



# Global Environment Facility

**Mohamed T. El-Ashry**  
Chief Executive Officer  
and Chairman

1818 H Street, NW  
Washington, DC 20433 USA  
Tel: 202.473.3202  
Fax: 202.522.3240/3245  
Email: melashry@worldbank.org

April 17, 2001

Dear Council Member:

The World Bank, as the Implementing Agency for the project, *Mexico: Methane Capture and Use (Landfill Demonstration)*, has submitted the attached proposed project document for CEO endorsement prior to final approval of the project document in accordance with World Bank procedures.

The Secretariat has reviewed the project document. It is consistent with the proposal approved by the Council in May 2000 and the proposed project remains consistent with the Instrument and GEF policies and procedures. The attached explanation prepared by the World Bank satisfactorily details how Council's comments and those of the STAP reviewer have been addressed. I am, therefore, endorsing the project document.

We have today posted the proposed project document on the GEF website at [www.gefweb.org](http://www.gefweb.org). If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,

cc: Alternates, Implementing Agencies, STAP

# OFFICE MEMORANDUM

DATE: April 9, 2001

TO: Mr. Mohamed El-Ashry, CEO/Chairman, GEF

FROM: Lars Vidaeus, GEF Executive Coordinator



EXTENSION: 34188

SUBJECT: **Mexico: Methane Capture and Use at a Landfill Demonstration Project  
Submission for Final CEO Endorsement**

1. Please find attached the electronic file of the Project Appraisal Document (PAD) for the above-mentioned project for your final review and endorsement. This project was approved for Work Program entry at the Bilateral Review Meeting with the World Bank on March 23, 2000 under streamlined CEO endorsement procedures
2. The PAD is fully consistent with the objectives, scope, and overall cost of the proposal approved at the April 2000 Council meeting. Only, minor adjustments have been made during final preparation. GEFSEC, STAP, and Council comments have also been addressed. Modifications to the PAD and how comments have been addressed are detailed below.

### Comments from Council Members

It was suggested that there needed to be a discussion of the water management associated with the landfill gas project. The issues of water management at the SIMEPRODESOS landfill were further analyzed before appraisal and are discussed in the PAD (page 33 "liquid wastes"; page 87 "Landfill Gas Condensate"). The leachate management system SIMEPRODESOS was reviewed and their current method of recirculating the water was found to be adequate. In addition, the landfill gas condensate will be recirculated. Monitoring of groundwater is also included in the environmental management plan.

It was suggested that additional details should be provided regarding the role and participation of private investors. The role and participation of private investors was significantly expanded upon as it is the basis for financing of the demonstration project. See Institutional Section, pg 23 and Annex 12.

It was suggested that the project document should indicate how, in future projects, economic actors will assume responsibility for the financial incentive provided by the grant. In terms of the long-term viability of the project, the replicability component

(pg 20 "Replication of the Project") now clarifies that there are several financial mechanisms (listed below) that can assume the role that the grant played in the demonstration project. Their role in future development of the landfill gas projects along with strategies to encourage their application will be a focus of the replication strategy:

- In the demonstration project, the GEF grant was needed to compensate for project risks and provide adequate internal rate of return. It is expected that the operational and management experience of the demonstration project will reduce the costs of developing a LFG project in Mexico and reduce the perceived and real risks to private investment. This combined with the high electricity selling price (2-3 times higher than those commonly found in the US) for these projects in Mexico may allow future projects to be financially self-sustaining.
- The estimated CO<sub>2</sub> mitigation costs from this project are in the range of \$5/ton of CO<sub>2</sub> and therefore constitute a very attractive option for the carbon trade market. It is expected that future projects in Mexico and elsewhere would benefit from financing provided from the carbon trade.
- The US system of providing tax incentives that effectively increase the transfer price of electricity is a potential option for enhancing the financial returns of these projects. This will be evaluated as to its necessity and policy implications and, if appropriate, the optimal means of implementation will be explored.

#### Comments from STAP

STAP comments were incorporated at the time of Concept Review as described in the attached memo. The changes continue to be reflected in the project.

3. The grant has been adjusted from the US \$6.53 million approved by the Council to the current US \$6.27 million. This reflects the incorporation of updated costs and financial analysis provided by the feasibility study into the incremental cost analysis.
4. Please let me know if you require any additional information to complete your review of the project document. We look forward to receiving your endorsement of the project for Bank Board approval.

Many thanks,

cc: Messrs./Mmes. King, GEF PROGRAM COORDINATION (GEFSEC); Challa (LCC1C);Leipziger, Goldmark (LCSFP); Redwood, Serra, Vergara, Shepherdson, Bradley, Spainhower, Isaac, Morton, Abedin, Montas; Genta-Fons (LEGLA); Fowler (LOAEL); Gazoni (LCOPR) Sharma, Vidaeus, Khanna, Aryal (ENV); ENVGC ISC, Regional Files

Attachment

PAD

STAP comments and task team response (from PCD)

World Bank User  
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MEXICO

Methane Gas Capture and Use at a Landfill - Demonstration Project

**Project Appraisal Document**

Latin America and Caribbean Region  
LCSEN

<b>Date:</b> April 6, 2001	<b>Team Leader:</b> Walter Vergara
<b>Country Manager/Director:</b> Olivier Lafourcade	<b>Sector Manager/Director:</b> Danny M. Leipziger
<b>Project ID:</b> P063463	<b>Sector(s):</b> PY - Other Power & Energy Conversion
	<b>Theme(s):</b> Energy
<b>Focal Area:</b> G	<b>Poverty Targeted Intervention:</b> N

<b>Project Financing Data</b>			
<input type="checkbox"/> Loan	<input type="checkbox"/> Credit	<input checked="" type="checkbox"/> Grant	<input type="checkbox"/> Guarantee
<input type="checkbox"/> Other:			
<b>For Loans/Credits/Others:</b>			
<b>Amount (US\$m):</b>			
<b>Financing Plan:</b>	<b>Source</b>	<b>Local</b>	<b>Foreign</b>
		<b>Total</b>	
BORROWER		0.25	0.14
GLOBAL ENVIRONMENT FACILITY		1.77	4.50
OTHER PRIVATE COMMERCIAL SOURCES (UNIDENTIFIED)		1.36	5.23
<b>Total:</b>		3.38	9.87
			13.25

**Borrower/Recipient:** UNITED MEXICAN STATES, BANOBRAS  
**Responsible agency:** BANOBRAS  
 BANOBRAS  
 Address: Tecoyotitla 100 piso 3, Col Florida, Mexico D.F. 01030  
 Contact Person: Lic. Alejandro Peralta  
 Tel: 525 723 6261 Fax: 525 723 6007 Email: aperalta@banobras.gob.mx  
 idiaza@banobras.gob.mx  
**Other Agency(ies):**  
 SEDESOL  
 Address: Exhacienda Belem de Las Flores S/N  
 Contact Person: Ing. Gustavo Rosiles Castro  
 Tel: 525 273 2959 Fax: 525 273 2959 Email: direcressol@yahoo.com.mx  
 SIMPRODESO  
 Address: Emilio Carranza No. 730 Sur 2do Piso  
 C.P. 64000 Monterrey, N.L.  
 Contact Person: Ing. Carlos Segovia  
 Tel: 528 344 5430 Fax: 528 344 5430 ext 214 Email: simeprode@infosel.net mx

<b>Estimated disbursements ( Bank FY/US\$M):</b>							
<b>FY</b>	2002	2003	2004	2005	2006		
<b>Annual</b>	2.50	2.44	0.82	0.38	0.13		
<b>Cumulative</b>	2.50	4.94	5.76	6.14	6.27		

**Project implementation period:** October 31, 2001-June 30, 2006

## **A. Project Development Objective**

### **1. Project development objective:** (see Annex 1)

The proposed project seeks to demonstrate a proven technology for landfill gas (LFG) capture and use and reduce barriers to development of future LFG projects. The proposed GEF project would build upon an existing Government and Bank-supported program to modernize solid waste management in small- and medium-sized cities (Ln. 3752-ME). The GEF Alternative would complement and build upon activities implemented under this baseline program, and provide financial and technical assistance for: i) introduction of a cost-effective, demonstrated technology to collect and utilize LFG; ii) demonstrate an institutional structure that includes private sector participation under which LFG projects can be implemented; iii) development of federal and municipal capacity for LFG collection and use programs and project implementation; and iv) design of a replication strategy for comparable cities in Mexico and dissemination of lessons from the Mexican experience to other interested parties regionally.

### **2. Key performance indicators:** (see Annex 1)

The LFG collection system and power plant to be installed and operated at the SIMEPRODESO landfill located in Salinas Victoria near the Monterrey metropolitan area in the State of Nuevo León, the key physical activity of the project, is expected to capture or substitute for an equivalent of 0.99 million tons of carbon over 20 years. The key performance indicator for this component is that the demonstration LFG facility is shown to be technically, financially and institutionally feasible within the Mexican context. The key performance indicators that will monitor the performance of the remaining components (Capacity Building, Policy and Regulatory Reform and Regional Dissemination) are: i) the number of potential participants in LFG projects in Mexico and Latin America to whom technical, institutional, and managerial knowledge on LFG were made available; ii) incorporation of LFG management issues into proposed legislation; iii) increase in number of government programs for support of LFG facility development; and iv) increase in number of planned LFG projects in Mexico.

## **B. Strategic Context**

### **1. Sector-related Country Assistance Strategy (CAS) goal supported by the project:** (see Annex 1)

**Document number:** 19289-MX

**Date of latest CAS discussion:** May 13, 1999

The CAS identifies three core themes for World Bank Group Assistance to Mexico – social sustainability, removing obstacles to sustainable growth, and effective public governance. Within this broad framework, the Bank Strategy for Infrastructure mentions support for renewable energy and municipal development plans as priorities for action. The Solid Waste Sector is noted as one of the key sectors that needs attention in order to improve service delivery. The CAS also includes, as part of the environmental agenda, promotion of institutional development, decentralization of environmental management, improved cost recovery of environmental services and "win-win" investment opportunities where global environmental benefits and national economic benefits can be generated through an integrated and mainstreamed approach to development priorities. Additionally, a draft of the Mexico Urban Policy Note mentions the development of nation-wide managerial training and institution building for state and local officials as a priority.

#### **1a. Global Operational strategy/Program objective addressed by the project:**

The project is fully consistent with guidance from the United Nations Framework Convention on Climate Change (UNFCCC). Specifically, the GEF resources will be utilized to finance part of the incremental costs associated with reductions in greenhouse gas emissions. A pre-feasibility study that used technical, social, economic and financial criteria to rank project options, identified Salinas Victoria as the most

attractive site out of the 33 cities preselected for the analysis, and power generation as the most viable use of LFG.

The proposed project is consistent with both the GEF guidance (June 1997) for Operational Program Number 6 (Renewable Energy) and with the GEF Operational Strategy (February 1996) for short-term projects in the climate change focal area. This is because the project is: i) technically, environmentally and socially sustainable, ii) a national priority and country driven; iii) cost effective, capturing and substituting for greenhouse gases at an anticipated cost of about \$4.99 per ton of carbon; and iv) it provides a programmatic approach to barrier removal that is expected to lay the foundation for cost-effective replication over the medium and long-term. In addition, the project would support essential transfer of technology and managerial assistance through the technical and financial partnership formed to implement the demonstration project and practical hands on experience for widespread application of methane capture at landfills in Mexico and elsewhere.

## **2. Main sector issues and Government strategy:**

### *Main Sector Issues.*

Solid Waste Management (SWM). As is the case with many developing nations, Mexico faces serious difficulties in the management of urban refuse and solid waste. It is estimated that over 82,000 tons of solid waste is generated in the country every day. Yet, there is a general lack of proper treatment and disposal facilities, institutional capacities are weak, and financial support at local and municipal levels is frequently deficient. The problem is exacerbated by: i) the sustained growth of population; ii) the high rate of rural migration to urban settings; and iii) an increased degree of industrialization and associated local consumption patterns. For example, during the last several decades, Mexico has been urbanizing rapidly (currently, approximately 60% of the population of 92 million\* live in cities with over 15,000 inhabitants). The per capita generation of urban refuse has also increased in response to increased per capita incomes.

Regrettably, of all the solid waste generated, only 77% is collected (62 thousand tons per day) and less than 35% is disposed under sanitary conditions (29 thousand tons per day). Open dumping is the most common solid waste disposal method in small- and medium-sized cities in Mexico. Open dumping contributes to serious health and safety problems in affected communities, has a negative impact on property values and has been linked to the contamination of aquifers and surface waters. Further, open dumpsites are often associated with a significant scavenging population who depend upon recycling of refuse items for their livelihood. Sanitary landfills have been gradually introduced in Mexico over the past fifteen years\*\*, together with training and occupational programs that create jobs for scavengers at transfer stations and recycling plants.

At present, there are approximately 20 small- and medium-sized cities in Mexico that operate sanitary landfills. Institutional and regulatory arrangements for SWM appear to be clear and satisfactory. Of particular importance is the Social Development Secretary (SEDESOL), the agency responsible for setting national solid waste policies and directing federal assistance for solid waste. Under the leadership of SEDESOL, and in cooperation with several municipalities (seven of which are also receiving Bank assistance) a training and investment program was launched to address SWM needs in: a) institutional development (management and operation); b) training of regulators, managers and operators; c) support for investments in solid waste management; and d) development of cost-recovery schemes for waste management services. Independent operators are now involved in 14 municipalities and are dealing

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\*Estimate of 1997 population size, annual growth rate 2%.

\*\*The first "sanitary" landfill-i.e., an engineered solid waste management facility with a liner, cover material, and some degree of waste compaction--was built in the DF in 1986 (Poniente landfill) as a prelude to a nation-wide program initiated in 1993.

with collection and transfer. These efforts have yielded a higher level of participation of the private sector in the delivery of solid waste management services as well as in a higher level of managerial capacity in the assisted communities. The participation of private sector and joint private/public solid waste companies have addressed a chronic weakness in the delivery of services. It is now expected that the examples provided by these operators will open the way to a higher level of service and accountability. New regulations have recently been issued that establish the minimum requirements for sanitary landfills and are now in force.

Landfill Gas Management. As the waste that is deposited in landfills and dumpsites decomposes, it produces LFG which is typically composed of 50% methane and 50% CO<sub>2</sub>+ trace gases. Methane is a greenhouse gas and emissions from landfills contribute about 10% of total methane emissions in Mexico\*. As a greenhouse gas, methane is 21 times more potent than CO<sub>2</sub> on a molecular weight basis. Put another way, each ton of methane emitted into the atmosphere has the equivalent warming impact of 21 tons of carbon dioxide\*\* and by burning CH<sub>4</sub> for conversion to CO<sub>2</sub>, greenhouse gas emissions will decrease 21 fold. Recently, additional calls for forceful actions in the reduction of methane emissions have been made in the scientific and climate change policy communities. The reduction of methane emissions is a critical part of the Mexican strategy to control emission of greenhouse gases.

There is currently no LFG facilities in Mexico. In fact, only a handful of LFG utilization plants are in operation in developing nations worldwide. Mexico lacks technical and institutional experience specific to the identification, design and implementation of LFG capture and utilization projects. Regulations targeting LFG management at sanitary landfills have yet to be issued. Under the proposed project, a demonstration LFG project will be implemented through a public-private partnership at a landfill in Salinas Victoria. The landfill operator, SIMEPRODESO, will implement the project under a private-public institutional arrangement common to independent power production in Mexico. Through the Ministry of Social Development, SEDESOL, the project will also provide training and dissemination of the results of the demonstration project to municipalities and other participants in the solid waste and energy sectors. SEDESOL will also oversee the studies necessary for incorporation of LFG into existing solid waste legislation.

Electricity Supply by Independent Generators. Power supply in Mexico has been a traditional public sector domain, but as supply has failed to keep up with growing demand (6% per year), the electricity authority (CFE) has opened the door to private sector participation in financing and operating generating facilities. Current regulations now allow for private generators to supply electricity to the national grid or for self-use (as a co-generation company or independently). Most of the independent generation is still for the latter. However, the current plan for the electric sector envisions a large increase in installed capacity from independent generators. The expected increase in power requirements and the commitment of the Government and the CFE to expand the clean energy component in the national power mix provide a basis for the planning and implementation of independent generation capacity. There are currently 80 Independent Power Producers (IPPs) that are either generating or scheduled to provide almost 4,000 MW by 2003. The proposed plant will provide 7 MW (~0.2%) of this emerging sector. LFG has not been regulated as an alternative fuel but is excluded from the definition of natural gas and therefore does not fall

\*Avances en el desarrollo de indicadores para la evaluación del desempeño ambiental en Mexico 1997, INE, SEMARNAP.

\*\* "Turning Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook", Landfill Methane Outreach Program, USEPA (September 1996).



under the jurisdiction of PEMEX, thus allowing private sector exploitation of LFG. The use of LFG is possible for independent power generation because current regulations allow for the use of by-products from existing production processes for electricity generation.

### Government Strategy.

Solid Waste Management. In its broadest form, the GoM's strategy for halting environmental degradation and remedying past problems is articulated in its "Plan Nacional de Desarrollo: 1995-2000" and its "Programa Nacional para la Protección del Medio Ambiente". Within this framework, UMS has initiated reforms to enhance the participation of state and municipal governments in the provision of basic conditions to improve solid waste management through "La Norma Oficial Mexicana" (NOM-083-ECOL-1996) and is implementing a strategy to strengthen solid waste management at multiple levels. The strategy calls for: a) strengthening of regulations and institutions at a federal and local level conducive to more effective practices and incentives; b) extension of services to medium and small size localities and promotion of private sector participation; c) harmonization of solid waste management efforts with efforts aimed at controlling the release of greenhouse gases (emissions of landfill methane); and d) promotion of recycling.

Mindful of the long-term costs of improper solid waste management, the UMS has initiated, with assistance from the World Bank, a program designed to address some of the underlying causes of improper solid waste management. This program is being implemented by SEDESOL and is assisting specific communities, committed to policy and institutional reform to develop, design and operate long-term solid waste management programs. The assistance will also result in the mapping of a comprehensive recycling plan. The Baseline Project has been successful in reaching policy and institutional agreements with various municipalities representing a wide-spectrum of local conditions (see Annex 14 for more details).\*

The UMS now wishes to expand its approach to solid waste management in small- and medium-sized cities by integrating management of LFG as one of the required elements for sanitary landfills. It also wishes to expand technical and financial assistance to committed municipalities so that they may build their capacity to handle this new aspect of solid waste management effectively. The proposed GEF project is intended to demonstrate the application of the technology and institutional framework necessary for the operation of a methane capture and use plant in Mexico. Over the longer term, the UMS intends to expand its program of assistance to additional small- and medium-sized municipalities, and such expansion programs would integrate LFG management as part of the solid waste strategy, building on the lessons from the demonstration project. The proposed GEF project would assist in this process by analyzing barriers and capacity gaps, and developing a national dissemination/replication strategy.

Social Participation Strategy Related to Waste Management. SEDESOL's solid waste management strategy calls for the upgrading of open dumps to sanitary landfills at sites where unregulated scavenging operations are routinely performed. Conversion of open dumps to sanitary landfills include measures to mitigate the social impact on scavengers. The Baseline Project included social participation strategies for populations negatively affected by the improved solid waste disposal. Measures that have proved successful include the organization of transfer stations where recycling operations will be regulated, general hygienic conditions improved, and training for alternative jobs, such as carpentry and baking. The transfer stations are expected to employ many of the displaced scavengers. The UMS also has General Strategic Guidelines which promote public participation in cleaning up neighborhoods. In general, introducing

\*Including the following municipalities: Guanajuato; Monterrey; Durango; Aguascalientes; Tampico-Madero-Altamira; Manzanillo; Cuautla.

LFG capture technologies at a well-managed sanitary landfill does not entail additional social impacts.

Institutional Capacity for Solid Waste/Landfill Gas Management. UMS has invested substantial resources over the past 5 years for the purposes of technical assistance, training courses, and workshops aimed at improving the knowledge and skills base of both federal officials and municipalities staff related to solid waste management. Many of the courses and materials were supported by the Baseline Project. The UMS, with support from the GEF, now intends to expand the scope of training and technical assistance to include LFG management. Under thus proposed GEF project, a LFG expert will be hired by SEDESOL to assist in the implementation of this training and technical assistance in order to facilitate the replication of the technology throughout the country.

Policy Strategy for Solid Waste/Landfill Gas Management. The current regulatory framework for solid waste management in Mexico is satisfactory with respect to standards established for solid waste collection and disposal, environmental impact and social impact mitigation, and monitoring requirements. However, LFG is currently not addressed in the normative framework. LFG collection and capture has been recently recognized as a solid waste management concern and has been highlighted as a pending area for regulation in SEDESOL's current strategy. Therefore, the UMS intends to prepare new regulations to strengthen landfill construction guidelines in order to facilitate venting and collection of LFG and to promote proper monitoring of LFG generation. The proposed Norma will address LFG issues in sanitary landfills. The proposed GEF project will provide reviews in order to assist UMS in integrating LFG issues in the proposed Norma. Enforcement of existing and proposed regulations has been delegated to the Municipalities and therefore, SEDESOL has focused on training and capacity building efforts at the local level. SEDESOL intends to continue its program of assistance to municipal waste management authorities to raise awareness on the need for enforcement of federal regulations related to LFG emissions.

Policy Strategy for Independent Power Providers. The UMS has committed to expanding the role of clean sources of energy in the national energy mix. To this end, CFE has created a unit for New Sources of Energy, with the responsibility to promote and encourage the development and use of cleaner sources of energy. The Secretary of Energy and CFE have indicated their support for future development of power projects by the private sector. As the UMS has already decided to promote cleaner sources of energy and independent power producers, the LFG project would be in support of this strategy. The UMS further intends to analyze issues affecting LFG use and propose any necessary measures. There are no indications that the recent change in government will change these policies.

### **3. Sector issues to be addressed by the project and strategic choices:**

The Baseline Project is a key part of the UMS's commitment to improving solid waste management in small- and medium-sized cities. The sector issues related to improving solid waste management, including physical investments, capacity-building, social mitigation measures, and regulatory framework, are part of the baseline project (Solid Waste Management II/Ln 3752-ME).

The major sector issues will be addressed in the following manner:

- The absence of sound technical information on how LFG capture and use technologies can be adapted to Mexican landfill conditions will be addressed by supporting the design and implementation of a system to capture and utilize LFG at the SIMEPRODESO landfill in Salinas Victoria;
- The need for a model institutional structure for implementing LFG projects will be addressed through the development of the demonstration facility at SIMEPRODESO under an institutional structure that

can be applied elsewhere in Mexico;

- The goal to reduce methane emissions from open dumps and landfills will be addressed by implementing a gas utilization project that will capture and estimated 214 million m<sup>3</sup> of methane;
- The lack of municipal, private, state, or federal knowledge of and capacity for LFG management at solid waste disposal sites will be addressed through the organization of workshops, dissemination of technical documents, and other outreach materials designed to educate these stakeholders;
- The incomplete regulatory framework as it pertains to LFG capture and use will be addressed by working with SEDESOL to include technical specifications and standards for future LFG capture and use plants in a draft Norma (084);
- The absence of a replication strategy for integrating LFG capture in the SWM programs for small- and medium-sized cities will be addressed through the development of a national replication strategy;
- The need to design a participatory approach to deal with social impacts of future LFG capture plants in Mexico and Latin America will be addressed in the preparation of a national replication strategy and regional dissemination materials; and
- The need to support and consolidate institutional capacity of SEDESOL, will be addressed by working with SEDESOL to fund training, workshops on LFG capture and utilization, and by publishing technical dissemination materials.

## **C. Project Description Summary**

### **1. Project components** (see Annex 2 for a detailed description and Annex 3 for a detailed cost breakdown):

The major project component (A) will be the demonstration project at the SIMEPRODESO landfill in Salinas Victoria. This will be implemented under a public-private institutional arrangement that can be used as a model for replication in Mexico. The remaining components will be implemented by SEDESOL and are designed to build capacity, disseminate project results, develop a strategy for replication, and provide support in draft legislation.

#### **A. *Detailed Engineering Design and Construction of a Plant for Methane Capture and Use.***

This component will provide funding for the design and construction of a LFG collection system and a power plant (estimated to be 7 MW) at a 44 ha filled cell at the SIMEPRODESO landfill. The facility will include: i) the wells, piping network and blowers that will collect the methane produced by the landfill and deliver it to the power plant; ii) a power plant with a treatment plant to remove moisture from the LFG before combustion; iii) substation and electrical connection lines necessary for connection to CFE grid; iv) a flare that burns off excess methane not used by the power plant and thus allows for maximal destruction of methane even during plant shutdowns; v) supporting infrastructure such as roads, sewerage, water supply, buildings and lighting; and vi) project design, operator training and supervision. The design, construction and operation of the plant will be implemented through a private-public partnership with responsibilities shared between the two major partners, the landfill owner (SIMEPRODESO) and a private company experienced in LFG ("Strategic Partner") (for details see institutional section of Summary Analysis). As the project will be a technical, financial and institutional model for replication, the development of the facility will be documented by SIMEPRODESO for use in the Capacity Building and Regional Dissemination Components. These documents will include: i) a design and construction summary report; ii) a quarterly operational summary report; iii) an annual progress report that would include lessons learned during project implementation and recommendations for future project replication; and iv) an annual environmental summary report. In addition to this documentation, a representative from SEDESOL will be appointed as an observer of the activities at SIMEPRODESO for the purpose of gathering information for the implementation of the remaining components.

#### **B. *Capacity building.***

In order to promote replication of LFG collection and use facilities elsewhere in Mexico, this component will build the capacity of SEDESOL, local and state government entities and private contractors to promote and manage LFG projects. In addition, this component will fund the preparation of a national replication strategy.

SEDESOL will implement this component and components C and D. To build SEDESOL's capacity to assist municipalities in the design and implementation of LFG projects and directing federal assistance in the subsector, this component will fund international training of SEDESOL employees. The project will also allow SEDESOL to build capacity and promote LFG adoption in state and local governments and private companies in the solid waste industry. Funding will be provided for the preparation of dissemination materials, for training workshops, and for twinning arrangements where an operating facility would provide managerial and technical assistance to a developing facility. Public dissemination will also be undertaken through news releases, tours and demonstrations.

The national replication strategy will focus on: i) developing LFG capture and use systems in existing cells in sanitary landfills ("retrofitting"), in new cells within existing landfills, and in new facilities; ii) introducing LFG management issues in the process of converting open dumps to sanitary landfills, including discussion of methodologies, analysis and options for scavengers; iii) incorporating LFG management in the planning, design and construction of future landfill sites; iv) assessing the prospects of using non-grant financing modalities for future support to municipalities including access to carbon trade resources; and v) assessing the prospects for the use of LFG as a source of energy for municipal services in other Mexican cities. The applicability of international experience on separating biodegradable materials for composting and its compatibility with landfill gas projects will also be addressed.

**C. *Regulatory reform.***

The project will strengthen the capacity of SEDESOL for the future development of a modern legal and regulatory framework applicable to LFG management issues, through the provision of a regulatory reform study. SEDESOL will implement this component.

**D. *Regional (Latin America) Dissemination.***

The project will support efforts aimed at facilitating the dissemination of design and operational experience gained in Salinas Victoria and other projects worldwide (such as those supported by the Bank in Indonesia, Latvia, Uruguay as well as others) for possible use throughout the region. The potential compatibility of composting (including its use in agriculture) with landfill gas projects will also be explored and included in the dissemination materials. The following activities will be funded by the project and implemented by SEDESOL:

- i) Preparation of a study on worldwide economic and technical effectiveness of LFG plants with a focus on technical, financial and institutional barriers to implementation in developing countries and best practice models appropriate to the Latin America context. In addition, a consultative workshop will be funded that will include public, private and other entities in Latin America that are interested in LFG;
- ii) Development of information tools (a webpage and newsletter);
- iii) Organization of international workshops for owners and operators of sanitary landfills interested in LFG management and other potentially interested parties from the private sector, such as independent power producers in the region; and
- iv) Twinning arrangements that include internships and site visits for managers at operating LFG facilities in other countries.

The impact of this component will be monitored by maintaining a list of participants and monitoring what government programs or LFG projects are initiated by the participants.

**E. *Project Management.***

The project will fund the technical and administrative support necessary to implement the components and to provide monitoring of the project as a whole. LFG specialists will be employed for the project in SEDESOL and SIMEPRODESO. The specialist at SIMEPRODESO will coordinate the administrative implementation of the project including: planning, monitoring and evaluation, financial management, accounting, risk management, procurement and information technology. The specialist will also prepare the supporting reports for capacity building and regional dissemination components, design tours, press releases and other public dissemination activities and coordinate with the Strategic Partner in the training of SIMEPRODESO personnel. The specialist at SEDESOL assist in the implementation of the Capacity Building, Policy and Regulatory Reform and Latin American dissemination components. (see Institutional section of Summary Analysis for detailed institutional

responsibilities). A portion of the costs of implementing the environmental management plan (see Environmental section of Summary Analysis or Annex 11 for details on EMP) will also be funded. The component will also fund the necessary consultants and staff for SIMEPRODESO to execute their financial and procurement auditing and reporting responsibilities.

Component	Sector	Indicative Costs (US\$M)	% of Total	Bank financing (US\$M)	% of Bank financing	GEF financing (US\$M)	% of GEF financing
A. Physical Investment Construction of the Plant for Methane Capture and Use	Other Power & Energy Conversion	11.45	86.5	0.00	0.0	4.92	78.5
B. Capacity Building	Institutional Development	0.90	6.8	0.00	0.0	0.60	9.6
C. Policy and Regulatory Reform	Institutional Development	0.05	0.4	0.00	0.0	0.05	0.8
D. Regional (LAC) Dissemination	Institutional Development	0.50	3.8	0.00	0.0	0.50	8.0
E. Project Management		0.34	2.6	0.00	0.0	0.20	3.2
<b>Total Project Costs</b>		13.24	100.0	0.00	0.0	6.27	100.0
<b>Total Financing Required</b>		13.24	100.0	0.00	0.0	6.27	100.0

## 2. Key policy and institutional reforms supported by the project:

The project supports the modernization of solid waste management policies through the incorporation of LFG management needs in draft legislation. This will be sought through a review of LFG legislative needs.

On the institutional front, the project seeks the adoption by SEDESOL and, through it, at the municipal level, an adequate level of awareness and technical expertise for proper consideration of LFG management in landfill planning and design. The demonstration project will be implemented by a Co-generation Company (see section 4 below and institutional section of Summary Analysis) involving a private sector partner. This participation will further encourage involvement of private companies in the provision of services in the solid waste management sector.

## 3. Benefits and target population:

The baseline project (see Annex 14 for details) is intended to yield the following benefits:

- improved implementation capacity for solid waste management at seven municipalities;
- improved regulatory framework for solid waste management without the inclusion of LFG concerns; and
- improved institutions and management capacity on landfill design and operation at a National level.

Implementation of the proposed LFG project would result in the following benefits:

- improved solid waste management practices that include LFG management;
- collection of LFG (resulting in the capture of 214 million m<sup>3</sup> of methane during the project's life);

- reduction of explosion risk and odor at the landfill;
- reduction in high carbon fuel consumption through the use of LFG as a fossil fuel substitute;
- increased profitability of solid waste management; and
- improved technical expertise in the area of solid waste management (including LFG management).

Target population. The primary benefits of the project will be institutional including lower costs of electricity for public services. However, the project would also benefit a local population of about 10,000 nearby inhabitants (5 km. radius) through reduced landfill emissions. On a national scale, replication of the project will contribute to more effective waste management systems which will eventually benefit all urban dwellers.

#### **4. Institutional and implementation arrangements:**

Recipient: BANOBRAS.

Flow of Funds: All funds will be transferred from the GEF to BANOBRAS. A single special account in US dollars with an authorized allocation of US \$550,000 will be established for the project at BANOBRAS. Funds will be earmarked for specified recipients and purposes. The funds under components B-D will be earmarked for SEDESOL for implementation of the activities under that component. The funds under Component E will be used by both SEDESOL and SIMEPRODESO and they will be earmarked accordingly. For component A, BANOBRAS will reserve the right to disburse using direct payments. BANOBRAS will enter into contractual agreements for transfer of funds between (a) BANOBRAS and SIMEPRODESO on a non reimbursable basis for an amount of SDR 4,046,000 equivalent and (b) BANOBRAS and SEDESOL on a non reimbursable basis for an amount of SDR 954,000 equivalent. The contracts will be finalized on or before April 10, 2001 and the signing of the contracts will be a condition of effectiveness. (See Main Grant Conditions; Section G.)

Executing agencies: SEDESOL will implement the capacity building, legal and regulatory reform and Latin America dissemination components. To implement these components the project will provide funds to SEDESOL for the cost of a LFG specialist and for training of other staff. SIMEPRODESO will be responsible for coordinating with SEDESOL to provide the necessary information, tours and other support to implement these components (see institutional section of Summary Analysis for details). A representative from SEDESOL will be appointed as an observer of the activities at SIMEPRODESO for the purpose of gathering information for the implementation of the remaining components.

The first component, the construction of the LFG demonstration plant, will involve the formation of a Cogeneration Company between SIMEPRODESO, a private partner ("Strategic Partner"), the Municipality of Monterrey, Servicios de Agua y Drenaje and Metrorrey (the subway system) (see section E4 for detailed company structure). SIMEPRODESO will be responsible for the overall administrative implementation of the demonstration project via an agreement with the Strategic Partner (see agreements in Section E4. SIMEPRODESO will cover the following functions: planning, monitoring and evaluation, financial management, accounting, risk management, procurement and information technology. The Strategic Partner will be responsible for the overall technical implementation of the project including design, construction and training. Operation of the plant will be the responsibility of the Strategic Partner for the first five years of operation at which time the operational responsibility will be shared with SIMEPRODESO.

Participation Strategy. Given the demonstration character of the project, public participation is essential for the dissemination of results and to facilitate early replication of the experience. The detailed strategy is presented in the social section of the Summary Analysis. The capacity building and Latin America dissemination components are specifically designed for participation for the purpose of project replication. These components will include dissemination and training workshops, twinning arrangements and public awareness activities such as tours and press releases. The development of the materials for these components will be done in a participatory fashion through consultation of the major project stakeholders, affected parties and interested public, private and non-profit entities. In addition, USEPA's Landfill Methane Outreach Program, a voluntary program designed to provide technical and project facilitation assistance to landfill owners and government agencies, will assist in the development of the materials for dissemination and the twinning arrangements.

Mid term review. A mid term review is scheduled for 24 months after the Effective Date. It will be carried out jointly with the UMS and the Bank and will review the progress of the project and the attainment of its objectives on the basis of a report containing: (i) integrated summary of the monitoring and evaluation activities (see Annex 1 for reporting requirements) and (ii) a summary of the progress achieved in the carrying out of the project including the implementation of the EMP, and assessment of the performance of the Cogeneration Company to be used in implementation of the demonstration project (see section E4 for details of Cogeneration Company). The report will be produced 20 months after the Effective Date.



## D. Project Rationale

### 1. Project alternatives considered and reasons for rejection:

A line of credit for widespread support of LFG capture schemes was considered but rejected because of weak institutional, management and operational capacity in this field in Mexico. The design and development of a new landfill for the purposes of maximizing methane generation and capture was also considered. However, the time required to generate and collect methane was not consistent with the need to implement Short-Term Measures.

Alternative locations. The prefeasibility study was designed to identify the optimum location for the demonstration project among the many potential sites in Mexico. Initially 33 landfills and dumps that met the list of basic requirements (at least 500,000 inhabitants; minimum annual precipitation of 200 mm; and annual temperature between 15-30 C) were considered. In order to determine the optimum location, a technical, financial and institutional assessment was conducted that included: i) technical issues at a regional level and municipal level; ii) economic conditions; and iii) financial, social, political and legal considerations. The analysis led to a short list of seven municipalities (and 10 landfill sites). A questionnaire was sent to all 7 municipalities, requesting technical, institutional and social information about the specific sites. Using 3 different gas generation models and the data in the questionnaires, LFG generation was estimated and the list of 7 municipalities was ranked according to potential LFG production. It should be noted that the process was designed to identify the optimal site for the demonstration project and therefore eliminated many sites at which LFG facilities can be developed. The potential sites for post project replication include the 33 sites prequalified for this study and others in larger cities that were not considered.

Alternative uses. Several end-uses were considered for the LFG: i) power generation for sale to CFE or to the municipality; ii) direct LFG supply to nearby industry; iii) supply of compressed methane to industry pipelines for domestic use; and iv) purifying LFG to methane gas for use as vehicle fuel. Barrier analysis and a financial assessment led to the conclusion that the best alternative end use was the sale of electricity to the municipality (as defined by financial rate of return and the track record of the various end-use technologies). Alternative schemes for power generation were considered and compared through an economic-financial analysis. When the above steps were combined, Salinas Victoria (followed by Leon, Guadalajara, Tijuana and Ciudad Juarez) was determined to be the best site for this project.

<b>SIMEPRODESO Landfill: Main Technical Characteristics (see Annex 16 for more details)</b>	
Location	Salinas Victoria, Nuevo León, Mexico
Population served	Approximately 2 million
Annualized average volume of waste received	830,000 tons
Type of waste received in gas extraction cells	Domestic and commercial (industrial and construction waste are placed in another cell)
Date gas extraction cells opened	1991
Date gas extraction cells <b>filled</b>	1999
Lining in gas extraction cells	Clay layer
Current LFG management system	Passive vents are in place on 20% of cells
Volume of waste in place from gas extraction cells	7,698,057 tons
Estimated LFG production from gas extraction cells	313 million cubic meters over the lifetime of the project
Measured % methane in LFG	50-60 %

**2. Major related projects financed by the Bank and/or other development agencies (completed, ongoing and planned).**

Sector Issue	Project	Latest Supervision (PSR) Ratings (Bank-financed projects only)	
		Implementation Progress (IP)	Development Objective (DO)
<b>Bank-financed</b>			
Environmental protection and natural resource management, strengthening institutional and policy framework	Mexico: Environmental Project (FY 92)	S	S
Environmental investments, strengthening institutional capacity on the state and municipal level	Mexico: Northern Border (FY 95)	S	S
Conservation and natural resource management of protected areas	Mexico: Protected Areas (GEF); (FY 94)	S	S
Regulatory framework and institutional strengthening	Mexico: Air Quality I	S	S
Strengthening institutional, technical, administrative and regulatory capacity and improving solid waste services	Mexico: Solid Waste Management II (FY 94)	S	S
Municipal infrastructure and capacity building	Mexico: Water and Sanitation II (FY 95)	S	S
Small scale municipal infrastructure, institutional strengthening	Mexico: Decentralization & Rural Development (DRD II); (FY 96)	U	S
Institutional Strengthening	Mexico: Consolidation of Office of Climate Change (IDF Grant)	S	S
Institutional Strengthening	Mexico: Decentralization Adjustment Loan		
Renewable Energy	Mexico: Hybrid Solar (in preparation)		
Solid Waste Management	Indonesia		
Landfill Gas Capture and Use	Uruguay: Methane Capture and Use		

Solid Waste Management	Latvia: Liepaja Region Solid Waste Management Project	S	S
Solid Waste Management	Latvia Municipal Solid Waste Management Project	S	S
<b>Other development agencies</b>			
Inter-American Development Bank (IDB)	Water and Sanitation in Rural Areas (US\$ 30 million)		
Inter-American Development Bank (IDB)	Water supply and Management in ZMVM (US\$ 365 million)		
US Environmental Protection Agency	Landfill Gas-to-Energy Feasibility Analysis, Prados de la Montana Landfill, Mexico		
German Cooperation (GTZ)	Air quality Mexico DF		
German Cooperation (GTZ)	Decentralization of Solid Waste Management		
German Cooperation (GTZ)	Industrial Waste and Hazard-ous Waste in Mexico DF		
German Cooperation (GTZ)	Environmental Technology for Small-sized Industry		

IP/DO Ratings: HS (Highly Satisfactory), S (Satisfactory), U (Unsatisfactory), HU (Highly Unsatisfactory)

### 3. Lessons learned and reflected in the project design:

The preparation team has drawn on the experience and lessons learned from other GEF supported projects in order to improve project design and benefit from best practice. Peer reviewers have included task managers of on-going and planned methane capture projects in Latvia and Uruguay. The STAP expert has also provided useful comments.

The following lessons have been applied during project preparation:

Decision-makers at the municipal level should support the project objectives prior to site selection.

The project has been conceived and is being prepared with full participation of the municipal authorities and the proposed owner-operator (SIMEPRODESO).

Workshops and training are critical for enabling the replication of project activities.

A technical training program has been included in project design.

Technical assistance provided to municipalities is essential.

The baseline project has provided the necessary technical assistance and training in municipal SWM to support an integrated approach which includes LFG capture and use. The proposed GEF project will provide technical assistance focused on LFG management.

Development of integrated plans is essential for effective management of municipal solid waste.

The baseline project has provided needed training and technical support to local and national decision makers in developing integrated municipal SWM plans. The proposed project will build upon these plans

by integrating LFG management and utilization.

Full cost recovery is necessary to promote sustainability.

The LFG plant will be financed with GEF equity financing (grant) and financing from a private investor. The financial analysis has determined that with GEF financing the plant is financially viable and that all costs will be recovered.

Clear managerial and institutional responsibilities are required.

Implementation of first component, the construction and operation of the demonstration project, will be the primary responsibility of SIMEPRODESOL. The rest of the project is under the purview of SEDESOL.

#### **4. Indications of borrower and recipient commitment and ownership:**

Mexico ratified the framework Convention on Climate Change on March 11, 1993. The UMS submitted its First National Communication and Climate Change Action Plan in 1997, which was supportive of the principle of common but differentiated responsibilities under the framework convention. The first communication provided an estimate of the total emissions of greenhouse gases, outlined programs for their control and reduction and identified some of the impacts anticipated as a result of climate change. The communication explicitly identified the uncontrolled release of LFG from landfills as one of the priority sources of emissions of methane to the atmosphere and suggested measures to contain these emissions. On April 30, 2000, the Mexican Congress approved by unanimous vote, the Kyoto Protocol, which includes a national commitment to promote a program of actions to mitigate emissions of greenhouse gases.

The government has initiated the following measures, as part of the commitments under the UNFCCC: i) promotion of cleaner fuels; ii) fuel conservation; and iii) energy conservation and efficiency. Other measures adopted for conservation of the environment and natural resources are: i) The Protected Natural Area Program; ii) The Forestry Program; iii) National Reforestation Program; iv) Integrated System for Environmental Regulation and Administration; v) various policies regarding industrial and urban pollution; and vi) registration of emissions and the transfer of contaminants.\* The national communications attest to the increasing awareness of the impacts and sources of methane emissions in the country. Mexico is now drafting the second communication to the UNFCCC which includes reductions in LFG emissions as part of their plan of action.

With respect to the LFG management project proposed for GEF support, UMS has demonstrated its commitment in the form of entering into a loan agreement (through BANOBRAS) with the World Bank for the baseline project. In addition, the national GEF focal point has endorsed the project as a national priority and as being fully consistent with Mexico's Climate Change Action Plan.

SEDESOL has demonstrated its commitment by organizing a course on LFG management in Salinas Victoria and a conference in Puebla. They have also committed to forming the project management unit for this GEF add-on project. SIMEPRODESOL has demonstrated its commitment to the demonstration project through active participation in its preparation. They are organizing the bid for the strategic partner, have hired financial and legal staff specifically for project preparation, and have successfully solicited approval from the Congress of the State of Nuevo Leon to allow SIMEPRODESOL to form the public-private partnership proposed for the project. They have also have approval for continued preparation of the project from the Board of Directors of SIMEPRODESOL.

#### **5. Value added of Bank and Global support in this project:**

The involvement of the Bank/GEF in the proposed project provides an opportunity to support a critical

effort by the UMS to: i) improve solid waste management; ii) improve global environmental quality through the reduction of greenhouse gases; and iii) partly reduce dependence on high-carbon fuel-generated energy. Bank involvement has made possible the sharing of its broad experience in solid waste management and adapting it to Mexican conditions. GEF involvement is critical to catalyzing local willingness to test and demonstrate LFG capture and use technology. As previously stated, the project could serve as a model for other small- and medium-sized cities in Mexico, all facing serious problems with the management of solid waste and emissions of methane.

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\*First National Communication to UNFCCC. UMS, 1997; Second Communication UNFCCC is in draft.

## **E. Summary Project Analysis** (Detailed assessments are in the project file, see Annex 8)

### **1. Economic (see Annex 4):**

- Cost benefit      NPV=US\$ million; ERR = % (see Annex 4)
- Cost effectiveness
- Incremental Cost
- Other (specify)

Following the guidelines of the GEF, an incremental cost analysis has been completed (see Annex 4). A cost-effectiveness analysis has also been completed on the LFG demonstration project in Salinas Victoria and concluded that the equivalent of 0.99 million tons carbon will be captured or substituted for at an additional cost (over that of the baseline project) of US \$17.32 million (investment cost=\$11.5; O&M=\$5.82 million). The portion of the GEF grant allocated to this component (US \$4.92 million) will capture methane and reduce carbon emissions by fossil fuels at a cost of US \$4.99 per ton of carbon.

### **2. Financial (see Annex 4 and Annex 5):**

NPV=US\$ 7.2 million; FRR = 27.6 % (see Annex 4)

#### **Project Preparation**

During project preparation, financial and other criteria were used to choose the site of the demonstration project, the best technology alternative and for what purpose the electricity produced by the LFG plant will be sold. Although the prefeasibility study indicated there are many potential sites at which LFG facilities could be developed in Mexico (the prefeasibility study identified 33 in small- and medium-sized cities), SIMEPRODESO was chosen as the best site for the demonstration project based on economic, social, technical and financial criteria. It was found to be the most attractive project site after weighing the investment costs, sources of financing, likelihood of private sector involvement and cooperation of state and municipal authorities.

The technology alternatives considered in project preparation included the form of the gas (either biogas or methane purified from the biogas) and the use of the gas (either for sale directly to industries and other consumers or for the production of electricity). Of all the alternatives, the most financially viable was the use of the unpurified biogas to produce electricity\*. The potential consumers and uses for the electricity that were considered during project preparation were: i) Municipality of Monterrey for street lighting or lighting in public buildings; ii) Servicios de Agua y Drenaje de Monterrey (water utility) for water pumping; iii) Metrorrey, and iv) CFE for use in their supply grid. As the tariffs currently charged by CFE to the Municipality of Monterrey for street lighting, Metrorrey and Servicios de Agua y Drenaje de Monterrey for water pumping are the highest, the best option is to sell electricity to them at a slightly lower tariff (the financial analysis assumes a 5 % discount of the costs of electricity)\*\*. The potential consumers have supplied letters of interest in the project and discussions concerning the exact tariffs to be charged have begun. The exact prices will be part of the agreements and permits to be signed for formal constitution of the project company ("Cogeneration Company"), which is a Condition of Grant Effectiveness (See section G. Main Grant Conditions).

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\*Proyecto Piloto Para El Aprovechamiento de Biogas de Los Sitios de Disposicion Final de Residuos Solidos Municipales, January 1999 (Estudio de Prefactibilidad), ETEISA.

\*\*As selling electricity to Metrorrey (the subway system) became an option after the financial analysis was done, it is not considered in the analysis. The electricity tariff for Metrorrey is only slightly higher than that for Servicios de Agua y Drenaje and therefore will only increase the average selling price and thus the IRR marginally.

## Project Financial Analysis

Without GEF financing, the project has a rate of return (FRR=13.4%; NPV=\$2.2 million) that is marginal for attracting private sector investment. However, with the addition of the GEF grant, the project has a much higher rate of return (FRR=27.6%; NPV=\$7.2 million).

Assumptions of Financial Analysis	
Project start date and length	20 years starting LFG capture in 2002.
Discount rate	10%
Gas production	Based on USEPA model (see section 3 below).
Investment costs	Based on detailed design and confirmation by suppliers US\$11.5 million (w/o GEF grant); US\$6.58 million (w/GEF grant)
Electricity use	Sold to Municipality of Monterrey for street lighting during nighttime and Servicios de Agua y Drenaje and SIMEPRODESO during the day.
Electricity price	5 % discount on current cost of electricity charged by CFE to each consumer*.
Transmission and backup costs	Wheeling and transportation costs given by CFE (0.153 pesos/kWh). Backup costs given by CFE (544,942 pesos/yr).
Contingencies	17% (10% physical+7% price).
*The project will sell electricity at a 5% discount on the electricity costs charged by CFE. Current costs charged by CFE for electricity: Municipality of Monterrey for street lighting: 1.35 pesos/kwh; Servicios de Agua y Drenaje for water pumping and SIMEPRODESO for materials recovery facility: 0.53-0.72 pesos/kwh (depending on the amount, time of day and type of line). As selling electricity to Metrorrey (the subway system) became an option after the financial analysis was done, it is not considered in the analysis. The electricity tariff for Metrorrey is only slightly higher than that for Servicios de Agua y Drenaje and therefore will only increase the average selling price and thus the IRR marginally.	

A sensitivity analysis was performed (see table below) for the important parameters in the financial analysis. With the GEF grant, the project has an internal rate of return greater than 18% regardless of the

Sensitivity of Internal Rate of Return (%) to Changes in Important Parameters										
% change in parameter	With GEF Grant					Without GEF Grant				
	-20%	-10%	Base	+10%	+20%	-20%	-10%	Base	+10%	+20%
Electricity price	18.7	23.3	27.6	31.6	35.5	7.1	10.4	13.4	16.2	18.9
Investment costs	35.1	31.0	27.6	24.7	22.3	18.4	15.7	13.4	11.6	9.9
Gas production	20.6	24.2	27.6	30.8	34.0	8.5	11.0	13.4	15.0	16.5
<b>Delay in start of operation</b>			<b>Base</b>	<b>6 mths*</b>	<b>12 mths*</b>			<b>Base</b>	<b>6 mths*</b>	<b>12 mths*</b>
			27.6	23.7	22.4			13.4	11.2	10.5
* It is assumed that in a delay of 6 months or less there would not be sufficient time for the contractor to adjust the design and reduce the capacity of the plant (to 6 MW) to account for the lower total gas captured as a result of the delay. This extra capacity is assumed to be sold at 70% of the original price. ** For longer delays, it is assumed the contractor will be able to adjust the design and reduce the capacity of the plant (to 6 MW) to account for the lower total gas captured as a result of the delay.										

change in the parameters. Thus, with the aid of the GEF grant, the returns of the project stay within a range sufficient for attracting private sector investment. The project IRR is most sensitive to the electricity price and less sensitive to project delay, investment costs and gas production. Several safeguards will be built into the project to control these project inputs. The international competitive bidding of the private partner will provide a built-in incentive for lower investment costs. In addition, incentives for timely construction and gas capture above the estimated amounts will be included as part of the contractual agreements.

### **Ability of Project to Attract Private Investment Under the Financial Structure of Cogeneration Company**

Through a international competitive bidding process (using Bank procurement guidelines), SIMEPRODESO will select a Strategic Partner who will provide technical capacity and will invest in the project (for details see Institutional section below). To ensure that the project (with the GEF grant) will be able to attract a private sector investor from the LFG industry, a financial analysis (see Annex 12 for details) was performed from the perspective of the Strategic Partner. The analysis assumed the financing provided by the Strategic Partner (US\$ 6.58 million) will contain proportions of debt and equity typical of other LFG projects. The profit sharing and capital structure of the Cogeneration Company detailed in the Institutional section below was also assumed. The results show the rate of return on the Strategic Partner's equity investment will be equal to or greater than industry expectations (20-25% over 10 years) and thus is a financially attractive investment.

### **Replication of the Project**

The project is designed to set the stage for replication of LFG projects in Mexico and Latin America. The demonstration project, capacity building, dissemination, policy and regulatory studies and the replication strategy are all designed to encourage replication. Besides the risks associated with the lack of precedents for LFG projects in Mexico and the barriers in institutional and technical capacity, the project will also, through the national replication strategy (for Mexico) and the worldwide study on LFG projects (for Latin America), develop mechanisms to address financing and financial barriers.

There are several financial mechanisms (listed below) that can assume the role that the grant played in the demonstration project. Their role in future development of the landfill gas projects along with strategies to encourage their application will be a focus of the replication strategy:

- In the demonstration project, the GEF grant was needed to compensate for project risks and provide adequate internal rate of return. It is expected that the operational and management experience of the demonstration project will reduce the costs of developing a LFG project in Mexico and reduce the perceived and real risks to private investment. This combined with the high electricity selling price (2-3 times higher than those commonly found in the US) for these projects in Mexico may allow future projects to be financially self-sustaining.
- The estimated CO<sub>2</sub> mitigation costs from this project are in the range of \$5/ton of CO<sub>2</sub> and therefore constitute a very attractive option for the carbon trade market. It is expected that future projects in Mexico and elsewhere would benefit from financing provided from the carbon trade.
- The US system of providing tax incentives that effectively increase the transfer price of electricity is a potential option for enhancing the financial returns of these projects. This will be evaluated as to its necessity and policy implications and, if appropriate, the optimal means of implementation will be explored.



**Fiscal Impact:**

The project has no negative impact on State or Federal Tax revenues.

**3. Technical:**

During project preparation, a prefeasibility study determined direct power generation from unpurified LFG as the most viable technology alternative. In addition a feasibility study for the construction and operation of a plant using the 44 ha filled cell at SIMEPRODESO was also prepared. The study was prepared by a Mexican consulting firm (ETEISA) under the guidance of a consultant (SCS Engineers) with 15 years of experience in LFG management in the United States and some experience in Latin America.

As described in the financial analysis (section 2 above), the prefeasibility study determined the most viable technology alternative to be the use of unpurified LFG to produce electricity. To assess the use of this technology at the SIMEPRODESO site, the feasibility study addressed the following issues:

1) **Production of gas from the landfill and the associated electrical generation:** A USEPA LFG production model was used to estimate the amount of biogas to be produced over the project lifetime. The model has been extensively and successfully used in the U.S. as the basis for designing and financing LFG projects. The dry conditions and differences in moisture content of the waste in Salinas Victoria were accounted for in parameter estimation. The model found enough methane would be produced from the filled 44 ha cell to support a 7 MW power plant (See Annex 15 for details). The input parameters for the model are shown below along with the basis for the values.

<b>Input parameters for model used to estimate gas production at the SIMEPRODESO landfill.</b>		
<b>Parameter</b>	<b>Value</b>	<b>Basis</b>
Methane gas generation constant (k)	0.066/yr	Typical value for a site such as this. The value was consistent with that found from a 'pump test' at the site (0.0606/yr). The pump test was able to estimate the methane production rate by determining the rate of methane extraction (by the pump) necessary to balance the rate of methane production (by the portion of the waste that methane was extracted from).
Waste methane gas generation potential (Lo)	95.4 m <sup>3</sup> CH <sub>4</sub> /Mg waste	Estimated based on value of US waste accounting for the low annual precipitation in Salinas Victoria and the differences in moisture content resulting from the higher waste food content in the SIMEPRODESO landfill.
Waste cell area	44 ha	SIMEPRODESO data.
Waste depth	22 meters	SIMEPRODESO data.
Waste density	0.71 Mg/m <sup>3</sup>	Typical value for 'in place' waste.
Waste age (year 2000)	5 years average	SIMEPRODESO fill history.
Concentration of methane in LFG	50%	Typical value confirmed by measurement at site (actual measurements ranged from 50-60%).

The model indicated 313 million m<sup>3</sup> of methane will be produced over the 20 year project lifetime. The amount of electricity that could be produced from this quantity of methane was determined using the assumptions listed in the table below. Of the total methane produced in the landfill, it was estimated 214 million m<sup>3</sup> of methane (70% of LFG production) would be captured by the collection system. From this quantity of methane, it was estimated the project could generate 700 GWh of electrical energy for a total installed capacity of 7 MW. The effect of model uncertainty on project viability was assessed in the financial sensitivity analysis where the estimated biogas production was varied +/- 20 % (see previous financial section).

<b>Assumptions used to estimate the amount of electricity produced from the LFG at SIMEPRODESO.</b>		
Parameter	Value	Basis
Methane capture efficiency	70%	Industry averages* and observations of condition of the <b>filled</b> 44 ha cell (good soil cover, no interfering landfilling activities and no standing liquids in the waste).
Engine thermal conversion efficiency	34%	Typical value.
Engine down time (for maintenance and repairs).	15%	A conservative (high) estimate based on the operational difficulties that may be expected in Mexico. The value is based on World Bank experience in Latin America and industry standards.
*Reported values in US range from 60-85%. 75% is normally assumed unless there are reasons (such as poor landfill covering, or unusually small or large collection system) to doubt this assumption.		

The model also showed that, as expected, the gas produced by the 44 ha filled cell will decline over the lifetime of the project (see Annex 16 for gas generation curve) as is the case with all LFG projects on filled landfills or filled portions of landfills.\*

2) **Design of methane collection system:** From the pump tests (see Annex 16) the radius of influence (the area around the well from which the well is extracting methane) was estimated and used as a basis for choosing the spacing and thus the number of wells for the gas collection system. The network was designed to facilitate drainage of condensed water vapor into condensate traps. Condensate sumps located off the waste mound will be emptied and the liquid will be recirculated into the landfill in the same manner as leachate is currently managed (see Environmental Management Plan, Annex 11 for details). The suction applied to the system to collect the methane will be done using blowers. The required number and size of the blowers was determined based on vacuum and discharge pressure requirements (Note: the cost of the electricity to run the blowers was included in the O&M costs of the financial analysis).

3) **Treatment Plant:** Landfill gas is typically saturated with water vapor and can have high concentrations of corrosive compounds such as CO<sub>2</sub>. Based on field measurements of the LFG composition, a treatment plant to remove moisture was found to be suitable for the project.

4) **Flare:** To allow for maximal destruction of methane at the site, a flare will be installed that will burn excess captured methane not used to produce electricity. Excess methane capture may occur when the methane flow rate is higher than the engine capacity or during plant maintenance or repair.

5) **Electrical connection to CFE grid:** The electricity produced by the plant will be connected to the CFE grid and subsequently transported to the Municipality of Monterrey, Servicios de Agua y Drenaje and Metrorrey by CFE. Based on consultations with CFE, the electricity will go through a substation that will transform the voltage to 34.5 kW. Using a short line (~200 m), it can then be connected directly to the public network in front of the landfill. This simple setup minimizes the costs of interconnection by using connections that are cost-effective and by avoiding long interconnection lines. Note: the electrical connection will be the responsibility of the Strategic Partner and is included in the project costs.

\*It is expected that when the gas production from the 44 ha site declines to below the capacity of the existing engines, either the gas collection will be expanded to include new cells that SIMEPRODESO will be filling or the engines will be sold. As the newly filled cells at SIMEPRODESO are not within the framework of the proposed GEF project, the financial analysis assumes the unused engines will be sold.

For use in the Capacity Building and Latin America Dissemination components, a summary report detailing the design and construction of the plant will be compiled from the reports provided by the Strategic Partner during construction (such as design report, design criteria memorandum and as-built drawings). O&M manuals will also be included in this report. SIMEPRODESO will be responsible for consolidating the information into a format from which dissemination materials can be developed. This will be produced after construction of the landfill gas facility.

#### **Quarterly Operational Summary and Progress Report**

The operation of the plant will be tracked weekly and summarized in quarterly reports (due October, January, March and June 31) that include the following indicators: i) the available and rated capacity of the engines; ii) total and average gas flow; iii) gas used for electricity production; iv) gas flared; v) electricity produced; vi) electricity sales itemized by consumer; vii) itemized operational costs; and viii) itemized maintenance costs. This report will be used in the evaluation process at the mid-term review (see Main Grant Conditions, section G). In addition, quarterly progress reports will describe operational as well as other lessons learned from the demonstration project that would be important in replication. The quarterly reports will be prepared and furnished to the Bank on March 31, June 30, September 30 and December 31 of each year during project implementation beginning not later than December 31, 2001.

#### **4. Institutional:**

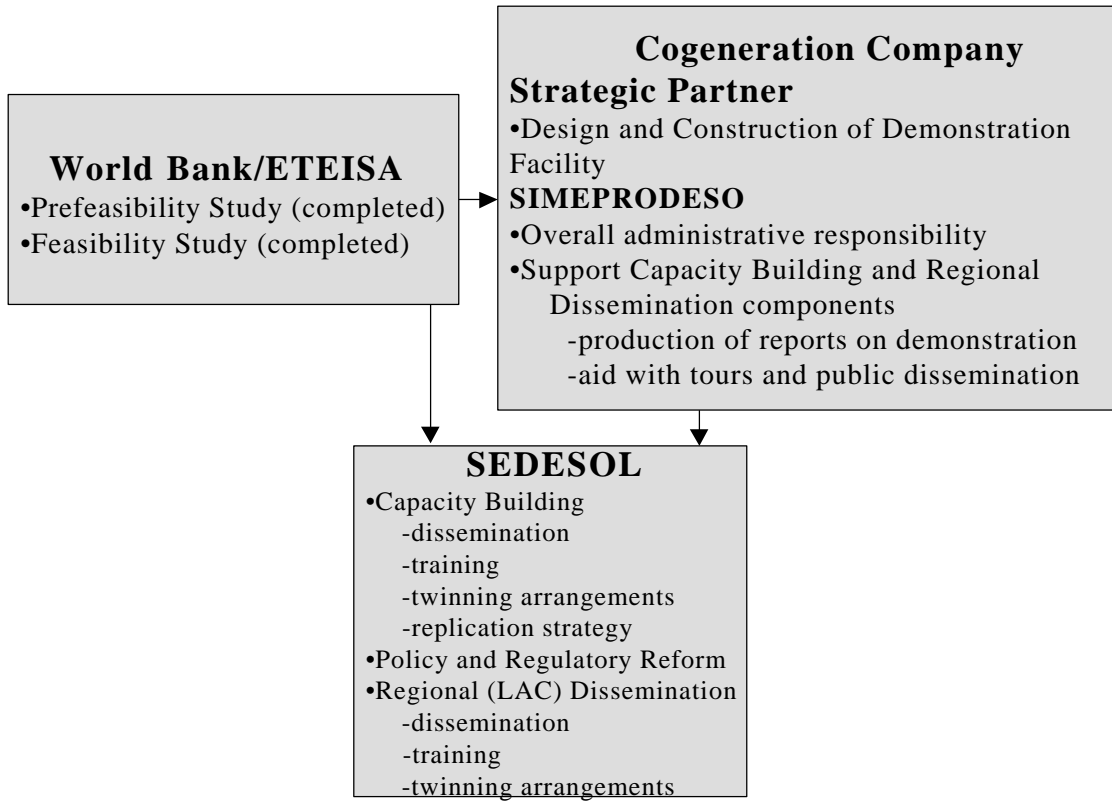
##### **Implementation of Project**

The institutions responsible for implementation of the project are shown in the diagram below. The feasibility and prefeasibility studies were completed by a Mexican solid waste management consultant (ETEISA) with the aid of a US consultant with experience in LFG. These reports will be used in the execution of the demonstration project and the Capacity Building and Regional Dissemination Components.

The first component which involves the design and construction of the demonstration facility will be implemented under a Cogeneration Company framework (detailed below). One of the major partners in the Cogeneration Company will be a private sector "Strategic Partner" who will be expected to design and construct the plant. SIMEPRODESO will be responsible for the overall administrative implementation of the demonstration project via an agreement with the Strategic Partner. This will include: planning, monitoring and evaluation (see Annex 1 for reporting requirements), financial management, procurement, accounting, risk management, procurement and information technology. They will also provide SEDESOL with the design and construction summary report, operational summary reports, annual progress reports and environmental summary reports that will aid in the development of the dissemination materials and replication strategy portions of the Capacity Building and Regional Dissemination components. They will also provide access to their facilities and other support to SEDESOL for implementation of the other components. This will include the development of tours, press releases and other public dissemination activities.

SEDESOL will be responsible for implementing the Capacity Building, Policy and Regulatory Reform and Regional (LAC) Dissemination components. The training of the SEDESOL staff and the preparation of the major studies and materials for these components will be subcontracted to consultants. For the Capacity Building Component the dissemination materials will be prepared for SEDESOL by a national consultant guided by an international consultant familiar with LFG. The National Replication Strategy Report

**Institutional Responsibilities for Implementation of Project Components**



and the study on policy and regulatory reform will also be prepared for SEDESOL by a consultant. For the Latin American dissemination component, a worldwide study on LFG facilities as well as the dissemination materials will be prepared by for SEDESOL consultants. SEDESOL will be responsible for the procurement, financial and monitoring and evaluation reports for the portion of the grant provided under those components (see Annex 1 for reporting requirements).

### **Institutional setup for the SIMEPRODESO Demonstration Project Component**

The LFG facility at SIMEPRODESO will be developed, constructed and operated under a Cogeneration Company framework. The basic framework for the formation of the company was outlined after extensive consultation with SIMEPRODESO, regulatory authorities (CRE), legal and business advisors and private investors in the electricity sector in Mexico. The contracts that will be used to form the Cogeneration Company were developed by the recipient with guidance and clearance from World Bank financial and legal experts. The functioning of the Cogeneration Company including the roles of the partners described below will be assessed at the mid-term review (see Main Grant Conditions, section G).

### **The Framework of the Company**

A Cogeneration Company: The "Ley del Servicio Público de Energía Eléctrica" (Electricity Law) allows public or private investors to form a Cogeneration Company that provides electric services to its members or partners. Since the passing of this Electricity Law many Cogeneration Companies have been formed in Mexico. While the law does not allow electricity to be "sold", the Co-generation Company framework allows electricity to be supplied by partners in the company to the other partners.

For the Co-generation Company in this project the electricity will be supplied by 2 partners, SIMEPRODESO and a private sector Strategic Partner that will provide technological capacity. The partners that will consume the electricity will be the Municipality of Monterrey, Servicios de Agua y Drenaje de Monterrey (the water utility in Monterrey), Metrorrey (the subway system) and SIMEPRODESO. The members of the Cogeneration Company will be contracted to be part of the company for the 20 year lifetime of the project.

### **The Cogeneration Company that will produce electricity using LFG from the SIMEPRODESO landfill.**

Cogeneration Company Partner*	Approximate Contribution (\$US millions)	Role (s)	Use of Electricity	Potential Demand by Users
Strategic Partner	6.58	Provider of capital investment and technical capacity***	none	none
SIMEPRODESO	4.92**	LFG supplier, provider of capital investment, electricity consumer	Materials recovery facility operation	1 MW (day)
Municipality of Monterrey	0.01	Electricity consumer	Street lighting in Monterrey	10.4 MW (night)
Servicios de Agua y Drenaje****	0.01	Electricity consumer	Water pumping	6 MW (day)
Metrorrey*****	0.01	Electricity consumer	Subway	6 MW (day)

\*The partners of the Cogeneration Company will be contracted to be part of the Cogeneration Company for the 20 year lifetime of the project.  
\*\*The GEF grant will provide a US \$4.92 million contribution to the capital costs. This money will be contributed as equity by SIMEPRODESO.  
\*\*\*The Strategic Partner will provide the design and construction, and operator training . The Strategic Partner will be responsible for operation for the first 5 years of the project. After that time, the operation will be shared between the Strategic Partner and SIMEPRODESO. As a partner in the Cogeneration Company the Strategic Partner will receive profits from the project for its 20 year lifetime.  
\*\*\*\* Both Metrorrey and Servicios de Agua y Drenaje have indicated their interest as electricity customers during the day. The exact proportion of electricity sold to these customers will be determined at contract negotiations. They have similar demand but differ slightly in the selling price (Metrorrey is higher) and peak hours of operation.

There have been many Cogeneration Companies formed in Mexico in the past. Comisión Reguladora de Energía (CRE) has indicated that they would grant a cogeneration permit for the proposed scheme and CFE has confirmed its interest in the connection of the LFG facility to the grid. Prospective bidders have also been consulted and had no problems with the proposed company structure.

Type of Company and Capital structure: The company will be a corporation or Sociedad Anónima de Capital Variable (S.A. de C.V.) formed in accordance with Mexican law. The capital allocation of the company will be the capital required to execute the project, estimated to be US \$11.5 million. The major contributions will be from the electricity suppliers, SIMEPRODESOS (using the funds from the GEF grant as an equity contribution) and the Strategic Partner. The Municipality of Monterrey, Servicios de Agua y Drenaje and Monterrey will only act as electricity consumers and thus will be expected to invest only a nominal amount each. The Strategic Partner will be required to contribute its share of the capital costs (estimated to be US \$6.58 million) with a minimum amount of equity (US\$1.5 million), the remainder may be as equity or debt. If they chose to use debt-financing, they will be expected to obtain it themselves and pay the debt service from their share of the revenues.

#### Profit Sharing

The profits will not be shared in proportion of the capital contributions in the first 5 years in order to allow the Strategic Partner to benefit from the GEF grant. The rationale for this is explained below.

If the profits were shared in proportion to the partners capital contributions, the Strategic Partner would receive 57% of the profits which would provide a rate of return on their investment (US\$6.58 million) of 13.4%, equivalent to the project return without the GEF grant. This is because under this hypothetical profit sharing setup, only SIMEPRODESOS would benefit from the grant. While the Strategic Partner could increase their return to greater than 13.4% using debt financing, the return would still be marginal for them. Thus, it is necessary for SIMEPRODESOS to share the benefits of the GEF grant with the Strategic Partner.

The GEF grant will be used to increase the IRR of the Strategic Partner by allowing the Strategic Partner a greater share of the profits in the first 5 years of the project (i.e. 80-100% rather than 57%). After the first 5 years the profits will be shared in proportion to the capital contributions (i.e. 57% Strategic Partner; 43% SIMEPRODESOS). SIMEPRODESOS has this flexibility because they have received a grant to cover their investment costs and thus a reduction in profits is not a critical issue to their participation. It has been confirmed that this type of profit sharing setup is legal under Mexican law. The exact profit sharing to be used in the project will be specified by the bidders in the bidding process (see Annex 6 for details). By determining the exact profit sharing setup as part of the bidding for the Strategic Partner, an arrangement that provides the minimum benefits necessary to attract private sector investment and maximizes benefits for SIMEPRODESOS's landfill operation can be achieved (again see Annex 6 for details).

#### Roles of Cogeneration Company Partners

*Strategic Partner:* As SIMEPRODESOS does not have the experience with the technology for conversion of LFG to electric power, a Strategic Partner will be chosen to be a partner in the company using an ICB procedure consistent with Bank guidelines. The Strategic Partner will be expected to: i) invest the capital required to complete project financing; ii) design and build the LFG collection system (including the collection field, blowers, flare and associated buildings and roads) and the power plant (including engines, engine house, treatment plant, and electrical substation and connection line); iii) assume full responsibility for operation for the first 5 years of the project and share the responsibility with SIMEPRODESOS for the remainder of the project lifetime; and iv) train SIMEPRODESOS operators by project year 5. As a member

of the Cogeneration Company the Strategic Partner will receive profits for the 20 year lifetime of the project.

*SIMEPRODESO:* SIMEPRODESO will continue to be responsible for the maintenance of the existing landfill that will provide fuel for the power plant. A nominal charge may be paid to SIMEPRODESO for the use of the LFG. They will also share in the operation of the plant after the first 5 years of the project. State congressional approval for SIMEPRODESO to enter into obligations with a foreign corporation (ie., the Strategic Partner) and thus to be a partner in the Cogeneration Company has been given and is now reflected in SIMEPRODESO's constitution.

*Electricity Consumers:* SIMEPRODESO, Servicios de Agua y Drenaje and the Municipality of Monterrey will use the electricity for public functions. The details of the delivery of the electricity will be provided through an Agreement for Supply and Consumption of Energy (see below). The highly regulated independent power producer market in Mexico means that the competition for electricity pricing is limited to the prices charged by CFE. Thus the electricity will be provided at discount below the costs charged by CFE (the financial analysis -section E2- assumes a 5% discount on current costs of electricity charged by CFE).

Company incorporation agreements including the By-laws and Joint Venture Agreement

The joint venture agreement will include (i) organization and purpose of the Cogeneration Company; (ii) Capital structure; (iii) Operation of the Cogeneration Company; (iv) Additional agreements to be executed by the Shareholders; (v) non-competition and confidentiality clauses; (vi) representations and warranties; (v) conditions for implementation of the company; (viii) restriction on the transfer of shares; (ix) term and termination; and (x) Buy-out arrangements.

The By-laws will include: (i) name, domicile, nationality, purpose and duration of the company; (ii) capital structure and categories of shares; (iii) restrictions on the transfer of shares; (iv) increase and reduce of capital; (v) voting rights; (vi) shareholders meeting; (vii) administration of the company; (viii) surveillance of the company; (ix) profit and losses; (x) dissolution and liquidation of th company and; (xi) provisions consistent with references made in the Grant agreement (Article IV, section 6.01 a)) related to events that will seriously affect the nature of the GEF project or impair the realization of its objectives.

The establishment and operation of the Cogeneration Company (including signing the incorporation agreements, all in a manner satisfactory to the Bank) will be a condition of effectiveness (see Main Grant Conditions, section G).

Contracts, agreements and permits

Listed in the following table are the required contracts and agreements. The required Cogeneration permit is also described.

*Cogeneration Permit:* CRE grants the permit that allow for independent power production in Mexico. This includes the Cogeneration permit necessary for this project. CRE has been consulted throughout project preparation and has agreed with the proposed setup. SIMEPRODESO will initiate the permitting process during bidding in order to obtain the permit shortly after the award of the bid.

**Required Legal Instruments for the formation and operation of the Co-generation Company\***

Legal Instrument	Parties involved
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Co-generation Permit	Granted by CRE to SIMEPRODESO
Contracts for electricity connection and backup **	Agreement between CFE and the Co-generation Company.
Agreements for Supply and Consumption of Energy	Agreement between the Co-generation Company and the electricity consuming partners in the Co-generation Company.
Landfill Gas Supply Agreement	Agreement between the Co-generation company and SIMEPRODESO.
Land Rental Agreements	Agreements between SIMEPRODESO and the Cogeneration Company.
Contract for technical project design, construction and operation of LFG facility and operator training.	Agreement between the Co-generation Company and the Strategic Partner.

\*\*The contracts have been drafted with guidance from Bank financial and legal experts and will be included in the bidding documents.

\*This includes connection to the distribution grid, wheeling (transportation) and backup in case of temporary failure of the LFG power plant. The formation of the Cogeneration Company (including signing the agreements and permits described in this table and the associated text) will be a condition of effectiveness (see Main Grant Conditions, section G).

*Contracts for Electricity Connection and Backup:* These contracts between CFE and the Cogeneration Company will include: (i) interconnection agreement; (ii) excess energy agreement; (iii) distribution agreement; and (iv) backup agreement. This will cover connection to the distribution grid, wheeling (transportation), backup in case of temporary failure of the LFG power plant and sale of excess power to the grid. The standard formats for the contracts have been obtained and CFE has been consulted concerning the exact tariff to be charged for these services.

*Power Purchase Agreements:* These agreements will be made between the Cogeneration Company and the consumers. They will include: (i) commitment of capacity for and purchase and sale of electric power; (ii) commencement date; (iii) obligations of the producer prior to providing capacity; (iv) testing; (v) obligations of the producer after the commercial operation date; (vi) obligations of the purchaser; (vii) prices, payments and billing; (viii) metering; (ix) risk mitigation measures; (x) representations and warranties; (xi) liability and indemnification; (xii) force majeure; (xiii) notices; (xiv) insurance; and (xv) assignment, transfer of the power plant, change in producers corporate structure.

*Landfill Gas Supply Agreement:* This is a contract between SIMEPRODESO, the landfill owner and therefore gas supplier, and the Cogeneration Company. The contract will include a detailed description of the landfill, the installations to be developed, the length of time for exploitation and the cost (nominal) for supply of the LFG. Although the GEF project is limited to the 44 ha filled cells, the SIMEPRODESO landfill is expanding, and thus the LFG facility could be expanded to exploit the LFG in these new cells. It should be made clear that any projects that would expand to these new cells are not part of GEF-funded project. The conditions under which the rights to this gas will be granted, however, will be included in the contracts of the GEF project in order to provide an incentive for the Strategic Partner to perform well and to maintain interest in the GEF project for its lifetime.

*Land Rental Agreement:* This is a contract between SIMEPRODESO and the Cogeneration Company. It will specify details of the use of the land and the time period of the rental.

*Contract for technical project design, construction and operation of the LFG facility and operator training:* This will specify the facilities to be built, the terms under which the Strategic Partner will operate

the plant, and the training required. The Strategic Partner will be expected to operate the plant for the first 5 years of the project and share the responsibility SIMEPRODESO after that. The exact time period, roles of the partners in the Cogeneration Company in operation, and other terms will be included in the bidding documents and finalized during contract negotiation.

*Preparation of Contracts and Agreements:* The proposed details of the structure of the Cogeneration Company including the contents of the contracts will be incorporated in a draft MOU to be presented as part of the bidding documents for the selection of the Strategic Partner and finalized after award of the bid. The development of draft contracts is being done by SIMEPRODESO with the help of a Mexican business consultant and a lawyer with experience in structuring Cogeneration Companies, public-private partnerships and international joint ventures. The Municipality of Monterrey, Servicios de Agua y Drenaje, Metrorrey, CFE and CRE are being consulted during this process of developing the contracts. The draft contracts have been reviewed by the Bank legal and financial experts and it has been agreed that SIMEPRODESO will use the opportunity of a bidding conference with the prospective bidders to consider modifications and amendments to the contracts. At that time, the Bank may offer additional suggestions to the texts, which would subsequently need to be approved by the Bank as a condition of effectiveness (See Main Grant Conditions, section G.)

#### Incentives for Continued Involvement of the Strategic Partner

To insure continued involvement by the Strategic Partner, the project has many built-in incentives.

- After the first five years the Strategic Partner will only have recovered its capital investment. They will need to remain in the project in order to receive the return on their investment.
- They have operational obligations throughout the lifetime of the project.
- Contingent on their continued involvement and satisfactory performance, they will be offered the opportunity to participate in projects to expand the gas extraction system to newly **filled** cells at the SIMEPRODESO landfill.
- Contractual penalties will be applied in the event of an early departure from the project.

The project is also safeguarded against major operational problems in the event of early departure of the Strategic Partner. This is because SIMEPRODESO will have the capacity to operate the plant after 5 years.

#### 4.1 Executing agencies:

SEDESOL and SIMEPRODESO

#### 4.2 Project management:

SIMEPRODESO will have project implementation staff (PIS) to implement their responsibilities in the first component under their Directorate of the Technology and Development. The PIS will include a landfill gas specialist, financial management specialist, accounting and procurement specialists. For implementation of the other components, the PIS at SEDESOL will be lead by the Director of the Solid Waste Management Division and will include a landfill gas specialist, a procurement specialist and representatives from BANOBRAS and INE. PISs at SIMEPRODESO and SEDESOL, including appointment of an individual procurement consultant by SIMEPRODESO in order to organize its record keeping and train the PIS will be a condition of effectiveness (see Main Grant Conditions, section G). A mid term review is scheduled for 24 months after the Effective Date. It will be carried out jointly with the UMS and the Bank and will review the progress of the project and the attainment of its objectives on the basis of a report containing: (i) integrated summary of the monitoring and evaluation activities (see Annex 1 for reporting requirements) and (ii) a summary of the progress achieved in the carrying out of the project including the implementation

of the EMP, and assessment of the performance of the Cogeneration Company to be used in implementation of the demonstration project. The report will be produced 20 months after the Effective Date.

#### 4.3 Procurement issues:

##### **International Competitive Bid for Strategic Partner**

The Strategic Partner that will design, build, operate the LFG facility (including the collection system, power plant and electrical connections as described in the technical section of the Summary Analysis and specified in the Joint Venture Agreement of the Cogeneration Company) and provide training under will be procured through an international competitive bidding (ICB) process in accordance with section (a) of subclause 3.13 "Procurement Under BOT and Similar Private Sector Arrangements" in the above mentioned Procurement Guidelines. Under this clause the Strategic Partner shall be free to procure the goods, works and services required for the design and construction of the LFG facility. The GEF grant will cover US \$4.92 million of the estimated \$11.5 million total cost of the LFG facility.

SIMEPRODESO is organizing the bid. The bidding process includes prequalification followed by bidding. The bidders have been prequalified based on their experience in design, construction and operation of LFG facilities, their personnel and financing capabilities. The prequalified companies will be invited to bid and the award given based on the bidder that will provide the highest profit stream for SIMEPRODESO (highest net present value). Under a USTDA grant, the prequalification and bidding documents have been prepared by SIMEPRODESO with the assistance of a consultant with experience in procurement for LFG projects. In addition, the consultant along with the task team are providing advice during prequalification and bid evaluation. All documents have and will be reviewed by the task team and cleared by the Regional Procurement Advisors for Latin America and the Caribbean.

##### General Approach

The Strategic Partner will be a major driving force in the project and will influence the structure of the deal in important ways. The procurement process therefore must provide enough flexibility in the finalization of the arrangements in order to accommodate the demands of the Strategic Partner while having a clearly defined structure that allows for fair and effective competition. To this end, a description of the proposed Cogeneration Company structure with the relevant aspects of the associated permits and contracts were provided in the prequalification documents. In the bidding documents the bidders will be provided with a draft incorporation agreements, draft contracts, letters of interest for the proposed members of the Cogeneration Company and other arrangements. The relevant technical and financial information necessary for the bidders to analyze and bid the project will also be provided.

This information will include:

- Description of works with design and performance specifications.
- Gas generation model with all assumptions.
- Tariff charge and quantity of electricity to be sold to each consumer.
- Other costs such as wheeling, transport and backup.
- Range and conditions of profit sharing arrangements allowed.
- Minimum equity financing allowed.
- A preformatted spreadsheet for making all calculations.

The bidders will be given an opportunity to comment on the contents of the bidding package and ask questions. They will then bid on this basis and provide the following information in the bid:

- Gas generation model output: They will be allowed to change certain assumptions in the model and will be expected to guarantee these. (i.e. they can change their capture efficiency from 70 to 75% and they will have to guarantee this under contract).
- Investment costs: Within the parameters of the design description and specifications they will come up with the costs for design and construction of the plant.
- Profit sharing setup: Within pre-stated restrictions they will have to specify how the profits will be shared in the first five years.
- Capacity to raise financing and proof of access to funds.
- From this information the bidder will be required to fill in a preformatted spreadsheet and calculate the net present value of the profit stream of SIMEPRODESO. This will be the bidding item with the award going to the highest bid. After selection of the Strategic Partner modifications to the contracts will be negotiated.

#### Status of Process

The procurement schedule is shown below. The prequalification process has been completed and the bidding documents have been prepared and finalized by the Bank. The bidding documents will be sent to the prequalified firms immediately after Board Approval.

#### Schedule for Procurement of Strategic Partner

8/20/00:	Published Invitation to Submit Letters of Interest in Development Business, trade journals and in Mexico.
1/11/01:	Sent prequalification documents to those that submitted letters of interest. Publish invitation to prequalify in Development Business and in Mexico.
2/16/01:	Received prequalification documents from 10 companies.
2/16/01-3/30/01:	Prequalified bidders.
4/18/01:	Send invitation to bid and bidding documents to prequalified firms.
7/01/01:	Bids received from prequalified firms.
7/01/01-8/01/01:	Evaluate bids.
08/20/01:	Award contract.

#### 4.4 Financial management issues:

##### **Overall**

A certified Financial Management Specialist supervised the assessment carried out by a consultant, and agreed to certify the project as 4-B , ineligible for PMR-Based Disbursements” This was based on the fact that while systems specific for this project have not been established, the project will be implemented under previously established institutional financial management arrangements in SEDESOL and SIMEPRODESO.

It was concluded that both SEDESOL and SIMEPRODESO, helped by BANOBRAS, are currently prepared to implement the Project but all systems need to be customised, and strengthened as necessary, to specifically handle the above mentioned project. The Project Implementation Staff (PIS) in both executing agencies currently include the necessary staff and are operational with a financial management system which meets minimum Bank financial management requirements. However, they are not fully satisfactory because they do not have in place an adequate project financial management module that can provide, with reasonable assurance, accurate and timely information on the status of the project (PMRs) as required by the Bank for PMR-based disbursements (under the Financial Management Initiative). Thus, the financial

management arrangements for the activities of SEDESOL and SIMEPRODESO are operational and will be appropriate for the Project, but they need a specific system for project management. SEDESOL, SIMEPRODESO and BANOBRAS must: (i) prepare a Financial Management Guidebook and (ii) customize the existing information systems to suit this operation and the agreed action plan for PMR Based Reporting (see Section G)

#### SIMEPRODESO

Financial Management. The existing MIS and financial management systems were reviewed in detail (i.e. Integrated Accounting system or COI) and found to be adequate to control entities budget codes as well as project operations but these systems do not produce information in the format of project management reports (PMRs). There will be two financial management systems, one at SIMEPRODESO and one at SEDESOL. BANOBRAS' MIS is already in place and has been used in other projects). Although SIMEPRODESO is ready to manage the funds of the project, the MIS should be slightly adjusted to allow for the flow of financial data, physical indicators and procurement information, which includes not only the production of PMRs but more important, the preparation of SOEs and their supporting documentation. A Financial Management Guidebook (FMGb) will be prepared, separately or in conjunction with the preparation of the FMGb for SEDESOL.

Internal Control System and auditing. SIMEPRODESO has in place acceptable internal control arrangements, however it is incomplete because of the lack of the internal audit function. The institution is annually audited by external auditors (Leal Tijerina y Asociados S.C. associated with VHI Jeffrey Henry International). The same as for SEDESOL existing internal control arrangements must be adjusted to cover additional requirements for the Methane Capture and Use Landfill Project, essentially to separate/identify/control specific project operations (i.e. disbursements related to the Plant – Component A). The audit review will be carried out by external auditors (a private firm), based on satisfactory TOR and in line with the existing MET. The audit report will be submitted to the Bank within the next six months after each audited year. A consolidated audit report will be prepared and submitted to the Bank. SECODAM and BANOBRAS will coordinate with SIMEPRODE these annual audits, which will include an opinion on the internal controls, transactions, bank accounts, financial statements of the project and on the compliance on norms and regulations (i.e. legal agreements). An audit report of the executing agency as Entity will be required as well.

#### SEDESOL

Financial Management. The existing MIS and systems (for instance the accounting and budgetary systems) were reviewed specifically for this project (Subsecretaria de Desarrollo Urbano y Vivienda, Dirección General de Infraestructura y Equipamiento) and for other Bank projects (i.e. Dirección de Integración y Seguimiento de programas). The financial management arrangements are adequate to control the national budget codes as well as the Bank's loan categories and project components but they do not produce information in the format of project management reports (PMRs).

SEDESOL has prepared a comprehensive chart of accounts, which was suitable for the needs of previous Bank projects but this new project will produce PMRs acceptable to the Bank, therefore, the management information system should be adjusted to allow for the flow of financial data, physical indicators and procurement information. A Financial Management Guidebook (FMGb) will be prepared, separately or in conjunction with the preparation of other project documents, guides and manuals.

Internal Control System. SEDESOL has in place acceptable internal control system, which is

complemented with the audits carried out by the internal auditor (which reports to SECODAM). While existing internal control arrangements are satisfactory to the Bank, they must be adjusted to satisfactorily cover additional requirements for the Project, essentially to separate/identify/control specific project operations (i.e. disbursements).

Auditing. The auditor is designated by and reports to SECODAM. The audit review is carried out in line with Bank guidelines and procedures, and in accordance with the Technical Memorandum of Understanding on Auditing (MET). SEDESOL is annually audited by its Internal Audit Department. For this project this IAD will submit the annual independent financial audit report to the Bank no later than six months after the end of each Secretariat's fiscal year. The Terms of Reference (TOR) of the audit are those prepared by the SAI (based on the Bank TOR and guidelines) and considered satisfactory to the Bank. The audit will include an opinion on the internal controls, transactions, bank accounts, financial statements of the project and on the compliance on norms and regulations (i.e. legal agreements). A consolidated audit report will be prepared and submitted to the Bank.

### SEDESOL and SIMEPRODESOL

SEDESOL and SIMEPRODESOL will attend a Seminar on PMRs and follow-up discussions will take place before project effectiveness. During negotiations the action plan prepared in coordination with governmental officials will be agreed. SEDESOL and SIMEPRODE (with support from BANOBRAS) will prepare quarterly PMRs but, because the characteristics of the components in which SIMEPRODE participates, this institution will prepare simplified PMRs. These reports will not support project disbursements as the project will disburse following traditional procedures such as SOEs, direct payments and special commitments. The project cannot currently provide quarterly PMRs but will, on the basis of an action plan agreed with the borrower, be able to do so within the first six months (June 30, 2002) (SIMEPRODESOL) and the first year (December 31, 2002) (SEDESOL) after project effectiveness.

### **Flow of funds.**

All funds will be transferred from the GEF to BANOBRAS. A single special account in US dollars with an authorized allocation of US \$550,000 will be established for the project in BANOBRAS. Funds will be earmarked for specified recipients and purposes. The funds under components B-D will be earmarked for SEDESOL for implementation of the activities under that component. The funds under Component E will be used by both SEDESOL and SIMEPRODESOL and they will be earmarked accordingly. For component A, BANOBRAS will reserve the right to disburse using direct payments. BANOBRAS will enter into contractual agreements for transfer of the GEF grant funds between (a) BANOBRAS and SIMEPRODESOL on a non reimbursable basis and (b) BANOBRAS and SEDESOL on a non reimbursable basis. The contracts will be finalized on or before April 10, 2001 and the signing of the contracts will be a condition of effectiveness. (See Main Grant Conditions; Section G.)

### **Staffing**

Based on discussions with BANOBRAS, SEDESOL and SIMEPRODE, it seems that there is a good financial management team although the staff of both executing agencies will not be dedicated full time to project financial management because the characteristics of the project. The FMGb must include an organisational chart, job descriptions and so on to clearly indicate the staff assigned to/and responsible for project financial management. The SIMEPRODESOL Project Implementation Staff will, in addition to a landfill gas specialist, include at all times during the execution of the project, a financial management specialist, an accounting specialist and a procurement specialist. The SEDESOL Project Implementation Staff will at all times during the execution of the project include a landfill gas specialist and a procurement specialist. SEDESOL already has internal staff and procedures to deal with the financial aspects of the

project in place.

**5. Environmental:** Environmental Category: B (Partial Assessment)

5.1 Summarize the steps undertaken for environmental assessment and EMP preparation (including consultation and disclosure) and the significant issues and their treatment emerging from this analysis.

**Environmental Assessment Process and Main Conclusions**

An environmental assessment for the Salinas Victoria LFG facility was finalized on September 19, 2000 and approved by the Bank on December 6, 2000. As a result of the assessment, an "Environmental Management Plan" (EMP), an instrument that details i) the measures to be taken during implementation and operation of the project to eliminate or offset adverse environmental impacts, or to reduce them to acceptable levels; and ii) the actions needed implement these measures, was drafted. The draft (shown in Annex 11) will be finalized during negotiations. As a condition of disbursement, the EMP will be incorporated into signed contracts of the Cogeneration Company that specify the procedures for implementation of the EMP (as described in Annex 11) and the responsible parties (see Main Grant Conditions, section G).

The environmental assessment revealed that, as the plant will reduce emissions of greenhouse gases, as well as volatile organic compounds (VOCs) from the landfill, the major impacts of the project will be beneficial to the environment. Some minor negative impacts will also occur as a result of the project. An environmental management plan (Annex 11) was also developed by an engineering consulting firm (SCS Engineers, USA) with the participation of the executing agency (SIMEPRODESO) to mitigate these problems. The EMP will be implemented by SIMEPRODESO and the Strategic Partner and will be specified in the grant agreements, bidding documents and contractual agreements of the Cogeneration Company. The effects of the project are described in more detail below.

**Effects of Landfill Gas Plant Construction**

Global warming gas emissions: The LFG plant to be constructed in Salinas Victoria will result in the capture of 214 million cubic meters of methane (a potent greenhouse gas). In addition, the energy produced by the plant will substitute for other energy sources that use fossil fuels, thus reducing the emission of global warming gases from these sources. If successful, the replication strategy will catalyze the construction of more plants in Mexico. The regional dissemination component of the project is intended to have a similar effect in other Latin American countries.

Other pollutant emissions: In addition to the methane, the LFG mixture that will be combusted for power generation contains volatile organic compounds (VOCs). If VOCs are allowed to be released directly from a landfill they can be hazardous to humans and contribute to low-level ozone formation, a precursor to smog. The power plant will burn these VOCs and thus reduce their emission and LFG combustion will also reduce odors associated with LFG. To maximize these environmental benefits, the plant will have a flare to combust captured LFG that is not combusted during production of electricity.

The internal combustion engines used in the power plant will produce small volumes of NO<sub>x</sub> (a smog-forming gas) and CO (a toxic gas). The reduction in emissions of VOCs from the combustion of LFG and the reduced emissions of smog-forming compounds from the fossil fuel energy sources that the LFG energy substitutes for, will more than offset the impacts of the smog-forming compounds produced by the engines and flare. The engine emissions will be mitigated through requirements (specified in the bidding documents) for low emission engines. These emissions will be in compliance with World Bank guidelines. In addition, the engine emissions will be monitored for compliance with local environmental laws as described in the EMP (Annex 11). To prevent increased emissions due to poor engine performance, it will

be required that the engines be operated and maintained in accordance with the manufacturers specifications.

Explosion risk: The high methane content in LFG makes the gas potentially explosive when mixed with air. As the LFG plant will destroy a large proportion of the methane from the landfill under controlled conditions, the explosion risk on or near the landfill itself will be reduced. There will be some increased risk of explosion near the equipment used for the conveyance, pressurization and delivery of LFG to the engine. This risk is minimized by locating the compressors outdoors. An alarm system that detects methane leaks will be installed near the indoor equipment.

Liquid Wastes: The internal combustion engines produce waste oil and coolant that must be disposed of properly. Both of these wastes will be brought to a government approved hazardous waste treatment facility already used by SIMEPRODESO for similar wastes. Water that condenses in the gas collection system is somewhat similar in content to the landfill leachate and therefore can contain low concentrations of heavy metals and hydrocarbons. The condensate will be collected and as is currently done with the leachate, recirculated into the landfill. Given the dry conditions, the landfill will be able to absorb this excess water without any danger of migration or runoff and there is expected to be no affect on the moisture content of the waste.

Noise: As the proposed site of the plant is not adjacent to neighbors, noise from the engines is expected to be only an occupational safety problem for workers at the plant. To mitigate effects of noise employees will be required to use proper ear protection and the engine house will be located away from neighbors and constructed to reduce noise outside the building.

Construction-related effects: During construction there will be waste produced from the water used at the construction facilities and from the scrap construction materials. Construction activities will also increase noise, the suspension of particulates and vehicular emissions at the site. The bidding documents will specify that proper waste management practices be used during construction. In addition, construction practices that mitigate noise and pollution will be required.

Loss of Flora: The construction of the power plant and collection system will impact no flora as the areas proposed for construction currently are not vegetated.

### **Landfill Management Issues**

Leachate control: The LFG plant will not increase the likelihood of groundwater contamination by leachate. With the high rates of evapotranspiration and low precipitation at the site, very little leachate is produced. Under these dry conditions, the small amount of leachate is pumped periodically and recirculated into the landfill. This practice has been adequate and will continue. Additionally, SIMEPRODESO monitors the groundwater monthly in compliance with Mexican environmental laws. Under this project these groundwater monitoring practices will continue.

Methane migration: The migration of methane from landfills is an important issue because methane can diffuse into enclosed rooms in nearby houses and buildings and cause an explosion hazard. The project will reduce this risk through the collection and combustion of the LFG. In addition, because SIMEPRODESO currently does not monitor for methane migration, the environmental management plan requires a monitoring system to be put into place. Similar monitoring systems are effective at landfills in the US with more extensive neighboring communities than that found at the SIMEPRODESO landfill.

### **Occupational Health and Safety Issues**



The criteria for selection of the Strategic Partner who will be responsible for construction, operation and training activities will include an evaluation of the companies environmental and safety record. Within the contractual agreements of the Cogeneration Company occupational and safety practices based on international standards will be specified.

### **Siting of Plant**

The SIMEPRODESO landfill is located in a relatively unpopulated area. Immediate neighbors include several ranches, a junk yard and a squatter community. These neighbors will benefit from the reduced emissions and reduction in explosion risks associated with the project. The filled landfill cell (the portion of the landfill from which gas will be extracted) borders a road. The power plant will be located on the landfill in an area that borders uninhabited private land. This location will limit the potential effects of construction and operation on the local inhabitants.

#### **5.2 What are the main features of the EMP and are they adequate?**

The draft EMP finalized on April 5, 2001 outlines procedures to properly address the issues mentioned in section 5.1. It was developed in collaboration with engineering specialists in LFG and modeled after practices in the US. It is adequate for mitigating the negative environmental effects of the project and complies with OP4.01. The effects of the project do not trigger any other Bank Safeguard Policies.

#### **5.3 For Category A and B projects, timeline and status of EA:**

Date of receipt of final draft: September 19, 2000

An environmental assessment for the Salinas Victoria LFG facility was finalized on September 19, 2000.

#### **5.4 How have stakeholders been consulted at the stage of (a) environmental screening and (b) draft EA report on the environmental impacts and proposed environment management plan? Describe mechanisms of consultation that were used and which groups were consulted?**

The plant will be located on an existing landfill, away from any neighbors. The landfill has The negative environmental effects and associated mitigation measures affect the operation of the landfill and property and not the neighboring property or people. Therefore, there are no groups that, from an environmental or social perspective, will be directly affected by the project. The groups that will be indirectly affected by the project through reduced landfill emissions and public electricity prices, include the 10,000 people living within the 5 km radius of the landfill and the Salinas Victoria population. These groups were given access to the environmental assessment through local libraries.

#### **5.5 What mechanisms have been established to monitor and evaluate the impact of the project on the environment? Do the indicators reflect the objectives and results of the EMP?**

### **Annual Environmental Summary**

The environmental performance of the plant will be tracked during the project and summarized in annual reports that include the following indicators: i) methane captured; ii) methane used for electricity; iii) methane flared; iv) results of any engine emissions tests; v) engine maintenance records as compared to manufacturers suggestions; vi) engine waste oil and coolant handling records; vii) complaints from neighbors by type (noise, emissions, other); viii) methane leaks detected on methane conveyance system near or in engine house; and ix) underground methane concentrations on perimeter of landfill. This report will be produced annually after plant is operational.

### **6. Social:**

6.1 Summarize key social issues relevant to the project objectives, and specify the project's social development outcomes.

## **Overview**

There are several social issues of potential concern. These concerns have been addressed in a social analysis contracted during project preparation. The social analysis can be split into two areas: that which apply to the Salinas Victoria project and that which apply to future replication. The analysis of the Monterrey project was done specifically for project design and have been taken into account. The analysis on the replication was performed in preparation for the replication strategy that will be developed as part of the project. The actual implementation of the replication strategy, along with its associated social plans, will be done by the Government of Mexico and is out of the scope of the project.

## **Salinas Victoria Landfill Gas Project**

### Political and Social Barriers

The political and social barriers of potential concern to LFG projects involve those groups whose livelihoods depend on the collection and disposal of solid waste (contractors, municipalities and scavengers), the trade unions in the electric industry and the local community. In the case of the project site in Salinas Victoria, there are no scavengers and the municipalities and entities involved with solid waste collection and disposal openly support the project and will collaborate during preparation and implementation. The electricity sector trade unions include Sindicato Mexicano de Electricistas (SME) and Sindicato Unico de Trabajadores electricistas de la Republica Mexicana (SUTERM). These trade unions are politically involved with the national debate on the privatization of the electric sector. SME has taken a position against privatization and SUTERM's position is more moderate, focusing on issues such as limiting the effects of the privatization process on labor. While the LFG project in Salinas Victoria and in other future sites would involve at least some private participation, the small magnitude of power produced in these projects make them a low priority for the labor unions and therefore will not create a barrier for project implementation. In addition, because the project in Salinas Victoria will be done on existing landfill and will involve only minor negative environmental effects and mostly positive effects, the resistance from the population of Salinas Victoria is unlikely to be a barrier.

Scavenger Issues: There are no scavengers at the Salinas Victoria site. The landfill, which started operation in 1991, was developed as a secure sanitary landfill on a greenfield site and thus scavengers were never present at the site. The LFG plant will be located on the landfill which is owned by SIMEPRODESO and has no one living on it. There will be no land acquisition as a result of the project. The LFG project will thus not cause any involuntary resettlement of people living in the vicinity of the site or threaten their livelihoods.

### Effects on Local Population

The landfill is surrounded by a local population of approximately 10,000 inhabitants (5 km. radius). The human activity directly surrounding the landfill includes several ranches, a junk yard and a community of squatters. The filled landfill cell borders a road and the proposed site of the power plant borders uninhabited private property. As there are no settlements or scavenging activities on the landfill site, no resettlement will be required and the project will not threaten the livelihoods of the local population. The main social benefits to the local population will be the reduced costs of electricity for public services and subsequent increased availability of public funds. The project would provide environmental benefits to the local population by eliminating the risk of explosions, reducing odor, and controlling emissions of volatile organic compounds that are found in LFG. The immediate neighbors will yield additional safety benefits through increased monitoring of methane migration (to mitigate any explosion risks). The landfill currently does not monitor for methane migration and the project will require it.

## **Post-project Replication**

As one of the project goals is to encourage post-project replication in landfills in Mexico, the social

analysis identified political and social barriers to replication and potential scavenger issues. The analysis of the political and social barriers reached similar conclusions as that described above for the Salinas Victoria Project.

Methodologies for analyzing and mitigating the impacts of future projects on scavengers were also developed. Landfill gas projects are typically built on filled or partially filled landfills. Therefore in many cases scavenger issues would be dealt with when the landfill was filled and secured and therefore are not a concern to the Landfill Gas project. It is probable, however, that a LFG facility will be developed on an open dump or a landfill that is partially filled but was not secured and still has scavengers or squatters living on the site. In these cases, the landfill or a portion of the landfill will need to be filled and secured, thus necessitating relocation.

In anticipation of this indirect effect of LFG projects on scavengers, the analysis looked at the effect of landfill closure on scavenger communities in 5 small to medium sized cities: Puebla, Queretaro, Nuevo Laredo, Piedras Negras, and Salinas Victoria. In addition, the case of Mexico City was also analyzed. The procedures and programs used and their outcomes were assessed. The study concluded that, with the exception of Mexico City, scavengers were adversely affected by the closure. The main reason for the problems was an inadequate understanding of the socio-economic conditions and perspective of the scavenger communities. The study recommended an analysis and consultation procedure that could be used to identify the socio-economic problems of scavenger communities before future closures of landfills. In addition, the study provided a detailed approach for the development and implementation of employment programs for relocated scavenger communities. The results of this study along with the outcome of a consultation workshop will be incorporated into the national replication strategy to be prepared during project implementation. A worldwide study on LFG that will include the effects on scavengers will also be performed as part of the Latin America dissemination component. The results of this study along with the outcomes of a consultative workshop will provide a basis for inclusion of scavenger issues in the regional dissemination materials and workshops.

## 6.2 Participatory Approach: How are key stakeholders participating in the project?

As this is a demonstration project, replication of the project is a major goal and participation is essential. The participation is outlined in the table below.

	Preparation	component A Plant design and construction	component B Capacity building	component C Regulatory reform	component D Regional (LAC) dissemination	component E Project Management
<b>Primary stakeholders and affected parties</b>						
SIMEPRODESO	COL	COL	COL		COL	COL
SEDESOL	COL	CON	COL	COL	COL	COL
Municipality of Monterrey	CON	COL	CON			
Metrorrey	CON	COL	CON			
Servicios de Agua y Drenaje	CON	COL	CON			
Comision Reguladora de Energia (CRE)	CON	COL	CON			
Comision Federal de Electricidad (CFE)	CON	COL	CON			
Private sector partner for project	CON	COL	CON			

Local population in <b>Salinas Victoria</b>	IS					
Beneficiaries and affected parties in Mexico and Latin America						
landfill owners and operators			CON/IS		CON/IS	
potential private investors			CON/IS		CON/IS	
interested municipalities and other government entities			CON/IS		CON/IS	
affected populations			CON		CON	
NGO's			CON		CON	
general public			IS			
<b>Other</b>						
Bank experts	CON				CON	
USEPA			CON		CON	
Academics	CON					
Mexican government entities dealing with greenhouse gases	CON	IS	COL	COL	COL	
UN organizations dealing with greenhouse gases	CON	IS				

*COL=collaboration; CON=consultation; IS=information sharing*

#### Primary stakeholders and affected parties

Project preparation was done with the full participation of SIMEPRODESO, an autonomous public entity involved with solid waste management in Salinas Victoria, and SEDESOL, the Social Development Secretary in the federal government. During implementation SIMEPRODESO will take overall administrative responsibility for component A. The private sector Strategic Partner will be in charge of the plant design, construction and training responsibilities of this component. SEDESOL will take primary responsibility for developing the materials and activities of the capacity building component (component B). SEDESOL will also be responsible for the regulatory reform component (component C) and take primary responsibility for the regional (LAC) dissemination component (component D).

The public entities (Municipality of Monterrey, Servicios de Agua y Drenaje de Monterrey, Metrorrey, Comision Federal de Electricidad (CFE)) and private sector companies potentially involved with the methane utilization plant in Salinas Victoria were consulted during project preparation. All have indicated their interest in participation in the project. The Municipality of Monterrey was consulted in order to discuss the electricity pricing and concerning their use of the power for street lighting in the city of Monterrey. Similarly, Metrorrey, the operating organization in charge of the subway in Monterrey, and Servicios de Agua y Drenaje de Monterrey, a decentralized state entity in charge of the supply of potable water, drains and sanitation in Monterrey, were consulted in order to discuss the electricity pricing and their use of the power for the subway and water pumping operations respectively. CRE, the entity that provides the required permits to private investors to install or import electric power was consulted concerning the permitting requirements for the Cogeneration Company. CFE, the federal electrical authority, was consulted to negotiate the connection, transport and backup fees for the electricity produced by the SIMEPRODESO LFG facility. Private sector companies in Mexico and the United States were also consulted in order to assess their suitability as, and willingness to be, a project partner.

### Beneficiaries and affected parties in Mexico and Latin America

The capacity building component and the regional (LAC) dissemination component are designed to disseminate the results of the demonstration project to facilitate replication in Mexico and in Latin America. In these components, government entities, private sector companies, and other groups in Mexico and Latin America interested in LFG utilization will participate in the workshops, training courses, twinning arrangements, internship programs and other programs associated with these components. NGO's will also be consulted in consultative workshops for the development of the replication strategy (component B) and the materials and workshops for regional dissemination (component D). As part of the capacity building component (component B), tours, demonstrations and press releases will disseminate knowledge of the project to the general public.

### Other participants

During implementation of the capacity building and regional (LAC) dissemination components, the USEPA's Landfill Methane Outreach Program, a voluntary program designed to provide technical and project facilitation assistance to landfill owners and government agencies will be consulted by SEDESOL to share experiences in developing outreach materials explaining the benefits of LFG capture and use. They may also be consulted in the coordination of twinning arrangements with U.S. municipalities and entities with experience using LFG technology, and to help develop tours and other public dissemination activities for the demonstration project.

The UNDP has supported the development of the first communication to the UNFCCC. With USEPA/USDOE assistance, the UMS has also prepared an assessment of vulnerabilities and updated the GHG inventory. The project activities were coordinated with the work at the Mexican Office for Greenhouse Gas Mitigation at INE (Instituto Nacional de Ecología) which in turn corresponds with the UNDP assistance in this field.

During project preparation, the project team has sought the advice of Bank colleagues, academics and engineering consultants with expertise in LFG management. During implementation, their suggestions and previous experience will be integrated into the analysis and dissemination components of the project.

### 6.3 How does the project involve consultations or collaboration with NGOs or other civil society organizations?

NGOs will be invited to participate in consultation workshops for the development of the national replication strategy (component B) and the development of the materials and workshops for regional dissemination (component D).

### 6.4 What institutional arrangements have been provided to ensure the project achieves its social development outcomes?

The effects of reduced electricity costs, emissions and explosion risk as a result of the construction of the LFG facility in Salinas Victoria are inherent to the profitability of the project and therefore will be the responsibility of the Co-generation Company as specified in bidding documents and contracts between the partners. The results of the studies and workshops on LFG projects and scavengers will be incorporated into the national replication strategy. This strategy will be used by SEDESOL as a basis for replication of LFG projects in Mexico.

### 6.5 How will the project monitor performance in terms of social development outcomes?

The reduced cost of electricity will be monitored in the operational summary reports provided by SIMEPRODESO. The emissions reductions from the plant and the explosion risks will be included as part

of the environmental monitoring. The assessment of the effect of LFG projects on scavengers will be monitored by the completion of the workshops and the inclusion of the inputs on scavengers in the reports and materials.

## 7. Safeguard Policies:

7.1 Do any of the following safeguard policies apply to the project?

Policy	Applicability
Environmental Assessment (OP 4.01, BP 4.01, GP 4.01)	<input checked="" type="radio"/> Yes <input type="radio"/> No
Natural habitats (OP 4.04, BP 4.04, GP 4.04)	<input type="radio"/> Yes <input type="radio"/> No
Forestry (OP 4.36, GP 4.36)	<input type="radio"/> Yes <input type="radio"/> No
Pest Management (OP 4.09)	<input type="radio"/> Yes <input type="radio"/> No
Cultural Property (OPN 11.03)	<input type="radio"/> Yes <input type="radio"/> No
Indigenous Peoples (OD 4.20)	<input type="radio"/> Yes <input type="radio"/> No
Involuntary Resettlement (OD 4.30)	<input type="radio"/> Yes <input type="radio"/> No
Safety of Dams (OP 4.37, BP 4.37)	<input type="radio"/> Yes <input type="radio"/> No
Projects in International Waters (OP 7.50, BP 7.50, GP 7.50)	<input type="radio"/> Yes <input type="radio"/> No
Projects in Disputed Areas (OP 7.60, BP 7.60, GP 7.60)	<input type="radio"/> Yes <input type="radio"/> No

7.2 Describe provisions made by the project to ensure compliance with applicable safeguard policies.

See section 5.

## F. Sustainability and Risks

### 1. Sustainability:

This GEF project is a continuation of a World Bank-financed project. Factors critical to the sustainability of the project include:

- i) The proposed technology (LFG collection from production wells for the purposes of power generation in internal combustion engines) is well-proven elsewhere;
- ii) The institutional structure of the demonstration project includes the formation of a public-private partnership and a Cogeneration Company. Precedents for both arrangements can be found in Mexico. Their application to a LFG will provide an excellent model for replication.
- iii) The current regulation for solid waste management does not cover LFG issues. However, regulatory reform is in the process of being formulated that would satisfactorily address construction and management issues related to LFG. As part of the project a framework for more detailed inclusion of LFG issues in Mexican legislation will facilitate future replication of the project;
- iv) The financial analysis (see section 2 in Summary Analysis and Annex 4a) carried out for the demonstration project shows that without GEF assistance, the project's financial rate of return is marginal. However, with GEF involvement, the return is more attractive;
- v) The institutional capacity of SIMEPRODESOS has been tested during the operation of the sanitary landfill (the second largest in Mexico). A financial capacity assessment of SIMEPRODESOS indicated that they satisfy the Bank's minimum financial management requirements but do not have in place an adequate project financial management system for PMR-Based disbursements. An action plan including details of accounting, auditing arrangements, reporting, flow of funds and management information system has been formulated with the client to address the financial issues. A procurement capacity assessment prescribed

an action plan to assist SIMEPRODESO during the project and build their capacity. This plan will be followed during project implementation. In addition, SIMEPRODESO's management and operational capacity for the LFG plant will be further strengthened as part of the project through the involvement of a private sector partner with experience in LFG management. Given the past management record and the proposed additional support, the institutional capacity supports the sustainability of the project.

vi) From the perspective of replication of the demonstration project, the experience of project preparation was very encouraging. The prefeasibility study found many potential sites for development of LFG projects in Mexico and a recent draft regional study on LFG has indicated that there are many potential sites in Latin America. As evidenced by the success of recent workshops on LFG in Mexico and SEDESOL's commitment to this issue, there is great interest at the federal and local level for LFG projects in Mexico and therefore replication of the demonstration project. Additionally, the project itself is designed to encourage replication. The project is specifically designed to remove barriers to replication (including institutional and technical capacity restraints, project risk, and financing and financial barriers) through the demonstration project, dissemination activities, capacity building activities and policy and regulatory studies. The project will also develop mechanisms to encourage replication through the replication strategy for Mexico and worldwide study to be completed for application to Latin America. The later two studies will identify the need for, types of and utility of different financing mechanisms (such as the emerging Carbon Trade) for future projects.

## 2. Critical Risks (reflecting the failure of critical assumptions found in the fourth column of Annex 1):

Risk	Risk Rating	Risk Mitigation Measure
<b>From Outputs to Objective</b>		
Demonstration project provides a good model for replication.	M	Engineering feasibility study, experienced private sector partner, well researched institutional structure prepared by experienced staff at SIMEPRODESO and the Bank.
Sufficient Mexican government and private sector interest in dissemination activities.	N	Dissemination materials prepared by international consultant, discussions with SEDESOL.
Local and federal government interest in developing programs to support LFG development.	N	Discussions with SEDESOL, creation of office of Landfill Gas Management at SEDESOL.
Adequate non-GEF financing mechanisms for future replication are identified.	S	National Replication Strategy and worldwide study on LFG will address this as part of the project.
Private sector interest in LFG projects in Mexico.	M	Discussions with industry consultants and company representatives.

Dissemination and training programs are effective at reducing barriers to replication in Mexico.	S	Preparation of dissemination materials by experienced international consultant, results of demonstration project incorporated into materials, preparation of national replication strategy to identify issues important to replication.
Political interest in regulatory reform in Mexico.	M	Discussions with SEDESOL, incorporation of reforms into proposed legislation.
Regional (LAC) government and private sector interest in the dissemination activities.	M	Dissemination materials prepared by experienced international consultant and consultative workshop.
Regional (LAC) government interest in developing programs to support LFG development.	M	Discussions with Bank staff working on LFG in LAC.
Private sector interest in LFG projects in LAC.	M	Discussions with Bank staff and industry consultants working in LAC.
Dissemination and training programs are effective at reducing barriers to replication in LAC.	S	Incorporation of lessons from demonstration project and results of consultation workshop in dissemination and training materials.
<b>From Components to Outputs</b>		
Landfill gas production at estimated levels.	M	Engineering feasibility study and experienced private sector partner.
High tariffs charged by CFE maintained.	M	Contractual arrangements with consumers, quick payback period for capital investment, use of grant financing to insure project viability.
Payment by electricity consumers.	S	Research consumer payment records, 6-12 month bond provided by consumers for payments, state guarantees, opportunity to obtain other consumers.
Continued support from CRE and CFE for project.	M	Continued discussions with CFE and CRE.
Continued commitment by SIMEPRODESO to project.	N	Project ownership demonstrated by SIMEPRODESO, commitment to project implementation responsibilities, incentives for project benefits.
Private sector interest in bidding on project.	M	Discussions with potential bidders and use of industry consultants in bidding process.



Sufficient coordination and interest in developing twinning arrangements.	M	Involvement of USEPA Landfill Methane Outreach Program.
Continued commitment to project by SEDESOL.	M	Financial contribution by SEDESOL for project.
Qualified labor available for project management component.	N	Assessment of experience from previous projects in Mexico.
<b>Overall Risk Rating</b>	M	

Risk Rating - H (High Risk), S (Substantial Risk), M (Modest Risk), N(Negligible or Low Risk)

### 3. Possible Controversial Aspects:

## **G. Main Grant Conditions**

### **1. Effectiveness Condition**

The Recipient (Borrower) will enter into contractual agreements for transfer of funds between (a) BANOBRAS and SIMEPRODESO on a non reimbursable basis, out of the proceeds of the GEF Trust Funds for an amount of (SDR4,046,000 equivalent) and (b) BANOBRAS and SEDESOL on a non reimbursable basis, out of the GEF Trust Funds for an amount of (SDR 954,000 equivalent) (as described under "Flow of Funds" in Section C4).

Establishment and operation of the Cogeneration Company (including signing the incorporation agreements described under the "Framework of the Company" in Section E4), all in a manner satisfactory to the Bank.

SIMEPRODESO will furnish to the Bank a legal opinion satisfactory to the Bank, of counsel acceptable to the Bank, showing that the Incorporation Agreements have been duly authorized or signed by, and executed and delivered by SIMEPRODESO and the Shareholders, and are legally binding upon SIMEPRODESO and the Shareholders, in accordance with their terms.

Appointment of project implementation staff both at SEDESOL and SIMEPRODESO (including the appointment of a financial management specialist, accounting specialist, and a procurement specialist at SIMEPRODESO and a procurement specialist at SEDESOL)(Section E 4.2).

SEDESOL, SIMEPRODESO and BANOBRAS must : (i) prepare a Financial Management Guidebook -FMGb- and (ii) customize the existing management information systems to suit this operation and the agreed action plan for PMR based-reporting (Section E4).

### **Disbursement Conditions**

Disbursement of the Grant funds (under Component A) will be conditional upon: Incorporation of the Environmental Management Plan (EMP) into signed contracts for the establishment of the Cogeneration Company, including institutional responsibilities for the implementation of the EMP (as described in Annex 11).

### **2. Other [classify according to covenant types used in the Legal Agreements.]**

#### **Other Covenants.**

The Joint Venture Agreement will include provisions ensuring that SIMEPRODESO shall cause the Cogeneration Company to:(a) take out and maintain with responsible insurers, insurance against such risks and in such amounts as shall be consistent with appropriate practice.

#### **Legal Covenants**

Obtain and maintain Cogeneration Permit

Sign and implement CFE Agreements and other operational agreements to allow the Cogeneration company to generate and provide electricity to eligible users.

Implement the terms of EMP, including the monitoring indicators.

Carry out the project within the site owned by SIMEPRODESO and not requiring acquisition of land and or resettlement of population

Audit reports submitted annually to the Bank by SIMEPRODESO and SEDESOL that include a review of the procurement record keeping and filing system (see "Procurement Capacity Assessment" in Annex 6).

A midterm review will be undertaken at the end of project year 2 (exactly 24 months after Effective Date) that will include an assessment of the function of the Cogeneration Company (including the roles of the partners described under "Framework of the Company" in section E4), the record of delivery of service of the plant (contained in the Quarterly Operational Summary Report described in section E3) and the record of project outputs (contained in reports described in Annex 1) for the components implemented by SEDESOL.

The procurement action plan (as specified under the "Procurement Capacity Assessment" in Annex 6) will be prepared and implemented..

A monitoring and evaluation plan (including the reporting requirements in Annex 1) will be undertaken.

## **H. Readiness for Implementation**

- 1. a) The engineering design documents for the first year's activities are complete and ready for the start of project implementation.
- 1. b) Not applicable.
- 2. The procurement documents for the first year's activities are complete and ready for the start of project implementation.
- 3. The Project Implementation Plan has been appraised and found to be realistic and of satisfactory quality.
- 4. The following items are lacking and are discussed under loan conditions (Section G):

## **I. Compliance with Bank Policies**

- 1. This project complies with all applicable Bank policies.
- 2. The following exceptions to Bank policies are recommended for approval. The project complies with all other applicable Bank policies.

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Walter Vergara  
**Team Leader**

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Danny M. Leipziger  
**Sector Manager**

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Olivier Lafourcade  
**Country Manager**

## Annex 1: Project Design Summary

### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

Hierarchy of Objectives	Key Performance Indicators	Monitoring & Evaluation	Critical Assumptions
<b>Sector-related CAS Goal:</b> Institutional development.  Decentralization of environmental management.  Improved cost recovery of environmental services.	<b>Sector Indicators:</b> Improved capacity of local and national institutions.  Increase in the number of environmental projects initiated by local institutions.  Improved cost recovery in environmental service sectors.	<b>Sector/ country reports:</b> Sector Work (World Bank). <sup>1</sup>  Sector Work (World Bank).  Sector Work (World Bank).	<b>(from Goal to Bank Mission)</b> Macroeconomic stability.  Political acceptance.

<p><b>GEF Operational Program:</b></p> <p>Operational Program 6: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs.</p>	<p>Increase in the amount of electricity supplied by LFG projects in Mexico.</p> <p>Decreased methane emissions by landfills relative to baseline situation with no LFG projects.</p>	<p>SEDESOL and CFE reports.</p> <p>Greenhouse gas emission inventories (Mexican Office for Greenhouse Gas Mitigation at Instituto Nacional de Ecología).</p>	<p>Government remains committed to promoting the adoption of renewable energy and reducing greenhouse gas emissions.</p>
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Hierarchy of Objectives	Key Performance Indicators	Monitoring & Evaluation	Critical Assumptions
<p><b>Global Objective:</b></p> <p><u>Project Development Objective:</u> Successful demonstration of LFG capture and use facility and reduction of barriers to replication.</p>	<p><b>Outcome / Impact Indicators:</b></p> <p>Landfill gas capture and use facility proven to be technically, institutionally and financially feasible within the Mexican context by PY4.</p> <p>Number of potential participants in LFG projects in Mexico to whom technical, institutional and managerial knowledge on LFG were made available by PY4.</p> <p>Study on landfill gas management issues completed.</p> <p>Increased Mexican state and federal government programs for support of LFG facility development during the five years following project launch.</p> <p>Increase in the number of planned LFG projects in Mexico during the five years following project launch.</p> <p>Number of potential participants in LFG projects in Latin America to whom technical, institutional and managerial knowledge on LFG were made available by PY4.</p>	<p><b>Project reports:</b></p> <p>Quarterly Operational Summary Reports <sup>2</sup> (SIMEPRODESO).</p> <p>Workshop participant list, and distribution list for dissemination of materials (SEDESOL).</p> <p>Final report.</p> <p>Follow-up surveys on activities of government workshop participants <sup>3</sup> (SEDESOL).</p> <p>Follow-up surveys on activities of government workshop participants <sup>3</sup> (SEDESOL).</p> <p>Workshop participant list, newsletter distribution lists, and website visitation count (SEDESOL).</p>	<p><b>(from Objective to Goal)</b></p> <p>Local and federal Government interest in programs to support LFG development continue after project.</p> <p>Landfill gas projects are financially feasible in Mexico under non-GEF financing mechanisms.</p> <p>The technical, institutional and financial experience can be applied successfully to future projects in Mexico.</p> <p>Findings disclosed and discussed with key stakeholders.</p> <p>Landfill gas projects are financially feasible in Latin America under non-GEF financing mechanisms.</p> <p>Landfill gas projects are institutionally, technically and financially feasible in other Latin American countries.</p>

Hierarchy of Objectives	Key Performance Indicators	Monitoring & Evaluation	Critical Assumptions
<p><b>Output from each Component:</b></p> <p>1.0 Landfill gas facility successfully collecting LFG, producing energy and selling electricity.</p> <p>2.0 Landfill gas technical, institutional and managerial knowledge and results of demonstration project disseminated to potential LFG project participants through technical reports, workshops, training, twinning arrangements and development of a national strategy.</p>	<p><b>Output Indicators:</b></p> <p>1.1 Capture system including collection system, treatment plant and flare in place by mid PY2.</p> <p>1.2 Power plant with electrical connection to CFE grid constructed by mid PY2.</p> <p>1.3 At least 54 million cubic meters of methane collected and destroyed by end of PY4.</p> <p>1.4 At least 155,000 MWh of electricity produced by end of PY4.</p> <p>1.5 At least 95% of energy produced sold to members of Cogeneration Company (&lt;5% sold to CFE grid).</p> <p>2.1 Course by international consultant to train SEDESOL staff on LFG by end of PY1.</p> <p>2.2 LFG study tour in US for 3 SEDESOL staff by end of PY1.</p>	<p><b>Project reports:</b></p> <p>Design and Construction Summary Report<sup>4</sup> (SIMEPRODESO), Bank supervision reports (World Bank).</p> <p>Design and Construction Summary Report<sup>4</sup> (SIMEPRODESO), Bank supervision reports (World Bank).</p> <p>Quarterly Operational Summary Reports<sup>2</sup> (SIMEPRODESO).</p> <p>Quarterly Operational Summary Reports<sup>2</sup> (SIMEPRODESO).</p> <p>Quarterly Operational Summary Reports<sup>2</sup> (SIMEPRODESO).</p> <p>Course outline (SEDESOL).</p> <p>Study tour itinerary (SEDESOL).</p>	<p><b>(from Outputs to Objective)</b></p> <p>Demonstration project provides a good model for replication.</p> <p>Sufficient government and private sector interest in dissemination activities.</p> <p>Local and federal government interest in developing programs to support LFG development.</p> <p>Adequate financing mechanisms for future replication are identified.</p> <p>Private Sector interest in LFG projects.</p>

<p>3.0 Identification of LFG legislative needs and manner by which these needs can be integrated into federal legislation.</p>	<p>2.3 Technical materials, including toolkit, best practice notes and procurement documents, drafted and disseminated to government and private entities by mid PY2.</p> <p>2.4 Public dissemination of project via news releases, tour development, and attendance at conferences during PY2-PY4.</p> <p>2.5 6 training courses on LFG management held during PY2-PY4 in Salinas Victoria.</p> <p>2.3 14 trips by managers to twinning facility by end of PY4 (There will be 7 twinning arrangements and 2 trips per twinning arrangement: 1 trip by a manager of the developing facility to the operational facility and 1 trip by a manager of operational facility to the developing facility).</p> <p>2.4 7 internships at an operating facility for managers at a developing facility during PY2-PY4.</p> <p>2.5 Consultative workshop and study on national replication strategy by end of PY4.</p> <p>3.1 Analysis of legislative needs of LFG for inclusion in research report by mid PY2.</p> <p>3.2 Identify how LFG legislative needs can be integrated into proposed legislation and prepare draft legislation by mid PY2.</p>	<p>Technical materials and distribution list (SEDESOL).</p> <p>Bank supervision reports (World Bank).</p> <p>Course outlines (SEDESOL).</p> <p>Report on managerial exchange experiences written by participating managers (SEDESOL).</p> <p>Report on managerial exchange experiences written by participating managers (SEDESOL).</p> <p>Workshop program and national replication strategy report (SEDESOL).</p> <p>Research report (SEDESOL).</p> <p>Research report and draft legislation (SEDESOL).</p>	<p>Dissemination and training programs are effective at reducing barriers to replication.</p> <p>Political interest in regulatory reforms</p>
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<p>4.0 Mexican experience disseminated regionally (LAC).</p>	<p>4.1 Conduct a study of LFG projects worldwide.</p> <p>4.2 Consultative workshop on LFG development in Latin America.</p> <p>4.3 Prepare materials to be used for dissemination by mid PY2.</p> <p>4.4 Website up and running by end of PY2.</p> <p>4.5 Monthly newsletter of best practices for LFG capture and use published and disseminated to environment ministries, solid waste management agencies and industries in 15 countries by mid PY3.</p> <p>4.6 5 training courses on LFG held during PY2-PY4: 2 in Salinas Victoria and 3 in different countries in Latin America.</p>	<p>Study report (SEDESOL).</p> <p>Workshop program (SEDESOL),</p> <p>Dissemination materials (SEDESOL).</p> <p>Website (SEDESOL).</p> <p>Newsletter and distribution list (SEDESOL).</p> <p>Course outlines (SEDESOL).</p>	<p>Regional government and private sector interest in the dissemination activities.</p> <p>Government interest in developing programs to support LFG development.</p> <p>Adequate non-GEF financing mechanisms for future replication are identified.</p> <p>Private Sector interest in LFG projects.</p> <p>Dissemination and training programs are effective at reducing barriers to replication.</p>
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5.0 SEDESOL and SIMEPRODESO Project Management Team in Place and Operating Successfully

<p>4.7 10 trips by managers to twinning facility by end of PY4 (There will be 5 twinning arrangements and 2 trips per twinning arrangement: 1 trip by a manager of the developing facility to the operational facility and 1 trip by a manager of operational facility to the developing facility).</p>	<p>Summary report of management exchange experiences written by participating managers (SEDESOL).</p>
<p>4.8 5 internships at the twinning facility for managers at the operating facility by end of PY4.</p>	<p>Summary report of management exchange experiences written by participating managers (SEDESOL).</p>
<p>5.1 LFG specialist staff in place at SIMEPRODESO and SEDESOL by first quarter of PY1.</p>	<p>Bank supervision reports (World Bank).</p>
<p>5.3 Management information system designed and operating by mid PY1.</p>	<p>Bank supervision reports (World Bank).</p>
<p>5.4 SIMEPRODESO's record keeping organized and staff trained on procurement procedures by mid PY1.</p>	<p>Bank supervision reports (World Bank).</p>
<p>5.5 Requirements for PMR-based disbursement met by SIMEPRODESO by end of PY1.</p>	<p>Bank supervision reports (World Bank).</p>
<p>5.5 Implementation of environmental management plan.</p>	<p>Bank supervision reports (World Bank).</p>
<p>5.6 Quarterly SOEs produced.</p>	<p>Annual Environmental summary report <sup>5</sup> (SIMEPRODESO).</p>
<p>5.7 Annual financial statements produced.</p>	<p>Quarterly PMRs/SOEs (SIMEPRODESO and SEDESOL).</p>
<p>5.8 Annual audit reports produced.</p>	<p>Annual Financial statements (SIMEPRODESO and SEDESOL).</p>
<p>5.9 Project reports (listed above for separate subcomponents) produced.</p>	<p>Audit reports (SIMEPRODESO and SEDESOL).</p>
<p>5.10 Reports on demonstration project produced.</p>	<p>Project reports (SIMEPRODESO and SEDESOL).</p>
<p>5.11 Monitoring reports on Capacity Building and Latin America Dissemination Components produced.</p>	<p>Design and Construction Summary Report <sup>4</sup> (SIMEPRODESO). Quarterly Operational Summary Report <sup>2</sup> (SIMEPRODESO). Annual Environmental Summary Report <sup>5</sup> (SIMEPRODESO). Annual Progress report <sup>3</sup> (SEDESOL).</p>





design criteria memorandum and as-built drawings). O&M manuals will also be included in this report.

<sup>5</sup>An annual environmental summary will include: i) methane captured; ii) methane used for electricity; iii) methane flared; iv) results of any engine emissions tests; v) engine maintenance records as compared to manufacturers suggestions; vi) engine waste oil and coolant handling records; vii) complaints from neighbors by type (noise, emissions, other); viii) methane leaks detected on methane conveyance system near or in engine house; and ix) underground methane concentrations on perimeter of landfill. This report will be produced annually after plant is operational.

## **Annex 2: Detailed Project Description**

### **MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project**

The proposed project seeks to demonstrate a proven technology for LFG capture and use at a landfill in Mexico. The project will result in immediate reductions in emissions of greenhouse gases (GHG) and will serve as a model for the internalization of GHG control measures in solid waste management programs.

The project would build upon an existing Government and Bank-supported program to modernize solid waste management in small and medium sized cities (Ln. 3752-ME). The GEF Alternative would complement and build upon activities implemented under this baseline program and provide financial and technical assistance for : i) introduction of a cost effective, demonstrated technology to collect and utilize LFG; ii) development of capacity of government and private entities for LFG collection and use at the national, state and local level; iii) demonstration of an institutional and management framework for LFG capture and use at an existing facility in Mexico; and iv) preparation of a replication strategy for comparable cities in Mexico and dissemination lessons from the Mexican experience to Latin America.

To this end the project will:

- Design and construct an 7 MW power station fueled by LFG in Salinas Victoria, Mexico.
- Build capacity of the government and private sector in Mexico for LFG management through: i) dissemination of the experience of the Salinas Victoria project, ii) training, and iii) twinning arrangements where an operating LFG facility will provide managerial and technical support to a project to be developed in Mexico.
- Design a national replication strategy for LFG development in Mexico.
- Provide a framework for incorporation of LFG management into existing legislation.
- Facilitate replication of the demonstration project in Latin America through workshops, a website and newsletter, and twinning arrangements.

#### **By Component:**

##### **Project Component 1 - US\$11.50 million**

**GEF contribution: US\$ 4.92 million; Private Sector Strategic Partner Contribution: US\$ 6.58 million**

##### **Detailed Engineering Design and Construction of a Plant for Methane Capture and Use**

This component of the project will provide funding for the design and construction of a LFG collection system and a 7 MW power plant at a 44 ha filled cell at the SIMEPRODESO landfill. The facility will include: i) wells, piping network and blowers that will collect LFG produced by the landfill and deliver it to the power plant; ii) a power plant with an 7 MW capacity and a treatment plant to remove moisture from the LFG before combustion; iii) a flare that burns off excess methane not used by the power plant and thus allows for maximal destruction of methane even during plant shutdowns; iv) electrical connection to power grid; v) supporting infrastructure such as roads, sewerage, water supply, buildings and lighting; and vi) project design, operator training and supervision. The construction of methane monitoring wells around the landfill will also be funded under this component.

This will be implemented under a public-private partnership that includes a private sector company with experience in LFG development. As the "Strategic Partner" in the public-private electric "Cogeneration Company" the private company will be expected to execute and provide a portion of the financing for the design and construction of the plant and operator training. The operation of the plant will be the

responsibility of the Strategic Partner during the first 5 years of the project. After this time the operational responsibility will be shared by the Strategic Partner and SIMEPRODESO. Under the Co-Generation Company framework (outlined in the Institutional section of the Summary Analysis), the several company partners (SIMEPRODESO, Municipality of Monterrey, Metrorey-the subway system in Monterrey, and Servicios de Agua y Drenaje de Monterrey) will pay for the use of the power produced by the landfill. SIMEPRODESO will use the power for their materials recovery facility, the Municipality of Monterrey will use it for street lighting, Metrorey to power their subway system and Servicios de Agua y Drenaje will use it for water pumping.

As the LFG facility at Salinas Victoria will be a demonstration, it will be documented for purposes of replication. SIMEPRODESO will prepare the following reports:

A design and construction summary will be compiled from the reports provided by the Strategic Partner during construction (such as design report, design criteria memorandum and as-built drawings). O&M manuals will also be included in this report.

A quarterly operational summary including: i) the available and rated capacity of the engines; ii) total and average gas flow ; iii) gas used for electricity production; iv) gas flared; v) electricity produced; vi) electricity sales, itemized by consumer; vii) itemized operational costs; and, viii) itemized maintenance costs.

An annual environmental summary including: i) methane captured; ii) methane used for electricity; iii) methane flared; iv) results of any engine emissions tests; v) engine maintenance records as compared to manufacturers suggestions; vi) engine waste oil and coolant handling records; vii) LFG condensate collection and handling records; viii) complaints from neighbors by type (noise, emissions, other); ix) methane leaks detected on methane conveyance system near or in engine house; x) underground methane concentrations on perimeter of landfill; xi) safety procedures; and, xii) safety records.

An annual progress report that would include lessons learned during project implementation and recommendations for future project replication;

A mid-term consolidated report, in preparation of mid-term review that will contain: (i) integrated summary of the monitoring and evaluation activities (see Annex 1 for reporting requirements) and (ii) a summary of the progress achieved in the carrying out of the project including the implementation of the EMP, and assessment of the performance of the Cogeneration Company to be used in implementation of the demonstration project. The report will be produced 20 months after the Effective Date.

## **Project Component 2 - US\$0.90 million**

**GEF contribution: US\$ 0.60 million; SEDESOL contribution: US\$ 0.30 million**

### **Capacity Building**

In order to promote replication of the LFG collection and use facility elsewhere in Mexico, this component will fund training, workshops and information dissemination designed to build the capacity of SEDESOL, local and state government entities and private contractors to promote and manage LFG projects. In addition, this component will fund the development of a national replication strategy. SEDESOL will be responsible for implementing this component.

### Capacity Building

To build SEDESOL's capacity to assist municipalities in the design and implementation of LFG projects and directing federal assistance in the sector, this component will fund international training of SEDESOL employees. The training would include courses from international consultants as well as study tours of operating LFG projects and government institutions in the US where there is significant experience in LFG. This component will also providing funding for SEDESOL to build capacity and promote LFG adoption in state and local governments and private companies in the solid waste industry. Funding will be provided

for the preparation of dissemination materials, for dissemination and training workshops, and for twinning arrangements.

The dissemination of the results of the demonstration project and the promotion of LFG development will be done through distribution of the materials to interested public and private entities. In addition, public tours, demonstrations and press releases will be planned to highlight the demonstration project and the development of LFG in Mexico to the general public. Training workshops (6) in Monterrey will be run for those government and private entities interested in developing LFG projects in the future. For these training workshops practical materials will be developed such as a "LFG toolkit" that includes technical design, construction and operational manuals, monitoring and supervision guidelines (which will be developed for application to various regions of the country), "best practice notes", and procurement and competitive bidding documents for the retrofitting of landfills and for composting in new cells and/or new facilities. Twinning arrangements where SIMEPRODESO or an international LFG facility provide managerial and technical support to a project to be developed in Mexico will also be arranged as part of this component. The project will fund travel for managers from both facilities involved in the twinning arrangement to visit their counterparts sites. In addition, internships will be available at the operating facility for the manager planning on developing the LFG project. The visits and internships will be profitable experiences by themselves and provide a starting point for more a substantial twinning relationship that would be financed by the two parties involved.

#### Replication Strategy

This component will also provide funding for the preparation of a national replication strategy. To this end the project will fund the production of a national replication strategy report detailing a framework for: i) developing LFG capture and use systems in existing cells in sanitary landfill ("retrofitting"), in new cells within existing landfills, and in new facilities; ii) introducing LFG management issues in the process of converting open dumps to sanitary landfills, including discussion of methodologies, analysis and options for scavengers; iii) incorporating LFG management in the planning, design and construction of future landfill sites; iv) assessing the prospects of using non-grant financing modalities for future support to municipalities including access to carbon trade resources; and v) assessing the prospects for the use of LFG as a source of energy for municipal services in other Mexican cities. The potential compability of composting (including its use in agriculture) with landfill gas projects will also be explored and included as a component of the replication strategy. A consultative workshop with public, private and other entities interested in solid waste and LFG will be held and the outcomes will be incorporated in the national replication strategy report.

#### **Project Component 3 - US\$ 0.05 million**

**GEF contribution: US\$ 0.05 million**

##### **Policy and Regulatory Reform**

The project will fund the necessary technical background reviews for identification of LFG management legislative needs. The project will strengthen the capacity of SEDESOL for the future development of a modern legal and regulatory framework applicable to LFG management issues, through the provision of a regulatory reform study. SEDESOL will implement this component.

#### **Project Component 4 - US\$0.50 million**

**GEF contribution: US\$ 0.50 million**

##### **Regional (Latin America) Dissemination**

The project will support efforts aimed at facilitating the dissemination of the design and operational experience gained from the SIMEPRODESO demonstration project and other projects worldwide for replication throughout the region.



Specifically, the project will fund the development of materials appropriate for dissemination in Latin America. During preparation of the materials a study will be funded that assesses the worldwide economic and technical effectiveness of LFG plants with a focus on barriers to implementation in developing countries and best practice models appropriate to the Latin America context. In addition, a consultative workshop will be funded that will include public, private and other entities in Latin America that are interested in LFG. The potential compability of composting (including its use in agriculture) with landfill gas projects will also be explored and included in the dissemination materials.

Funding will be provided to develop a website and a newsletter based on the dissemination materials. In addition, the funding will support workshops in Monterrey and other locations in Latin America for government officials, owners and operators of sanitary landfills interested in LFG and other potentially interested parties from the private sector, such as independent power producers in the region.

This component will also fund the development of twinning arrangements between developing LFG projects in Latin America and operating projects such as the one at SIMEPRODESO or other international facilities. Similar to the capacity building component, the project will fund travel for managers from both facilities involved in the twinning arrangement to visit the other's facilities. In addition, internships will be available at the operating facility for the manager planning on developing the LFG project. SEDESOL will be responsible for implementing this component.

#### **Project Component 5 - US\$0.34 million**

**GEF contribution: US\$ 0.20 million; SEDESOL contribution: US\$ 0.04 million; SIMEPRODESO contribution US\$ 0.1 million**

#### **Project Management, Supervision and Monitoring**

##### Landfill Gas Specialists

The project will hire 2 LFG specialists over the 3 year project period. One specialist will be at SIMEPRODESO and will be in charge of administrative oversight of the demonstration project and will coordinate with SEDESOL to provide information for the development of dissemination materials and organizing public dissemination activities and other support necessary for implementation of the capacity building and dissemination components. Another LFG specialist will be located in the Office of Landfill Gas Management at SEDESOL. This specialist will be in charge of implementing the capacity building, policy and regulatory reform and regional dissemination components of the project.

##### EMP

This component will fund some of the equipment and tests necessary to implement the environmental management plan. This will include the engine stack tests. In addition the EMP monitoring and administration costs will be covered. The remainder of the costs of the EMP will be covered by the Strategic Partner as specified in the bidding documents.

##### Project Management and Administration

The project will fund the technical and administrative support necessary to implement the project and to provide monitoring of the project as a whole. Landfill gas specialists will be employed for the project in SEDESOL and SIMEPRODESO. In accordance with the procurement capacity assessment, this component will pay for a consultant to organize the booking and train SIMEPRODESO's procurement team. In accordance with the financial capacity assessment, the salaries of independent auditors for annual audits of SIMEPRODESO will also be funded. The costs of production of the required project monitoring, supervision and auditing reports, the operational summary report, the environmental summary report and the lessons learned report will also be funded.



### Annex 3: Estimated Project Costs

#### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

Project Cost By Component	Local US \$million	Foreign US \$million	Total US \$million
Detailed Engineering Design and Construction of a Plant for Methane Capture and Use	1.96	7.83	9.79
Capacity Building	0.44	0.40	0.84
Regulatory Reform	0.04	0.00	0.04
Regional (Latin America) Dissemination	0.21	0.26	0.47
Project Management	0.32	0.00	0.32
<b>Total Baseline Cost</b>	2.97	8.49	11.46
<b>Physical Contingencies</b>	0.20	0.78	0.98
<b>Price Contingencies</b>	0.21	0.60	0.81
<b>Total Project Costs</b>	3.38	9.87	13.25
<b>Total Financing Required</b>	3.38	9.87	13.25

Project Cost By Category	Local US \$million	Foreign US \$million	Total US \$million
<b>Goods</b>	0.01	0.00	0.01
<b>Training*</b>	0.40	0.08	0.48
<b>Consultant Services</b>	0.28	0.28	0.56
<b>Joint Venture Agreement**</b>	2.30	9.16	11.46
<b>Project Management***</b>	0.39	0.35	0.74
<b>Total Project Costs</b>	3.38	9.87	13.25
<b>Total Financing Required</b>	3.38	9.87	13.25

\* Training refers to the costs related to the provision of training and capacity building (including twinning arrangements) such as domestic and foreign travel, room, board and per diem and other administrative expenses incurred by trainees in connection with their training and capacity building activities; the organization and delivery of workshops and other dissemination and consultation activities; training facility rental; and the preparation, production and publication of instructional materials.

\*\* Joint Venture Agreement refers to the expenditures for goods, works and consultants' services procured by the Strategic Partner contracted to design, build and operate the LFG power plant and provide the training activities referred to in Component A of the project.

\*\*\*Project Management refers to the reasonable recurrent expenditures incurred by the SIMEPRODESOL PIU and the SEDESOL PI, in the daily implementation, management, coordination, monitoring and evaluation of the Project, such as cost of office supplies, equipment and computers, maintenance of facilities and equipment and transportation and per diem of staff of the PIU's, all of which expenditures would not have been incurred absent the Project.

<sup>1</sup> Identifiable taxes and duties are 0 (US\$m) and the total project cost, net of taxes, is 13.25 (US\$m). Therefore, the project cost sharing ratio is 47.32% of total project cost net of taxes.

## Annex 4

### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

#### Annex 4a: Detailed Financial Analysis

A detailed financial analysis was performed as part of the feasibility study. The results and basis of the analysis are shown below:

**Investment costs:** The costs of design and construction of the LFG capture and use facility were determined through a detailed technical design of the collection system and power plant to be constructed at the SIMEPRODESO landfill. The costs were confirmed through quotes by suppliers.

<b>Investment Costs for Methane Gas Capture and Use Facility at SIMEPRODESO</b>	
<b>Item</b>	<b>Cost (pesos)</b>
Gas collection system	18,020,000
Treatment plant	500,000
Engine house	400,000
Engines	3 x 16,605,000 1 x 9,963,000
Electrical substation (34.5 kV)	7,670,000
Interconnection line	4,000,000
Training	350,000
<b>Subtotal</b>	<b>90,718,000</b>
Contingencies (10% physical; 7% price)	15,422,060
<b>Total Investment</b>	<b>106,140,060</b> <b>(US \$11.5 million)</b>

**Recurrent costs:** The costs of administration were estimated based on the requirements for similar projects. The maintenance costs were estimated based on manufacturers' estimates, CFE estimates and typical costs from previous LFG projects. The transmission charges were based on CFE estimates.

## Recurrent Costs for Methane Capture and Use Facility at SIMEPRODESO

	Administration Costs ( A )				Maintenance Costs ( B )									Total Operation and Maintenance Costs	Transmission Costs	Price Conting.	Total costs of exploitation
	Personnel	Gas Capture	Operators	Other costs	Total costs of Administration	System of Capture	Treatment Plant	Engine Units	Control Systems	Electrical Subst.	Interconnection line	Backup Charges	Total Maint. Costs	C = A + B	( D )	7%	E = C + D
															0.1530		
															pesos / kWh		
	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos	pesos
año																	
2001													0		0		0
2002	307,800		469,800	12,000	789,600	500,000	50,000	1,267,937	100,000	37,500	5,000	272,471	2,232,908	3,022,508	3,987,985	490,734	7,501,227
2003	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874		75,000	10,000	544,942	4,265,815	5,845,015	7,975,969	967,469	14,788,453
2004	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874		75,000	10,000	544,942	4,265,815	5,845,015	7,975,969	967,469	14,788,453
2005	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874	100,000	75,000	10,000	544,942	4,365,815	5,945,015	7,975,969	974,469	14,895,453
2006	615,600	50,000	939,600	24,000	1,629,200	1,000,000	100,000	4,640,118		75,000	10,000	544,942	6,370,060	7,999,260	7,853,293	1,109,679	16,962,232
2007	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874		75,000	10,000	544,942	4,265,815	5,845,015	7,344,549	923,269	14,112,834
2008	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874	100,000	75,000	10,000	544,942	4,365,815	5,945,015	6,878,797	897,667	13,721,479
2009	615,600		939,600	24,000	1,579,200	1,000,000	100,000	2,535,874		75,000	10,000	544,942	4,265,815	5,845,015	6,441,707	860,071	13,146,793
2010	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,901,905		75,000	10,000	544,942	3,631,847	5,211,047	6,026,113	786,601	12,023,761
2011	615,600	50,000	939,600	24,000	1,629,200	1,000,000	100,000	12,170,975	100,000	75,000	10,000	544,942	14,000,917	15,630,117	5,642,763	1,489,102	22,761,981
2012	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,901,905		75,000	10,000	544,942	3,631,847	5,211,047	5,205,673	729,170	11,145,890
2013	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,901,905		75,000	10,000	544,942	3,631,847	5,211,047	4,951,301	711,364	10,873,712
2014	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,901,905	100,000	75,000	10,000	544,942	3,731,847	5,311,047	4,625,274	695,542	10,631,864
2015	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,901,905		75,000	10,000	544,942	3,631,847	5,211,047	4,331,492	667,978	10,210,517
2016	615,600	50,000	939,600	24,000	1,629,200	1,000,000	100,000	2,320,059		75,000	10,000	544,942	4,050,001	5,679,201	4,059,207	681,689	10,420,096
2017	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,267,937	100,000	75,000	10,000	544,942	3,097,879	4,677,079	3,794,086	592,982	9,064,147
2018	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,267,937		75,000	10,000	544,942	2,997,879	4,577,079	3,550,462	568,928	8,696,469
2019	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,267,937		75,000	10,000	544,942	2,997,879	4,577,079	3,328,335	553,379	8,458,792
2020	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,267,937	100,000	75,000	10,000	544,942	3,097,879	4,677,079	3,113,372	545,332	8,335,782
2021	615,600		939,600	24,000	1,579,200	1,000,000	100,000	1,267,937		75,000	10,000	544,942	2,997,879	4,577,079	2,923,489	525,040	8,025,607

### Financial Analysis:

**Project Benefits:** The financial benefit of the project was calculated as the revenue from electricity sale. The electricity will be sold to the Municipality of Monterrey for street lighting at night, Servicios de Agua y Drenaje (the water utility) for water pumping and SIMEPRODESO for their materials recovery facility during the day. The costs of electricity to these entities (including the tariff and the fixed costs) were discounted 5% below the current costs charged by CFE.\* The benefit was calculated as the kwh produced by the LFG facility each year (as estimated by the LFG production model (see Annex 15)), multiplied by the average selling price of electricity (calculated as the average price charged to each of the consumers weighted by the expected kwh used). The average price was 0.81 pesos/kwh.

**Project Costs:** The project costs included the investment costs and the recurrent costs and took into account depreciation and taxes.

\*Municipality of Monterrey for street lighting: 1.35 pesos/kwh; Servicios de Agua y Drenaje for water pumping and SIMEPRODESO for materials recovery facility: 0.53-0.72 pesos/kwh depending on the amount, time of day and type of line. As selling electricity to Monterrey (the subway system) became an option after the financial analysis was done, it is not considered here. The electricity tariff for Monterrey is only slightly higher than that for Servicios de Agua y Drenaje and therefore will only increase the average selling price and thus the IRR marginally.

\*\*The costs of the electricity to run the blowers are included in "other costs" under administration costs.

### Cash flow Analysis of Methane Gas Capture and Use Facility at SIMEPRODESO.

	Revenue from Electricity Sales	Investment	Costs of Exploitation	Depreciation	Taxes	Cash Flow
					35%	
	pesos	pesos	pesos	pesos	pesos	
año						
2001	0	106,140,060	0	0	0	-106,140,060
2002	21,159,803	0	7,501,227	6,853,500	2,381,777	11,276,799
2003	42,319,606	0	14,788,453	9,016,800	6,480,023	21,051,129
2004	42,319,606	0	14,788,453	9,016,800	6,480,023	21,051,129
2005	42,319,606	0	14,895,453	9,016,800	6,442,573	20,981,579
2006	41,668,701	0	16,962,232	9,016,800	5,491,384	19,215,085
2007	38,969,360	0	14,112,834	9,016,800	5,543,904	19,312,622
2008	36,498,132	0	13,721,479	9,016,800	4,815,949	17,960,704
2009	34,178,980	0	13,146,793	9,016,800	4,205,386	16,826,802
2010	31,973,884	-1,195,560	12,023,761	9,016,800	4,245,109	16,900,574
2011	29,939,874	0	22,761,981	8,020,500	0	7,177,893
2012	27,620,722	0	11,145,890	1,187,000	5,350,741	11,124,091
2013	26,271,051	0	10,873,712	20,000	5,382,069	10,015,271
2014	24,541,192	0	10,631,864	20,000	4,861,265	9,048,063
2015	22,982,418	0	10,210,517	20,000	4,463,165	8,308,735
2016	21,537,700	0	10,420,096	20,000	3,884,161	7,233,442
2017	20,131,001	0	9,064,147	20,000	3,866,399	7,200,455
2018	18,838,359	0	8,696,469	20,000	3,542,661	6,599,228
2019	17,659,773	0	8,458,792	20,000	3,213,343	5,987,638
2020	16,519,207	0	8,335,782	20,000	2,857,199	5,326,226
2021	15,511,706	0	8,025,607	20,000	2,613,135	4,872,964

The final financial statistics were then calculated assuming a 10% discount rate.

**NPV= 20,665,222 pesos**  
**(US\$ 2.2 million)**  
**IRR=13.4 %**

**Analysis with GEF grant:** In order to determine the effect of the GEF grant on the financial viability of the project, the financial analysis was also run assuming that, as proposed, the GEF grant will pay for US\$4.92 million of the investment costs. This was done as described above with the GEF grant subtracted from the total investment costs.

**NPV=66,074,708 pesos**  
**(US\$ 7.2 million)**  
**IRR=27.6%**

**Sensitivity Analysis:** A sensitivity analysis was also performed in order to assess the effect of uncertainty in the electricity price, investment costs, gas production and discount rate on the results of the financial analysis. This was done by changing each of the parameters +/- 20% and performing the financial analysis as described above.

<b>Sensitivity of Internal Rate of Return (%) to Changes in Important Parameters</b>											
	With GEF Grant						Without GEF Grant				
% change in parameter	-20%	-10%	Base	+10%	+20%		-20%	-10%	Base	+10%	+20%
Electricity price	18.7	23.3	27.6	31.6	35.5		7.1	10.4	13.4	16.2	18.9
Investment costs	35.1	31.0	27.6	24.7	22.3		18.4	15.7	13.4	11.6	9.9
Gas production	20.6	24.2	27.6	30.8	34.0		8.5	11.0	13.4	15.0	16.5
Delay in start of operation			Base	6 mths*	12 mths**				Base	6 mths*	12 mths**
			27.6	23.7	22.4				13.4	11.2	10.5

\* It is assumed that in a delay of 6 months or less there would not be sufficient time for the contractor to adjust the design and reduce the capacity of the plant (to 6 MW) to account for the lower total gas captured as a result of the delay. This extra capacity is assumed to be sold at 70% of the original price.

\*\*For longer delays, it is assumed the contractor will be able to adjust the design and reduce the capacity of the plant (to 6 MW) to account for the lower total gas captured as a result of the delay. As selling electricity to Metrorrey (the subway system) became an option after the financial analysis was done, it is not considered here. The electricity tariff for Metrorrey is only slightly higher than that for Servicios de Agua y Drenaje and therefore will only increase the average selling price and thus the IRR marginally.

## **Annex 4b: Incremental Costs and Global Environmental Benefits**

### **Overview**

1. The proposed GEF project seeks to demonstrate the technology and strengthen the regulatory, policy, and social frameworks for the introduction of LFG capture and use in Mexico, as indicated by capture and use of LFG (LFG) at one facility. Project activities would be included to boost the replication potential of the experience.
2. The proposed Methane Gas Capture and Use at a Landfill - Demonstration Project would provide complementary support to an existing (baseline) integrated solid waste management project (Second Solid Waste Management Project -Ln. 3752-ME). In addition to GEF funding, the federal government and a private sector company will be contributing to project costs, as well as IBRD loan funds.

### **Context and Broad Development Goals**

3. As is the case with many developing nations, Mexico faces serious difficulties in the management of urban refuse and solid waste. It is estimated that over 82,000 tons of solid waste is generated in the country every day. Yet, there is a generalized lack of proper treatment and disposal facilities; institutional capacities are weak; and financial conditions, at the local, municipal level are frequently adverse. The problem continues to compound, exacerbated by: i) the sustained growth of population; ii) the high rate of rural migration to urban settings; and iii) an increased degree of industrialization and associated local consumption patterns. For example, during the last several decades, Mexico has been urbanizing rapidly\*. Per capita generation of urban refuse has also increased.
4. Of all the solid waste generated, only 77% is collected (62 thousand tons) and less than 35% is disposed under sanitary conditions (29 thousand tons). Improper waste management practices contribute to serious health and safety problems in nearby communities, negatively impacts property values and has been linked to the contamination of aquifers and surface waters. In addition, the waste that is deposited in landfills decomposes and produces LFG (LFG), which is customarily 50% methane. Methane is a potent greenhouse gas, contributing to smog, global warming and the risk of explosion if not properly controlled.
5. Mindful of the long-term costs of improper solid waste management, the Government of Mexico has initiated (with assistance from the World Bank) a program designed to address some of the underlying causes of improper solid waste management. The program supports efforts to: a) strengthen regulations and institutions at a federal and local level to provide more effective practices and incentives; and b) assist in the development of sustainable solid waste management practices. This program is assisting specific communities, committed to policy, institutional reform and the implementation of sustainable practices in its efforts to develop, design and operate long-term, solid waste management programs. It also includes revisions and strengthening of the regulatory framework ("La Norma Oficial Mexicana" (NOM-083-ECOL-1996). This integrated approach taken by the UMS

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\*Currently, approximately 60% of the population of 92 million Estimate of 1997 population size, assuming an annual growth rate of 2%. live in cities with over 15,000 inhabitants National Communication of Mexico, available on the Climate Change Commission Homepage.



has led to better collection, transfer and disposal of solid waste and the introduction of cost recovery for solid waste collection and disposal.

6. The UMS now wishes to turn its attention to LFG management, which is not addressed in its current solid waste management program. Methane emissions from landfills make up 10% of total methane emissions in Mexico\*, and UMS considers the reduction of methane emissions to be a critical part of a national strategy to control emission of greenhouse gases. The current proposal involves the utilization of the methane produced by a single landfill site, as a demonstration for future replication elsewhere in Mexico (and potentially the region). This would result in a reduction in methane emissions, a reduction in the need for other fossil fuels, lower CO<sub>2</sub> emissions from fossil fuel combustion, and more profitable municipal solid waste management programs. The current proposal is consistent with UMS climate change assessment and objectives as presented in Mexico's First National Communication and Climate Change Action Plan. The first communication provided an estimate of the total emissions of greenhouse gases, outlined programs for their control and reduction and identified some of the impacts anticipated as a result of climate changes. The communication explicitly identified the uncontrolled release of LFG as one of the sources of emissions of methane to the atmosphere and suggested measures to contain these emissions.

7. Looking beyond the solid waste sector, institutional, normative, and programmatic capabilities in the area of environmental control in Mexico have improved noticeably over the past three years. Energy policy has been improved environmentally, through the following measures: i) use of improved fuels; ii) fuel conservation; and iii) energy conservation and efficiency. Other programs initiated for conservation of the environment and natural resources are: i) The Protected Natural Area Program; ii) The Forestry Program; iii) National Reforestation Program; iv) Integrated System for Environmental Regulation and Administration; v) various policies regarding industrial and urban pollution; and vi) registration of emissions and the transfer of contaminants\*\*

### **Scope of the Analysis**

8. The analysis of physical investments is limited to the single demonstration site at Monterrey where solid waste management improvements and methane capture and use are being demonstrated. The analysis of capacity building, policy reform, and dissemination activities is national in scope, focusing on small- and medium-sized cities.

### **Baseline Scenario**

9. The baseline scenario would consist of the GoM's program to improve physical solid waste management in selected small- and medium-size municipalities, strengthen local and federal capabilities to plan and execute solid waste management programs, and improve the regulatory framework and enforcement efforts to ensure that appropriate solid waste management standards are in force and applied in practice. The emphasis under the baseline would be on solid waste management and associated monitoring activities, and little attention would be devoted to integrating LFG capture within the regulatory framework or physical investment program.

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\*Avances en el desarrollo de indicadores para la evaluación del desempeño ambiental en México 1997, Institución Nacional de Ecología, SEMARNAP.

\*\*First National Communication to UNFCCC, UMS, 1997.

10. Expenditures under the baseline scenario amount to US\$ 14.0 million, from the ongoing IBRD loan, UMS financing, and municipal counterpart. The baseline investments consist of: i) capacity building of BANOBRAS and SEDESOL to appraise and supervise solid waste projects and technical assistance to municipalities and states (US\$ 8.9 million); ii) technical assistance to advise on improvements in the legal and regulatory framework and design of cost recovery mechanisms to ensure sector sustainability and safeguard the environment (US\$ 1.4 million); iii) implementation of a pilot program of sustainable solid waste management practices at Monterrey, including environmental monitoring (US\$ 0.95 million); and iv) Operation and maintenance costs (US \$2.74 million) for the landfill are also considered part of the baseline scenario. The costs of establishing the sanitary landfill at the proposed site of the methane capture and use plant are not included in the baseline, as these are sunk costs.

11. The results from implementing the baseline scenario would be positive: a solid foundation -- institutional capacity, regulatory framework, and best practices/applied methodologies -- would have been established for future replication of modern solid waste management practices in other small and medium size cities. However, the issue of LFG management would not have been addressed in any meaningful way within sector planning or investment programs under the baseline scenario, due to the incremental costs associated with the required investments, lack of information/guidelines, and absence of practical experience adapted to local conditions.

12. In other words, without GEF financing, methane capture would not be a priority investment in the short term. Moreover, without the institutional strengthening and capacity building necessary to integrate and internalize global concerns within the existing local environmental actions plans, involving not only the whole array of local authorities but also the participation of main stakeholders, LFG management is likely to continue to be ignored and not viewed as a local environmental responsibility.

### **Global Environmental Benefits**

13. The proposed project will result in a capture of 214 million cubic meters (857,945 tC equivalent) of methane and substitute for 127 thousand tons of carbon from fossil fuel energy sources. This is a total of 0.99 million tons of carbon reduction. The portion of the GEF grant for the methane capture and use facility in Monterrey (US \$4.92 million) would pay for this reduction at a cost of US \$4.99 per ton of carbon. The integration of a renewable energy application in the LFG strategy is expected to result in sustainability of the GEF Alternative in the long-term. Beyond the specific methane mitigation benefit, the project will also lay the foundation for future replication within Mexico in comparably sized cities, and for greater awareness among regional practitioners of the LFG management issue and options through dissemination activities.

### **GEF Alternative**

14. Due to the unbinding nature of Mexico's commitments under the FCCC and the Kyoto Protocol, the national efforts to mitigate the current emission of GHG will be undertaken based on a gradual and voluntary participation of stakeholders, and supported by available international funding mechanisms to cover the associated incremental costs. Parallel to these initiatives, and as part of the Government's efforts for controlling the emission of greenhouse gases, there is an attractive opportunity to internalize concerns about methane emissions at landfills (in the context of efforts to address improper waste management). This could be done through properly designed systems to capture and utilize LFG, at facilities being developed under the existing program. Implementation of these systems would reduce the emissions of methane to the atmosphere while mitigating local air pollution and improving the safety of operations at the landfills. Adding a methane capture element to the program would lay the basis for future replication

efforts by demonstrating costs, potential, and effective management arrangements under Mexican conditions while addressing generic institutional barriers.

15. The proposed project is complementary to the baseline scenario and would consist of mainstreaming LFG management considerations into the baseline sector program. Total expenditures for the GEF Alternative are estimated at US\$ 33.1 million which would include: i) the baseline program described above (US\$ 14.0 million); ii) a pilot methane capture and use program in Monterrey (US\$ 11.50 million); iii) strengthening the capacity of the Ministry of Social Development, SEDESOL, to provide expert advice on LFG management measures, and building capacity of Monterrey and comparably sized cities facing similar problems by developing methodologies, manuals, providing training and twinning opportunities (US\$ 0.9 million); iv) the necessary technical background reviews for identification of LFG management legislative needs. (US\$ 0.05 million); v) dissemination of information on the Mexican experience regionally through the development of technical tools to address barriers to methane capture and use and development (US\$ 0.05 million); organization of LFG technical training workshops (US \$0.25 million); and sponsorships of technical interns (US\$ 0.2 million); vi) project management, supervision, environmental monitoring and evaluation (US\$ 0.3 million) vii) operation and maintenance costs (US \$5.82 million) of GEF alternative are considered in the incremental cost analysis but will be covered by the private investor in the project (LFG O&M) and the landfill owner (landfill O&M).

### **Costs**

16. Implementation of the Baseline scenario would entail costs estimated at US\$ 14.0 million, while the GEF Alternative would incur costs estimated at US\$ 33.1 million. The additional costs associated with the integration of LFG management concerns in the baseline scenario are estimated at US\$19.07 million, of which US\$ 6.27 million are considered agreed incremental costs, after calculating the domestic benefits related to revenues generated from LFG-based electricity sales. Note: These calculations have been updated since GEF Council Approval (in May, 2000 of \$6.53 million agreed incremental costs) to reflect more accurate cost estimates.

**INCREMENTAL COST MATRIX (all figures in US\$ million)**

<b>Cost Categories</b> (all figures PV@10%)	<b>Baseline:</b> Landfill filled	<b>Alternative:</b> CH4 Capture and Use	<b>Incremental Costs</b> Alternative minus Baseline	<b>Domestic Benefit</b>	<b>Global Benefit</b>
Investment Costs	0.95	12.45	11.5	Improvement of solid waste disposal. Generation of 733 GWh of electricity from a non-polluting source and collection of revenues from electricity sales. Reduction of odor and explosion risks.	Capture of 229 million m <sup>3</sup> of methane over the life of the project.
O&M Costs	2.74	8.57*	5.82	Management of landfill.	Successful operation of LFG plant (C emissions abated).
Project Management	0	0.3	0.3	Improved site operational efficiency; lower operating costs; reduced environmental impact of landfill on local community.	Cost effective reduction of methane emissions.
Capacity Building	8.9	9.8	0.9	Improved solid waste management. Improved local knowledge on LFG capture and use resulting in local environmental benefits.	Potential replication of experience at a national level with associated reductions in methane emissions.
Policy Regulation	1.4	1.45	0.05	Improved solid waste management. Lower cost of solid waste management; creation of a new LFG industry; use of a clean, local energy resource.	Integration of LFG concerns into sector norms and standards.
Regional Dissemination	0	0.5	0.5	Development of a LFG industry with expertise applicable in other countries.	LFG information exchange in other countries in the region.
<b>Total Costs</b>	<b>14.0</b>	<b>33.1</b>	<b>19.07</b>	<b>NOTES:</b> * O&M costs of GEF alternative project include landfill O&M and LFG O&M (based on the NPV of costs (discounted 10%) shown in financial analysis, not including transmission charges).  ** The revenue from electricity was calculated using the kwh production estimates in Annex 15 and the long run marginal cost of electricity provided by CFE 0.35 pesos/kwh.	
<b>Revenue from Electricity**</b>	<b>0</b>	<b>(12.8)</b>	<b>(12.8)</b>		
<b>Incremental Costs</b>			<b>6.27</b>		

<u>Type of Benefits</u>	<u>Baseline</u>	<u>GEF Alternative</u>	<u>Alternative-Baseline</u>
<b>Domestic Benefits</b>	-----	<b>700 GWh of Electricity</b>	<b>700 GWh of Electricity</b>
<b>Global Benefits</b>	<b>0 tC abated</b>	<b>0.99 million tC abated</b>	<b>0.99 million tC abated</b>

**Annex 5: Financial Summary**  
**MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project**

Years Ending  
October 1

	IMPLEMENTATION PERIOD						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
<b>Total Financing Required</b>							
<b>Project Costs</b>							
Investment Costs	8.7	3.6	0.4	0.4	0.0	0.0	0.0
Recurrent Costs	0.1	0.1	0.1	0.1	0.0	0.0	0.0
<b>Total Project Costs</b>	8.8	3.7	0.5	0.5	0.0	0.0	0.0
<b>Total Financing</b>	8.8	3.7	0.5	0.5	0.0	0.0	0.0
<b>Financing</b>							
IBRD/IDA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Government	0.0	0.2	0.1	0.1	0.0	0.0	0.0
Central	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Provincial	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Co-financiers (Private Sector)	5.0	1.7	0.0	0.0	0.0	0.0	0.0
GEF	3.8	1.8	0.3	0.4	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Project Financing</b>	8.8	3.7	0.4	0.5	0.0	0.0	0.0

**Main assumptions:**

## **Annex 6: Procurement and Disbursement Arrangements**

### **MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project**

#### **Procurement**

##### **General**

Procurement for the project will be carried out in accordance with the Bank's Guidelines for Procurement under IBRD Loans and IDA Credits (January 1995, revised in January and August 1996, September 1997 and January 1999) and Guidelines for Selection and Employment of Consultants by World Bank Borrowers (January 1997, revised September 1997 and January 1999).

##### **International Competitive Bid for Strategic Partner**

The Strategic Partner that will design, build, operate the LFG facility (including the collection system, power plant and electrical connections as described in the technical section of the Summary Analysis and specified in the Joint Venture Agreement of the Cogeneration Company) and provide training under will be procured through an international competitive bidding (ICB) process in accordance with section (a) of subclause 3.13 "Procurement Under BOT and Similar Private Sector Arrangements" in the above mentioned Procurement Guidelines. Under this clause the goods, works and services required for the design and construction of the LFG facility. The GEF grant will cover US \$4.93 million of the estimated \$11.5 million total cost of the LFG facility.

SIMEPRODESO is organizing the bid. The bidding process includes prequalification followed by bidding. The bidders have been prequalified based on their experience in design, construction and operation of LFG facilities, their personnel and financing capabilities. The prequalified companies will be invited to bid and the award given based on the bidder that will provide the highest profit stream for SIMEPRODESO (highest net present value). Under a USTDA grant, the prequalification and bidding documents have been prepared by SIMEPRODESO with the assistance of a consultant with experience in procurement for LFG projects. In addition, the consultant along with the task team are providing advice during prequalification and bid evaluation. All documents have and will be reviewed by the task team and cleared by the Regional Procurement Advisors for Latin America and the Caribbean.

##### **General Approach**

The Strategic Partner will be a major driving force in the project and will influence the structure of the deal in important ways. The procurement process therefore must provide enough flexibility in the finalization of the arrangements in order to accommodate the demands of the Strategic Partner while having a clearly defined structure that allows for fair and effective competition. To this end, a description of the proposed Cogeneration Company structure with the relevant aspects of the associated permits and contracts were provided in the prequalification documents. In the bidding documents the bidders will be provided with a draft incorporation agreements, draft contracts, letters of interest for the proposed members of the Cogeneration Company and other arrangements. The relevant technical and financial information necessary for the bidders to analyze and bid the project will also be provided.

This information will include:

- Description of works with design and performance specifications.
- Gas generation model with all assumptions.
- Tariff charge and quantity of electricity to be sold to each consumer.
- Other costs such as wheeling, transport and backup.
- Range and conditions of profit sharing arrangements allowed.

- Minimum equity financing allowed.
- A preformatted spreadsheet for making all calculations.

The bidders will bid on this basis and provide the following information in the bid:

- Gas generation model output: They will be allowed to change certain assumptions in the model and will be expected to guarantee these. (i.e. they can change their capture efficiency from 70 to 75% and they will have to guarantee this under contract).
- Investment costs: Within the parameters of the design description and specifications they will come up with the costs for design and construction of the plant.
- Profit sharing setup: Within pre-stated restrictions they will have to specify how the profits will be shared in the first five years.
- Capacity to raise financing and proof of access to funds.
- From this information the bidder will be required to fill in a preformatted spreadsheet and calculate the net present value of the profit stream of SIMEPRODESO. This will be the bidding item with the award going to the highest bid. After selection of the Strategic Partner modifications to the contracts will be negotiated.

#### Status of Process

The procurement schedule is shown below. The prequalification process was completed before negotiations and the bidding documents will have been prepared and approved by the Bank before Board Presentation. The bidding documents will be sent to the prequalified firms immediately after Board Approval.

#### Schedule for Procurement of Strategic Partner

8/20/00:	Published Invitation to Submit Letters of Interest in Development Business, trade journals and in Mexico.
1/11/01:	Sent prequalification documents to those that submitted letters of interest.
2/16/01:	Publish invitation to prequalify in Development Business and in Mexico.
2/16/01-3/30/01:	Received prequalification documents from 10 companies.
4/18/01:	Prequalified bidders.
7/01/01:	Send invitation to bid and bidding documents to prequalified firms.
7/01/01-8/01/01:	Bids received from prequalified firms.
08/20/01:	Evaluate bids.
	Award contract.

#### **Consultant Services**

Consultants will be hired for the Capacity Building, Policy and Regulatory Reform and Latin America Dissemination Components. Consultants will be used to prepare dissemination materials, design the replication strategy, prepare the research report and draft legislation, research worldwide experience, perform tests required under the EMP and perform the necessary auditing and training to implement the project. International consultants will provide guidance on the preparation of dissemination materials and research worldwide experience in LFG. The remaining consultants will be national.

Quality and Cost Based Selection (as per the Consultant Guidelines, Section II, paragraph 3 of Appendix 1, Appendix 2 and paragraphs 3.13 through 3.18) will be used for firms with contracts >US \$100,000. Selection based on Consultant Qualifications (as per paragraphs 3.1 and 3.7 of Consultant Guidelines) will be used for firms with contracts <US \$100,000. Individual consultants will be procured as under the individual consultant procedures (as per paragraphs 5.1 and 5.3 of Consultant Guidelines).

Contracts for consultant firms estimated to cost US\$ 100,000 equivalent or more and individual consultants estimated to cost US\$ 50,000 equivalent or more shall be subject to prior review by the Bank. Contracts below this threshold shall require prior approval of the Terms of Reference by the Bank.

### **Goods**

The major goods to be purchased as part of the project are computer equipment (<US \$15,000). These will be procured through national shopping.

### **Training**

Training refers to the costs related to the provision of training and capacity building (including twinning arrangements) such as domestic and foreign travel, room, board and per diem and other administrative expenses incurred by trainees in connection with their training and capacity building activities; the organization and delivery of workshops and other dissemination and consultation activities; training facility rental; and the preparation, production and publication of instructional materials. These will be procured using consultant selection or using SOE procedures.

### **Project Management**

Refers to the reasonable recurrent expenditures incurred by the SIMEPRODESO PIU and the SEDESOL PI, in the daily implementation, management, coordination, monitoring and evaluation of the Project, such as cost of office supplies, equipment and computers, maintenance of facilities and equipment and transportation and per diem of staff of the PIU's, all of which expenditures would not have been incurred absent the Project. These will be procured using SOE procedures.

### **Procurement Capacity Assessment**

A procurement capacity assessment was completed for SIMEPRODESO and approved by the RPA on August 14, 2000. The capacity assessment concluded that the risk is high but may be reduced after selection of the Strategic Partner. An action plan (described below) was prescribed. The plan will be agreed at negotiations and implementation of the plan will be included in the Grant Agreement as a Legal Covenant (see Main Grant Conditions, section G). This action plan, the commitment by SIMEPRODESO to the procurement process and the consultant services that have been arranged will significantly reduce the procurement risk.

#### Procurement Action Plan

- Legal Covenant:  
A covenant in the Legal Documents will require that audit reports be submitted annually to the Bank that include a review of the procurement record keeping and filing system.
  
- Hire the following consultant services:
  - i) A procurement consultant to prepare the prequalification and bidding documents and assist SIMEPRODESO in evaluating proposals by Negotiations.
  
  - ii) An individual procurement consultant to organize record keeping and train SIMEPRODESO's project implementation staff.
  
- Publications  
Publish a Request for Letters of Interest to participate in the selection of the private partner should be published by August 15, 2000.
  
- Workshop



Prepare a project launch workshop after Board approval.

- Training

Periodic participation in specialized workshops on procurement under Bank Guidelines as they become available during the life of the project.

**Procurement methods (Table A)**

**Table A: Project Costs by Procurement Arrangements  
(US\$ million equivalent)<sup>1</sup>**

Expenditure Category	Procurement Method				Total
	ICB	Shopping	Consultant Selection (see table A1)	SOEs	
<b>Goods</b>	0.00 (0.00)	0.014 (0.014)	0.00 (0.00)	0.00 (0.00)	0.014 (0.014)
<b>Training<sup>2</sup></b>	0.00 (0.00)	0.00 (0.00)	0.14 (0.10)	0.34 (0.27)	0.48 (0.37)
<b>Consultant Services</b>	0.00 (0.00)	0.00 (0.00)	0.56 (0.42)	0.00 (0.00)	0.56 (0.42)
<b>Joint Venture Agreement<sup>3</sup></b>	11.50 (4.92)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	11.50 (4.92)
<b>Project Management<sup>4</sup></b>	0.00 (0.00)	0.00 (0.00)	0.19 (0.13)	0.51 (0.42)	0.70 (0.55)
<b>Total</b>	11.50 (4.92)	0.014 (0.014)	0.89 (0.65)	0.85 (0.69)	13.25 (6.27)

1/ Figures in parenthesis are the amounts to be financed by the GEF Grant. All costs include contingencies.

2/ Training refers to the costs related to the provision of training and capacity building (including twinning arrangements) such as domestic and foreign travel, room, board and per diem and other administrative expenses incurred by trainees in connection with their training and capacity building activities; the organization and delivery of workshops and other dissemination and consultation activities; training facility rental; and the preparation, production and publication of instructional materials.

3/ Joint Venture Agreement refers to the expenditures for goods, works and consultants' services procured by the Strategic Partner contracted to design, build and operate the LFG power plant and provide the training activities referred to in Component A of the project.

4/ Project Management refers to the reasonable recurrent expenditures incurred by the SIMEPRODESO PIS and the SEDESOL PIS, in the daily implementation, management, coordination, monitoring and evaluation of the Project, such as cost of office supplies, equipment and computers, maintenance of facilities and equipment and transportation and per diem of staff of the PIU's, all of which expenditures would not have been incurred absent the Project.

**Table A1: Consultant Selection Arrangements (optional)**  
(US\$ million equivalent)

Consultant Services Expenditure Category	Selection Method							Total Cost <sup>1</sup>
	QCBS	QBS	SFB	LCS	CQ	Other	N.B.F.	
<b>A. Firms</b>	0.27 (0.18)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.32 (0.27)	0.00 (0.00)	0.00 (0.00)	0.59 (0.45)
<b>B. Individuals</b>	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.30 (0.20)	0.00 (0.00)	0.30 (0.20)
<b>Total</b>	0.27 (0.18)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.32 (0.27)	0.30 (0.20)	0.00 (0.00)	0.89 (0.65)

1\ Including contingencies

Note: QCBS = Quality- and Cost-Based Selection  
 QBS = Quality-based Selection  
 SFB = Selection under a Fixed Budget  
 LCS = Least-Cost Selection  
 CQ = Selection Based on Consultants' Qualifications  
 Other = Selection of individual consultants (per Section V of Consultants Guidelines), Commercial Practices, etc.

N.B.F. = Not Bank-financed

Figures in parenthesis are the amounts to be financed by the Bank Grant.

Prior review thresholds (Table B)

**Table B: Thresholds for Procurement Methods and Prior Review** <sup>1</sup>

<b>Expenditure Category</b>	<b>Contract Value Threshold (US\$ thousands)</b>	<b>Procurement Method</b>	<b>Contracts Subject to Prior Review (US\$ millions)</b>
<b>1. Works</b>			none
<b>2. Goods</b>	<15 (aggregate not to exceed 30)	National Shopping	none
<b>3. Services</b>	>100	QCBS	all
<b>Firms</b>	<100	CQ	Terms of Reference only
<b>Individuals</b>	>50	Individual Consultant	all
	<50	Individual consultant	Terms of Reference only
<b>4. Joint Venture Agreement</b>		ICB	all (is only one)
<b>5. Training</b>		QCBS and SOEs	none
<b>6. Project Management</b>		SOEs	none

**Total value of contracts subject to prior review:**

**Overall Procurement Risk Assessment**

**High**

**Frequency of procurement supervision missions proposed:** One every 6 months (includes special procurement supervision for post-review/audits)

Procurement supervision missions will coincide with the project procurement supervision missions.

<sup>1</sup>Thresholds generally differ by country and project. Consult OD 11.04 "Review of Procurement Documentation" and contact the Regional Procurement Adviser for guidance.

## Disbursement

### Allocation of grant proceeds (Table C)

**Table C: Allocation of Grant Proceeds**

<b>Expenditure Category</b>	<b>Amount in US\$million</b>	<b>Financing Percentage</b>
Goods	0.01	100 Foreign 100% exfob local 86% other items procured locally
Training	0.37	100
Consultant Services	0.42	100
Joint Venture Agreement	4.92	50
Project Management	0.55	100
<b>Total Project Costs</b>	<b>6.27</b>	
<b>Total</b>	<b>6.27</b>	

### **Disbursement Arrangements**

A special account in US dollars with an authorized allocation of US \$550,000 will be established in BANOBRAS. All components in the project will use this special account in a manner specified in the subsidiary agreements for the flow of funds (see Flow of Funds, section C4). Retroactive financing for urgent expenditures will be allowed in order to facilitate early start-up of the project.

Traditional documentation requirements apply for direct payment and special commitment. If project is converted to PMR-based disbursement methodology, disbursement procedures should be in line with the Financial Management Initiative. SEDESOL and SIMEPRODESOL, with technical support from the financing agency, BANOBRAS, will prepare the necessary documentation for prompt disbursements and file the withdrawal applications and requests for replenishments of the special account. The SOE's will document expenditures below the thresholds for prior review as described in Table B. For expenditures above prior review thresholds, Bank approval will be required. An operating account in Mexican pesos would be established and should be used for all project transactions. This local-currency operating account should be replenished on a monthly basis. The amount to be transferred from the Special Account to this account must be only that estimated to cover one month of eligible expenditures.

Under the Joint Venture Agreement in component A, the disbursement will be as lump sums against completed activities as follows: 15% upon contract signing; 40% upon receipt of main equipment at site; 20% against plant completion; 15% against successful startup of plant operation and completion of performance tests; and 10% against completion of training prior to plant operation. Payments will be against expenditures incurred.

## Annex 7: Project Processing Schedule

### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

Project Schedule	Planned	Actual
Time taken to prepare the project (months)	22	
First Bank mission (identification)	02/01/99	
Appraisal mission departure	12/11/2000	
Negotiations	04/02/2001	
Planned Date of Effectiveness	10/15/2001	

**Prepared by:**

SIMEPRODESO and SEDESOL

**Preparation assistance:**

ETEISA (prefeasibility and feasibility studies), SCS Engineers (feasibility study and procurement), Brown Vence and Associates (procurement).

**Bank staff who worked on the project included:**

Name	Speciality
Walter Vergara	Chemical Engineer
John Morton (Consultant)	Environmental Engineer
Kirsten Oleson	Environmental Engineer
Luis Luzuriaga (Consultant)	Institutional Energy Specialist
Esme Abedin	Operations Analyst
Suman Babbar	Private Sector
Tomoko Matsukawa	Private Sector
Andrew Fitchie	Legal
Teresa Genta Fons	Legal
Catarina Isabel Portelo (Temporary)	Legal
Amadeu Blasco Munoz (Temporary)	Legal
Lea Braslavsky	Procurement Specialist
Victor Ordonez	Financial Specialist
Ernesto Terrado (Consultant)	Energy Specialist
Dianalva Montas	Program Assistant

**Annex 8: Documents in the Project File\***  
**MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project**

**A. Project Implementation Plan**

The important implementation events of the project will be finalized at negotiations and included in the Grant Agreement.

**B. Bank Staff Assessments**

PCD and other comments in project file.

**C. Other**

Proyecto Piloto Para El Aprovechamiento del Biogas de Los Sitios de Disposicion Final de Residuos Sólidos Municipales, Estudio de Factibilidad de Aprovechamiento del Biogas Generado en el Relleno Sanitario del Area Metropolitana de Monterrey, N. L. Estudios Y Technicas Especializadas en Ingeniera S. A. de C. V.(ETEISA)

Proyecto Piloto Para El Aprovechamiento del Biogas Generado en Sitios de Disposicion Final de Residuos Sólidos. January, 1999 (Estudio de Prefactibilidad), ETEISA.

Proyecto Pilot Para El Aprovechamiento del Biogas de Sitios de Disposicion Final de Residuos Sólidos Municipales, presentacion del Estudio de Prefactibilidad, ETEISA.

Proyecto Piloto Para El Aprovechamiento del Biogas Generado en Sitios de Disposicion Final de Residuos Sólidos. October, 1999, ETEISA.

Estudio Preliminar de Impacto Ambiental Para Proyecto: Conversion de Biogas a Energia Eléctrica, SIMEPRODESO, September 2000.

Proyecto Piloto Para El Aprovechamiento de Biogas De los Sitios de Disposicion Final De Residuos Sólidos Municipales, Analisis Social, ETEISA, September, 2000.

Conditions of Selling Price of Electric Energy from Private's and Cooperative Small Scale Power Generation, Minister of Mines and Energy, The Republic of Indonesia.

Advancing Sugar Cogeneration Development in Uttar Pradesh, India, Policy Review and Power Purchase Agreements, George E. St. John, P.E.

Sugarmill Power Sale Contracts, International Cane Energy Network, Winrock International.

Standardised Agreement for Purchase of Electrical Energy Between The Ceylon Electricity Board and (Renewable Source Small Power Producer).

Electricity Energy Supply Contract and Proposal for Arrangement of Financing. Bio-Gen Project, Honduras.

Draft Power Purchase Agreement From PT PLN (Persero).

Project Description for Proposed Bamboo Fired Biomass Power Plant Project in Sula Valley, Honduras.  
\*Including electronic files

## Annex 9: Statement of Loans and Credits

### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

Project ID	FY	Purpose	Original Amount in US\$ Millions				Cancel.	Undisb.	Difference between expected and actual disbursements <sup>a</sup>	
			IBRD	IDA	SF	GEF			Orig	Frm Rev'd
P048505	1999	AGRICULTURAL PRODUCT	444.45	0.00			0.00	266.35	-15.70	0.00
P067491	2000	Bank Restructuring Facility	505.06	0.00			0.00	150.00	-5.06	0.00
P007700	1997	COMMUNITY FORESTRY	15.00	0.00			0.00	7.81	1.91	0.00
P007610	1999	FOVI RESTRUCTURING	505.05	0.00			0.00	462.00	242.00	0.00
P007723	1993	HWY RHB & SAFETY	480.00	0.00			0.00	10.50	10.50	0.00
P007667	1992	IRRIG SCTR	400.00	0.00			50.00	2.85	52.85	2.85
P044531	1998	KNOWLEDGE & INNOV.	300.00	0.00			0.00	253.77	11.77	0.00
P007648	1993	MEDIUM CITIES TRANSP	200.00	0.00			23.00	109.01	126.91	91.01
P066867	2000	MX DECENTRALIZATION SAL	606.07	0.00			0.00	300.00	300.00	0.00
P066938	2000	MX GENDER (LIL)	3.07	0.00			0.00	3.07	0.00	0.00
P007720	1998	MX: HEALTH SYSTEM REFORM - SAL	700.00	0.00			0.00	350.00	350.00	0.00
P040199	1998	MX: BASIC EDUC.DEVELOPMENT PHASE I	115.00	0.00			0.00	84.00	29.18	0.00
P007689	1996	MX: BASIC HEALTH II	310.00	0.00			0.00	99.78	61.78	31.78
P055061	1998	MX: HEALTH SYSTEM REFORM TA	25.00	0.00			0.00	21.39	15.59	0.00
P049895	1998	MX: HIGHER ED. FINANCING	180.20	0.00			0.00	165.94	26.00	0.00
P007725	1994	MX: PRIMARY EDUC.II	412.00	0.00			40.00	86.25	126.25	86.25
P034490	1995	MX: TECHNICAL EDUC/TRAINING	265.00	0.00			30.00	132.13	162.13	7.10
P007710	1994	N. BORDER I ENVIRONM	368.00	0.00			300.99	36.22	317.51	43.61
P007701	1994	ON-FARM & MINOR IRRI	200.00	0.00			30.00	53.71	83.71	0.01
P007711	1998	RURAL DEV. MARG.AREA	47.00	0.00			0.00	35.94	12.94	0.00
P057530	2000	RURAL DEV.MARG.ARII	55.00	0.00			0.00	55.00	0.00	0.00
P007702	1995	SECOND DECENTRALZTN	500.00	0.00			0.00	58.28	58.28	58.28
P007612	1994	SOLID WASTE II	200.00	0.00			193.06	1.48	-4.46	1.47
P007713	1996	WATER RESOURCES MANA	186.50	0.00			0.00	138.41	59.09	10.62
P007707	1994	WATER/SANIT II	350.00	0.00			84.30	71.42	155.72	0.00
<b>Total:</b>			<b>7372.40</b>	<b>0.00</b>			<b>751.35</b>	<b>2955.31</b>	<b>2178.90</b>	<b>332.98</b>



**MEXICO**  
**STATEMENT OF IFC's**  
**Held and Disbursed Portfolio**

In Millions US Dollars

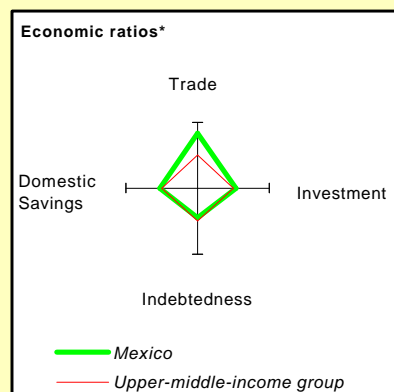
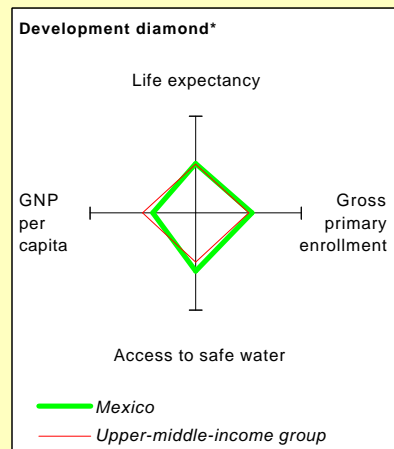
FY Approval	Company	Committed				Disbursed			
		IFC				IFC			
		Loan	Equity	Quasi	Partic	Loan	Equity	Quasi	Partic
1988/91/92/93/95	Apasco	14.40	0.00	0.00	57.60	14.40	0.00	0.00	57.60
1998	Ayvi	10.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00
1990/92/96	BANAMEX	96.21	0.00	0.00	50.83	96.21	0.00	0.00	50.83
1997	Banco Bilbao MXC	75.52	0.00	30.00	0.00	75.52	0.00	30.00	0.00
1992	Banorte-SABROZA	3.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00
1995/96	Baring Mex. FMC	0.00	0.03	0.00	0.00	0.00	0.02	0.00	0.00
1995/99	Baring Venture	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00
1998	CIMA Mexico	0.00	4.80	0.00	0.00	0.00	4.80	0.00	0.00
1998	CIMA Puebla	7.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00
1994	CTAPV	4.01	0.00	2.53	0.00	4.01	0.00	2.53	0.00
0	Chiapas-Propalma	0.00	0.80	0.00	0.00	0.00	0.31	0.00	0.00
1997	Comercializadora	3.28	0.00	2.34	6.88	3.28	0.00	2.34	6.88
1990/91	Condumex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	Corsa	13.00	3.00	0.00	0.00	13.00	3.00	0.00	0.00
1993	Derivados	2.20	0.00	0.00	0.00	2.20	0.00	0.00	0.00
1997	Fondo Chiapas	0.00	4.20	0.00	0.00	0.00	0.31	0.00	0.00
1998	Forja Monterrey	13.00	3.00	0.00	13.00	13.00	3.00	0.00	13.00
1991/96	GIBSA	21.64	0.00	10.00	72.76	21.64	0.00	10.00	72.76
1993	GIDES A	7.50	8.00	0.00	8.50	7.50	8.00	0.00	8.50
1996/00	GIRSA	45.00	0.00	0.00	60.00	22.71	0.00	0.00	30.29
1993	GOTM	0.98	0.00	0.00	0.44	0.98	0.00	0.00	0.44
1997/98	Gen. Hipotecaria	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00
1998	Grupo Calidra	12.00	6.00	0.00	10.00	12.00	6.00	0.00	10.00
	Grupo FEMSA	0.00	9.43	0.00	0.00	0.00	9.43	0.00	0.00
1989	Grupo Minsa	18.00	10.00	0.00	27.00	18.00	10.00	0.00	27.00
1997	Grupo Posadas	25.00	0.00	10.00	10.00	25.00	0.00	10.00	10.00
1992/93/95/96/99	Grupo Probursa	0.00	1.32	0.00	0.00	0.00	1.32	0.00	0.00
1992/96/97/98	Grupo Sanfandila	9.58	0.00	0.00	4.70	6.25	0.00	0.00	3.03
1998	Heller Financial	0.00	0.32	0.00	0.00	0.00	0.32	0.00	0.00
1994/96/98/00	Interceramic	8.00	0.00	6.00	3.50	8.00	0.00	6.00	3.50
1994	InverCap	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
2000	Masterpak	2.40	0.00	0.00	0.00	2.40	0.00	0.00	0.00
1993	Merida III	30.00	0.00	0.00	73.95	27.36	0.00	0.00	67.44
1998	Mexplus Puertos	0.00	1.41	0.00	0.00	0.00	1.41	0.00	0.00
1995/99	NEMAK	0.00	0.00	0.83	0.00	0.00	0.00	0.83	0.00
1996/99/00	Petrocel	1.30	0.00	0.60	0.70	1.30	0.00	0.60	0.70
1990	Punta Langosta	2.63	1.00	0.00	4.55	2.63	1.00	0.00	4.55
1998	Rio Bravo	50.00	0.00	0.00	59.50	0.00	0.00	0.00	0.00
2000	Saltillo S.A.	35.00	0.00	0.00	43.00	0.00	0.00	0.00	0.00
2000	Sigma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988/94/95	Sudamerica	0.00	15.00	0.00	0.00	0.00	15.00	0.00	0.00
1999	TMA	2.77	0.00	2.10	9.60	2.77	0.00	2.10	9.60
1997	Toluca Toll Road	7.23	0.00	0.00	0.00	7.23	0.00	0.00	0.00
1992	Vitro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1991/92									
	<b>Total Portfolio:</b>	<b>525.61</b>	<b>98.54</b>	<b>64.40</b>	<b>518.58</b>	<b>408.85</b>	<b>67.85</b>	<b>64.40</b>	<b>378.19</b>

FY Approval	Company	Approvals Pending Commitment			
		Loan	Equity	Quasi	Partic
1997	Altamira	17800.00	1000.00	0.00	38000.00
1999	BANAMEX LRF II	50000.00	0.00	0.00	0.00
1999	Baring BMPEF FMC	0.00	0.00	60.00	0.00
1998	Cima Hermosillo	7000.00	0.00	0.00	0.00
2000	Educacion	9700.00	0.00	0.00	0.00
2000	FCCM	10500.00	0.00	2000.00	17700.00
2000	Hospital ABC	30000.00	0.00	0.00	14000.00
2000	ITR	14000.00	0.00	0.00	4000.00
2000	Innopack	15000.00	0.00	15000.00	0.00
2000	Teksid Aluminio	25000.00	0.00	0.00	0.00
2000	Teksid Hierro	15000.00	0.00	0.00	30000.00
Total Pending Commitment:		194000.00	1000.00	17060.00	103700.00

## Annex 10: Country at a Glance

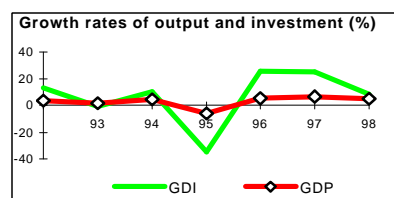
### MEXICO: Methane Gas Capture and Use at a Landfill - Demonstration Project

POVERTY and SOCIAL	Mexico	Latin America & Carib.	Upper-middle-income		
<b>1998</b>					
Population, mid-year ( <i>millions</i> )	95.9	502	588		
GNP per capita ( <i>Atlas method, US\$</i> )	3,970	3,940	4,860		
GNP ( <i>Atlas method, US\$ billions</i> )	380.9	1,978	2,862		
<b>Average annual growth, 1992-98</b>					
Population (%)	1.8	1.6	1.4		
Labor force (%)	2.6	2.3	2.0		
<b>Most recent estimate (latest year available, 1992-98)</b>					
Poverty (% of population below national poverty line)	..	..	..		
Urban population (% of total population)	74	75	77		
Life expectancy at birth ( <i>years</i> )	72	70	70		
Infant mortality ( <i>per 1,000 live births</i> )	31	32	27		
Child malnutrition (% of children under 5)	14	8	..		
Access to safe water (% of population)	95	75	79		
Illiteracy (% of population age 15+)	10	13	11		
Gross primary enrollment (% of school-age population)	115	113	108		
Male	116	..	..		
Female	113	..	..		
<b>KEY ECONOMIC RATIOS and LONG-TERM TRENDS</b>					
	<b>1977</b>	<b>1987</b>	<b>1997</b>	<b>1998</b>	
GDP ( <i>US\$ billions</i> )	87.4	140.2	401.7	410.3	
Gross domestic investment/GDP	21.6	19.2	26.0	24.4	
Exports of goods and services/GDP	8.6	19.5	30.3	31.2	
Gross domestic savings/GDP	20.6	25.3	26.0	22.4	
Gross national savings/GDP	18.2	21.8	24.1	20.6	
Current account balance/GDP	-2.2	3.0	-1.9	-3.8	
Interest payments/GDP	1.8	5.5	2.1	2.0	
Total debt/GDP	35.7	78.1	37.3	39.0	
Total debt service/exports	57.4	40.1	32.4	18.8	
Present value of debt/GDP	..	..	36.0	36.2	
Present value of debt/exports	..	..	110.3	106.0	
	<b>1977-87</b>	<b>1988-98</b>	<b>1997</b>	<b>1998</b>	<b>1999-03</b>
<i>(average annual growth)</i>					
GDP	2.2	2.9	6.8	4.8	4.8
GNP per capita	0.1	0.5	6.0	2.9	2.9
Exports of goods and services	9.4	12.3	10.8	9.7	6.9

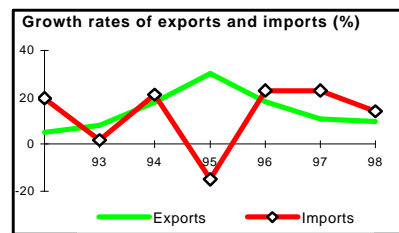


#### STRUCTURE of the ECONOMY

	1977	1987	1997	1998
<i>(% of GDP)</i>				
Agriculture	10.2	8.6	5.7	5.4
Industry	30.7	35.9	28.5	29.1
Manufacturing	22.4	25.7	21.4	21.9
Services	59.1	55.5	65.8	65.5
Private consumption	69.6	65.9	64.1	68.2
General government consumption	9.8	8.8	9.9	9.4
Imports of goods and services	9.6	13.4	30.4	33.2



	1977-87	1988-98	1997	1998
<i>(average annual growth)</i>				
Agriculture	2.2	1.6	0.2	0.5
Industry	2.7	3.5	9.3	6.6
Manufacturing	2.3	3.9	10.0	7.4
Services	2.1	2.7	6.4	4.4
Private consumption	2.2	2.5	6.4	6.4
General government consumption	5.2	1.8	2.9	-1.3
Gross domestic investment	-4.6	4.1	25.0	8.4
Imports of goods and services	-1.3	12.1	22.8	14.2
Gross national product	2.6	2.4	7.9	4.7



Note: 1998 data are preliminary estimates.

\* The diamonds show four key indicators in the country (in bold) compared with its income-group average. If data are missing, the diamond will be incomplete.

## **Additional Annex 11**

### **Environmental Management Plan**

An environmental assessment for the Salinas Victoria LFG facility was finalized on September 19, 2000 and approved by the Bank on March 30, 2001. As a result of the assessment, an "Environmental Management Plan" (EMP), an instrument that details i) the measures to be taken during implementation and operation of the project to eliminate or offset adverse environmental impacts, or to reduce them to acceptable levels; and ii) the actions needed implement these measures, was drafted. The EMP was agreed upon and finalized at negotiations. It is shown below As a condition of disbursement, the EMP will be incorporated into signed contracts of the Cogeneration Company that specify the procedures for implementation of the EMP and the responsible parties (see Main Grant Conditions, section G).

#### The EMP is shown below:

Overall, the installation and operation of a LFG – fueled power plant will significantly improve the environment. The primary environmental benefit is the collection and destruction of volatile organic compounds (VOCs) and methane. VOCs contribute to low level ozone formation (a precursor to smog) and methane is a potent greenhouse gas. The secondary emissions of nitrogen oxides (another smog forming compound) by the engine generators will be more than offset by the destruction of VOCs and the offsetting of fossil fuels that would otherwise be used to generate the electricity produced by the plant. In addition to emissions reductions, LFG collection will control and reduce odors and subsurface methane migration.

Notwithstanding the above environmental benefits, the project does pose several potential environmental impacts, which are discussed herein. Each environmental issue is presented along with measures to address the same (i.e., to minimize the potential impact). A portion of the costs of the environmental management plan (the emissions tests and the methane monitoring system and the monitoring and evaluation documentation) will be covered by the Project Management component of the project. The rest will be specified as construction requirements in the bidding documents. The entity responsible for operation of the plant will implement the related portion of environmental management plan (power plant emissions, engine waste oil, LFG condensate, spent engine coolant, noise, construction-related effects, fire hazard and occupational health and safety). The responsible entity will be Strategic Partner for the first 5 years of the project. After this time, the responsibility will be shared by SIMEPRODESO and the Strategic Partner. The Strategic Partner will be responsible for the operator training including the procedures outlined in the EMP. The methane migration will portion of the EMP is related to landfill management and therefore the responsibility of SIMEPRODESO.

#### **Power Plant and Emissions**

Internal combustion engine generators emit significant levels of carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>). When engine generators are viewed as a pollution control device (via destruction of VOCs and methane), NO<sub>x</sub> and CO become secondary pollutants. Nonetheless, emission levels from this equipment has been sufficient to cause some US projects to be classified as a major source in areas where reduction of emissions is a priority. In response to the demand for lower emissions, the engine generator manufacturers have developed lean burn technology to achieve significant reductions. To take advantage of the improved technology, the Salinas Victoria project specifications will require lean burn equipment to be used in the power plant. In addition, a stack test, which measures emissions from each engine, will be required to

demonstrate compliance with Mexican regulations, any Monterrey airshed management plans and the latest industry standards. This is consistent with World Bank guidelines that recommend compliance with any national or local airshed management programs. Likewise, operations and maintenance requirements will specify that the equipment be operated and maintained in accordance with manufacturer's requirements and within the parameters measured at the time stack test compliance was achieved. Operation and maintenance records as well as the results of the stack test will be documented for monitoring and evaluation purposes. The costs of implementation of the emissions tests will be covered by the Project Management component.

### **Engine Waste Oil**

Because of the corrosive nature of the LFG fueling the engines, the lubricating oil needs to be changed regularly. As such, waste oil is generated and must be managed appropriately. Typically, the oil is handled in a closed system that automatically pumps the waste oil to a storage tank. The waste oil is relatively free of particulates and is sometimes can be sold as fuel. SIMEPRODESO already manages waste oil generated by heavy equipment operated on the landfill. This oil is collected and trucked offsite to a government approved hazardous waste treatment facility. The waste oil from the engines will be managed in the same manner unless a more beneficial method is identified. The amount of waste oil produced and the handling procedures will be documented by the operator (Strategic Partner and/or SIMEPRODESO) for monitoring and evaluation purposes. The tanks and other necessary infrastructure to implement this will be specified in the bidding documents.

### **Landfill Gas Condensate**

Condensate is formed as LFG cools in the collection system piping and the treatment vessels at the power plant and is similar in composition as landfill leachate. The condensate in the collection system is returned to the landfill refuse mass via a series of traps buried in the waste. Condensate will be collected at the power plant and stored in a tank. This condensate will be recirculated back to the landfill along with collected leachate. SIMEPRODESO's current practice is to periodically pump out leachate from a series of riser pipes in the north end of the cell and return it to the refuse. Given the arid conditions at the site, the waste in place is well below its moisture field capacity and can easily absorb the condensate planned for recirculation. The collection and recirculation procedure including the frequency and volume of condensate will be documented for monitoring and evaluation purposes. The tanks and other necessary infrastructure to implement this will be specified in the bidding documents.

### **Groundwater Monitoring**

SIMEPRODESO monitors the groundwater for contamination monthly in compliance with Mexican environmental laws. Under this project these groundwater monitoring practices will continue.

### **Spent Engine Coolant**

The cooling medium for the engines contains anti-freeze (ethylene glycol) and requires periodic replacement. Similar to the requirements for waste oil management, the spent coolant will require collection, storage and offsite disposal. This procedure will be documented in the same fashion as the waste oil. The tanks and other necessary infrastructure to implement this will be specified in the bidding documents.

### **Noise**

Engine generators produce a lot of noise and hearing protection must be worn in the engine room. The extent to which this noise can be a nuisance depends on the building construction and the proximity to landfill neighbors. Most buildings effectively limit noise to the outside except when the bay doors are open, which may be frequent when the operator is working in the engine room and wants to increase ventilation. Requirements for construction of an engine house that limits noise will be included in the bidding documents. In addition, the proposed location of the power plant for this project is far from any neighbors and is not anticipated to be a problem. Any complaints will be noted for monitoring and evaluation purposes.

### **Construction-related effects**

During construction waste will be produced from the water used at the construction facilities and from the scrap construction materials. Construction activities will also increase noise and vehicular emissions at the site and cause the suspension of particulates. The bidding documents will specify that proper waste management practices be used during construction. In addition, construction practices that minimize noise and pollution will be required.

### **Fire Hazard**

LFG will be delivered to the engines under pressure. As such, leaks in the piping, fittings, and valves could result in a the release of the flammable gas. To reduce the risk of explosion, compressors will be located outdoors and methane detectors linked to a fire suppression and alarm system will be installed near the indoor equipment. Any leaks will be addressed and documented for monitoring and evaluation purposes. This will be a requirement specified in the bidding documents.

### **Methane Migration**

As noted above, the project will reduce the potential for offsite subsurface methane migration. However, the landfill currently lacks a system of perimeter methane monitoring wells. As part of this project, monitoring wells will be installed between the landfill limits and the facility property boundary. These wells will document both the effectiveness of the landfill liner systems and the proposed LFG collection system. Monitoring and record keeping should be performed on a quarterly basis as is typical in the United States and Canada. The costs of implementation will be covered by the Project Management component.

### **Occupational Health and Safety Issues**

The criteria for selection of the Strategic Partner who will be responsible for construction, operation and training activities will include an evaluation of the companies environmental and safety record. Within the contractual agreements of the Cogeneration Company and the bidding documents, occupational and safety practices based on internationally-recognized standards will be specified. Accident and medical records will be documented for monitoring and evaluation purposes.

### **Annual Environmental Summary**

The environmental performance of the plant will be tracked during the project and summarized in annual reports that include the following indicators: i) methane captured; ii) methane used for electricity; iii) methane flared; iv) results of any engine emissions tests; v) engine maintenance records as compared to manufacturers suggestions; vi) engine waste oil and coolant handling records; vii) complaints from

neighbors by type (noise, emissions, other); vii) methane leaks detected on methane conveyance system near or in engine house; and ix) underground methane concentrations on perimeter of landfill. This report will be produced annually after plant is operational.

**Additional  
Annex 12**

**Financial Analysis from Perspective of Strategic Partner**

Through an international competitive bidding process, SIMEPRODESO will select a private sector Strategic Partner who will provide technical capacity and will invest in the project. To insure the project will be able to attract private sector investment, a financial analysis was performed from the perspective of the private sector partner.

The project team contacted several of the prospective bidding companies to ask their opinion on the institutional structure of the Salinas Victoria project, typical financing arrangements, typical rates of return and the critical risks. In addition, the project team consulted financial experts at the Bank and in Mexico, energy experts at the Bank and LFG industry experts in the US.

Institutional Arrangements: Prospective bidders and industry experts did not anticipate any problems with the proposed Cogeneration Company institutional setup (as described in the Institutional section of the Summary Analysis).

Typical financing arrangements: It is common for projects such as this to be financed with a combination of debt and equity. Common financing setups for LFG projects involve between 25 and 40% equity with the remainder as debt. Some projects have been financed entirely by equity and therefore this needs to be considered as a possibility.

Typical rates of return

The industry generally expects 20-25% return on their investment over 10 years.

Profit sharing arrangement

The fact that SIMEPRODESOS equity contribution will come from the GEF grant, provides a means of increasing the Strategic Partner's rate of return to higher levels than would be expected otherwise. This will be done by providing the Strategic Partner a disproportionate amount of profits (approximately 80-100%) in the first five years.

Financial rate of return for private investor

Using the typical financing arrangements explained above and accounting for debt service, the rate of return on the Strategic Partner's equity investment was calculated. The conditions of the loan were based on what would be expected from a US bank for a project in Mexico (13% over 5 years).

**Return on Strategic Partner's Investment Under Different Financing Arrangements**

% Equity Financing	Return on Equity Investment over 10 years*
25%	31-48%
40%	25-37%
100%	17-23%

\*Range expected depending on profit sharing setup. It is expected that between 80-100% of the profits will go to the strategic partner in first five years of project with profits shared in proportion to initial capital contributions thereafter.

The analysis summarized in the above table shows that, under typical financing conditions, the project is well above the industry expectations of 20-25% return over 10 years. Where debt financing is not used (100% equity) the rate of return can be met with the strategic partner receiving a higher share of the profits than under the debt financing setup.



It should be noted that the rates of return shown above are the range of returns that can occur under the possible profit sharing and financing arrangements in the project. They show that, under the proposed company structure, it is possible for the Strategic Partner to receive adequate returns. The actual profit sharing and financing arrangements (as well as other factors such as investment costs) will be determined by the Strategic Partner in the bidding process. For bidding, the private sector company will be required to maximize SIMEPRODESO's benefits. They will thus pick a profit sharing and financing arrangement on the basis of the minimum return they would need to participate in the project. This will provide an efficient way to establish a company financial structure that will both attract private investment and maximize the benefits of the project to SIMEPRODESO's landfill operation.

### Risks

Based on conversations with prospective bidders, Bank energy, financial and legal experts and a financing consultant in Mexico, the risks to the private sector strategic partner were determined to be: (i) the stability of the high tariff charged by CFE to the Municipality of Monterrey for street lighting; and (ii) the risk of non-payment by the electricity consumers. In order to mitigate these risks (described below), measures have been developed and are being reviewed by Bank financial and legal experts. These experts will review and clear the draft contracts of the Cogeneration Company (including the risk mitigation measures) before board presentation.

#### *Stability of Tariff for Street Lighting:*

The proposed tariff to be charged to the electricity consumers is based on a discount on the current costs of electricity charged by CFE. The future sustainability of the CFE tariff schedule is thus an important risk to project profitability and financing. Trends in the tariff have shown a constant increase in the tariff with no indication by CFE that it will be reduced. The threat of a change in the tariff schedule is not a due to government proposals or statements but rather arises from the fact that the tariff schedule is antiquated and thus may become a target for reform in the future. This risk will be mitigated by providing the Strategic Partner the option of receiving a disproportionate amount of profits in the first 5 years of the project, thus allowing their investment to be paid off quickly (estimated to occur within 4-5 years). As it is less likely tariff reform will occur in this time, the risk will be reduced significantly. As an additional measure, a tariff structure that includes a minimum payment that would allow the investment costs to be recuperated if the CFE tariff changes and the Cogeneration Company is forced to sell to the CFE grid also is being considered. These and other potential risk mitigation measures are being reviewed by Bank financial and legal experts who will also provide clearance of the associated contracts before board presentation (see Section G., Main Grant Conditions).

#### *Non-payment by Electricity Consumers:*

The risk of non-payment by electricity consumers is also an important potential barrier to financing. In the case of the Municipality of Monterrey, which will use the most electricity and will pay the highest tariff, their rating was found to be AA (Standard and Poors) and AA- (Moody's). The ratings of the other electricity consumers will be evaluated during the preparation of the bidding documents that will be finalized before board presentation. A "take or pay" payment structure will be also be used as an added safeguard. Additionally, several risk mitigation measures are being considered by Bank financial and legal experts reviewing the contracts. The review of the contracts will be completed for inclusion in the finalized bidding documents (a condition of Board presentation, see section G. Main Grant Conditions).

## **Additional Annex 13**

### **Description of the Mexican Electric Power Sector**

#### **Overview**

The economic growth of the Mexican economy during the last decade resulted in a 5.2% average annual growth in electricity demand over the same time period. Total installed capacity in Mexico in 1999 was 35,000 MW and future demand is expected to grow 5.8% per year until 2010. This growth will require 27,000 MW of additional generating capacity at a cost of close to four billion dollars per year. Access to electricity in the country is high, 95% of the Mexicans have electric service.

#### **Demand of Power in the Monterrey Area**

The State of Nuevo León is served by CFE as part of the North-eastern Zone, and includes the municipalities of Monterrey, García, Santa Catarina, San Nicolás de la Garza, General Escobedo, Apodaca and Guadalupe. These municipalities combined have a population of approximately 4 million people. Total demand of the State of Nuevo León in 1999 was 2,285 MW, which was served with local power plants (1,145 MW) and power imported from the National Transmission System (1,149 MW).

The Municipality of Monterrey, a future partner in the Co-generation Company, has a demand of about 10.4 MW to power about 70,000 streetlights in the City of Monterrey. The average tariff paid to CFE for this energy is approximately 12.0 cents of US\$ per kWh. The demand of Servicios de Agua y Drenaje (the water utility) for pumping of potable water and sewerage is high, on the order 25 MW. The loads that could be serviced by the Co-generation Company amount to about 6.0 MW. The average tariff paid to CFE is 6.7 cents of US\$ per kWh (daytime tariffs). SIMEPRODESO will require about 1 MW for the operation of its Materials Recovery Facility when it is in full operation.

#### **Power Sector Regulations**

Article 27 of the Constitution of Mexico provides exclusive rights to the state for electric power generation, transmission and distribution for public service. Until 1992, the state owned Comisión Federal de Electricidad (CFE) and Compañía de Luz y Fuerza del Centro (CLFC) were the only players in the power sector. This situation changed in 1992 when the Ley del Servicio Público de Energía Eléctrica (the Electricity Law) was modified to allow participation of private investors in power generation. Since then, private parties can : i) generate power for self consumption, i.e., for co-generation or for small industries; ii) generate power as independent power producers for exclusive sale to CFE; iii) generate power for emergencies in the case of the failure of the public service system; and iv) import power for self consumption.

The Comisión Reguladora de Energía (CRE), created in 1995, is the entity that provides the required permits to private investors to install or import electric power. SIMEPRODESO will have to apply to CRE for a permit for the co-generation of electricity in its landfills.

#### **The Future of Mexico's Power Sector**

The tremendous investments required to support the growth in the power sector can no longer be financed by the state owned companies alone and therefore there is growing pressure to restructure and open the power sector to private investors. It is expected that, in addition to bringing to the power sector the required capital, restructuring the sector would promote efficiency and competition in the electric power market, which should benefit the users. The changes proposed by the outgoing administration, which Congress decided to postpone for future consideration, are focused on the vertical and horizontal unbundling of the existing companies (CFE and CLFC), and the subsequent formation of several generation and distribution companies and a national transmission company. A national power market, to which all qualified players would have access, would be created.

**Additional  
Annex 14**

**Background Information  
Solid Waste Management II Project (3752-ME)  
BANOBRAS  
SEDESOL**

**1. Solid Waste Management II Project (Loan 3752-ME) Background**

The project was originally approved by the Board in June 9, 1994. In December 1994, the Mexican economy suffered a recession, lasting over two years. At the time, high interest rates contributed to a downturn in economic activity and drastic cuts in the federal budget. Because of these fiscal difficulties and despite significant efforts to maintain the viability of the project, BANOBRAS (Banco Nacional de Obras y Servicios Públicos), the implementing agency, requested the cancellation of US\$193.06 out of the original loan of US\$200 million.

Despite the lack of resources, during the first two years of the "crisis", the implementing agencies carried out a significant share of the activities originally intended to be supported through the institutional and technical assistance components of the project. The capacity of the implementing agencies to appraise and supervise solid waste projects and provide technical assistance to the municipalities has been strengthened. Likewise, the regulatory framework has been improved by the enactment of the federal standard on disposal sites and the development of model regulations for the operation of municipal solid waste services.

The main objectives of the Solid Waste Management project II were to :

- Implement a pilot program of sustainable solid waste management at selected municipalities;
- Strengthen the capacity of BANOBRAS & SEDESOL (Secretaría de Desarrollo Social) to appraise and supervise solid waste projects and provide technical assistance to municipalities and states;
- Increase technical, administrative and regulatory capacity of agencies at the state and local level in order to improve sector management and operations; and,
- Improve the legal and regulatory framework and cost recovery mechanisms of the sector to safeguard the environment.

The project has achieved many of its objectives:

- Training on solid waste management was provided to 400 persons, along with technical assistance to more than 90 municipalities. The whole operation benefited a total of 190 municipalities;
- Editing, publication and distribution of 19 technical-administrative guides was carried out; and,
- Elaboration of 34 executive projects for landfills was supported, 28 in medium cities and 6 in small cities.

**2. BANOBRAS' role**

BANOBRAS is the government instrument for financing project investments in the sectors of infrastructure, public service and environment, including solid waste management projects. Its clients are as follows:

- The Federal Government, its organizations and private companies;
- The Government of the Federal District, State and Municipal Governments, as well as its organizations and state and municipal counterparts, and;
- The private sector, under special programs promoted by the governments or grant-based projects.

### **3. SEDESOL's role:**

According to the article 32, section XIV and XV of the Organic Law of the Federal Public Administration and the article 24, section I and II of the SEDESOL's Intern Regulation, SEDESOL has the following duties:

XIV. To promote and support financial mechanisms for social welfare, urban regional development, as well as for housing and environmental protection, with the participation of the corresponding Federal Public Administration entities, the State and Municipal governments, the credit institutions and the various social groups.

XV. To promote, in coordination with the state and municipal governments, and the private sector involvement, the construction of equipment and infrastructures for the regional and urban development, the social welfare and environmental protection and remediation.

#### SEDESOL's internal regulation

Art. 24 – The following items correspond to the Division of Infrastructure and Equipment (Dirección General de Infraestructura y Equipamiento) responsibilities:

I. To promote, in coordination with the Division for Urban Development and Housing Financing (Dirección General de Financiamiento para el Desarrollo Urbano y la Vivienda), investment programs and investment projects in infrastructure and equipment (solid waste management) that support the regional and urban development and the social welfare. This is accomplished with the participation of the state and municipal governments, and with private and social sector involvement.

II. To formulate studies and projects, as well to participate in the promotion of actions, construction, infrastructure services, and equipment (solid waste management ) that support the regional and urban development, and social welfare.

The Division of Municipal Solid Waste (Dirección de Residuos Sólidos Municipales), under the Division of Infrastructure and Equipment is in charge of solid waste management within SEDESOL.

SEDESOL, with the help of the lessons learned during the Solid Waste Management Pilot Project, acts as the national clearinghouse for information on solid waste management.

#### SEDESOL's strategy to improve the quality of the current solid waste management is:

- To extend the collection and disposal system by means of comprehensive projects;
- To increase investment funds base by reorienting fiscal resources, encouraging the participation of the private sector in the collection and disposal services of the solid wastes, broadening the credit lines, and increasing the investment returns through tariffs and quotas;
- To provide incentives for the adoption of alternative technologies that reduce cost and increase the

- efficiency of collection and disposal;
- To strengthen the legal framework for solid waste management focusing on the creation of decentralized operators, establishment of recovery quotas and provision of investment guarantees to the private sector;
- To create and strengthen operator organizations in solid waste management; and;
- To increase public participation on the solid waste system through education and environmental awareness.

#### **4. Lessons learned from previous Bank involvement**

The Bank's involvement in the sector to date has been through the Solid Waste Management Pilot project (In 2660-ME) and the ongoing Solid Waste Management II project. The main lessons learned are:

- The importance of developing integrated plans for municipal solid waste management to avoid piecemeal approaches to investments and ensure satisfactory environmental controls;
- The need to have full cost recovery to promote sustainability of investments and efficient service delivery;
- The elimination of conflicting sources of finance for solid waste management and the provision of adequate counterpart funding; and,
- Avoidance of complex multi-sectoral, multi-institutional projects.

Many of these lessons were integrated in the Solid Waste Management II Project design, with particular emphasis on an integrated solution to municipal solid waste management and the use of full cost recovery and sustainable collection mechanisms.

## Additional Annex 15

### Estimation of Landfill Gas Production and Electricity Generation

#### LFG Production

LFG production was estimated using a model developed by the USEPA referred to as "USEPA E-PLUS". The model is shown below:

$$Q_{T,X} = kR_x L_o e^{-k(T-X)}$$

$Q_{T,X}$  = flow of methane gas in year T for waste deposited in year X (m<sup>3</sup>/yr)

X= year waste was added to landfill

T= current year

$L_o$  = methane gas generation potential (m<sup>3</sup>/ton waste)

k= methane gas generation constant (1/yr)

$R_x$  = the total residue deposited in year X

#### Parameter Estimation

Among the most important parameters in this model are the methane gas generation constant (k) and the methane gas generation potential ( $L_o$ ).  $L_o$  was estimated using typical values from operating US LFG projects and adjusting for differences in the composition of the SIMEPRODESO waste. k was estimated by measuring the methane gas production on site and using the USEPA E-PLUS model equation to solve for k.

#### *The methane gas generation potential ( $L_o$ )*

Using flow data from operating U.S. LFG projects, a relationship between apparent values of  $L_o$  and annual precipitation was determined. Based on this relationship and the annual precipitation in Monterrey, an  $L_o$  of 134 m<sup>3</sup>/Mg was estimated.

This  $L_o$  was then adjusted to account for the higher food content and thus higher moisture content of Mexican waste relative to US waste (see Annex 16 for waste characteristics). This was done using the measured food waste content at the SIMEPRODESO landfill (38%) and typical food content and moisture content values of US waste (25% moisture content and 6.7% food content). It was also assumed that food waste has a moisture content of 70%. Given this data and assumption, the larger food waste content at the SIMEPRODESO landfill increases the waste moisture content from 25% to 46.6%. This increased moisture content reduces the  $L_o$  value from 134 m<sup>3</sup>/Mg (for the US-based estimate) to 95.4 m<sup>3</sup>/Mg (for the SIMEPRODESO waste).

#### *The methane gas generation constant (k)*

A pump test was conducted at a representative location in the closed 44 ha cell of the SIMEPRODESO landfill (see picture on following page) and the data were analyzed using the USEPA Method 2E in order to estimate k.

The approach was as follows:

- Landfill gas was extracted from a test well at a rate equal to the production of the LFG (i.e. the steady state flow rate) and the influence of the well extraction was measured by the change in pressure at monitoring probes installed at various distances from the extraction well. The radius of influence of the well and thus the area around the well from which gas could be extracted was then estimated from these measurements.
- Based on the landfill depth and the radius of influence, the volume of waste influenced (i.e. the volume contributing gas to the well) was then calculated.
- The corresponding waste mass ( $R_x$ ) is then determined by multiplying the volume of waste by the estimated waste density.
- As the rate of gas extraction equaled the rate of gas production, the measured steady state flow rate could be taken as the rate of LFG production. In order to determine the rate of methane production, this number was multiplied by 0.5 to account for the 50% methane content of LFG. This flow rate was then related to the waste mass, average age and  $L_0$  using the USEPA E-PLUS model equation in order to solve for  $k$ .

**Operator Performing the Pump Test at the SIMEPRODESO Landfill**



Based on the data from the SIMEPRODESO landfill, the radius of influence of the well was estimated to be 38 meters. The pump test also indicated the gas flows were unimpeded by any barriers such as the clay filling used in landfilling. The LFG generation constant was calculated using the USEPA E-PLUS equation (above) and the following parameters:

<b>Parameters used in USEPA Method 2E to estimate the LFG generation constant (k)</b>		
<b>Parameter</b>	<b>Value</b>	<b>Basis</b>
waste depth	22 meters	SIMEPRODESO data
radius of influence of well	38 meters	field pump test
steady state flow	1.736 m <sup>3</sup> /min	field pump test
average waste age	5 years	SIMEPRODESO data
waste density	0.71 Mg/m <sup>3</sup>	typical value for 'in place' waste
methane gas generation potential (Lo)	95.4 m <sup>3</sup> /Mg	estimated as described above

The LFG generation constant ( $k$ ) was found to be 0.0606/yr. This corresponded with a recommended value (0.066 /yr) that was developed based on previous studies and adapted to the Monterrey conditions. Since the variables of the pump test program can be interpreted in different ways, the test results were considered to be confirmation of the recommended  $k$  value (0.066/yr), which was used for the model estimation of the



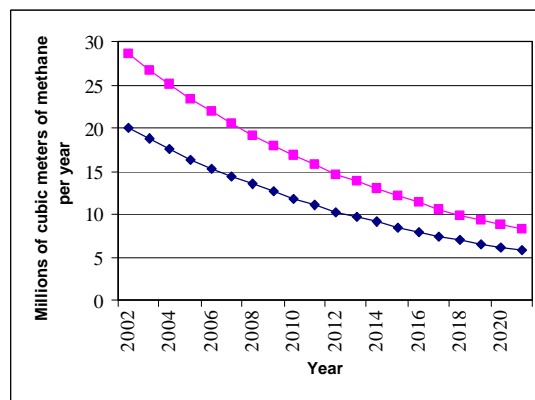
gas production. The rest of the parameters used in the LFG production model are shown in the following table.

<b>Input parameters for model used to estimate gas production at the SIMEPRODESO landfill.</b>		
Parameter	Value	Basis
Methane gas generation constant (k)	0.066/yr	Precipitation-based value increased to account for highly degradable food waste. The value was consistent with that found from a 'pump test' at the site (0.0606/yr). The pump test was able to estimate the methane production rate by determining the rate of methane extraction (by the pump) necessary to balance the rate of methane production (by the portion of the waste that methane was extracted from). (see detailed description above)
Waste methane gas generation potential (Lo)	95.4 m <sup>3</sup> CH <sub>4</sub> /Mg waste	Estimated based on value of US waste accounting for the differences in moisture content resulting from the higher waste food content in the SIMEPRODESO landfill. (see detailed description above)
Waste cell area	44 ha	SIMEPRODESO data.
Waste depth	22 meters	SIMEPRODESO data.
Waste density	0.71 Mg/m <sup>3</sup>	Typical value for 'in place' waste.
Waste age (year 2000)	5 years average	SIMEPRODESO fill history.
Concentration of methane in LFG	50%	Typical value confirmed by measurement at site (actual measurements ranged from 50-60%).

#### Model Results

The model was used to estimate the methane production over the project lifetime (top line in graph below). The amount of methane captured was determined assuming a 70% capture efficiency (bottom line in graph below).

**Estimated Methane Production (top line) and Capture (bottom line)  
Over the Lifetime of the Project**



The model predicted that, over the lifetime of the project, 313 million m<sup>3</sup> of methane will be produced by the landfill. Of that 214 million m<sup>3</sup> of methane, equivalent to 858,000 tC, will be captured by the LFG collection system.

## Electric Energy Production

Assuming an engine thermal conversion efficiency of 34% and that the engines are running at 85% capacity (i.e. 15% down time due to maintenance and repairs), the 44 ha closed cell at SIMEPRODESO will produce enough methane to generate 700 GWh of electrical energy over the lifetime of the project. This will require 3 x 2 MW + 1 x 1 MW (or equivalent) engines for a total installed capacity of 7 MW and an operating capacity of 6 MW (after accounting for down time). The yearly electricity production is summarized in the table below.

### Electric Energy Production from the SIMEPRODESO Landfill Gas

	Methane Production	Methane Capture	Thermal Energy	Electric Energy	Installed Capacity					Energy Generated				Annual equiv. capacity	
		70%	8,460 kcal / M3	Thermoelectric Conversion 34% 860 kcal / kWh	U1	U2	U3	U4	TOTAL	U1	U2	U3	U4		TOTAL
	mmM3	mmM3	Gcal	MWh	kW	kW	kW	kW	kW	MWh	MWh	MWh	MWh	MWh	Kw
año															
2001	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	14.3	10.0	84,537	33,421	2,000	2,000	2,000	1,000	7,000	14,892	14,892	14,892	7,446	26,061	5,950
2003	26.7	18.7	158,177	62,535	2,000	2,000	2,000	1,000	7,000	14,892	14,892	14,892	7,446	52,122	5,950
2004	25.0	17.5	148,109	58,555	2,000	2,000	2,000	1,000	7,000	14,892	14,892	14,892	7,446	52,122	5,950
2005	23.4	16.4	138,693	54,832	2,000	2,000	2,000	1,000	7,000	14,892	14,892	14,892	7,446	52,122	5,950
2006	21.9	15.3	129,810	51,320	2,000	2,000	2,000	1,000	7,000	14,090	14,892	14,892	7,446	51,320	5,858
2007	20.5	14.4	121,401	47,996	2,000	2,000	2,000	1,000	7,000	10,766	14,892	14,892	7,446	47,996	5,479
2008	19.2	13.4	113,702	44,952	2,000	2,000	2,000	1,000	7,000	7,722	14,892	14,892	7,446	44,952	5,132
2009	18.0	12.6	106,478	42,096	2,000	2,000	2,000	1,000	7,000	4,866	14,892	14,892	7,446	42,096	4,805
2010	16.8	11.8	99,608	39,380	2,000	2,000	2,000	1,000	7,000	2,150	14,892	14,892	7,446	39,380	4,495
2011	15.8	11.0	93,272	36,875	2,000	2,000	2,000	0	6,000	7,091	14,892	14,892	0	36,875	4,209
2012	14.5	10.2	86,047	34,018	2,000	2,000	2,000	0	6,000	4,234	14,892	14,892	0	34,018	3,883
2013	13.8	9.7	81,842	32,356	2,000	2,000	2,000	0	6,000	2,572	14,892	14,892	0	32,356	3,694
2014	12.9	9.0	76,453	30,226	2,000	2,000	2,000	0	6,000	442	14,892	14,892	0	30,226	3,450
2015	12.1	8.5	71,597	28,306	2,000	2,000	0	0	4,000	13,414	14,892	0	0	28,306	3,231
2016	11.3	7.9	67,096	26,526	2,000	2,000	0	0	4,000	11,634	14,892	0	0	26,526	3,028
2017	10.6	7.4	62,714	24,794	2,000	2,000	0	0	4,000	9,902	14,892	0	0	24,794	2,830
2018	9.9	6.9	58,687	23,202	2,000	2,000	0	0	4,000	8,310	14,892	0	0	23,202	2,649
2019	9.3	6.5	55,015	21,750	2,000	2,000	0	0	4,000	6,858	14,892	0	0	21,750	2,483
2020	8.7	6.1	51,462	20,346	2,000	2,000	0	0	4,000	5,454	14,892	0	0	20,346	2,323
2021	8.2	5.7	48,324	19,105	2,000	2,000	0	0	4,000	4,213	14,892	0	0	19,105	2,181

As is typical of LFG projects on closed landfill cells, the production of biogas will dissipate, necessitating either expansion to new gas sources (newly filled cells) or the sale of excess capacity. While SIMEPRODESO will expand to their landfill to new cells, gas collection from these newly filled cells is not within the framework of the proposed GEF project. Accordingly, the project analysis assumes the unused engines will be sold.

**Additional  
Annex 16**

**Description of SIMEPRODESO Landfill**

**General Description of Landfill Facilities**

The SIMEPRODESO landfill is located in north side of Salinas Victoria, Nuevo Leon in the district of Salinas Victoria. The landfill was established on a greenfield site with a total landfill area of 220 hectares. Since operation began in 1991, the landfill has been accepting mostly non-hazardous domestic and commercial waste as well as some non-hazardous hospital and industrial waste.

The landfill is fenced off with a security patrol. It has no scavengers and is not accessible. The landfill facility is well equipped. The infrastructure includes an administration building, a weigh station for incoming waste, a laboratory, a guard house at the entrance of the facility, a machine and truck maintenance area, a state of the art materials recovery facility, an incinerator (not in operation) and a building for sanitation and gasoline supply.

**Administration Building**



**Guard House at Entrance**



**Laboratory**



**Maintenance Area**



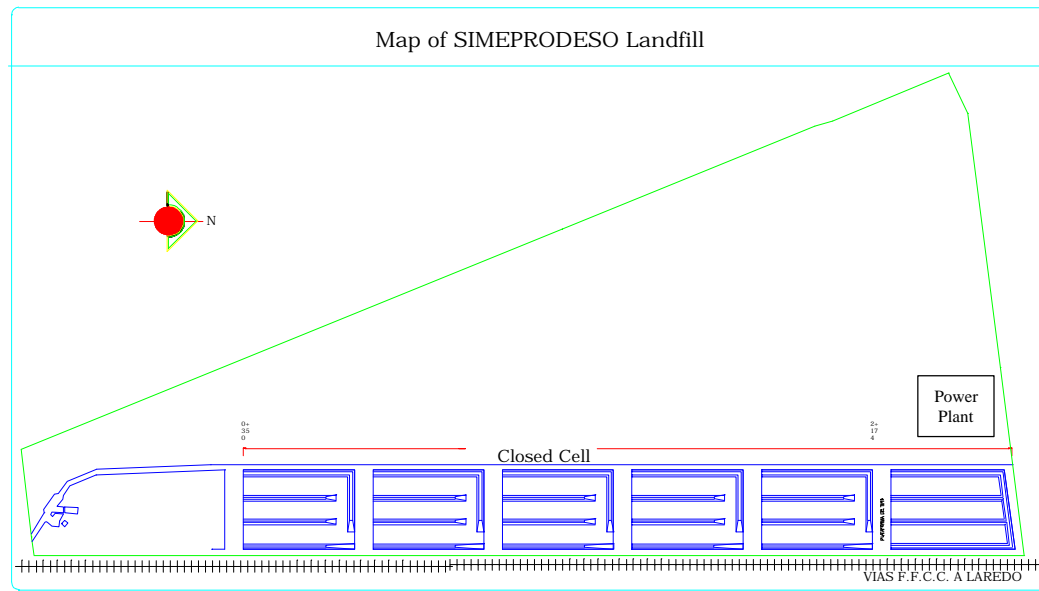
**Materials Recovery Facility**



**Fill History**

The 44 ha cell from which the biogas will be collected was filled with 7.7 million tons of waste between 1991 to 1999, at which time it was **filled** and capped with clay. The landfill continues to accept waste and is expanding to fill other cells in the 220 ha site.

**The SIMEPRODESO landfill showing the filled cell and future site of LFG power plant**



**Fill History for 44 ha Filled Cell to be Used for the Collection of Biogas**

<b>Year</b>	<b>Tons deposited</b>
1991	518,732
1992	732,000
1993	988,818
1994	812,000
1995	824,000
1996	850,000
1997	928,535
1998	912,587
1999	1,134,385
<b>Total</b>	<b>7,698,057</b>

**Waste Composition**

The composition of the waste at SIMEPRODESO is listed on the table on the following page. Relative to US landfills, the food waste content is higher and as a result the moisture content is higher. This difference in the waste food content were accounted for in the estimation of the amount of biogas produced by the cell (see Annex 15 for details).

<b>Type of Waste</b>	<b>Percent by weight (degradability)</b> SD=slowly degradable; MD=moderately degradable RD=rapidly degradable
Cardboard	2.4 (MD)
Coated cardboard	3.1 (MD)
Clothing	6.5 (SD)
Rubber	2.2 (SD)
Tin	2.3
Aluminum	0.85
China and ceramics	0.74
Wood	2.1 (MD)
Construction materials	2.9
Newspaper	3.1 (MD)
Toilet paper	3.6 (MD)
Office paper	3.1 (MD)
Plastic film	6.6 (SD)
Rigid plastic	3.4 (SD)
Polystyrene	1.1 (SD)
Food waste	38.4 (RD)
Garden waste	4.1 (RD)
Glass	4.3
Other	9.3
<b>Rapidly degradable</b>	42.5
<b>Moderately+rapidly degradable</b>	60.0
<b>Total degradable</b>	79.8
<b>Moisture content*</b>	46.6%
*Moisture content estimated as described in Annex 15	

**Additional  
Annex 17**

**Additional  
Annex 18**

