar los costos de evaluación y seguimiento en que deba incurrir el Ministerio para la prestación de estos servicios.

De conformidad con el artículo 338 de la Constitución Nacional para la fijación de las tarifas que se autorizan en este artículo, el Ministerio del Medio Ambiente y las autoridades ambientales aplicarán el sistema que se describe a continuación. La tarifa incluirá:

- a) El valor total de los honorarios de los profesionales requeridos para la realización de la tarea propuesta;
- b) El valor total de los viáticos y gastos de viaje de los profesionales que se occasionen para el estudio, la expedición, el seguimiento y/o el monitoreo de la licencia ambiental, permisos, concesiones o autorizaciones y demás instrumentos de control y manejo ambiental establecidos en la ley y los reglamentos;
- c) El valor total de los análisis de laboratorio u otros estudios y diseños técnicos que sean requeridos tanto para la evaluación como para el seguimiento.

Las autoridades ambientales aplicarán el siguiente método de cálculo: Para el literal a) se estimará el número de profesionales/mes o contratistas/mes y se aplicarán las categorías y tarifas de sueldos de contratos del Ministerio del Transporte y para el caso de contratistas Internacionales, las escalas tarifarias para contratos de consultoría del Banco Mundial o del PNUD; para el literal b) sobre un estimativo de visitas a la zona del proyecto se calculará el monto de los gastos de viaje necesarios, valorados de acuerdo con las tarifas del transporte público y la escala de viáticos del Ministerio del Medio Ambiente; para el literal c) el costo de los análisis de laboratorio u otros trabajos técnicos será incorporado en cada caso, de acuerdo con las cotizaciones específicas. A la sumatoria de estos tres costos a), b), y c) se le aplicará un porcentaje que anualmente fijará el Ministerio del Medio Ambiente por gastos de administración.

Las tarifas que se cobran por concepto de la prestación de los servicios de evaluación y de los servicios de seguimiento ambiental, según sea el caso, no podrán exceder los siguientes topes:

1. Aquellos que tengan un valor de dos mil ciento quince (2.115) salarios mínimos mensuales vigentes tendrán una tarifa máxima del cero punto seis por ciento (0.6%).
2. Aquellos que tengan un valor superior a los dos mil ciento quince (2.115) salarios mínimos mensuales vigentes e inferior a los ocho mil cuatrocientos cincuenta y ocho (8.458) salarios mínimos mensuales vigentes tendrán una tarifa máxima del cero punto cinco por ciento (0.5%).

3. Aquellos que tengan un valor superior a los ocho mil cuatrocientos cincuenta y ocho (8.458) salarios mínimos mensuales vigentes, tendrán una tarifa máxima del cero punto cuatro por ciento (0.4%).

Las autoridades ambientales prestarán los servicios ambientales de evaluación y seguimiento a que hace referencia el presente artículo a través de sus funcionarios o contratistas.

Los ingresos por concepto de los permisos de importación y exportación de especies de fauna y flora silvestres no Cites, los establecidos en la Convención Internacional sobre Comercio de Especies Amenazadas de Fauna y Flora Silvestres Cites, los de fabricación y distribución de sistemas de marcaje de especies de la biodiversidad y los ingresos percibidos por concepto de ecoturismo ingresarán al Fondo Nacional Ambiental, Fonam".

RESOLUCIÓN 1280 DE 2010 (JULIO 7 DE 2010) – MINISTERIO DE AMBIENTE, VIVIENDA Y DESARROLLO TERRITORIAL DE COLOMBIA

Por la cual se establece la escala tarifaria para el cobro de los servicios de evaluación y seguimiento de las licencias ambientales, permisos, concesiones, autorizaciones y demás instrumentos de manejo y control ambiental para proyectos cuyo valor sea inferior a 2.115 smmv (salarios mínimos mensuales) y se adopta la tabla única para la aplicación de los criterios definidos en el sistema y método definido en el artículo 96 de la Ley 633 para la liquidación de la tarifa.

Artículo 1º. Establecer la siguiente escala tarifaria para el cobro de los servicios de evaluación y seguimiento de las licencias ambientales, permisos, concesiones, autorizaciones y demás instrumentos de manejo y control ambiental que deban tramitar las Corporaciones Autónomas Regionales, las de Desarrollo Sostenible, los Grandes Centros Urbanos y las autoridades ambientales creadas mediante la Ley 768 de 2002, para proyectos, obras o actividades cuyo valor sea inferior a 2.115 salarios mínimos mensuales (smmv):

Valor proyecto Tarifa máxima	Valor proyecto Tarifa máxima
Menores a 25 SMMV	\$ 76,941.00
Igual o superior a 25 SMMV e inferior a 35 SMMV	\$ 1 07,841.00
Igual o superior a 35 SMMV e inferior a 50 SMMV	\$ 1 54,191.00
Igual o superior a 50 SMMV e inferior a 70 SMMV	\$ 2 15,991.00
Igual o superior a 70 SMMV e inferior a 100 SMMV	\$ 3 08,691.00
Igual o superior a 100 SMMV e inferior a 200 SMMV	\$ 6 17,691.00
Igual o superior a 200 SMMV e inferior a 300 SMMV	\$ 9 26,691.00
Igual o superior a 300 SMMV e inferior a 400 SMMV	\$ 1,235,691.00
Igual o superior a 400 SMMV e inferior a 500 SMMV	\$ 1,544,691.00
Igual o superior a 500 SMMV e inferior a 700 SMMV	\$ 2,162,691.00
Igual o superior a 700 SMMV e inferior a 900 SMMV	\$ 2,780,691.00
Igual o superior a 900 SMMV e inferior a 1500 SMMV	\$ 4,634,691.00
Igual o superior a 1500 SMMV e inferior a 2115 SMMV	\$ 6,535,041.00

Parágrafo. Las tarifas máximas establecidas en la escala tarifaria definida en el presente artículo, deberán ser actualizadas anualmente por las Corporaciones Autónomas Regionales, las de Desarrollo Sostenible, los Grandes Centros Urbanos y las autoridades ambientales creadas por la Ley 768 de 2002, de conformidad con el Índice de Precios al Consumidor (IPC), Total nacional del año inmediatamente anterior, fijado por el Departamento Administrativo Nacional de Estadística (DANE).

RESOLUCIÓN 0909 DE 2008 (JUNIO 5 DE 2008) – MINISTERIO DE AMBIENTE VIVIENDA Y DESARROLLO TERRITORIAL DE COLOMBIA

Por la cual se establecen las normas y estándares de emisión admisibles de contaminantes a la atmósfera por fuentes fijas y se dictan otras disposiciones.

Capítulo III

Estándares de emisión admisibles de contaminantes al aire para equipos de combustión externa

Artículo 7º. Estándares de emisión admisibles para equipos de combustión externa existentes. En la Tabla 4 se establecen los estándares de emisión admisibles para equipos de combustión externa existentes a condiciones de referencia, de acuerdo al tipo de combustible y con oxígeno de referencia del 11%.

Tabla 4

Estándares de emisión admisibles para equipos de combustión externa existentes a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 11%

Combustible	Estándares de emisión admisibles (mg/m ³)		
	MP	SO ₂	Nox
Sólido	200	500	350
Líquido	200	500	350
Gaseoso	NO APLICA	NO APLICA	350

Parágrafo. Las calderas existentes que tengan una producción de vapor superior a 25 toneladas por hora deben cumplir con los estándares de emisión admisibles establecidos en el artículo 13.

Artículo 8º. Estándares de emisión admisibles para equipos de combustión externa nuevos. En la Tabla 5 se establecen los estándares de emisión admisibles para equipos de combustión externa nuevos a condiciones de referencia, de acuerdo al tipo de combustible y con oxígeno de referencia del 11%.

Tabla 5

Estándares de emisión admisibles para equipos de combustión externa nuevos, a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 11%

Combustible	Estándares de emisión admisibles (mg/m3)		
	MP	SO2	NOx
Sólido	50	500	350
Líquido	50	500	350
Gaseoso	NO APLICA	NO APLICA	350

Parágrafo. Las calderas nuevas que tengan una producción de vapor superior a 25 toneladas por hora deben cumplir con los estándares de emisión admisibles establecidos en el artículo 14.

Capítulo IV

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas con capacidad instalada igual o superior a 20 MW

Artículo 9º. Estándares de emisión admisibles de contaminantes al aire para centrales térmicas existentes con capacidad instalada igual o superior a 20 MW. En la Tabla 6 se establecen los estándares de emisión admisibles para cada uno de los puntos de descarga de las centrales térmicas existentes con capacidad igual o superior a 20 MW por tipo de combustible y condiciones de referencia. Los datos medidos serán corregidos al oxígeno de referencia correspondiente.

Tabla 6

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas existentes con capacidad instalada igual o superior a 20 MW por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	100	2800	760	6%
Líquido	100	2000	650	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Artículo 10º. Estándares de emisión admisibles de contaminantes al aire para centrales térmicas nuevas con capacidad instalada igual o superior a 20 MW. En la Tabla 7 se establecen los estándares de emisión admisibles para cada uno de los puntos de descarga de las centrales térmicas nuevas con capacidad igual o superior a 20 MW, por tipo de combustible y condiciones de referencia. Los datos medidos serán corregidos al oxígeno de referencia correspondiente.

Tabla 7

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas nuevas con capacidad igual o superior a 20 MW por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	50	2000	600	6%
Líquido	50	2000	450	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Artículo 11º. Centrales térmicas que utilicen turbinas a gas con capacidad igual o superior a 20 MW. En la Tabla 8 se establecen los estándares de emisión admisibles para centrales térmicas nuevas y existentes que utilicen turbinas a gas con capacidad igual o superior a 20 MW, por tipo de combustible a condiciones de referencia y oxígeno de referencia del 15%. Dichos estándares deben cumplirse en cada uno de los puntos de descarga de las centrales térmicas que utilicen turbinas a gas.

Tabla 8

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas nuevas y existentes que utilicen turbinas a gas con capacidad instalada igual o superior a 20 MW por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 15%

Combustible	Estándares de emisión admisibles (mg/m ³)		
	MP	SO ₂	NO _x
Gaseoso	NO APLICA	NO APLICA	120
Líquido	NO APLICA	850	300

Artículo 12º. Características de las mediciones directas para las centrales térmicas. La frecuencia de las mediciones directas en las centrales térmicas debe determinarse de acuerdo con las recomendaciones de los fabricantes, en función del número de horas equivalentes de operación, al finalizar el mantenimiento de la zona caliente recomendado por el mismo. El término horas equivalentes de operación hace referencia a un concepto técnico que define cada fabricante, en donde se establecen los límites seguros para los mantenimientos de las plantas en función de las horas de operación de la planta y del número de arranques y paradas de la misma.

Parágrafo. La unidad de la central térmica que haya sido objeto de mantenimiento en la zona caliente, debe realizar una medición directa a plena carga para evaluar la emisión de los gases contaminantes reglamentados en esta resolución, antes de iniciar nuevamente su operación.

Capítulo V

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas con capacidad instalada inferior a 20 MW y plantas de cogeneración

Artículo 13º. Estándares de emisión admisibles de contaminantes al aire para centrales térmicas con capacidad instalada inferior a 20 MW y plantas de cogeneración existentes. En la Tabla 9 se establecen los estándares de emisión admisibles para cada uno de los puntos de descarga de las centrales térmicas existentes con capacidad instalada inferior a 20 MW y plantas de cogeneración existentes, por tipo de combustible y condiciones de referencia. Los datos medidos serán corregidos al oxígeno de referencia correspondiente.

Tabla 9

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas con capacidad instalada inferior a 20 MW y plantas de cogeneración existentes, por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	100	2800	760	6%
Líquido	100	2000	650	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Artículo 14º. Estándares de emisión admisibles de contaminantes al aire para centrales térmicas con capacidad instalada inferior a 20 MW y plantas de cogeneración nuevas. En la Tabla 10 se establecen los estándares de emisión admisibles para cada uno de los puntos de descarga de las centrales térmicas nuevas con capacidad instalada inferior a 20 MW y plantas de cogeneración nuevas, por tipo de combustible y condiciones de referencia. Los datos medidos serán corregidos al oxígeno de referencia correspondiente.

Tabla 10

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas nuevas con capacidad instalada inferior a 20 MW y plantas de cogeneración nuevas, por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	50	2000	600	6%
Líquido	50	2000	450	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Artículo 15º. Centrales térmicas que utilicen turbinas a gas con capacidad inferior a 20 MW. En la Tabla 11 se establecen los estándares de emisión admisibles para centrales térmicas nuevas y existentes que utilicen turbinas a gas con capacidad inferior a 20 MW, por tipo de combustible a condiciones de referencia y oxígeno de referencia del 15%. Dichos estándares deben cumplirse en cada uno de los puntos de descarga de las centrales térmicas.

Tabla 11

Estándares de emisión admisibles de contaminantes al aire para centrales térmicas nuevas y existentes que utilicen turbinas a gas con capacidad instalada inferior a 20 MW por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 15%

Combustible	Estándares de emisión admisibles (mg/m3)		
	MP	SO2	NOx
Gaseoso	NO APLICA	NO APLICA	120
Líquido	NO APLICA	850	300

Capítulo VII

Estándares de emisión admisibles de contaminantes al aire para equipos de combustión externa que utilicen biomasa como combustible

Artículo 18º. Estándares de emisión admisibles para equipos de combustión externa existentes que utilicen biomasa como combustible. En la Tabla 14 se establecen los estándares de emisión admisibles para equipos de combustión externa existentes que utilicen biomasa como combustible a condiciones de referencia, con oxígeno de referencia del 13%.

Tabla 14

Estándares de emisión admisibles para equipos de combustión externa existentes que utilicen biomasa como combustible a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 13%

Combustible	Producción de vapor (t/h)	Estándares de emisión admisibles (mg/m3)	
		MP	NOx
Biomasa	TODOS	300	350

Artículo 19º. Estándares de emisión admisibles para equipos de combustión externa nuevos que utilicen biomasa como combustible. En la Tabla 15 se establecen los estándares de emisión admisibles para equipos de combustión externa nuevos que utilicen biomasa como combustible a condiciones de referencia, con oxígeno de referencia del 13%.

Tabla 15

Estándares de emisión admisibles para equipos de combustión externa nuevos que utilicen biomasa como combustible a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 13%

Combustible	Producción de vapor (t/h)	Estándares de emisión admisibles (mg/m3)	
		MP	NOx
Biomasa	TODOS	50	350

Artículo 20º. Control de Variables. Aquellos procesos e instalaciones que utilicen biomasa como combustible en sus procesos de combustión deberán controlar las siguientes variables: porcentaje en peso de humedad de la biomasa, temperatura de los gases de chimenea y poder calorífico de la biomasa (en base seca).

Artículo 21º. Mezcla de combustibles. Cuando un equipo de combustión externa que utilice biomasa como combustible, use adicionalmente otro combustible en proporción superior al 5%, deberá cumplir con lo establecido en el CAPITULO III de la presente resolución.

Capítulo VIII

Estándares de emisión admisibles de contaminantes al aire para la fabricación de productos de la refinación del petróleo

Artículo 22º. Estándares de emisión admisibles de contaminantes al aire para las actividades existentes de fabricación de productos de la refinación del petróleo. En la Tabla 16 se establecen los estándares de emisión admisibles para las actividades existentes de fabricación de productos de la refinación del petróleo, por tipo de combustible a condiciones de referencia y el oxígeno de referencia con base en el cual se debe realizar la corrección de oxígeno posterior a la medición. Dichos estándares deben cumplirse en cada uno de los puntos de descarga de las actividades de refinación.

Tabla 16

Estándares de emisión admisibles de contaminantes al aire para las actividades existentes de fabricación de productos de la refinación del petróleo por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	170	2800	760	6%
Líquido	170	2000	650	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Artículo 23º. Estándares de emisión admisibles de contaminantes al aire para las actividades nuevas de fabricación de productos de la refinación del petróleo. En la Tabla 17 se establecen los estándares de emisión admisibles para las actividades nuevas de fabricación de productos de la refinación del petróleo, por tipo de combustible a condiciones de referencia y el oxígeno de referencia con base en el cual se debe realizar la corrección de oxígeno posterior a la medición. Dichos estándares deben cumplirse en cada uno de los puntos de descarga de las actividades de refinación.

Tabla 17

Estándares de emisión admisibles de contaminantes al aire para las actividades nuevas de fabricación de productos de la refinación del petróleo por tipo de combustible, a condiciones de referencia (25°C, 760 mm Hg)

Combustible	Estándares de emisión admisibles (mg/m3)			Oxígeno de referencia
	MP	SO2	NOx	
Sólido	50	1700	600	6%
Líquido	50	1700	450	3%
Gaseoso	NO APLICA	NO APLICA	300	3%

Capítulo XIII

Estándares de emisión admisibles de contaminantes al aire para instalaciones donde se realice tratamiento térmico a residuos no peligrosos

Artículo 54º. Temperaturas de operación. La temperatura de la cámara de combustión en las instalaciones de incineración de residuos no peligrosos debe ser superior a 800 °C y la temperatura de la cámara de poscombustión debe ser superior a 1200 °C.

Artículo 55º. Tiempo de retención en la cámara de poscombustión. El tiempo de retención en la cámara de poscombustión para las instalaciones de incineración de residuos no peligrosos debe ser igual o superior a dos (2) segundos.

Artículo 56º. Estándares de emisión admisibles de contaminantes para instalaciones de incineración de residuos no peligrosos. En la Tabla 33 se establecen los estándares de emisión admisibles de contaminantes para instalaciones de incineración de residuos no peligrosos a condiciones de referencia con oxígeno de referencia del 11%.

Tabla 33

Estándares de emisión admisibles de contaminantes al aire para instalaciones de incineración de residuos no peligrosos a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 11%

Instalaciones de incineración de residuos no peligrosos	Promedio	Estándares de emisión admisibles (mg/m ³)							
		MP	SO ₂	NOx	CO	HCl	HF	Hg	HCT
Instalaciones de incineración con capacidad igual o mayor a 500 kg/hora	Promedio diario	10	50	200	50	10	1	0,03	10
	Promedio horario	20	200	400	100	40	4	0,05	20
Instalaciones de incineración con capacidad menor a 500 kg/hora	Promedio diario	15	50	200	50	15	1	0,05	10
	Promedio horario	30	200	400	100	60	4	0,1	20

Parágrafo. El estándar de emisión admisible para dioxinas y furanos es de 0,5 (ng-TEQ/m³) a condiciones de referencia (25°C, 760 mm Hg) con oxígeno de referencia del 11% y su cumplimiento se debe verificar de acuerdo con lo establecido en el artículo 5º de la presente resolución.

Artículo 57º. Estándares de emisión admisibles de metales pesados en instalaciones de incineración de residuos no peligrosos. Las instalaciones de incineración de residuos no peligrosos deben cumplir un

estándar de emisión admisible para la sumatoria de Cadmio (Cd), Talio (Tl) y sus compuestos de 0,05 mg/m³ y para la sumatoria de metales de 0,5 mg/m³, a condiciones de referencia (25°C, 760 mm Hg).

Parágrafo. Para la determinación de metales, se debe contemplar la sumatoria de los siguientes metales y sus compuestos: Arsénico (As), Plomo (Pb), Cromo (Cr), Cobalto (Co), Níquel (Ni), Vanadio (V), Cobre (Cu), Manganese (Mn), Antimonio (Sb), Estaño (Sn).

Artículo 58º. Temperatura de los gases de salida en la cámara de poscombustión. Todas las instalaciones de incineración de residuos no peligrosos deben contar con un sistema que registre de forma automática la temperatura de los gases de salida en la cámara de poscombustión; esta temperatura debe ser inferior a 250 °C. Si el registro de dicha temperatura está por encima de este valor se debe instalar un sistema de enfriamiento que reduzca la temperatura como máximo hasta 250 °C.

Artículo 59º. Estándares de emisión admisibles para instalaciones que incineren residuos no peligrosos con deficiencia de oxígeno (pirólisis o termólisis). Las instalaciones que incineren residuos no peligrosos con deficiencia de oxígeno (pirólisis o termólisis) deben realizar la corrección de oxígeno posterior a la medición al 3% de oxígeno y deben cumplir con los estándares de emisión admisibles establecidos en la Tabla 33.

Artículo 60º. Tratamiento térmico de residuos no peligrosos en hornos cementeros. Se permitirá el tratamiento térmico de residuos no peligrosos en hornos cementeros que realicen coprocesamiento, siempre y cuando cumplan con los estándares de emisión establecidos en el presente capítulo.

DECRETO 3930 DE 2010 (OCTUBRE 25 DE 2010) – PRESIDENCIA DE LA REPÚBLICA DE COLOMBIA

Por el cual se reglamenta parcialmente el Título I de la Ley 9^a de 1979, así como el Capítulo II del Título VI -Parte III-Libro II del Decreto-ley 2811 de 1974 en cuanto a usos del agua y residuos líquidos y se dictan otras disposiciones.

Capítulo III Del Ordenamiento del Recurso Hídrico

Artículo 4º. Ordenamiento del Recurso Hídrico. La Autoridad Ambiental Competente deberá realizar el Ordenamiento del Recurso Hídrico con el fin de realizar la clasificación de las aguas superficiales, subterráneas y marinas, fijar en forma genérica su destinación a los diferentes usos de que trata el artículo 9º del presente decreto y sus posibilidades de aprovechamiento.

Entiéndase como Ordenamiento del Recurso Hídrico, el proceso de planificación del mismo, mediante el cual la autoridad ambiental competente:

1. Establece la clasificación de las aguas.

2. Fija su destinación y sus posibilidades de uso, con fundamento en la priorización definida para tales efectos en el artículo 41 del Decreto 1541 de 1978.
3. Define los objetivos de calidad a alcanzar en el corto, mediano y largo plazo.
4. Establece las normas de preservación de la calidad del recurso para asegurar la conservación de los ciclos biológicos y el normal desarrollo de las especies.
5. Determina los casos en que deba prohibirse el desarrollo de actividades como la pesca, el deporte y otras similares, en toda la fuente o en sectores de ella, de manera temporal o definitiva.
6. Fija las zonas en las que se prohibirá o condicionará, la descarga de aguas residuales o residuos líquidos o gaseosos, provenientes de fuentes industriales o domésticas, urbanas o rurales, en las aguas superficiales, subterráneas, o marinas.
7. Establece el programa de seguimiento al recurso hídrico con el fin de verificar la eficiencia y efectividad del ordenamiento del recurso.

Parágrafo 1º. Para efectos del ordenamiento de que trata el presente capítulo, el cuerpo de agua y/o acuífero es un ecosistema. Cuando dos (2) o más autoridades ambientales tengan jurisdicción sobre un mismo cuerpo de agua y/o acuífero, establecerán la comisión conjunta de que trata el parágrafo 3º del artículo 33 de la Ley 99 de 1993, la cual ejercerá las mismas funciones para el ecosistema común previstas en el Decreto 1604 de 2002, o aquella que la adicione, modifique o sustituya, para las cuencas hidrográficas comunes.

Parágrafo 2º. Para el ordenamiento de las aguas marinas se tendrán en cuenta los objetivos derivados de los compromisos internacionales provenientes de tratados o convenios internacionales ratificados por Colombia, incluidos aquellos cuya finalidad es prevenir, controlar y mitigar la contaminación del medio marino.

Artículo 5º. Criterios de Priorización para el Ordenamiento del Recurso Hídrico. La autoridad ambiental competente, priorizará el Ordenamiento del Recurso Hídrico de su jurisdicción, teniendo en cuenta como mínimo lo siguiente:

1. Cuerpos de agua y/o acuíferos objeto de ordenamiento definidos en la formulación de Planes de Ordenación y Manejo de Cuencas Hidrográficas.
2. Cuerpos de agua donde la autoridad ambiental esté adelantando el proceso para el establecimiento de las metas de reducción de que trata el Decreto 3100 de 2003 o la norma que lo modifique o sustituya.
3. Cuerpos de agua y/o acuíferos en donde se estén adelantando procesos de reglamentación de uso de las aguas o en donde estos se encuentren establecidos.
4. Cuerpos de agua en donde se estén adelantando procesos de reglamentación de vertimientos o en donde estos se encuentren establecidos.

5. Cuerpos de agua y/o acuíferos que sean declarados como de reserva o agotados, según lo dispuesto por el Capítulo II del Título V del Decreto 1541 de 1978 o la norma que lo modifique, adicione, o sustituya.
6. Cuerpos de agua y/o acuíferos en los que exista conflicto por el uso del recurso.
7. Cuerpos de agua y/o acuíferos que abastezcan poblaciones mayores a 2.500 habitantes.
8. Cuerpos de agua y/o acuíferos que presenten índices de escasez de medio a alto y/o que presenten evidencias de deterioro de la calidad del recurso que impidan su utilización.
9. Cuerpos de agua cuya calidad permita la presencia y el desarrollo de especies hidrobiológicas importantes para la conservación y/o el desarrollo socioeconómico.

Una vez priorizados los cuerpos de agua objeto de ordenamiento, se deberá proceder a establecer la gradualidad para adelantar este proceso.

Parágrafo. Esta priorización y la gradualidad con que se desarrollará, deberán ser incluidas en el Plan de Gestión Ambiental Regional (PGAR) de la respectiva Corporación Autónoma Regional o de Desarrollo Sostenible regulado por el Decreto 1200 de 2004 o en el instrumento de planificación de largo plazo de la Autoridad Ambiental Urbana respectiva, de acuerdo con la reglamentación vigente en la materia. Igualmente en los planes de acción de estas autoridades deberá incluirse como proyecto el ordenamiento de los cuerpos de agua y/o acuíferos.

Artículo 6º. Aspectos mínimos del Ordenamiento del Recurso Hídrico. Para adelantar el proceso de Ordenamiento del Recurso Hídrico, la autoridad ambiental competente deberá tener en cuenta como mínimo:

1. Identificación del cuerpo de agua de acuerdo con la codificación establecida en el mapa de zonificación hidrográfica del país.
2. Identificación del acuífero.
3. Identificación de los usos existentes y potenciales del recurso.
4. Los objetivos de calidad donde se hayan establecido.
5. La oferta hídrica total y disponible, considerando el caudal ambiental.
6. Riesgos asociados a la reducción de la oferta y disponibilidad del recurso hídrico.
7. La demanda hídrica por usuarios existentes y las proyecciones por usuarios nuevos.
8. La aplicación y calibración de modelos de simulación de la calidad del agua, que permitan determinar la capacidad asimilativa de sustancias biodegradables o acumulativas y la capacidad de dilución de sustancias no biodegradables y/o utilización de índices de calidad del agua, de acuerdo con la información disponible.
9. Aplicación de modelos de flujo para aguas subterráneas.

10. Los criterios de calidad y las normas de vertimiento vigentes en el momento del ordenamiento.
11. Lo dispuesto en el Decreto 1541 de 1978 con relación a las concesiones y/o la reglamentación del uso de las aguas existentes.
12. Las características naturales del cuerpo de agua y/o acuífero para garantizar su preservación y/o conservación.
13. Los permisos de vertimiento y/o la reglamentación de los vertimientos, planes de cumplimiento y/o planes de saneamiento y manejo de vertimientos al cuerpo de agua.
14. La declaración de reservas y/o agotamiento.
15. La clasificación de las aguas, de conformidad con lo dispuesto en el artículo 205 del Decreto 1541 de 1978 o de la norma que lo modifique, adicione o sustituya.
16. La zonificación ambiental resultante del Plan de Ordenación y Manejo de la Cuenca Hidrográfica.
17. Los demás factores pertinentes señalados en los Decretos 2811 de 1974, 1729 de 2002, 1875 de 1979 y 1541 de 1978 o las normas que los modifiquen, adicionen o sustituyan.

Parágrafo 1º. La identificación de los usos existentes o potenciales, debe hacerse teniendo en cuenta las características físicas, químicas, biológicas, su entorno geográfico, cualidades escénicas y paisajísticas, las actividades económicas y las normas de calidad necesarias para la protección de flora y fauna acuática.

Parágrafo 2º. El ordenamiento de los cuerpos de agua y/o acuífero deberá incluir los afluentes o zonas de recarga de los mismos.

Artículo 7º. De los modelos simulación de la calidad del recurso hídrico. Para efectos del Ordenamiento del Recurso Hídrico, previsto en el artículo anterior y para la aplicación de modelos de simulación de la calidad del recurso, el Ministerio de Ambiente, Vivienda y Desarrollo Territorial expedirá dentro de los ocho (8) meses, contados a partir de la fecha de publicación de este decreto, la Guía Nacional de Modelación del Recurso Hídrico, con base en los insumos que aporte el Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM).

Parágrafo. Mientras el Ministerio de Ambiente, Vivienda y Desarrollo Territorial, expide la Guía Nacional de Modelación del Recurso Hídrico, las autoridades ambientales competentes podrán seguir aplicando los modelos de simulación existentes que permitan determinar la capacidad asimilativa de sustancias biodegradables o acumulativas y la capacidad de dilución de sustancias no biodegradables, utilizando, por lo menos los siguientes parámetros:

1. DBO5: Demanda bioquímica de oxígeno a cinco (5) días.
2. DQO: Demanda química de oxígeno.
3. SS: Sólidos suspendidos.
4. pH: Potencial del Ion hidronio, H⁺

5. T: Temperatura.
6. OD: Oxígeno disuelto.
7. Q: Caudal.
8. Datos Hidrobiológicos.
9. Coliformes Totales y Coliformes Fecales.

Artículo 8º. Proceso de Ordenamiento del Recurso Hídrico. El Ordenamiento del Recurso Hídrico por parte de la autoridad ambiental competente se realizará mediante el desarrollo de las siguientes fases:

1. Declaratoria de ordenamiento. Una vez establecida la prioridad y gradualidad de ordenamiento del cuerpo de agua de que se trate, la autoridad ambiental competente mediante resolución, declarará en ordenamiento el cuerpo de agua y/o acuífero y definirá el cronograma de trabajo, de acuerdo con las demás fases previstas en el presente artículo.

2. Diagnóstico. Fase en la cual se caracteriza la situación ambiental actual del cuerpo de agua y/o acuífero, involucrando variables físicas, químicas y bióticas y aspectos antrópicos que influyen en la calidad y la cantidad del recurso.

Implica por lo menos la revisión, organización, clasificación y utilización de la información existente, los resultados de los programas de monitoreo de calidad y cantidad del agua en caso de que existan, los censos de usuarios, el inventario de obras hidráulicas, la oferta y demanda del agua, el establecimiento del perfil de calidad actual del cuerpo de agua y/o acuífero, la determinación de los problemas sociales derivados del uso del recurso y otros aspectos que la autoridad ambiental competente considere pertinentes.

3. Identificación de los usos potenciales del recurso. A partir de los resultados del diagnóstico, se deben identificar los usos potenciales del recurso en función de sus condiciones naturales y los conflictos existentes o potenciales.

Para tal efecto se deben aplicar los modelos de simulación de la calidad del agua para varios escenarios probables, los cuales deben tener como propósito la mejor condición natural factible para el recurso. Los escenarios empleados en la simulación, deben incluir los aspectos ambientales, sociales, culturales y económicos, así como la gradualidad de las actividades a realizar, para garantizar la sostenibilidad del Plan de Ordenamiento del Recurso Hídrico.

4. Elaboración del Plan de Ordenamiento del Recurso Hídrico. La autoridad ambiental competente, con fundamento en la información obtenida del diagnóstico y de la identificación de los usos potenciales del cuerpo de agua y/o acuífero, elaborará un documento que contenga como mínimo:

- a) La clasificación del cuerpo de agua en ordenamiento.
- b) El inventario de usuarios.
- c) El uso o usos a asignar.

- d) Los criterios de calidad para cada uso.
- e) Los objetivos de calidad a alcanzar en el corto, mediano y largo plazo.
- f) Las metas quinquenales de reducción de cargas contaminantes de que trata el Decreto 3100 de 2003, o la norma que lo modifique, adicione o sustituya.
- g) La articulación con el Plan de Ordenación de Cuencas Hidrográficas en caso de existir y,
- h) El programa de seguimiento y monitoreo del Plan de Ordenamiento del Recurso Hídrico.

El Plan de Ordenamiento del Recurso Hídrico será adoptado mediante resolución.

Parágrafo 1º. En todo caso, el Plan de Ordenamiento del Recurso Hídrico deberá definir la conveniencia de adelantar la reglamentación del uso de las aguas, de conformidad con lo establecido en el artículo 108 del Decreto 1541 de 1978 y la reglamentación de vertimientos según lo dispuesto en el presente decreto o de administrar el cuerpo de agua a través de concesiones de agua y permisos de vertimiento. Así mismo, dará lugar al ajuste de la reglamentación del uso de las aguas, de la reglamentación de vertimientos, de las concesiones, de los permisos de vertimiento, de los planes de cumplimiento y de los planes de saneamiento y manejo de vertimientos y de las metas de reducción, según el caso.

Parágrafo 2º. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial expedirá la Guía para el Ordenamiento del Recurso Hídrico, dentro de los ocho (8) meses contados a partir de la publicación del presente decreto.

Parágrafo 3º. El Plan de Ordenamiento del Recurso Hídrico, tendrá un horizonte mínimo de diez (10) años y su ejecución se llevará a cabo para las etapas de corto, mediano y largo plazo. La revisión y/o ajuste del plan deberá realizarse al vencimiento del período previsto para el cumplimiento de los objetivos de calidad y con base en los resultados del programa de seguimiento y monitoreo del Plan de Ordenamiento del Recurso Hídrico.

Capítulo IV **De la destinación genérica de las aguas superficiales, subterráneas y marinas**

Artículo 9º. Usos del agua. Para los efectos del presente decreto se tendrán en cuenta los siguientes usos del agua:

1. Consumo humano y doméstico.
2. Preservación de flora y fauna.
3. Agrícola.
4. Pecuario.
5. Recreativo.
6. Industrial.
7. Estético.
8. Pesca, Maricultura y Acuicultura.
9. Navegación y Transporte Acuático.

Parágrafo. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial dentro de los dieciocho (18) meses, contados a partir de la publicación del presente decreto, podrá definir nuevos usos, establecer la denominación y definir el contenido y alcance de los mismos.

Artículo 10º. Uso para consumo humano y doméstico. Se entiende por uso del agua para consumo humano y doméstico su utilización en actividades tales como:

1. Bebida directa y preparación de alimentos para consumo inmediato.
2. Satisfacción de necesidades domésticas, individuales o colectivas, tales como higiene personal y limpieza de elementos, materiales o utensilios.
3. Preparación de alimentos en general y en especial los destinados a su comercialización o distribución, que no requieran elaboración.

Artículo 11º. Uso para la preservación de flora y fauna. Se entiende por uso del agua para preservación de flora y fauna, su utilización en actividades destinadas a mantener la vida natural de los ecosistemas acuáticos y terrestres y de sus ecosistemas asociados, sin causar alteraciones sensibles en ellos.

Artículo 12º. Uso para pesca, maricultura y acuicultura. Se entiende por uso para pesca, maricultura y acuicultura su utilización en actividades de reproducción, supervivencia, crecimiento, extracción y aprovechamiento de especies hidrobiológicas en cualquiera de sus formas, sin causar alteraciones en los ecosistemas en los que se desarrollan estas actividades.

Artículo 13º. Uso agrícola. Se entiende por uso agrícola del agua, su utilización para irrigación de cultivos y otras actividades conexas o complementarias.

Artículo 14º. Uso pecuario. Se entiende por uso pecuario del agua, su utilización para el consumo del ganado en sus diferentes especies y demás animales, así como para otras actividades conexas y complementarias.

Artículo 15º. Uso recreativo. Se entiende por uso del agua para fines recreativos, su utilización, cuando se produce:

1. Contacto primario, como en la natación, buceo y baños medicinales.
2. Contacto secundario, como en los deportes náuticos y la pesca.

Artículo 16º. Uso industrial. Se entiende por uso industrial del agua, su utilización en actividades tales como:

1. Procesos manufactureros de transformación o explotación, así como aquellos conexos y complementarios.
2. Generación de energía.
3. Minería.

4. Hidrocarburos.
5. Fabricación o procesamiento de drogas, medicamentos, cosméticos, aditivos y productos similares.
6. Elaboración de alimentos en general y en especial los destinados a su comercialización o distribución.

Artículo 17º. Navegación y transporte acuático. Se entiende por uso del agua para transporte su utilización para la navegación de cualquier tipo de embarcación o para la movilización de materiales por contacto directo.

Artículo 18º. Uso estético. Se entenderá por uso estético el uso del agua para la armonización y embellecimiento del paisaje.

Capítulo V

De los criterios de calidad para destinación del recurso

Artículo 19º. Criterios de calidad. Conjunto de parámetros y sus valores utilizados para la asignación de usos al recurso y como base de decisión para el Ordenamiento del Recurso Hídrico.

Artículo 20º. Competencia para definir los criterios de calidad del recurso hídrico. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial dentro de los dieciocho (18) meses contados a partir de la publicación del presente decreto, definirá los criterios de calidad para el uso de las aguas superficiales, subterráneas y marinas.

Artículo 21º. Rigor subsidiario para definir los criterios de calidad del recurso hídrico. La autoridad ambiental competente, con fundamento en el artículo 63 de la Ley 99 de 1993, podrá hacer más estrictos los criterios de calidad de agua para los distintos usos previa la realización del estudio técnico que lo justifique.

El criterio de calidad adoptado en virtud del principio del rigor subsidiario por la autoridad ambiental competente, podrá ser temporal o permanente.

Artículo 22º. Criterios de Calidad para usos múltiples. En aquellos tramos del cuerpo de agua o acuífero en donde se asignen usos múltiples, los criterios de calidad para la destinación del recurso corresponderán a los valores más restrictivos de cada referencia.

Artículo 23º. Control de los criterios de calidad del recurso hídrico. La autoridad ambiental competente realizará el control de los criterios de calidad por fuera de la zona de mezcla, la cual será determinada para cada situación específica por dicha autoridad, para lo cual deberá tener en cuenta lo dispuesto en la Guía Nacional de Modelación del Recurso Hídrico.

Capítulo VI

De los vertimientos

Artículo 24º. Prohibiciones. No se admite vertimientos:

1. En las cabeceras de las fuentes de agua.
2. En acuíferos.
3. En los cuerpos de aguas o aguas costeras, destinadas para recreación y usos afines que impliquen contacto primario, que no permita el cumplimiento del criterio de calidad para este uso.
4. En un sector aguas arriba de las bocatomas para agua potable, en extensión que determinará, en cada caso, la autoridad ambiental competente.
5. En cuerpos de agua que la autoridad ambiental competente declare total o parcialmente protegidos, de acuerdo con los artículos 70 y 137 del Decreto-ley 2811 de 1974.
6. En calles, calzadas y canales o sistemas de alcantarillados para aguas lluvias, cuando quiera que existan en forma separada o tengan esta única destinación.
7. No tratados provenientes de embarcaciones, buques, naves u otros medios de transporte marítimo, fluvial o lacustre, en aguas superficiales dulces, y marinas.
8. Sin tratar, provenientes del lavado de vehículos aéreos y terrestres, del lavado de aplicadores manuales y aéreos, de recipientes, empaques y envases que contengan o hayan contenido agroquímicos u otras sustancias tóxicas.
9. Que alteren las características existentes en un cuerpo de agua que lo hacen apto para todos los usos determinados en el artículo 9º del presente decreto.
10. Que ocasionen altos riesgos para la salud o para los recursos hidrobiológicos.

Artículo 25º. Actividades no permitidas. No se permite el desarrollo de las siguientes actividades.

1. El lavado de vehículos de transporte aéreo y terrestre en las orillas y en los cuerpos de agua, así como el de aplicadores manuales y aéreos de agroquímicos y otras sustancias tóxicas y sus envases, recipientes o empaques.
2. La utilización del recurso hídrico, de las aguas lluvias, de las provenientes de acueductos públicos o privados, de enfriamiento, del sistema de aire acondicionado, de condensación y/o de síntesis química, con el propósito de diluir los vertimientos, con anterioridad al punto de control del vertimiento.
3. Disponer en cuerpos de aguas superficiales, subterráneas, marinas, y sistemas de alcantarillado, los sedimentos, lodos, y sustancias sólidas provenientes de sistemas de tratamiento de agua o equipos de control ambiental y otras tales como cenizas, cachaza y bagazo. Para su disposición deberá cumplirse con las normas legales en materia de residuos sólidos.

Artículo 26º. Requerimientos a puertos o terminales marítimos, fluviales o lacustres. Los puertos deberán contar con un sistema de recolección y manejo para los residuos líquidos provenientes de embarcaciones, buques, naves y otros medios de transporte, así como el lavado de los mismos. Dichos sistemas deberán cumplir con las normas de vertimiento.

Artículo 27º. De la reinyección de residuos líquidos. Solo se permite la reinyección de las aguas provenientes de la exploración y explotación petrolífera, de gas natural y recursos geotérmicos, siempre y cuando no se impida el uso actual o potencial del acuífero.

El Estudio de Impacto Ambiental requerido para el otorgamiento de la licencia ambiental para las actividades de exploración y explotación petrolífera, de gas y de recursos geotérmicos, cuando a ello hubiere lugar, deberá evaluar la reinyección de las aguas provenientes de estas actividades, previendo la posible afectación al uso actual y potencial del acuífero.

Artículo 28º. <Artículo modificado por el artículo 1º del Decreto 4728 de Diciembre 23 de 2010. El nuevo texto es el siguiente:> Fijación de la norma de vertimiento. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial fijará los parámetros y los límites máximos permisibles de los vertimientos a las aguas superficiales, marinas, a los sistemas de alcantarillado público y al suelo.

El Ministerio de Ambiente Vivienda y Desarrollo Territorial dentro de los diez (10) meses, contados a partir de la fecha de publicación de este decreto, expedirá las normas de vertimientos puntuales a aguas superficiales y a los sistemas de alcantarillado público.

Igualmente, el Ministerio de Ambiente Vivienda y Desarrollo Territorial deberá establecer las normas de vertimientos al suelo y aguas marinas, dentro de los treinta y seis (36) meses, contados a partir de la fecha de publicación de este decreto.

Artículo 29º. Rigor subsidiario de la norma de vertimiento. La autoridad ambiental competente con fundamento en el Plan de Ordenamiento del Recurso Hídrico, podrá fijar valores más restrictivos a la norma de vertimiento que deben cumplir los vertimientos al cuerpo de agua o al suelo.

Así mismo, la autoridad ambiental competente podrá exigir valores más restrictivos en el vertimiento, a aquellos generadores que aún cumpliendo con la norma de vertimiento, ocasionen concentraciones en el cuerpo receptor, que excedan los criterios de calidad para el uso o usos asignados al recurso. Para tal efecto, deberá realizar el estudio técnico que lo justifique.

Parágrafo. En el cuerpo de agua y/o tramo del mismo o en acuíferos en donde se asignen usos múltiples, los límites a que hace referencia el presente artículo, se establecerán teniendo en cuenta los valores más restrictivos de cada uno de los parámetros fijados para cada uso.

Artículo 30º. Infiltración de residuos líquidos. Previo permiso de vertimiento se permite la infiltración de residuos líquidos al suelo asociado a un acuífero. Para el otorgamiento de este permiso se deberá tener en cuenta:

1. Lo dispuesto en el Plan de Manejo Ambiental del Acuífero o en el Plan de Ordenación y Manejo de la Cuenca respectiva, o
2. Las condiciones de vulnerabilidad del acuífero asociado a la zona de infiltración, definidas por la autoridad ambiental competente.

Estos vertimientos deberán cumplir la norma de vertimiento al suelo que establezca el Ministerio de Ambiente, Vivienda y Desarrollo Territorial.

Artículo 31º. Soluciones individuales de saneamiento. Toda edificación, concentración de edificaciones o desarrollo urbanístico, turístico o industrial, localizado fuera del área de cobertura del sistema de alcantarillado público, deberá dotarse de sistemas de recolección y tratamiento de residuos líquidos y deberá contar con el respectivo permiso de vertimiento.

Artículo 32º. Control de vertimientos para ampliaciones y modificaciones. Los usuarios que amplíen su producción, serán considerados como usuarios nuevos con respecto al control de los vertimientos que correspondan al grado de ampliación.

Toda ampliación o modificación del proceso o de la infraestructura física, deberá disponer de sitios adecuados que permitan la toma de muestras para la caracterización y aforo de sus efluentes. El control de los vertimientos deberá efectuarse simultáneamente con la iniciación de las operaciones de ampliación o modificación.

Artículo 33º. Reubicación de instalaciones. Los usuarios que no dispongan de área apropiada para la construcción de sistemas de control de contaminación y/o que no cumplan con las normas de vertimiento, deberán reubicar sus instalaciones, cuando quiera que no puedan por otro medio garantizar la adecuada disposición de sus vertimientos.

Artículo 34º. <Artículo modificado por el artículo 2º del Decreto 4728 de Diciembre 23 de 2010. El nuevo texto es el siguiente:> Protocolo para el Monitoreo de los Vertimientos en Aguas Superficiales y Subterráneas. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial expedirá dentro de los diecisésis (16) meses siguientes, contados a partir de la publicación del presente decreto, el Protocolo para el Monitoreo de los Vertimientos en Aguas Superficiales y Subterráneas, en el cual se establecerán, entre otros aspectos: el punto de control, la infraestructura técnica mínima requerida, la metodología para la toma de muestras y los métodos de análisis para los parámetros a determinar en vertimientos y en los cuerpos de agua o sistemas receptores.

Parágrafo. Mientras el Ministerio de Ambiente, Vivienda y Desarrollo Territorial adopta el Protocolo para el Monitoreo de los Vertimientos en Aguas Superficiales y Subterráneas, se seguirán los procedimientos establecidos en la Guía para el Monitoreo de Vertimientos, Aguas Superficiales y Subterráneas del Instituto de Hidrología, Meteorología y Estudios Ambientales - Ideam".

Artículo 35º. <Artículo modificado por el artículo 3º del Decreto 4728 de Diciembre 23 de 2010. El nuevo texto es el siguiente:> Plan de Contingencia para el Manejo de Derrames de Hidrocarburos o Sustancias Nocivas. Los usuarios que exploren, exploten, manufacturen, refinen, transformen, procesen, transporten o almacenen hidrocarburos o sustancias nocivas para la salud y para los recursos hidrobiológicos, deberán estar provistos de un plan de contingencia y control de derrames, el cual deberá contar con la aprobación de la autoridad ambiental competente.

Cuando el transporte comprenda la jurisdicción de más de una autoridad ambiental, le compete el Ministerio de Ambiente, Vivienda y Desarrollo Territorial definir la autoridad que debe aprobar el Plan de Contingencia.

Artículo 36º. Suspensión de actividades. En caso de presentarse fallas en los sistemas de tratamiento, labores de mantenimiento preventivo o correctivo o emergencias o accidentes que limiten o impidan el cumplimiento de la norma de vertimiento, de inmediato el responsable de la actividad industrial, comercial o de servicios que genere vertimientos a un cuerpo de agua o al suelo, deberá suspender las actividades que generan el vertimiento, exceptuando aquellas directamente asociadas con la generación de aguas residuales domésticas.

Si su reparación y reinicio requiere de un lapso de tiempo superior a tres (3) horas diarias se debe informar a la autoridad ambiental competente sobre la suspensión de actividades y/o la puesta en marcha del Plan de Gestión del Riesgo para el Manejo de Vertimientos previsto en el artículo 44 del presente decreto.

Artículo 37º. Registro de actividades de mantenimiento. Las actividades de mantenimiento preventivo o correctivo quedarán registradas en la minuta u hoja de vida del sistema de pretratamiento o tratamiento de aguas residuales del generador que desarrolle actividades industriales, comerciales o de servicios que generen vertimientos a un cuerpo de agua o al suelo, documento que podrá ser objeto de seguimiento, vigilancia y control por parte de la autoridad ambiental competente.

Artículo 38º. Obligación de los suscriptores y/o usuarios del prestador del servicio público domiciliario de alcantarillado. Los suscriptores y/o usuarios en cuyos predios o inmuebles se requiera de la prestación del servicio comercial, industrial, oficial y especial, por parte del prestador del servicio público domiciliario de alcantarillado, de que trata el artículo 3º del Decreto 302 de 2000 o la norma que lo modifique, adicione o sustituya, están obligados a cumplir la norma de vertimiento vigente.

Los suscriptores y/o usuarios previstos en el inciso anterior, deberán presentar al prestador del servicio, la caracterización de sus vertimientos, de acuerdo con la frecuencia que se determine en el Protocolo para el Monitoreo de los Vertimientos en Aguas Superficiales, Subterráneas, el cual expedirá el Ministerio de Ambiente, Vivienda y Desarrollo Territorial.

Los usuarios y/o suscriptores del prestador del servicio público domiciliario de alcantarillado, deberán dar aviso a la entidad encargada de la operación de la planta tratamiento de residuos líquidos, cuando con un vertimiento ocasional o accidental puedan perjudicar su operación.

Artículo 39º. Responsabilidad del prestador del servicio público domiciliario de alcantarillado. El prestador del servicio de alcantarillado como usuario del recurso hídrico, deberá dar cumplimiento a la

norma de vertimiento vigente y contar con el respectivo permiso de vertimiento o con el Plan de Saneamiento y Manejo de Vertimientos –PSMV reglamentado por la Resolución 1433 de 2004 del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, o la norma que lo modifique, adicione o sustituya.

Igualmente, el prestador será responsable de exigir respecto de los vertimientos que se hagan a la red de alcantarillado, el cumplimiento de la norma de vertimiento al alcantarillado público.

Cuando el prestador del servicio determine que el usuario y/o suscriptor no está cumpliendo con la norma de vertimiento al alcantarillado público deberá informar a la autoridad ambiental competente, allegando la información pertinente, para que esta inicie el proceso sancionatorio por incumplimiento de la norma de vertimiento al alcantarillado público.

Parágrafo. El prestador del servicio público domiciliario del alcantarillado presentará anualmente a la autoridad ambiental competente, un reporte discriminado, con indicación del estado de cumplimiento de la norma de vertimiento al alcantarillado, de sus suscriptores y/o usuarios en cuyos predios o inmuebles se preste el servicio comercial, industrial, oficial y especial de conformidad con lo dispuesto por el artículo 3º del Decreto 302 de 2000 o la norma que lo modifique, adicione o sustituya. Este informe se presentará anualmente con corte a 31 de diciembre de cada año, dentro de los dos (2) meses siguientes a esta fecha.

El Ministerio de Ambiente, Vivienda y Desarrollo Territorial dentro de los tres (3) meses siguientes, contados a partir de la publicación del presente decreto, expedirá el formato para la presentación de la información requerida en el presente parágrafo.

Artículo 40º. Control de contaminación por agroquímicos. Además de las medidas exigidas por la autoridad ambiental competente, para efectos del control de la contaminación del agua por la aplicación de agroquímicos, se prohíbe:

1. La aplicación manual de agroquímicos dentro de una franja de tres (3) metros, medida desde las orillas de todo cuerpo de agua.
2. La aplicación aérea de agroquímicos dentro de una franja de treinta (30) metros, medida desde las orillas de todo cuerpo de agua.

Para la aplicación de plaguicidas se tendrá en cuenta lo establecido en el Decreto 1843 de 1991 o la norma que lo modifique, adicione o sustituya.

Capítulo VII **De la obtención de los permisos de vertimiento y planes de cumplimiento**

Artículo 41º. Requerimiento de permiso de vertimiento. Toda persona natural o jurídica cuya actividad o servicio genere vertimientos a las aguas superficiales, marinas, o al suelo, deberá solicitar y tramitar ante la autoridad ambiental competente, el respectivo permiso de vertimientos.

Parágrafo 1º. Se exceptúan del permiso de vertimiento a los usuarios y/o suscriptores que estén conectados a un sistema de alcantarillado público.

Parágrafo 2º. Salvo en el caso de la Corporación para el Desarrollo Sostenible del Archipiélago de San Andrés, Providencia y Santa Catalina–Coralina, los permisos de vertimiento al medio marino, que hayan sido otorgados por autoridades ambientales distintas al Ministerio de Ambiente, Vivienda y Desarrollo Territorial, con anterioridad a la publicación del presente decreto, deberán ser entregados con su respectivo expediente al Ministerio para lo de su competencia. Se exceptúan los permisos que hayan sido otorgados dentro de una licencia ambiental o por delegación del Ministerio de Ambiente, Vivienda y Desarrollo Territorial.

Artículo 42º. Requisitos del permiso de vertimientos. El interesado en obtener un permiso de vertimiento, deberá presentar ante la autoridad ambiental competente, una solicitud por escrito que contenga la siguiente información:

1. Nombre, dirección e identificación del solicitante y razón social si se trata de una persona jurídica.
2. Poder debidamente otorgado, cuando se actúe mediante apoderado.
3. Certificado de existencia y representación legal para el caso de persona jurídica.
4. Autorización del propietario o poseedor cuando el solicitante sea mero tenedor.
5. Certificado actualizado del Registrador de Instrumentos Públicos y Privados sobre la propiedad del inmueble, o la prueba idónea de la posesión o tenencia.
6. Nombre y localización del predio, proyecto, obra o actividad.
7. Costo del proyecto, obra o actividad.
8. Fuente de abastecimiento de agua indicando la cuenca hidrográfica a la cual pertenece.
9. Características de las actividades que generan el vertimiento.
10. Plano donde se identifique origen, cantidad y localización georreferenciada de las descargas al cuerpo de agua o al suelo.
11. Nombre de la fuente receptora del vertimiento indicando la cuenca hidrográfica a la que pertenece.
12. Caudal de la descarga expresada en litros por segundo.
13. Frecuencia de la descarga expresada en días por mes.
14. Tiempo de la descarga expresada en horas por día.
15. Tipo de flujo de la descarga indicando si es continuo o intermitente.
16. Caracterización actual del vertimiento existente o estado final previsto para el vertimiento proyectado de conformidad con la norma de vertimientos vigente.

17. Ubicación, descripción de la operación del sistema, memorias técnicas y diseños de ingeniería conceptual y básica, planos de detalle del sistema de tratamiento y condiciones de eficiencia del sistema de tratamiento que se adoptará.
18. Concepto sobre el uso del suelo expedido por la autoridad municipal competente.
19. Evaluación ambiental del vertimiento.
20. Plan de gestión del riesgo para el manejo del vertimiento.
21. Plan de contingencia para la prevención y control de derrames, cuando a ello hubiere lugar.
22. Constancia de pago para la prestación del servicio de evaluación del permiso de vertimiento.
23. Los demás aspectos que la autoridad ambiental competente consideré necesarios para el otorgamiento del permiso.

Parágrafo 1º. En todo caso cuando no exista compatibilidad entre los usos del suelo y las determinantes ambientales establecidas por la autoridad ambiental competente para el Ordenamiento Territorial, estas últimas de acuerdo con el artículo 10 de la Ley 388 de 1997 o la norma que lo modifique, adicione o sustituya, prevalecerán sobre los primeros.

Parágrafo 2º. Los análisis de las muestras deberán ser realizados por laboratorios acreditados por el IDEAM, de conformidad con lo dispuesto en el Decreto 1600 de 1994 o la norma que lo modifique, adicione o sustituya. El muestreo representativo se deberá realizar de acuerdo con el Protocolo para el Monitoreo de los Vertimientos en Aguas Superficiales, Subterráneas.

Parágrafo 3º. Los estudios, diseños, memorias, planos y demás especificaciones de los sistemas de recolección y tratamiento de las aguas residuales deberán ser elaborados por firmas especializadas o por profesionales calificados para ello y que cuenten con su respectiva matrícula profesional de acuerdo con las normas vigentes en la materia.

Parágrafo 4º. Los planos a que se refiere el presente artículo deberán presentarse en formato análogo tamaño 100 cm x 70 cm y copia digital de los mismos.

Artículo 43º. Evaluación ambiental del vertimiento. Para efectos de lo dispuesto en el numeral 19 del artículo 42 del presente decreto, la evaluación ambiental del vertimiento solo deberá ser presentada por los generadores de vertimientos a cuerpos de agua o al suelo que desarrollen actividades industriales, comerciales y de servicio, así como los provenientes de conjuntos residenciales y deberá contener como mínimo:

1. Localización georreferenciada de proyecto, obra o actividad.
2. Memoria detallada del proyecto, obra o actividad que se pretenda realizar, con especificaciones de procesos y tecnologías que serán empleados en la gestión del vertimiento.

3. Información detallada sobre la naturaleza de los insumos, productos químicos, formas de energía empleados y los procesos químicos y físicos utilizados en el desarrollo del proyecto, obra o actividad que genera vertimientos.

4. Predicción y valoración de los impactos que puedan derivarse de los vertimientos generados por el proyecto, obra o actividad sobre el cuerpo de agua y sus usos o al suelo. Para tal efecto se debe tener en cuenta los Planes de Ordenamiento del Recurso Hídrico y/o el plan de manejo ambiental del acuífero asociado. Cuando estos no existan, la autoridad ambiental competente definirá los términos y condiciones bajo los cuales se debe realizar la predicción y valoración de los impactos.

5. Predicción a través de modelos de simulación de los impactos que cause el vertimiento en el cuerpo de agua y/o al suelo, en función de la capacidad de asimilación y dilución del cuerpo de agua receptor y de los usos y criterios de calidad establecidos en el Plan de Ordenamiento del Recurso Hídrico.

6. Manejo de residuos asociados a la gestión del vertimiento.

7. Descripción y valoración de los proyectos, obras y actividades para prevenir, mitigar, corregir o compensar los impactos sobre el cuerpo de agua y sus usos o al suelo.

8. Posible incidencia del proyecto, obra o actividad en la calidad de la vida o en las condiciones económicas, sociales y culturales de los habitantes del sector o de la región en donde pretende desarrollarse, y medidas que se adoptarán para evitar o minimizar efectos negativos de orden sociocultural que puedan derivarse de la misma.

Parágrafo 1º. La modelación de que trata el presente artículo, deberá realizarse conforme a la Guía Nacional de Modelación del Recurso Hídrico. Mientras se expide la guía, los usuarios continuarán aplicando los modelos de simulación existentes.

Parágrafo 2º. Para efectos de la aplicación de lo dispuesto en este artículo en relación con los conjuntos residenciales, la autoridad ambiental definirá los casos en los cuales no estarán obligados a presentar la evaluación ambiental del vertimiento en función de la capacidad de carga del cuerpo receptor, densidad de ocupación del suelo y densidad poblacional.

Parágrafo 3º. En los estudios ambientales de los proyectos, obras o actividades sujetos a licencia ambiental, se incluirá la evaluación ambiental del vertimiento prevista en el presente artículo.

Artículo 44º. Plan de gestión del riesgo para el manejo de vertimientos. Las personas naturales o jurídicas de derecho público o privado que desarrollen actividades industriales, comerciales y de servicios que generen vertimientos a un cuerpo de agua o al suelo deberán elaborar un Plan de Gestión del Riesgo para el Manejo de Vertimientos en situaciones que limiten o impidan el tratamiento del vertimiento. Dicho plan debe incluir el análisis del riesgo, medidas de prevención y mitigación, protocolos de emergencia y contingencia y programa de rehabilitación y recuperación.

Parágrafo. El Ministerio de Ambiente, Vivienda y Desarrollo Territorial mediante acto administrativo, adoptará los términos de referencia para la elaboración de este plan dentro de los seis (6) meses, contados a partir de la publicación del presente decreto.

Artículo 45º. Procedimiento para la obtención del permiso de vertimientos. El procedimiento es el siguiente:

1. Una vez radicada la solicitud de permiso de vertimiento, la autoridad ambiental competente contará con diez (10) días hábiles para verificar que la documentación esté completa, la cual incluye el pago por concepto del servicio de evaluación. En caso que la documentación esté incompleta, se requerirá al interesado para que la allegue en el término de diez (10) días hábiles, contados a partir del envío de la comunicación.
2. Cuando la información esté completa, se expedirá el auto de iniciación de trámite.
3. Dentro de los treinta (30) días hábiles siguientes a la publicación del auto de iniciación de trámite, realizará el estudio de la solicitud de vertimiento y practicará las visitas técnicas necesarias.
4. Dentro de los ocho (8) días hábiles siguientes a la realización de las visitas técnicas, se deberá emitir el correspondiente informe técnico.
5. Una vez proferido dicho informe, se expedirá el auto de trámite que declare reunida toda la información para decidir.
6. La autoridad ambiental competente decidirá mediante resolución si otorga o niega el permiso de vertimiento, en un término no mayor a veinte (20) días hábiles, contados a partir de la expedición del auto de trámite.
7. Contra la resolución mediante la cual se otorga o se niega el permiso de vertimientos, procederá el recurso de reposición dentro de los cinco (5) días hábiles siguientes a la fecha de notificación de la misma.

Parágrafo 1º. Para los efectos de la publicidad de las actuaciones que den inicio o pongan fin a la actuación, se observará lo dispuesto en los artículos 70 y 71 de la Ley 99 de 1993.

Parágrafo 2º. Al efectuar el cobro del servicio de evaluación, la autoridad ambiental competente aplicará el sistema y método de cálculo establecido en el artículo 96 de la Ley 633 de 2000 y su norma que la adicione, modifique o sustituya.

Parágrafo 3º. Las audiencias públicas que se soliciten en el trámite de un permiso de vertimiento se realizaran conforme a lo previsto en el Decreto 330 de 2007 o la norma que lo adicione, modifique o sustituya.

Artículo 46º. De la visita técnica. En el estudio de la solicitud del permiso de vertimiento, la autoridad ambiental competente practicará las visitas técnicas necesarias sobre el área y por intermedio de profesionales con experiencia en la material verificará, analizará y evaluará cuando menos, los siguientes aspectos:

1. La información suministrada en la solicitud del permiso de vertimiento,
2. Clasificación de las aguas de conformidad con lo dispuesto en el artículo 205 del Decreto 1541 de 1978.
3. Lo dispuesto en los artículos 24 y 25 del presente decreto.

4. Si el cuerpo de agua está sujeto a un Plan de Ordenamiento del Recurso Hídrico o si se han fijado objetivos de calidad.

5. Si se trata de un cuerpo de agua reglamentado en cuanto a sus usos o los vertimientos.

6. Plan de Manejo o condiciones de vulnerabilidad del acuífero asociado a la zona en donde se realizará la infiltración.

7. Los impactos del vertimiento al cuerpo de agua o al suelo,

8. El plan de gestión del riesgo para el manejo del vertimiento y plan de contingencia para el manejo de derrames hidrocarburos o sustancias nocivas.

Del estudio de la solicitud y de la práctica de las visitas técnicas se deberá elaborar un informe técnico.

Artículo 47º. Otorgamiento del permiso de vertimiento. La autoridad ambiental competente, con fundamento en la clasificación de aguas, en la evaluación de la información aportada por el solicitante, en los hechos y circunstancias deducidos de las visitas técnicas practicadas y en el informe técnico, otorgará o negará el permiso de vertimiento mediante resolución.

El permiso de vertimiento se otorgará por un término no mayor a diez (10) años.

Artículo 48º. Contenido del permiso de vertimiento. La resolución por medio de la cual se otorga el permiso de vertimiento deberá contener por lo menos los siguientes aspectos:

1. Nombre e identificación de la persona natural o jurídica a quien se le otorga.

2. Nombre y localización del predio, proyecto, obra o actividad, que se beneficiará con el permiso de vertimientos.

3. Descripción, nombre y ubicación georreferenciada de los lugares en donde se hará el vertimiento.

4. Fuente de abastecimiento de agua indicando la cuenca hidrográfica a la cual pertenece.

5. Características de las actividades que generan el vertimiento.

6. Un resumen de las consideraciones de orden ambiental que han sido tenidas en cuenta para el otorgamiento del permiso ambiental.

7. Norma de vertimiento que se debe cumplir y condiciones técnicas de la descarga.

8. Término por el cual se otorga el permiso de vertimiento y condiciones para su renovación.

9. Relación de las obras que deben construirse por el permisionario para el tratamiento del vertimiento, aprobación del sistema de tratamiento y el plazo para la construcción y entrada en operación del sistema de tratamiento.

10. Obligaciones del permisionario relativas al uso de las aguas y a la preservación ambiental, para prevenir el deterioro del recurso hídrico y de los demás recursos relacionados.

11. Aprobación del Plan de Gestión del Riesgo para el Manejo del Vertimiento.

12. Aprobación del Plan de Contingencia para la Prevención y Control de Derrames, cuando a ello hubiere lugar.

13. Obligación del pago de los servicios de seguimiento ambiental y de la tasa retributiva,

14. Autorización para la ocupación de cauce para la construcción de la infraestructura de entrega del vertimiento al cuerpo de agua.

Parágrafo 1º. Previa a la entrada en operación del sistema de tratamiento, el permisionario deberá informar de este hecho a la autoridad ambiental competente con el fin de obtener la aprobación de las obras de acuerdo con la información presentada.

Parágrafo 2º. En caso de requerirse ajustes, modificaciones o cambios a los diseños del sistema de tratamientos presentados, la autoridad ambiental competente deberá indicar el término para su presentación.

Parágrafo 3º. Cuando el permiso de vertimiento se haya otorgado con base en una caracterización presuntiva, se deberá indicar el término dentro del cual se deberá validar dicha caracterización.

Artículo 49º. Modificación del permiso de vertimiento. Cuando quiera que se presenten modificaciones o cambios en las condiciones bajo las cuales se otorgó el permiso, el usuario deberá dar aviso de inmediato y por escrito a la autoridad ambiental competente y solicitar la modificación del permiso, indicando en qué consiste la modificación o cambio y anexando la información pertinente.

La autoridad ambiental competente evaluará la información entregada por el interesado y decidirá sobre la necesidad de modificar el respectivo permiso de vertimiento en el término de quince (15) días hábiles, contados a partir de la solicitud de modificación. Para ello deberá indicar qué información adicional a la prevista en el artículo 42 del presente decreto, deberá ser actualizada y presentada.

El trámite de la modificación del permiso de vertimiento se regirá por el procedimiento previsto para el otorgamiento del permiso de vertimiento, reduciendo a la mitad los términos señalados en el artículo 45.

Artículo 50º. Renovación del permiso de vertimiento. Las solicitudes para renovación del permiso de vertimiento deberán ser presentadas ante la autoridad ambiental competente, dentro del primer trimestre del último año de vigencia del permiso. El trámite correspondiente se adelantará antes de que se produzca el vencimiento del permiso respectivo.

Para la renovación del permiso de vertimiento se deberá observar el trámite previsto para el otorgamiento de dicho permiso en el presente decreto. Si no existen cambios en la actividad generadora del vertimiento, la renovación queda supeditada solo a la verificación del cumplimiento de la norma de vertimiento mediante la caracterización del vertimiento.

Artículo 51º. Revisión. Los permisos de vertimiento deberán revisarse, y de ser el caso ajustarse, de conformidad con lo dispuesto en el Plan de Ordenamiento del Recurso Hídrico y/o en la reglamentación de vertimientos.

Artículo 52º. <Artículo modificado por el artículo 4º del Decreto 4728 de Diciembre 23 de 2010. El nuevo texto es el siguiente:> Requerimiento del Plan de Cumplimiento. Si de la evaluación de la información proveniente de la caracterización del vertimiento, así como de la documentación aportada por el solicitante, de los hechos y circunstancias deducidos de las visitas técnicas practicadas por la autoridad ambiental competente y del informe técnico, se concluye que no es viable otorgar el permiso de vertimiento al cuerpo de agua o al suelo, la autoridad ambiental competente exigirá al usuario la presentación de un Plan de Cumplimiento, siempre y cuando el vertimiento no se realice en cuerpos de agua Clase I de que trata el artículo 205 del Decreto 1541 de 1978.

El Plan de Cumplimiento deberá incluir los proyectos, obras, actividades y buenas prácticas, que garanticen el cumplimiento de la norma de vertimientos. Así mismo, deberá incluir sus metas, sus períodos de evaluación y sus indicadores de seguimiento, gestión y resultados con los cuales se determinará el avance correspondiente.

En la resolución mediante la cual se exija el Plan de Cumplimiento, se deberán entregar los términos de referencia para la elaboración de la primera etapa, establecer las normas de vertimiento que deben cumplirse y el plazo para la presentación de la primera etapa del plan.

Parágrafo 1º. El Plan de Cumplimiento se presentará por una (1) sola vez y no podrá ser prorrogado por la autoridad ambiental competente, sin embargo, en los caso de fuerza mayor o caso fortuito definidos en los términos de la Ley 95 de 1890 y en concordancia con el artículo 8º de la Ley 1333 de 2009, su cumplimiento podrá ser suspendido hasta tanto se restablezcan las condiciones normales. Para tal efecto, el interesado deberá presentar la justificación ante la autoridad ambiental competente.

Parágrafo 2º. Los prestadores del servicio público domiciliario de alcantarillado, se regirán por lo dispuesto en los Planes de Saneamiento y Manejo de Vertimientos aprobados por la autoridad ambiental competente, teniendo en cuenta lo establecido en la Resolución 1433 de 2004 del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, o la norma que lo modifique, adicione o sustituya".

Artículo 53º. Etapas de los Planes de Cumplimiento. En los planes de cumplimiento se exigirá el desarrollo de las siguientes etapas:

1. Primera etapa: Elaboración del programa de ingeniería, cronograma e inversiones y el Plan de Gestión del Riesgo para el Manejo del Vertimiento y el Plan de Contingencia para la Prevención y Control de Derrames cuando a ello hubiere lugar.
2. Segunda etapa: Ejecución de los proyectos, obras, actividades y buenas prácticas propuestas, de acuerdo con el cronograma presentado y aprobado.
3. Tercera etapa: Verificación del cumplimiento de las normas de vertimiento.

Artículo 54º. <Artículo modificado por el artículo 5º del Decreto 4728 de Diciembre 23 de 2010. El nuevo texto es el siguiente:>

Plazos para la presentación de los Planes de Cumplimiento. Los generadores de vertimientos que no tengan permiso de vertimiento y que estén cumpliendo con el Decreto 1594 de 1984, tendrán un plazo de hasta ocho (8) meses, contados a partir de la fecha de publicación del presente decreto, para efectuar la legalización del mismo, sin perjuicio de las sanciones a las que haya lugar.

Los generadores de vertimientos que no tengan permiso de vertimiento y que no estén cumpliendo con el Decreto 1594 de 1984, tendrán un plazo de hasta ocho (8) meses, contados a partir de la fecha de publicación del presente decreto, para presentar ante la autoridad ambiental competente, el Plan de Cumplimiento, sin perjuicio de las sanciones a las que haya lugar".

Artículo 55º. Plazos para el desarrollo de los Planes de Cumplimiento. Los plazos que podrán concederse para el desarrollo de planes de cumplimiento, para cada una de las etapas, son los siguientes:

1. Primera etapa: Hasta tres (3) meses.
2. Segunda etapa: Hasta doce (12) meses
3. Tercera etapa: Hasta tres (3) meses

Artículo 56º. Aprobación del Plan de Cumplimiento. La autoridad ambiental competente tendrá un plazo de tres (3) meses, contados a partir de la radicación del Plan de Cumplimiento para pronunciarse sobre su aprobación.

La resolución mediante la cual se aprueba el Plan de Cumplimiento deberá relacionar el programa de ingeniería, cronograma e inversiones, Plan de Gestión del Riesgo para el Manejo del Vertimiento, Plan de Contingencia para la Prevención y Control de Derrames, los proyectos, obras, actividades y buenas prácticas aprobados.

Cuando la autoridad ambiental competente no apruebe el Plan de Cumplimiento, se indicarán las razones para ello y se fijará al interesado un plazo de un (1) mes para que presente los ajustes requeridos. En caso de no presentarse dentro del término señalado para ello, el interesado deberá dar cumplimiento inmediato a la norma de vertimiento vigente.

Artículo 57º. Revisión. Los planes de cumplimiento deberán revisarse, y de ser el caso ajustarse, de conformidad con lo dispuesto en el Plan de Ordenamiento del Recurso Hídrico y/o en la reglamentación de vertimientos.

Artículo 58º. Seguimiento de los permisos de vertimiento, los Planes de Cumplimiento y Planes de Saneamiento y Manejo de Vertimientos–PSMV. Con el objeto de realizar el seguimiento, control y

verificación del cumplimiento de lo dispuesto en los permisos de vertimiento, los Planes de Cumplimiento y Planes de Saneamiento y Manejo de Vertimientos, la autoridad ambiental competente efectuará inspecciones periódicas a todos los usuarios.

Sin perjuicio de lo establecido en los permisos de vertimiento, en los Planes de Cumplimiento y en los Planes de Saneamiento y Manejo de Vertimientos, la autoridad ambiental competente, podrá exigir en cualquier tiempo y a cualquier usuario la caracterización de sus residuos líquidos, indicando las referencias a medir, la frecuencia y demás aspectos que considere necesarios.

La oposición por parte de los usuarios a tales inspecciones y a la presentación de las caracterizaciones requeridas, dará lugar a las sanciones correspondientes.

Parágrafo. Al efectuar el cobro de seguimiento, la autoridad ambiental competente aplicará el sistema y método de cálculo establecido en el artículo 96 de la Ley 633 de 2000 o la norma que la adicione, modifique o sustituya.

Artículo 59º. Sanciones. El incumplimiento de los términos, condiciones y obligaciones previstos en el permiso de vertimiento, Plan de Cumplimiento o Plan de Saneamiento y Manejo de Vertimientos, dará lugar a la imposición de las medidas preventivas y sancionatorias, siguiendo el procedimiento previsto en la Ley 1333 de 2009 o la norma que la adicione, modifique o sustituya.

Artículo 60º. Disposición de residuos líquidos provenientes de terceros. El generador de vertimientos que disponga sus aguas residuales a través de personas naturales o jurídicas que recolecten, transporten y/o dispongan vertimientos provenientes de terceros, deberán verificar que estos últimos cuenten con los permisos ambientales correspondientes.

DECRETO 1541 DE 1978 (JULIO 28 DE 1978) – PRESIDENCIA DE LA REPÚBLICA DE COLOMBIA

Por el cual se reglamenta la Parte III del Libro II del Decreto-Ley 2811 de 1974: "De las aguas no marítimas" y parcialmente la Ley 23 de 1973.

Título II – Capítulo III Extinción del dominio privado de las aguas

Artículo 20º. Para declarar la extinción del dominio privado de aguas previstas por el artículo 82 del Decreto-Ley 2811 de 1974, el Instituto Nacional de Recursos Naturales Renovables y del ambiente, Inderena, podrá actuar de oficio o petición del Ministerio Público o de parte interesada en obtener concesión de uso de las aguas de que se trata.

El Instituto de los Recursos Naturales Renovables y del Ambiente, Inderena, fijará audiencia inclusive cuando actúe de oficio, la que será pública para oír al peticionario, si lo hubiere, y quien se repute dueño de las aguas, y a terceros que tengan derecho o interés. La convocatoria será notificada al presunto

dueño de las aguas en la forma establecida por el Código de Procedimiento Civil, y al peticionario, y se publicará por una vez en el periódico de la localidad, con antelación mínima de cinco (5) días hábiles a la fecha de la audiencia.

Artículo 23º. La declaratoria de extinción se hará previo el procedimiento establecido en los artículos procedentes, y contra ella proceden recursos previstos por el Decreto 2733 de 1959. Al quedar firme la providencia que declare la extinción, se podrá iniciar el trámite de solicitudes de concesión para el aprovechamiento de tales aguas.

Artículo 27º. Los particulares que soliciten conforme al artículo 20, la declaración de extinción del dominio de aguas privadas, si simultáneamente piden concesión para usar esas mismas aguas, tendrán prioridad para obtener ésta, si cumplen los demás requisitos y calidades que exige este reglamento. Sus solicitudes de concesión sólo serán tramitadas una vez en firme la providencia que declara la extinción del dominio privado de las aguas de que se trate.

Título VIII

De las obras hidráulicas

Artículo 184º. Los beneficios de una concesión o permiso para el usos de aguas o el aprovechamiento de cauces, están obligados a presentar al Inderena, para su estudio aprobación y registro, los planos de las obras necesarias para la captación, control, conducción, almacenamiento o distribución del caudal o el aprovechamiento del cauce.

En la resolución que autorice la ejecución de las obras se impondrá la titular del permiso o concesión la obligación de aceptar y facilitar la supervisión que llevará a cabo el Inderena para verificar el cumplimiento de las obligaciones a su cargo.

Los interesados en adelantar obra de rectificación de cauces o de defensa de los taludes marginales para evitar inundaciones o daños en los predios ribereños, deberán presentar los planos y memorias a que se refiere este Título al Instituto colombiano de Hidrología, Meteorología y Adecuación de Tierras, el cual coordinará con el Ministerio de Obras Públicas y Transporte sistemas para su estudio, aprobación y control.

DECRETO 0155 DE 2004 (ENERO 22 DE 2004) – PRESIDENCIA DE LA REPÚBLICA DE COLOMBIA

Por el cual se reglamenta el artículo 43 de la Ley 99 de 1993 sobre tasas por utilización de aguas y se adoptan otras disposiciones

Artículo 3º. Sujeto activo. Las Corporaciones Autónomas Regionales, las Corporaciones para el Desarrollo Sostenible, las Autoridades Ambientales de los Grandes Centros Urbanos y las que se refiere el artículo 13 de la Ley 768 del 2002 y la Unidad Administrativa Especial del Sistema de Parques

Nacionales Naturales del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, son competentes para recaudar la tasa por utilización de agua reglamentada en este decreto.

Artículo 4º. Sujeto pasivo. Están obligadas al pago de la tasa por utilización del agua todas las personas naturales o jurídicas, públicas o privadas, que utilicen el recurso hídrico en virtud de una concesión de aguas.

Artículo 5º. Hecho Generador. Dará lugar al cobro de esta tasa, la utilización del agua en virtud de concesión, por personas naturales o jurídicas, públicas o privadas.

Artículo 6º. Base Gravable. La tasa por utilización del agua se cobrará por el volumen de agua efectivamente captada, dentro de los límites y condiciones establecidos en la concesión de aguas.

Parágrafo. El sujeto pasivo de la tasa por utilización de aguas que tenga implementado un sistema de medición podrá presentar a la autoridad ambiental competente, en los términos y periodicidad que esta determine conveniente, reportes sobre los volúmenes de agua captada. En caso de que el sujeto pasivo no cuente con un sistema de medición de agua captada, la autoridad ambiental competente procederá a realizar la liquidación y el cobro de la tasa con base en lo establecido en la concesión de aguas.

Artículo 7º. Fijación de la tarifa. La tarifa de la tasa por utilización de agua (TUA) expresada en pesos/m³, será establecida por cada autoridad ambiental competente para cada cuenca hidrográfica, acuífero o unidad hidrológica de análisis y está compuesta por el producto de dos componentes: la tarifa mínima (TM) y el factor regional (FR):

$$\text{TUA} = \text{TM} * \text{FR}$$

Donde:

TUA: Es la tarifa de la tasa por utilización del agua, expresada en pesos por metro cúbico (\$/m³).

TM: Es la tarifa mínima nacional, expresada en pesos por metro cúbico (\$/m³).

FR: Corresponde al factor regional, adimensional.

Artículo 8º. Tarifa mínima (TM). El Ministerio de Ambiente, Vivienda y Desarrollo Territorial, mediante resolución, fijará anualmente el monto tarifario mínimo de las tasas por utilización de aguas.

RESOLUCIÓN 086 DE 1996 (OCTUBRE 15 DE 1996) – COMISIÓN DE REGULACIÓN DE ENERGÍA Y GAS (CREG)

Por la cual se reglamenta la actividad de generación con plantas menores de 20 MW que se encuentra conectado al Sistema Interconectado Nacional (SIN).

Artículo 1º. Definiciones. Para efectos de la presente Resolución y en general para interpretar las disposiciones aplicables a la actividad de generación con plantas menores, se adoptan las siguientes definiciones:

Generación con Plantas Menores: Es la generación producida con plantas con capacidad efectiva menor a 20 MW, operadas por empresas generadoras, productores marginales o productores independientes de electricidad y que comercializan esta energía con terceros, o en el caso de las empresas integradas verticalmente, para abastecer total o parcialmente su mercado. La categoría de Generación con Plantas Menores y la de Autogenerador son excluyentes.

Productor Marginal o Productor Independiente: Es la persona natural o jurídica que deseé utilizar sus propios recursos para producir los bienes o servicios propios del objeto de las empresas de servicios públicos para si misma; o a otras personas a cambio de cualquier tipo de remuneración; o gratuitamente a quienes tengan vinculación económica con ella.

Artículo 3º. <Artículo modificado por el artículo 1º de la Resolución 039 de Marzo 29 de 2001. El nuevo texto es el siguiente:>

Opciones de las Plantas Menores. Las personas naturales o jurídicas propietarias u operadores de plantas menores tienen las siguientes opciones para comercializar la energía que generan dichas plantas:

Plantas Menores con Capacidad Efectiva menor de 10 MW

Estas plantas no tendrán acceso al Despacho Central y por lo tanto no participarán en el Mercado Mayorista de electricidad. La energía generada por dichas plantas puede ser comercializada, teniendo en cuenta los siguientes lineamientos:

1. La energía generada por una Planta Menor puede ser vendida a una comercializadora que atiende mercado regulado, directamente sin convocatoria pública, siempre y cuando no exista vinculación económica entre el comprador y el vendedor. En este caso, el precio de venta será única y exclusivamente el Precio en la Bolsa Energía en cada una de las horas correspondientes, menos un peso moneda legal (\$ 1.00) por kWh indexado conforme a lo establecido en la Resolución CREG-005 de 2001.
2. La energía generada por una Planta Menor puede ser ofrecida a una comercializadora que atiende mercado regulado, participando en las convocatorias públicas que abran estas empresas. En este caso y como está previsto en la Resolución CREG-020 de 1996, la adjudicación se efectúa por mérito de precio.
3. La energía generada por una Planta Menor puede ser vendida, a precios pactados libremente, a los siguientes agentes: Generadores, o Comercializadores que destinen dicha energía a la atención exclusiva de Usuarios No Regulados.

Plantas Menores con Capacidad Efectiva mayor o igual a 10 MW y menor de 20 MW.

Estas plantas podrán optar por acceder al Despacho Central, en cuyo caso participarán en el Mercado Mayorista de electricidad. De tomar esta opción, deberán cumplir con la reglamentación vigente.

En caso de que estas plantas menores no se sometan al Despacho Central, la energía generada por dichas plantas puede ser comercializada, así:

1. La energía generada por una Planta Menor puede ser vendida a una comercializadora que atiende mercado regulado, directamente sin convocatoria pública, siempre y cuando no exista vinculación económica entre el comprador y el vendedor. En este caso, el precio de venta será única y exclusivamente el Precio en la Bolsa de Energía en cada una de las horas correspondientes, menos un peso moneda legal (\$ 1.00) por kWh indexado conforme a lo establecido en la Resolución CREG-005 de 2001.
2. La energía generada por una Planta Menor puede ser ofrecida a una comercializadora que atiende mercado regulado, participando en las convocatorias públicas que abran estas empresas. En este caso y como está previsto en la Resolución CREG-020 de 1996, la adjudicación se efectúa por mérito de precio.
3. La energía generada por una Planta Menor puede ser vendida, a precios pactados libremente, a los siguientes agentes: Generadores, o Comercializadores que destinen dicha energía a la atención exclusiva de Usuarios No Regulados.”

RESOLUCIÓN 084 DE 1996 (OCTUBRE 15 DE 1996) – COMISIÓN DE REGULACIÓN DE ENERGÍA Y GAS (CREG)

Por la cual se reglamentan las actividades del Autogenerador conectado al Sistema Interconectado Nacional (SIN).

Artículo 1º. Definiciones. Para efectos de la presente Resolución y en general para interpretar las disposiciones aplicables a la actividad de Autogeneración, se adoptan las siguientes definiciones:

Autogenerador: Es aquella persona natural o jurídica que produce energía eléctrica exclusivamente para atender sus propias necesidades. Por lo tanto, no usa la red pública para fines distintos al de obtener respaldo del SIN, y puede o no, ser el propietario del sistema de generación.

RESOLUCIÓN 005 DE 2010 (FEBRERO 1 DE 2010) – COMISIÓN DE REGULACIÓN DE ENERGÍA Y GAS (CREG)

Por la cual se determinan los requisitos y condiciones técnicas que deben cumplir los procesos de cogeneración y se regula esta actividad.

Artículo 1º. Definiciones. Para efectos de la presente Resolución se aplicarán las siguientes definiciones:

Cogenerador: Persona natural o jurídica que tiene un proceso de producción combinada de energía eléctrica y energía térmica como parte integrante de su actividad productiva, que reúne las condiciones y requisitos técnicos para ser considerado como cogeneración. El Cogenerador puede o no, ser el

propietario de los activos que conforman el sistema de Cogeneración; en todo caso el proceso de cogeneración deberá ser de quien realice la actividad productiva de la cual hace parte.

LEY 142 DE 1994 (JULIO 11 DE 1994) – CONGRESO DE LA REPÚBLICA DE COLOMBIA

Por la cual se establece el régimen de los servicios públicos domiciliarios y se dictan otras disposiciones.

Título I De las personas prestadoras de servicios públicos

Artículo 16º. Aplicación de la ley a los productores de servicios marginales, independiente o para uso particular. Los productores de servicios marginales o para uso particular se someterán a los artículos 25 y 26 de esta Ley. Y estarán sujetos también a las demás normas pertinentes de esta Ley, todos los actos o contratos que celebren para suministrar los bienes o servicios cuya prestación sea parte del objeto de las empresas de servicios públicos, a otras personas en forma masiva, o a cambio de cualquier clase de remuneración, o gratuitamente a quienes tengan vinculación económica con ellas según la Ley, o en cualquier manera que pueda reducir las condiciones de competencia. Las personas jurídicas a las que se refiere este artículo, no estarán obligadas a organizarse como empresas de servicios públicos, salvo por orden de una comisión de regulación. En todo caso se sobrentiende que los productores de servicios marginales independientes o para uso particular de energía eléctrica están sujetos a lo dispuesto en el artículo 45 de la ley 99 de 1993.

Parágrafo. Cuando haya servicios públicos disponibles de acueducto y saneamiento básico será obligatorio vincularse como usuario y cumplir con los deberes respectivos, o acreditar que se dispone de alternativas que no perjudiquen a la comunidad. La Superintendencia de Servicios Públicos será la entidad competente para determinar si la alternativa propuesta no causa perjuicios a la comunidad.

Las autoridades de policía, de oficio o por solicitud de cualquier persona procederán a sellar los inmuebles residenciales o abiertos al público, que estando ubicados en zonas en las que se pueden recibir los servicios de acueducto y saneamiento básicos no se hayan hecho usuarios de ellos y conserven tal carácter.

RESOLUCIÓN 131 DE 1998 (DICIEMBRE 23 DE 1998) – COMISIÓN DE REGULACIÓN DE ENERGÍA Y GAS (CREG)

Por la cual se modifica la Resolución CREG-199 de 1997 y se dictan disposiciones adicionales sobre el mercado competitivo de energía eléctrica.

Artículo 1º. Definiciones. Para efectos de la presente resolución se adoptan las siguientes definiciones:

Mercado competitivo: Es el conjunto de generadores y comercializadores en cuanto compran y venden

energía eléctrica entre ellos. Forman parte de él, igualmente, los usuarios no regulados y quienes les proveen de energía eléctrica.

Usuario No Regulado: Para todos los efectos regulatorios, es una persona natural o jurídica con una demanda máxima superior a un valor en MW o a un consumo mensual mínimo de energía en MWh, definidos por la Comisión, por instalación legalizada, a partir de la cual no utiliza redes públicas de transporte de energía eléctrica y la utiliza en un mismo predio o en predios contiguos. Sus compras de electricidad se realizan a precios acordados libremente entre el comprador y el vendedor.

Artículo 2º. Límites para contratación en el mercado competitivo. A partir de la vigencia de la presente resolución, se establecen los siguientes límites de potencia o energía mensuales para que un usuario pueda contratar el suministro de energía en el mercado competitivo:

- Hasta el 31 de diciembre de 1999 0.5 MW o 270 MWh
- A partir del 1º de enero del 2000 0.1 MW o 55 MWh

Parágrafo. Para verificar las condiciones que deben cumplir los usuarios para comercializar en el mercado competitivo, se aplicará lo establecido en el Anexo No. 1 de la presente resolución.

RESOLUCIÓN 020 DE 1996 (FEBRERO 27 DE 1996) – COMISIÓN DE REGULACIÓN DE ENERGÍA Y GAS (CREG)

Por la cual se dictan normas con el fin de promover la libre competencia en las compras de energía eléctrica en el mercado mayorista.

Artículo 4º. Condiciones para la compra de energía con destino al mercado regulado. <Artículo modificado por el artículo 1º de la Resolución 167 de 2008. El nuevo texto es el siguiente:> Las empresas comercializadoras y distribuidoras comercializadoras, realicen o no una de tales actividades en forma combinada con la de generación, cualquiera de ellas sea la actividad principal, deberán realizar todas las compras de electricidad destinadas a cubrir la demanda de su mercado regulado, mediante procedimientos que aseguren la libre competencia de oferentes.

Con el propósito de hacer efectiva la competencia deberán solicitar y dar oportunidad, en igualdad de condiciones, a las empresas comercializadoras y generadoras actuales y a otros agentes interesados en desarrollar nuevos proyectos de generación, para que presenten ofertas. Las ofertas deberán ser evaluadas con base en el precio ofertado para la energía y este será el único criterio para la selección del oferente.

CORPORACIÓN AUTÓNOMA REGIONAL DEL CENTRO DE ANTIOQUIA

RESOLUCIÓN No 7529

**POR LA CUAL SE OTORGА LA LICENCIA AMBIENTAL PARA EL
PROYECTO DENOMINADO “CENTRO INDUSTRIAL DEL SUR - CIS”**

**EL DIRECTOR GENERAL DE LA CORPORACIÓN AUTÓNOMA
REGIONAL DEL CENTRO DE ANTIOQUIA “CORANTIOQUIA”**

En uso de sus atribuciones legales, en especial las conferidas por la Ley 99
de 1993, el Decreto 1180 de 2003 y

CONSIDERANDO

1. Que la Empresa de Servicios Públicos “EVAS ENVIAMBIENTALES S.A. E.S.P.” Nit 0811046698-0, matriculada en la Cámara de Comercio del Aburrá Sur – Sede Envigado bajo el número 00097349, constituida por escritura pública No 1542 del 11 de agosto de 2004, modificada por escritura pública 1955 del 12 de octubre de 2004 de la Notaría Segunda del mismo municipio, y representada legalmente por el señor Andrés Felipe Henao Arango, identificado con cédula de ciudadanía No 71'786.842, solicitó a CORANTIOQUIA, mediante petición No 130 AS – 2021 del 20 de octubre de 2004, la Licencia Ambiental para llevar a cabo el proyecto denominado **“Centro Industrial del Sur – CIS”** destinado a la disposición final de los residuos sólidos generados en el área metropolitana del Valle de Aburrá y municipios cercanos, a construirse en sus predios identificados con los Folios de Matrícula Inmobiliaria No 217234, 217235, 217236, 217237 y 217238 de la Oficina de Registro de Instrumentos Públicos de Medellín Zona Sur, ubicados en la veredas La Chorrera y Monteadentro del municipio de Heliconia entre las coordenadas X:1'180.000 - 1'184.000 N. Y: 1'150.000 - 1'154.000 E. Planchas Topográficas del IGAC No 146-I-D y 146-II-C
2. Que una vez allegada a la anterior solicitud los documentos e información requerida en el artículo 17 del decreto 1180 de 2003, CORANTIOQUIA la admitió mediante resolución No 7272 del 5 de noviembre de 2004 la cual fue publicada en el Boletín 065 del 11 de noviembre de este año dando cumplimiento a lo previsto en el artículo 70 de la ley 99 de 1993. Igualmente se ordenó notificar a Empresas Varias de Medellín E.S.P. la resolución 7272 por ser considerada como parte interesada en este proceso, como quiera que con anterioridad esta Corporación le otorgó, mediante la Resolución 6221 del 21 de noviembre de 2003, una licencia Ambiental para el proyecto **“Centro Integrado de Residuos Sólidos El Guacal”** a ejecutarse en los mismos predios sobre los cuales la Empresa de Servicios Públicos EVAS-

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ENVIAMBIENTALES S.A. E.S.P. solicitó actualmente la licencia para ejecutar el proyecto "Centro Integral del Sur – CIS"

3. Que mediante radicado 412-20140 del 6 de diciembre de 2004 EVAS-ENVIAMBIENTALES S.A. E.S.P. presentó el Estudio de Impacto Ambiental que consta de cuatro volúmenes en los cuales se allega la siguiente información presentada en cuatro tomos a saber:

- a) *Resumen ejecutivo*
- b) *Introducción*
- c) *Descripción técnica del proyecto*
- d) *Análisis de estabilidad del lleno*
- e) *Diseño de muros de contención*
- f) *Diseño de obras de drenaje*
- g) *Personal y equipo requerido para operación*
- h) *Sistema de impermeabilización de las zonas efectivas de disposición final del Centro Industrial del Sur*
- i) *Sistema de captación, recolección y transporte de lixiviados y Gases*
- j) *Diseño de la cobertura final de las zonas de lleno*
- k) *Celda de seguridad para disposición final de residuos especiales y peligrosos*
- l) *Clausura del área de disposición final del Centro Industrial del Sur*
- m) *Costos y cronograma*
- n) *Bibliografía*

Adicionalmente la peticionaria presentó:

- a) *Sistema de adecuación, impermeabilización, disposición y conformación del lleno.*
- b) *Manual de operaciones para el lleno*
- c) *Diseño vías de acceso y vías internas*
- d) *Diseño de infraestructura de servicios*
- e) *Diseño de sistema de abastecimiento de agua*
- f) *Diseño del sistema de tratamiento de aguas residuales*
- g) *Diseño hidrosanitario*
- h) *Diseño eléctrico*
- i) *Estudio de impacto ambiental para el proyecto con los programas de manejo, monitoreo, seguimiento, contingencias, clausura y posclausura del lleno*

Allegaron también como anexos al Estudio de Impacto Ambiental los siguientes documentos:

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- a) *Estudio de suelos*
- b) *Planos Generales y Temáticos del proyecto.*

4. Que una vez reunida toda la información necesaria para estos efectos, CORANTIOQUIA procedió a realizar las visitas técnicas al lugar indicado para desarrollar el proyecto. Posteriormente aquella fue evaluada a través del Informe Técnico 110RN-265 del 30 de diciembre de 2004 elaborado por el Comité de Residuos Sólidos ***el cual forma parte integral de esta resolución*** y evalúa, entre otros, los siguientes aspectos: Línea base y descripción general del medio físico, biótico, abiótico y demás componentes del sistema ambiental (i). La descripción general del proyecto (ii). La identificación, caracterización y cuantificación de impactos. (iii). Plan de Manejo Ambiental propuesto para corregirlos, mitigarlos y prevenirlos (iv). Las consideraciones de orden ambiental tenidas en cuenta en la evaluación (v). Finalmente, las medidas ambientales propuestas e impuestas y demás condiciones, obligaciones y requisitos para llevar a cabo el proyecto (vi).

En los numerales siguientes citaremos en forma textual apartes del informe técnico de evaluación donde se refiere a aspectos como el objeto general y localización del proyecto, resumen de las consideraciones y motivaciones de orden ambiental tenidas en cuenta para el otorgamiento de la licencia, lista de las diferentes actividades y obras que se autorizan, los recursos naturales renovables que se podrán utilizar, aprovechar o afectar, las condiciones, prohibiciones y/o requisitos de su uso, los requisitos, condiciones y obligaciones presentados en el Plan de Manejo Ambiental y aquellas adicionales o requerimientos que debe cumplir la Empresa Beneficiaria durante la construcción, operación, clausura y posclausura del proyecto

Procederemos de conformidad, no sin antes mencionar la recomendación final producto de esta evaluación:

“(...) Se encuentra procedente desde el punto de vista técnico, otorgar la Licencia Ambiental solicitada para ejecutar el proyecto “Centro Industrial del Sur - CIS”, sujeto y limitado al cumplimiento de los términos y condiciones que a continuación se describen los cuales contienen las medidas de prevención, corrección, mitigación y control de los impactos generados durante la vida útil del proyecto (...)”.

“(...)

7.1. Objeto general y localización del proyecto

La zona donde se localiza el proyecto Centro Industrial del Sur – CIS que será destinado para la disposición final de residuos sólidos, está ubicada en jurisdicción del municipio de Heliconia departamento de Antioquia, en la vereda La Chorrera.

La zona hace parte de la cuenca media del río Cauca sobre su margen Oriental. La zona del relleno o de disposición final de residuos, comprende la ocupación de un área aproximada de 27 hectáreas. Esta área comprende tres microcuencas denominadas Sur, Central y Norte.

Se accede al sitio mediante la utilización de la vía Medellín – Itagüí - San Antonio de Prado, Vereda Yarumalito y de allí por vías secundarias y terciarias desarrolladas principalmente para explotación de madera. El sitio posee una elevación media de 2560 m.s.n.m. y se ubica a 22 Km aproximadamente del municipio de Itagüí entre el cuadrángulo de coordenadas Norte $X_1: 1'182.921$, $X_2: 1'184.000$ y Este $Y_1: 1'150.000$, $Y_2: 1'154.000$ de las planchas 146 ID y 146 IIC del IGAC.

7.2. Consideraciones de orden ambiental tenidas en cuenta

En el área de influencia del proyecto confluyen Las siguientes unidades litológicas: metamorfitas regionales del Paleozoico y Mesozoico; plutonitas ultramáficas, máficas, graníticas y volcanitas del Mesozoico; sedimentitas del Terciario y sedimentos aluviales, coluviales y piroclásticos del Cuaternario. Estas unidades litológicas, se encuentran en el marco de un sistema fallado regional que abarca fallas locales, zonas de cizalla y fracturamiento intenso en los límites o al interior de las unidades rocosas.

El área se dividió en tres vasos que presentan diferencias respecto a los procesos que mayor inciden en ellos: Vaso Norte, erosión laminar de las paredes del vaso. Vaso Centro, fenómenos correspondientes a movimientos rotacionales. Vaso Sur (Campamento), movimientos en masa iniciados en las partes altas de los promontorios. De acuerdo al análisis de estabilidad realizado y a los resultados obtenidos se concluye que los Vaso Norte y Vaso Central, presentan condiciones viables para la implementación del proyecto.

Las características de las aguas de todas las corrientes de la zona de influencia del proyecto son buenas y podrían ser utilizadas para el consumo humano con un tratamiento convencional.

7.3. Actividades y obras que se autorizan

El Centro Industrial del Sur – CIS se proyecta con la infraestructura, equipos, recursos y logística necesaria para realizar un manejo adecuado y eficiente de los procesos y alcances con que se concibe. A continuación se realiza una breve descripción de las zonas, procesos e infraestructura con que contará el complejo industrial.

Zona de portería y pesaje: Ubicada en la cota 2720 sobre la vía que conecta el acceso sur (Vía San Antonio de Prado - El Chuscal – Alto de la Humareda) del Centro Industrial del Sur – CIS con el área de recibimiento y descargue de residuos sólidos, se encuentra la zona de portería y pesaje.

Zona de oficinas y edificio administrativo: El edificio administrativo y la zona de oficinas se ubican en la parte superior del vaso Central en la cota 2710, en una explanación proyectada con un área total de 1720 m².

Sistema de abastecimiento de agua: Teniendo en cuenta que los almacenamientos tanto de agua cruda como de agua potable se encuentran sobre las cotas 2738 y 2734 respectivamente, el sistema abastece por gravedad los diferentes puntos de infraestructura del Centro Industrial del Sur – CIS y la red contra incendio, lo cual garantizará la presencia del recurso en las diferentes actividades de cada sitio.

Zona de recibo y descargue de residuos, banda seleccionadora y enfardado:

Una vez los vehículos recolectores realizan el pesaje, pasan a la zona de recibimiento y descargue de residuos, desde donde posteriormente salen nuevamente hacia la portería. Esta zona se encuentra sobre la cota 2716, y cuenta con un área total de 5491 m² sobre la cual se proyectan los siguientes componentes:

Pozo de descargue de residuos: Consiste en un pozo en el cual los vehículos recolectores realizan la descarga de los residuos para ser llevados por medio de una banda transportadora a los procesos de compactación y enfardado.

Banda de selección y separación: El equipo de compactación contaría con una banda transportadora donde se realizará un proceso de selección, separación y clasificación de los residuos sólidos (residuos orgánicos, residuos inorgánicos y residuos reciclables o reutilizables) que redundaría en un incremento de la vida útil del depósito dado que no todo el material recibido sería dispuesto.

Igualmente los residuos orgánicos que no son separados en la fuente y llegan al Centro Industrial del Sur – CIS mezclados con los otros residuos, serán seleccionados con el fin de recuperar parte de estos residuos, para posteriormente ser tratados en un área de procesamiento de orgánicos al interior del CIS.

Zona de Enfardado: Los residuos sólidos urbanos, ya sean previamente clasificados o no, son mecánicamente conducidos al área de compactación y enfardado en donde alcanzarán una densidad entre 1 a 1.2 ton/m³. Esto se logra mediante un prensado de los RSU en un equipo compactador que funciona con gatos hidráulicos.

Zona de tratamiento y transformación de orgánicos: En el Centro Industrial del Sur, se prevé la clasificación, tratamiento y transformación de orgánicos, pues se cuenta con la tecnología y el área suficiente para desarrollar el proyecto de aprovechamiento, procesamiento y transformación de residuos orgánicos.

Zona de tratamiento y transformación de residuos reciclables recuperados: Se realizará el procesamiento de materiales recuperados en las áreas definidas y de acuerdo a las tecnologías específicas para desarrollar esta actividad.

En estas áreas se instalará la infraestructura, maquinaria y medios para realizar actividades tales como lavado, secado, triturado, compactado, y embalado. Igualmente es importante anotar que se prevé de un sistema de recolección y transporte de aguas de proceso, el cual estaría conectado al sistema de tratamiento de lixiviados, con el fin de garantizar la depuración de cualquier efluente que allí se produzca.

Zona de talleres y almacenamiento temporal de fardos: La zona de talleres se ubicará en la cota 2680 y tendrá un área total de 5825 m² la cual tiene como objetivo la reparación y mantenimiento. Igualmente se diseña una zona de lavado de vehículos recolectores, cuyo efluente estará conectado al sistema de depuración de lixiviados para ser también tratado. Igualmente en esta área, debido a su cercanía a la zona de disposición final, se proyecta un sitio de almacenamiento temporal de fardos.

Zona de tratamiento de lixiviados y aguas de proceso: Los lixiviados serán recolectados en todas las áreas efectivas de lleno mediante sistemas de tuberías ubicadas en la base de las plataformas, posteriormente conducidas hasta los tanques de igualación colocados en las zonas aledañas al lleno y finalmente llevadas a la planta de tratamiento y depuración de lixiviados.

En aras de impactar lo menor posible el recurso hídrico, el sistema de tratamiento de lixiviados deberá contar con los siguientes componentes: Cámara de arietamiento, neutralización y aforo, tanque de igualación y homogenización, caja de distribución, zona de unidades de precipitación química, zona de unidades de reactores UASB, zona de deshidratación de lodos, y finalmente canal de aireación.

Zona de tratamiento y combustión de gases: La infraestructura a implementar para captación, transporte y tratamiento de gases, plantea una red de chimeneas verticales y horizontales para captar y extraer los gases de la zona efectiva de lleno, posteriormente, mediante un sistema activo compuesto por un extractor mecánico y una red de conducción, el gas se conduce al punto de tratamiento final que tiene como infraestructura un sistema de combustión y control de gases producto de la combustión.

Zona de disposición final

Debido a que el Centro Industrial del Sur – CIS se concibe como una solución integral a las necesidades de los residuos sólidos, se proyectan tres tipos de zonas de disposición final:

Zona de disposición final de residuos sólidos domiciliarios: Los RSU que sean recibidos deberán ser finalmente dispuestos en un sitio adecuado como relleno sanitario, el cual abarca un área de 26.96 Ha, y presenta una capacidad volumétrica de 5'740.203 m³.

Zona de disposición final de residuos sólidos especiales: Teniendo en cuenta el nivel de industrialización existente y la heterogeneidad y complejidad de sus materias primas, residuos y efluentes, el Centro Industrial del Sur – CIS cuenta con una zona designada para la disposición final de residuos sólidos especiales, esta zona se encuentra ubicada en la parte superior del vaso Central entre las cotas 2685 y 2710. Su importancia radica en la posibilidad de solucionar la necesidad urgente que existe en el área metropolitana del valle de aburrá, de contar con sitios adecuados para disponer este tipo de residuos; en especial, teniendo en cuenta que en la región no existen rellenos de seguridad con zonas adecuadas para este fin, lo cual diferencia este proyecto con aquellos licenciados anteriormente para la disposición de residuos sólidos.

Zona de disposición final de lodos: En el CIS se permitirá la disposición final de lodos. En caso de recibirse estos materiales para otros propósitos, se evaluará puntualmente cada tipo de material para determinar si puede utilizarse como mezcla del material para revegetalización o mezclado con RSU para ser compactados y enfardados.

7.4. Sobre los impactos ambientales

Lo que se expone a continuación son los aspectos relevantes de la evaluación efectuada por esta Corporación sobre la información aportada por el interesado y analizada a la luz del conocimiento que se tiene del proyecto y de la zona donde se propone su implementación, de acuerdo a la normatividad ambiental vigente y a los términos de referencia que fueron entregados para su realización.

De acuerdo con esta información, un 24% del total de los impactos identificados son positivos y no generan daños o alteraciones al ambiente, un 52% son prevenibles, mitigables o controlables, es decir que con la implementación de los programas del Plan de Manejo Ambiental correspondientes, su magnitud se reduce considerablemente, un 10% son impactos que aunque no admiten manejo, pueden ser compensados por algún tipo de programa, un 4% son impactos que ocasionan daños inevitables pero que con la implementación del respectivo Plan de Manejo se puede volver a las condiciones iniciales y el 10% restante corresponden a los impactos residuales que no admite ningún tipo de manejo.

El municipio de Heliconia no cuenta en la actualidad con un sitio adecuado para la disposición de sus residuos. El Centro Industrial Sur - CIS permite resolver la problemática de disposición y manejo de dichos residuos, fortaleciendo de otro lado, los niveles de producción y el consecuente cambio parcial de las actividades económicas de la población por la introducción de nuevas actividades relacionadas con la operación del proyecto.

7.5. Sobre el Plan de Manejo ambiental a ejecutar

A partir del análisis de los impactos generados por el proyecto, se realiza un Plan de Manejo Ambiental con una serie de medidas para sus diferentes etapas.

Las medidas propuestas en el Plan de Manejo Ambiental durante las fases de construcción, adecuación y operación se consideran válidas y se presentan a continuación.

Sistema de impermeabilización –protección del subsuelo

Se proyecta la impermeabilización con las siguientes especificaciones:

Tipo de residuo a disponer.	Sistema de impermeabilización en la base.	Sistema de impermeabilización en taludes.
Residuos Sólidos Domiciliarios	Capa compactada, Geomembrana. Capa granular.	Geomembrana. Geodren o Geotubo.
Residuos Sólidos Especiales y/o Peligrosos.	Doble capa compactada, Doble Geomembrana y Capa granular.	Doble Geomembrana. Doble Geodren o Geotubo.

Tipo de Sistema de impermeabilización a utilizar en la zona de disposición de residuos sólidos domiciliarios de acuerdo a la pendiente.

Pendiente del área de lleno (%)	Sistema de impermeabilización
0 - 2	Capa compactada, Geomembrana., Capa granular.
2 - 20	Geomembrana, Geotextil , Geodren o Geotubo
> 20	Geomembrana

La celda de seguridad se utilizará para la disposición final de residuos sólidos especiales y peligrosos y tendrá unas especificaciones de impermeabilización mas completas que la zona de disposición de RSU.

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Sistema de captación, recolección y transporte de lixiviados y aguas de proceso en las zonas de tratamiento de residuos. Red de recolección de lixiviados en las áreas efectivas de lleno de los vasos central y norte. Tanto los lixiviados como los efluentes de las zonas efectivas de lleno serán recolectados y llevados a un sitio de tratamiento

De acuerdo al balance hídrico el máximo valor obtenido para año húmedo .46 l/s. Ha; de donde, el máximo caudal de lixiviados, en las 26.96 Ha efectivas de disposición final es de 12.50 l/s.

El tren de tratamiento para el sistema de tratamiento de lixiviados y otros efluentes del Centro Industrial del Sur es el siguiente:

Estructura de medición de caudales y aplicación de neutralizante.

Tanque de igualación - Homogenización.

Precipitación química.

Sistema de tratamiento biológico Anaerobio UASB.

Sistema de mecánico de deshidratación de lodos. (Filtro prensa o centrifuga).

Canal de aireación.

Para el tratamiento de los gases generados en el área efectiva de lleno se presentan dos alternativas:

Alternativa 1: combustión In Situ del biogás al final de cada chimenea

Alternativa 2: recolección del gas mediante una red, y posteriormente llevarlo hasta el sitio de combustión.

Descripción general del sistema de abastecimiento de agua.

En el Centro Industrial del Sur se estima una demanda de agua diaria de aproximadamente 190 m³, o lo que es equivalente a un Caudal medio diario de 2.18 l/s.

El sistema consiste básicamente de una zona de captación, compuesta por una bocatoma de fondo, desarenador y pozo de bombeo, desde donde se impulsa el agua a la zona de almacenamiento de aguas crudas a través de una línea de impulsión de una longitud total de 396.19 m.

Zona de almacenamiento de aguas crudas: En aras de garantizar un correcto abastecimiento de las demandas de agua que se presentan en los diferentes puntos del Centro Industrial del Sur, y de atenuar los picos de estas demandas, se debe construir un sistema de almacenamiento de 300 m³, el cual debe constar de 9 tanques en fibra de vidrio de 3 m de diámetro y 5 m. de altura.

Sistema de potabilización de agua: El Centro Industrial del Sur contará con una red de agua potable, la cual está alimentada por un sistema de potabilización que

tiene los siguientes componentes: Conducción (abastecido constantemente por el sistema de almacenamiento de aguas crudas), Unidad de floculación - sedimentación (lecho poroso y alta tasa respectivamente), unidad de filtración (con retrolavado por bombeo)

Sistema de almacenamiento de agua potable: En aras de garantizar un correcto abastecimiento de agua potable en los diferentes puntos del Centro Industrial del Sur, y atenuar los picos de estas demandas, se proyecta un sistema de almacenamiento con capacidad total de 42 m³ el cual consiste de 2 tanques en fibra de vidrio de 3 m. de diámetro y 3 m. de altura.

Deben ejecutarse en su totalidad y de acuerdo a la propuesta y diseños presentados, los siguientes programas de manejo ambiental durante las diferentes fases del proyecto:

- *Programa de adecuación morfológica*
- *Programa de control de erosión, y manejo de aguas de escorrentía*
- *Programa de manejo de lixiviados y gases*
- *Manejo de aguas residuales*
- *Programa de señalización*
- *Programa de abastecimiento hídrico*
- *Programa de abastecimiento de materiales de construcción*

Asimismo, deben realizarse en su totalidad de acuerdo a los cronogramas y actividades propuestas, los siguientes programas de Manejo Ambiental.

- *Programa 1: Rehabilitación del Suelo degradado por el Proyecto*
- *Programa 2: Apoyo, Mantenimiento y Manejo de Vías*
- *Programa 3: Control Ambiental durante la Ejecución, Adecuación y Conformación de las Obras*
- *Programa 4: Plan de Manejo, Componentes Flora y Fauna Silvestre*
- *Programa 5: Control de Olores y Vectores*
- *Programa 6: Gestión Socioambiental*
- *Programa 7: Prospección, Monitoreo y Rescate Arqueológico.*

Y los programas de monitoreo:

- *Programa de monitoreo de la calidad del aire*
- *Programa de monitoreo de calidad del agua*
- *Programa de monitoreo de calidad del agua subterránea*
- *Programa de Monitoreo de la calidad hidrobiológica de los cuerpos de agua*
- *Programa de Monitoreo de presión interna de poros en el relleno*
- *Programa Monitoreo topográfico de posibles movimientos diferenciales del relleno.*

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5. Que el Informe Técnico 110RN-265 hace las siguientes recomendaciones a las cuales debe sujetarse la Empresa Beneficiaria de esta licencia; razón por la cual nos permitimos citarlas textualmente:

“(...)

8.1. El proyecto deberá tener como mínimo las siguientes características generales:

Localización		Vereda La Chorrera Municipio de Heliconia
Etapas		Adecuación inicial Operación Clausura y posclausura.
Vida útil (Etapa de Operación)	años	24
Duración del Proyecto (Operación, Clausura y Posclausura)	años	54
Tipo de residuos	*	Sólidos urbanos, Especiales y Peligrosos, lodos
Tipo de relleno	*	Área -- Trinchera
Fondo Residuos Sólidos Domiciliarios	*	Capa compactada, Geomenbrana, y Capa granular.
Fondo Residuos Sólidos Especiales y/o Peligrosos.	*	Doble capa compactada, Doble Geomenbrana y Capa granular.
Capacidad total	$10^6 m^3$	5.7
Densidad de compactación de los Fardos	Ton / m^3	1,2
Densidad de compactación de los Residuos Dispuestos Directamente	Ton / m^3	1,0
Manejo de gases	*	Combustión In Situ del biogás al final de cada chimenea
Manejo de lixiviados	*	Estructura de medición de caudales y aplicación de neutralizante, Tanque de igualación – Homogenización, Precipitación química, Sistema de tratamiento biológico Anaerobia UASB, Sistema de mecánico de deshidratación de lodos. (Filtro prensa o centrifuga) y Canal de aireación.
Tipo de operación	*	Recuperación del 30%, y del 70% restante el 60% compactación en fardos y 40% disposición tradicional combinado (área y trinchera)

8.2. Mantener en buen estado toda la maquinaria, con el fin de evitar escapes de lubricantes o combustibles que puedan afectar los suelos, corrientes de agua, aire y seres vivos

8.3. Las vías transitorias o permanentes no pavimentadas, para el acceso a frentes de operación deberán ser regadas periódicamente con agua para minimizar el levantamiento de polvo, en los tramos que indique la Supervisión Ambiental. Adicionalmente, se prohíbe el riego de aceite quemado para atenuar este efecto.

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- 8.4. Los vehículos que transportan material que genere polvo, deberán transitar cubiertos con lonas resistentes.
- 8.5. Se deberá controlar el ruido de los motores de los equipos utilizados durante las tareas de mantenimiento y reparación de maquinaria y equipo, mediante el cerramiento de los sitios de talleres y campamentos.
- 8.6. Los residuos provenientes de la tala y rocería no deben disponerse cerca, ni en los cursos de agua.
- 8.7. Las cunetas que confluyan a un curso de agua, deberán estar provistas de obras que permitan la decantación de sedimentos y si es del caso, se debe efectuar un tratamiento previo antes de su vertimiento al curso de agua.
- 8.8. Los drenajes deben conducirse hacia canales naturales. En caso de no ser posible, se deben construir obras de protección mecánica para el vertimiento de las aguas.
- 8.9. Los aceites y lubricantes usados, los residuos de limpieza y mantenimiento, y otros residuos tóxicos deberán ser retenidos en recipientes herméticos y su disposición final deberá hacerse conforme a instrucciones de la interventoría. En ningún caso podrán tener como receptor final los cursos de agua.
- 8.10. La empresa operadora del relleno debe llevar a cabo la demarcación y aislamiento del área de trabajo, señalizar y controlar el flujo de personal ajeno a las obras en las zonas de trabajo.
- 8.11. La empresa operadora del relleno deberá disponer dentro del campamento de unidades sanitarias higiénicas destinadas al aseo de personal y cambio de ropa de trabajo, las cuales deberán contar con duchas, lavamanos, sanitarios y el respectivo suministro de agua potable. Los sanitarios se instalarán en proporción de uno por cada 12 trabajadores en promedio. Para estos efectos deberá presentar los diseños a la Corporación antes de iniciar la operación del proyecto
- 8.12. Al ejecutar las obras debe tenerse en cuenta la protección de predios aledaños y de cualquier tipo de infraestructura existente, como es el caso de tomas de agua, redes eléctricas, referentes simbólicos, y en caso de afectaciones, estas deberán remediarse inmediatamente.
- 8.13. Cuando en las excavaciones o movimientos de tierra se encuentren yacimientos arqueológicos, restos fósiles u otro vestigio de interés histórico o cultural, se debe suspender de inmediato la actividad e informar al interventor ambiental quien decidirá sobre la mejor forma de realizar el rescate del yacimiento.
- 8.14. Para evitar los procesos erosivos que deterioren el paisaje, afecten la estabilidad de los taludes y el relleno y restablecer el aspecto paisajístico, se

deberá ejecutar el programa **Rehabilitación del suelo degradado por el proyecto**. La revegetalización deberá realizarse mediante el método más apropiado para recubrir estas áreas, bien sea la siembra directa por semillas combinadas de pastos y gramíneas o por estolón, trazando surcos cada cincuenta (50) centímetros de aproximadamente tres (3) centímetros de profundidad a los cuales se les adicionará abono orgánico, se colocarán las semillas y se taparán con tierra. Por último se regarán y este riego deberá mantenerse periódicamente hasta el establecimiento de la cobertura vegetal.

8.15. Para evitar la formación de focos erosivos en la zona de excavación y controlar que los sedimentos generados en las labores de remoción de vegetación y descapote, así como en los sitios de excavación, sean arrastrados por escorrentía y lleguen a las corrientes de agua, deberá ejecutarse el Programa **Control de erosión y manejo de aguas de escorrentía** mediante los siguientes procedimientos recomendados para conjugar los procesos erosivos y el arrastre de sedimentos:

- En los sitios donde se va a remover la capa vegetal, se deben hacer rondas de coronación para interceptar las aguas de escorrentía que podrían desestabilizar los taludes, y cunetas perimetrales para hacer una adecuada disposición de los sedimentos arrastrados.
- Las cunetas y cárcamos adyacentes a los sitios de excavación que confluyan a un curso de agua, deberán estar provistos de obras civiles que permitan la decantación de sedimentos.
- Los drenajes deben conducirse siguiendo curvas de nivel hacia canales naturales. En caso de no ser posible, y de acuerdo con las indicaciones del ingeniero de campo, se deben construir obras civiles de protección mecánica (disipadores de energía en concreto o piedra pegada) para el vertimiento de las aguas.
- Los pisos de los patios de almacenamiento de desechos y los frentes de obra deberán tener un drenaje que transporte las aguas, primero a un sistema de retención de sólidos y luego a las fuentes naturales.
- Donde haya susceptibilidad a la erosión, flujos de corrientes superficiales, sobrecarga con materiales de desechos, o cualquier otro problema geotécnico que ponga en peligro la estabilidad del terreno, se recomienda construir gaviones, filtros, cunetas, etc., como sistemas de protección.

8.16. Para aumentar la diversidad florística y disminuir los procesos erosivos se deberá reforestar y enriquecer con especies nativas las zonas de retiro de las fuentes de agua del sector y algunos bosques secundarios muy intervenidos en las veredas La Chorrera y Yarumalito. Lo anterior se llevará a cabo con el desarrollo del **Programa manejo del componente Flora y Fauna silvestre** en franjas a lo largo de las quebradas y sobre manchones de vegetación remanente.

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Se deberán considerar los siguientes aspectos en la selección de las posibles especies a utilizar:

- Se hará la clasificación preliminar de las especies en grupos ecológicos (pioneras, secundarias y climáticas).
- Se deberán adaptar las especies a las condiciones ambientales existentes en la zona.
- Deberá garantizarse el poblamiento con diversidad de especies teniendo en cuenta su variabilidad genética y la distribución espacial de los individuos.
- Deberá hacerse polinización y dispersión de semillas y se creará la formación de bancos de semillas.

En los sitios donde se realice el enriquecimiento vegetal, la distribución de especies y las labores tradicionales de siembra y mantenimiento, deben realizarse de tal forma que exista la menor intervención del hombre, las técnicas deben ir encaminadas a facilitar el arraigo de las especies, pero alterando lo menos posible las condiciones ya existentes.

Se enriquecerán 10 hectáreas de bosque secundario intervenido, con una densidad de siembra de 555 árboles por hectárea en las veredas La Chorrera y Yarumalito, para un total de 11.111 árboles.

En los sitios donde la presencia del ganado o factores antrópicos sean un inconveniente para la protección o donde se hayan realizado alguno de los programas de repoblamiento vegetal, se debe aislar la zona con alambre de púa, ya sea utilizando estacones o cercos vivos. Las especificaciones del cerco serán: Postes cada 2.5 m de 4" y 2.2 m de altura, piamigos cada 30 m, 4 hilos de alambre de púas calibre 12.

8.17. En caso de apertura de accesos en zonas donde se prevea un posible aporte de sedimentos a cuerpos de agua, se deberán instalar trinchos de madera o sacos de suelo - cemento para la retención del material proveniente de la excavación.

8.18. En la zona de retiro comprendida entre las fuentes de agua superficiales y el perímetro de las plataformas de disposición, no podrán realizarse actividades inherentes a la operación del relleno con excepción de la siembra de árboles o actividades de reforestación o mejoramiento paisajístico o ambiental.

8.19. Para evitar el impacto paisajístico y visual, para retener papeles y plásticos elevados por el viento y evitar la entrada de animales a las instalaciones del relleno se deberá ejecutar un Programa de Barreras Vivas para su aislamiento visual, para lo cual se deben plantar mínimo tres hileras de árboles y arbustos formando una barrera cuyo corte transversal sea triangular. Se plantará inicialmente plántulas cada 20 cm con el fin de que se cierre lo más pronto posible, la siguiente hilera se plantará a una distancia de un (1) metro y para ello se utilizarán arbustos de no

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menos de 30 cm. de altura al momento de la siembra y una distancia entre plántulas de un (1) metro y por ultimo se plantará una hilera de árboles de no menos de 60 cm. al momento de la siembra y que alcancen una altura final entre 15 y 20 metros, con una distancia de siembra entre plántulas de dos (2) metros, que permitan una densidad alta al momento de la siembra y más adelante cuando las copas de los árboles estén muy entrecruzadas que es lo ideal, la realización de entresacas si fuere necesario.

8.20. Todos los materiales áridos necesarios para la ejecución del proyecto deberán obtenerse de fuentes autorizadas previa consulta a esta Corporación.

8.21. El equipo móvil, incluyendo maquinaria pesada, deberá operarse de tal manera que cause el mínimo deterioro a los suelos, vegetación y las corrientes de agua. Además, se evitará al máximo, las incomodidades a la población que reside en sitios cercanos a las vías de acceso, y al tráfico en general.

8.22. Para garantizar condiciones sanitarias adecuadas en el interior de la zona de influencia inmediata del relleno y minimizar la presencia de carroñeros y necrófagos se debe ejecutar el Programa **Control de olores y vectores**. Para su desarrollo se debe realizar cobertura diaria con material inerte de los residuos depositados en el relleno, cercamiento de sus instalaciones para evitar la entrada de animales y se deben colocar cebos para control de roedores así como “siembra” de avispas para control biológico de las larvas de moscas e insectos asociados.

8.23. Para la disposición de residuos especiales y peligrosos, se deberá construir la celda de seguridad de acuerdo a los diseños presentados en el plano CIS-CSEG-DX-10. Igualmente se permitirá la disposición de residuos hospitalarios previo el cumplimiento de las normas sanitarias y de seguridad previstas en las disposiciones legales y reglamentarias.

8.24. Se permitirá la disposición de residuos hospitalarios previo el cumplimiento de las disposiciones legales y reglamentarias que rigen este tipo de residuos.

8.25. Deberá desarrollarse el Programa “**Gestión Socioambiental**”, con las comunidades del área de influencia directa, cuyos ejes temáticos serán la educación para la participación, proyectos de desarrollo y gestión ambiental, condiciones del entorno, formación ciudadana, desarrollo familiar, gestión para la cultura del reciclaje.

8.26. Para establecer una política de empleo que ayude a resolver la problemática económica de los habitantes de la región y que permita la selección objetiva y equitativa del personal que laborará en el proyecto a través de la vinculación de

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representantes de la comunidad, se debe ejecutar el Programa **Proyecto de Gestión socioambiental**.

8.27. Los programas a desarrollar contenidos en el Plan de Manejo, deberán ser ejecutados de acuerdo al siguiente cronograma:

Cronograma de ejecución del PMA para el primer año de operación del CIS

PROGRAMAS DE MANEJO AMBIENTAL	MESES												
	-1	1	2	3	4	5	6	7	8	9	10	11	12
Rehabilitación del suelo degradado por las actividades del proyecto.													
Programa de apoyo al mantenimiento de la vía de penetración y manejo vial													
Control ambiental durante la ejecución, adecuación y conformación de obras													
Manejo ambiental de los componentes flora y fauna silvestre													
Control de vectores y dolores													
Gestión socioambiental													
Información y participación comunitaria													
Control epidemiológico													
Generación de empleo													
Asesoría técnica y jurídica para que la comunidad organizada de San Antonio de Prado pueda crear una empresa o cooperativa prestadora del servicio de aseo en su Corregimiento													
Apoyo al fortalecimiento de la gestión ambiental municipal de Halcónia													
Educación ambiental con énfasis en el manejo integral de residuos sólidos													
Prospección, monitoreo y rescate arqueológico													

Cronograma de ejecución del plan de monitoreo y seguimiento para el primer año de operación del CIS

PROGRAMAS DE MONITOREO Y SEGUIMIENTO	MESES											
	1	2	3	4	5	6	7	8	9	10	11	12
Programa de monitoreo de la calidad del aire												
Programa de monitoreo de calidad del agua superficial												
Programa de monitoreo de calidad del agua subterránea												
Programa de Monitoreo de la calidad hidrobiológica de los cuerpos de agua												
Programa de Monitoreo de presión interna de poros en el relleno												
Programa Monitoreo topográfico de posibles movimientos diferenciados del relleno												
Programa de Monitoreo de la Gestión socioambiental												

8.28. Para detectar cambios en la calidad fisicoquímica, bacteriológica e hidrobiológica de las aguas de las quebradas del sector, e identificar las posibles

fuentes de contaminación que originan la alteración de su calidad, se debe ejecutar los Programas **Monitoreo de la calidad del aguas** y **Monitoreo de la calidad hidrobiológica de los cuerpos de agua**. El seguimiento de la calidad fisicoquímica y microbiológica de las aguas se hará mediante el uso del Índice de Calidad para ríos NFS-WQI.

8.29. El análisis de la calidad Hidrobiológica de las aguas se hará mediante la evaluación de la diversidad de familias de macroinvertebrados de las quebradas del sector y se empleara como indicador biológico de la calidad del agua. Con base en valores predeterminados para familias de macroinvertebrados, se construirá el índice BMWP (Biological Monitoring Working Party). El muestreo se debe hacer antes y después del sitio del relleno con una frecuencia de seis meses.

8.30. Para prevenir y controlar la potencial infiltración del percolado a través de la matriz de suelo y deteriorar la calidad y disponibilidad del agua subterránea se debe ejecutar el **Programa Monitoreo de calidad del aguas Subterráneas**. El monitoreo se realizará mediante la toma de muestras puntuales en los pozos que se instalan para tal fin, los pozos deben ubicarse en puntos externos a las áreas donde se proyecten llenos. Desde el momento en que se inicie el proyecto, se realizará anualmente un análisis de los parámetros fisicoquímicos básicos: nutrientes, carga orgánica, sales disueltas, pH, Temperatura, Conductividad y metales.

8.31. Para realizar el control y registro de las cantidades y características del biogás evacuado del sistema en condiciones pasivas y evaluar la eficacia y eficiencia de las medidas implementadas, se debe ejecutar el Programa **Monitoreo de Calidad del Aire**. Este programa de seguimiento es anual y se deberán presentar a esta Corporación los análisis de resultados y el informe del respectivo estado ambiental. El sistema se implementará desde el momento en que se inicie el proyecto y continuará hasta el final de la fase de posclausura del relleno.

8.32. Instalar una estación Hidrometeorológica y definir un sistema de monitoreo que permita capturar, procesar y analizar la información obtenida a partir de la estación con el objetivo de poder controlar variables físicas fundamentales para la adecuada operación del proyecto.

8.33. Para determinar las condiciones de estabilidad del relleno sanitario se debe ejecutar los Programas **Monitoreo de la presión interna en el relleno** y **Monitoreo topográfico de posibles movimientos diferenciales del relleno**. Este programa de seguimiento es permanente y se desarrollará durante las fases de construcción, operación, clausura y posclausura del relleno y comprenderá los siguientes aspectos:

- Control topográfico: En la superficie del relleno se instalarán puntos de control topográfico que permitan establecer los movimientos horizontales y verticales de la masa del relleno, así como las tasas y direcciones de los movimientos.

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- Presiones de poros: desde los estudios de suelos se dejaron instalados piezómetros que permitirán establecer las presiones de poros generadas por efecto de los gases y lixiviados sobre la superficie del relleno y en las zonas ya llenadas, con esta información, se determinará el factor de seguridad en caso de detectarse evidencias de fallas y para la determinación de acciones encaminadas a su control.
- Presencia de grietas y brotes de lixiviados: A través de inspecciones continuas en la superficie del relleno se identificará la presencia de grietas y brotes de lixiviados. Las grietas serán caracterizadas por su longitud, ancho y dirección y los brotes por su localización y caudal si es posible.
- Caudal de lixiviados: Adicionalmente será medido el caudal de lixiviados generado en el interior de la masa del relleno. Para tal efecto se realizarán aforos volumétricos con una frecuencia mensual.
- Inspecciones de obras hidráulicas: Se establecerá diariamente el correcto funcionamiento de las cunetas y los desagües, previniendo su obstrucción.

8.34. Para controlar la efectividad de la recolección de los lixiviados producidos en el relleno se debe ejecutar el Programa de Monitoreo calidad del agua. Este programa de seguimiento será permanente y se desarrollará durante las diferentes etapas del proyecto. Este monitoreo se iniciará una vez el sistema de manejo de lixiviados inicie su operación y hasta la posclausura del relleno, con monitoreos trimestrales durante los dos primeros años de operación, semestrales en los siguientes años de operación y en la etapa de clausura y anuales en la de posclausura.

8.35. Para evaluar y mitigar los posibles cambios que se puedan presentar en la calidad del aire debido a las actividades de construcción de las vías. (Material particulado, SO₂, NO₂, CO y ruido). Se debe ejecutar el Programa de **Monitoreo de la Calidad del aire**. Este programa de seguimiento será permanente y se desarrollará durante las diferentes etapas del proyecto, se debe hacer el monitoreo cada seis meses, desde que se inicie la adecuación del lote, hasta la etapa de clausura del relleno. El monitoreo se debe efectuar de manera continua durante ocho días en cada uno de los sitios.

8.36. Para obtener información constante sobre el desarrollo de los proyectos contemplados en el programa de gestión socioambiental del P.M.A y tomar las medidas correctivas se debe ejecutar un Programa: **Monitoreo y evaluación del programa de gestión socioambiental del proyecto**. Este programa de seguimiento será permanente y se desarrollará durante todas las diferentes fases del proyecto, incluida la posclausura.

8.37. Se deberá informar a esta Corporación con al menos un (1) mes de anticipación, la fecha de inicio de la operación del Centro Industrial del Sur y deberá presentarse el Plan de Aprovechamiento Forestal que deberá realizarse de acuerdo

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a la guía para la formulación de planes de Aprovechamiento Forestal de Corantioquia contenido en sus páginas 53, 54 y 55.

8.38. Para la etapa de la clausura final se deberá presentar un informe o proyecto actualizando los cambios ocurridos durante la operación misma. Este informe deberá ser entregado a la autoridad ambiental correspondiente con cuatro (4) meses de anticipación a la fecha prevista para el fin de operación, para iniciar la clausura del relleno sanitario. El informe debe contemplar como mínimo la revisión de los planos relativos a la topografía final del sitio y se deberá entregar un levantamiento topográfico y especificar además, el tipo y las fuentes de material de cobertura final. Contemplará igualmente:

- Medidas tendientes al control de plagas y roedores incluyendo entre otros aspectos: Tipo de medida, frecuencia de aplicación, responsable y tiempo de ejecución.
- Propuesta de conformación de cobertura final del relleno sanitario que incluya: descripción de las propiedades geométricas, granulométricas y mecánicas en caso tal de requerirse de cada una de las capas de las que la conforman.
- Programa de recuperación ambiental y paisajística que contenga: sistema de siembra, especies a sembrar, cantidades por especie, periodicidad del mantenimiento, tipo y periodicidad del abonado.
- Memorias de cálculo y diseño del sistema completo de captación, transporte y evacuación de aguas de escorrentía.
- Programa de participación comunitaria y difusión del proceso de clausura y posclausura, que incluya entre otros aspectos: mecanismos de participación comunitaria que se propiciaran, metodología de divulgación a emplear, personal que participara en el programa, frecuencia de implementación, etc. Los mecanismos de divulgación que se implementen, contemplaran por lo menos, los siguientes temas: razones del cierre, el plan para llevar a cabo la clausura y posclausura y nuevas alternativas de manejo de residuos.

8.39. La cubierta final debe tener seis capas así: Sobre la superficie de los desechos se instalara una capa de 30 centímetros de suelo compactado con el fin de aislar los desechos confinados de los componentes de la cobertura final, sobre ésta, se colocará una capa de material granular de un espesor de 20 centímetros conectada a los filtros de evacuación de gases. Posteriormente una capa de material compactado de 30 centímetros de espesor, con una permeabilidad no superior a 10^{-9} m/s. Cubriendo estos materiales se deberá instalar una geomembrana entre 1.5 y 2.5 milímetros de espesor, sobre ésta se colocara una capa de 15 centímetros de espesor de material granular con granulometría comprendida entre $\frac{3}{4}$ y 1 1/2 pulgada. Por último una capa de suelo orgánico de 15 centímetros de espesor.

8.40. Transcurridos los tres (3) primeros meses después del fin de operación, se deberá tener listo y concluido todas las obras de drenaje pluvial, se deberá tener culminado en este periodo de tiempo toda la instalación de los dispositivos para el

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control de asentamientos de la masa de residuos sólidos y de otras estructuras. Igualmente se deberá tener concluidos los sistemas de recolección y tratamiento final de gases, los sistemas de ventilación, los de captación transporte y tratamiento de lixiviados y los de seguimiento y monitoreo de gases y lixiviados.

8.41. Transcurrido un (1) año de la finalización de la etapa de clausura se deberá garantizar que el área de disposición final presente un establecimiento de cobertura vegetal en un 95 %.

8.42. El seguimiento de la etapa de posclausura comprenderá un período de 30 años.

8.43. La frecuencia del monitoreo en cada una de las actividades del programa de seguimiento será trimestral durante los primeros cuatro años y semestral después del cuarto año.

8.44. Como sistema de protección de la geomembrana durante la aplicación de las cargas debe emplearse geomalla, u otro material que cumpla esta función y minimice los punzonamientos sobre aquella.

8.45. En caso de ser necesario, se deberá implementar sistemas de extracción forzada de lixiviados que garanticen la permanencia del valor de la presión de poros por debajo de 0.2.

8.46. Para el control del ingreso de residuos al relleno sanitario, se deberá instalar un sistema de registro y pesaje que permita determinar las cantidades, origen y tipo de residuos que ingresan a él.

8.47. Las quemas de todo tipo de materiales (basuras, residuos de construcción, material vegetal, etc.) deberán ser controladas.

8.48. Luego de la etapa de posclausura, una vez se verifique a través de los monitoreos que el relleno no presenta riesgo ambiental, se utilizará dicho lote como un área de reserva y se dejará para que se inicie un proceso de regeneración natural; tal como lo propuso la Empresa Beneficiaria en el Estudio de Impacto Ambiental.

8.49. Si se presentan problemas o dificultades en la operación del relleno que impidan el desarrollo del Plan de Manejo Ambiental, se deberá dar aviso de manera inmediata a CORANTIOQUIA, con el fin de que se analicen y evalúen las alternativas de solución a la problemática presentada.

8.50. Se deberá presentar un informe de interventoría ambiental cada cuatro (4) meses en el que se consigne el estado de la implementación del Plan de Manejo Ambiental, incluidos los planes de monitoreo y seguimiento y los requerimientos contenidos en esta resolución. Asimismo, se describirá allí de manera concreta, los

avances en la construcción de las obras autorizadas y un informe de la atención de contingencias que se hubieran presentado durante el periodo de objeto del informe.

8.51. Mantener actualizado un plan de prevención y control de incendios en todos los componentes de la gestión integral de los residuos sólidos. En caso de presentarse un incendio, se deberá ejecutar las medidas de mitigación y corrección pertinentes. Asimismo, se deberá garantizar la capacitación de todo su personal sobre los procedimientos a seguir en caso de presentarse incendios, explosiones y demás aspectos de seguridad industrial y de primeros auxilios.

8.52. Antes de iniciar la fase de operación del relleno sanitario deberán estar totalmente construidos los sistemas de tratamiento para las aguas residuales domésticas e industriales, de conformidad con los diseños presentados.

8.53. Implementar en su totalidad el Plan de Contingencias y Emergencias determinado en el Estudio de Impacto Ambiental

(...)".

6. Que en materia de permisos ambientales, el Informe Técnico 110RN-265 recomienda lo siguiente:

"(...) Otorgar una concesión de aguas de 2.18 l/s distribuidos de la siguiente manera: para uso doméstico un caudal de 0.23 l/s y para uso industrial un caudal de 1.95 l/s. Estos caudales se derivaran de la fuente sin nombre que posee un caudal mínimo de 5.5 l/s y sobre la cual se harán las respectivas captaciones de acuerdo al plano CIS-SA-CAP 01 anexo al EIA.

Otorgar un Permiso de Vertimientos para las aguas residuales domésticas e industriales (lixiviados), el cual tendrá una vigencia de cinco (5) años y está condicionado a la construcción de los sistemas de tratamiento, según los términos, diseños y ubicación propuestos en el Estudio de Impacto Ambiental (...)".

7. Que la decisión final sobre este asunto se tomará teniendo en cuenta las evaluaciones y recomendaciones efectuadas por el Comité de Residuos Sólidos de CORANTIOQUIA a través del Informe Técnico 110RN-265 y además, con fundamento en las siguientes:

7.1. Consideraciones.

Además de determinar la procedencia de otorgar la licencia ambiental solicitada de conformidad con lo establecido por las normas legales y reglamentarias, es necesario definir para estos efectos la necesidad de presentar o no un Diagnóstico Ambiental de Alternativas (i), haber examinado las normas locales de Heliconia o su Esquema de Ordenamiento Territorial

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concertado con esta Corporación, por el cual se definen los usos del suelo en el municipio (ii). Verificar si el área de influencia del proyecto afecta comunidades indígenas o negras a fin de garantizarles el derecho de participación mediante el procedimiento previo de la consulta definido en el decreto 1320 de 1998, reglamentario de la Ley 70 de 1993 (iii), y por último expresar las consideraciones relevantes por las cuales se adopta la decisión de fondo (iv).

7.1.1. Sobre la necesidad de presentar un Diagnóstico Ambiental de Alternativas

Para determinar la necesidad de este estudio, basta remitirse a lo previsto en los artículos 9 y 14, numeral 2 del decreto 1180 de 2003, para precisar que la ejecución de este proyecto no requiere tal estudio, el cual debe exigirse por parte de las Corporaciones Autónomas Regionales únicamente para llevar a cabo la construcción de presas, represas o embalses con capacidad igual o inferior a 200 millones de metros cúbicos de agua; la construcción y operación de centrales generadoras de energía con una capacidad mayor o igual a 10 MW y menor de 100 MW y por último, para la construcción y operación de puertos en la red fluvial.

7.1.2. Conformidad con el Esquema de Ordenamiento Territorial

En cuanto a determinar si el proyecto, obra o actividad está conforme a los usos definidos en el Esquema de Ordenamiento Territorial, CORANTIOQUIA, en atención a lo previsto en el artículo 17, numeral 7 del decreto 1180 de 2003 y mediante radicado 040-6097 del 13 de diciembre de 2004, solicitó al señor Alcalde del municipio de Heliconia certificar si el proyecto denominado "*Centro Industrial del Sur*" a ejecutarse en las coordenadas definidas en el artículo 1 de esta resolución, se ajusta o no a los usos del suelo definidos en el Esquema de Ordenamiento Territorial 2000 – 2008 aprobado por el Concejo Municipal. En respuesta a esta solicitud, el municipio certificó que el proyecto se encuentra incluido dentro de su E.O.T. donde se observa textualmente "(...) Art Segundo: Se ratifica el sector de Monteadentro y se incluye la vereda la chorrera como posibles sitios o lugares donde se podría desarrollar labores para el manejo y disposición final de los residuos sólidos proyecto denominado "Centro Industrial del Sur (...)"

7.1.3. Presencia de Comunidades Indígenas o Negras

La Dirección de Etnias del Ministerio del Interior y de justicia, en oficio DET-1000 – 06596 del 7 de octubre de 2004, certificó lo siguiente en cuanto a la

presencia de comunidades indígenas y/o negras en el área donde se llevará a cabo el proyecto:

“(...) Revisadas las bases de datos institucionales del DANE, Asociaciones de Cabildos y/o Autoridades Tradicionales y los reconocimientos emanados de esta Dirección sobre comunidades indígenas NO SE REGISTRAN comunidades indígenas en el municipio de Heliconia, departamento de Antioquia.

Revisada la información existente en esta Dirección sobre comunidades negras, NO SE REGISTRAN comunidades negras en el municipio de Heliconia, departamento de Antioquia (...)” (Mayúsculas originales)

7.1.4. Consideraciones especiales

Además del resultado final de la evaluación técnica efectuada, y del cumplimiento de los requisitos legales y reglamentarios sobre licencias ambientales, encontramos necesario exponer las razones por las cuales esta Corporación accede en esta oportunidad a la petición de EVAS-ENVIAMBIENTALES S.A. E.S.P, de otorgarle la licencia ambiental para ejecutar un proyecto que se enmarca geográficamente en los mismos predios, zonas o cuadrángulos sobre los cuales otorgamos con anterioridad a Empresas Varias de Medellín E.S.P otra licencia ambiental para desarrollar el proyecto denominado “Centro Integrado de Residuos Sólidos El Guacal” destinado a la disposición final de residuos sólidos según se advierte en la resolución 6621 del 21 de noviembre de 2003.

Expondremos las razones de la decisión adoptada en la presente resolución, no sin antes precisar y advertir que lo relevante en este asunto es la probabilidad de que existan dos (2) licencias ambientales para ejecutar dos (2) proyectos **en un mismo lote cuyo propietario es el titular de una de ellas**. Lo significativo aquí no es la naturaleza o tipo de proyectos, obras o actividades licenciadas, sino el hecho de que técnicamente ambos se encuentran licenciados para ser desarrollados en los mismos predios, por lo cual se excluyen y rechazan si tenemos en cuenta además que son proyectos esencialmente diferentes. No obstante, es posible adoptar la decisión contenida en esta resolución por cuanto sólo se ejecutará el nuevo proyecto que aquí se autoriza y además, porque su construcción y puesta en operación es necesaria para prevenir y controlar graves factores de deterioro ambiental.

En efecto, CORANTIOQUIA procederá a licenciar ambientalmente el denominado “Centro Industrial del Sur – CIS” por cuanto obra con

pleno conocimiento de que el proyecto denominado “Centro Integrado de Residuos Sólidos El Guacal” no se llevará a cabo por voluntad expresa y manifiesta de los máximos órganos de dirección de Empresas Varias de Medellín, tal como se observa en los apartes siguientes.

Según certificación del 29 de junio de 2004 expedida por la Secretaría General de Empresas Varias de Medellín, en sesión del 5 de mayo de 2004, su Junta Directiva adoptó la siguiente decisión sobre el “Centro Integrado de Residuos Sólidos El Guacal”:

“(…)

- *No realizar inversión alguna en el Lote El Guacal*
- *Solicitar a la Administración que se formalicen los estudios económico – financieros discutidos en la presente reunión para dar soporte a la decisión que se toma.*
- *AUTORIZAR a la Gerencia para negociar la licencia ambiental otorgada por Corantioquia para el relleno sanitario en el Municipio de Heliconia denominado El Guacal (...)*
- *Solicitar a la Administración que se busquen otras alternativas de lotes para el relleno sanitario en el sur del Valle de Aburrá (...)"*

Lo anterior es ratificado por el gerente de Empresas Varias en oficio con radicado 86207 del 27 de mayo de 2004: “(...) la Junta Directiva de Empresas Varias de Medellín E.S.P., en su sesión Nro 07 del pasado 5 de mayo, tomo la decisión de no realizar inversión alguna en el lote El Guacal, para darle prioridad e invertir en otros proyectos que garanticen la prestación eficiente del servicio público de aseo (...”).

Nuevamente el gerente, en oficio radicado 87737 del 29 de junio de 2004 dirigido a los propietarios del predio donde se llevaría a cabo el proyecto, les anexa y expresa:

“(…)

Extracto del acta de Junta Directiva de la Empresa No. 07, de la sesión realizada el día 05, en el cual se consideró no viable para la Empresa el proyecto El Guacal y se autorizó al Gerente para adelantar los trámites necesarios para la eventual negociación de la licencia.

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(...)

En lo relacionado con las razones por las cuales se descarta el Guacal como alternativa para Empresas Varias de Medellín E.S.P., debe tenerse en cuenta que las mismas fueron expuestas por la Junta Directiva, según se establece en la parte pertinente de la copia del acta que se anexa (...)"

Igualmente, en el informe de la Contraloría General de Medellín con radicado de Corantioquia No 410-17278 del 26 de octubre de 2004 se lee:

"(...)

En este orden de ideas y de acuerdo a certificación de la Secretaría General de las Empresas Varias de Medellín, según acta No.7 de Reunión de la Junta Directiva realizada el día 5 de mayo de 2004, en el numeral 5 del orden del día se concluyó no realizar inversión alguna en el lote El Guacal, además de autorizar a la Gerencia para negociar la licencia ambiental otorgada por Corantioquia para el Relleno Sanitario en el municipio de Heliconia denominado El Guacal (...)"

De otro lado, en sesión ordinaria del Concejo de Medellín efectuada el miércoles 3 de noviembre de 2004, convocada para discutir el tema de los residuos sólidos en el área metropolitana del valle de aburrá y a la cual se invitó a CORANTIOQUIA, el señor gerente de Empresas Varias manifestó lo siguiente sobre la negociación de la licencia otorgada mediante la resolución 6621 del 21 de noviembre de 2003:

"(...) La semana anterior tuvimos reunión con la gerente de Enviaseo y el gerente de la nueva empresa de servicios públicos domiciliarios, EVAS, Doctor José Zuluaga, la cual se constituyó entre el municipio de Envigado con una participación del 50% y las empresas, Inversiones Laguna S.A y Ambientales S.A. E.S.P. en un 50%. EVAS desarrollará el proyecto del Guacal y Empresas Varias les ha ofrecido en forma verbal, la licencia ambiental que sobre una porción de ese terreno posee.

Vemos con buenos ojos que otros municipios del valle de Aburrá estén buscando soluciones para sitios de disposición final y prestos a compartir con ellos todas nuestras experiencias en esta materia (...)"

De otro lado, mediante oficios 040-12, 040-13 y 04011, CORANTIOQUIA le solicitó a los propietarios del predio, a la señora Gerente de Enviaseo E.S.P y al señor Alcalde de Envigado, que certificaran si en la actualidad se

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encuentran en negociaciones con Empresas Varias de Medellín, para venderle los predios que le permitan a ésta ejecutar el proyecto "Centro Integrado de Residuos Sólidos El Guacal"; o en su defecto, certificar si alguno de ellos se encuentra actualmente adelantando conversaciones con EEVVM para adquirir la Licencia Ambiental otorgada a esta última mediante la resolución 6621 del 21 de noviembre de 2003, con el fin de llevarlo a cabo.

Atendiendo la anterior solicitud y mediante radicado 51-63, la empresa propietaria de los predios manifestó:

"(...) le informo que EVAS ENVIAMBIENTALES S.A. E.S.P. no adelanta en la actualidad negociación alguna con Empresas Varias de Medellín tendiente a la venta de los predios para desarrollar el proyecto Centro Integrado de Residuos Sólidos El Guacal, los cuales son propiedad de nuestra empresa, así como tampoco se pensó en venderle dichos predios a Empresas Varias de Medellín cuando éstos eran propiedad de INVERSIONES LAGUNA S.A. y AMBIENTALES S.A. E.S.P."

Con respecto a la adquisición de la licencia ambiental otorgada a favor de Empresas Varias de Medellín para desarrollar el proyecto Centro Integrado de Residuos Sólidos El Guacal, certifico que en Acta No 3 de junta Directiva de EVAS ENVIAMBIENTALES S.A. E.S.P. se tomó la decisión de no adquirir dicha licencia por la suma exorbitante solicitada por ella, y además por la imposibilidad jurídica y práctica de Empresas Varias de Medellín de ejecutar el proyecto mencionado toda vez que los predios no son de su propiedad (...)"

De igual forma y mediante radicado interno 51-62, la Empresa Enviaseo E.S.P. manifestó:

"(...) le comunico que actualmente ENVIASEO E.S.P. no adelanta negociación alguna con Empresas Varias de Medellín, tendiente a la enajenación de los predios sobre los cuales se proyectó el "Centro Integrado de Residuos Sólidos El Guacal" licenciado por Corantioquia mediante la Resolución 6621 del 21 de noviembre de 2003.

Al respecto debe recordarse que, no obstante lo resuelto mediante dicha Resolución, Empresas Varias de Medellín nunca ha sido ni es propietaria de los predios, por lo que cualquier pretensión por parte de éstas de implementar y ejecutar el mencionado Proyecto, es inútil y legalmente imposible.

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Así las cosas, le certifico que, por las razones expuestas, nuestra Junta Directiva tomó formalmente la decisión de no negociar la Licencia con Empresas Varias de Medellín (...)"

Finalmente, el señor Alcalde del municipio de Envigado expresó:

"(...) le comunico que actualmente, el Municipio de Envigado no adelanta negociación alguna con Empresas Varias de Medellín, para adquirir la licencia ambiental otorgada por Corantioquia mediante la resolución No 6621 del 21 de noviembre de 2003, la cual como se expresó, autoriza la ejecución del proyecto "Centro Integrado de Residuos Sólidos El Guacal" en el municipio de Heliconia (...)"

En conclusión, para esta autoridad ambiental es claro que Empresas Varias de Medellín, además de descartar la construcción y puesta en operación del proyecto licenciado mediante la resolución 6621 del 21 de noviembre de 2003, no tiene la posibilidad de ejecutarlo como quiera que no es la propietaria de los predios donde se le autorizó el proyecto y los dueños no se encuentran interesados en enajenarlos. Esto elimina la circunstancia de que se lleven a cabo por personas distintas dos proyectos en un mismo predio; recordando además que la Empresa propietaria de los predios fue quien solicitó a Corantioquia la licencia ambiental para ejecutar un proyecto diferente denominado "Centro Industrial del Sur – CIS", para lo cual cumplió con los requisitos exigidos en las disposiciones legales y reglamentarias que nos permiten otorgar el permiso solicitado.

De otro lado, reiteramos nuevamente que para esta Corporación es de suma importancia contar con soluciones definitivas y reales de disposición final de los residuos sólidos generados en el área metropolitana el valle de aburrá, como quiera que no ha sido superado el riesgo de una posible emergencia sanitaria y ambiental tantas veces advertido en los diferentes actos administrativos expedidos por CORANTIOQUIA sobre esta materia. Así lo reconoce también Empresas Varias de Medellín cuando informa sobre la amenaza de una eventual suspensión de operaciones en el relleno sanitario La Pradera, el cual ya presenta serios incumplimientos de la Licencia Ambiental que son objeto de un proceso sancionatorio por las graves afectaciones al ambiente y los recursos naturales renovables que está generando, como el presentado al recurso agua por el vertimiento de lixiviados.

En conclusión, este es un riesgo latente no resuelto aún, en especial, si recordamos que hasta la fecha Empresas Varias de Medellín no nos ha presentado ninguna solución definitiva diferente al "Sistema Integral de

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Residuos Sólidos El Guacal", cuya construcción y puesta en operación, lamentablemente fue descartada en forma expresa por razones de orden financiero. Lo anterior agrava la problemática de los residuos sólidos, pues según la resolución 5288 del 3 de julio de 2003, por la cual licenciamos el relleno sanitario La Pradera, donde actualmente depositan los residuos, este es meramente una solución de contingencia como las autorizadas en su momento para los municipios de Girardota, Caldas, La Estrella y Sabaneta que ya fueron clausuradas y entendidas en esa oportunidad como "(...) aquella que contiene la solución por la cual se resuelve durante un período máximo de 30 meses, la problemática presentada con los residuos sólidos del Vale de Aburrá, término en el cual se deberá presentar una solución a largo plazo (...)"". Es la razón por la cual, una vez cerrado el relleno sanitario Curva de Rodas, Empresas Varias de Medellín presentó a consideración de CORANTIOQUIA el relleno sanitario de La Pradera como una solución de contingencia, el cual se entiende licenciado solamente por treinta (30) meses contados a partir del 6 de junio de 2003, fecha en la cual inició sus operaciones. Dentro de este término, EEVVM debió adecuar o construir la solución definitiva previa la obtención de los permisos y autorizaciones necesarias para ello. Pero desafortunadamente aún no ha iniciado los trámites necesarios para este fin, generando una gran incertidumbre sobre la oportuna adecuación y puesta en operación de lugares previamente autorizados para la disposición final de los residuos sólidos.

En las actuales circunstancias, se convierte en una necesidad urgente para la salud pública y el ambiente, construir propuestas definitivas que tiendan a solucionar la disposición final de los residuos sólidos generados en el Valle de Aburrá. Mientras persista esta delicada situación, CORANTIOQUIA no dejará de insistir en la importancia de llevar a cabo proyectos como el que licenciamos a través de esta resolución, por cuanto la adecuada disposición final de los residuos sólidos garantiza la prestación continua y regular del servicio domiciliario de aseo, que además de ser un servicio público inherente a la finalidad social del estado, se constituye a la vez en una forma de prevenir y controlar graves factores de deterioro sanitario y ambiental con la característica de comprometer seriamente la salud pública y los recursos naturales renovables en aquellos centros urbanos como el nuestro, donde no se cuenta con lugares adecuados para su manejo y disposición final. Por estas razones, Corantioquia encuentra conveniente y necesaria la construcción y puesta en operación de este nuevo relleno sanitario por el doble beneficio que hoy representa para la gestión administrativa y ambiental; de un lado, puede asegurar en algunos municipios metropolitanos la eficiente prestación del servicio de aseo al que subyace un interés público y social, y de otro lado, le facilita al Estado cumplir con la obligación social que tiene de brindarle a esas comunidades el saneamiento ambiental

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considerado por nuestra Constitución Política (49) como un servicio público equiparable con el acceso a los servicios de promoción, protección y recuperación de la salud.

8. Que en atención al Informe Técnico 110RN-265 como también a las consideraciones ya expresadas, CORANTIOQUIA encuentra procedente desde el punto de vista técnico y jurídico otorgar la Licencia Ambiental solicitada para ejecutar el proyecto "Centro Industrial del Sur CIS", no sin antes recordar a la empresa beneficiaria que el deber de prevención y control del deterioro ambiental se ejerce, entre otras formas, a través del otorgamiento, negación, suspensión o modificación de las licencias ambientales por ser éstas el instrumento establecido por la normatividad vigente para autorizar la ejecución de una obra o actividad que potencialmente puede afectar los recursos naturales renovables o el ambiente. La licencia otorgada a través de esta resolución, habilita a su titular para desarrollar el proyecto obrando siempre dentro de los términos y condiciones reglados por esta Autoridad Ambiental según las necesidades y conveniencias que discrecional, pero razonablemente le impone en relación con la prevención, mitigación, corrección y manejo de los efectos o impactos ambientales que la ejecución del proyecto produzca o sea susceptible de producir.

De este modo, la licencia ambiental que se otorga tiene un fin preventivo en la medida que busca eliminar o por lo menos prevenir, mitigar o reversar, en cuanto sea posible, los efectos nocivos que se generen a los recursos naturales y el ambiente durante la vida útil del proyecto. Por tal razón, las condiciones y requerimientos impuestos en esta resolución son de obligatorio cumplimiento para la Empresas de Servicios Públicos "EVAS - ENVIAMBIENTALES S.A. E.S.P" y su desacato se constituye en la principal causa de modificación, suspensión o revocatoria de la licencia una vez rituado el procedimiento establecido para tal fin por el decreto 1180 de 2003. **Es necesario entonces reiterar que el otorgamiento de esta licencia y las medidas aquí impuestas como los términos y condiciones para cumplirlas, tienen el alcance de condicionarla en el sentido mencionado por cuanto garantizan el deber constitucional que tiene el Estado de prevenir y controlar los factores de deterioro ambiental y garantizar el saneamiento básico.**

9. Que en mérito de lo expuesto

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RESUELVE

Artículo 1. Otorgar la Licencia Ambiental a la Empresa de Servicios Públicos "EVAS - ENVIAMBIENTALES S.A. E.S.P." Nit 0811046698-0, representada legalmente por el señor Andrés Felipe Henao Arango, identificado con cédula de ciudadanía No 71'786.842, para la construcción y puesta en operación del proyecto denominado "**Centro Industrial del Sur – CIS**", a construirse en sus predios identificados con los Folios de Matrícula Inmobiliaria 217234, 217235, 217236, 217237 y 217238 de la Oficina de Registro de Instrumentos Públicos de Medellín Zona Sur, ubicados en las veredas La Chorrera y Monteadentro del municipio de Heliconia entre las coordenadas X:1'180.000 - 1'184.000 N. Y: 1'150.000 - 1'154.000 E. Planchas Topográficas del IGAC No 146-I-D y 146-II-C

Parágrafo. Esta licencia se otorga por la vida útil del proyecto y cobija sus fases de construcción, operación, clausura, posclausura.

Artículo 2. Otorgar a la Empresa de Servicios Públicos "EVAS ENVIAMBIENTALES S.A. E.S.P." una Concesión de Agua en un caudal de **2.18 litros/segundo** distribuidos de la siguiente manera: Para **uso doméstico un caudal de 0.23 litros/segundo** y para **uso Industrial un caudal de 1.95 litros/segundo**. Estos caudales se derivarán de la fuente de abastecimiento sin nombre que tiene un caudal mínimo de 5.5 litros/ segundo y sobre la cual se deberán hacer las respectivas captaciones en las siguientes coordenadas: N:1'182.609; E:819.446, según el Plano CIS-SA-CAP-01 anexo al Estudio de Impacto Ambiental

Esta Concesión se otorga por un término de diez (10) años prorrogables a solicitud de la Beneficiaria dentro del último año de vigencia

Artículo 3. Para el ejercicio de la Concesión de Aguas la Empresa "EVAS ENVIAMBIENTALES S.A. E.S.P." deberá cumplir los siguientes requerimientos:

- a. Construir las obras hidráulicas de acuerdo a los diseños (Planos y memorias de cálculo) propuestos en el Estudio de Impacto Ambiental.

- b. Cancelar oportunamente las tasas por utilización de aguas que en su debida oportunidad facture CORANTIOQUIA de conformidad a lo previsto en el artículo 43 de la Ley 99 de 1993 y su decreto reglamentario 155 de 2004.
- c. Emplear sistemas técnicos, eficientes y económicos de aprovechamiento para el objeto y usos autorizados en esta resolución.
- d. No utilizar caudales mayores a los otorgados.
- e. Dar efectivo cumplimiento a las obligaciones contenidas en el artículo 133 del decreto ley 2811 de 1974 y en la ley 373 de 1997 y sus normas reglamentarias sobre uso eficiente y ahorro del agua

Artículo 4. Otorgar a la Empresa de Servicios “EVAS ENVIAMBIENTALES S.A. E.S.P.” el Permiso de Vertimientos para las aguas residuales domésticas e industriales (lixiviados).

Este permiso tendrá una vigencia de cinco (5) años y está condicionado a la construcción de los sistemas de tratamiento, según los términos, diseños y ubicación propuestos en el Estudio de Impacto Ambiental.

Los dos (2) sistemas de tratamiento para las aguas residuales domésticas deberán garantizar una remoción no inferior al 90% según los diseños propuestos en el Estudio de Impacto Ambiental para las áreas administrativas y para las zonas de manipulación y/o tratamiento de residuos.

Artículo 5. Si en el término de dos (2) años contados a partir de la notificación de esta resolución, la Empresa Beneficiaria no ha iniciado las obras y actividades tendientes a la ejecución de este proyecto, CORANTIOQUIA podrá modificarla, suspenderla o revocarla de acuerdo al procedimiento establecido para tal fin y a las especiales circunstancias que se presenten pasado aquél término. Igualmente, si CORANTIOQUIA llega a la conclusión de que el proyecto licenciado no se llevará a cabo o la Empresa Beneficiaria desiste de su ejecución, podrá autorizar el desarrollo de otro proyecto en la misma zona, previo el cumplimiento de los requisitos legales y reglamentarios establecidos.

Artículo 6. La empresa “EVAS ENVIAMBIENTALES S.A. E.S.P.” deberá dar estricto cumplimiento a las medidas propuestas en el Plan de Manejo Ambiental, en especial a las actividades definidas en el **numeral 4** y a las recomendaciones o requerimientos relacionados en el **numeral 5** de la parte motiva de esta resolución.

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Artículo 7. En un término de treinta (30) días, la Empresa Beneficiaria deberá presentar los diseños (Planos y memorias de cálculo) de las alternativas viales, de tal manera que se cuente con una propuesta integral de transporte de residuos que facilite y mejore el servicio.

Artículo 8. Se autoriza la disposición final de lodos provenientes de plantas de tratamiento de aguas residuales y en la zona prevista para tal fin. En caso de recibirse estos materiales para otros propósitos, se evaluará puntualmente cada tipo de ellos para determinar si pueden utilizarse como mezcla del material para revegetalización o mezclado con RSU para ser compactados y enfardados.

Artículo 9. De conformidad con lo previsto en la Ley 633 de 2000 y en la resolución 5803 del 26 de noviembre de 2002 por la cual Corantioquia fijó las tarifas por servicios ambientales, la Empresa "EVAS ENVIAMBIENTALES S.A. E.S.P." deberá cancelar dentro de los treinta (30) días siguientes a la notificación de esta resolución, el 50% restante o *valor real* por la evaluación ambiental que liquide CORANTIOQUIA en la respectiva cuenta de cobro. Contra la factura o cuenta de cobro procede la reclamación respectiva prevista en la resolución 5828 del 28 de noviembre de 2002.

Artículo 10. La etapa de operación del relleno sanitario entendida como la disposición permitida de residuos sólidos, podrá suspenderse cuando se presente alguno de los siguientes eventos:

a. Cuando a juicio de CORANTIOQUIA la Empresa "EVAS ENVIAMBIENTALES S.A. E.S.P." incumpla de manera injustificada las medidas ambientales propuestas en el Plan de Manejo Ambiental o las impuestas por Corantioquia en esta resolución.

b. Cuando se compruebe técnicamente la presencia o manifestación de elementos significativos que impliquen riesgos inminentes por inestabilidad del relleno.

Artículo 11. "EVAS ENVIAMBIENTALES S.A. E.S.P." asume la responsabilidad por los perjuicios derivados del incumplimiento de los términos, requisitos y obligaciones señalados en esta Licencia Ambiental, como también por cualquier daño ambiental causado por los contratistas a su cargo.

Artículo 12. Cuando por causa plenamente justificada la Beneficiaria de esta licencia prevea el incumplimiento de los términos, condiciones y obligaciones señaladas en esta resolución, deberá informar a CORANTIOQUIA con el objeto de adelantar las acciones correctivas pertinentes o el procedimiento contenido en el decreto 1180 de 2003 previsto para la modificación de las licencias ambientales.

Artículo 13. El incumplimiento de las obligaciones establecidas en esta resolución será causal de suspensión, revocatoria o modificación unilateral de la licencia mediante acto administrativo motivado, sin perjuicio de las acciones a que haya lugar por los daños ocasionados al medio ambiente.

Artículo 14. Además de los eventos anteriores, la licencia otorgada podrá modificarse total o parcialmente a iniciativa de Corantioquia, cuando varíen sustancialmente las condiciones existentes al momento de otorgarla o para exigir la corrección, complementación o sustitución de las medidas ambientales impuestas, cuando éstas resulten poco efectivas o se presenten condiciones imprevistas que generen impactos graves no identificados previamente. También podrá modificarse a solicitud de "EVAS ENVIAMBIENTALES S.A. E.S.P." cuando pretenda variar las condiciones de uso, aprovechamiento o afectación de un recurso natural renovable.

Artículo 15. La Beneficiaria de esta Licencia Ambiental podrá cederla en cualquier momento para lo cual deberá solicitar autorización previa a Corantioquia anexando la respectiva aceptación del cessionario.

Sin la autorización de esta Corporación la cesión no producirá efecto alguno y en consecuencia la Beneficiaria continuará siendo responsable de todas las obligaciones y condiciones aquí contenidas, como también de los derechos que esta licencia le otorga.

Artículo 16. Corantioquia realizará las actividades necesarias de control y seguimiento a este proyecto para verificar la implementación del Plan de Manejo Ambiental, constatar el cumplimiento de todas las obligaciones y condiciones impuestas y monitorear el comportamiento real del medio ambiente y los recursos naturales frente al desarrollo del proyecto, a efectos de exigir el ajuste de las medidas ambientales cuando a ello haya lugar.

Artículo 17. Notificar esta resolución a Empresas Varias de Medellín E.S.P, al municipio de Heliconia y a la Empresa de Servicios Públicos beneficiaria.

CORPORACIÓN AUTÓNOMA REGIONAL DEL CENTRO DE ANTIOQUIA

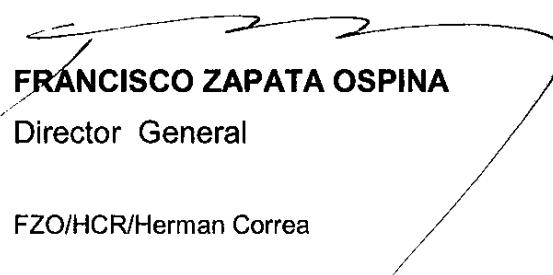
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Artículo 18. Contra esta resolución únicamente procede el recurso de reposición ante el Director General dentro de los cinco (5) días siguientes a su notificación.

Artículo 19. Esta Resolución se publicará en nuestro boletín oficial a costa de la Beneficiaria.

Dada en Medellín el 12 ENF 2005

NOTIFÍQUESE, PUBLÍQUESE Y CÚMPLASE


FRANCISCO ZAPATA OSPINA

Director General

FZO/HCR/Herman Correa

2005 ENE 12 P 2 30
REVISADO _____
Nº _____ PÁGINA _____

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

Task 11 Report: Development Impacts

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

in association with:

Quality & Evolution S.A.

September 20, 2011

The contents of this Task 11 Report are listed below:

Task 11 Report Contents

Section	Title
A	Impacts
B	Conclusions

A. Impacts

A1. Infrastructure

For the development of this Task 11 report, we base our assessment of development impacts on the technical and economic selection in Task 4 of Landfill Gas to Energy as the recommended technical configuration, based on the technical and financial feasibility it represents.

The selected configuration is to divert landfill gas from the existing flare to utilize this gas as a fuel in internal combustion engines with integral generators in modules of 1.6 MW capacity each. The existing landfill gas flare will be left in place as a backup during engine-generator maintenance down time.

In order to provide a platform on which the generation modules can be installed, one single concrete slab or three individual concrete slabs will be built with a total surface area of approximately 7.5 m x 20 m (or an area of approximately 150 square meters) and a thickness (to be confirmed during detailed design in the project implementation phase) of 34 cm to 56 cm thickness (between 16 cm to 18 cm of which will be installed below surrounding grade.) It is anticipated that the generation equipment will be acquired with a prefabricated housing for each module. This provides flexibility over the years as modules are added or removed.

The selected technical configuration of Landfill Gas to Energy (LGGE) would not increase the amount of waste delivered to the landfill and will not require additional modifications the internal operations of the landfill itself. As a result, no effect on the existing incoming traffic or the internal roads of the landfill is foreseen.

At the same time, there is sufficient footprint space near the existing gas flaring equipment, where the generation equipment can be installed without disrupting current operations. Please see Task 4, Section D General Plot Plan. Depending on the equipment selected, the prefabricated structures around the modules should have a height on the order of 5 meters, including the usually top-mounted mufflers.

The interface with existing systems is primarily the gas connection piping from the existing flare system to the gas cleaning equipment supporting the generation modules. Installation of this piping connection should be straightforward and should not cause any prolonged interruption in the operation of the existing flare.

A2. Market-Oriented Reforms

As observed in Task 2, the Colombian electricity market is in an advanced state of liberalization, which provides significant incentives for independent power producers to enter and remain in the market. For example, it is guaranteed that all power produced will be sold. Although the project will have the

advantage of operating within this market, the project will not, given its relatively small size, change the dynamics of the market or reform its structure.

A3. Human Capacity Building

During the plant construction phase, direct construction positions created are estimated at a maximum of 10 positions. Of these maximum 10 construction positions created, it is anticipated that 1 would be supervisory, 1 would be a foreman position, 2 would be skilled concrete workers, and 6 would be laborers. These positions are temporary during construction only.

It is foreseen that the employment impact of the ongoing energy generation operation will be minor, with some positions being created for technical operator (2 positions). The personnel needed to install the landfill gas system throughout each landfill cell are already part of the existing operations.

The equipment provider will train the 2 technical operators in operations and maintenance of the generation and gas cleaning systems. Several copies of operational manuals will be provided. The equipment provider will usually send its technical representative to the site for training during construction and startup, and then periodically afterward.

A4. Technology Transfer

The technology for Landfill Gas to Energy will include three types of equipment for each module: gas cleaning equipment, internal combustion engine, and an electricity generator. This same technology is being considered in another similar project in Colombia (Bogotá Doña Juana landfill) as described in **Figure A-1**, but to date the project is still in gas collection and flaring mode, without energy generation:

**Figure A-1: Experience with this Type of Project in Colombia:
Landfill Gas to Energy Project at Doña Juana**

City / Location	Project Type
Bogotá – Doña Juana Landfill	Clean Development Mechanism project registered for landfill gas capture and, during a second phase, for electricity generation and supply of energy to nearby industries. The electricity generation project is in developmental stage and has not entered operations.

Source: www.unfccc.int

As a result, the recommended technical configuration is proposed or in development for another landfill in Colombia that receives significantly higher intake tonnage than the intake tonnage at the CIS El Guacal. The CIS El Guacal project would be an example that could be replicated in other landfills with characteristics similar to those of the landfill in the CIS El Guacal, both in other parts of Antioquia as well as in other parts of the country.

Normally, Landfill Gas to Energy equipment is supplied on a "turn-key" basis, so that the primary contractor is responsible for transporting, installing, and transferring the equipment to the project owner. Even so, operations and maintenance training will serve as a technology transfer and transfer of know-how at the regional level.

A5. Social Benefits and Other Impacts

A5.1 Jobs Creation

During the plant construction phase, direct construction positions created are estimated at a maximum of 10 positions. Of these maximum 10 construction positions created, it is anticipated that 1 would be supervisory, 1 would be a foreman position, 2 would be skilled concrete workers, and 6 would be laborers. These positions are temporary during construction only.

It is foreseen that the employment impact of the ongoing energy generation operation will be minor, with some positions being created for technical operator (2 positions). The personnel needed to install the landfill gas system throughout each landfill cell are already part of the existing operations.

A5.2 Impacts on the Labor Force

There should be no significant noise impact for neighbors or workers at the CIS El Guacal landfill. Access to the prefabricated module housing structures will require personal protective equipment (PPP) according to any measures suggested by the ARP (Administradora de Riesgos Profesionales) agency for the new project systems (in addition to the general requirements that apply to the landfill in general). Noises external to the prefabricated housings should be normal for diesel engines equipped with mufflers. Numerous units of heavy equipment with muffled diesel engines are already in operation at the landfill.

A5.3 Impacts on Existing Emissions at CIS El Guacal

Atmospheric emissions should not change noticeably from current levels associated with current gas flaring. As a result, emissions should not affect the workforce or neighboring communities.

A5.4 Impacts on Municipal Revenues

According to Law 14 of 1983, the Industria y Comercio, Avisos y Tableros Tax ("Industry and Commerce, Advertisement and Billboards Tax" commonly abbreviated as "ICA"):

"applies to all commercial, industrial, and service activities that are performed in each municipal jurisdiction, directly or indirectly, by persons or corporate entities (legal or de facto), whether such activities are performed permanently or occasionally, in certain structures, in connection with a commercial establishment or not."

Additionally, Law 56 of 1981, article 7, provides for special tax treatment for industrial power generation under the ICA tax, payable by the owner of the power generation facilities. The basis for payment of this tax is the installed capacity in kilowatts (kW). The applicable rate stipulated in Law 56 of 1981 is five pesos (COP\$ 5.00 originally and adjusted for inflation to COP\$ 410.08 currently) annually per kW installed capacity.

This is a municipal tax and its proceeds would be paid to the Municipality of Heliconia.

Based on the above, In **Figure A-2**, the maximum ICA tax receipts that would be received by the Municipality of Heliconia are estimated.

Figure A-2: Maximum projected ICA Tax Receipts to Heliconia from Power Sales at CIS El Guacal

Year	Maximum Installed Capacity (MW)	ICA Tax Amount (2011 Pesos)	ICA Tax Amount (2011 USD)
2011	3.2	1,312,256	656
2012	3.2	1,312,256	656
2013	3.2	1,312,256	656
2014	4.8	1,968,384	984
2015	4.8	1,968,384	984
2016	4.8	1,968,384	984
2017	4.8	1,968,384	984
2018	4.8	1,968,384	984
2019	4.8	1,968,384	984
2020	4.8	1,968,384	984
2021	4.8	1,968,384	984
2022	4.8	1,968,384	984
2023	6.4	2,624,512	1,312
2024	6.4	2,624,512	1,312
2025	6.4	2,624,512	1,312
2026	6.4	2,624,512	1,312
2027	6.4	2,624,512	1,312
2028	6.4	2,624,512	1,312
2029	6.4	2,624,512	1,312
2030	6.4	2,624,512	1,312
2031	6.4	2,624,512	1,312
2032	6.4	2,624,512	1,312
2033	6.4	2,624,512	1,312
2034	6.4	2,624,512	1,312
2035	6.4	2,624,512	1,312
Total		55,770,880	27,885

Currency Rate source: Tasa Representativa del Mercado (TRM): COL\$ 2,000 x USD\$ 1.00

The amounts presented in Figure A-2 show that the ICA maximum tax receipts to the Municipality of Heliconia from the project would be an average over 24 years of approximately 2.3 million pesos annually, equivalent to approximately USD\$ 1162 annually.

B. Conclusions

- The implementation of the landfill gas to energy project at the CIS El Guacal does not require significant investments in surrounding infrastructure and does not cause major changes to the landfill's basic operations. Therefore, no infrastructure investment is required other than the capital investment in the project itself (which includes the transmission line for export of energy from the CIS El Guacal to the national grid).
- The project includes a technology transfer to local personal with regard to the maintenance and operations of the engine-generator sets that utilize landfill gas as a fuel.
- The project will not cause negative impacts on the quality of life of the nearby community or on the workforce of the CIS El Guacal.
- It is foreseen that the project will generate approximately USD\$ 1200 annually in additional tax revenues from the ICA (Impuesto de Industria y Comercio, Avisos y Tableros) tax for the Municipality of Heliconia.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 12 Report:
Off-Take Agreements**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

23 November 2011

The contents of this Task 12 Report are listed below:

Task 12 Report Contents

A	Procedure
B	Agreement Key Provisions
C	Conclusions

A. Procedure

Even though the feasibility study terms of reference utilize the general term "Off-Take Agreements" as the main subject of this Task 12, the only type of "Off-Take" agreement that will be required is a Power Purchase Agreement (PPA). For example, the Landfill Gas to Energy project will not produce recyclable materials for sale. Therefore, this Task 12 discusses only PPA's.

Figure E-1 from Task 2 below illustrates the anticipated power sales model, which includes commercial relationships between the key entities involved in the project.

As shown near the bottom of the power sales model in Figure E-1, power may be sold in one of two fundamentally different modes:

- **Power sales to the Spot Market Sales;** or
- **Power sales under a fixed term PPA to a specific Contracted Client.**

PPA's applicable to the Landfill Gas to Energy (LGFE) project as a generator and seller of electrical power under either of these modes is discussed in this Task 12.

In Task 2, it was recommended that the LGFE project begin operations under the Spot Market mode so that the new project could take advantage of:

- The flexibility offered by the Spot Market, which does not have minimum power production requirements and penalties for power production shortfalls in any given month. This is especially important during the first year of operation, when monthly gas production rates may take some time to stabilize.
- Moderately higher Spot Market pricing in recent years compared to Contracted Client pricing (which is normally fixed throughout the year), especially during dry periods when hydroelectric power capacity declines.
- The ability to sell some of the power to the Spot Market and some to a Contracted Client (if selling to a Contracted Client is determined to be advantageous in the future).

It is anticipated that the project will become the basis for the formation of a new entity, a Special Purpose Company (SPC) or New Company (NEWCO). The NEWCO that will own and operate the project will qualify, under Colombian regulations, as a public sector-owned "Generator", probably as a partnership of:

- IDEA
- EVAS

- EMGEA

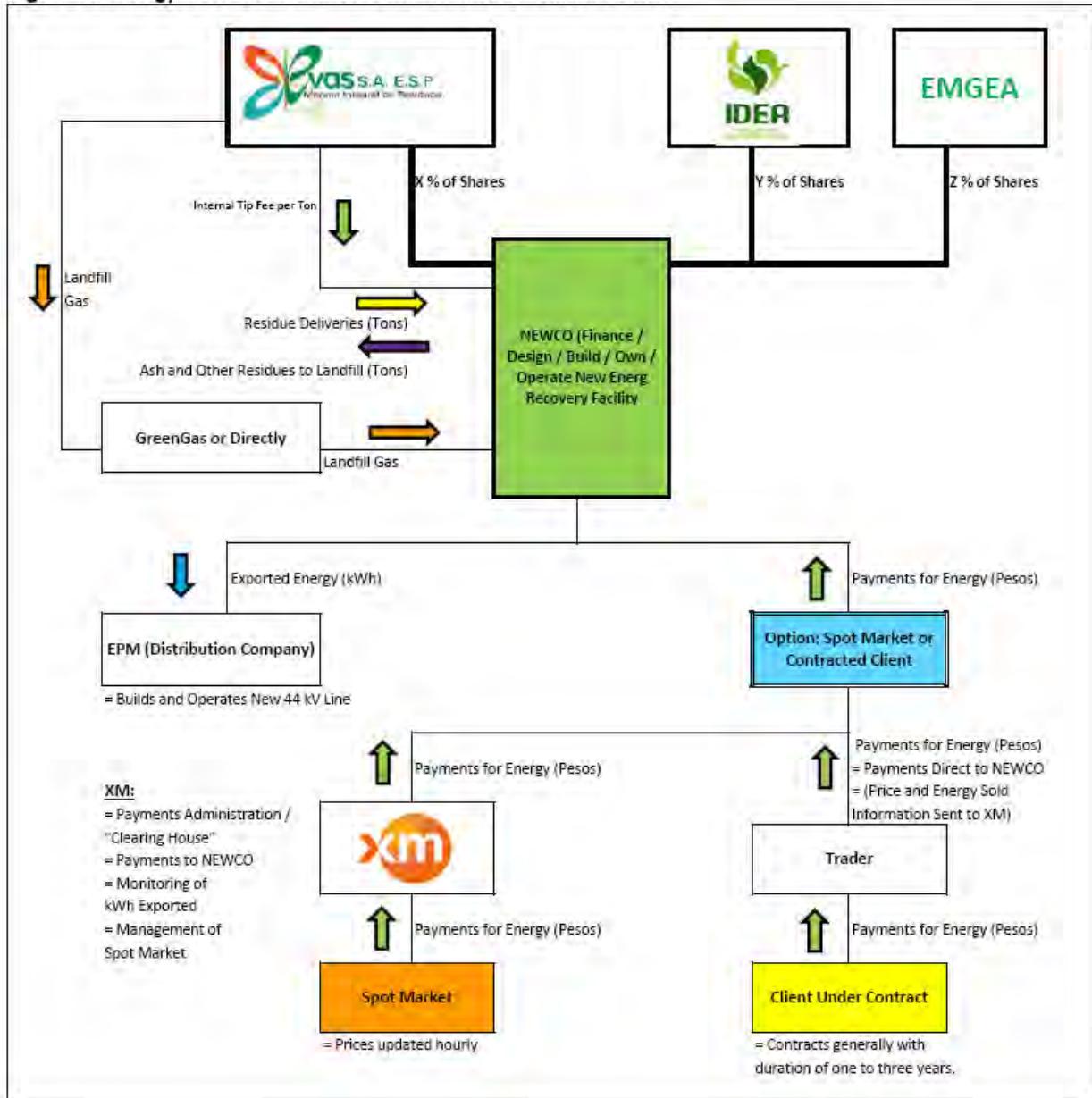
The various shares and financing mechanisms are to be negotiated among IDEA, EVAS, and EMGEA and will be incorporated in a NEWCO shareholders agreement.

We restate here that XM (Compañía de Expertos en Mercados S.A. ESP) is a subsidiary of ISA (Interconexión Eléctrica S.A.), and is in charge of:

- Operating and coordinating the overall National Interconnection System (SIN)
- Administering the electric power commercial settlement mechanism in the wholesale power market
- Settling and clearing of charges for use of the SIN grids
- Handling all Spot Market transactions (invoicing and payments) between Generators and the Spot Market.

The centralized administration and operation of the SIN as provided by XM has been a key element in the successful matching of power production with demand within this complex market.

Figure E-1: Energy Sales Business Model and Relations Between Entities



B. Agreement Key Provisions

B1. Spot Market Mode

Agreement Key Provisions

Despite several attempts by the project team, it has not been possible to obtain an example of an agreement between XM and a Generator selling into the Spot Market, which would have assisted in creating a context for this section. XM has indicated that such agreements are proprietary or confidential and not available for distribution, even if specific names of entities are deleted, as proposed by the project team.

However, from the Business Model presented in Figure E-1 from Task 2, the following key provisions in a PPA agreement between the Generator and XM are known to be required:

- Point of measurement and export voltage level (44 kV) at the new CIS El Guacal power export substation.
- Control and audit arrangements for measurement for power export.
- Sales pricing per kWh updating on an hourly basis according to Spot Market pricing
- XM methodology in calculating Spot Market sales pricing
- Invoicing terms
- Reconciliation procedure in case of discrepancies
- Payment terms and funds wiring instructions.

It should be noted that there is no minimum power production level (for example, kWh per month) under the Spot Market mode. Therefore, there are no penalties for shortfalls in power production under the mode of sales to the Spot Market.

Approvals

A PPA must be entered into with XM in order to establish the new LFGE facility as a Generator within the Spot Market.

The project must also be registered as a Generator with the Unidad de Planeación Minero Energética (UPME), or "Mining and Energy Planning Unit" of the central government.

Potential Obstacles

There are no foreseeable obstacles to entering into a PPA with XM, or for obtaining UPME registration for the new LFGE generating facility, since many such independent power producers (primarily hydroelectric power producers) have been registered and entered the market over the years. In fact, one of the key successes of the SIN system as administered by XM has been the large number of independent power producers that have been given incentive to enter the SIN system as generators (with less than 20 MW installed capacity) through the SIN guarantee that 100% of their power will be sold. This has greatly increased the availability of power in the country as a whole.

B2. Contracted Client Mode

Agreement Key Provisions

The key provisions of a PPA between the Generator and a Contracted Client would be:

- Point of measurement and export voltage level (44 kV) at the new CIS El Guacal power export substation.
- Control and audit arrangements for measurement for power export.
- Sales pricing per kWh fixed for the term of the contract (usually one to two years), with adjustments for inflation.
- Minimum power supply level and penalties to Generator for shortfalls (not caused by uncontrollable events such as natural disasters).
- Invoicing terms and timing.
- Reconciliation procedure in case of accounting discrepancies.
- Payment terms and funds wiring instructions.

Approvals

The Generator and the Contracted Client must sign the PPA to indicate their mutual agreement to the PPA terms.

As indicated in Task 10-Regulatory Framework, the project must be registered as a Generator with the Unidad de Planeación Minero Energética (UPME) or "Mining and Energy Planning Unit" of the central government.

Potential Obstacles

There are no foreseeable obstacles to obtaining UPME registration as a Generator for the new LFGE generating facility, since dozens of such independent power producers have been established over the years. It is not foreseen that a Contracted Client would be difficult to secure, since during our interviews with stakeholders including XM, no shortage of Contracted Clients has been reported.

C. Conclusions

Even though the feasibility study terms of reference utilize the general term "Off-Take Agreements" as the main subject of this Task 12, the only type of "Off-Take" agreement that will be required is a Power Purchase Agreement (PPA). For example, the Landfill Gas to Energy project will not produce recyclable materials for sale. Therefore, this Task 12 discusses only PPA's.

Power may be sold in one of two different modes:

- Sales to the Spot Market; or
- Sales under a fixed term contract to a specific Contracted Client.

The following key provisions would be included in a PPA agreement between the Generator and XM under the Spot Market mode:

- Control and audit arrangements for measurement for power export.
- Sales pricing per kWh updating on an hourly basis according to Spot Market pricing.
- XM methodology in calculating Spot Market sales pricing.
- Invoicing terms and timing.

It should be noted that there is no minimum power production level (for example, kWh per month) under the Spot Market mode. Therefore, there are no penalties for shortfalls in power production.

The key provisions of a PPA between the Generator and a Contracted Client would include:

- Control and audit arrangements for measurement for power export.
- Sales pricing per kWh fixed for the term of the contract (usually one to two years), with adjustments for inflation.
- Minimum power supply level and penalties to Generator for shortfalls (not caused by uncontrollable events such as natural disasters).
- Invoicing terms and timing.

It is recommended in Task 2 that the project initiate operations under the Spot Market power sales mode (rather than the Contracted Client power sales mode), in order to take advantage of the flexibility afforded by this mode (lack of minimum power generation levels), especially during the first year of operations when some fluctuations in gas production may be anticipated. In addition, the Spot Market has offered moderately higher prices to Generators in recent years.

For the Spot Market power sales mode:

- It will be necessary to enter into a PPA with XM in order to establish the new LFGE plant as a participant in the Spot Market.
- The project should be registered as a Generator with the Unidad de Planeación Minero Energética (UPME) or Mining and Energy Planning Unit of the central government.
- No obstacles are foreseen to entering into a PPA with XM.
- No obstacles are foreseen for registering the project as a Generator with the UPME.

For the Contracted Client power sales mode:

- The Generator and the Contracted Client will have to enter into a PPA in order to indicate their agreement to the contractual conditions.
- The project will need to be registered as a Generator with the UPME.
- No obstacles are foreseen in obtaining registration of the project before the UPME.
- No shortage of Contracted Clients is foreseen.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 13 Report:
Implementation Plan**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

in association with:

Quality & Evolution S.A.

23 November 2011

The contents of this Task 13 Report are listed below:

Task 13 Report Contents

Section	Title
A	Schedule
B	Responsibilities and Implementation Budget
C	Conclusions

A. Schedule

Figure A-1 shows a target schedule for implementation of the project, beginning with completion of this present feasibility study. Sequential months are shown in the event that implementation activities do not begin immediately after completion of this present feasibility study. Assumed **Critical Path Activities** are designated with a "C" in each applicable cell of the schedule. Implementation activities are classified into the following categories:

- **Business Aspects:** Negotiation of contractual arrangements between stakeholders, including IDEA, EVAS, EMGEA, power traders (for spot market sales), and potentially GreenGas. GreenGas is the company currently operating the landfill gas flaring system under contract to EVAS. It may be necessary to amend the contract with GreenGas, but this contract has not been made available to the project team to date. In parallel, financing arrangements are finalized with financing institutions, including negotiation of debt to equity structure, loan conditions (loan period for capital repayment, interest rate, etc.), and other conditions applicable to the financing of the project;
- **Permitting and Licenses:** Preparation of applications for any permits or licenses, including modifications of existing permits or licenses. Applications are followed by processing of the applications by environmental and other regulatory authorities. The primary environmental authority is anticipated to be Corantioquia, who must process an expected modification of the existing environmental license (issued by Corantioquia). We include in this activities grouping the registration of the project as a Generator under the Unidad de Planeación Minero Energética (UPME) or "Mining and Energy Planning Unit" of the central government and under XM as operator of the "Sistema Interconectado Nacional" (SIN) or National Interconnected System.
- **EPM-Related Scope:** after the connection study is completed, negotiations for EPM's scope are finalized, and EPM procures and installs the 44 kV line, the step-up transformer at CIS El Guacal, and the step-up transformer at one of the existing substations in the area.
- **Turnkey EPC Contract:** The request for proposals (RFP) is prepared based on the findings of this feasibility study. After a competitive bid process, a turnkey Engineering-Procurement-Construction (EPC) contractor is selected and the EPC contract is finalized before detailed design, construction of the concrete slab(s) is (are) completed, purchase order and delivery of equipment (including the engine-generators), equipment is installed, and the entire system of two engine-generator sets is tested and started up. The EPC contractor must guarantee performance of the overall system.

Total duration of implementation activities is projected as approximately 12 months, based on a high level of sponsorship by the stakeholders.

Critical Path Activities are those activities whose total duration is likely to equal the total duration of the overall implementation program. **The Program Manager (please see Section B-Responsibilities below) must carefully monitor the actual duration of these critical path activities to ensure that the overall implementation program is not delayed.**

Installation of the landfill gas collection wells in the North Cell is filled is not shown, since this activity is already underway under contract to EVAS.

Please see Task 10-Regulatory Framework for additional detail on permitting activities.

Figure A-1: Project Implementation Target Schedule

Sequential and Calendar Months												
1	2	3	4	5	6	7	8	9	10	11	12	13
2011		2012										
NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Feasibility Study Completed	C											
Business Aspects												
Negotiate Contracts		C	C									
Negotiate Financing				C								
Permitting and Licenses												
Complete Applications												
Regulatory Review (Corantioquia, UPME, XM)												
EPM Scope of Work												
Interconnection Study												
Negotiations with EPM												
EPM Installs 44 kV Line + Transformers												
Turnkey EPC Contract												
Prepare Request for Proposals												
Proponents Prepare Responses												
Evaluate Responses and Award					C							
Detailed Design						C	C					
Purchase Order and Deliver Equipment									C	C	C	
Install Modules and Auxiliary Equipment											C	
Testing and Startup											C	
Begin Power Sales												C

B. Responsibilities and Implementation Budget

We assume that IDEA would assume the role of Program Manager to lead and coordinate the implementation activities. Within each activity category, key participants are listed:

- **Business Aspects:**
 - **Contractual Negotiations:** IDEA, EVAS, EMGEA, power traders (for spot market sales), XM, and potentially Green Gas.
 - **Financing:** IDEA, EVAS, EMGEA, financial institutions
- **Permitting and Licenses:** Program Manager (IDEA), Environmental Consultant, and .
- **EPM-Related Scope:** Program Manager, Connection Study Consultant, and EPM.
- **Turnkey EPC Contract:** Program Manager and Turnkey EPC Contractor.

Even though IDEA is expected to serve as Program Manager, it is assumed that the NEWCO will be the entity entering into contracts (including the important Turnkey EPC Contract) with the various consultants and contractors during the implementation phase. The NEWCO is anticipated to be the operator of the LFGE system once startup testing is completed.

Figure B-1 below presents a budget for the implementation phase of the project. This budgeted total amount corresponds to the estimated dollar amount for soft costs related to Tranche 1 (please see Task 14-Investment Memorandum for final financial projections). These soft costs include, specifically, consulting (environmental, legal, EPM connection study, etc.), design, and financing costs.

**Figure B-1: Implementation Budget
by Implementation Activity**

Business Aspects		
Negotiate Contracts	\$ 67,859	10.0%
Negotiate Financing	\$ 67,859	10.0%
Permitting and Licenses		
Complete Applications	\$ 33,930	5.0%
Regulatory Review	\$ 33,930	5.0%
EPM Scope of Work		
Interconnection Study	\$ 40,715	6.0%
Negotiations with EPM	\$ 16,965	2.5%
EPM Installs 44 kV Line + Transformers	\$ 16,965	2.5%
Turnkey EPC Contract		
Prepare Request for Proposals	\$ 33,930	5.0%
Proponents Prepare Responses	\$ 16,965	2.5%
Evaluate Responses and Award	\$ 16,965	2.5%
Detailed Design	\$ 169,648	25.0%
Purchase Order and Deliver Equipment	\$ 54,287	8.0%
Install Modules and Auxiliary Equipment	\$ 54,287	8.0%
Testing and Startup	\$ 54,287	8.0%
Begin Power Sales	\$ -	0.0%
Total	\$ 678,592	100.0%

C. Conclusions

Total duration of implementation activities is projected as approximately 12 months, based on a high level of sponsorship by the stakeholders.

Critical Path Activities are those activities whose total duration is likely to equal the total duration of the overall implementation program. The Program Manager must carefully monitor the actual duration of these critical path activities to ensure that the overall implementation program is not delayed.

We assume that IDEA will assume the role of Program Manager to lead and coordinate the implementation activities. Within each activity category, key participants are listed:

- **Business Aspects:**
 - **Contractual Negotiations:** IDEA, EVAS, EMGEA, power traders (for spot market sales), XM and potentially Green Gas.
 - **Financing:** IDEA, EVAS, EMGEA, financial institutions
- **Permitting and Licenses:** Program Manager and Environmental Consultant.
- **EPM Scope:** Program Manager, Connection Study Consultant, and EPM.
- **Turnkey EPC Contract:** Program Manager and Turnkey EPC Contractor.

Even though IDEA is expected to serve as Program Manager, it is assumed that the NEWCO will be the entity entering into contracts (including the important Turnkey EPC Contract) with the various consultants and contractors during the implementation phase. The NEWCO is anticipated to be the operator of the LFGE system once startup testing is completed.

The total budget for the implementation phase of the project is USD\$ 679 thousand. This amount corresponds to the soft costs projected for Tranche 1 of the financing. The total capital budget for Tranche 1 is USD\$ 11.0 Million. Please see Task 14-Investment Memorandum for the updated project financial projections.

**Waste to Energy Facility at El Guacal Landfill
Feasibility Study**

**Task 14 Report:
Investment Memorandum**

Presented to Study Grantee IDEA:



and to funding agency:

United States Trade and Development Agency (USTDA)

by:

CAMBRIDGE
Project Development Inc.

23 November 2011

The contents of this Task 14 Report are listed below:

Task 14 Report Contents

A	Executive Summary
B	Financial Information
C	Implementation Plan
D	U.S. Sources of Supply
E	Power Sales and Off-Take Agreements
F	Financial Projection Sheets

A. Executive Summary

Background

In fourth quarter of 2010, the Instituto para el Desarrollo de Antioquia (IDEA), a decentralized agency of the state government of Antioquia, Colombia, awarded a contract to Cambridge Project Development Inc. to conduct a Feasibility Study for developing a waste to energy facility at the Centro Industrial Sur (CIS) El Guacal landfill and recycling center located southwest of central Medellín, within the municipality of Heliconia. The Feasibility Study, funded by the United States Trade and Development Agency (USTDA) as a grant to IDEA, began in May of 2011 and was completed in November 2011.

The primary contact for Project information is:

Mr. Santiago Piedrahita Tabares
Director for International Cooperation and Business
Instituto para el Desarrollo de Antioquia (IDEA)
Calle 42 N° 52-259
Medellín, Colombia
Tel. +57 4 381 9129
Email: SantiagoPT@idea.gov.co

The Feasibility Study has determined that a facility to recovery energy from gas produced by landfilled solid waste at the CIS El Guacal is feasible and within the normal criteria of IDEA for sponsoring such power production projects. IDEA has a long history of successfully implementing regional independent power projects, especially with regard to hydroelectric generation.

It is noted here that over 380 such facilities are in routine operations in North America, utilizing the same technology as proposed for the subject facility.

With completion of the Feasibility Study in November 2011, the Project is ready for the Implementation Phase to begin. The Implementation Phase includes arranging financing for the Project, and this Investment Memorandum is intended to present information to parties that could be potentially interested in participating financially in the Project.

Please note that all monetary amounts presented in this Investment Memorandum are in United States Dollars, unless otherwise noted. All tonnage amounts presented are in metric tons.

The primary goals of the Feasibility Study, as defined in the USTDA-funded Definitional Mission (pre-feasibility) study completed in 2009 and further defined through interviews with IDEA and other Stakeholders in Colombia, are:

- Determine if it is technically and economically feasible to produce, export, and sell electrical power derived from the approximately 900 tons per day of solid waste being delivered to the CIS El Guacal facility;
- Select a commercially proven technical configuration that does not require an increase in the CIS El Guacal tipping fee charged to users at the facility scalehouse; and
- Define the technical conceptual design, economic and financial profile, and implementation plan for the energy recovery facility.

It is considered that the project provides the following significant environmental, regional, and national benefits:

- The combustion of landfill gas in the internal combustion engines selected for the project supports the elimination of methane generated by decomposition of organic matter within the landfill waste mass. Methane has a global warming effect on the order of 21 times greater than carbon dioxide itself.
- The project provides a maximum generating capacity of 6.4 MW to the national grid.
- With the installation of a new 44 kV power export line between the CIS El Guacal and one of the three existing substations in the region, the project supports future efforts to increase the power supply to neighboring municipalities, such as the municipality of Heliconia.
- At a national level, this would be the first landfill gas energy recovery project in the country. As a result, the project would support the implementation of similar projects at other Colombian landfills.

The Medellín metropolitan area currently has a population of approximately 6.1 million residents. The CIS El Guacal facility receives solid wastes generated in the southwestern portion of this metropolitan area. **Figure A-1** below illustrates the Project location, primary waste generation area served ("waste shed"), and several other waste related facilities in the region.

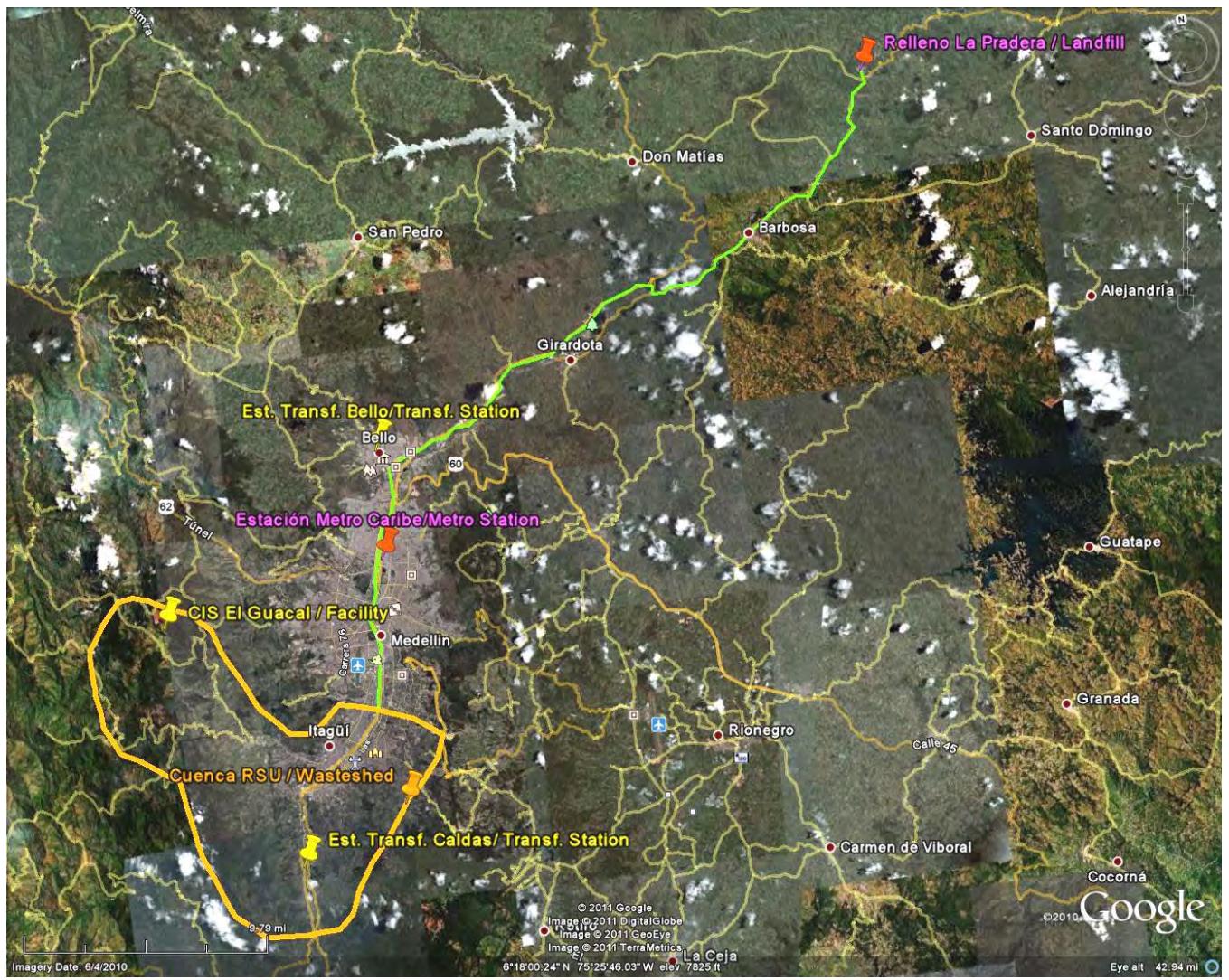


Figure A-1: Alternative Landfill in the far Northeast (La Pradera), Bello Transfer Station (Northwest), Caldas Transfer Station (extreme South), and Approximate CIS El Guacal Wasteshed ("Cuenca RSU") in Orange Outline

Figure A-2 below illustrates typical landfill gas generation equipment and the prefabricated housings recommended for this Project.

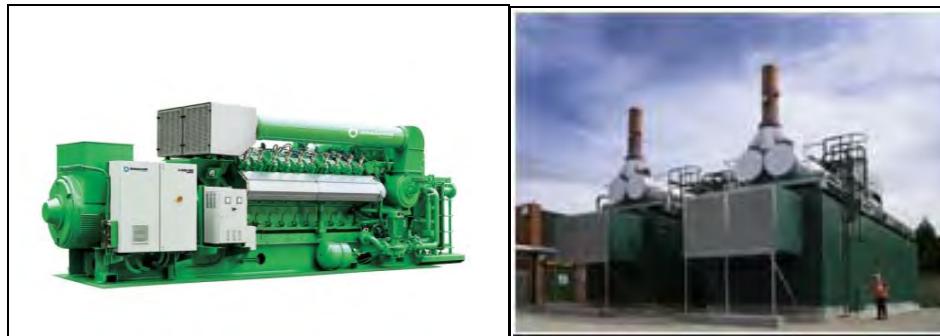


Figure A-2: Typical Landfill Gas Engine-Generator Set and Pre-Fabricated Enclosures

The key Stakeholders in the Project are:

- **IDEA (Instituto para el Desarrollo de Antioquia):** IDEA is an agency of the state government of Antioquia with the mission of promoting, facilitating, and financing projects with high impact on the economic, social, financial, administrative, and institutional development of the Department of Antioquia in the strategic areas of Banking, Infrastructure, Energy, Mining, and Reforestation. IDEA also provides consulting services and other support to entities developing such Projects. IDEA has a long track record of successfully sponsoring and facilitating Projects within Antioquia, including numerous hydroelectric independent power production Projects. IDEA is the grantee under the Feasibility Study grant funded by USTDA (United States Trade Development Agency.)
- **United States Trade Development Agency (USTDA)** has funded the Feasibility Study through a grant to IDEA. It is not intended that USTDA remain, after the Feasibility Study, as a direct commercial participant in the Project. However, we understand that the expectation of USTDA is to for the Project to **maximize the use of United States-sourced equipment and services during the implementation of the Project.**
- **EVAS S.A. ESP (EVAS)** is a public sector corporation owned and controlled by the Municipality of Envigado. EVAS is the owner and operator of the CIS El Guacal facility, although sub-contracts have been let for various significant operations at CIS El Guacal for activities such as North Cell operations, Material Recovery Facility (MRF) labor, and gas extraction and flaring. Gas extraction and flaring (without energy recovery) are currently accomplished under a contract between EVAS and private firm GreenGas.
- **EMGEA (Empresa de Generación y Promoción de Energía de Antioquia):** Within the Colombian national electric power system (Sistema de Interconexión Nacional, or "SIN"), registered

Generating Companies only are permitted to sell power into the SIN. IDEA holds 37.5% of the shares of EMGEA. EMGEA is already registered as a Generating Company within the SIN, and operates as developer and operator of multiple power generation projects in Antioquia.

- **XM S.A. E.S.P.:** XM is an entity that administers the SIN in terms of matching demand and load, and also serves as a payment clearing house for payments to electricity generating companies. It is noted here that our entire discussion is applicable to power generating Projects of capacity less than 20 MW. Above 20 MW capacity, significantly different requirements and business arrangements are required under the SIN. **The SIN is an extremely innovative structure that has been highly successful in supporting the establishment of numerous small independent power producers (IPP's). One of the primary features of the SIN is that small IPP's (below 20 MW installed capacity) are guaranteed that 100% of their power will be sold through a vigorous Spot Market administered as part of the SIN.**
- **Empresas Públicas de Medellín (EPM):** EPM is the entity responsible for distribution of electric power within the Medellín region, including the area surrounding the CIS El Guacal facility. Any power export from the CIS El Guacal facility will flow through a new 44 kV line installed and operated by EPM.
- **New Company (NEWCO):** This newly established entity would have as its scope to Finance / Design / Build / Own / Operate (FDBOO) the new energy recovery facility. It is anticipated that the NEWCO would be owned by IDEA, EVAS, and EMGEA as shareholders in percentages to be determined by these three Stakeholders.

It is anticipated that the initial shareholders of the NEWCO will be IDEA, EVAS, and EMGEA. The number of shares and their pricing to be offered to investors will be defined shortly by these initial shareholders.

Technical and Operational Features

The CIS El Guacal facility presents excellent stability in the following key factors:

- Approximately 90% of its 900 tons per day waste delivery tonnage is assured under long term arrangements, and the remaining 10% is unlikely to be diverted to the nearest alternative landfill at La Pradera, some 70 km distant through urban and rural roadways.
- Sufficient landfill airspace for approximately 50 years is available from three landfill cells (North Cell, Central Cell, and South Cell); only North Cell is currently active, and is projected to have sufficient airspace for approximately 5 more years.
- The Feasibility Study concluded that combustion (direct combustion of solid waste or combustion of landfill gas derived from solid waste) is the only means of extracting energy from waste that has a proven commercial track record worldwide. However, direct combustion of

solid waste would be prohibitively expensive in light of the relatively low Tipping Fee and Power Sales Price available (please see immediately below). "Conversion" technologies employing gasification, biological, or chemical conversion do not have acceptable commercial track records and are considered "emerging" technologies. Therefore, generating electrical power feasibly using the solid waste at CIS El Guacal requires that a landfill gas to energy facility be developed.

A significant amount of power can be generated at the facility using landfill gas derived from the solid waste deposited in the facility's landfill cells. Landfill gas to energy (LFGE) is widely proven, full-cycle waste treatment and energy recovery technology, in that it includes:

- Final disposal and decomposition of waste in a lined landfill cell, with significant volume reduction from biological degradation; and
- Significant energy recovery through electricity generation available for export.

A modern landfill will have the following features, which are already available at CIS El Guacal:

- Lined landfill cell;
- Leachate collection system;
- Landfill gas collection and flaring system.

LFGE takes advantage of the landfill gas (which contains from 40% to over 50% methane) already being collected and flared and converts it to electricity. Landfill gas from the landfill is collected from a series of vertical wells in the waste mass (as is already being done at the CIS El Guacal) and is piped to an internal combustion engine linked to a generator. The engine-generator sets are acquired as an integral unit and are called "modules". Landfill gas cleaning equipment, to remove many of the non-methane components (such as water and carbon dioxide) present in the landfill gas is usually installed just upstream of the modules. The modules are to be delivered within prefabricated housings and mounted on simple concrete slabs built near the existing landfill gas flare.

Figure A-3 below presents the overall process flow for a typical landfill gas to energy installation.

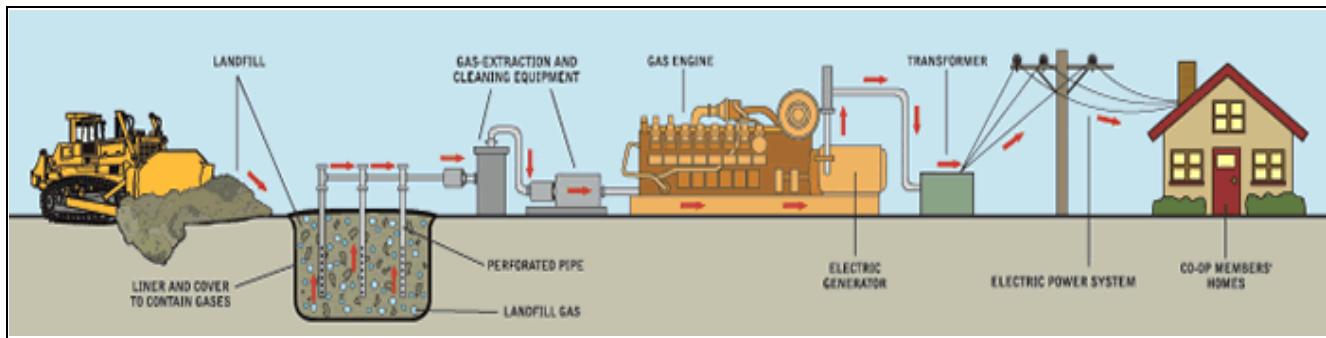


Figure A-3: Landfill Gas to Energy Process Flow

Figure A-4 below presents the Feasibility Study projection of power generation over 20 years in megawatts (MW) number of 1.6 MW modules installed, and projected life span of the North Cell and the Central Cell. It is anticipated that the remaining third cell, the South Cell would not enter operations for at least 20 years from present. The projection shows potential power generation, which varies as a function of the tonnage in place in the landfill and the age of the waste in place in the landfill. Landfill gas generation continues for several years after each cell stops receiving waste but declines gradually. Summarizing the information presented in Figure A-4:

- Power generation begins in sequential Year 1 with two modules (Module A and Module B) of capacity 1.6 MW each to reach a total installed capacity of 3.2 MW. Even though this capacity is not fully utilized until Year 3, two modules are acquired from the beginning to provide redundancy and thereby ensure reliable operations from the start.
- A third module (Module C) is installed in Year 4 to reach a total installed capacity of 4.8 MW.
- In Year 12, a fourth module (Module D) is installed to reach a total installed capacity of 6.4 MW.
- Power exported begins in Year 1 at 2.0 MW and peaks in Year 17 at 5.6 MW.
- It is anticipated that all four modules will continue in operation and be fully utilized after Year 20, when the new South Cell is projected to begin receiving waste.

Figure A-4: Landfill Gas Generation and Projected Plant Capacity

Year: Sequential	Active Cell	Power Plant Generation (MW)	Total Installed Engines @ 1.6 MW Capacity Each	Total Installed Plant Capacity (MW)	Annual Power Sold (kWh)
Base	North Cell	Base	Base	Base	Base
1		2.0	2.0	3.2	17,520,000
2		2.8	2.0	3.2	24,528,000
3		3.2	2.0	3.2	28,032,000
4		3.4	3.0	4.8	29,784,000
5	Central Cell	3.6	3.0	4.8	31,536,000
6		3.7	3.0	4.8	32,412,000
7		3.8	3.0	4.8	33,288,000
8		4.0	3.0	4.8	35,040,000
9		4.2	3.0	4.8	36,792,000
10		4.3	3.0	4.8	37,668,000
11		4.5	3.0	4.8	39,420,000
12		4.7	4.0	6.4	41,172,000
13		4.9	4.0	6.4	42,924,000
14		5.0	4.0	6.4	43,800,000
15		5.2	4.0	6.4	45,552,000
16		5.4	4.0	6.4	47,304,000
17		5.6	4.0	6.4	49,056,000
18		5.1	4.0	6.4	44,676,000
19		4.0	4.0	6.4	35,040,000
20		3.2	4.0	6.4	28,032,000

The resulting projected kWh (kilowatt-hours) sold are represented by the following selected sequential years:

- Year 1: 17.5 Million kWh
- Year 5: 31.5 Million kWh
- Year 10: 37.7 Million kWh
- Year 15: 45.6 Million kWh
- Year 20: 28.0 Million kWh

As presented in the Financial Information section (Section B) below, LFGE power sales will allow the facility to generate a return on investment that is considered attractive to investors.

Project Risks

Risks are considered minimal. During the feasibility study, the following risk factors, among others, were carefully evaluated:

- Waste Supply: 90% of the tonnage delivered to the CIS El Guacal is assured under long term arrangements, and the remaining 10% would have to be transported to a remote landfill under difficult logistical conditions.
- Landfill Airspace: The CIS El Guacal landfill has an estimated remaining airspace adequate for approximately 50 years.
- Technology: More than 380 facilities routinely operate in North America using the same technology as that proposed. The landfill gas collection system is already 30% installed in the active North Cell, and is feeding significant landfill gas flows to the existing flare.
- Economics: With an installed generating capacity of less than 20 MW, the project is guaranteed the ability to sell 100% of generated power to the national grid ("Sistema Interconectado Nacional" or "SIN"). The anticipated average power sales price is \$0.0705 per kWh in 2011 dollars.

B. Financial Information

We highlight here that all monetary amounts presented in this Investment Memorandum are in United States Dollars, unless otherwise noted. Key financial indicators for the recommended LFGE facility are:

- Total capital investment is projected at \$ 15.2 Million and is composed of:
 - Investment Tranche 1 (Year 1 through Year 9): \$ 11.0 Million
 - Investment Tranche 2 (Year 10 through Year 20): \$ 4.2 Million
- Net Income as a percent of revenue varies as follows:
 - Average of 19.5% from Year 1 through Year 9
 - Average of 28.5% from Year 10 through Year 20
- Internal Rate of Return (IRR) on equity averages as follows:
 - 12.3% from Year 1 through Year 9
- The Net Present Value (NPV) of the project cash flows over 20 years is projected to be:
 - \$3.8 Million

It should be noted that capital investment estimates include the following major components:

- Tranche 1
 - Three generation modules (Module A, Module B, and Module C)
 - North Cell (currently active) completion of 60% of the landfill gas collection system (40% of the gas collection system will already be in place at the estimated time of project startup).
- Tranche 2
 - One generation module (Module D)
 - Central Cell (planned) installation of entire landfill gas collection system.

The financing calculations for the Project are based on the assumption that Project (and therefore the NEWCO) funding will be structured as follows:

- Equity 40%
- Debt 60%

As indicated in Section A above, it is anticipated that the initial shareholders of the NEWCO will be IDEA, EVAS, and EMGEA. The number of shares and their pricing to be offered to investors will be defined shortly by these initial shareholders.

Project financial projections are presented for reference below in Section F at the end of this Investment Memorandum.

C. Implementation Plan

Figure D-1 below presents a Project Implementation Plan target schedule. Target duration of the Project implementation is estimated at 12 months from completion of the Feasibility Study through construction completion.

Based on meetings held during September 2011 with IDEA and EVAS, it has been anticipated that the Project will be implemented on a "Turnkey" basis (one direct contractor). Therefore, proposals would be requested from suppliers for Tranche 1 (which operates Year 1 through Year 20 while Tranche 2 operates from Year 10 through at least Year 20) for the selected single contractor to accomplish the following Turnkey services, also called an EPC (Engineering-Procurement-Construction) scope of work:

- Engineering (including detailed design)
- Procurement (including logistics for importation and in-country transport of the equipment)
- Construction (includes civil works and equipment installation)
- Subcontracting local contractors for civil, electrical, etc. scopes of work
- Guarantee performance of the entire system.

Figure C-1: Project Implementation Plan Target Schedule

D. U.S. Sources of Supply

The following suppliers with applicable manufacturing facilities in the United States should be in a position to submit proposals for an EPC Turnkey scope of work for the Project:

- Caterpillar, Inc. (Indiana)
- Cummins Inc. (Indiana)
- Curtis Engine & Equipment Inc. (Maryland)
- GE Waukesha (Wisconsin) (subsidiary of General Electric).

It is estimated that approximately 85% of the capital investment will be sourced from U.S. companies:

- \$ 13.0 Million or 85% of the \$ 15.2 Million total capital investment.

E. Power Sales and Off-Take Agreements

As an independent generating facility with capacity of less than 20 MW, the new LFGE facility is guaranteed, under the innovative Sistema Interconectado Nacional (SIN), to be able to sell 100% of the power generated.

The new LFGE facility will have the option of selling to the Spot Market or to a specific power customer under contract. Based on historical review of pricing, it is recommended that the new LFGE facility sell power to the Spot Market, at least initially.

Power sales pricing under contracts have been historically slightly lower than Spot Market prices; a new facility may also want to take advantage of the added flexibility offered by the Spot Market (no minimum export level required), especially during early years of operations.

A standard agreement between the generating company and XM allows the generating company to sell to the Spot Market.

If it is determined later that it is advantageous for the Project to sell some or all of the available power to a contracted client, no obstacles are foreseen in finding a contracted client or implementing one of many standard form Power Purchase Agreement contracts (usually of one to two year terms).

As a generating facility owned by public entities (assumed to be a combination of IDEA, EVAS, and EMGEA), the facility will be exempt from value added sales tax (IVA tax).

F. Financial Projection Sheets

The following financial projection sheets prepared during the Feasibility Study Task 8 are attached for reference:

- **Figure F-1:** Capital Investment and Use Over Time
- **Figure F-2:** Cash Flow Projection
- **Figure F-3:** Pro-Forma Income Statement
- **Figure F-4:** Internal Rate of Return
- **Figure F-5:** Net Present Value (NPV) of Cash Flows
- **Figure F-6:** Operations and Maintenance Expense

Figure F-1: Capital Investment and Use Over Time

Figure F-2: Cash Flow Projection / Cuadro F-2: Proyecciones de Flujo de Caja

	2012	2013	2014	2015	2016	2017	2018	2019	2020		
	1	2	3	4	5	6	7	8	9		
Operating Activities/ Actividades Operacionales											
Cash Received / Flujo de Caja Recibido											
Power Sales Revenue / Ventas de Energía	\$ 1,235,160	\$ 1,729,224	\$ 1,976,256	\$ 2,099,772	\$ 2,223,288	\$ 2,285,046	\$ 2,346,804	\$ 2,470,320	\$ 2,593,836		
Total Cash Received/Recibido	\$ 1,235,160	\$ 1,729,224	\$ 1,976,256	\$ 2,099,772	\$ 2,223,288	\$ 2,285,046	\$ 2,346,804	\$ 2,470,320	\$ 2,593,836		
Cash Used / Consumo de Caja											
Operations Expense / Costos Operacionales	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936		
Total Cash Used / Consumo	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936		
Net / Neto	\$ 743,497	\$ 1,072,537	\$ 1,237,057	\$ 1,319,317	\$ 1,225,120	\$ 1,266,250	\$ 1,307,380	\$ 1,389,640	\$ 1,471,900		
Investing Activities / Actividades de Inversión											
Cash Received / Flujo de Caja Recibido											
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Cash Used / Consumo de Caja											
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Used / Consumo	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908						
Net / Neto	\$ (7,190,289)	\$ (55,599)	\$ (2,775,599)	\$ (55,599)	\$ (70,908)						
Financing Activities/Actividades de Financiamiento											
Cash Received / Flujo de Caja Recibido											
Contributed Equity / Equity Contribuido	\$ 4,419,683	\$ 55,599	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Bank Loan / Préstamo Bancario	\$ 2,770,606	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908		
Total Cash Received/Recibido	\$ 7,190,289	\$ 55,599	\$ 2,775,599	\$ 55,599	\$ 70,908						
Cash Used / Consumo de Caja											
Interest Paid / Intereses	\$ 193,942	\$ 178,440	\$ 352,949	\$ 317,628	\$ 282,990	\$ 247,855	\$ 212,224	\$ 176,097	\$ 139,473		
Principal Payment / Repembolso de Capital	\$ 277,061	\$ 282,620	\$ 560,180	\$ 565,740	\$ 572,831	\$ 579,922	\$ 587,013	\$ 594,104	\$ 601,194		
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Total Cash Used / Consumo	\$ 471,003	\$ 461,061	\$ 913,129	\$ 889,368	\$ 855,821	\$ 827,777	\$ 799,237	\$ 770,200	\$ 740,658		
Net / Neto	\$ 6,719,286	\$ (405,462)	\$ 1,862,470	\$ (827,769)	\$ (784,912)	\$ (756,869)	\$ (728,328)	\$ (699,292)	\$ (669,759)		
Taxes and Fees Activities/Actividades Tributarias											
Cash Received / Flujo de Caja Recibido											
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Total Cash Received/Recibido	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Cash Used / Consumo de Caja											
ICA Municipal Tax / Impuesto ICA Municipal	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655	\$ 655		
Sales Tax / Impuesto Sobre la Renta	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251	\$ 415,014		
Total Cash Used / Consumo	\$ 196,282	\$ 277,332	\$ 316,857	\$ 336,948	\$ 356,710	\$ 366,592	\$ 376,473	\$ 396,235	\$ 415,998		
Net / Neto	\$ (656)	\$ (656)	\$ (656)	\$ (656)	\$ (656)	\$ (656)	\$ (656)	\$ (656)	\$ (656)		
Net Increase/(Decrease) in Cash held	\$ 271,838	\$ 610,820	\$ 323,272	\$ 434,964	\$ 368,315	\$ 437,489	\$ 507,159	\$ 618,456	\$ 730,249		
(Aumento o Decreimiento en Balance de Caja)											
Cash Balance	\$ 271,838	\$ 882,658	\$ 1,205,929	\$ 1,640,894	\$ 2,009,209	\$ 2,446,698	\$ 2,953,857	\$ 3,572,313	\$ 4,302,562		
(Balance de Caja)											
Free Cash Flow / Flujo de Caja Libre	\$ (6,447,448)	\$ 1,016,282	\$ (1,539,198)	\$ 1,262,734	\$ 1,153,228	\$ 1,194,358	\$ 1,235,488	\$ 1,317,748	\$ 1,400,008		
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	10	11	12	13	14	15	16	17	18	19	20
Operating Activities/ Actividades Operacionales											
Cash Received / Flujo de Caja Recibido											
Power Sales Revenue / Ventas de Energía	\$ 2,655,594	\$ 2,779,110	\$ 2,902,626	\$ 3,026,142	\$ 3,087,900	\$ 3,211,416	\$ 3,334,932	\$ 3,458,448	\$ 3,149,658	\$ 2,473,320	\$ 1,976,256
Total Cash Received/Recibido	\$ 2,655,594	\$ 2,779,110	\$ 2,902,626	\$ 3,026,142	\$ 3,087,900	\$ 3,211,416	\$ 3,334,932	\$ 3,458,448	\$ 3,149,658	\$ 2,473,320	\$ 1,976,256
Cash Used / Consumo de Caja											
Operations Expense / Costos Operacionales	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Total Cash Used / Consumo	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Net / Neto	\$ 1,513,030	\$ 1,595,290	\$ 1,677,550	\$ 1,759,810	\$ 1,800,940	\$ 1,883,200	\$ 1,965,460	\$ 2,047,720	\$ 1,842,070	\$ 1,389,640	\$ 1,060,600
Investing Activities / Actividades de Inversión											
Cash Received / Flujo de Caja Recibido											
Proceeds from Sales of Equipment / Venta de Equipos	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Received/Recibido	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Cash Used / Consumo de Caja											
Capital Equipment & Civil Works / Equipo Capital & Obra Civil	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908
Total Cash Used / Consumo	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908							
Net / Neto	\$ (795,561)	\$ (70,908)	\$ (2,790,908)	\$ (70,908)							
Financing Activities/Actividades de Financiamiento											
Cash Received / Flujo de Caja Recibido											
Contributed Equity / Equity Contribuido	\$ 1,689,858	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Bank Loan / Préstamo Bancario	\$ (894,297)	\$ 70,908	\$ 2,790,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908	\$ 70,908
Total Cash Received/Recibido	\$ 795,561	\$ 70,908	\$ 2,790,908	\$ 70,908							
Cash Used / Consumo de Caja											
Interest Paid / Intereses	\$ (62,601)	\$ 4,964	\$ (1,035)	\$ 146,294	\$ 134,118	\$ 121,834	\$ 109,550	\$ 97,267	\$ 84,983	\$ 72,700	\$ 60,416
Principal Payment / Reembolso de Capital	\$ 511,765	\$ 241,795	\$ 151,326	\$ 244,857	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 246,388	\$ 342,908
Return of Contributed Equity/Reembolso de Equity	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Dividends Paid / Dividendos Pagados	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Cash Used / Consumo	\$ 449,164	\$ 246,758	\$ 514,291	\$ 391,151	\$ 380,505	\$ 368,222	\$ 355,938	\$ 343,655	\$ 331,371	\$ 318,088	\$ 403,325
Net / Neto	\$ 346,397	\$ 175,850	\$ 2,276,617	\$ (320,242)	\$ (309,597)	\$ (297,131)	\$ (285,030)	\$ (272,746)	\$ (260,463)	\$ (248,179)	\$ (332,416)
Taxes and Fees Activities/Actividades Tributarias											
Cash Received / Flujo de Caja Recibido											
Sales Tax Exemption / Impuesto Sobre la Renta Exención	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 553,352	\$ 503,945	\$ 395,251	\$ 316,201
Total Cash Received/Recibido	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 553,352	\$ 503,945	\$ 395,251	\$ 316,201
Cash Used / Consumo de Caja											
ICA Municipal Tax / Impuesto ICA Municipal	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Sales Tax / Impuesto Sobre la Renta	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 553,352	\$ 503,945	\$ 395,251	\$ 316,201
Total Cash Used /											

Figure F-3: Pro-Forma Income Statement / Cálculo de Ingresos Netos

	2012	2013	2014	2015	2016	2017	2018	2019	2020
	1	2	3	4	5	6	7	8	9
Revenue									
Power Sales (Ventas de Electricidad)									
Total Revenue	\$ 1,235,160	\$ 1,729,224	\$ 1,976,256	\$ 2,099,772	\$ 2,223,288	\$ 2,285,046	\$ 2,346,804	\$ 2,470,320	\$ 2,593,836
Expenses									
Operations Expense (Costos Operacionales)									
LFG Collection System (Sistema de Recolección)	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Power Generation System (Sistema de Generación)	\$ 360,000	\$ 504,000	\$ 576,000	\$ 612,000	\$ 648,000	\$ 666,000	\$ 684,000	\$ 720,000	\$ 756,000
EPM Charges (Pagos a EPM por Interconexión)	\$ 52,560	\$ 73,584	\$ 84,096	\$ 89,352	\$ 94,608	\$ 97,236	\$ 99,864	\$ 105,120	\$ 110,376
Sub-Total	\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936
Interest Expense (Pago de intereses)									
Interest Expense (Pago de Intereses)	\$ 193,942	\$ 178,440	\$ 352,949	\$ 317,628	\$ 282,990	\$ 247,855	\$ 212,224	\$ 176,097	\$ 139,473
Sub-Total	\$ 193,942	\$ 178,440	\$ 352,949	\$ 317,628	\$ 282,990	\$ 247,855	\$ 212,224	\$ 176,097	\$ 139,473
Years Depreciation / Depreciación (Años)									
Tranche 1 / Fase 1	20.0	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460
Tranche 2 / Fase 2	20.0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460
Total Expense	\$ 1,238,066	\$ 1,387,588	\$ 1,644,608	\$ 1,650,543	\$ 1,833,618	\$ 1,819,111	\$ 1,804,108	\$ 1,809,237	\$ 1,813,869
Taxes									
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (197,626)	\$ (276,676)	\$ (316,201)	\$ (355,964)	\$ (355,726)	\$ (365,607)	\$ (375,489)	\$ (395,251)
Sales Tax (Exención)	16.0%	\$ 197,626	\$ 276,676	\$ 316,201	\$ 335,964	\$ 355,726	\$ 365,607	\$ 375,489	\$ 395,251
Sub-Total	\$ 656	\$ 656	\$ 656	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984	\$ 984
Net Income (Ingresos Netos)	\$ (3,562)	\$ 340,980	\$ 330,992	\$ 448,244	\$ 388,686	\$ 464,951	\$ 541,712	\$ 660,099	\$ 778,983
Percent of Revenue (Porcentaje de Ventas)	-0.3%	19.7%	16.7%	21.3%	17.5%	20.3%	23.1%	26.7%	30.0%
EBITDA [b]	\$ 743,497	\$ 1,072,537	\$ 1,237,057	\$ 1,319,317	\$ 1,225,120	\$ 1,266,250	\$ 1,307,380	\$ 1,389,640	\$ 1,471,900

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	10	11	12	13	14	15	16	17	18	19	20
Revenue											
Power Sales (Ventas de Electricidad)											
Total Revenue	\$ 2,655,594	\$ 2,779,110	\$ 2,902,626	\$ 3,026,142	\$ 3,087,900	\$ 3,211,416	\$ 3,334,932	\$ 3,458,448	\$ 3,149,658	\$ 2,470,320	\$ 1,976,256
Expenses											
Operations Expense (Costos Operacionales)											
LFG Collection System (Sistema de Recolección)	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560	\$ 255,560
LFG Power Generation System (Sistema de Generación)	\$ 774,000	\$ 810,000	\$ 846,000	\$ 882,000	\$ 900,000	\$ 936,000	\$ 972,000	\$ 1,008,000	\$ 918,000	\$ 720,000	\$ 576,000
EPM Charges (Pagos a EPM por Interconexión)	\$ 113,004	\$ 118,260	\$ 123,516	\$ 128,772	\$ 131,400	\$ 136,656	\$ 141,912	\$ 147,68	\$ 134,028	\$ 105,120	\$ 84,096
Sub-Total	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656
Interest Expense (Pago de intereses)											
Interest Expense (Pago de Intereses)	\$ (62,601)	\$ 4,964	\$ (1,035)	\$ 146,294	\$ 134,118	\$ 121,834	\$ 109,550	\$ 97,267	\$ 84,983	\$ 72,700	\$ 60,416
Sub-Total	\$ (62,601)	\$ 4,964	\$ (1,035)	\$ 146,294	\$ 134,118	\$ 121,834	\$ 109,550	\$ 97,267	\$ 84,983	\$ 72,700	\$ 60,416
Years Depreciation / Depreciación (Años)											
Tranche 1 / Fase 1	20.0	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460	\$ 552,460
Tranche 2 / Fase 2	20.0	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232	\$ 211,232
Total	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693	\$ 763,693
Total Expense	\$ 1,843,656	\$ -	\$ 1,987,734	\$ 2,176,318	\$ 2,184,770	\$ 2,213,742	\$ 2,242,715	\$ 2,271,687	\$ 2,156,264	\$ 1,917,072	\$ 1,739,764
Taxes											
ICA Municipal Tax (Impuesto Municipal ICA)	[a]	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Sales Tax (Impuesto Sobre Renta)	16.0%	\$ (424,895)	\$ (444,658)	\$ (464,420)	\$ (484,183)	\$ (494,064)	\$ (513,827)	\$ (533,589)	\$ (533,352)	\$ (503,945)	\$ (316,201)
Sales Tax (Exención)	16.0%	\$ 424,895	\$ 444,658	\$ 464,420	\$ 484,183	\$ 494,064	\$ 513,827	\$ 533,589	\$ 533,352	\$ 503,945	\$ 316,201
Sub-Total	\$ 984	\$ 984	\$ 984	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312	\$ 1,312
Net Income (Ingresos Netos)	\$ 810,954	\$ 825,650	\$ 913,908	\$ 848,512	\$ 901,818	\$ 996,361	\$ 1,090,905	\$ 1,185,449	\$ 992,082	\$ 551,936	\$ 235,179
Percent of Revenue (Porcentaje de Ventas)	30.5%	29.7%	31.5%	28.0%	29.2%	31.0%	32.7%	34.3%	31.5%	22.3%	11.9%
EBITDA [b]	\$ 1,513,030	\$ 1,595,290	\$ 1,677,550	\$ 1,759,810	\$ 1,800,940	\$ 1,883,200	\$ 1,965,460	\$ 2,047,720	\$ 1,842,070	\$ 1,389,640	\$ 1,060,600

Notes / Notas

[a] Please see Task 11. / Favor ver Tarea 11.

[b] EBITDA = Earnings before interest, taxes, depreciation & amortization. / EBITDA = Ingresos antes de pagarse intereses, impuestos, depreciación & amortización.

Figure F-4: IRR Analysis

Sequential Year
Free Cash Flow

1	2	3	4	5	6	7	8	9
\$ (6,447,448)	\$ 1,016,282	\$ (1,539,198)	\$ 1,262,734	\$ 1,153,228	\$ 1,194,358	\$ 1,235,488	\$ 1,317,748	\$ 1,400,008

Sequential Year
Free Cash Flow

10	11	12	13	14	15	16	17	18	19	20
\$ 716,485	\$ 1,523,398	\$ (1,114,342)	\$ 1,687,590	\$ 1,728,720	\$ 1,810,980	\$ 1,893,240	\$ 1,975,500	\$ 1,769,850	\$ 1,317,420	\$ 988,380

Internal Rate of Return (IRR)

12.3%

Figure F-5: Net Present Value of Cash Flows

Figure F-6: Operations and Maintenance Expense

	Sequential Year	1	2	3	4	5	6	7	8	9	
	Calendar Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	
LFG Collection System Tranche 1		\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	
LFG Collection System Tranche 2		\$ 360,000	\$ 504,000	\$ 576,000	\$ 612,000	\$ 648,000	\$ 666,000	\$ 684,000	\$ 720,000	\$ 756,000	
LFG Power Generation System		\$ 52,560	\$ 73,584	\$ 84,096	\$ 89,352	\$ 94,608	\$ 97,236	\$ 99,864	\$ 105,120	\$ 110,376	
EPM Transmission Line Charge											
Annual Total		\$ 491,663	\$ 656,687	\$ 739,199	\$ 780,455	\$ 998,168	\$ 1,018,796	\$ 1,039,424	\$ 1,080,680	\$ 1,121,936	
	10	11	12	13	14	15	16	17	18	19	
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
LFG Collection System Tranche 1	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	\$ 79,103	
LFG Collection System Tranche 2	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	\$ 176,456	
LFG Power Generation System	\$ 774,000	\$ 810,000	\$ 846,000	\$ 882,000	\$ 900,000	\$ 936,000	\$ 972,000	\$ 1,008,000	\$ 918,000	\$ 720,000	\$ 576,000
EPM Transmission Line Charge	\$ 113,004	\$ 118,260	\$ 123,516	\$ 128,772	\$ 131,400	\$ 136,656	\$ 141,912	\$ 147,168	\$ 134,028	\$ 105,120	\$ 84,096
Annual Total	\$ 1,142,564	\$ 1,183,820	\$ 1,225,076	\$ 1,266,332	\$ 1,286,960	\$ 1,328,216	\$ 1,369,472	\$ 1,410,728	\$ 1,307,588	\$ 1,080,680	\$ 915,656