REPORT OF THE PUMP TEST AND PRE-FEASIBILITY STUDY FOR LANDFILL GAS RECOVERY AND UTILIZATION AT THE EL TRÉBOL LANDFILL GUATEMALA CITY, GUATEMALA

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EXECUTIVE SUMMARY

This Pre-Feasibility Study Report addresses the potential implementation of a landfill gas (LFG) collection, control and utilization project at the El Trébol Landfill located in Guatemala City, Guatemala. SCS Engineers (SCS) has prepared this report for U.S. EPA's Landfill Methane Outreach Program (LMOP) and the U.S. Agency for International Development (USAID).

The project would consist of the installation of a landfill gas collection system to extract LFG to either fuel a power plant using internal combustion engine generators or deliver via pipeline to nearby industrial facilities for use as a fuel substitute. Both utilization scenarios also would involve flaring any unused LFG. Revenues for the project would be generated from the sale of credits for the reduction of greenhouse gas emissions and from energy sales (exporting power to the grid or selling LFG to end users). The emission reductions are created by the combustion of methane, which makes up approximately 50 percent of LFG. Methane has a global warming potential about 21 times that of carbon dioxide (CO_2).

As part of this investigation, a pumping test was conducted at the El Trébol Landfill. This test has provided additional information regarding the available LFG volume and quality at the landfill, along with other physical information such as buried waste characteristics and leachate levels within the waste mass. The results of the test generally support the LFG recovery projections prepared via mathematical modeling.

The following is a summary of the relevant project information:

- The El Trébol Landfill has been used historically as a disposal site for the City of Guatemala. The area of the landfill under consideration for this study began receiving wastes in 1966 and is anticipated to remain open until about 2018, with a total capacity of approximately 11.4 million U.S. tons (about 10.34 million tonnes) of municipal solid waste (MSW) and construction debris.

- The landfill is currently filling at a rate of approximately 309,000 tons per year, and presently has about 6.4 million tons of waste in place.

- The site comprises a total of about 16.2 hectares (ha), of which approximately 3.5 ha has been closed, with a final soil cover installed.

- The landfill is owned by private landowners. Site operations are managed by the Municipality of Guatemala City Public Works Department ("MUNI").

- The landfill is an unlined canyon fill located within Guatemala City. Maximum waste thickness is approximately 100 meters.

- The landfill does not have an existing active landfill gas collection and control system.

- There are no historical records of waste disposal, and the site history is complicated by landslide events, including one following a hurricane in 1998 that washed about 1 million cubic meters of waste from the landfill down the canyon.

- Gas Recovery Projections:

    - Projected gas recovery in 2006 is estimated to be approximately 823 cubic meters per hour (484 cubic feet per minute) under a mid-range estimate. This projection assumes that only about one-quarter of the landfill area is closed and available for installing LFG collection facilities until 2010. The recovery rate is expected to increase to approximately 1,464 cubic meters per hour (862 cubic feet per minute) in 2011 following the expansion of the wellfield into newly closed areas, and to approximately 2,013 cubic meters per hour (1,185 cubic feet per minute) in 2015 following a second wellfield expansion. LFG recovery is projected to reach a maximum of approximately 2,482 cubic meters per hour (1,461 cubic feet per minute) in 2019 following site closure and completion of the final system expansion. Gas recovery is expected to decline thereafter, reaching about 600 cubic meters per hour in 2030.

- Power Plant Sizing:

    - Assuming start-up of a power plant in 2007, it is estimated that there will be sufficient gas available to support a 1.06 MW power plant. Increased LFG recovery in 2011 following the collection system expansion is expected to be sufficient to add a second 1.06 MW engine at that time. Increases in LFG recovery in 2015 and 2019 following additional system expansions may make future expansion of the power plant possible. However, for the economic evaluation, SCS assumed a maximum power plant size of 2.12 MW.

- Direct Use Project:

    - Assuming start-up of a direct use project in 2007, it is estimated that there will be sufficient gas available to support the sale of approximately 105,560 mmBtus per year to several potential end users located near the landfill. Increased LFG recovery in 2011 following the collection system expansion is expected to be sufficient to increase LFG sales to approximately 193,160 mmBtus per year at that time. Increases in LFG recovery in 2015 and 2019 following additional system expansions may make future expansion of the direct use project possible. However, to be conservative SCS assumed that no additional expansions of the project would occur.

- Projection of methane emissions reduction:

    - It is estimated that development of an LFG utilization project at the landfill would generate CO_2 equivalent (CO_2e) emission reductions totaling approximately 1,300,392 tonnes for the period 2006 through 2020, through reduction of landfill methane emissions.

      It is estimated that development of an LFG-to-energy (LFGE) project at the landfill would result in an additional 120,312 tonnes of CO_2e emission reductions for the period 2007 through 2020 by displacing electricity produced via other sources.

It is estimated that development of a direct use project at nearby industrial facilities would result in an additional 121,618 tonnes of CO_2e emission reductions for the period 2007 through 2020 by displacing conventional fuels.

The project economics were analyzed for the 2006 - 2020 period under a variety of scenarios, including initial equity investment percentage (25 or 100 percent), project type (power generation with flaring of excess gas or direct use with flaring of excess gas), and emission reduction pricing ($5 or $6/tonne of CO_2e). A power sales price of $0.060/kWh was assumed for the LFGE project based on the average estimated wholesale electricity sales price in Guatemala as of July 2005.[1] A gas sales price of $5 per mmBtu was assumed for the direct use project, but the basis for this assumption is limited. No pricing information has yet been provided by two industrial end-users which have expressed interest in purchasing the LFG.

The results of the analysis indicate that the project economic feasibility appears favorable enough to likely attract developers/investors under all project scenarios analyzed. The direct use project was found to have higher estimated net present values and internal rates of return than the power plant project under all scenarios evaluated.

A summary of economic indicators is presented in Table ES-1 below.

TABLE ES-1: SUMMARY OF ECONOMIC EVALUATION

	PROJECT PERIOD	EMISSION REDUCTION PRICE ($/TONNE)	INITIAL EQUITY INVESTMENT (%)	NET PRESENT VALUE (X1,000 $)	INTERNAL RATE OF RETURN (%)
Power Plant	2006 - 2020	5	100	$1,519	15.3%
	2006 - 2020	5	25	$1,364	25.3%
	2006 - 2020	6	100	$1,819	17.0%
	2006 - 2020	6	25	$1,664	31.0%
Direct Use	2006 - 2020	5	100	$4,268	39.4%
	2006 - 2020	5	25	$4,171	88.3%
	2006 - 2020	6	100	$4,569	42.9%
	2006 - 2020	6	25	$4,472	103.2%

[1] Source: Administrador del Mercado Mayorista (AMM), which is the federal agency responsible for the operation of electrical generating plants in Guatemala (www.amm.org.gt).

SECTION 1.0
INTRODUCTION

SCS Engineers (SCS) is pleased to present this Pre-Feasibility Study Report for the implementation of a LFG collection, control and utilization project at the El Trébol Landfill in Guatemala City, Guatemala. SCS has prepared this report for LMOP and USAID in accordance with SCS's Contract Scope of Work.

LMOP has identified the El Trébol Landfill as a candidate for a LFG utilization project for a number of reasons, including:

- Landfill size (volume), depth of fill, age, and future capacity.
- The continued filling and future capacity of the landfill results in a dependable supply of LFG in the future. Furthermore, the use of LFG as a fuel for a project at the landfill would result in a net reduction of carbon emissions directly from the combustion of methane, and perhaps also indirectly from the displacement of other carbon fuels.

1.1 OBJECTIVES AND APPROACH

The objectives of this evaluation are as follows:

- Assess the technical and economic feasibility of the development of an LFG control and utilization project at the landfill.
- To quantify the potential greenhouse gas (GHG) emission reduction from implementing a project.
- To provide LMOP with a tool to assist potential project developers in making informed decisions regarding additional investigations or moving forward with a project at the landfill.

The approach taken for this study has included the following tasks:

- Reviewing site conditions and available background information, including waste quantities and composition, landfill type and configuration, and meteorological data.
- Visiting the site to observe site features and operations and meet with the landfill owner and operator.
- Installing three test extraction wells and monitoring probes for pump testing; conducting the pump test and evaluating the results.
- Estimating the LFG recovery potential from the landfill using computer modeling based on available information, pump test results, and engineering experience at similar landfills.

- Quantifying the potential for on-site electricity generation using LFG as a fuel, or for selling LFG to off-site industrial facilities.

- Estimating the required elements for the gas collection and utilization system (number and depth of wells, piping sizes and lengths, flare capacities, etc.) for evaluating the capital and operational costs required for implementing gas collection and flaring at the landfill.

- Estimating the cost of implementing an energy recovery project, including capital and operational costs.

- Estimating the cost of implementing a direct use project, including capital and operational costs.

- Evaluating the project economics by quantifying capital and operational costs and sources of revenues, and calculating the net present value and internal rate of return.

1.2 LANDFILL GAS UTILIZATION BACKGROUND

Landfills produce LFG as organic materials decompose under anaerobic (without oxygen) conditions. LFG is composed of approximately equal parts methane and carbon dioxide, with trace concentrations of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and other constituents. Both of the two primary constituents of LFG (methane and carbon dioxide) are considered to be greenhouse gases (GHG) which contribute to global warming, although the Intergovernmental Panel on Climate Change (IPCC) does not consider the carbon dioxide specifically present in raw LFG to be a GHG (it is considered to be “biogenic”, and therefore a natural part of the carbon cycle).

Methane present in raw LFG is, however, considered to be a GHG. In fact, methane is a much more potent GHG than carbon dioxide, with a global warming potential of approximately 21 times that of CO_2. Therefore, the capture and combustion of methane (transforming it to carbon dioxide and water) in an LFG flare, an engine generator or other device, results in a substantial net reduction of GHG emissions. Additional benefits beyond GHG emission reductions include the potential for improvement in local air quality through the destruction of HAPs and VOCs through LFG combustion.

There are two natural pathways by which LFG can leave a landfill: by migration into the adjacent subsurface and by venting through the landfill cover system. In both cases, without capture and control the LFG (and methane) will ultimately reach the atmosphere. The volume and rate of methane emission from a landfill is a function of the total quantity of organic material buried in the landfill and its age and moisture content, compaction techniques, temperature, and waste type and particle size. While the methane emission rate will decrease after a landfill is closed (as the organic fraction is depleted), a landfill will typically continue to emit methane for many (20 or more) years after its closure.

A common means for controlling LFG emissions is to install an LFG collection and control system. LFG control systems are typically equipped with a combustion (or other treatment) device designed to destroy methane, VOCs, and HAPs prior to their emission to the atmosphere.

Good quality LFG (high methane content with low oxygen and nitrogen levels) can be utilized as a fuel to offset the use of conventional fossil fuels or other fuel types. The heating value typically ranges from 400 to 600 Btus (British thermal units) per standard cubic foot (scf), which is approximately one half the heating value of natural gas. Existing and potential uses of LFG generally fall into one of the following categories: electrical generation, direct use for heating/boiler fuel (medium-Btu), upgrade to high Btu gas, and other uses such as vehicle fuel. This study focuses on evaluation of a potential electrical generation project and a direct use project.

1.3 PROJECT LIMITATIONS

During our evaluation, SCS relied upon information provided and various assumptions in completing the LFG recovery modeling and economic evaluation. Judgments and analysis are based upon this information and SCS' experience with LFG collection and utilization systems. Specific limitations include:

- LFG production estimates are based on a desktop analysis and visual observation of the landfill and its operations.
- Because the landfill does not currently have an LFG recovery system, the economic analysis uses typical capital and operating cost data for similar systems rather than project specific information.
- The LFG recovery projections have been prepared in accordance with the care and skill generally exercised by reputable LFG professionals, under similar circumstances, in this or similar localities. No other warranty, express or implied, is made as to the professional opinions presented herein. Changes in the landfill property use and conditions (for example, variations in rainfall, water levels, landfill operations, final cover systems, or other factors) may affect future gas recovery at the landfill. SCS does not guarantee the quantity or quality of available LFG.
- This pre-feasibility study has made assumptions regarding the future availability and accessibility of areas of the landfill for installing a gas collection system, based on information available at the time this study was conducted. These assumptions were made in the absence of specific information regarding the dates that various portions of the landfill will become accessible for wellfield development, and the age of the waste in each area. Because the assumptions were used to estimate a schedule for collection system build-out and coverage of the LFG generating refuse mass, they have significant impacts on projected future LFG recovery and resulting estimates of project feasibility.
- Although a pump test helps reduce the uncertainties of predicting LFG recovery, it also has limitations. First, it is conducted on only a small area of the landfill and the results are assumed to apply to the entire site. Secondly, pump tests can only indicate the quantity of LFG during the period of the field test and don’t provide any indication of future gas resources.

- This modeling work has been conducted exclusively for the use of LMOP and USAID for this Pre-Feasibility Study. No other party, known or unknown to SCS is intended as a beneficiary of this report or the information it contains. Third parties use this report at their own risk. SCS assumes no responsibility for the accuracy of information obtained from, or provided by, third-party sources.

1.4 REPORT REVISIONS

This report was originally presented at a workshop in Guatemala City on October 25, 2005. During the workshop, new information became available regarding limits on the availability of portions of the landfill for installing LFG collection equipment. This new information had a significant potential impact on the results of the study. In addition, comments received during the workshop included a request to provide a range of LFG recovery projections to accommodate investors' interest in estimates of the likely upper and lower limits of project potential at the site. This final version of the report has been revised accordingly and includes the following changes:

- The October version of the report did not account for any limits on the availability of areas of the landfill for gas collection system installation. This revised report assumes the following schedule for areas of the landfill becoming filled with refuse, having a final cover installed, and becoming available for gas collection system installation: 25 percent of the landfill area will be available from now through 2010; 50 percent of the landfill area will become available from 2011 through 2014; 75 percent of the landfill area will become available from 2015 through 2018; and 100 percent of the landfill area will become available after site closure. These revisions impact estimates of future collection system coverage, LFG recovery, and potential project size.

- The October version of the report assumed no increases in LFGE or direct use project size during the project period (2006-2020). This revised report assumes that a project expansion will occur in 2010 and go on-line in 2011 that will consist of either a second I.C. engine (for an LFGE project) or increased LFG flow to an end-user (for a direct use project).

- The October version of the report provided a single set of LFG recovery estimates only. In the revised report, estimates of LFG recovery given the limitations of the planned collection system were expanded to include low, mid-range, and high recovery projections. The economic assessment was based on the mid-range projections only, as these were estimated to be the most likely to be realized.

Other revisions made to this report consisted of minor text changes that did not significantly impact the results of this study.

SECTION 2.0
PROJECT BACKGROUND INFORMATION

2.1 LANDFILL BACKGROUND

The El Trébol Landfill is a municipal solid waste (MSW) landfill located in the central part of Guatemala City, Guatemala. The site consists of a deep canyon approximately 100 - 250 meters (m) wide and 100 m deep. According to a 1999 report by Parsons Infrastructure and Technology Group, Inc. ("Parsons Report") to the U.S. Agency for International Development (USAID),[2] the upper portions of the canyon were filled prior to 1966 and were subsequently closed and developed as a soccer field.

Since 1966, the landfill has extended approximately 650 m down the canyon to the north of the soccer field and covered about 16.2 hectares (ha). The lower (northernmost) 200 m of the landfill is the area of active operations, and the remainder of the landfill has been closed. A service road separates the active fill area to the north from the closed area to the south. Waste depths in the active area extend up to 100 m. Figure 2-1 from the Parsons Report (reproduced below as Figure 2-1) shows the layout of the landfill as of February 1999.

Site operations are managed by the Municipality of Guatemala City Public Works Department ("MUNI"). According to the Parsons Report, MUNI does not limit access to the landfill, and allows waste-hauling vehicles to enter the service road and unload wastes along the north end of the road. Waste loads are spread out along the road by MUNI with bulldozers, and waste pickers ("Guajeros") recover metal, glass, and other materials considered to have value. The MUNI bulldozers then push the waste to the north off of the road and onto a level area known as "the playa" that is situated at the same elevation as the road. As waste accumulates on the playa, it is subsequently pushed by MUNI bulldozers off of the north end of the playa into the canyon.

At the time of the Parsons Report (1999), the MUNI did not charge disposal (tipping) fees, conduct leachate management activities, or apply a daily soil cover. No LFG collection system or venting wells exist at the site. In 2005, the site owner, Rellenos de Guatemala, reported that a portion of the site (about 3-4 ha) has about 40 cm of final cover installed, has been walled off, and is currently available for installing LFG collection facilities. The remainder of the site is still being managed by the MUNI and is not currently available for LFG extraction.

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[2] "Final Report, El Trébol Landfill, Guatemala City, Guatemala." Parsons Infrastructure and Technology Group, Inc. December 1999.

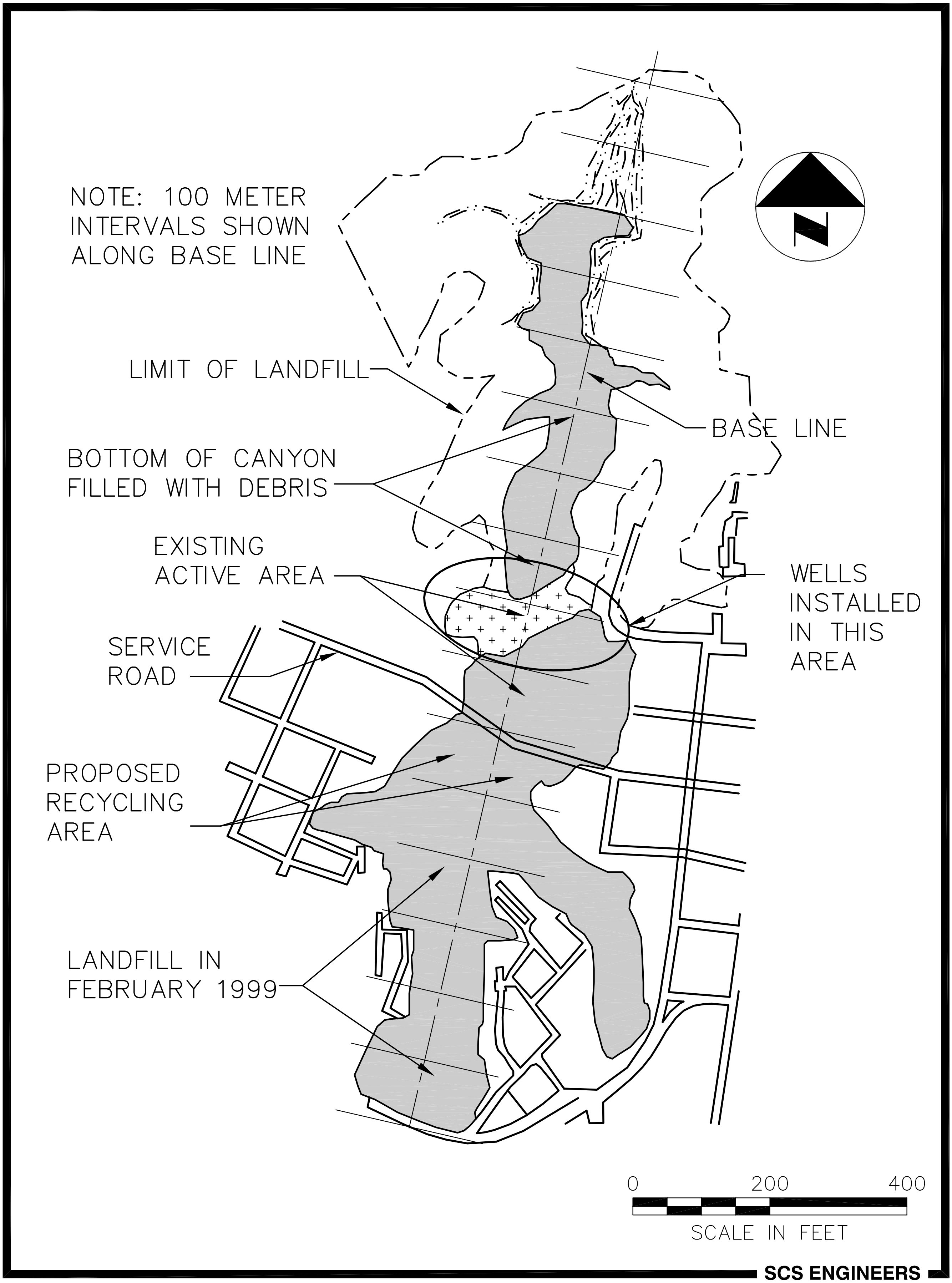


Figure 2-1 El Trébol Landfill

2.2 WASTE DISPOSAL RATES

No historical records of waste disposal rates at El Trébol exist. The best source of information on historical disposal is the Parsons Report, which developed disposal estimates based on a topographical map dated 1966, aerial photos taken in 1966, 1990, and 1999, and a study conducted in 1991 by the Japan International Cooperation Agency ("JICA Report").[3] Waste volumes were converted to tons after accounting for the following factors:

- A large portion of the waste consists of construction debris.
- In 1998 a hurricane (Hurricane Mitch) caused a large landslide during which approximately 1 million cubic meters of landfill material was washed down the canyon.
- As reported in the JICA Report, disposed wastes contained a very high moisture content. Disposal estimates provided in the Parsons Report were adjusted downward to eliminate a portion of the water weight.[4]

Table 2-1 summarizes the estimates of disposal from 1966 - 2004. Based on this information, as of the end of 2004, the landfill contained a total of 6.2 million tons of waste, including 3.9 million tons of municipal solid waste (MSW) and 2.3 million tons of construction debris.

Future annual disposal rates are estimated by continuing the trends in the disposal estimates provided in the Parsons Report, which showed a 3.35 percent annual increase in MSW and a 2.5 percent annual increase in construction debris from 1995-2004. No estimates of total site capacity have been made available to SCS. Site managers have indicated that the site has adequate capacity for at least the next 10 years, and that there is no projected closure date.

SCS estimated the landfill's projected closure date based on estimates of amount of waste in place as of 1999 and the fraction of the canyon filled at that time. Figure 2-1 shows that slightly over one-third of the canyon had been filled as of February 1999, and another 20 percent of the landfill area had debris covering the bottom of the landfill. Based on this drawing, it appears that about 40 percent of the landfill capacity had been filled as of February 1999. Using disposal estimates shown in Table 2-1, we estimate that approximately 4.56 million tons of waste had been disposed as of February 1999. This implies a total site capacity of 11.4 million tons. Table 2-2 shows the future waste disposal estimates developed using the methods described above. As shown in the table, the future disposal rate assumptions and site capacity estimate imply a closure date of late 2018.

[3] "The Study of Solid Waste Management in Metropolitan Areas of Guatemala City." Japan International Cooperation Agency. September 1991.

[4] The moisture content of disposed municipal solid waste (not including construction debris) was reported in the JICA report to be 62.65%. Disposal estimates provided in the Parsons Report were adjusted by multiplying by 46.69% to convert to a moisture content of 20% (based on the ratio of solids contents, or 37.35%/80%), which the Parsons Report viewed as "typical." It should be noted that a moisture content of 20% is typical for U.S. waste, but not for wastes from developing countries which tend to have much greater amounts of food waste.

TABLE 2-1: HISTORICAL DISPOSAL RATES
EL TRÉBOL LANDFILL, GUATEMALA

Year	Unadjusted MSW (1) (tons/year)	Unadjusted MSW (2) (tons/year)	Construction Debris (tons/year)	Total Waste (tons/year)
1966	83,693	39,076	14,132	53,208
1967	86,686	40,474	14,485	54,959
1968	89,786	41,921	14,847	56,768
1969	92,997	43,420	15,218	58,638
1970	96,323	44,973	15,599	60,572
1971	99,768	46,582	15,988	62,570
1972	103,336	48,248	24,582	72,830
1973	107,031	49,973	25,197	75,170
1974	110,859	51,760	25,827	77,587
1975	114,824	53,611	26,47	80,083
1976	118,930	55,528	27,134	82,662
1977	123,183	57,514	27,813	85,327
1978	127,588	59,571	28,508	88,079
1979	132,151	61,701	38,961	100,662
1980	136,877	63,908	39,935	103,843
1981	141,772	66,193	40,933	107,126
1982	158,590	74,046	45,313	119,359
1983	177,402	82,829	50,161	132,990
1984	198,446	92,654	55,529	148,183
1985	222,025	103,663	61,481	165,144
1986	224,244	104,700	78,700	183,400
1987	226,485	105,746	78,660	184,406
1988	228,749	106,803	78,621	185,424
1989	231,035	107,870	78,582	186,452
1990	233,132	108,849	78,471	187,320
1991	266,383	124,374	80,433	204,807
1992	274,743	128,278	82,444	210,722
1993	283,361	132,301	84,505	216,806
1994	292,243	136,448	86,617	223,065
1995	301,398	140,723	88,783	229,506
1996	311,505	154,442	91,002	236,444
1997	321,950	150,318	93,277	243,595
1998	332,743	155,538	95,609	250,967
1999	343,897	160,556	98,000	258,566
2000	355,423	165,947	100,450	266,397
2001	367,334	171,508	102,961	274,469
2002	379,641	177,254	105,535	282,789
2003	392,360	183,193	108,173	291,366
2004	405,502	189,329	110,877	300,206
TOTAL	**8,294,395**	**3,872,653**	**2,329,815**	**6,202,468**

Notes: 1. Waste disposal (excluding construction debris) prior to adjustment to account for moisture content in excess of 20%

2. Adjustment to 20% moisture by multiplying by 47.65%

TABLE 2-2: PROJECTED FUTURE DISPOSAL RATE
EL TRÉBOL LANDFILL, GUATEMALA

Year	Unadjusted MSW (1) (tons/year)	Adjusted MSW (2) (tons/year)	Construction Debris (3) (tons/year)	Total Waste (tons/year)	Cumulative Waste In Place (4) (tons/year)
2005	419,100	195,700	113,600	309,300	6,511,768
2006	433,100	202,300	116,400	318,700	6,830,468
2007	447,600	209,100	119,300	328,400	7,158,868
2008	462,600	216,100	122,300	338,400	7,497,268
2009	478,100	223,300	125,400	348,700	7,845,968
2010	494,100	230,800	128,500	359,300	8,205,268
2011	510,700	238,500	131,700	370,200	8,575,468
2012	527,800	246,500	135,000	381,500	8,956,968
2013	545,500	254,800	138,400	393,200	9,350,168
2014	563,800	263,300	141,900	405,200	9,755,368
2015	582,700	272,100	145,400	417,500	10,172,868
2016	602,200	281,200	149,000	430,200	10,603,068
2017	622,400	290,600	152,700	443,300	11,046,368
2018	497,916	232,478	121,154	353,632	11,400,000
TOTAL	**7,187,616**	**3,356,778**	**1,840,754**	**5,197,532**	**11,400,000**

Notes:
1. Waste disposal (excluding construction debris) prior to adjustment to account for waste moisture content in excess of 20%, assuming 3.35% annual increase in disposal
2. Adjustment to 20% moisture by multiplying by 46.69%
3. Assumes a 2.5% annual increase in construction debris disposal
4. Includes waste in place as of 1/1/2005

Not all of the waste disposed at the landfill is still in place and available for gas production. As noted above, the Parsons Report described a landslide event that occurred in 1998, where approximately 1 million cubic meters of waste was washed down the canyon. A smaller event reportedly occurred in 1990 which washed approximately 140,000 cubic yards down the canyon. As shown in Figure 2-1, the bottom of the canyon below the filled portion of the landfill is covered with debris. In addition, there are closed portions of the landfill which are unavailable for LFG extraction because houses have been built or the area is being used for recycling operations. The Parsons Report has provided estimates of the amount of waste unavailable due to these events. The analysis in the Parsons Report only covers waste deposited from 1985-1998 and provides no information on the availability of older waste for LFG extraction. This omission is based on the reasoning that wastes deposited before 1985 would be too old to be producing LFG currently. SCS concurs with this assumption as it is in agreement with our gas model projections for developing countries (where large amounts of food waste is disposed) that show rapid declines in LFG production from older waste. Table 2-3 provides a summary of the estimates of the amount of waste available for LFG production as of 2005, based on the estimates found in Table 5-1 of the Parsons Report (assumes wastes disposed after 1998 are 100% available).

TABLE 2-3: ESTIMATES OF WASTE AVAILABLE FOR LFG PRODUCTION EL TRÉBOL LANDFILL, GUATEMALA

Year	Unadjusted MSW (tons/year)	Construction Debris (tons/year)	Total Waste (tons/year)	Fraction Available (%)	MSW Available (tons/year)	Construction Debris Available (tons/year)	Total Waste Available (tons/year)
1985	103,663	61,481	165,144	60%	62,198	36,889	99,087
1986	104,700	78,700	183,400	60%	62,820	47,220	110,040
1987	105,746	78,660	184,406	50%	52,873	39,330	92,203
1988	106,803	78,621	185,424	50%	53,401	39,311	92,712
1989	107,870	78,582	186,452	0%	0	0	0
1990	108,849	78,471	187,320	100%	108,849	78,471	187,320
1991	124,374	80,433	204,807	100%	124,374	80,433	204,807
1992	128,278	82,444	210,722	100%	128,278	82,444	210,722
1993	132,301	84,505	216,806	100%	132,301	84,505	216,806
1994	136,488	86,617	223,065	100%	136,448	86,617	223,065
1995	140,723	88,783	229,506	100%	140,723	88,783	229,506
1996	145,442	91,002	236,444	100%	145,442	91,002	236,444
1997	150,318	93,277	243,595	0%	0	0	0
1998	155,358	95,609	250,967	0%	0	0	0
1999	160,556	98,000	258,566	100%	160,556	98,000	258,566
2000	165,947	100,450	266,397	100%	165,947	100,450	266,397
2001	171,508	102,961	274,469	100%	171,508	102,961	274,469
2002	177,254	105,535	282,789	100%	177,254	105,535	282,789
2003	183,193	108,173	291,366	100%	183,193	108,173	291,366
2004	189,329	110,877	300,206	100%	189,329	110,877	300,206
TOTAL	**2,798,670**	**1,783,181**	**4,581,851**	**78%**	**2,195,504**	**1,381,000**	**3,576,504**

Notes:
1. 40-50% of wastes disposed in 1985-88 were unavailable for LFG production due to development in the disposal areas
2. Wastes disposed in 1989 and 1997-98 were lost down the canyon during landside events
3. Construction debris is shown as available but is expected to contribute minimally to LFG production

As shown in Table 2-3, it is estimated that about 78 percent of the waste disposed between 1985 and 2004, or 3,576,504 tons, is still intact and is located in areas accessible to LFG extraction. Note that this amount includes construction debris which contains little organic waste and is expected to produce minimal amounts of LFG. Accordingly, only the MSW totals will be used to project LFG recovery rates.

2.3 WASTE COMPOSITION

Waste composition is an important consideration in evaluating a LFG recovery project, in particular the organic content, moisture content, and "degradability" of the various waste fractions. For example, landfills with a high amount of food wastes, which are highly degradable, will tend to produce LFG sooner but over a shorter length of time. The effect of waste composition on LFG production is discussed further in Section 4.0.

Table 2-4 presents a summary of the waste composition data for the landfill, based on published reports. No information on the waste composition at El Trébol Landfill was obtained during the pump test operations due to the wet drilling method used for extraction well installation.

TABLE 2-4: WASTE COMPOSITION DATA

COMPONENT	FRACTION OF WASTE STREAM (%)
Food and Green Waste	50.4
Paper and Cardboard	18.1
Plastics	10.1
Leather, Textiles, Bones	4.8
Metals	2.2
Glass	1.6
Ash, Tiles, other Construction Debris	6.1
Other Inorganic	6.7
TOTAL	**100.0**

Source: Table 2.5 in “Programa de Modernización del Manejo de Desechos Sólidos en la Ciudad de Guatemala”

SECTION 3.0
LANDFILL GAS PUMP TEST PROGRAM

3.1 PUMP TEST BACKGROUND INFORMATION

A pump test program was conducted at the El Trébol Landfill. The objectives of the pumping test were:

- To measure vacuum (pressure) and flow relationships while actively extracting LFG from the landfill.
- To measure sustainable methane levels of the extracted LFG during the pump test.
- To measure vacuum (pressure) in probes to estimate the lateral vacuum influence of the active pump test.
- To measure oxygen levels of the extracted biogas during the pump test to check for air infiltration through the landfill cover soil during pump test.
- Utilize the results of the pump test to refine the projections of landfill gas recovery.

The pump test generally consisted of the following physical elements and equipment:

- A total of three vertical extraction wells (referred to as Wells 1, 2, and 3). Well 1 was installed at a depth of 75 feet (approximately 23 m). Wells 2 and 3 were installed at a depth of about 100 ft (30 m). The extraction wells were spaced generally in triangular fashion about 150 to 200 feet (45-60 m) apart. Figure 3-1 presents a typical detail of construction for the extraction wells. Well construction logs are provided in Appendix A.
- A total of nine gas and pressure monitoring probes. Three probes were installed for each extraction well. The probes were installed to a depth of approximately 2 meters, and were spaced in line at distances of 5, 15 and 25 meters from each extraction well. Figure 3-2 presents a typical detail of construction for the monitoring probes.
- An electrically-powered mechanical blower, to exert a vacuum on the extraction wells and withdrawal LFG from the wells. The blower was powered on-site by a portable diesel powered electrical generator.
- Interconnection of the three extraction wells and the blower with solid piping. Flow control valves were installed at each extraction well as well as at the blower inlet to allow adjustment of vacuum and flow both system-wide and at individual wells. Figure 3-3 presents a schematic diagram showing the typical layout for the pump test system.
- Gas testing, and flow and pressure monitoring equipment. Gas quality (methane, oxygen) and static pressure measurements were taking using a Landtec GEM 500 Infrared Gas Analyzer (GEM 500). Gas flow measurements were taken using an Accu-Flow meter and the GEM 500.

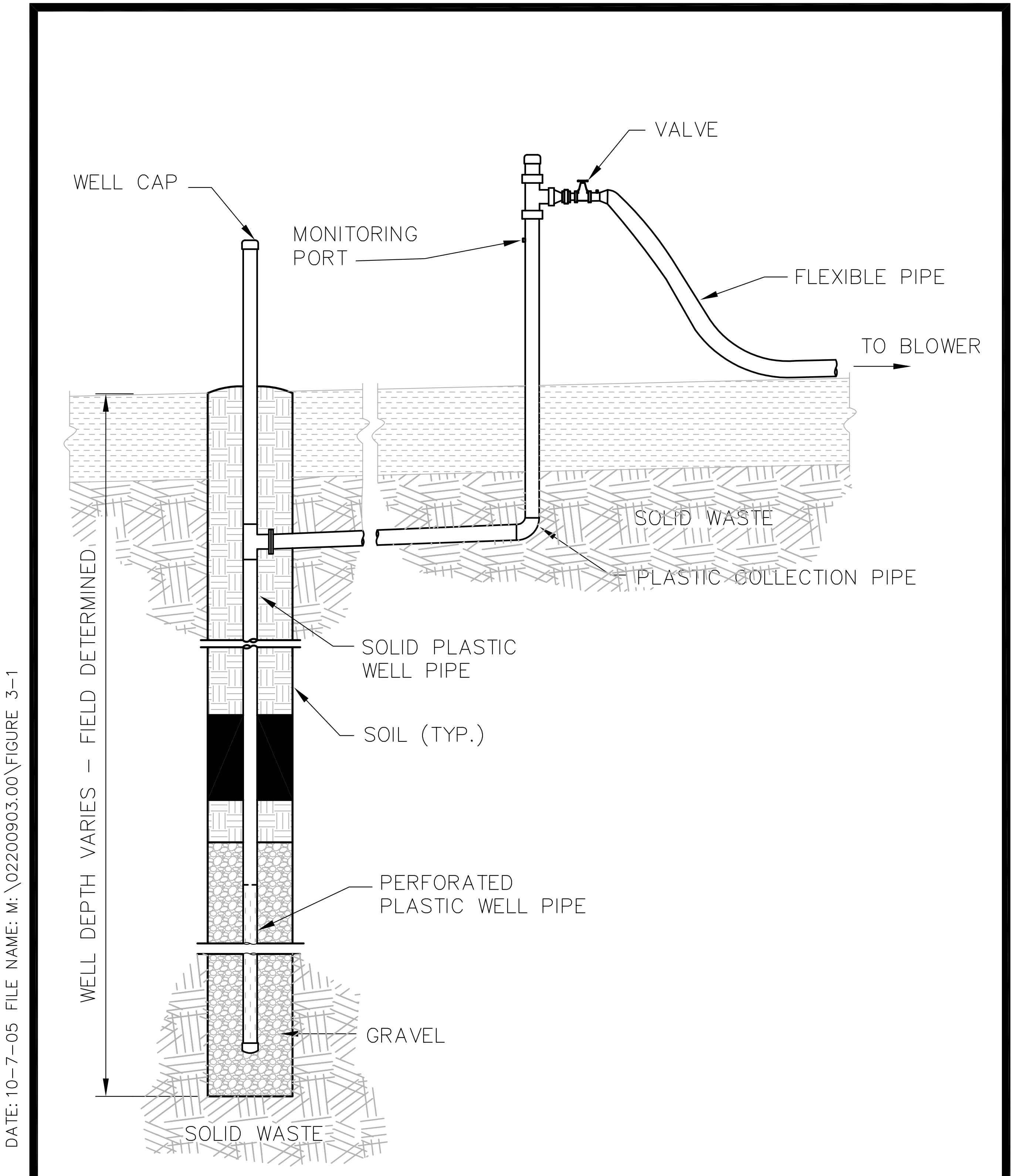


Figure 3-1 Typical Extraction Well and Wellhead Diagram

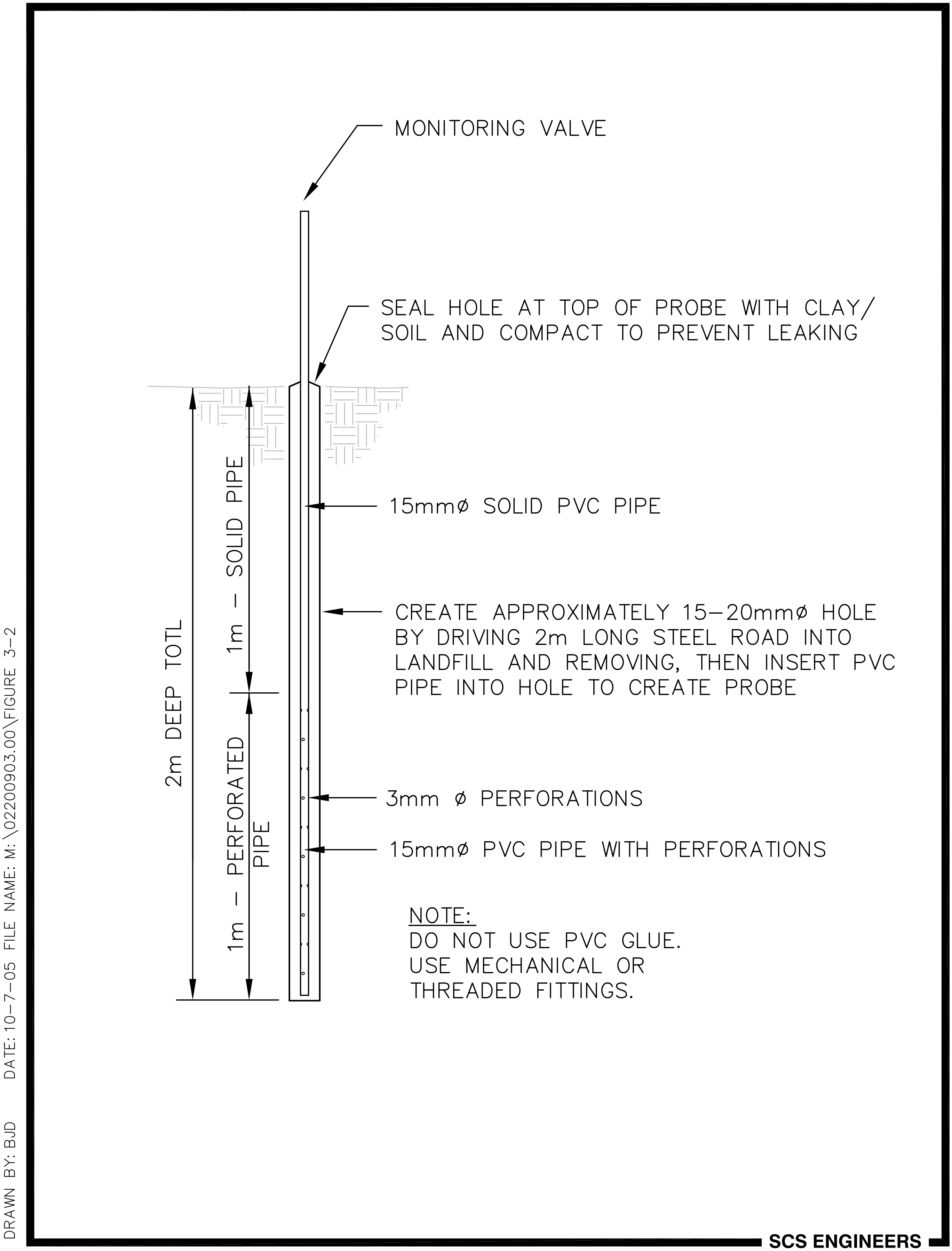


Figure 3-2 Monitoring Probe Diagram

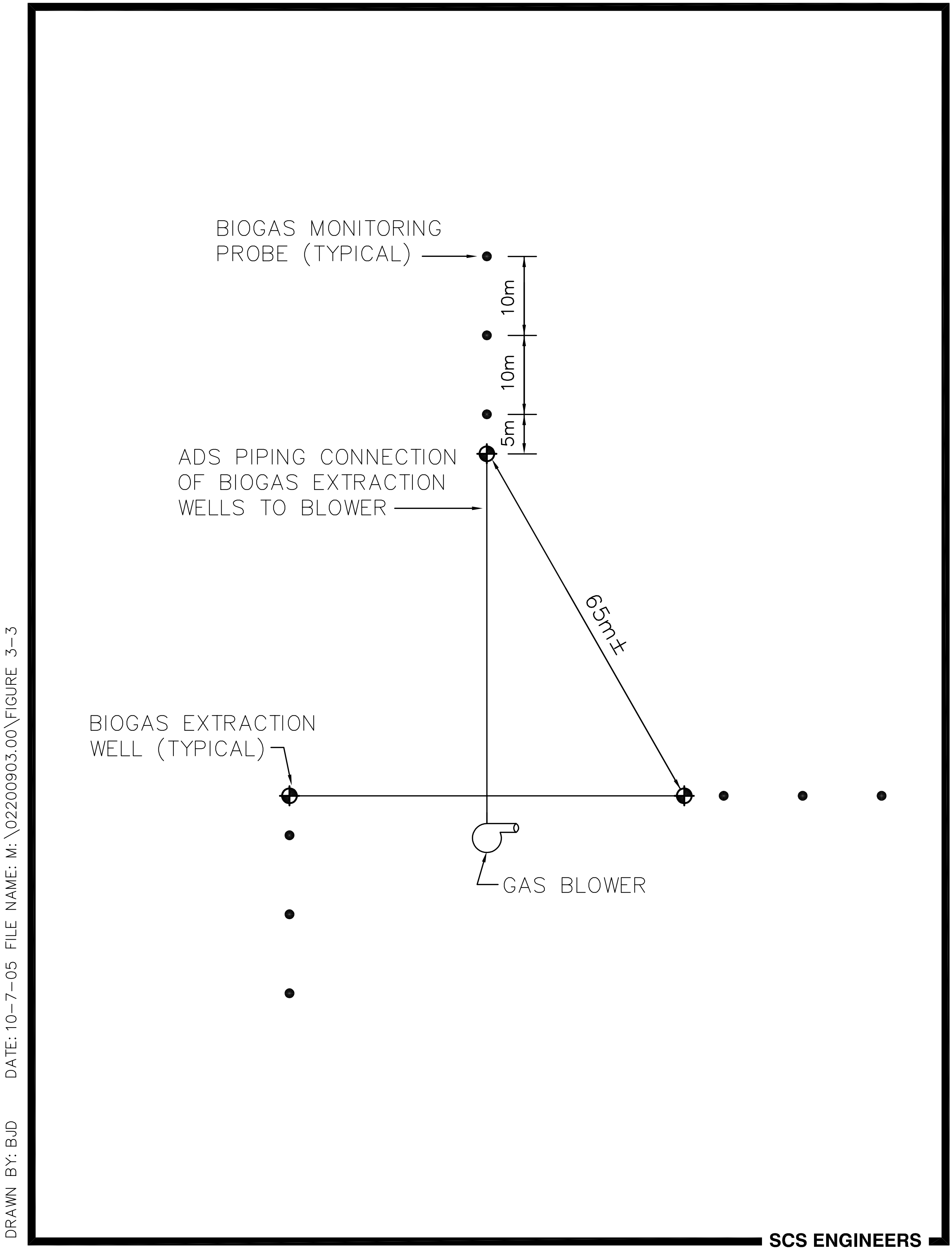


Figure 3-3 Typical Layout for the Pump Test System

SCS contracted with a local driller Perforsonda -Guatemala, C.A. (Perfosonda) to perform the drilling and a local general contractor Tecnicas, Equipos y Servicios (T.E.S.) for construction of the three extraction wells, the installation of the nine monitoring probes, and the installation of the blower, motor, and generator, and the interconnecting piping. SCS Field Services provided construction oversight and performed monitoring of the wells and probes and recorded the data.

3.2 PUMP TEST ACTIVITIES AND RESULTS

During our initial site visit on April 2004, SCS met with representatives from USAID, Guatemala City, and the private land owners to discuss the well construction and objectives of the pumping test. Personnel from SCS, USAID, Guatemala City, and the landowners visited the landfill to establish the general location of the pumping test and specific location for the extraction wells. A few weeks later, Perfosonda mobilized its crew and equipment to the landfill and began well drilling activities.

SCS personnel returned to the landfill in early June 2005 to provide oversight for the completion of well construction, as well as construction of the test program elements. Construction continued through June and into July. SCS returned to the site during the last week of July to begin the pump test.

During construction of the three extraction wells elevated leachate levels were observed in each of the three wells. Because the rainy season in Guatemala includes the summer months, flood conditions prevailed at the site and leachate was an ongoing problem throughout the pump test program. Leachate pumps were operated over a two-day period in each well in an attempt to clear liquids from the perforated sections of the well. Pumping successfully cleared a 20-ft section of perforated piping in Well 1. Well 2 could not be cleared at all due to the presence of plastic film waste which clogged the pumps. Pumping was partially successful in Well 3 and was able to clear temporarily a 7 ft section of perforated pipe, but liquid kept flowing into the well and re-clogging the perforated sections.

Test Program: Passive Conditions

During the morning of July 26, prior to starting the blower and beginning active test conditions, the technician performed gas quality and pressure monitoring to document system conditions under static (i.e., passive) conditions for comparison with data to be taken under active conditions. Table 3-1 presents a summary of the average static conditions at each monitoring point. Additional pump test monitoring results are provided in Appendix A.

In general, gas quality under static conditions was observed to be generally very good (i.e., high methane levels, with little or no oxygen). Well 2 had low methane content (19.3%) and elevated oxygen and balance gas (mainly nitrogen) levels (13.3% and 52.7%, respectively) and one monitoring probe (3A) was found to also have low methane content (1.7%) and high oxygen (18.7%) and balance gas (75.9%). This data suggests air intrusion in the gas samples or lack of LFG in this well and probe.

TABLE 3-1: PUMP TEST PROGRAM - STATIC CONDITIONS (JULY 26, 2005)

Location	Methane (%)	Oxygen (%)	Static Pressure (inches w.c.)
EW-1	56.4	0.1	0.0
Probe 1A	55.9	0.1	--
Probe 1B	55.0	0.2	--
Probe 1C	56.4	0.2	--
EW-2	19.3	13.3	0.0
Probe 2A	51.4	0.1	--
Probe 2B	37.6	0.1	--
Probe 2C	41.3	0.1	--
EW-3	52.6	0.2	0.0
Probe 3A	1.7	18.7	--
Probe 3B	59.8	0.1	--
Probe 3C	67.8	0.1	--

Static pressure readings were taken at the wells only, and all three wells were found to have zero static pressure. This suggests a limited amount gas buildup within the landfill, perhaps due to the lack of soil cover, limited amounts of gas generation, or a combination of these or other factors.

Test Program: Active Conditions

On July 29, the blower was turned on and active extraction conditions were established. During active gas pumping, wells were monitored two to four times daily for methane, carbon dioxide, oxygen, balance gas, static pressure, and flow. During the same period, probes were monitored two to four times daily for methane, carbon dioxide, oxygen, balance gases, and static pressure.

Extraction Well Data--

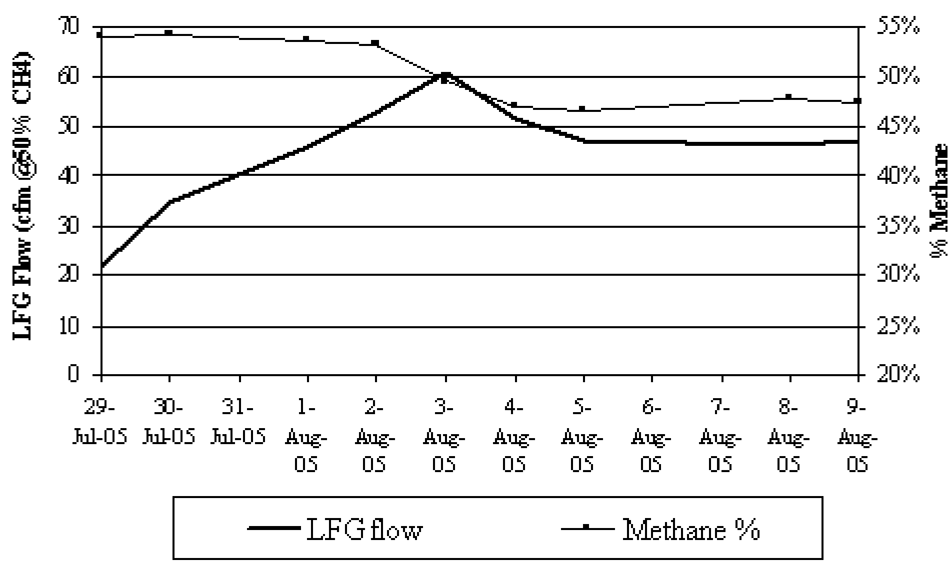
Monitoring conducted throughout the pump test showed that Wells 1 and 3 consistently had good gas quality (46% methane or higher). Well 2, however, showed consistently poor gas quality (i.e., low methane levels with high oxygen) for much of the testing period, and averaged only about 28 percent methane. In addition, gas flow was not established at Well 2 during the pump test, indicating that the elevated leachate inundated the slotted portion of the extraction well and prevented gas flow to the well. While good gas quality was observed at Well 3, gas flows from this well were measured to be very low or zero, indicating that elevated leachate intermittently prevented gas flow to this well.

Due to the lack of gas flow from Wells 2 and 3, only data from Well 1 was considered for evaluating LFG recovery at the landfill. Table 3-2 below summarizes the monitoring results for Well 1, and shows the average of the measured values for each day. Figure 3-4 shows the Well 1 LFG flow and methane content data. Appendix A provides a complete data set showing all monitoring data for all three wells and 9 probes.

TABLE 3-2: SUMMARY OF WELL 1 MONITORING RESULTS

DATE	Metane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Pressure (in. w.c.)	LFG Flow (cfm)	System Vacuum (in. w.c.)
29-Jul-05	54.2	42.6	0.7	2.7	-3.8	21.5	19-30
30-Jul-05	54.3	41.8	0.5	4.1	-6.5	34.8	38
1-Aug-05	53.8	41.7	0.6	3.9	-12.1	46.0	28-32.5
2-Aug-05	53.4	41.5	0.7	4.4	-16.4	52.7	25.6-26.6
3-Aug-05	49.5	41.6	0.7	6.3	-23.8	61.0	30
4-Aug-05	46.8	41.1	0.7	11.5	-22.3	51.7	30
5-Aug-05	46.5	40.9	0.6	12.0	-19.1	47.0	28-33
8-Aug-05	47.8	40.4	0.5	11.3	-15.2	46.3	29-32
9-Aug-05	47.3	40.3	0.6	11.8	-14.5	47.3	30-33
AVERAGES	**50.4**	**41.3**	**0.6**	**7.5**	**-14.8**	**45.4**	**30**
AVERAGES from Aug 4-9	**47.1**	**40.7**	**0.6**	**11.6**	**-17.8**	**48.1**	**31**

TABLE 3-4: WELL 1 LFG FLOW AND METHANE DATA



The table and figure show that Well 1 initially was yielding relatively low LFG flows at a high gas quality (about 54%). As the pump test continued, LFG flows increased, reaching a peak of 61 cubic feet per minute (cfm) on the 5th day following system start-up. At the same time, methane quality remained constant for the first few days and declined on the 5th and 6th days of active extraction.

From the 6th day through the remainder of the pump test program (the period of August 4-9), LFG flows and methane content appeared to stabilize, averaging approximately 48 cfm and 47 percent methane during this period. This is an indication that the pump test had reached steady state conditions, where LFG extraction rates are approximately equal to LFG generation rates. The vacuum applied by the system during this period averaged approximately 31 inches of water column (in-w.c.).

Monitoring Probe Data--

As mentioned previously, a total of nine monitoring probes (three per well) were installed. The objective of these probes is to measure gas quality and static pressures at varying distances from each extraction well in order to estimate the "radius of influence" of each well, and thus the volume of waste within the influence of each well. The rate of LFG recovery for the pump test can then be extrapolated to the entire landfill to estimate the recovery potential of the entire site.

The most direct indication that a monitoring probe is within the influence of an extraction well is the establishment of a vacuum at the probe. Another indication is a decline in methane content accompanied by an increase in the concentrations of oxygen and balance gases.

Because Wells 2 and 3 were inundated with leachate and not considered for this evaluation, the data for the 6 probes for these wells was not evaluated. During the pump test, vacuum was not measured at any of the three monitoring probes associated with Well 1. However, Probe 1-C, located 25 meters from Well 1, showed significant deterioration of gas quality as the pump test progressed, indicating that Probe 1-C was located within the "radius of influence" of Well 1. Probes 1-A and 1-B did not show deterioration of gas quality during the pump test, however. This is likely due to the fact that the well influence had not extended vertically to these shallow probes (these probes are located closer to Well 1 than Probe 1-C).

Table 3-3 presents a summary of the monitoring data for Probe 1-C. The complete set of probe monitoring data is provided in Appendix A.

TABLE 3-3: PUMP TEST MONITORING DATA - PROBE 1C

DATE	METHANE (%)	CARBON DIOXIDE (%)	OXYGEN (%)	BALANCE (%)	PROBE VACUUM (in. w.c.)
26-Jul-05	56.4	41.6	0.2	1.8	0.0
29-Jul-05	56.5	41.9	0.2	1.4	0.0
29-Jul-05	56.5	41.9	0.2	1.4	0.0
29-Jul-05	55.3	42.3	0.1	2.3	0.0
29-Jul-05	52.9	41.0	0.2	5.9	0.0
30-Jul-05	53.7	41.2	0.2	4.9	0.0
30-Jul-05	45.6	40.3	0.2	13.9	0.0
30-Jul-05	41.0	39.7	0.6	18.7	0.0
30-Jul-05	39.1	38.0	0.7	22.2	0.0
1-Aug-05	45.3	39.2	1.0	14.5	0.0
1-Aug-05	22.9	35.0	1.4	40.7	0.0
1-Aug-05	13.1	30.7	2.2	54.0	0.0
2-Aug-05	47.0	38.2	0.7	14.1	0.0
2-Aug-05	16.6	30.0	2.5	50.9	0.0
2-Aug-05	7.6	27.4	2.9	62.1	0.0
3-Aug-05	0.0	17.5	5.0	77.5	0.0
3-Aug-05	0.0	17.1	5.0	77.9	0.0
3-Aug-05	0.0	15.6	5.7	78.7	0.0
4-Aug-05	0.0	13.8	7.4	78.8	0.0
4-Aug-05	0.0	12.6	7.8	79.6	0.0
4-Aug-05	0.0	12.0	7.5	80.5	0.0
5-Aug-05	0.0	13.2	5.5	81.3	0.0
5-Aug-05	0.0	12.2	6.6	81.2	0.0
5-Aug-05	0.0	12.1	6.6	81.3	0.0
8-Aug-05	0.0	12.2	6.7	81.1	0.0
8-Aug-05	0.0	12.9	6.6	80.5	0.0
8-Aug-05	0.0	12.5	6.2	81.3	0.0
9-Aug-05	0.0	11.0	9.7	79.3	0.0
9-Aug-05	0.0	11.0	9.4	79.6	0.0
9-Aug-05	0.0	10.8	9.4	79.8	0.0

3.3 INTERPRETATION OF PUMP TEST RESULTS

SCS utilized the results of the pump test during the projection of LFG recovery rates at the landfill (see Section 4.0). The general procedure by which the pump test data are utilized for this purpose is as follows:

- Estimate the maximum steady-state flow rate achievable in the pump test area. This flow is essentially the maximum flow observed without evidence of air infiltration. Based on the pump test data, SCS believes that the average LFG flow obtained during the period of operation from August 4 - 9 (averages listed in Table 3-2) is that of maximum steady-state conditions, because flows and methane concentrations remained constant during this period when the vacuum applied to the well remained relatively unchanged. The average LFG recovery rate observed during this period was 48.1 cfm or 81.7 cubic meters per hour (m^3/hour) at 47.1 percent methane, which is equivalent to 45.3 cfm or77 m^3/hour at 50 percent methane.

- Estimate the radius of influence (ROI) of the extraction wells. As discussed above, there is evidence of influence extending to Probe 1-C located 25 meters from Well 1. As a general industry guideline, extraction wells normally have a ROI approximately equal to between 1.25 and 2.5 times its depth, depending on well construction, refuse permeability, and other factors.

- Refuse permeability is expected to be low at this landfill because it is located in a wet climate and contains a large amount of wet, organic wastes. The presence of elevated liquids in the landfill was confirmed in the well boring logs provided in Appendix A, which show liquid levels between 21 and 29 feet below the ground surface. The low refuse permeability suggests that the ROI is likely near the low end of the typical range. Given these considerations and the results of the pump test, SCS estimates that the average ROI of Well 1 at maximum steady-state conditions is approximately 1.5 times the well depth of 23 meters, or about 35 meters.

- Using an estimated ROI of 35 meters, the volume of refuse within the influence of Well 1 during the pump test is estimated to be 178,312 cubic meters. Figure 3-5 presents a diagram of a typical pump test cross-section showing theoretical "zones of influence" under active conditions.

- Estimate the unit recovery rate for the pump test in cubic feet of LFG per year per pound of waste. This requires estimating a refuse density for the landfill to apply to the volume of refuse within the influence of Well 1. Section 4.2 of the Parsons Report provides information on waste volumes and tons in place as of February 1999 (5,651,049 m^3 and 4,544,730 tons), which converts to a density of 1,230 pounds per cubic yard. This density can be applied to the volume of waste estimated to be within the influence of the pump test (178,312 m^3), which results in 143,403 tons. The flow rate of 45.3 cfm converts to 23.8 million cubic feet per year, which results in a unit recovery rate of 0.083 cubic feet per pound per year.

- Extrapolate the unit recovery rate achieved during the pump test to the total amount of refuse in the landfill that is available for LFG recovery. This is done by multiplying the pump test unit recovery rate by the 2004 tons in place from Table 2-3 (3,756,504 tons). Using this approach, one would expect the total gas recovery of the entire landfill if a fully comprehensive system were installed to be approximately 1,130 cfm (1,920 m^3/hour). This estimate for the potential recovery rate was used for refining the LFG recovery projections in Section 4.0.

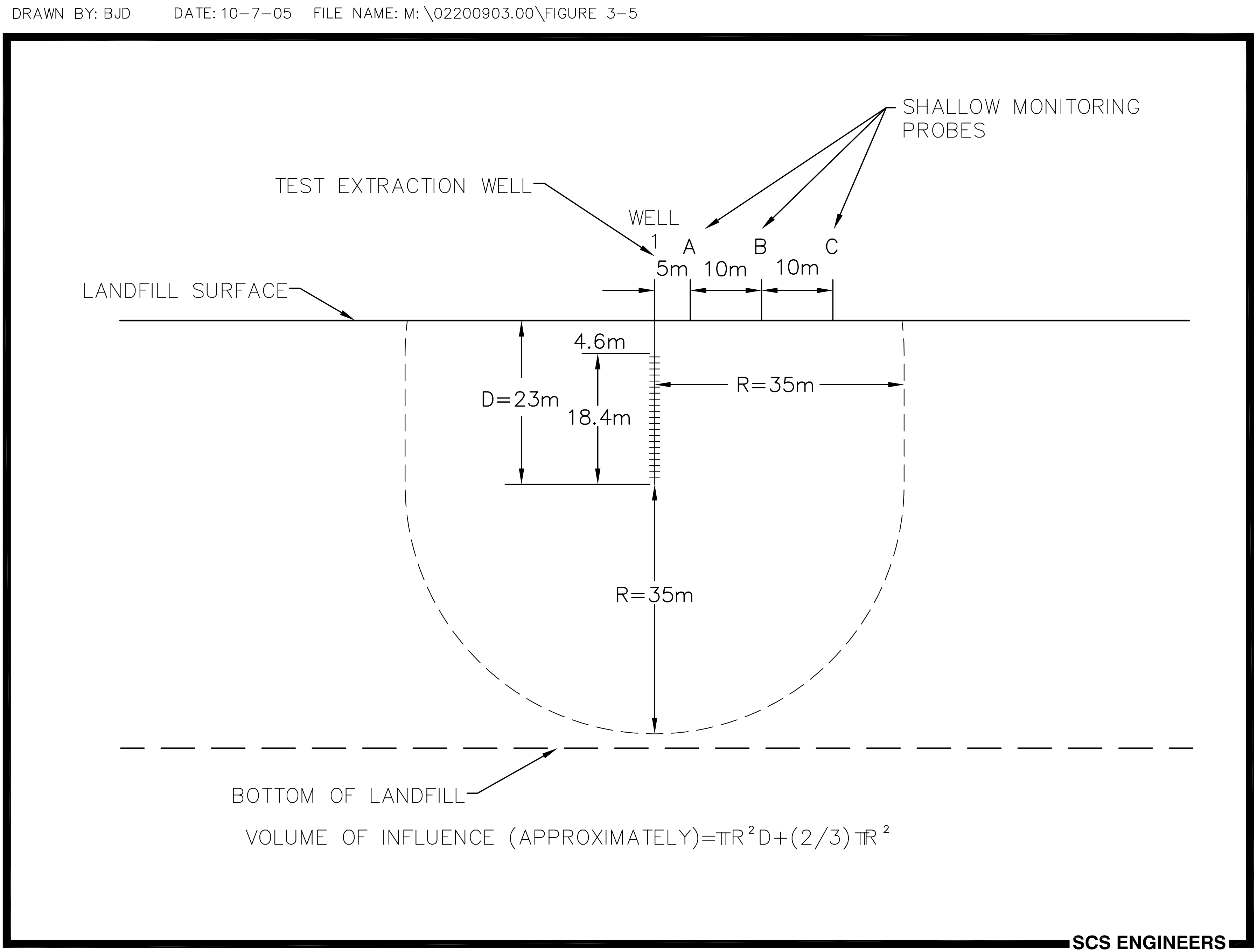


Figure 3-5 Illustration of Pump Test Active Zones of Influence

SECTION 4.0
LANDFILL GAS RECOVERY PROJECTIONS

4.1 INTRODUCTION

For projecting LFG recovery rates from the El Trébol Landfill, SCS utilized the results of the pump test (see Section 3) to refine the mathematical modeling parameters. Specifically, the projected rate of 1,130 cfm (1,920 m^3/hour) for the entire landfill was used to evaluate the model and make adjustments as needed. The specific modeling approach is discussed below.

4.2 LANDFILL GAS MATHEMATICAL MODELING

Landfill gas is generated by the anaerobic decomposition of solid waste within a landfill. It is typically composed of between 40 to 60 percent methane, with the remainder primarily being carbon dioxide. The rate at which LFG is generated is largely a function of the type of waste buried and the moisture content and age of the waste. It is widely accepted throughout the industry that the LFG generation rate generally can be described by a first-order decay equation.

To estimate the potential LFG recovery rate for the landfill, SCS utilized its in-house model that employs a first-order decay equation identical to the algorithm in the U.S. EPA's landfill gas emissions model (LandGEM). The SCS model is described in detail below.

<u>SCS Model</u>

SCS has developed a first-order decay model for estimating the LFG recovery potential of landfills (the SCS Model). The model, essentially a modified version of the EPA's LandGEM, was developed based on actual LFG collection/recovery data from over 150 sites across the U.S.

When calibrating the model, SCS identified trends in the LFG collection data that were used to develop the model. Specifically, it was apparent that different values for the ultimate methane recovery potential [Lo] and the decay rate constant [k] were appropriate depending upon the amount of precipitation a landfill receives.

The SCS Model also uses an alternate approach to conventional LFG modeling, which is to estimate recovery directly. This approach requires an evaluation or estimate of the current and future coverage of the LFG collection system, generally defined as that fraction of the landfill under active collection. Many factors can affect system coverage, including: well spacing and depth, depth of well perforations, presence of a flexible membrane liner (FML) or low-permeability cover system, landfill type and depth, condition of LFG collection system, and other design and operational issues.

SCS used the model to estimate the projected LFG recovery rates for the landfill through 2030 using the following criteria and assumptions:

- **Refuse Disposal Rates -** The historical and projected future filling rates used in the model were provided in Table 2-3. Site closure is projected to occur in 2018 when the landfill reaches its estimated 11.4 million (U.S.) ton capacity.

As discussed in Section 2, the disposal rates only include regular waste disposed after 1984, and exclude construction debris. Wastes that washed down the canyon during landslide events or which are located in areas where development would prevent installation of LFG extraction equipment also are excluded from the disposal rates used in the model.

- **Methane Content -** SCS estimates future methane content to be 50 percent.

- **Methane Rate Constant [k] -** The decay rate constant is a function of refuse moisture content, nutrient availability, pH, and temperature. As mentioned earlier, SCS also recognized this variability and consequently developed various levels of “wet” and “dry” site k-values from its database of LFG recovery data. For the El Trébol evaluation, SCS employed three different k values based on the degradability of the waste components (see discussion of model inputs below).

- **Methane Recovery Potential [Lo] -** The methane recovery potential is the total amount of methane that a unit mass of refuse will produce given enough time. The Lo is a function of the organic content of the waste. For the El Trébol Landfill, SCS started with a default Lo value of 85 cubic meters per tonne (2,723 ft^3/ton) for recovery based on the AP-42 recommended values of 100 cubic meters per tonne (3,204 ft^3/ton) for Lo when modeling LFG generation, and 85 percent for the maximum achievable collection efficiency. This value was then adjusted based on the ratios of the organic content of U.S. waste and waste at the landfill (see discussion of model inputs below).

- **LFG System Coverage.** Varies. The model estimates both the potential “recoverable” LFG from a landfill assuming a 100 percent comprehensive LFG collection system, and the projected rate of LFG recovery using the estimated LFG system coverage. System coverage is a measure of the fraction of the refuse mass which is under active collection.

  The LFG system coverage factor is based on engineering judgment, and considers many factors including: whether the landfill is closed or active, the type of well construction and gas system construction, the level of operation that is provided, the likelihood that system components such pipes and wells may be damaged by landfill operations and/or settlement, how quickly damaged pipes and wells (and other equipment, such as blowers, etc.) are likely to be repaired, leachate levels in wells, and other factors. This value falls within the range of 0% (for no gas collection system) to 100% (for a comprehensive collection system over a closed landfill with excellent construction and operation).

  Modifications to the LFG system coverage can be made to account for expected collection system expansions or if other changes to the LFG system or landfill are anticipated (e.g., landfill closure or partial capping, increasing flows due to the presence of additional fill material). Active landfills generally tend to have lower system coverage than closed landfills due to the interferences caused by active filling operations.

  As noted in Section 1 (Introduction), only a portion of the landfill area (3-4 ha of a total of 16.2 ha) has been closed to disposal operations with final cover installed. This area has been walled off and is available for installing LFG extraction wells. The remaining portion of the landfill has been leased by the landowner back to the City for disposal operations and is currently not available for installing wells. It is expected that active portions of the landfill will be closed and made available for installing extraction wells over time. The actual schedule for making these areas available is not known. For the purposes of this study, the following assumptions were made regarding the dates that portions of the landfill become available:

- 2006-2010: Approximately 25 percent of the landfill area is available.
- 2011-2015: Approximately 50 percent of the landfill area is available.
- 2016-2018: Approximately 75 percent of the landfill area is available.
- 2019-2020: 100 percent of the landfill area is available.

The fraction of the total volume of waste disposed in areas available for installing LFG extraction wells is greater than the area percentages listed above because the closed areas will be filled to greater depths than the unavailable active areas. The fraction of total waste disposed that is contained in the closed areas will vary annually and be equal to the above listed percentages divided by the percentage of total landfill consumed, according to the schedule listed in Table 4-1 below.

TABLE 4-1: SCHEDULE FOR LANDFILL ACCESS

[A] YEAR	[B] % OF AREA AVAILABLE	[C] % OF CAPACITY FILLED*	[D] % REFUSE VOLUME ACCESSED ([B]/[C])
2006	25%	45%	56%
2007	25%	49%	51%
2008	25%	52%	48%
2009	25%	56%	44%
2010	25%	60%	41%
2011	50%	65%	77%
2012	50%	69%	72%
2013	50%	74%	68%
2014	50%	78%	64%
2015	75%	83%	90%
2016	75%	88%	85%
2017	75%	93%	80%
2018	75%	98%	77%
2019	100%	100%	100%
2020	100%	100%	100%

*Note: Percent of capacity filled is equal to the cumulative waste disposed as of July 1 of the indicated year divided by the total site capacity (5,552,280 tons).

As shown in Table 4-1, system expansions are projected to become effective in 2011, 2015, and after site closure in 2019. The percentages listed in Column D of the table represent the maximum potential collection system coverage achievable if a fully comprehensive collection system were installed and operated.

Additional discounts to system coverage to account for the expected level of skill and effort employed to operate and maintain the system to maximize recovery are described below.

For this evaluation, SCS has employed three system coverage scenarios in order to develop a range of estimates of predicted recovery with the proposed collection system. All three scenarios assume a comprehensive LFG collection system that will expanded into portions of the landfill as they become available, according to the schedule shown in Table 4-1. The system coverage estimates also assume that leachate accumulation will occur due to the relatively wet climate in Guatemala City, but that leachate management activities, including pumping out leachate accumulated in extraction wells, will be employed to limit the impact on LFG collection rates if leachate is encountered.

The three scenarios result in low, mid-range, and high projections and are as follows:

1. The low recovery scenario assumes that a moderate level of skill and effort is employed in the operation and maintenance of the collection system.

   System coverage is assumed to be 50 percent in areas available for well installation. This results in annual system coverage estimates that are equal to 50 percent multiplied by the percentages in Column D of Table 4-1. SCS considers the low recovery estimates to be conservative and should be employed only if a large margin of safety is needed.

2. The mid-range recovery scenario assumes that a moderately high level of skill and effort is employed in the operation and maintenance of the collection system.

   System coverage is assumed to be 70 percent in areas available for well installation. This results in annual system coverage estimates that are equal to 70 percent multiplied by the percentages in Column D of Table 4-1. SCS considers the mid-range recovery scenario to be its best estimates of likely recovery and recommends its use in the economic evaluation.

3. The high recovery scenario assumes that highest possible level of skill and effort is employed in the operation and maintenance of the collection system.

   System coverage is assumed to be 90 percent in areas available for well installation. This results in annual system coverage estimates that are equal to 90 percent multiplied by the percentages in Column D of Table 4-1. SCS considers the high recovery estimates to be ambitious and attainable only if the maintenance of an optimal LFG recovery system is considered to be a top priority.

It is important to note that, in addition to the potential variability in system coverage and the level of operation and maintenance, there is inherit uncertainty in the mathematical modeling of LFG itself. SCS considered (and tried to account for) this modeling uncertainty in selecting the values for the high and low recovery scenarios when estimating the LFG recovery potential.

Model Inputs--

For estimating the model parameters decay rate (k) and methane recovery capacity (Lo) for the landfill, SCS took into consideration the typical composition of waste buried in El Trébol Landfill. SCS compared site waste composition data from the landfill with USEPA's waste characterization data. These data are presented in Table 4-2.

One particularly important difference between the two sets of data is that the waste stream at the El Trébol Landfill contains significantly more food wastes (which are highly degradable) than typical U.S. wastes. Because food waste is so readily degraded, it produces LFG sooner, but over a shorter length of time. Therefore, a graph of LFG generation from wastes that are high in food waste, green waste, and other similar readily-degraded wastes will show a steeper slope in the LFG generation rate (reaching peak flows more rapidly), but a lower sustainable long term yield than the generation rate from waste with slower-degrading components. In the model, this effect is reflected in the parameter k.

Furthermore, the waste stream at the El Trébol Landfill contains both a higher organic fraction (per dry weight) than U.S. wastes and a higher level of moisture, primarily due to the food waste. The higher organic content will tend to increase the potential for methane generation per ton of waste. Conversely, however, the increased moisture content (which is inert) will tend to decrease the potential for methane generation per ton of waste. In the model, these effects are reflected in the parameter Lo. Because the waste disposal estimates used in this report already have been adjusted to account for waste moisture exceeding 20 percent (the average value for U.S. wastes), no further adjustment was made to the Lo to account for the higher moisture content of wastes disposed at El Trébol Landfill.

TABLE 4-2: COMPARISON OF WASTE COMPOSITION (%)

COMPONENTS	EL TRÉBOL LANDFILL[1]	TYPICAL U.S.[2]	DEGRADABILITY CATEGORY	DECAY RATE (K)
Food[3]	37.8	11.5	Fast	0.220
Green Waste[4]	6.3	5.6	Fast	0.220
Other Organic	0.0	1.6	Fast	0.220
Green Waste[4]	6.3	5.6	Medium	0.044
Paper	18.1	26.6	Medium	0.044
Wood	0.0	10.3	Slow	0.011
Rubber, Leather, Textiles, Bones	4.8	6.9	Slow	0.011
Plastics	10.1	9.7	Inert	0.0
Metals	2.2	5.4	Inert	0.0
Glass	1.6	5.3	Inert	0.0
Other Inorganic	12.8	11.4	Inert	0.0

See Notes to Table 4-2 on next page

Notes to Table 4-2:

1. El Trébol data is from Table 2.5 in "Programa de Modernizacion del Manejo de Desechos Solidos en la Ciudad de Guatemala"
2. U.S. data reflect 1995 MSW disposal data (source: USEPA, June 2002. Municipal Solid Waste in the United States: Facts and Figures - Table 3), with construction and demolition waste added (source: California Integrated Waste Management Board. 1999 California Statewide Waste Disposal Characterization Study)
3. Data provided included food and green waste in one category. SCS assumes that food comprises 75 percent of organic waste, and green waste comprises 25 percent of organics.
4. Assumes 50 percent of green waste is highly degradable (grass, etc.) and 50 percent of green waste is moderately degradable (branches, wood, etc.)

The specific approach for developing each parameter is discussed below.

Methane Recovery Potential--The Lo value used was derived by modifying an estimated Lo value for U.S. landfills based on the ratios of organic waste percentages of U.S. vs. El Trébol Landfill waste. Table 4-3 summarizes the calculation of the Lo value.

The value for the potential methane generation capacity (Lo) for the El Trébol Landfill was estimated to be 91.4 cubic meters per tonne (2,927 ft^3/ton).

TABLE 4-3: CALCULATION OF THE Lo VALUE

	U.S. LANDFILLS	EL TRÉBOL LANDFILL	RATIO: EL TRÉBOL / U.S.
Organic %	68.2%	73.3%	1.075
Dry Weight %	80.3%	80.0%	1.00
Lo value	85 m^3/Mg	**91.4 m^3/Mg**	1.075

Methane Decay Rate Constant--The k value reflects the fraction of refuse which decays in a given year and produces methane. An alternative approach to estimating a single k value for the entire landfill is to assign k values to different portions of the waste stream, based on their relative decay rates. Laboratory studies have suggested that fast-decaying organic refuse such as food waste typically decays at 5 times the rate of medium decay rate materials, such as wet paper, and 20 times the rate of slowly decaying components of the waste stream, such as textiles.[5] Because landfill moisture content significantly affects decay rates, the values of the decay rates for the fast, medium, and slow decaying waste fractions will vary with moisture as well. However, the relative rates of decay are expected to remain constant, despite varying landfill moisture.

The usefulness of evaluating decay rates for different waste components is that it provides a tool for comparing U.S. k values to k values at foreign landfills, which typically have significantly differing waste compositions. The procedure is based on the assumption that fast, medium, and slow decaying waste components will each have fixed k values for a given moisture regime in a

[5] Ehrig, Hans-Jürgen, "Prediction of Gas Production from Laboratory-Scale Tests." Landfilling Waste: LFG Edited by T.H. Christenson, R. Cossu and R. Stegmann, E & FN Spon, London: 1996.

landfill. Using average annual precipitation as a surrogate for landfill moisture conditions, fast, medium, and slow waste component k values can be developed for landfills with a given precipitation value, if a single overall k value is known for the entire landfill and can be used to calibrate the three k values.

SCS has developed a set of default k values that it employs when preparing LFG recovery projections for U.S. landfills for LMOP. The k values vary with average annual precipitation as follows: 0.02/year for sites experiencing less than 20 inches of precipitation per year; 0.04/year for sites experiencing 20-39 inches of precipitation per year; and 0.065 for sites experiencing 40 or more inches of precipitation per year. The procedure of developing k values for the El Trébol Landfill based on the appropriate U.S. k value for a landfill experiencing 119 centimeters per year (cm/year) of precipitation is as follows:

1. Prepare a single-k LFG model run using the El Trébol disposal data and the k value that would be appropriate for a U.S. site experiencing 47 inches per year (119 cm/year) of precipitation (0.065/year).

2. Using the percentages of fast, medium, and slow-decaying waste components in the U.S. waste stream and the El Trébol disposal data, prepare a multi-phased LFG model (summing the results of the fast, medium, and slow refuse decay calculations). Keeping the fast to medium to slow ratios constant, adjust the fast-decaying waste k value so that the resulting LFG recovery projection matches as closely as possible the results of the single k model run using the U.S. default k value. The resulting k values are to be used in a 3-k model run for El Trébol Landfill using the El Trébol waste composition percentages.

Results--The values for the three methane generation rate constants (k) used for modeling of LFG recovery at the El Trébol Landfill were as follows:

- Fast-decaying waste: 0.22 per year
- Medium-decaying waste: 0.044 per year
- Slowly-decaying waste: 0.011 per year

4.3 LANDFILL GAS MODELING RESULTS

SCS estimated both the LFG recovery potential at the landfill (essentially the amount of LFG SCS estimates to be available to be collected) and the expected LFG recovery rate (which accounts for the system coverage factor described above). As mentioned previously, the model results were compared with the results of the pump test to evaluate whether modifications to the model assumptions were required. The recovery projections and the comparison to the pump test results are described below.

LFG Recovery Potential

Using the assumptions outlined above, SCS estimates that the LFG recovery potential for the landfill in 2005 is 1,983 m^3/hour (1,167 cfm). This estimate can be compared with the 1,130 cfm estimate for the total recovery potential based on the results of the pump test, which represents the recovery rate that would be achieved if the LFG flows per ton of refuse within the volume of influence of the pump test well were applied to the total amount of waste available for LFG recovery. The pump test estimate is 37 cfm or about 3 percent lower than the model estimate. SCS considers a 3 percent difference to be acceptable given the level of precision of the pump test results. Based on the similarity of the pump test and model results, the model assumptions and results are generally supported by the pump test study.

The model projects that the LFG recovery potential will increase to 2,111 m^3/hour (1,243 cfm) in 2006, and will continue to increase to a peak of 3,568 m^3/hour (2,100 cfm) in 2018, the year that closure is projected to occur.

Expected LFG Recovery (Mid-Range Scenario)

SCS assumes that LFG recovery at the landfill will begin in 2006. After accounting for collection system coverage under the mid-range scenario, actual LFG recovery is projected to be 823 m^3/hour (484 cfm) in 2006. From 2007-2010, recovery is projected to decline slowly, reaching 749 m^3/hour (441 cfm), which reflects the assumption that no additional landfill areas become available for installing wells during this period. In 2011, LFG recovery is projected to increase to 1,464 m^3/hour (862 cfm), under the assumption that 50 percent of the landfill area will be closed and available for LFG extraction. Recovery is projected to slowly decline from 2012 until another portion of the landfill becomes available for development in 2015, and again decline in 2017 and 2018. LFG recovery is projected to reach a maximum rate of 2,482 m^3/hour (1,461 cfm) in 2019, one year after site closure, when all areas of the landfill are available for collection system installation and coverage is maximized (under the mid-range scenario) at 70 percent.

Assuming that 100 percent of the amount of LFG recovered is available for use for electrical generation (i.e., not accounting for available engine capacities or parasitic loads), a 1.3 MW power plant could be supported from 2006 through 2010, and a 2.3 MW plant could be supported from 2011 through 2022. Table 4-4 presents a summary of the projected potential LFG recovery rates, actual LFG recovery rates under the mid-range scenario, and corresponding power plant sizes for 2006-2020.

Tables 1 through 4 in Appendix B provide detailed results of the LFG modeling, including the following:

- Estimated annual disposal rates and waste in place values.
- The projected LFG recovery potential through 2030 (in m^3/hour, cfm, and mmBtu/hour).
- The k values used for the fast, medium, and slowly decaying waste fractions.

TABLE 4-4: SUMMARY OF LFG MODELING RESULTS UNDER THE MID-RANGE RECOVERY SCENARIO - EL TRÉBOL LANDFILL

Year	Potential LFG Recovery Rate (m^3/hour)	Estimated System Coverage (%)	Projected Actual LFG Recovery Rate (m^3/hour)	Projected Actual LFG Recovery Rate (mmBtus/yr)	Projected Maximum Project Capacity (MW)
2006	2,111	39%	823	128,838	1.4
2007	2,234	36%	805	125,963	1.4
2008	2,355	33%	786	123,039	1.3
2009	2,473	31%	768	120,144	1.3
2010	2,590	29%	749	117,322	1.3
2011	2,707	54%	1,464	229,224	2.5
2012	2,824	51%	1,431	224,046	2.4
2013	2,943	48%	1,400	219,133	2.4
2014	3,063	45%	1,370	214,494	2.3
2015	3,186	63%	2,013	315,167	3.4
2016	3,310	60%	1,974	308,969	3.3
2017	3,438	56%	1,937	303,132	3.3
2018	3,568	54%	1,913	299,493	3.2
2019	3,546	70%	2,482	388,599	4.2
2020	3,001	70%	2,101	328,837	3.5

- The Lo value calculated for all wastes and the Lo value used in the model runs for the organic portion of the waste only (equal to the calculated Lo value divided by the fraction of organic waste).

- Annual collection system coverage estimates under the low-range, mid-range, and high-range recovery scenarios.

- Predicted LFG recovery under each of the three scenarios after accounting for system coverage (in m^3/hour, cfm, and mmBtu/hour).

- The maximum electrical power plant size (in MW) that can be supported by the predicted LFG recovery rates under each scenario.

- Estimated emission reductions based on the predicted LFG recovery rates under each scenario.

The projected LFG recovery potential and predicted LFG recovery rates under the low-range, mid-range, and high-range scenarios are also shown graphically in Figure 1 of Appendix B.

SECTION 5.0
LANDFILL GAS COLLECTION AND UTILIZATION SYSTEM

5.1 INTRODUCTION

This section covers the components of the LFG collection and utilization system. Based on the evaluation of the potential for LFG recovery at the El Trébol Landfill in Section 4, the quantity of recoverable LFG appears to be sufficient for developing a system to utilize LFG as a fuel source for on-site electrical generation or for direct use in an off-site industrial facility. Electricity generated at the LFGE facility can provide cost savings from avoided electricity purchases for on-site energy needs and revenues from the sale of unused electricity to the local power grid. The sale of LFG for direct use at a nearby industrial facility can generate significant revenues while requiring less initial facility costs than an LFGE facility.

In order to ensure the combustion of all collected LFG, and to maximize the amount of GHG emission reductions achieved, any LFG not combusted in the LFGE facility or delivered off site for use in an industrial facility will be burned in a flare. Additional GHG emission reductions can be realized from an LFGE project to the extent that fuel sources normally employed for electricity generation are displaced by the use of methane in the LFGE facility.

5.2 COLLECTION AND CONTROL SYSTEM COMPONENTS

The landfill does not currently have a landfill gas collection system. Therefore, an active LFG collection and control system including new wells and an enclosed flare is assumed for the cost analysis in this report.

To maximize LFG recovery rates, the collection system should be installed comprehensively over closed landfill areas and inactive areas of the landfill at intermediate grade. In estimating the potential LFG recovery rates (and emission reductions), SCS assumed that construction of the gas collection and control system would occur in 2006. Start-up of the collection and flaring system is assumed to occur in mid-2006. Start-up of the LFGE facility or first delivery of the LFG to an off-site end user is assumed to occur in January 2007.

5.3 INITIAL COLLECTION AND CONTROL SYSTEM CONSTRUCTION

<u>Collection and Control System Components</u>

SCS has the following general recommendations for the LFG collection system:

- Initial installation of approximately 10 vertical extraction wells (approximately 1 well per acre). This will be followed by the installation of 10 more wells in 2010/2011, another 10 wells in 2014/2015, and finally 10 more wells in 2018/2019, according to the assumed schedule for areas of the landfill becoming available (as shown in Table 4-1). Once available, operational data can be used to evaluate the well spacing by assessing flow rates from individual wells and the range of vacuum influence exerted by the wells.

The pump test data indicated that the ROI of the extraction wells at the El Trébol Landfill is approximately 35 meters, or approximately 1.5 times well depth. SCS used this site-specific ROI for developing the estimated number and depth of wells required.

For budgetary purposes, SCS assumes that each extraction well would be fitted with a wellhead with a flow control valve and gas monitoring ports.

- Initial installation of approximately 1,100 meters of HDPE piping to connect the extraction wells with the flare station and LFG control plant. This piping includes main gas header piping designed to accommodate greater gas flow rates, and smaller lateral gas piping designed to connect the main header piping to the extraction wells. Another 1,100 meters of HDPE piping is assumed to be required for each subsequent phase of wellfield expansion, resulting in a total of 4,400 meters of HDPE piping to be installed.

  For budgetary purposes, SCS assumes that the header piping will be 350 mm in diameter, and the lateral piping will be 110 mm in diameter.

- Installation of a condensate management system. Condensate, which forms in the LFG piping network as the warm gas cools, can cause significant operational problems if not managed properly. The LFG collection system must be designed to accommodate the formation of condensate. SCS presumes that this will be accomplished through a series of self-draining condensate traps located within the waste footprint.

  For budgetary purposes, SCS assumes that a total of 5 self-draining condensate traps and two condensate manholes with pumps will be required by 2019, with one condensate trap and one manhole assumed for the initial collection system installation in 2006.

- Installation of a blower and flaring station. While SCS expects that the primary operational scenario will be LFG utilization, it is anticipated that a significant fraction of recovered LFG will not be utilized and must be combusted in an alternative control device. Also, the flare will provide backup control equipment to allow continued emission reduction during periods of downtime or maintenance of the utilization equipment.

  SCS has assumed that the flaring system will be an enclosed-type flare so that exhaust components can be tested and quantified, if applicable, for registration of emission reductions (exhaust testing is not possible on candlestick-type open flares).

  For budgetary purposes, SCS has assumed that the initial system construction would include installing approximately 2,550 cubic meters per hour (1,500 cfm) of gas flaring capacity and blower equipment. This capacity is sufficient to approximately handle the maximum projected LFG recovery rate (which will occur in 2019).

- Installation of an LFG utilization plant under the LFGE project option. For budgetary purposes, SCS has assumed that the initial system construction would include installing a reciprocating engine generator set with a gross capacity of 1.06 MW (one 1.06 MW engines). This facility will require approximately 641 m^3/hour (377 cfm) to operate at full capacity. In 2011, it is estimated that there will be sufficient LFG to power a second 1.06

MW engine for all remaining project years (at least through 2020). SCS has assumed that some pre-treatment of the LFG will be required to remove moisture.

Combustion gas turbines have also been used successfully for LFG-fired electric power generation. However, combustion turbines require a high-pressure fuel supply and typically two stages of gas compression, which results in a higher net heat rate and higher capital costs (turbines do, however, generally have lower emission of combustion products [primarily NOx] and lower costs for operation and maintenance than I.C. engines). Most small LFG power plants employ reciprocating engines.

An additional advantage of reciprocating engines is that the units are available in many different incremental capacities, which makes it easy to tailor the size of small plants to the specific rate of gas production at a landfill. Furthermore, engines are typically more accommodating of modular plant expansion/contraction as gas flow increase or decrease. Based on these factors, SCS feels that reciprocating engines may be more appropriate for the El Trébol LFGE project than turbines.

- Installation of a gas filter, compressor, de-hydration unit, and pipeline for delivering LFG to potential end-users under the direct use project option. Based on the projected amount of LFG available starting in 2007, the initial amount of LFG available to be delivered to end-user facilities under this project scenario is estimated to be about 749 m^3/hour (441 cfm). After 2010, LFG recovery is projected to increase to allow delivery of at least 1,464 m^3/hour (862 cfm) through 2020.

Collection System Expansion and Maintenance

In order to maintain a high level of efficiency for the LFG collection system, and thus maximize LFG recovery rates and emission reductions, it will be necessary to expand the collection system, and to implement a regular program of operation and maintenance of the gas collection system equipment. As noted previously, it is assumed that future wellfield expansions will occur to collect LFG from portions of the landfill as they become closed and available for development, according to the schedule described in Table 4-1.

Following system start-up, operational data should be reviewed with respect to the system design criteria, and adjustments made during future system expansions as appropriate. Adjustments to the wellfield layout that are indicated by operating data may include the following:

- Wells that are unproductive or are damaged will need to be repaired or replaced.
- Areas of the landfill where monitoring data indicate a surplus of LFG may yield higher recovery rates if additional wells are installed.
- Ongoing monitoring of leachate levels in wells will indicate whether or not additional leachate pumps are required.

SECTION 6.0
EVALUATION OF PROJECT COSTS

For purposes of evaluating the project economics, SCS estimated the capital costs for development of an LFG recovery system and two alternative utilization projects at the landfill. SCS also estimated the expected annual costs for operation, maintenance, and regular expansion of the LFG collection system.

6.1 LANDFILL GAS COLLECTION AND FLARING SYSTEM COSTS

Budgetary Construction Cost Estimate

SCS estimates the budgetary cost for the initial LFG collection and flaring system construction to be $721,800 (U.S.). These are costs associated with the proposed gas collection system described previously, including: gas extraction wells, header and lateral piping, condensate management, and installation of a blower and enclosed flaring station.

Table 6-1 presents a summary of the cost items. A more detailed outline of these costs and their associated quantities is presented in Appendix C.

TABLE 6-1: BUDGETARY COSTS FOR INITIAL LFG COLLECTION AND CONTROL SYSTEM

ITEM	TOTAL ESTIMATED COST (U.S. $)
Mobilization and project management	$40,000
Vertical extraction wells and wellheads (10 wells @ 30 m avg. depth)	$127,000
Leachate pumping equipment (for 50% of wells)	$25,000
Main gas header collection piping (assume about 775 meters of 350 mm diameter) and road crossing (for header leading to flare station)	$112,000
Lateral piping (assume about 325 m of 110 mm diameter)	$9,800
Condensate management	$35,000
Blower and flaring equipment (enclosed flare)(1)	$285,000
Engineering/Contingency, and Up-Front (Pre-Operational) CDM Costs(2)	$88,000
TOTAL ESTIMATED COST	**$721,800**

Notes: 1. Blower and flaring equipment includes: blower and flare, construction and site work, LFG measurement and recording equipment, flare start-up costs, and emissions testing
2. Pre-operational CDM costs include: preparation of PDD, registration, validation, and legal fees

Budgetary Estimate for Annual Operation and Maintenance

SCS estimates the budgetary cost for annual operation and maintenance of the gas collection system, excluding wellfield expansions, to be approximately 10% of the initial construction costs, or about $72,000 (U.S.) prior to inflation adjustments. These costs include those associated with operation and maintenance of the existing collection system such as labor, testing equipment and parts, routine maintenance and system repairs, and replacement of existing wells and piping. System O&M costs are expected to increase as a result of system expansions (as well as inflation), and then decrease following landfill closure in 2018 due to decreased repair and well replacement needs. This annual O&M cost does not include costs associated with the process of obtaining emission reductions, including registration fees, and monitoring and verification of the emission reductions. These costs are estimated to be $30,000 (U.S.) prior to inflation adjustments.

In addition to these costs, SCS estimates the budgetary cost for wellfield expansions to be approximately $355,000 (U.S.) in 2010, $390,000 in 2014, and $355,000 in 2018 (prior to inflation adjustments). These costs are for the installation of 10 wells, associated header and lateral piping, and one additional condensate trap in 2010 and 2018, and 10 wells, associated header and lateral piping, two additional condensate traps, and one condensate manhole in 2014.

6.2 ELECTRICAL GENERATION PROJECT COSTS

SCS evaluated the projected capital and annualized costs for implementing an LFG-fueled IC engine power plant. These costs are presented below.

Budgetary Estimate of Initial Plant Cost

SCS estimates that the initial cost for implementing an LFG-fueled 1.06 MW (gross) IC engine power plant to be approximately $2,014,400 (U.S.). This cost is additional to the LFG collection and flaring system. A second 1.06 MW engine is assumed installed in 2010 for $1,200,000 (prior to inflation).[6] LFG recovery projections indicate that there should be sufficient LFG to support a 2.12 MW power plant from 2011 through 2020.

Table 6-2 presents a summary of the initial cost items. A more detailed outline of the initial costs and their associated quantities is presented in Appendix C.

TABLE 6-2: BUDGETARY COSTS FOR IC ENGINE POWER PLANT

ITEM	TOTAL ESTIMATED COST ($)
Mobilization	$100,000
Plant construction/sitework (incl. piping)	$114,400
LFG measuring and recording equipment	$35,000
2.12 MW LFG-fueled power plant *	$1,060,000
Electrical Interconnection	$500,000
Source Test	$25,000
Engineering/Contingency (~10% of other costs)	$180,000
TOTAL ESTIMATED COST	**$2,014,400**

[6] Includes $1.06 million for the engine, plus costs of construction work/piping, source test, and 10% engineering and contingency.

*Note to Table 6-1: Plant costs assume containerized engine generators with no other building for this equipment

<u>Budgetary Estimate for Annual Operation and Maintenance</u>

SCS estimates the budgetary cost for annual operation and maintenance of the power plant to be approximately 1.8 cents per kilowatt-hour of electricity output, or about $140,000 per year (based on initial capacity and prior to inflation adjustments). These costs include those associated with operation and maintenance of the power plant such as labor, testing equipment and parts, routine maintenance and repairs, and minor equipment replacement. Other annual costs such as wellfield O&M and project monitoring and emission reduction verification are included in the collection and flaring system annual O&M costs.

6.3 DIRECT USE PROJECT COSTS

SCS evaluated the projected capital and annualized costs for implementing a direct use project to deliver LFG to end-users up to 2 miles from the landfill. These costs are presented below.

<u>Budgetary Estimate of Initial Plant Cost and Ongoing Costs</u>

Using LMOP's LFGCost tool and adding mobilization costs, SCS estimates that the initial cost for implementing a direct use project to deliver LFG to potential end-user facilities to be approximately $935,000 (U.S.). This cost is additional to the LFG collection and flaring system and does not include any costs that might be required for modifications to the existing equipment at the end users' facilities.

Table 6-3 presents a summary of the initial cost items.

TABLE 6-3: BUDGETARY COSTS FOR DIRECT USE PROJECT

ITEM	TOTAL ESTIMATED COST ($)
Mobilization	$50,000
Skid-mounted Filter, Compressor, and Dehydration Unit	$200,000
2.2-mile Pipeline to Convey Gas to Project Sites	$600,000
Engineering/Contingency (~10% of other costs)	$85,000
TOTAL ESTIMATED COST	**$935,000**

Annual operating and maintenance costs include pipeline and compressor station maintenance, and electricity costs for running the compressor station. For the first year of operation (2007), these costs are estimated using the LFGCost model at approximately $45,000 and $55,000, respectively, for a total of $100,000.

SECTION 7.0
ECONOMIC EVALUATION

The economics of implementing either a gas recovery and utilization project or a direct use project at the landfill were evaluated using the projected capital and annualized costs outlined in Section 6, and anticipated revenues described below.

For purposes of this evaluation, SCS assumed that the revenue streams include those associated with the sale or offset of electricity or LFG (under either project scenario) as well as revenues associated with GHG emissions reductions (i.e., the purchase of emissions reductions).

A summary of the economic evaluation and assumptions is presented below. More detailed analysis of the economics is presented in Appendix D.

7.1 SUMMARY OF ASSUMPTIONS

The following general assumptions were used in evaluating the project economics:

- The economic evaluation was performed for a 15-year period (2006 -2020).
- Two financing options were considered, one with no financing of capital expenditures (i.e., 100% initial application of capital expenditures), and one with financing of 75 percent of initial capital expenditures (25% equity investment).
- Two scenarios for the pricing of emission reductions were considered, with sales prices of $5 and $6 per CO_2e through 2012.
- An interest rate of 8 percent is used for both the NPV analysis and the loan financing.
- Initial investment for the LFG collection and flaring system, the power plant, and direct use facilities is assumed to occur in 2006. Loan payback period is assumed to be 10 years.
- For purposes of this analysis, payment of approximately 20 percent of the emission reduction revenue to the landfill owner for use of LFG was considered (represented by a rate of $0.35/MMBtu). This is based on international experience that payment to the landfill owner for LFG typically ranges between 10 and 30 percent of the emission reduction revenue. If the landfill owner were to self develop the project (which is not typical) this value could be assumed to be zero.
- Annual escalation rate of 3 percent for purchase of LFG.
- Future O&M and system upgrade expenditures escalate at an annual rate of 3 percent.

- Under the power plant (LFG utilization) scenario, the following assumptions apply:
  - The plant will consist of one 1.06 MW IC engine that will be operational from 2007 through 2010, and two 1.06 MW engines that will be operational from 2011 through the end of the project period (2020).
  - A 7 percent reduction in electricity output by the plant was assumed to account for parasitic load, and a plant capacity factor of 90 percent was assumed to account for routine and non-routine plant downtime. Landfill gas collected during plant downtime will be routed to the flare for combustion.
  - All electricity generated by the project is assumed to be sold off-site.[7]
- Under the direct use scenario, the following assumptions apply:
  - One or more direct use projects will be implemented that will be operational from 2007 through the end of the project period (2020). A total of 2.2 miles of pipeline is assumed to be built to deliver the LFG to potential end-user facilities.
  - A facility capacity factor of 90% is used to account for facility downtime for problems with project equipment, weather related interruptions of the local utilities, and shut-downs at the energy consumer end of the system.
  - Although LFG is combusted off-site, revenues from emission reductions will be retained by the project developer.
- The gas collection system and flare will be operational from mid-2006 through the end of the project period. The flare will be used to combust excess gas under both utilization scenarios.

7.2 PROJECT EXPENDITURES

The following project expenditures were considered under the power plant scenario:

- Initial capital investment for LFG collection system, flare, and power plant in 2006 (see Section 6).
- Purchase of LFG from landfill owner.
- Annual cost for operation and maintenance of the LFG collection system, flare, and power plant (see Section 6).
- Expansion of the collection system in 2010, 2014, and 2018.

The following project expenditures were considered under the direct use scenario:

[7] Use of generated electricity to meet on-site power needs would provide increased cash flows since electricity is typically purchased from utilities at a higher price than the utilities will pay for the electricity generated by the project.

- Initial capital investment in 2006 for LFG collection system and flare; filter, compressor, and dehydration unit; and 2.2 miles of pipeline (see Section 6).

- Purchase of LFG from the landfill owner.

- Annual cost for operation and maintenance of the LFG collection system, flare, compressor station, and pipeline (see Section 6).

- Expansion of the collection system in 2010, 2014, and 2018.

7.3 PROJECT REVENUES

For the economic evaluation, the following project revenues were considered under the power plant scenario:

- The power plant produces a total of 7,772 MWh/year from 2007-2010 and 15,544 MWh/year from 2011-2020, which is sold to the power grid at a rate of U.S. $0.06/kWh based on the average estimated wholesale electricity sales price in Guatemala as of July 2005.[8]

- GHG emission reductions are sold at a rate of U.S. $5 or $6 per tonne CO2e.

- It was assumed that LFG collected in excess of the power plant capacity, along with LFG collected during plant downtime, is combusted in the flare.

For the economic evaluation, the following project revenues were considered under the direct use scenario:

- The direct use projects produce a total of 105,557 mmBtu/year from 2007-2010 and 193,162 mmBtu/year from 2011-2020, which is sold to the end-users at a rate of U.S. $5.00/mmBtu. The basis for the price assumption is limited. No pricing information has yet been provided by the two industrial end-users which have expressed interest in purchasing the LFG.

- GHG emission reductions are sold at a rate of U.S. $5 or $6 per tonne CO2e.

- It was assumed that LFG collected in excess of the amounts delivered to the two facilities is combusted in the flare.

Appendix D presents a more detailed summary of the anticipated project revenue streams.

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8 Source: Administrador del Mercado Mayorista (AMM), which is the federal agency responsible for the operation of electrical generating plants in Guatemala (www.amm.org.gt).

7.4 SUMMARY OF ECONOMIC EVALUATIONS

Power Plant Scenario

Table 7-1 presents a summary of the results of the economic evaluation under the power plant scenario, presenting a general comparison of the various financing and emission reductions sales price scenarios using the estimated net present value (NPV) and the internal rate of return (IRR) of the project. These values include revenues from both GHG emissions reductions and from LFG project utilization revenue. The results are presented on a pre-tax basis.

TABLE 7-1: SUMMARY OF ECONOMIC EVALUATION UNDER THE POWER PLANT SCENARIO

Project Period	Emission Reduction Price ($/tonne)	Equity Investments (%)	Net Present Value (x1,000 $)	Internal Rate of Return (%)
2006 - 2020	5	100	$1,519	15.3%
2006 - 2020	6	100	$1,819	17.0%
2006 - 2020	5	25	$1,364	25.3%
2006 - 2020	6	25	$1,664	31.0%

As shown in Table 7-1, economics for the power plant project appear attractive under all emission reduction price and loan financing scenarios evaluated. Project financing appears to lower the NPV slightly while increasing the IRR.

Direct Use Scenario

Table 7-2 presents a summary of the results of the economic evaluation under the direct use scenario, presenting a general comparison of the various financing and emission reduction sales price scenarios using the estimated NPV and IRR of the project. These values include revenues from both GHG emissions reductions and from LFG project utilization revenue. The results are presented on a pre-tax basis.

As shown in Table 7-2, economics for the direct use project appear attractive under all emission reduction price and loan financing scenarios. Project financing appears to lower the NPV slightly but substantially increases the IRR.

TABLE 7-2: SUMMARY OF ECONOMIC EVALUATION UNDER THE DIRECT USE SCENARIO

Project Period	Emission Reduction Price ($/tonne)	Equity Investments (%)	Net Present Value (x1,000 $)	Internal Rate of Return (%)
2006 - 2020	5	100	$4,268	39.4%
2006 - 2020	6	100	$4,569	42.9%
2006 - 2020	5	25	$4,171	88.3%
2006 - 2020	6	25	$4,773	103.2%

Summary of Economic Evaluation Results

Tables 7-1 and 7-2 provide information regarding the advantages and disadvantages of the power plant and direct use project scenarios. For the assumptions stated above, it appears that development of a LFG utilization project at the landfill is economically feasible if the project consists of either a power plant or a direct use project.

These results suggest the following:

- Emission reduction price differences appeared to have a moderate impact on the power plant project economics, but had a limited effect on direct use project economics.

- The revenue stream from electricity sales from a power plant project and from sales of emission reductions is large enough to create favorable project economics.

- The costs of a direct use project are relatively moderate while generating revenues that are comparable to a power plant project, making a direct use project the most economically favorable project scenario evaluated. It should be noted, however, that the outcome of the economic evaluation of the direct use project is sensitive to assumptions regarding the price received for LFG, which is subject to change pending the receipt of information from the end users.

- Project economics appears to be positively influenced by the assumption that the project size is expanded in 2011. If the second I.C. engine is not added in 2011 and electrical output remains at 2007 levels, power plant economics were found to be poor (negative NPV and IRR values under most scenarios). The direct use project is less economically favorable if there are no LFG flow increases to the project in 2011, although the effects were not as dramatic as with the power plant project (NPV and IRR values remained strongly positive under all scenarios).

SECTION 8
ENVIRONMENTAL BENEFITS

8.1 GREENHOUSE GAS EMISSIONS REDUCTIONS

SCS estimated the potential GHG emission reductions associated with a LFG recovery project at the landfill (in metric tons of methane/year and metric tonnes of CO_2 equivalent/year using a methane/CO_2 equivalency factor of 21) for the evaluation period. Table 8-1 presents a summary of the GHG emission reduction projections for the period through 2020.

The projections shown in Table 8-1 assume that all of the LFG recovered through the proposed projects is combusted, and does not consider additional greenhouse gas emission reductions associated with the displacement of other fuels sources through electricity generation or direct use.

TABLE 8-1: SUMMARY OF PROJECTED GHG EMISSION REDUCTIONS

YEAR	PREDICTED GHG REDUCTIONS (TONNES CO_2E/YEAR)
2006	24,769
2007	48,433
2008	47,309
2009	46,196
2010	45,111
2011	88,138
2012	86,147
2013	84,258
2014	82,474
2015	121,183
2016	118,800
2017	116,556
2018	115,157
2019	149,419
2020	126,440
TOTAL FOR PERIOD =	**1,300,392**

8.2 ENVIRONMENTAL BENEFITS FROM LANDFILL GAS UTILIZATION

Environmental benefits resulting from LFG utilization include indirect emission reductions from the displacement of conventional fuels as well as direct emission reductions from the combustion of LFG at the power plant or industrial facility. The environmental benefits can be described in a variety of ways which are listed below.

For a power plant with a capacity of 2.12 MW[9], annual environmental benefits include a reduction of 3,444 metric tonnes of methane from LFG combustion (direct benefit) and the displacement of 10,026 metric tonnes of CO_2 emissions from conventional energy sources (indirect benefit). These benefits are equivalent to the following:

- Removing emissions equivalent to 16,468 cars
- Planting 22,254 acres of forest
- Offsetting the use of 369 railcars of coal
- Preventing the use of 175,191 barrels of oil
- Powering 1,406 homes per year.

For a direct use project utilizing 193,162 mmBtu of LFG per year, annual environmental benefits include a reduction of 4,035 metric tonnes of methane from LFG combustion (direct benefit) and the displacement of 9,979 metric tonnes of CO_2 emissions from conventional energy sources (indirect benefit). These benefits are equivalent to the following:

- Removing emissions equivalent to 18,944 cars
- Planting 25,600 acres of forest
- Offsetting the use of 425 railcars of coal
- Preventing the use of 201,531 barrels of oil
- Heating 5,871 homes per year.

[9] Assumes 10,800 Btu/kWh, 7% parasitic load, and 10% facility down time (90% utilization).

SECTION 9
CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS AND RECOMMENDATIONS

The El Trébol Landfill is a fairly large landfill with over 10 years of waste filling remaining. As such, the projected gas recovery and emission reductions (and thus potential revenues from energy and emission reduction sales) are significant.

Based on the results of the economic analysis, it appears that development of an LFG utilization project at the landfill is economically feasible under either of the following two scenarios:

- A direct use project with sales of approximately 105,560 mmBtu per year from 2006-2010 and 193,160 mmBtu per year from 2011-2020; or
- An LFGE project with a 1.06 MW gross capacity from 2006-2010 and a 2.12 MW gross capacity from 2011-2020.

Both the NPV and the IRR values were highest for the direct use project under all scenarios analyzed, given the assumed LFG sales price of $5 per mmBtu. The power plant project also had positive NPV and IRR values, but was less economically attractive than the direct use project due to the substantially higher construction costs for a power plant project (total capital costs over the lifetime of the project of about $5.57 million including the gas collection and flaring system vs. $3.1 million for the direct use project). Projected revenues from both projects were found to be approximately equal.

Note that the economic analysis essentially indicates the cash flow to the project developer (assumed to be a third party). The revenue to the landfill owner is represented by the sale of LFG at $0.35 per mmBtu. Adjustments to this rate have a significant impact on the cash flow to the developer. At this pre-feasibility phase, negotiable parameters such as this cannot be further refined.

The results of this study are based on limited contingency factors included in the cost estimates for capital and O&M. To the best of our knowledge there are no existing LFGE projects at present in Guatemala. As such, no basis for comparison exists to verify the cost and revenue assumptions. It is possible that further refinement of some of the assumptions used in the economic evaluation may change the results of this pre-feasibility analysis.

APPENDIX A

SUMMARY OF PUMP TEST RESULTS

EXTRACTION WELLS

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Pressure (in. w.c.)	LFG Flow (cfm)
Well W-1						
26-Jul-05	56.4	42.3	0.1	1.2	0.0	0.0
29-Jul-05	53.8	42.2	0.7	3.3	-4.3	24.0
29-Jul-05	54.5	42.9	0.6	2.0	-3.2	19.0
30-Jul-05	54.5	41.6	0.6	3.3	-4.7	26.0
30-Jul-05	55.0	41.6	0.3	3.1	-5.7	32.0
30-Jul-05	54.1	42.3	0.3	6.0	-6.5	38.0
30-Jul-05	53.6	41.6	0.7	4.1	-9.2	43.0
1-Aug-05	54.6	42.0	0.5	2.9	-9.8	38.0
1-Aug-05	53.8	41.9	0.7	3.6	-11.0	48.0
1-Aug-05	52.9	41.2	0.7	5.2	-15.4	52.0
2-Aug-05	54.3	41.7	0.6	3.4	-12.0	43.0
2-Aug-05	53.5	41.0	0.7	4.8	-17.7	55.0
2-Aug-05	52.3	41.8	0.8	5.1	-19.4	60.0
3-Aug-05	50.4	41.1	0.6	7.9	-23.8	68.0
3-Aug-05	49.3	41.7	0.6	8.4	-23.1	60.0
3-Aug-05	48.8	41.9	0.8	2.5	-24.5	55.0
4-Aug-05	47.8	40.6	0.6	11.0	-28.6	56.0
4-Aug-05	46.6	41.2	0.6	11.6	-19.2	50.0
4-Aug-05	46.0	41.4	0.8	11.8	-19.0	49.0
5-Aug-05	47.0	40.5	0.6	11.9	-19.2	48.0
5-Aug-05	46.0	41.3	0.6	12.1	-19.0	46.0
8-Aug-05	47.7	40.0	0.7	11.6	-14.0	47.0
8-Aug-05	48.5	40.6	0.2	10.7	-18.8	46.0
8-Aug-05	47.2	40.6	0.6	11.6	-12.8	46.0
9-Aug-05	47.3	40.3	0.7	11.7	-14.2	49.0
9-Aug-05	47.5	40.2	0.6	11.7	-14.2	48.0
9-Aug-05	47.0	40.4	0.6	12.0	-15.0	45.0
29-Jul-05	54.2	42.6	0.7	2.7	-3.8	21.5
30-Jul-05	54.3	41.8	0.5	4.1	-6.5	34.8
1-Aug-05	53.8	41.7	0.6	3.9	-12.1	46.0
2-Aug-05	53.4	41.5	0.7	4.4	-16.4	52.7
3-Aug-05	49.5	41.6	0.7	6.3	-23.8	61.0
4-Aug-05	46.8	41.1	0.7	11.5	-22.3	51.7
5-Aug-05	46.5	40.9	0.6	12.0	-19.1	47.0
8-Aug-05	47.8	40.4	0.5	11.3	-15.2	46.3
9-Aug-05	47.3	40.3	0.6	11.8	-14.5	47.3

EXTRACTION WELLS

	Methane	Carbon Dioxide	Oxygen	Balance	Pressure	LFG Flow
Date	(%)	(%)	(%)	(%)	(in. w.c.)	(cfm)
Well W-2						
26-Jul-05	19.3	14.7	13.3	52.7	0.0	0.0
29-Jul-05	3.2	4.3	18.6	73.9	0.0	0.0
29-Jul-05	2.4	3.8	19.1	74.7	0.0	0.0
30-Jul-05	5.7	6.8	17.6	69.9	0.0	0.0
30-Jul-05	3.7	5.2	18.2	72.9	0.0	0.0
30-Jul-05	2.9	9.2	17.2	70.7	0.0	0.0
30-Jul-05	3.3	5.9	17.1	73.7	0.0	0.0
1-Aug-05	32.1	29.8	5.3	32.8	0.0	0.0
1-Aug-01	35.8	34.8	3.9	25.5	0.0	0.0
1-Aug-05	22.5	28.5	5.6	43.4	0.0	0.0
2-Aug-05	23.3	28.4	5.4	42.9	0.0	0.0
2-Aug-05	23.1	30.3	4.7	41.9	0.0	0.0
2-Aug-05	32.4	31.8	3.9	34.9	-4.2	0.0
3-Aug-05	42.4	34.4	2.4	20.8	-28.1	0.0
3-Aug-05	44.0	36.0	2.0	18.0	-28.0	0.0
3-Aug-05	44.7	35.8	2.1	17.4	-28.4	0.0
4-Aug-05	47.5	34.3	2.0	16.2	-29.4	0.0
4-Aug-05	41.0	31.9	2.8	24.3	-30.8	0.0
4-Aug-05	37.0	29.5	3.9	29.6	-30.8	0.0
5-Aug-05	40.7	31.7	2.4	25.5	-31.8	0.0
5-Aug-05	33.0	28.5	3.6	34.9	-32.7	0.0
8-Aug-05	33.5	27.6	3.9	35.0	-32.6	0.0
8-Aug-05	33.8	34.1	3.0	29.1	-30.8	0.0
8-Aug-05	33.6	30.9	3.3	32.2	-31.0	0.0
9-Aug-05	37.7	30.0	3.6	28.7	-32.4	0.0
9-Aug-05	38.8	29.9	3.4	27.9	-33.2	0.0
9-Aug-05	34.4	28.9	3.7	33.0	-33.2	0.0

EXTRACTION WELLS

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Pressure (in. w.c.)	LFG Flow (cfm)
Well W-3						
26-Jul-05	52.6	45.2	0.2	2.0	0.0	0.0
29-Jul-05	56.3	40.5	0.2	3.0	-7.1	0.0
29-Jul-05	56.0	39.5	0.5	4.0	-8.7	5.0
30-Jul-05	57.3	39.3	0.2	3.2	-8.6	0.0
30-Jul-05	57.4	39.4	0.1	3.1	-38.3	0.0
30-Jul-05	56.4	40.7	0.3	2.6	-37.1	0.0
30-Jul-05	55.7	38.8	0.6	4.9	-32.9	0.0
1-Aug-05	57.3	39.7	0.2	2.8	-33.4	0.0
1-Aug-05	56.8	39.0	0.6	3.6	-31.0	2.0
1-Aug-05	56.6	38.6	0.6	4.2	-25.4	0.0
2-Aug-05	58.3	39.0	0.2	2.5	-17.4	0.0
2-Aug-05	57.5	37..7	0.6	4.2	-25.2	0.0
2-Aug-05	56.8	38.0	0.7	4.5	-24.3	0.0
3-Aug-05	57.6	38.0	0.3	4.1	-28.6	0.0
3-Aug-05	57.3	37.7	0.7	4.3	-28.9	0.0
4-Aug-05	60.3	36.9	0.1	2.7	-29.0	0.0
4-Aug-05	59.2	37.1	0.2	3.5	-30.1	5.0
4-Aug-05	59.1	36.7	0.6	3.6	-30.6	0.0
5-Aug-05	60.9	26.4	0.2	22.5	-30.5	0.0
5-Aug-05	59.2	35.9	0.6	4.3	-35.1	0.0
8-Aug-05	60.0	34.7	0.6	4.7	-33.6	0.0
8-Aug-05	60.2	35.7	0.1	4.0	-30.6	0.0
8-Aug-05	59.1	34.7	0.5	5.7	-30.6	0.0
9-Aug-05	59.3	34.1	0.6	6.0	-31.6	0.0
9-Aug-05	59.5	34.6	0.5	5.4	-32.4	0.0
9-Aug-05	58.7	34.5	0.5	6.3	-31.8	0.0

PUMP TEST MONITORING DATA FOR W-1 PROBES

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in w.c.)
Probe 1-A (5 meters from W-1)					
26-Jul-05	55.9	42.5	0.1	1.5	0.0
29-Jul-05	56.6	42.4	0.2	0.8	0.0
29-Jul-05	56.6	42.3	0.3	0.8	0.0
29-Jul-05	53.5	39.3	0.6	6.6	0.0
29-Jul-05	55.9	42.5	0.2	1.4	0.0
30-Jul-05	56.1	41.4	0.2	2.3	0.0
30-Jul-05	56.4	42.0	0.2	1.4	0.0
30-Jul-05	55.5	41.8	0.6	2.1	0.0
30-Jul-05	55.4	41.4	0.6	2.6	0.0
1-Aug-05	55.7	41.8	0.6	1.9	0.0
1-Aug-05	55.4	41.9	0.5	2.2	0.0
1-Aug-05	54.8	42.5	0.8	1.9	0.0
2-Aug-05	56.2	42.5	0.6	0.7	0.0
2-Aug-05	56.3	41.3	0.5	1.9	0.0
2-Aug-05	55.2	42.1	0.6	2.1	0.0
3-Aug-05	54.5	41.7	0.2	3.6	0.0
3-Aug-05	54.4	42.0	0.2	3.4	0.0
3-Aug-05	54.6	42.2	0.7	2.5	0.0
4-Aug-05	56.2	42.3	0.1	1.4	0.0
4-Aug-02	55.1	43.0	0.6	1.3	0.0
4-Aug-05	55.1	43.1	0.6	1.2	0.0
5-Aug-05	55.6	41.8	0.2	2.4	0.0
5-Aug-05	55.6	42.8	0.1	1.5	0.0
5-Aug-05	54.8	42.6	0.6	2.0	0.0
8-Aug-05	56.0	41.9	0.2	1.9	0.0
8-Aug-05	56.4	43.2	0.2	0.2	0.0
8-Aug-05	55.0	41.9	0.6	2.5	0.0
9-Aug-05	55.4	42.0	0.6	2.0	0.0
9-Aug-05	55.6	42.7	0.5	1.2	0.0
9-Aug-05	55.4	41.8	0.6	2.2	0.0

PUMP TEST MONITORING DATA FOR W-1 PROBES

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in w.c.)
Probe 1-B (15 meters from W-1)					
26-Jul-05	55.0	44.0	0.2	0.8	0.0
29-Jul-05	58.4	41.4	0.2	0.0	0.0
29-Jul-05	58.4	41.2	0.4	0.0	0.0
29-Jul-05	58.0	41.8	0.2	0.0	0.0
29-Jul-05	55.7	41.5	0.2	2.6	0.0
30-Jul-05	57.4	42.4	0.2	0.0	0.0
30-Jul-05	58.2	41.8	0.0	0.0	0.0
30-Jul-05	57.7	42.0	0.3	0.0	0.0
30-Jul-05	56.9	42.6	0.5	0.0	0.0
1-Aug-05	57.4	42.4	0.2	0.0	0.0
1-Aug-05	56.7	42.7	0.6	0.0	0.0
1-Aug-05	56.3	42.9	0.8	0.0	0.0
2-Aug-05	56.6	42.8	0.6	0.0	0.0
2-Aug-05	56.4	43.3	0.3	0.0	0.0
2-Aug-05	56.0	43.4	0.6	0.0	0.0
3-Aug-05	56.0	43.8	0.2	0.0	0.0
3-Aug-05	55.5	44.0	0.2	0.3	0.0
3-Aug-05	55.4	44.0	0.6	0.0	0.0
4-Aug-05	57.2	42.7	0.1	0.0	0.0
4-Aug-05	56.7	43.1	0.2	0.0	0.0
4-Aug-05	56.3	43.1	0.6	0.0	0.0
5-Aug-05	56.2	43.4	0.1	0.3	0.0
5-Aug-05	56.1	43.8	0.1	0.0	0.0
5-Aug-05	55.2	43.7	0.6	0.5	0.0
8-Aug-05	56.1	43.7	0.2	0.0	0.0
8-Aug-05	56.9	42.9	0.2	0.0	0.0
8-Aug-05	55.0	43.8	0.5	0.7	0.0
9-Aug-05	55.7	43.8	0.5	0.0	0.0
9-Aug-05	55.8	44.0	0.2	0.0	0.0
9-Aug-05	55.3	43.5	0.6	0.6	0.0

PUMP TEST MONITORING DATA FOR W-1 PROBES

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in w.c.)
Probe 1-C (25 meters from W-1)					
26-Jul-05	56.4	41.6	0.2	1.8	0.0
29-Jul-05	56.5	41.9	0.2	1.4	0.0
29-Jul-05	56.5	41.9	0.2	1.4	0.0
29-Jul-05	55.3	42.3	0.1	2.3	0.0
29-Jul-05	52.9	41.0	0.2	5.9	0.0
30-Jul-05	53.7	41.2	0.2	4.9	0.0
30-Jul-05	45.6	40.3	0.2	13.9	0.0
30-Jul-05	41.0	39.7	0.6	18.7	0.0
30-Jul-05	39.1	38.0	0.7	22.2	0.0
1-Aug-05	45.3	39.2	1.0	14.5	0.0
1-Aug-05	22.9	35.0	1.4	40.7	0.0
1-Aug-05	13.1	30.7	2.2	54.0	0.0
2-Aug-05	47.0	38.2	0.7	14.1	0.0
2-Aug-05	16.6	30.0	2.5	50.9	0.0
2-Aug-05	7.6	27.4	2.9	62.1	0.0
3-Aug-05	0.0	17.5	5.0	77.5	0.0
3-Aug-05	0.0	17.1	5.0	77.9	0.0
3-Aug-05	0.0	15.6	5.7	78.7	0.0
4-Aug-05	0.0	13.8	7.4	78.8	0.0
4-Aug-05	0.0	12.6	7.8	79.6	0.0
4-Aug-05	0.0	12.0	7.5	80.5	0.0
5-Aug-05	0.0	13.2	5.5	81.3	0.0
5-Aug-05	0.0	12.2	6.6	81.2	0.0
5-Aug-05	0.0	12.1	6.6	81.3	0.0
8-Aug-05	0.0	12.2	6.7	81.1	0.0
8-Aug-05	0.0	12.9	6.6	80.5	0.0
8-Aug-05	0.0	12.5	6.2	81.3	0.0
9-Aug-05	0.0	11.0	9.7	79.3	0.0
9-Aug-05	0.0	11.0	9.4	79.6	0.0
9-Aug-05	0.0	10.8	9.4	79.8	0.0

PROBES ASSOCIATED WITH W-2

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 2-A (5 meters from W-2)					
26-Jul-05	51.4	45.5	0.1	3.0	0.0
29-Jul-05	49.3	49.2	0.2	1.3	0.0
29-Jul-05	49.3	49.0	0.4	1.3	0.0
29-Jul-05	48.1	48.6	0.1	3.2	0.0
29-Jul-05	47.4	47.3	0.1	5.2	0.0
30-Jul-05	48.4	47.8	0.1	3.7	0.0
30-Jul-05	48.2	48.8	0.0	3.0	0.0
30-Jul-05	48.6	49.2	0.2	2.0	0.0
30-Jul-05	47.2	47.2	0.2	5.4	0.0
1-Aug-05	48.6	48.6	0.1	2.7	0.0
1-Aug-05	48.5	48.8	0.3	2.4	0.0
1-Aug-05	48.1	48.3	0.7	2.9	0.0
2-Aug-05	48.4	48.5	0.2	2.9	0.0
2-Aug-05	48.3	48.0	0.2	3.5	0.0
2-Aug-05	47.8	48.2	0.7	3.3	0.0
3-Aug-05	49.2	48.4	0.2	2.2	0.0
3-Aug-05	49.3	48.7	0.5	1.5	0.0
3-Aug-05	48.5	46.2	2.6	2.7	0.0
4-Aug-05	49.5	47.7	0.1	2.7	0.0
4-Aug-05	48.8	47.6	0.2	3.4	0.0
4-Aug-05	48.7	48.6	0.7	2.0	0.0
5-Aug-05	49.8	46.4	0.1	3.7	0.0
5-Aug-05	50.1	47.7	0.2	2.0	0.0
5-Aug-05	49.3	47.6	0.6	2.5	0.0
8-Aug-05	49.9	46.1	0.2	3.8	0.0
8-Aug-05	50.6	47.8	0.2	1.4	0.0
8-Aug-05	49.5	47.0	0.5	3.0	0.0
9-Aug-05	49.8	46.4	0.2	3.6	0.0
9-Aug-05	49.8	47.6	0.6	2.0	0.0
9-Aug-05	49.8	46.9	0.6	2.7	0.0

PROBES ASSOCIATED WITH W-2

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 2-B (15 meters from W-2)					
26-Jul-05	37.6	57.3	0.1	5.0	0.0
29-Jul-05	41.4	55.2	0.2	3.2	0.0
29-Jul-05	41.4	55.2	0.4	3.0	0.0
29-Jul-05	41.3	54.0	0.1	4.6	0.0
29-Jul-05	40.3	52.7	0.1	6.9	0.0
30-Jul-05	42.3	52.4	0.1	5.2	0.0
30-Jul-05	42.2	53.4	0.0	4.4	0.0
30-Jul-05	42.7	53.7	0.2	3.4	0.0
30-Jul-05	41.3	50.2	0.2	8.3	0.0
1-Aug-05	43.1	51.6	0.1	5.2	0.0
1-Aug-05	43.2	52.4	0.3	4.1	0.0
1-Aug-05	42.3	51.8	0.6	5.3	0.0
2-Aug-05	43.5	52.1	0.2	4.2	0.0
2-Aug-05	43.2	51.0	0.2	5.6	0.0
2-Aug-05	43.1	51.3	0.6	5.0	0.0
3-Aug-05	43.7	51.4	0.1	4.8	0.0
3-Aug-05	43.4	51.7	0.2	4.7	0.0
3-Aug-05	43.3	52.1	0.5	4.1	0.0
4-Aug-05	44.2	51.6	0.1	4.1	0.0
4-Aug-05	43.6	51.7	0.2	4.5	0.0
4-Aug-05	43.7	52.2	0.6	3.5	0.0
5-Aug-05	43.6	50.5	0.1	5.8	0.0
5-Aug-05	43.7	51.1	0.2	5.0	0.0
5-Aug-05	43.8	51.1	0.5	4.6	0.0
8-Aug-05	45.3	49.1	0.2	5.4	0.0
8-Aug-05	46.1	50.7	0.1	3.1	0.0
8-Aug-05	45.1	48.9	0.2	5.8	0.0
9-Aug-05	45.4	49.3	0.2	5.1	0.0
9-Aug-05	45.2	49.8	0.2	4.8	0.0
9-Aug-05	44.6	48.9	0.5	6.0	0.0

PROBES ASSOCIATED WITH W-2

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 2-C (25 meters from W-2)					
26-Jul-05	41.3	54.6	0.1	4.0	0.0
29-Jul-05	43.4	52.9	0.1	3.6	0.0
29-Jul-05	43.4	52.9	0.1	3.6	0.0
29-Jul-05	43.0	52.9	0.1	4.0	0.0
29-Jul-05	40.1	49.9	0.1	9.9	0.0
30-Jul-05	43.1	50.9	0.1	5.9	0.0
30-Jul-05	43.1	52.2	0.1	4.6	0.0
30-Jul-05	42.6	52.5	0.2	4.7	0.0
30-Jul-05	38.1	48.9	0.2	12.8	0.0
1-Aug-05	44.1	51.8	0.1	4.0	0.0
1-Aug-05	43.7	52.9	0.6	2.8	0.0
1-Aug-05	42.8	52.0	0.6	4.6	0.0
2-Aug-05	44.4	52.0	0.6	3.0	0.0
2-Aug-05	40.8	50.6	0.2	8.4	0.0
2-Aug-05	40.9	51.1	0.6	7.4	0.0
3-Aug-05	44.1	51.4	0.1	4.4	0.0
3-Aug-05	44.3	52.1	0.2	3.4	0.0
3-Aug-05	43.5	51.5	0.5	4.5	0.0
4-Aug-05	44.4	51.3	0.1	4.2	0.0
4-Aug-05	43.5	51.8	0.5	4.2	0.0
4-Aug-05	43.6	50.5	0.6	5.3	0.0
5-Aug-05	44.0	49.8	0.1	6.1	0.0
5-Aug-05	43.5	50.8	0.2	5.5	0.0
5-Aug-05	42.0	52.3	0.2	5.5	0.0
8-Aug-05	43.0	50.8	0.2	6.0	0.0
8-Aug-05	41.8	51.5	0.1	6.6	0.0
8-Aug-05	40.2	50.2	0.2	9.4	0.0
9-Aug-05	42.7	51.0	0.2	6.1	0.0
9-Aug-05	42.8	51.8	0.2	5.2	0.0
9-Aug-05	42.4	51.0	0.3	6.3	0.0

PROBES ASSOCIATED WITH W-3

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 3-A (5 meters from W-3)					
26-Jul-05	1.7	3.7	18.7	75.9	0.0
29-Jul-05	9.0	7.6	15.5	67.9	0.0
29-Jul-05	9.0	7.6	15.6	67.8	0.0
29-Jul-05	9.0	7.4	15.4	68.2	0.0
29-Jul-05	7.8	7.1	15.4	69.7	0.0
30-Jul-05	13.2	11.6	13.0	62.2	0.0
30-Jul-05	14.3	13.1	11.7	60.9	0.0
30-Jul-05	14.5	12.9	11.8	60.8	0.0
30-Jul-05	13.7	13.0	11.6	61.7	0.0
1-Aug-05	17.2	17.6	7.7	57.5	0.0
1-Aug-05	16.7	17.6	7.7	58.0	0.0
1-Aug-05	16.2	17.5	7.6	58.7	0.0
2-Aug-05	30.0	27.0	4.2	38.8	0.0
2-Aug-05	27.1	26.3	4.5	42.1	0.0
2-Aug-05	26.5	25.3	4.7	43.5	0.0
3-Aug-05	26.5	26.1	4.2	43.2	0.0
3-Aug-05	26.5	26.1	4.5	42.9	0.0
3-Aug-05	26.2	26.0	4.5	43.3	0.0
4-Aug-05	26.1	27.1	4.3	42.5	0.0
4-Aug-05	25.9	27.4	3.9	42.8	0.0
4-Aug-05	26.2	26.5	4.3	43.0	0.0
5-Aug-05	28.7	27.9	3.4	40.0	0.0
5-Aug-05	31.6	28.5	3.3	36.6	0.0
5-Aug-05	35.1	29.6	2.9	32.4	0.0
8-Aug-05	22.3	26.1	4.4	47.2	0.0
8-Aug-05	27.0	27.8	4.0	41.2	0.0
8-Aug-05	29.5	27.3	4.0	39.2	0.0
9-Aug-05	29.5	33.4	0.3	36.8	0.0
9-Aug-05	27.0	29.0	3.2	40.8	0.0
9-Aug-05	28.8	27.1	4.3	39.8	0.0

PROBES ASSOCIATED WITH W-3

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 3-B (15 meters from W-3)					
26-Jul-05	1.7	3.7	18.7	75.9	0.0
29-Jul-05	60.2	37.7	0.2	1.9	0.0
29-Jul-05	60.0	37.7	0.4	1.9	0.0
29-Jul-05	59.7	37.1	0.2	3.0	0.0
29-Jul-05	57.8	34.9	0.2	7.1	0.0
30-Jul-05	60.3	37.1	0.1	2.5	0.0
30-Jul-05	60.0	37.5	0.2	2.3	0.0
30-Jul-05	59.6	37.8	0.6	2.0	0.0
30-Jul-05	58.5	36.1	0.6	4.8	0.0
1-Aug-05	60.2	37.4	0.1	2.3	0.0
1-Aug-05	60.1	37.6	0.6	1.7	0.0
1-Aug-05	58.7	37.2	0.7	3.4	0.0
2-Aug-05	60.0	37.4	0.2	2.4	0.0
2-Aug-05	59.4	37.3	0.5	2.8	0.0
2-Aug-05	58.6	37.3	0.6	3.5	0.0
3-Aug-05	59.6	37.8	0.2	2.4	0.0
3-Aug-06	59.1	37.5	0.6	2.8	0.0
3-Aug-05	58.3	36.9	0.6	4.2	0.0
4-Aug-05	60.3	37.4	0.1	2.2	0.0
4-Aug-05	59.5	37.6	0.2	2.7	0.0
4-Aug-05	59.5	37.4	0.6	2.5	0.0
5-Aug-05	59.6	36.8	0.2	3.4	0.0
5-Aug-05	59.3	37.6	0.2	2.9	0.0
5-Aug-05	59.1	37.3	0.5	3.1	0.0
8-Aug-05	59.5	37.6	0.6	2.3	0.0
8-Aug-05	59.7	38.0	0.6	1.7	0.0
8-Aug-05	58.9	37.6	0.5	3.0	0.0
9-Aug-05	59.5	37.3	0.2	3.0	0.0
9-Aug-05	59.1	37.8	0.5	2.6	0.0
9-Aug-05	58.5	37.4	0.6	3.5	0.0

PROBES ASSOCIATED WITH W-3

Date	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)	Probe Vacuum (in. w.c.)
Probe 3-C (25 meters from W-3)					
26-Jul-05	67.8	24.9	0.1	7.2	0.0
29-Jul-05	68.3	24.8	0.1	6.8	0.0
29-Jul-05	68.0	24.8	0.4	6.8	0.0
29-Jul-05	66.8	24.5	0.2	8.5	0.0
29-Jul-05	65.3	23.3	0.2	11.2	0.0
30-Jul-05	62.6	24.4	0.0	13.0	0.0
30-Jul-05	67.5	24.5	0.1	7.9	0.0
30-Jul-05	66.7	24.6	0.2	8.5	0.0
30-Jul-05	65.8	24.1	0.5	9.6	0.0
1-Aug-05	18.8	11.6	10.7	58.9	0.0
1-Aug-05	33.4	15.9	6.5	44.2	0.0
1-Aug-05	32.0	15.8	6.4	45.8	0.0
2-Aug-05	32.2	15.8	6.2	45.8	0.0
2-Aug-05	33.9	15.3	6.6	44.2	0.0
2-Aug-05	35.6	15.7	6.3	42.4	0.0
3-Aug-05	34.3	14.5	4.6	46.6	0.0
3-Aug-05	34.7	16.4	5.3	43.6	0.0
3-Aug-05	31.8	14.9	6.4	46.9	0.0
4-Aug-05	23.4	10.8	11.4	54.4	0.0
4-Aug-05	29.0	12.8	9.5	48.7	0.0
4-Aug-05	22.5	10.1	11.5	55.9	0.0
5-Aug-05	31.3	15.4	4.6	48.7	0.0
5-Aug-05	33.1	15.0	5.8	46.1	0.0
5-Aug-05	28.0	13.8	7.2	51.0	0.0
8-Aug-05	15.6	7.5	14.0	62.9	0.0
8-Aug-05	29.1	13.0	9.7	48.2	0.0
8-Aug-05	30.2	12.6	9.6	47.6	0.0
9-Aug-05	23.8	11.8	10.3	54.1	0.0
9-Aug-05	25.9	11.5	10.6	52.0	0.0
9-Aug-05	31.1	13.3	9.3	46.3	0.0

APPENDIX B

LFG RECOVERY PROJECTIONS

TABLE 1
PROJECTION OF POTENTIAL LANDFILL GAS RECOVERY
EL TREBOL LANDFILL, GUATEMALA CITY

Year	Disposal Rate (Tons/yr)	Refuse In-Place (Tons)	Disposal Rate (Mg/yr)	Refuse In-Place (Mg)	LFG Recovery Potential (m^3/hr)	LFG Recovery Potential (cfm)	LFG Recovery Potential (mmBtu/hr)
1985	62,200	62,200	56,427	56,427	0	0	0
1986	62,820	125,020	56,990	113,417	142	84	3
1987	52,870	177,890	47,963	161,381	261	153	5
1988	53,400	231,290	48,444	209,825	336	198	6
1989	0	231,290	0	209,825	399	235	7
1990	108,850	340,140	98,748	308,573	330	194	6
1991	124,370	464,510	112,828	421,401	523	308	9
1992	128,280	592,790	116,375	537,776	717	422	13
1993	132,300	725,090	120,022	657,797	888	522	16
1994	136,450	861,540	123,787	781,584	1,038	611	19
1995	140,720	1,002,260	127,660	909,244	1,173	691	21
1996	145,440	1,147,700	131,942	1,041,187	1,296	763	23
1997	0	1,147,700	0	1,041,187	1,411	830	25
1998	0	1,147,700	0	1,041,187	1,174	691	21
1999	160,570	1,308,270	145,668	1,186,855	983	579	18
2000	165,950	1,474,220	150,549	1,337,404	1,195	703	21
2001	171,510	1,645,730	155,593	1,492,996	1,383	814	25
2002	177,250	1,822,980	160,800	1,653,797	1,552	914	28
2003	183,190	2,006,170	166,189	1,819,985	1,706	1,004	30
2004	189,330	2,195,500	171,759	1,991,745	1,849	1,088	33
2005	195,700	2,391,200	177,538	2,169,282	1,983	1,167	35
2006	202,300	2,593,500	183,525	2,352,808	2,111	1,243	38
2007	209,100	2,802,600	189,694	2,542,502	2,234	1,315	40
2008	216,100	3,018,700	196,045	2,738,547	2,355	1,386	42
2009	223,300	3,242,000	202,576	2,941,123	2,473	1,455	44
2010	230,800	3,472,800	209,380	3,150,503	2,590	1,524	46
2011	238,500	3,711,300	216,366	3,366,869	2,707	1,593	48
2012	246,500	3,957,800	223,623	3,590,493	2,824	1,662	50
2013	254,800	4,212,600	231,153	3,821,646	2,943	1,732	53
2014	263,300	4,475,900	238,864	4,060,510	3,063	1,803	55
2015	272,100	4,748,000	246,848	4,307,357	3,186	1,875	57
2016	281,200	5,029,200	255,103	4,562,460	3,310	1,948	59
2017	290,600	5,319,800	263,631	4,826,091	3,438	2,023	61
2018	232,480	5,552,280	210,904	5,036,995	3,568	2,100	64
2019	0	5,552,280	0	5,036,995	3,546	2,087	63
2020	0	5,552,280	0	5,036,995	3,001	1,766	54
2021	0	5,552,280	0	5,036,995	2,557	1,505	46
2022	0	5,552,280	0	5,036,995	2,195	1,292	39
2023	0	5,552,280	0	5,036,995	1,898	1,117	34
2024	0	5,552,280	0	5,036,995	1,655	974	30
2025	0	5,552,280	0	5,036,995	1,454	856	26
2026	0	5,552,280	0	5,036,995	1,288	758	23
2027	0	5,552,280	0	5,036,995	1,150	677	21
2028	0	5,552,280	0	5,036,995	1,034	609	18
2029	0	5,552,280	0	5,036,995	937	552	17
2030	0	5,552,280	0	5,036,995	855	503	15

MODEL INPUT PARAMETERS:

Assumed Methane Content of LFG: 50%

	Fast Decay	Med. Decay	Slow Decay	Total Site
Decay Rate Constant (k):	0.220	0.044	0.011	
CH4 Recovery Pot. (Lo) (ft3/ton):	3,993	3,993	3,993	2,927
Metric Equivalent Lo (m3/Mg):	124.6	124.6	124.6	91.4

TABLE 2
PREDICTED LANDFILL GAS RECOVERY - LOW RANGE ESTIMATES
EL TREBOL LANDFILL, GUATEMALA CITY

Year	Collection System Coverage (%)	Predicted LFG Recovery (m^3/hr)	(cfm)	(mmBtu/hr)	Maximum Power Plant Capacity* (MW)	Methane Emissions Reduction Estimates** (tonnes CH4/yr)	(tonnes CO_2eq/yr)
1985	0%	0	0	0	0.0	0	0
1986	0%	0	0	0	0.0	0	0
1987	0%	0	0	0	0.0	0	0
1988	0%	0	0	0	0.0	0	0
1989	0%	0	0	0	0.0	0	0
1990	0%	0	0	0	0.0	0	0
1991	0%	0	0	0	0.0	0	0
1992	0%	0	0	0	0.0	0	0
1993	0%	0	0	0	0.0	0	0
1994	0%	0	0	0	0.0	0	0
1995	0%	0	0	0	0.0	0	0
1996	0%	0	0	0	0.0	0	0
1997	0%	0	0	0	0.0	0	0
1998	0%	0	0	0	0.0	0	0
1999	0%	0	0	0	0.0	0	0
2000	0%	0	0	0	0.0	0	0
2001	0%	0	0	0	0.0	0	0
2002	0%	0	0	0	0.0	0	0
2003	0%	0	0	0	0.0	0	0
2004	0%	0	0	0	0.0	0	0
2005	0%	0	0	0	0.0	0	0
2006	28%	588	346	11	1.0	842	17,692
2007	26%	575	338	10	1.0	1,647	34,595
2008	24%	561	330	10	0.9	1,609	33,792
2009	22%	548	323	10	0.9	1,571	32,997
2010	21%	535	315	10	0.9	1,534	32,222
2011	39%	1,046	616	19	1.7	2,998	62,956
2012	36%	1,022	602	18	1.7	2,930	61,534
2013	34%	1,000	589	18	1.7	2,866	60,184
2014	32%	979	576	17	1.6	2,805	58,910
2015	45%	1,438	846	26	2.4	4,122	86,560
2016	43%	1,410	830	25	2.3	4,041	84,857
2017	40%	1,383	814	25	2.3	3,964	83,254
2018	38%	1,367	804	24	2.3	3,917	82,255
2019	50%	1,773	1,044	32	2.9	5,082	106,728
2020	50%	1,501	883	27	2.5	4,301	90,314
2021	50%	1,279	753	23	2.1	3,664	76,953
2022	50%	1,097	646	20	1.8	3,145	66,050
2023	50%	949	559	17	1.6	2,720	57,126
2024	50%	827	487	15	1.4	2,371	49,799
2025	50%	727	428	13	1.2	2,084	43,760
2026	50%	644	379	12	1.1	1,846	38,762
2027	50%	575	338	10	1.0	1,648	34,604
2028	50%	517	304	9	0.9	1,482	31,129
2029	50%	469	276	8	0.8	1,343	28,206
2030	50%	428	252	8	0.7	1,225	25,732

NOTES:
* Maximum power plant capacity assumes a conversion factor (heat rate) of 10,800 Btus per kW-hr.
**Predicted methane emission reductions in 2006 are 50% of the amount calculated by predicted LFG recovery because a July 1, 2006 system start-up date is assumed.

TABLE 3
PREDICTED LANDFILL GAS RECOVERY - HIGH RANGE ESTIMATES
EL TREBOL LANDFILL, GUATEMALA CITY

Year	Collection System Coverage (%)	Predicted LFG Recovery (m^3/hr)	(cfm)	(mmBtu/hr)	Maximum Power Plant Capacity* (MW)	Methane Emissions Reduction Estimates** (tonnes CH4/yr)	(tonnes CO_2eq/yr)
1985	0%	0	0	0	0.0	0	0
1986	0%	0	0	0	0.0	0	0
1987	0%	0	0	0	0.0	0	0
1988	0%	0	0	0	0.0	0	0
1989	0%	0	0	0	0.0	0	0
1990	0%	0	0	0	0.0	0	0
1991	0%	0	0	0	0.0	0	0
1992	0%	0	0	0	0.0	0	0
1993	0%	0	0	0	0.0	0	0
1994	0%	0	0	0	0.0	0	0
1995	0%	0	0	0	0.0	0	0
1996	0%	0	0	0	0.0	0	0
1997	0%	0	0	0	0.0	0	0
1998	0%	0	0	0	0.0	0	0
1999	0%	0	0	0	0.0	0	0
2000	0%	0	0	0	0.0	0	0
2001	0%	0	0	0	0.0	0	0
2002	0%	0	0	0	0.0	0	0
2003	0%	0	0	0	0.0	0	0
2004	0%	0	0	0	0.0	0	0
2005	0%	0	0	0	0.0	0	0
2006	50%	1,058	623	19	1.8	1,516	31,846
2007	46%	1,035	609	18	1.7	2,965	62,272
2008	43%	1,011	595	18	1.7	2,896	60,826
2009	40%	987	581	18	1.6	2,828	59,395
2010	37%	964	567	17	1.6	2,762	58,000
2011	70%	1,883	1,108	34	3.1	5,396	113,320
2012	65%	1,840	1,083	33	3.0	5,274	110,761
2013	61%	1,800	1,059	32	3.0	5,159	108,332
2014	58%	1,762	1,037	31	2.9	5,049	106,038
2015	81%	2,589	1,524	46	4.3	7,419	155,807
2016	77%	2,538	1,494	45	4.2	7,273	152,743
2017	72%	2,490	1,465	44	4.1	7,136	149,858
2018	69%	2,460	1,448	44	4.1	7,050	148,059
2019	90%	3,192	1,879	57	5.3	9,148	192,110
2020	90%	2,701	1,590	48	4.5	7,741	162,565
2021	90%	2,301	1,355	41	3.8	6,596	138,515
2022	90%	1,975	1,163	35	3.3	5,661	118,889
2023	90%	1,708	1,006	31	2.8	4,897	102,827
2024	90%	1,489	877	27	2.5	4,268	89,638
2025	90%	1,309	770	23	2.2	3,751	78,768
2026	90%	1,159	682	21	1.9	3,322	69,771
2027	90%	1,035	609	18	1.7	2,966	62,288
2028	90%	931	548	17	1.5	2,668	56,031
2029	90%	844	496	15	1.4	2,418	50,770
2030	90%	770	453	14	1.3	2,206	46,317

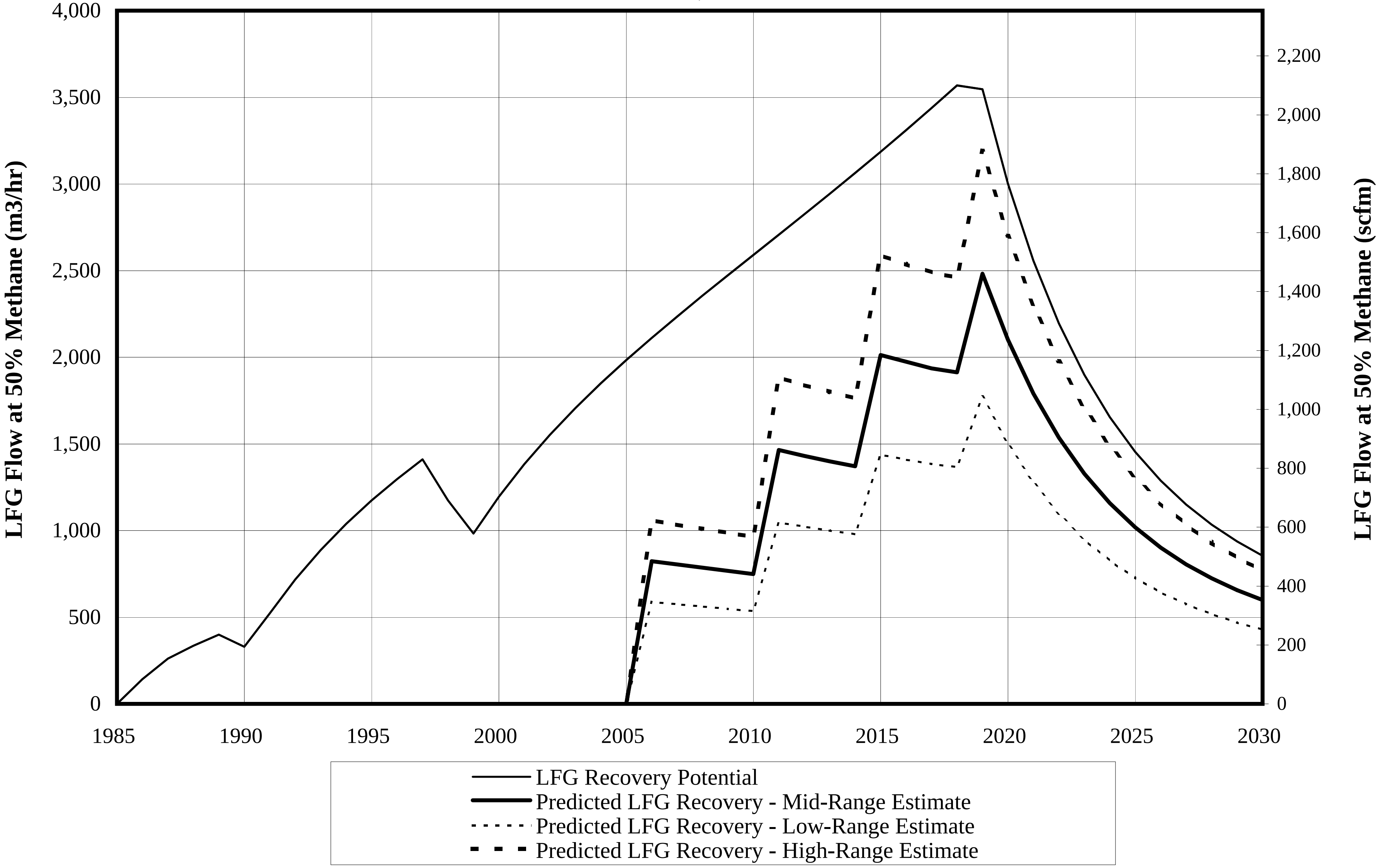
NOTES:
* Maximum power plant capacity assumes a conversion factor (heat rate) of 10,800 Btus per kW-hr.
**Predicted methane emission reductions in 2006 are 50% of the amount calculated by predicted LFG recovery because a July 1, 2006 system start-up date is assumed.

TABLE 4
PREDICTED LANDFILL GAS RECOVERY - MID-RANGE ESTIMATES
EL TREBOL LANDFILL, GUATEMALA CITY

Year	Collection System Coverage (%)	Predicted LFG Recovery (m^3/hr)	Predicted LFG Recovery (cfm)	Predicted LFG Recovery (mmBtu/hr)	Maximum Power Plant Capacity* (MW)	Methane Emissions Reduction Estimates** (tonnes CH4/yr)	Methane Emissions Reduction Estimates** (tonnes CO_2eq/yr)
1985	0%	0	0	0	0.0	0	0
1986	0%	0	0	0	0.0	0	0
1987	0%	0	0	0	0.0	0	0
1988	0%	0	0	0	0.0	0	0
1989	0%	0	0	0	0.0	0	0
1990	0%	0	0	0	0.0	0	0
1991	0%	0	0	0	0.0	0	0
1992	0%	0	0	0	0.0	0	0
1993	0%	0	0	0	0.0	0	0
1994	0%	0	0	0	0.0	0	0
1995	0%	0	0	0	0.0	0	0
1996	0%	0	0	0	0.0	0	0
1997	0%	0	0	0	0.0	0	0
1998	0%	0	0	0	0.0	0	0
1999	0%	0	0	0	0.0	0	0
2000	0%	0	0	0	0.0	0	0
2001	0%	0	0	0	0.0	0	0
2002	0%	0	0	0	0.0	0	0
2003	0%	0	0	0	0.0	0	0
2004	0%	0	0	0	0.0	0	0
2005	0%	0	0	0	0.0	0	0
2006	39%	823	484	15	1.4	1,179	24,769
2007	36%	805	474	14	1.3	2,306	48,433
2008	33%	786	463	14	1.3	2,253	47,309
2009	31%	768	452	14	1.3	2,200	46,196
2010	29%	749	441	13	1.2	2,148	45,111
2011	54%	1,464	862	26	2.4	4,197	88,138
2012	51%	1,431	842	26	2.4	4,102	86,147
2013	48%	1,400	824	25	2.3	4,012	84,258
2014	45%	1,370	807	24	2.3	3,927	82,474
2015	63%	2,013	1,185	36	3.3	5,771	121,183
2016	60%	1,974	1,162	35	3.3	5,657	118,800
2017	56%	1,937	1,140	35	3.2	5,550	116,556
2018	54%	1,913	1,126	34	3.2	5,484	115,157
2019	70%	2,482	1,461	44	4.1	7,115	149,419
2020	70%	2,101	1,236	38	3.5	6,021	126,440
2021	70%	1,790	1,054	32	3.0	5,130	107,734
2022	70%	1,536	904	27	2.5	4,403	92,469
2023	70%	1,329	782	24	2.2	3,808	79,977
2024	70%	1,158	682	21	1.9	3,320	69,719
2025	70%	1,018	599	18	1.7	2,917	61,264
2026	70%	902	531	16	1.5	2,584	54,266
2027	70%	805	474	14	1.3	2,307	48,446
2028	70%	724	426	13	1.2	2,075	43,580
2029	70%	656	386	12	1.1	1,880	39,488
2030	70%	599	352	11	1.0	1,715	36,024

NOTES:
* Maximum power plant capacity assumes a conversion factor (heat rate) of 10,800 Btus per kW-hr.
**Predicted methane emission reductions in 2006 are 50% of the amount calculated by predicted LFG recovery because a July 1, 2006 system start-up date is assumed.

FIGURE 1
PROJECTED LANDFILL GAS RECOVERY
EL TREBOL LANDFILL, GUATEMALA CITY



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APPENDIX C

CONSTRUCTION COST ESTIMATES

TABLE 1. ESTIMATE OF PROJECT CAPITAL COSTS
INITIAL GAS COLLECTION AND FLARING SYSTEM
EL TREBOL LANDFILL, GUATEMALA

Cost Item	Quantity	Unit	Unit Cost (U.S. $)	Total Initial Cost (U.S. $)
Mobilization and Project Management	1	each	$40,000	$40,000
New vertical extraction wells (10 wells @ 30 m avg. depth assumed)	300	m	$400	$120,000
Gas wellheads	10	each	$700	$7,000
Leachate pumping equipment	5	each	$5,000	$25,000
Gas header piping (assume 350 mm [14 in]) - below ground	775	m	$144	$112,000
Gas piping (assume 110 mm [4 in]) - above ground	325	m	$30	$9,800
Condensate traps, self-draining	1	each	$10,000	$10,000
Condensate manholes with pumping	1	each	$25,000	$25,000
LFG enclosed flaring station (1,500 cfm/2,550 m^3/hr LFG capacity)	1	each	$160,000	$160,000
Construction and sitework	1	each	$50,000	$50,000
Flare start-up	1	each	$15,000	$15,000
Source test	1	each	$25,000	$25,000
LFG measurement and recording equipment	1	each	$35,000	$35,000
Engineering, Contingency, and Up-front CDM Transaction Costs	1	each	$88,000	$88,000
			Total construction cost =	**$721,800**

Notes:
1. Extraction well costs include drilling and well construction
2. Flare station includes flare, blowers, flame arrester, controls, piping, valves, foundation and fencing.

TABLE 2. ESTIMATE OF PROJECT CAPITAL COSTS: INITIAL LFGE PROJECT
EL TREBOL LANDFILL, GUATEMALA

Alternative: Utilization of methane for electricity generation
NOTE: Costs are additional to collection system and flare station costs

Cost Item	Quantity	Unit	Unit Cost (U.S. $)	Total Initial Cost (U.S. $)
Mobilization	1	each	$100,000	$100,000
Plant construction and sitework	1	each	$100,000	$100,000
Gas header piping (assume 350 mm [14 in]) - below ground	100	m	$144	$14,400
LFG measurement and recording equipment	1	each	$35,000	$35,000
1.06 MW LFG-fueled power plant ($1000/kW installed capacity)	1,060	each	$1,000	$1,060,000
Electricity Interconnection	1	each	$500,000	$500,000
Right of Way (assumed right of way purchase not required)	0	each	$0	$0
Source Test	1	each	$25,000	$25,000
Engineering and Contingency	1	each	$180,000	$180,000
			Total construction cost (not including inflation) =	**$2,014,400**

APPENDIX D

ECONOMIC EVALUATION

TABLE 1. ECONOMIC ANALYSIS OF PROPOSED LFGTE PROJECT
EL TREBOL LANDFILL - NO FINANCING AND $5/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross Plant Capacity (MW)	0.00	1.06	1.06	1.06	1.06	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Net Plant Capacity (MW)	0.00	0.99	0.99	0.99	0.99	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Off Site Power Sales Rate ($/kWh)	$0.060	$0.062	$0.064	$0.066	$0.068	$0.070	$0.072	$0.074	$0.076	$0.078	$0.081	$0.083	$0.086	$0.088	$0.091
Off Site Power Sales (MWh/yr)	0	7,772	7,772	7,772	7,772	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544
Off Site Power Revenue	$0	$480,313	$494,722	$509,564	$524,850	$1,081,192	$1,113,628	$1,147,037	$1,181,448	$1,216,891	$1,253,398	$1,291,000	$1,329,730	$1,369,622	$1,410,710
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$123,847	$242,167	$236,546	$230,980	$225,556	$440,690	$430,736	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,013	5,013	5,013	5,013	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$25,065	$25,065	$25,065	$25,065	$50,130	$50,130	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$123,847**	**$747,544**	**$756,333**	**$765,608**	**$775,471**	**$1,572,012**	**$1,594,493**	**$1,147,037**	**$1,181,448**	**$1,216,891**	**$1,253,398**	**$1,291,000**	**$1,329,730**	**$1,369,622**	**$1,410,710**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$2,736,200	$0	$0	$0	$1,803,000	$0	$0	$0	$509,000	$0	$0	$0	$521,000	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Power Plant O&M Rate ($/kWhr)	$0.018	$0.019	$0.019	$0.020	$0.020	$0.021	$0.021	$0.022	$0.023	$0.023	$0.024	$0.025	$0.026	$0.026	$0.027
Annual Power Plant O&M Cost	$0	$144,094	$148,417	$152,869	$157,455	$162,179	$167,044	$172,055	$177,217	$182,534	$188,010	$193,650	$199,459	$205,443	$211,607
Annual GCCS O&M Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL COSTS	**$2,824,747**	**$294,563**	**$302,315**	**$310,277**	**$2,121,474**	**$373,431**	**$382,471**	**$354,934**	**$872,525**	**$420,405**	**$430,102**	**$440,177**	**$972,566**	**$458,045**	**$440,148**
NET CASH FLOW	**($2,700,899)**	**$452,981**	**$454,018**	**$455,331**	**($1,346,002)**	**$1,198,580**	**$1,212,023**	**$792,103**	**$308,923**	**$796,486**	**$823,296**	**$850,823**	**$357,163**	**$911,576**	**$970,562**
NPV															**$1,519,099**
INTERNAL RATE OF RETURN															**15.3%**

	1.06 MW 2006	2.12 MW 2010	2.12 MW 2014	2.12 MW 2018
INITIAL GROSS PLANT CAPACITY (MW)	1.06	2.12	2.12	2.12
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.99	1.97	1.97	1.97
PLANT CAPACITY FACTOR	90%	90%	0.90	0.90
ANNUAL POWER PRODUCTION (MWh/yr)	7,772	15,544	15,544	15,544
OFF SITE POWER SALE (MWH/yr)	7,772	15,544	15,544	15,544
FACILITY CAPITAL INVESTMENT COSTS	$2,736,200	$1,803,000	$509,000	$521,000
EQUITY PERCENTAGE	100%	100%	100%	100%
EQUITY CONTRIBUTION	$2,736,200	$1,803,000	$509,000	$521,000
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$5.00
OFF SITE SALES RATE	$0.060
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
POWER PLANT O&M COST ($/kW-hr)	$0.018
POWER PLANT O&M ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 2. ECONOMIC ANALYSIS OF PROPOSED LFGTE PROJECT
EL TREBOL LANDFILL - WITH FINANCING AND $5/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross Plant Capacity (MW)	0.00	1.06	1.06	1.06	1.06	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Net Plant Capacity (MW)	0.00	0.99	0.99	0.99	0.99	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Off Site Power Sales Rate ($/kWh)	$0.060	$0.062	$0.064	$0.066	$0.068	$0.070	$0.072	$0.074	$0.076	$0.078	$0.081	$0.083	$0.086	$0.088	$0.091
Off Site Power Sales (MWh/yr)	0	7,772	7,772	7,772	7,772	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544
Off Site Power Revenue	$0	$480,313	$494,722	$509,564	$524,850	$1,081,192	$1,113,628	$1,147,037	$1,181,448	$1,216,891	$1,253,398	$1,291,000	$1,329,730	$1,369,622	$1,410,710
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$123,847	$242,167	$236,546	$230,980	$225,556	$440,690	$430,736	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,013	5,013	5,013	5,013	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$25,065	$25,065	$25,065	$25,065	$50,130	$50,130	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$123,847**	**$747,544**	**$756,333**	**$765,608**	**$775,471**	**$1,572,012**	**$1,594,493**	**$1,147,037**	**$1,181,448**	**$1,216,891**	**$1,253,398**	**$1,291,000**	**$1,329,730**	**$1,369,622**	**$1,410,710**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$684,050	$0	$0	$0	$450,750	$0	$0	$0	$127,250	$0	$0	$0	$130,250	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Power Plant O&M Rate ($/kWhr)	$0.018	$0.019	$0.019	$0.020	$0.020	$0.021	$0.021	$0.022	$0.023	$0.023	$0.024	$0.025	$0.026	$0.026	$0.027
Annual Power Plant O&M Cost	$0	$144,094	$148,417	$152,869	$157,455	$162,179	$167,044	$172,055	$177,217	$182,534	$188,010	$193,650	$199,459	$205,443	$211,607
Annual GCCS O&M Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$152,915	$305,831	$305,831	$305,831	$406,593	$507,356	$507,356	$507,356	$551,603	$595,850	$442,934	$290,019	$379,320	$468,622	$367,859
TOTAL ANNUAL COSTS	**$925,512**	**$600,394**	**$608,145**	**$616,108**	**$1,175,817**	**$880,787**	**$889,827**	**$862,290**	**$1,042,378**	**$1,016,255**	**$873,036**	**$730,196**	**$961,137**	**$926,667**	**$808,007**
NET CASH FLOW	**($801,665)**	**$147,150**	**$148,187**	**$149,501**	**($400,346)**	**$691,224**	**$704,667**	**$284,747**	**$139,070**	**$200,636**	**$380,362**	**$560,804**	**$368,593**	**$442,954**	**$602,703**
NPV															**$1,364,198**
INTERNAL RATE OF RETURN															**25.3%**

	1.06 MW 2006	2.12 MW 2010	2.12 MW 2014	2.12 MW 2018
INITIAL GROSS PLANT CAPACITY (MW)	1.06	2.12	2.12	2.12
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.99	1.97	1.97	1.97
PLANT CAPACITY FACTOR	90%	90%	0.90	0.90
ANNUAL POWER PRODUCTION (MWh/yr)	7,772	15,544	15,544	15,544
OFF SITE POWER SALE (MWH/yr)	7,772	15,544	15,544	15,544
FACILITY CAPITAL INVESTMENT COSTS	$2,736,200	$1,803,000	$509,000	$521,000
EQUITY PERCENTAGE	25%	25%	25%	25%
EQUITY CONTRIBUTION	$684,050	$450,750	$127,250	$130,250
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$5.00
OFF SITE SALES RATE	**$0.060**
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
POWER PLANT O&M COST ($/kW-hr)	$0.018
POWER PLANT O&M ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 3. ECONOMIC ANALYSIS OF PROPOSED LFGTE PROJECT
EL TREBOL LANDFILL - NO FINANCING AND $6/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross Plant Capacity (MW)	0.00	1.06	1.06	1.06	1.06	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Net Plant Capacity (MW)	0.00	0.99	0.99	0.99	0.99	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Off Site Power Sales Rate ($/kWh)	$0.060	$0.062	$0.064	$0.066	$0.068	$0.070	$0.072	$0.074	$0.076	$0.078	$0.081	$0.083	$0.086	$0.088	$0.091
Off Site Power Sales (MWh/yr)	0	7,772	7,772	7,772	7,772	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544
Off Site Power Revenue	$0	$480,313	$494,722	$509,564	$524,850	$1,081,192	$1,113,628	$1,147,037	$1,181,448	$1,216,891	$1,253,398	$1,291,000	$1,329,730	$1,369,622	$1,410,710
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$148,617	$290,600	$283,855	$277,175	$270,667	$528,828	$516,883	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,013	5,013	5,013	5,013	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$30,078	$30,078	$30,078	$30,078	$60,156	$60,156	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$148,617**	**$800,991**	**$808,655**	**$816,817**	**$825,595**	**$1,670,176**	**$1,690,666**	**$1,147,037**	**$1,181,448**	**$1,216,891**	**$1,253,398**	**$1,291,000**	**$1,329,730**	**$1,369,622**	**$1,410,710**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$2,736,200	$0	$0	$0	$1,803,000	$0	$0	$0	$509,000	$0	$0	$0	$521,000	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Power Plant O&M Rate ($/kWhr)	$0.018	$0.019	$0.019	$0.020	$0.020	$0.021	$0.021	$0.022	$0.023	$0.023	$0.024	$0.025	$0.026	$0.026	$0.027
Annual Power Plant O&M Cost	$0	$144,094	$148,417	$152,869	$157,455	$162,179	$167,044	$172,055	$177,217	$182,534	$188,010	$193,650	$199,459	$205,443	$211,607
Annual GCCS O&M Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL COSTS	**$2,824,747**	**$294,563**	**$302,315**	**$310,277**	**$2,121,474**	**$373,431**	**$382,471**	**$354,934**	**$872,525**	**$420,405**	**$430,102**	**$440,177**	**$972,566**	**$458,045**	**$440,148**
NET CASH FLOW	**($2,676,130)**	**$506,428**	**$506,341**	**$506,540**	**($1,295,878)**	**$1,296,744**	**$1,308,196**	**$792,103**	**$308,923**	**$796,486**	**$823,296**	**$850,823**	**$357,163**	**$911,576**	**$970,562**
NPV															**$1,819,120**
INTERNAL RATE OF RETURN															**17.0%**

	1.06 MW 2006	2.12 MW 2010	2.12 MW 2014	2.12 MW 2018
INITIAL GROSS PLANT CAPACITY (MW)	1.06	2.12	2.12	2.12
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.99	1.97	1.97	1.97
PLANT CAPACITY FACTOR	90%	90%	0.90	0.90
ANNUAL POWER PRODUCTION (MWh/yr)	7,772	15,544	15,544	15,544
OFF SITE POWER SALE (MWH/yr)	7,772	15,544	15,544	15,544
FACILITY CAPITAL INVESTMENT COSTS	$2,736,200	$1,803,000	$509,000	$521,000
EQUITY PERCENTAGE	100%	100%	100%	100%
EQUITY CONTRIBUTION	$2,736,200	$1,803,000	$509,000	$521,000
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$6.00
OFF SITE SALES RATE	$0.060
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
POWER PLANT O&M COST ($/kW-hr)	$0.018
POWER PLANT O&M ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 4. ECONOMIC ANALYSIS OF PROPOSED LFGTE PROJECT
EL TREBOL LANDFILL - WITH FINANCING AND $6/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross Plant Capacity (MW)	0.00	1.06	1.06	1.06	1.06	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Net Plant Capacity (MW)	0.00	0.99	0.99	0.99	0.99	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Off Site Power Sales Rate ($/kWh)	$0.060	$0.062	$0.064	$0.066	$0.068	$0.070	$0.072	$0.074	$0.076	$0.078	$0.081	$0.083	$0.086	$0.088	$0.091
Off Site Power Sales (MWh/yr)	0	7,772	7,772	7,772	7,772	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544	15,544
Off Site Power Revenue	$0	$480,313	$494,722	$509,564	$524,850	$1,081,192	$1,113,628	$1,147,037	$1,181,448	$1,216,891	$1,253,398	$1,291,000	$1,329,730	$1,369,622	$1,410,710
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$148,617	$290,600	$283,855	$277,175	$270,667	$528,828	$516,883	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,013	5,013	5,013	5,013	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026	10,026
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$30,078	$30,078	$30,078	$30,078	$60,156	$60,156	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$148,617**	**$800,991**	**$808,655**	**$816,817**	**$825,595**	**$1,670,176**	**$1,690,666**	**$1,147,037**	**$1,181,448**	**$1,216,891**	**$1,253,398**	**$1,291,000**	**$1,329,730**	**$1,369,622**	**$1,410,710**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$684,050	$0	$0	$0	$450,750	$0	$0	$0	$127,250	$0	$0	$0	$130,250	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Power Plant O&M Rate ($/kWhr)	$0.018	$0.019	$0.019	$0.020	$0.020	$0.021	$0.021	$0.022	$0.023	$0.023	$0.024	$0.025	$0.026	$0.026	$0.027
Annual Power Plant O&M Cost	$0	$144,094	$148,417	$152,869	$157,455	$162,179	$167,044	$172,055	$177,217	$182,534	$188,010	$193,650	$199,459	$205,443	$211,607
Annual GCCS O&M Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$152,915	$305,831	$305,831	$305,831	$406,593	$507,356	$507,356	$507,356	$551,603	$595,850	$442,934	$290,019	$379,320	$468,622	$367,859
TOTAL ANNUAL COSTS	**$925,512**	**$600,394**	**$608,145**	**$616,108**	**$1,175,817**	**$880,787**	**$889,827**	**$862,290**	**$1,042,378**	**$1,016,255**	**$873,036**	**$730,196**	**$961,137**	**$926,667**	**$808,007**
NET CASH FLOW	**($776,895)**	**$200,597**	**$200,510**	**$200,709**	**($350,222)**	**$789,388**	**$800,840**	**$284,747**	**$139,070**	**$200,636**	**$380,362**	**$560,804**	**$368,593**	**$442,954**	**$602,703**
NPV															**$1,664,219**
INTERNAL RATE OF RETURN															**31.0%**

	1.06 MW 2006	2.12 MW 2010	2.12 MW 2014	2.12 MW 2018
INITIAL GROSS PLANT CAPACITY (MW)	1.06	2.12	2.12	2.12
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.99	1.97	1.97	1.97
PLANT CAPACITY FACTOR	90%	90%	0.90	0.90
ANNUAL POWER PRODUCTION (MWh/yr)	7,772	15,544	15,544	15,544
OFF SITE POWER SALE (MWH/yr)	7,772	15,544	15,544	15,544
FACILITY CAPITAL INVESTMENT COSTS	$2,736,200	$1,803,000	$509,000	$521,000
EQUITY PERCENTAGE	25%	25%	25%	25%
EQUITY CONTRIBUTION	$684,050	$450,750	$127,250	$130,250
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$6.00
OFF SITE SALES RATE	**$0.060**
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
POWER PLANT O&M COST ($/kW-hr)	$0.018
POWER PLANT O&M ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 5. ECONOMIC ANALYSIS OF PROPOSED DIRECT USE PROJECT
EL TREBOL LANDFILL - NO FINANCING AND $5/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Project Design Flow (cfm)	0	441	441	441	441	807	807	807	807	807	807	807	807	807	807
Gross Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Actual LFG Utilization (cfm)	0	397	397	397	397	726	726	726	726	726	726	726	726	726	726
Off Site Gas Sales Rate ($/mmBtu)	$5.00	$5.15	$5.30	$5.46	$5.63	$5.80	$5.97	$6.15	$6.33	$6.52	$6.72	$6.92	$7.13	$7.34	$7.56
Off Site Power Sales (mmBtu/yr)	0	105,557	105,557	105,557	105,557	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162
Off Site Power Revenue	$0	$543,618	$559,927	$576,725	$594,027	$1,119,639	$1,153,228	$1,187,825	$1,223,460	$1,260,164	$1,297,969	$1,336,908	$1,377,015	$1,418,325	$1,460,875
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$123,847	$242,167	$236,546	$230,980	$225,556	$440,690	$430,736	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,457	5,457	5,457	5,457	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$27,285	$27,285	$27,285	$27,285	$49,895	$49,895	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$123,847**	**$813,070**	**$823,758**	**$834,989**	**$846,867**	**$1,610,224**	**$1,633,859**	**$1,187,825**	**$1,223,460**	**$1,260,164**	**$1,297,969**	**$1,336,908**	**$1,377,015**	**$1,418,325**	**$1,460,875**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost	$1,656,800	$0	$0	$0	$412,000	$0	$0	$0	$509,000	$0	$0	$0	$521,000	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Annual Direct Use O&M + Electric Cost	$0	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853
Annual GCCS O&M and Upgrades Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL COSTS	**$1,745,347**	**$250,470**	**$256,898**	**$263,498**	**$682,291**	**$323,804**	**$331,354**	**$302,283**	**$818,295**	**$364,548**	**$372,569**	**$380,918**	**$911,530**	**$395,178**	**$375,395**
NET CASH FLOW	**($1,621,499)**	**$562,601**	**$566,860**	**$571,492**	**$164,576**	**$1,286,420**	**$1,302,505**	**$885,542**	**$405,165**	**$895,616**	**$925,399**	**$955,989**	**$465,485**	**$1,023,147**	**$1,085,480**
NPV															**$4,267,846**
INTERNAL RATE OF RETURN															**39.4%**

	2006	2010	2014	2018
INITIAL GROSS PLANT CAPACITY (MW)	0.00			
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.00			
PLANT CAPACITY FACTOR	90%			
ANNUAL POWER PRODUCTION (MWh/yr)	0			
OFF SITE POWER SALE (MWH/yr)	0			
TOTAL FACILITY INITIAL CAPITAL COST	$1,656,800	$412,000	$509,000	$521,000
EQUITY PERCENTAGE	100%	100%	100%	100%
EQUITY CONTRIBUTION	$1,656,800	$412,000	$509,000	$521,000
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$5.00
DIRECT USE PROJECT DESIGN FLOW (cfm)	441
OFF SITE GAS SALES RATE ($/mmBtu)	$5.00
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
2007 DIRECT USE O&M + ELECTRICITY COST	$100,000
DIRECT USE O&M + ELECTRICITY ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 6. ECONOMIC ANALYSIS OF PROPOSED DIRECT USE PROJECT
EL TREBOL LANDFILL - WITH FINANCING AND $5/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Project Design Flow (cfm)	0	441	441	441	441	807	807	807	807	807	807	807	807	807	807
Gross Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Actual LFG Utilization (cfm)	0	397	397	397	397	726	726	726	726	726	726	726	726	726	726
Off Site Gas Sales Rate ($/mmBtu)	$5.00	$5.15	$5.30	$5.46	$5.63	$5.80	$5.97	$6.15	$6.33	$6.52	$6.72	$6.92	$7.13	$7.34	$7.56
Off Site Power Sales (mmBtu/yr)	0	105,557	105,557	105,557	105,557	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162
Off Site Power Revenue	$0	$543,618	$559,927	$576,725	$594,027	$1,119,639	$1,153,228	$1,187,825	$1,223,460	$1,260,164	$1,297,969	$1,336,908	$1,377,015	$1,418,325	$1,460,875
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$123,847	$242,167	$236,546	$230,980	$225,556	$440,690	$430,736	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,457	5,457	5,457	5,457	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$27,285	$27,285	$27,285	$27,285	$49,895	$49,895	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$123,847**	**$813,070**	**$823,758**	**$834,989**	**$846,867**	**$1,610,224**	**$1,633,859**	**$1,187,825**	**$1,223,460**	**$1,260,164**	**$1,297,969**	**$1,336,908**	**$1,377,015**	**$1,418,325**	**$1,460,875**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$414,200	$0	$0	$0	$103,000	$0	$0	$0	$127,250	$0	$0	$0	$130,250	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Annual Direct Use O&M + Electric Cost	$0	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853
Annual GCCS O&M and Upgrades Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$92,592	$185,184	$185,184	$185,184	$208,209	$231,234	$231,234	$231,234	$275,481	$319,728	$227,136	$134,544	$223,845	$313,147	$290,122
TOTAL ANNUAL COSTS	**$595,339**	**$435,654**	**$442,082**	**$448,682**	**$581,500**	**$555,038**	**$562,588**	**$533,518**	**$712,026**	**$684,276**	**$599,705**	**$515,462**	**$744,626**	**$708,325**	**$665,517**
NET CASH FLOW	**($471,491)**	**$377,417**	**$381,676**	**$386,308**	**$265,367**	**$1,055,186**	**$1,071,271**	**$654,308**	**$511,434**	**$575,888**	**$698,263**	**$821,445**	**$632,389**	**$710,000**	**$795,358**
NPV															**$4,171,329**
INTERNAL RATE OF RETURN															**88.3%**

	2006	2010	2014	2018
INITIAL GROSS PLANT CAPACITY (MW)	0.00			
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.00			
PLANT CAPACITY FACTOR	90%			
ANNUAL POWER PRODUCTION (MWh/yr)	0			
OFF SITE POWER SALE (MWH/yr)	0			
TOTAL FACILITY INITIAL CAPITAL COST	$1,656,800	$412,000	$509,000	$521,000
EQUITY PERCENTAGE	25%	25%	25%	25%
EQUITY CONTRIBUTION	$414,200	$103,000	$127,250	$130,250
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$5.00
DIRECT USE PROJECT DESIGN FLOW (cfm)	441
OFF SITE GAS SALES RATE ($/mmBtu)	$5.00
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
2007 DIRECT USE O&M + ELECTRICITY COST	$100,000
DIRECT USE O&M + ELECTRICITY ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 7. ECONOMIC ANALYSIS OF PROPOSED DIRECT USE PROJECT
EL TREBOL LANDFILL - NO FINANCING AND $6/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Project Design Flow (cfm)	0	441	441	441	441	807	807	807	807	807	807	807	807	807	807
Gross Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Actual LFG Utilization (cfm)	0	397	397	397	397	726	726	726	726	726	726	726	726	726	726
Off Site Gas Sales Rate ($/mmBtu)	$5.00	$5.15	$5.30	$5.46	$5.63	$5.80	$5.97	$6.15	$6.33	$6.52	$6.72	$6.92	$7.13	$7.34	$7.56
Off Site Power Sales (mmBtu/yr)	0	105,557	105,557	105,557	105,557	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162
Off Site Power Revenue	$0	$543,618	$559,927	$576,725	$594,027	$1,119,639	$1,153,228	$1,187,825	$1,223,460	$1,260,164	$1,297,969	$1,336,908	$1,377,015	$1,418,325	$1,460,875
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$148,617	$290,600	$283,855	$277,175	$270,667	$528,828	$516,883	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,457	5,457	5,457	5,457	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$32,742	$32,742	$32,742	$32,742	$59,874	$59,874	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$148,617**	**$866,961**	**$876,524**	**$886,642**	**$897,435**	**$1,708,341**	**$1,729,985**	**$1,187,825**	**$1,223,460**	**$1,260,164**	**$1,297,969**	**$1,336,908**	**$1,377,015**	**$1,418,325**	**$1,460,875**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost	$1,656,800	$0	$0	$0	$412,000	$0	$0	$0	$509,000	$0	$0	$0	$521,000	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Annual Direct Use O&M + Electric Cost	$0	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853
Annual GCCS O&M and Upgrades Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL COSTS	**$1,745,347**	**$250,470**	**$256,898**	**$263,498**	**$682,291**	**$323,804**	**$331,354**	**$302,283**	**$818,295**	**$364,548**	**$372,569**	**$380,918**	**$911,530**	**$395,178**	**$375,395**
NET CASH FLOW	**($1,596,730)**	**$616,491**	**$619,626**	**$623,145**	**$215,144**	**$1,384,537**	**$1,398,631**	**$885,542**	**$405,165**	**$895,616**	**$925,399**	**$955,989**	**$465,485**	**$1,023,147**	**$1,085,480**
NPV															**$4,569,172**
INTERNAL RATE OF RETURN															**42.9%**

	2006	2010	2014	2018
INITIAL GROSS PLANT CAPACITY (MW)	0.00			
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.00			
PLANT CAPACITY FACTOR	90%			
ANNUAL POWER PRODUCTION (MWh/yr)	0			
OFF SITE POWER SALE (MWH/yr)	0			
TOTAL FACILITY INITIAL CAPITAL COST	$1,656,800	$412,000	$509,000	$521,000
EQUITY PERCENTAGE	100%	100%	100%	100%
EQUITY CONTRIBUTION	$1,656,800	$412,000	$509,000	$521,000
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$6.00
DIRECT USE PROJECT DESIGN FLOW (cfm)	441
OFF SITE GAS SALES RATE ($/mmBtu)	$5.00
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
2007 DIRECT USE O&M + ELECTRICITY COST	$100,000
DIRECT USE O&M + ELECTRICITY ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%

TABLE 8. ECONOMIC ANALYSIS OF PROPOSED DIRECT USE PROJECT
EL TREBOL LANDFILL - WITH FINANCING AND $6/TON FOR EMISSION REDUCTIONS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Project Design Flow (cfm)	0	441	441	441	441	807	807	807	807	807	807	807	807	807	807
Gross Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Actual LFG Utilization (cfm)	0	397	397	397	397	726	726	726	726	726	726	726	726	726	726
Off Site Gas Sales Rate ($/mmBtu)	$5.00	$5.15	$5.30	$5.46	$5.63	$5.80	$5.97	$6.15	$6.33	$6.52	$6.72	$6.92	$7.13	$7.34	$7.56
Off Site Power Sales (mmBtu/yr)	0	105,557	105,557	105,557	105,557	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162	193,162
Off Site Power Revenue	$0	$543,618	$559,927	$576,725	$594,027	$1,119,639	$1,153,228	$1,187,825	$1,223,460	$1,260,164	$1,297,969	$1,336,908	$1,377,015	$1,418,325	$1,460,875
LFG Recovery Rate (m3/hr)	823	805	786	768	749	1,464	1,431	1,400	1,370	2,013	1,974	1,937	1,913	2,482	2,101
Baseline Reduction (m3/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane Emission Reduction (tonnes/yr)	1,179	2,306	2,253	2,200	2,148	4,197	4,102	4,012	3,927	5,771	5,657	5,550	5,484	7,115	6,021
Methane Emission Reductions (tonnes CO2eq/yr)	24,769	48,433	47,309	46,196	45,111	88,138	86,147	84,258	82,474	121,183	118,800	116,556	115,157	149,419	126,440
Emission Reduction Sales Rate ($/tonne CO2eq)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Revenue from Methane Reductions ($/yr)	$148,617	$290,600	$283,855	$277,175	$270,667	$528,828	$516,883	$0	$0	$0	$0	$0	$0	$0	$0
Emission Reductions from Energy Displacement (tonnes CO2eq/yr)	0	5,457	5,457	5,457	5,457	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
Revenue from Emission Reductions from Energy Displacement ($/yr)	$0	$32,742	$32,742	$32,742	$32,742	$59,874	$59,874	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL REVENUE	**$148,617**	**$866,961**	**$876,524**	**$886,642**	**$897,435**	**$1,708,341**	**$1,729,985**	**$1,187,825**	**$1,223,460**	**$1,260,164**	**$1,297,969**	**$1,336,908**	**$1,377,015**	**$1,418,325**	**$1,460,875**
LFG Recovered (MMBtu/yr)	64,419	125,963	123,039	120,144	117,322	229,224	224,046	219,133	214,494	315,167	308,969	303,132	299,493	388,599	328,837
Equity Contribution to Capital Cost (including GCCS upgrades)	$414,200	$0	$0	$0	$103,000	$0	$0	$0	$127,250	$0	$0	$0	$130,250	$0	$0
LFG Purchase Price ($/MMBtu)	$0.35	$0.36	$0.37	$0.38	$0.39	$0.41	$0.42	$0.43	$0.44	$0.46	$0.47	$0.48	$0.50	$0.51	$0.53
Annual Cost for LFG Purchase ($)	$22,547	$45,410	$45,686	$45,949	$46,217	$93,007	$93,633	$94,327	$95,100	$143,927	$145,330	$146,862	$149,452	$199,735	$174,088
Annual Direct Use O&M + Electric Cost	$0	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853
Annual GCCS O&M and Upgrades Cost	$36,000	$74,160	$76,385	$78,676	$81,037	$83,468	$85,972	$88,551	$91,207	$93,944	$96,762	$99,665	$102,655	$52,867	$54,453
Annual Registration, Monitoring&Verification	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$0	$0	$0	$0	$0	$0	$0	$0
Annual Debt Service	$92,592	$185,184	$185,184	$185,184	$208,209	$231,234	$231,234	$231,234	$275,481	$319,728	$227,136	$134,544	$223,845	$313,147	$290,122
TOTAL ANNUAL COSTS	**$595,339**	**$435,654**	**$442,082**	**$448,682**	**$581,500**	**$555,038**	**$562,588**	**$533,518**	**$712,026**	**$684,276**	**$599,705**	**$515,462**	**$744,626**	**$708,325**	**$665,517**
NET CASH FLOW	**($446,722)**	**$431,307**	**$434,442**	**$437,961**	**$315,935**	**$1,153,303**	**$1,167,397**	**$654,308**	**$511,434**	**$575,888**	**$698,263**	**$821,445**	**$632,389**	**$710,000**	**$795,358**
NPV															**$4,472,655**
INTERNAL RATE OF RETURN															**103.2%**

	2006	2010	2014	2018
INITIAL GROSS PLANT CAPACITY (MW)	0.00			
INITIAL NET PLANT CAPACITY (MW) (7% parasitic load)	0.00			
PLANT CAPACITY FACTOR	90%			
ANNUAL POWER PRODUCTION (MWh/yr)	0			
OFF SITE POWER SALE (MWH/yr)	0			
TOTAL FACILITY INITIAL CAPITAL COST	$1,656,800	$412,000	$509,000	$521,000
EQUITY PERCENTAGE	25%	25%	25%	25%
EQUITY CONTRIBUTION	$414,200	$103,000	$127,250	$130,250
DEBT INTEREST RATE	8.0%	8.0%	8.0%	8.0%
NPV RATE	8.0%	8.0%	8.0%	8.0%
FINANCING LIFE (years)	10.0	10.0	5.5	2.5

EMISSION REDUCTIONS SALES RATE ($/tonne CO2eq)	$6.00
DIRECT USE PROJECT DESIGN FLOW (cfm)	441
OFF SITE GAS SALES RATE ($/mmBtu)	$5.00
POWER PRICE ESCALATION	3.0%
LFG PURCHASE RATE ($/MMBtu)	$0.35
FUEL ESCALATION RATE	3.0%
2007 DIRECT USE O&M + ELECTRICITY COST	$100,000
DIRECT USE O&M + ELECTRICITY ESCALATION	3.0%
2006 REGISTRATION, MONITORING, VERIFICATION	$30,000
2006 GCCS O&M COST	$36,000
GCCS O&M/UPGRADES ESCALATION	3.0%